INSTITUTE OF EDUCATION
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TOWARDS THE UNDERSTANDING OF THE ALPHABETIC PRINCIPLE

CONCEPTUAL CHANGES AS CHILDREN LEARN TO IDENTIFY AND SPELL NOVEL WORDS

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ABSTRACT

Although a unifying view of literacy development is already implicit within several studies, much of the knowledge is still fragmented. Hence, practitioners lack a comprehensive theoretical framework within which to articulate their practice. This thesis contributes to this framework by investigating whether children's conceptions of the alphabetic system:

1) determine the quality of their orthographic representations and their ability to make inferences about graph-phonetic segments,
2) are affected by adults' explanations of how scripts represent speech and by the characteristics of the particular orthography that children are trying to learn.

Sixty two monolingual Brazilian children (mean age 6 years) and 28 bilingual Portuguese children attending two schools in London (mean age 6:7 years), participated in this study, which involved a brief intervention (20 daily sessions).

The findings suggested that children's full understanding of the alphabetic principle is not affected by orthographic transparency and that it is the result of a process involving two levels of conceptual change:

1) The characteristics of written words are not related to their meaning - letters represent sub-lexical phonological units. This allows children to detect phonological identity of the initial syllable and to produce syllabic spellings by collating letters that represent syllables. Explicit information about letter-sound correspondences is not essential for this understanding.
2) Adding up the sounds of letters does not produce a word - letters within words or syllables do not sound the same as in isolation. This discovery triggers the use of partial phonological recoding, the production of syllabic-alphabetic spellings, the use of analogies and the detection of phonological identity based on articulatory cues. Explicit information about the role of the letters within words may facilitate this understanding and enables the children to work out the grapheme-phoneme correspondence, which is the last step towards grasping the alphabetic principle.

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1. INTRODUCTION

In the study of literacy, passionate debate on writing and reading has fuelled research in cognitive and developmental psychology and in psycholinguistics. However, the polarisation of the arguments has made it difficult to integrate the findings from different approaches and to give a satisfactory explanation for divergent (but equally effective) classroom practices.

For practitioners, this polarisation means that they lack a comprehensive theoretical framework to articulate their practice. In the absence of such a framework, many of the dos and don'ts that typify classroom practices are rooted in personal beliefs or in ideological principles, rather than in scientific findings, even though "scientific evidence" is often claimed as justification.

Teachers must have the power, the knowledge and the resources to adapt their teaching to the needs of each child and of the community served by the school. "Having the knowledge" includes, but is not restricted to, being clear about the theoretical and epistemological underpinnings of the practices one is trying to implement. If these are not clear, research findings and even research tasks may be transposed to the classroom uncritically and it becomes very difficult to reach any conclusion about their effectiveness.

Opposing theoretical models of literacy often provide support for different and contradictory practices. Therefore, either a teacher opts for a model and, as a consequence, refuses to implement all the practices labelled as "wrong", according to this model, or s/he ignores the theoretical discussion and follows the practices that seem to be most effective, regardless of their theoretical consistency. Most teachers know that some apparently contradictory practices seem to be equally effective in the classroom, depending on the children and on the situation. When researchers cannot agree on why this happens, it is likely that the problem lies in the weakness of the scientific explanations rather than in the practices themselves.

Reviewing the literature, I felt that everybody was talking about different parts of the same whole, as in the poem of the blind men and the elephant. It was comforting, therefore, to discover that I was not alone, when I found the following passage by Samuels (1979):

> Having discussed a number of views regarding theories and practices in reading, I am reminded of John Godfrey Saxes's poem "The Blind Men and the Elephant." Curious about the appearance of an elephant, the six blind men decided to study the elephant by direct examination. The first touched the elephant's sturdy side and likened it to a wall. The second felt the tusk and thought the elephant resembled a spear. The third touched the squirming trunk and though the elephant was much like a snake, while the fourth touched the elephant's knee and though the elephant was like a tree. The fifth chanced to touch the ear, and to him, the elephant was like a fan; and the sixth, having touched the tail, thought the elephant was like a snake. Saxe concluded his poem with this thought:
>
> And so these of Indostan
> Disputed loud and long,
> Each in his own opinion
> Exceeding still and strong,
> Though each was partly in the night,
> And all were in the wrong!
> The Morale:
> So oft in theologic wars
> The disputants, I ween,
> Rail on in utter ignorance
> Of what each other mean,
> And prate about an elephant
> Not one of them has seen!
>
> Perhaps we who study the reading process are like the blind men. Our views of the process, colored by the discipline orientations within which we work and by the procedures we use to study the process, give each of us but a limited perspective of the process, and so all our views of reading process are partly in the right and all are in the wrong (p. 367).

Although this text was published in 1979, much of the knowledge that is available in the nineties is still fragmented and findings produced by some research groups are often ignored by researchers from other groups.

The issue is not one of reconciling different, and sometimes even antagonistic, theoretical approaches. The co-existence of different theories and points of view is essential to the development of scientific knowledge. However, it is always important to examine whether the contradiction is rooted in epistemological or theoretical differences. If it is theoretical, it is likely that the different theories can be modified and merged to accommodate the contradictory evidence. When the contradiction is epistemological, the chances are that a resolution will only achieved by constructing a new theory, epistemologically situated halfway between the others.

In literacy, different approaches to written language (either code or whole language) have generated antagonistic theoretical models (bottom-up and top-down, respectively) which are irreconcilable because they are rooted in opposing epistemological presuppositions (see Cunningham & Fitzgerald, 1996, for a discussion on epistemology and reading). The pivotal points of disagreement are the assumptions about the origin and location of meaning in written language, the contribution of sensory data and mental information to the production or retrieval of meaning and whether the meaning is discovered or created.

For example, at one extreme, the whole-language approach considers that both the text and the reader (or writer) are part of a social system (written language) in which the meaning is produced. The retrieval of meaning is essentially a mental process. Meaning, being a social object, is both discovered and created by the subject. At the opposite extreme, code approaches avoid dealing with questions about meaning; writing is just a code to transcribe speech. Meaning is a property of speech, not a property of scripts. Therefore both the production and the retrieval of meaning are carried out in a language module somewhere within the brain. Text and subject are clearly separate in the literacy process and the role of the subject is just to retrieve the graphic signs and transform them into speech. So, clearly, meaning is discovered rather than created.

As research findings show, both models were simultaneously right and wrong. This means that the findings which each could offer a satisfactory account for were precisely those the other failed to account for. To solve this contradiction, new theoretical models (dual route and interactive models) were created.

Dual-route models try to solve the problem without solving the epistemological contradiction. They maintain the dualism of code approaches by separating the text and the subject (reader and writer). However, they concede that, although being mostly in the text, the meaning is sometimes created by the reader. They suggest that the retrieval of meaning in reading and the production of meaning in writing is first a contribution of sense data (or lower mental processes), but they concede that in skilled reading the higher mental processes take over. Consequently, meaning is discovered rather than created, although sometimes meaning may be created when the reader adopts a guessing strategy. Therefore dual-route models oscillate between opposite assumptions without proposing any sound solution to integrate them. In spite of being very popular among researchers as they account for contradictory findings these models are epistemologically inconsistent.

Interactive models are rooted in epistemological positions halfway between the extremes defended by the approaches just discussed. Contrary to dual-route models, they include a device which solves the epistemological contradictions by allowing the interaction between the subject and the object. This device is called the message centre. It is the place where meaning is produced by the interaction between the graphic features provided by the text and the subject's previous knowledge. Therefore, the subject and the text are still separate but the knowledge (meaning, in this case) is produced when they interact. Both the sense data and mental activity make important contributions to this interactive process. Consequently, meaning is both discovered and created. Because they do not take up extreme positions, interactive models (and their connectionist successors) have been used to support and test new theories that are more comprehensive.

Although a unifying view of literacy development has not yet been brought to light, we consider that it is already implicit within several studies.

The intention of this thesis is to contribute to this view, by focusing on the following pivotal issues:

- the developmental process of becoming literate
- the mental processing of written information
- the role of the interaction between beginners and experts

In the literature review, we start by presenting a historical overview, where the main divergences in literacy research and teaching approaches are summarised. Then some selected findings and theoretical proposals are considered; obviously, it is impossible to mention all of them, so those included here are considered of greater significance for a broad view of literacy development. A special emphasis is given to the work of Linnea Ehri and Emilia Ferreiro and their colleagues (see references in the literature review).

Ehri's work is chosen because she proposes a theory that accounts for the gradual construction of the mental representations of written words, bridging the gap between developmental theories and interactive models of skilled literacy. Reconciling developmental and skilled models of literacy was a problem that had eluded solution for a long time.

The main difference between the interactive approaches (including Ehri's theory) and Ferreiro's proposal concerns the nature of the object of study.

Ferreiro claims (based on Piaget's Genetic Epistemology) that knowledge is a system of interpretation. Thus, for the child, the writing system is an object of thought.

When studying literacy development, she focuses on the construction of the conceptual object by the child. The conceptual object is continuously modified, after being tested for its internal coherence and for its correspondence to particular pieces of writing. Therefore, both sense data and mental activity contribute to the construction of this conceptual object, but particular emphasis is given to mental activity.

In the interactive models, the focus is on the process of reconstructing the meaning through the appropriation of the object (script) by the subject. Knowledge is a mental representation of the input, produced by the interaction between the subject and the "real" physical object (pieces of script, in this case). According to Ehri, the appropriation of the object is achieved by coupling the orthographic images of specific words or word segments with the mental representations of word pronunciations or sounds and then associating them to their meaning. The interactive model elucidates the "mechanics" involved in this process.

Being able to understand children's hypotheses about the construction of the conceptual object provides the teacher with a valuable tool to help children to overcome their difficulties. For instance, in Brazil, the findings of Ferreiro and her colleagues have provided the basis for changing the teaching of literacy all over the country.

However, children's hypotheses are not directly accessible. They are only known through the interpretation of children's productions, such as orthographic representations of words and sentences and children's inferences about written materials. Thus, it is necessary to know whether and how the system of interpretation that the child is constructing (the conceptual object) guides and/or is affected by the processes involved in the construction and in the interpretation of specific materials (scripts).

For teachers, it is not enough to identify children's hypotheses. They need to know whether children's productions actually reflect their understanding about the writing system and how to help children to go beyond less sophisticated hypotheses. Hence, knowing the cognitive processes involved in the construction of mental representations of words is fundamental to planning classroom activities.

The problem is how to integrate these two kinds of information in a coherent theoretical framework, broad enough to articulate different teaching practices and to solve the epistemological contradictions (such as the different conceptions about the object of knowledge).

Therefore, we still need to construct a theory comprehensive enough to give a satisfactory account of the relationship between comprehension, perception and memory. In this case, the relationship is between children's hypotheses and the cognitive processes involved in the construction of mental representations. To construct this theory, more evidence about this relationship is needed.

This study aims to provide some of this evidence. The changes that occur as children go through the process of understanding the alphabetic principle are analysed. A special emphasis is given to considering whether, during this process, the production of orthographic representations of words, as well as the ability to make inferences about graph-phonetic segments could be considered to reflect children's hypotheses about how scripts represent spoken words. Aspects of this process that are affected by the adult's explanations of how scripts represent spoken words, as well as those related to the specific characteristics of the orthography that children are trying to learn, will also be investigated.

2. LITERATURE REVIEW

2.1 Historical Overview

During the first half of this century, the teaching of writing and reading was dominated by the maturationist approach, inspired by the work of A. Gesell. According to this approach, teaching should wait until children showed they were ready to learn. Batteries of tests were created to guarantee an objective evaluation of children's readiness. It was assumed that readiness would come naturally and any attempt to hasten reading and writing acquisition would harm children's natural development.

Once children were considered ready to learn, the teaching of reading and writing followed one of two main approaches, according to the definition of reading. The traditional approach reduced reading to decoding and writing to encoding sounds, so a good reader was supposed to be able to read aloud fluently; reading comprehension was not assessed because it was not supposed to be a distinct skill, different from fluency. The other approach, known as whole-word, considered reading as getting meaning from print, or in other words, making sense of written materials. This approach became popular in the U.S.A., after the First World War, when the US army realised that many soldiers weren't able to use written language functionally, in spite of being seemingly fluent readers. Its popularity resulted in the dissemination of whole-word methods of reading instruction from the 1930s onwards. The basic teaching materials advocated by these methods were reading schemes (basal readers), carefully organised according to word frequency and visual dissimilarity between the words, to make them easier to identify by using visual cues. The quality of the "texts" produced following these constraints was very poor and did not help to foster reading comprehension.

In the fifties and sixties, when compulsory primary education for all children was introduced in most western countries, schools were forced to include children from very different economic and cultural backgrounds. The low achievement of many children made clear that some educational systems were not prepared to cope with the problems of children from disadvantaged backgrounds and these children were being failed. As a result, the maturationist approach was severely criticised and was replaced by the technicist approach, inspired by behaviourist psychologists such as B. F. Skinner. According to this approach, children need to reach a level of readiness to learn to read and to write, but readiness was not just a matter of maturation: it could and should be accelerated by scientifically based school programmes. A considerable amount of research was carried out on the sensory skills involved in reading and writing activities. The functioning of the eye and visual perception, the functioning of the ear and auditory perception and the abilities involved in motor co-ordination became the focus of many research studies.

These studies had great impact on the design of the reading readiness materials used in pre-school programmes. Many schemes were published and bought by schools and parents in order to make sure that children were prepared to carry out literacy activities. These materials focused on visual and auditory discrimination, perception and motor co-ordination. Children were taught to recognise and to trace letters as part of the perceptual and motor training activities, but they were not encouraged to write and to read. Real books (such as storybooks, as opposed to exercise books or basal readers) were not considered important and it was thought that any attempt to spell without having learnt the conventional form would jeopardise subsequent spelling acquisition, by consolidating the errors.

In spite of its impact on instructional practices (especially in the United States), the technicist approach was not unrivalled. Instructional theories based on "learning by discovery" and "problem-solving" (Bruner, 1966, 1968; Bruner, Olver, & Greenfield, 1966; Gagné & Brown, 1961; Gagné & Smith, 1962) became as popular as programmed instruction, especially among those teachers who preferred more creative practices. In the late sixties, the widespread demand for freedom made it difficult to accept the prescriptiveness that the technicist approach had brought into education. Questions about the power and the role of educational systems in perpetuating social differences were raised mainly by Marxist sociologists and philosophers, in France (Althusser, Bourdieu and Passeron), and by Paulo Freire, in Brazil, whereas in the United States non-directive child-centred approaches were defended by Rogers.

This lively discussion about educational practices was backed by research findings in psychology. Behaviourism was being bombarded by the evidence from Gestalt theory (mainly in the study of perception) and the constructivism of Piaget in child development. Noam Chomsky's 1959 critique of Skinner's theory of language provided some of the strongest arguments against stimulus-response models and influenced the study of language development.

The work of Soviet Psychologists (Vygotsky, Luria and Leontiev) had started appearing in English and this influenced new research on the relation between language and thought, such as that carried out by Bruner and colleagues in the Center for Cognitive Studies at Harvard. Researchers focused on the observation of young children in order to understand the mental processes involved in language acquisition, as well as the role of language on mediating the construction of symbolic representations on problem solving. The interest in the role of language as a mediating process in learning and concept formation (inspired by the work of Vygotsky and his colleagues) was extended to the study of reading and writing.

In the seventies, the exclusive focus on whole-word instruction, in some classrooms, had produced a worrying number of children who were unable to spell or to read low frequency words and were no better comprehenders than their counterparts taught by traditional approaches. Arguments in support of a return to phonics instruction (a code emphasis approach) were supported by findings of the importance of linguistic awareness on reading (Liberman, Shankweiler, Fischer, & Carter, 1974; Mattingly, 1972; Rozin, Bressman, & Taft, 1974), based on a conception of written language as a mere transcription of speech. These claims were challenged vigorously by the supporters of meaning-based instructional programmes, who defended the use of real books and other real-life written materials to encourage children to experience literacy as a whole language, which could be acquired as naturally as spoken language (Goodman, 1970; Goodman & Goodman, 1979; Smith, 1971, 1973, 1979).

Written language was seen either as a simple code designed to transcribe speech, or as a communication tool, similar to but independent from spoken language. These different concepts about the nature of written language gave rise to different models of skilled reading and writing and, consequently, different theories of reading/writing acquisition, which had a great impact on classroom approaches to the teaching of literacy.

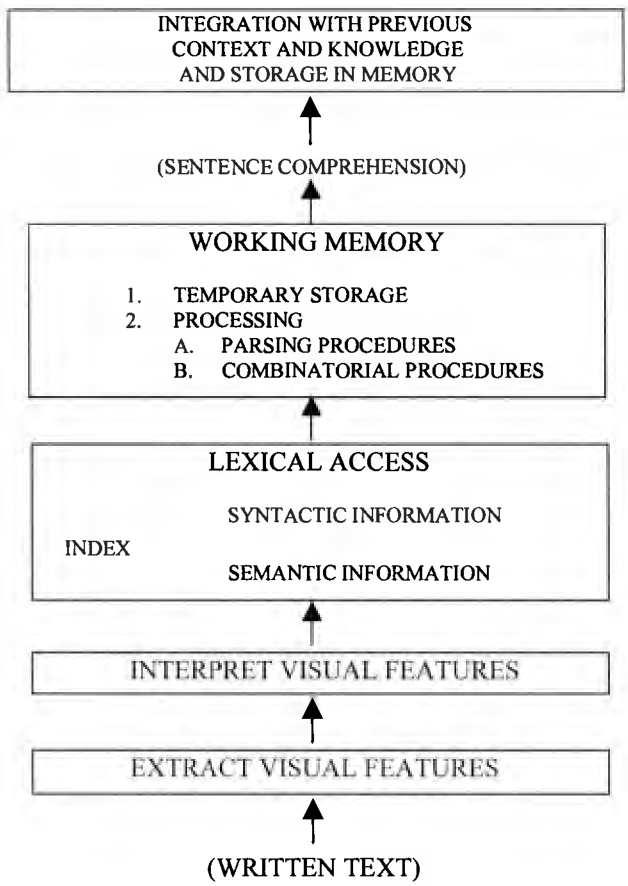
2.2 *Information-Processing Models of Reading*

Some theories assume that reading is a holistic process, which cannot be reproduced by assembling its components. However, the dominant approach in reading research has assumed that mental abilities are divisible into component processes. Most of these adopt an information-processing approach (Smith & Kleiman, 1979):

> An information-processing analysis entails more than dividing a mental ability into component parts. This kind of analysis starts by likening mental processing to a computational system and then endeavours to spell out the exact sequence of computational mechanisms involved in executing a complex ability. It asks not only what components are involved but also how they are sequenced and integrated so as to produce the output (reading) of interest. This approach, therefore differs in a fundamental way from the use of factor analytic techniques to divide a mental ability into component processes. Factor-analytic techniques do not tell us how the component parts are sequenced and integrated; information-processing analysis attempts to do so. (p. 68)

There are different information-processing models of skilled reading but all of them include at least the component levels shown in Figure 2.2-1.

Figure 2.2–1 An information-processing model of skilled reading (in Smith & Kleiman, 1979)



The different levels are connected in such way that the output of one level provides the input of the next.

The first level in the model (from bottom to top) concerns the description of the input. This involves the extraction of different features and the structural relationship between these features, but it is not still very clear what their nature is.

The next level concerns the interpretation of the features extracted from the text. This is related to the way the words are stored in the lexicon. Are these features interpreted as letters, as letter strings, as words? Another controversial question is whether the interpretation, as well as the extraction, of visual features is affected by the feedback from higher (syntactical and semantic) processes involved in sentence comprehension.

The next level of Smith and Kleiman's model is the lexical access, or the retrieval of the information stored in the lexicon:

> The lexicon is like an internal dictionary that stores information about individual words and other units of meaning. (...) We divide each lexical entry in two parts, the lexical index and the lexical information. (...) The index leads to the lexical information, which consists of both syntactic and semantic information.(p. 71)

The lexical level is one of the most controversial. While there is considerable agreement about the output of this level being the meaning of words, it is not clear how access to the meaning is organised, that is, about the nature and organisation of lexical indexes. Are the words organised by individual letters, as in a dictionary? Are they organised like a syllabary, by morphemic units, or are only the full spellings represented? Alternatively, should we consider the existence of many layers, each one with a different type of representation? All these questions concern the visual/orthographic representation of the lexical indexes, but the main question is whether these orthographic representations are coded into speech before the meaning is accessed. This question is important for the study of literacy development, as it has implications for the whole debate about phonological awareness mentioned above. We will return to this question later.

After the semantic and syntactic information about each individual word is retrieved from the lexicon, it is stored temporarily in the next level, the short-term memory. Here, the information about different words is integrated through semantic and syntactic processing, which produces the comprehension of the sentence.

Finally, the information from each sentence is integrated with previous information from the text, other pragmatic information and the reader's previous knowledge and then stored in the memory.

This is just a brief summary of the essential components of information-processing models. There are still several questions that remain unanswered, concerning not only the processing of information within each level of the model, but also how information flows between levels and what is the nature of this information. Different types of information-processing models have been created according to the answers they suggest to these questions.

As has already been suggested, information-processing models are not just sketches to illustrate reading theories. They require real machines to test their fitness and allow their reformulation. It is because they are directly testable that they are so appealing for scientific purposes. However, the components and processes that cannot be translated into a machine programme are not appropriately included in the model. This is one of the reasons why information-processing models have been widely used to explain the processes involved in word recognition but less so concerning text comprehension. It is unlikely that they can fully account for the complexity of the constructive process of literacy, especially concerning text comprehension. Readers' ability to make inferences based on their previous experiences and to integrate knowledge from different sources (sometimes not seemingly related to the text they are reading) is (so far) impossible to reproduce, even by using the most sophisticated computer networks (Smith, 1979). Besides, there is always the danger of going further and further in trying to construct such a sophisticated and testable computational model that one loses track of the theories it was meant to test.

However, there is another reason why such models are mostly limited to word recognition, and this is an epistemological and theoretical reason. As mentioned before, information-processing models assume an atomistic approach to reading, that is, that reading is a complex cognitive process which can be fully understood if analysed into its simplest components (and the connections between them). This approach is supported by researchers who consider written language as a mere transcription of spoken language, but not by researchers who consider it as a distinct language, different and independent from spoken language. Considering written language as a code means that, as soon as written words are translated into speech, the language processes involved in speech take over. Hence, text comprehension is not a problem restricted to the study of literacy; it is a problem that belongs to the study of language. Therefore, research on reading and writing is reduced to research on word recognition and spelling.

Another problem of these models is that they aim to represent what goes on inside the brain of skilled readers when they read words or texts. They cannot explain how a beginner becomes a skilled reader. For instance, they discuss whether a word is represented phonologically or orthographically in the lexicon, but they do not explain how the representations of the words were constructed, in first place. This is mainly because if written language is a code, orthographic representations are not constructed. They are simply associated with speech through phonological recoding.

Therefore, when literacy development and/or instruction are the focus of concern, information-processing models have not been of great help. Theories and models of reading/writing acquisition have been produced as an independent field of research.

However, it cannot be denied that developmental theories and models reflect different conceptions of the nature of reading and, consequently, different models of skilled reading (not necessarily information-processing models). So, it is quite deplorable that the contribution of developmental theories have been broadly ignored when the discussion of reading models is concerned, making them more useful for robotics and artificial intelligence than the prevention of children's problems. Fortunately, other researchers have been trying to integrate the contributions of both fields into a broader and more comprehensive theory, as we will see further on.

2.3 The Written Language as a Code

Studies in linguistics, based on Saussure's work, had considered written language as a simple reflection of spoken language, not worthy to be considered as an independent object of study. Written language was seen just as a code for mapping sounds onto letters. For many years, psychologists didn't object to this approach, believing that written language did not involve any significant cognitive process other than those involved in oral language.

The assumption that written language is *parasitic* on spoken language (Liberman & Shankweiler, 1979), implies a view that "reading involves interpretation of symbols that stand as surrogates for speech segments" (p.115). This involves the notion that spoken language is represented in phonological form (at least temporarily, in short-term memory) which makes it possible to use letters to map the phonological segments. Supporting this notion, Shankweiler & Liberman (1976) found that good readers were more likely to use phonological strategies than poor readers to recall words presented both orally and aurally. Moreover, as mentioned above, the ability to analyse speech into the phonological units represented by letters in print (phonemic segmentation) proved to be a significant predictor of reading acquisition (Liberman, Shankweiler, Liberman, Fowler, & Fischer, 1977).

The model of skilled word recognition implied in this conception (the theory of phonological mediation) presupposes the existence of phonological representation mediating the access to the mental lexicon (Van Orden, 1991):

Visual stimulus→orthographic representation→phonological representation→lexical representation (printed word)

This theory also presupposes that reading is a bottom-up process: letter and word recognition preceding and being necessary to comprehension of meaning (Gough, 1972):

Word recognition → syntactic processing → semantic interpretation

The main problem with this kind of bottom-up models is its linearity: the initial analysis and encoding of the sensorial information (perception) is not affected by higher level (cognitive) processes, such as pronounceability, syntactic features and meaning. Thus, perception is isolated from cognition. "Gough made no pretence of understanding the semantic memory and comprehension requirements of skilled reading: the model's semantic interpreter was labelled *"Merlin"* and its depository the "PWSGWTAU" - or the *Place Where Sentences Go When They Are Understood*!" (Lovett, 1981, p. 3).. Therefore, this kind of model is not adequate to account for the evidence that higher levels can affect the output of lower levels. For example, the syntactic and semantic information about a word can affect the interpretation of individual letters; the meaning of a sentence can affect the meaning of a word; the context of a text can affect the interpretation of words and sentences etc (see Rumelhart, 1994 for an account of this evidence). It is assumed that speech is represented in phonological form and children have to be taught to map the graphemes to these phonological representations, according to the rules of the specific orthography they are learning, through a process of phonological recoding (phonemic analysis and blending). Therefore, orthographic representations, as well as literacy, are assumed not to be constructed.

2.4 Literacy as a Language

Reacting to the mechanistic reductionism of code emphasis approaches and their linear models, other researchers (Goodman, 1970; Goodman & Goodman, 1979; Smith, 1971; 1973, 1979) claimed that written language is not parasitic on spoken language. It is a language itself, created to allow communication beyond the constraints of time and space. Written language has the same functions of communicating, of understanding and being understood as oral language. So, reading is, above all, getting meaning from scripts, as listening is getting meaning from speech.

2.4.1. Emergent literacy research

The kick-start of developmental research from this perspective was the investigation of children's conceptions about writing and reading in light of language acquisition research, which took place in the late sixties. Reacting against the conception of reading readiness, researchers started to focus on the prehistory of written language, as expressed by Vygotsky (1978):

> The first task of scientific investigation is to reveal this prehistory of children's written language, to show what leads children to writing, through what important points this prehistorical development passes, and in what relationship it stands to school learning. (The Prehistory of Written Language, p. 107).

Reid (1966) carried out a longitudinal study in which she used structured interviews to access children's concepts about reading and writing. The author was especially interested in observing how "a group of 5-year-old children came to the task of learning to read and to write, and how these notions (about reading) developed in the course of their first year in school (..) in concentrating on the language children used to talk about the process and about their experience as learners" (p. 56). In this study, Reid's perspective was still influenced by the ideas of reading readiness; she stressed what children didn't know, or didn't understand, according to an adult conception of writing and reading. For her, the difficulty in understanding what reading and writing are about, could prevent children from succeeding in learning to read and to write.

Instead of stressing what children didn't know, other researchers, such as Clay, (1966, 1967); Goodman (1970) and Goodman & Goodman (1979) emphasised children's achievements as constructors of written language. They inaugurated a new perspective of research focused on the investigation of how young children's concepts about written language evolved as they became literate. This perspective is generally known as "emergent literacy" (Teale & Sulzby, 1986). (The term literacy here refers to both writing and reading activities. We will use this term with the same meaning). Emergent literacy researchers use naturalistic observation, as well as structured interviews and case studies (including longitudinal ones). Inspired by the contributions of Piaget and Vygotsky, they provided detailed descriptions of the development of the trajectory of children's understanding as well as how this trajectory is affected by the interaction with adults and older children in a wide variety of socio-cultural and economic contexts. Their findings had a great impact on education, urging schools to create literacy environments, with books and a wide variety of print materials accessible for children of different levels and encouraging teachers and parents to read with the children and to stimulate literacy activities at home. Children's creations, especially invented spelling, were also encouraged and the use of mechanical and meaningless activities was discouraged.

The emergent literacy perspective refers to research on the development of young children's concepts about literacy. This is a wide field, and not all researchers will agree on every issue. Most emergent literacy researchers have identified themselves with the instructional approach known as whole language. This approach was based on a top-down model of reading which disregarded phonological information, as discussed below. They stressed children's discovery of the functions of written language and the use of print as a tool to convey meaning.

2.4.2. Top-down models

Considering written language as a code dependent on oral language or as a language with its own characteristics implies a different model of skilled reading and, consequently, a different model of word recognition.

Goodman et al.'s theory is essentially holistic, so it cannot be adequately translated into an information-processing model which, as discussed above, assumes an atomistic conception of mental processes. However, the issues raised by these authors are reinforced by the evidence (mentioned in the previous section) that higher processes affect lower processes. So, the processes of skilled reading are controlled by semantic information rather than by phonological information. The skilled reader is able to establish a direct connection between print and meaning. The process of phonological analysis removes meaning from script, stripping the written language of its functions.

The model of word recognition implied in this conception (theory of direct access) presupposes the direct activation of lexical representations when the visual/orthographic information is presented, without the need for any phonological representation

Visual stimulus → orthographic representation → lexical representation

This theory presupposes that reading is a top-down process (inside-out, according to Smith (1979). The generation of hypotheses about the meaning, which originate in the reader's previous knowledge, precedes the identification of the words:

semantic interpretation → minimal syntactic processing + visual cues → word recognition

This explains why readers don't actually need to read all the letters in a word or all the words in a text, to comprehend it. The supporters of top-down models claim that the reader uses several strategies which are faster than decoding, to read novel words, such as predicting the words from the context, or asking more experienced readers (when reading together). However, writers do need to analyse the sounds to spell novel words. Therefore, reading and spelling involve different processes.

The strength of this model is the emphasis on meaning. However, its supporters used the concept of meaning to refer to the communicative functions of written language, (what does the text say), without considering that, for children, the question *"what do these marks mean?"* involves not only the understanding of *what* written language says, but also *how* it says it. According to Goodman (1986), "(...) when children are reading and writing they are making sense out of or through print. Eventually, readers and writers of English intuitively come to know that written language in English is based upon certain alphabetic principles. However, this knowledge is not a prerequisite for children's learning to read and write." (p.5). Therefore, for these authors, there was no difference between the processes of reading of a skilled reader and those of a beginner: both would access meaning directly from written words, without the need for phonological mediation.

Because it fails to consider readers' understanding of how the writing system works, this model does not adequately account for literacy from a developmental perspective. Ignoring the productivity of the alphabetic writing system, it also fails to account for readers' ability to read and write novel words. Thus, rote learning would be the preferred strategy for storing the orthographic features of the words, so that they could be retrieved from memory in order to enable the recognition of written words.

Of course, this description is an oversimplification, whose purpose is to illustrate the difference between direct access and phonological mediation.

In reality, most authors admitted that phonological mediation is necessary in the early stages of literacy acquisition or when readers encounter a novel word, as is illustrated by the dual-route models described next.

2.5 Reading Is Not a One-Way Route

2.5.1. Dual-route models

Both the phonological mediation and the direct access theories take up extreme positions. Some researchers suggested that both positions had strong points as well as weaknesses and proposed the dual route theory (Coltheart, 1978).

Dual-route models were devised to account for the evidence of phonological recoding as well as for the evidence of the effects of higher processes on word identification.

The dual route theory suggests that lexical representations can be accessed either by direct access or by phonological mediation.

Visual stimulus → orthographic representation → → → → → → → →→ → → lexical representation
(printed word) ↘ phonological representation ↗

These routes are optional and mutually exclusive (either one or the other). Most of the time, skilled readers use direct access, as it is faster. Less skilled readers (and skilled readers when presented with unfamiliar words, or in the absence of contextual support) use phonological mediation.

One problem of the dual route model is the assumption that the activation of phonological representation is optional and controlled by the reader. Several studies (Coltheart, Avons, Masterson, & Laxon , 1991; Coltheart, Laxon, Rickard, & Elton, 1988; Daneman & Stainton, 1991) have shown that the activation of phonological information is automatic, even when reading texts where the meaning was supposed to exclude the need for phonological representations.

Since direct access to meaning and phonological access are mutually exclusive, dual-route models fail to take into account children's ability to read novel words in context by using partial graph-phonetic cues. They also fail to explain how orthographic representations acquired through phonological recoding mechanisms are accessible to an independent visual-semantic mechanism. (Ehri & Wilce, 1985; Ehri, 1992).

Ehri (1992) claims that, being arbitrary, the direct link between visual information (of a written word) and its meaning would overload memory and claims that spellings are connected to pronunciations rather than to meanings. However, this connection is not necessarily on a letter-by-letter basis. Phonological mediation should not be confounded with phonological recoding (translating each grapheme into its corresponding phoneme and then blending the phonemes to make up a word).

So, it is unlikely that the problem identified by McGuinness, McGuinness, & Donohue (1995) in the text below, would ever occur:

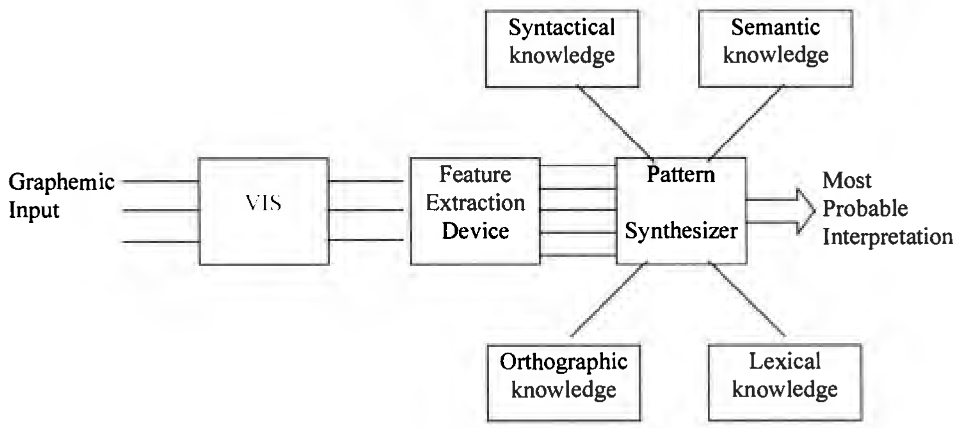
> Training in phonological awareness must be connected to knowledge of the alphabetic principle and accurate phoneme-grapheme correspondence (...). If this connection is not made clearly and concretely, a child's phonological processing skill may not become engaged in decoding, because visual strategies take precedence; such strategies are easier to employ and have more immediate success. Once adopted they are very hard to shift. (p. 850)

2.5.2. Interactive models

The development of more sophisticated parallel computer networks enabled the construction of more comprehensive models.

Rumelhart (1994) assumes the existence of a pattern synthesiser (the message centre), where top-down information, whether semantic, contextual or syntactic, could interact with bottom-up information, such as the critical features of the graphic input and the phonological information, generating, confirming, discarding and modifying hypotheses about the information contained in a written text (Figure 2.5-1).

Figure 2.5–1 A stage representation of an interactive model of reading (in Rumelhart, 1994, p. 864)



Thus, the heart of the model is the message-centre. This is a three-dimensional processor, whose functioning cannot be captured adequately in a flow-chart. One dimension is the input - the written text; the second dimension is the hypothesis level - features, letters, letter-clusters, words, phrases etc; the third dimension represents alternative hypotheses at the same level, generated by the interaction between the specific knowledge provided by all the levels in the second dimension. The creation of the message-centre solves the dichotomy between top-down and bottom-up models, because it allows the information to flow between all the levels, in either direction. So, the information received from the higher levels is affected by the information received from the lower levels and vice-versa. This occurs simultaneously. Therefore, it provides a satisfactory account of the evidence that readers' hypotheses about what can be written in a script (semantic and pragmatic levels) affect their perception of the input.

However, Perfetti (1992), proposes a restricted-interactive model rather than a fully interactive model of skilled word recognition. He states that, in skilled reading, the orthographic representations of familiar words are complete, stable and fully associated to their pronunciation (see section 2.6.4.2.). This enables very fast word recognition, so there is no time for the effects of context to take place. Therefore, the identification of these words is barely affected by the reader's expectations or other contextual influences. Context affects the selection of the meaning, but not the recognition (via pronunciation) of the word. This constraint is necessary to guarantee rapid and accurate word recognition, as it produces the deactivation of similar orthographic representations and semantically possible words that do not fit the pronunciation bonded to the specific orthographic representation.

The model of modified interactive activation (Ferrand, 1995), based on Mcclelland & Rumelhart, 1981 (see also Seidenberg, 1989) shows how the activation of phonological representations constrains the activation of lexical (semantic) representations. This model assumes a triangular relationship, where the orthographic information (activated by the visual input) activates automatically and immediately both the lexical and the phonological representations. These (phonological representations) also activate the lexical representations, provoking an intra-lexical inhibition at the level of word units (lexical representation).

According to Perfetti (1992), the constraints on the effects of context during the early stages of word recognition are applicable to the rapid processes of skilled reading and for words stored in the autonomous lexicon (see section 2.6.4.2.). They are not so effective for the slow processes of novice readers, or for unfamiliar words, as their orthographic representations are incomplete and unstable. Thus, we could expect that the word recognition abilities of novice readers (as well as the recognition of unfamiliar words by skilled readers) would be affected by their expectations of what could occur in a written utterance.

This is important if we want to understand how phonological and orthographic representations are affected by children's hypotheses about the nature of the writing system. Moreover, because of their interactivity at all levels, this kind of model allows for descriptions of partial representations, making it possible to describe the changes from novice to expert readers/writers, as we will see in section 2.6.4.

2.6 Understanding the Alphabetic System

The theories mentioned above imply a view of written language as a social tool, as seen by adults. Some researchers considered it as a simple code to transcribe spoken language; others as a distinct language, with specific characteristics and social functions (but still a social tool to allow communication across time and space). Both groups fail to consider the writing system from the child's point of view. For the child, the understanding of written language is not only the understanding of its functions, but also the understanding of how the writing system works, that is, the understanding of the alphabetic principle. Grasping the alphabetic principle is an essential part of the understanding of written language, as argued by Vygotsky (1978):

> (...) A feature of this system [written language] is that it is second-order symbolism, which gradually becomes direct symbolism. This means that written language consists of a system of signs that designate the sounds and words of spoken language, which, in turn, are signs for real entities and relations. Gradually this intermediate link, spoken language, disappears, and written language is converted into a system of signs that directly symbolize the entities and relations between them. (...) Only by understanding the entire history of sign development in the child and the place of writing in it can we approach a correct solution of the psychology of writing. (The Prehistory of Written Language, p. 106)

When we consider Vygotsky's words, we might argue that the view of written language as a transcription of spoken language assumes that written language is a second order symbolism, which never turns into a direct symbolism. On the other hand, the view of written language as providing direct access to meaning ignores the role of the writing system as a second order symbolism as well as the developmental processes which allow it to become a direct symbol system.

2.6.1. Cognitive-developmental theory

How children come to understand the writing system as a second order symbol system was the focus of the cognitive-developmental theory of reading acquisition proposed by Marsh, Friedman, Welch, & Desberg (1980, 1981). This theory has three basic assumptions, inspired by Piaget's theory:

- Cognitive development is the result of the interaction between the organism and its complex environment.

- The process of cognitive development goes through a number of different stages, characterised by the use of qualitatively different strategies.
- The strategies used by children who are just beginning to learn how to read and to spell are qualitatively different from the strategies used by skilled readers and spellers.

Marsh et al. defined a strategy as an "active change in processing modes to accommodate task demands" (Marsh et al., 1980). They identified four stages in reading development, according to the strategies that children use to identify and spell words. They also investigated whether, at each stage, the child used the same strategies in reading and in spelling (Marsh et al., 1980, 1981). Table 2.6-1 summarises their proposals:

Table 2.6-1 Summary of Marsh et al.'s Cognitive-Developmental theory of reading acquisition

Stages of reading development	**Development of reading strategies**	**Development of spelling strategies**
Stage 1 Linguistic substitution	- rote (for known words) - linguistic guess (for unknown word in context)	
Stage 2 Discrimination net substitution	- rote (for known words) - guess based on visual (graph-phonetic) cues (for unknown words in isolation) -guess based on linguistic and/or visual cues (for unknown word in context)	
Stage 3 Sequential decoding	- rote or decoding (for known words) - decoding left to right (for unknown word, in isolation or in context)	- sequential decoding (the development was slower than in reading)
Stage 4 Hierarchical decoding	- rote or decoding (for known words) - decoding using higher order rules (for unknown word, in isolation or in context) - analogy (optional and dependent on the task)	- decoding using higher order rules - analogy (optional and dependent on the task)

Inspired by Piaget's work, Marsh et al. claimed that the use of more adequate strategies is supported by the construction of more sophisticated general cognitive structures. However, their theory did not explain what provokes the adoption of a new strategy.

2.6.2. Frith's model of reading and writing acquisition

Frith (1984) adapted Marsh's cognitive developmental theory by proposing a three stage model. Each stage involves the development of a more advanced strategy, which should replace the more primitive ones.

- **Stage 1** - logographic - is characterised by children's inability to analyse words. For them, what makes one word identifiable and distinguishable from other words is the presence or absence of some salient graphic features (such as the first letter) and not the position of the letters. This allows children to identify words and to spell some of them correctly, by rote. Frith states that this stage corresponds to Marsh's stage I, but her characterisation of the logographic strategy also corresponds to Marsh's Discrimination net substitution, which characterises stage II.
- **Stage II** - alphabetic - the most important achievement of this stage is the grasp of the alphabetic principle. Children realise that both the arrangement and the sound values of letters are fundamental features of each specific word. This allows them to use their knowledge of the sound value of letters, first to spell (encode) and then to identify (decode) words. This enables them to identify and spell novel regular words (and non-words). The strategies used at this stage correspond mostly to Marsh's sequential decoding. At the higher levels of this stage, children might also use some hierarchical decoding strategies.
- **Stage III** - orthographic - The main characteristic of this stage is that (except for unfamiliar regular words) children are no long recoding words letter-by-letter. They are able to identify letter strings, which correspond to more stable phonological segments related to the syntactic and semantic properties of the word (morphemes). First they use this ability to identify words and later they are able to use it in spelling. The orthographic strategies correspond to the analogy strategy suggested by Marsh and al.'s model.

According to Frith (1984), before entering the logographic stage, the child has to have mastered several symbolic pre-literacy skills although these will not require as much linguistic awareness as the strategies found in the logographic stage. She also accepts that further research may find a fourth stage achieved by proficient readers - which would correspond to the ability to use written language as a direct symbolism, as stated by Vygotsky. However, this would not be a mandatory stage, so many people could still use written language for everyday purposes without reaching such a sophisticated level.

Frith has admitted that her theory is not yet complete and further research is needed to support it. For example, she pointed out that further research is required to understand how children move from one stage to another. She suggested that, in all probability, children would have to wait till they were able to merge the old and new strategies, an idea suggested by Bryant (1982), but she did not explore this idea further. We will return to this issue later, in section 2.6.4.1.

Frith also suggested that the parallel but asynchronic development of reading and spelling could push children forward. Reading would be the pacemaker for spelling development, moving from symbolic to logographic (although she does not cite any evidence to support this suggestion). Spelling would be the pacemaker for reading to develop from the logographic to the alphabetic stage and reading would be again the pacemaker for spelling to develop from the alphabetic to the orthographic stage (see Ellis, 1997 for a discussion of the evidence supporting these claims).

Another problem of both Marsh's and Frith's models is that the "jump" from a non-analytic to an alphabetic strategy is not supported by empirical evidence (see Stuart & Coltheart, 1988 for a more detailed discussion of these models).

2.6.3. The written language as an object of thought

Although agreeing that written language is not parasitic on spoken language, Ferreiro (1983, 1984, 1985, 1986, 1987) and Ferreiro & Teberosky (1983) introduced an original research perspective, reflected in Ferreiro's fundamental research questions (Ferreiro, 1997): "What type of object is writing for a developing child?" (p. 153). "How does one pass from the writing related to the language, but in a global and pre-analytic manner, to the marks treated as a system which retains well defined relations with the system of linguistic signs?" (p.167). Her originality consists of her view that, for a child immersed in a literate environment, scripts are objects of thought (Nunes, 1998). She investigates the development of reading and writing not as the mere acquisition of rules and principles, or the development of new strategies, or an expansion of the knowledge about the functions of written language. Literacy development is rather a process of conceptual change, provoked by the conflict between children's interpretations, the scripts (their object of thought) and the interpretations of the scripts provided by more skilled readers.

Ferreiro & Teberosky (1983) found that, from a very early age, it is the children's quest for the meaning of scripts that fuels the construction of new hypotheses about the writing system.

The early quest for the meaning of scripts confirmed the claims of other emergent literacy researchers. However, from Ferreiro's perspective, the quest for meaning is not (at least in the very early stages), "what does this script communicate?", as children do not assume immediately that a script is a communication tool. The quest for meaning starts by asking "what is this object and how does it work?" thus considering scripts as objects of thought. This triggers the operations involved in concept formation, to solve the main and more general problems of logical construction (Ferreiro, 1984, 1986, 1987):

- Co-ordination between similarities and differences (to differentiate scripts from other objects, to differentiate between words and between letters within words)
- Relationship between the whole and its parts (whole: sentence / parts: words; whole: words / parts: letters).
- One-to-one correspondences (between letters and sound segments)
- Order and identity (of letters within words; of words within sentences)

In addition to these general logical problems, children also have to deal with the problems of the particular object they are dealing with (the written language), in particular, its relation to oral language.

The first fundamental differentiation is between scripts and pictures, writing and drawing (Ferreiro, 1984; Ferreiro & Teberosky, 1983). This is not a visual differentiation, but a conceptual one, where children have to realise that writing is readable on its own, without the support of pictures, and that letters are not just graphemes with a name, but that they mean something (they are signifiers). These are the achievements which Frith (1984) referred to as "pre-literacy symbolic skills". Only by conceptualising scripts as substitute objects can children be free to concentrate on the specific text properties and ask themselves what is necessary for a string of letters to mean something and, afterwards, what is the *magic* secret (how do letters *say* something). This, again, involves a process of progressive differentiation that tackles both the quantitative and the qualitative characteristics of the text (Ferreiro, 1986; 1987):

Table 2.6-2 shows the sequence of criteria of differentiation built up by children.

Table 2.6-2 Sequence of criteria of differentiation

	Quantitative differentiation	*Qualitative differentiation*
Intra-relational	Minimum quantity of letters for a string to be readable	Internal variation of letters (a string is not readable if it is composed of repeated letters.)
Inter-relational (non-systematic)	The number of letters depends on an external referent (not fixed): the object itself or another written name	Different meanings can't be represented by the same letter strings, but the value attributed to a letter changes according to the external referent.
Inter-relational (systematic)	The number of letters depends on a fixed external referent, such as the sound segments (syllables, or smaller units of the words).	The words are made up of letters which have stable values (syllabic or phonemic sounds) and are arranged in a pre-determined order

Quantitative and qualitative differentiation of the same level does not necessarily occur simultaneously. For example, the "minimum quantity" requirement for readability is constructed prior to any other hypothesis (quantitative or qualitative).

Only when children consider an inter-relational systematic differentiation as a criterion for writing something readable, can we conclude that they realise that scripts represent speech. At this stage, they generally produce a syllabic representation of words in their invented spellings and make attempts to read syllabically (using one letter per syllable, sometimes without being concerned to produce correct qualitative matches between sounds and letters).

As shown in the table above, this is the last step on a long journey to discover what the object is that scripts represent. However, as soon as one enterprise finishes, new problems arise and now the child sets off in search of the *magic key* to answer the question "how do scripts represent speech?"

Ferreiro adopts Piaget's theory of equilibration to explain how children change their hypotheses about the writing system. According to this theory, children's awareness of the inadequacy of their interpretations to account for the new findings (provided by the object or by more experienced readers), motivates them to change their hypotheses so that the new information can be assimilated. However, when the gap is too big, the new information cannot be assimilated and children disregard it. Ferreiro argues that the process of differentiation allows children to deal with the contradictory evidence about the object (writing system), maintaining the co-ordination between the quantitative and qualitative aspects of the scripts.

The conflict between quantitative and qualitative aspects of scripts can also be interpreted, from a computational perspective, as the impossibility of mapping incompatible representations: the phonological and the orthographic (Ellis, 1997). Initially, the phonological units children are able to detect are syllables, or rimes, whereas the letters are the only orthographic segments they can detect in a written word. Therefore, the child has to create representations, which permit the mapping between orthography and phonology. In invented spelling, they just use one letter per phonological segment detected. However, this solution is not satisfactory, as they already know that, since written language is a social object, particular individuals cannot modify its rules. Therefore, as the orthography cannot be modified, the only solution is to work on the phonological representations to make them map the orthography. As phonological representations are refined from phonetic to phonemic, the function of letters as graphemes (units which represent phonemes) becomes clear. In other words, children come to understand the alphabetic principle.

Ferreiro (1985) identified four stages in children's construction of the alphabetic principle, according to the hypotheses they formulate about the writing system:

- **Pre-syllabic** - This stage includes all the interpretations produced before children are able to establish any kind of relationship between the sound segments of a spoken word and the letters of its written form. It comprises several levels, which we will not detail here, as their description is not relevant for the purposes of this thesis. For now, it is enough to say that, during the pre-syllabic stage, children complete the process of differentiating scripts from other forms of symbolic representations, and develop the criteria to determine whether a string of letters is likely to "say" something. At the higher level, they already realise that writing represents speech, but they still don't know how. The correspondence between oral and written language is global, non-analytical.

Gradually, the need to differentiate between words makes children pay attention to the properties of each word. The written word is seen as having different segments (letters) and children struggle to establish a systematic relationship between these segments and the characteristics of the spoken words.

- **Syllabic** - For languages where syllables are well defined, the first hypothesis about the relationship between the different segments in written words and the sound segments of spoken words is syllabic. Children develop the quantitative systematic inter-relational differentiation criterion on basis of the number of syllables in a spoken word as the referent to decide how many letters are necessary to write it down. Different levels can be identified in this stage, but a brief description of the overall evolution here will be sufficient. First, children modify the pronunciation of the word (either elongating or condensing it) to obtain a match between the sound segments and the number of letters. Soon, they are able to control the number of letters in their spellings to match the number of syllables (first by erasing superfluous letters, *a posteriori*, then by deciding the number of letters in advance of writing them). In reading, they find different solutions to matching letters to syllables: repeating the word; reading the word from left to right to match the initial letters and repeating it from right to left to match the final letters; dividing the word into as many "fragments" as the number of syllables etc. The difficulty of matching the number of letters to the number of syllables pushes children to create the qualitative systematic inter-relational differentiation criterion, using the sounds of the letters as the criterion to decide what letters should be used to make a word. First, a syllabic value is attributed to each letter (very often the name of the letter is used). This creates two problems: (1) as there are always more letters than syllables in a word (one-letter determiners are ignored here), some letters represent sounds and others do not have a function, other than making up a *readable* word with an acceptable number of letters. However, this would not explain why, for example, some three-syllable words have six or more letters. Children read these words pointing to the letters they consider relevant and ignoring the others. (2) There is no way to differentiate some words, as the same letter represents different syllables. For example, if just vowels are used, AO could represent CARROT, CAROL, PARROT, etc. If just consonants are used, then RK could represent RACKET, ROCKET, RACOON, ROCKER, RECORD etc. If both consonants and vowels are used, but in different syllables, then RE could still represent RACKET, ROCKET, ROLLER, ROCKER, RIVER etc.

- **Syllabic -Alphabetic** - To solve these problems, children have to change their referent from syllables to sub-syllabic units and to phonemes, but this is not achieved immediately for all syllables. In Portuguese, as in Spanish, most syllables are of the CV (consonant-vowel) type, so it is difficult to know whether children are considering the onset-rime or the phonemic segmentation of the syllable when they represent both the consonant and the vowel. During this stage, one letter can be given its phonemic (or sub-syllabic) value in a syllable but may be given a syllabic value elsewhere. Thus the syllabic-alphabetic can be considered as a transition stage.

- **Alphabetic** - At this stage, children are able to use the phonemes as the referent for both the quantitative and the qualitative differentiation, by establishing systematic grapheme-phoneme correspondences. In other words, they have grasped the alphabetic principle and, from now on, they will be able to take advantage of the productive properties of the alphabetic system to write any novel regular word. This doesn't mean that the process is complete. They still have to go a long way to cope with the specificity of the orthography they are using. However, in more transparent orthographies, the production of phonetic spellings does not usually seriously compromise the understanding of a text. Because most children's unconventional spellings can be fully understood, children can use writing to communicate successfully with other people and this encourages them to go on producing and improving their own writing

> (provided that this is not discouraged by the school). This is probably different in morphophonemic orthographies, such as English, where frequent use of phonetic spellings is likely to make the message very hard to understand.

During the process of discovering the nature of the object represented by scripts, children can test their hypotheses about quantitative and qualitative differentiation requirements by comparing their scripts against conventional written forms. They do not need much help from more skilled readers to make progress. They just need to have access to the real meaning and conventional spelling of words and sentences (we are not referring here to children with additional difficulties, such as dyslexia or other kinds of learning problems). However, the writing system is based on arbitrary (although historically constructed) relationships between sounds and letters. Perfetti & Zhang (1996) state:

> "In contrast to the biological foundation of language, writing systems result from human invention; they are altered, refined, and culturally transmitted across generations. (p. 41)
>
> To say a child learns a writing system is to say that he comes to know how that writing system works… (p. 40) In an alphabetic writing system, basic, meaningless speech units (letters), associate with basic meaningless speech units (phonemes)" (p. 41).

Because an alphabetic writing system is based on meaningless units, children need an *interpretant*[1]: someone who is able to provide the basic clues for them to find out "how scripts represent speech". This does not imply that the process of discovery of the alphabetic principle does not involve the construction of hypotheses by the subject who struggles to interpret the written messages (Ferreiro, 1986, 1987; Ferreiro & Teberosky, 1983) but that a *mediator* is also required in the process.

It is likely that children who have no learning difficulties, and who write at least syllabically, are able to grasp the alphabetic principle within a short period (usually less than a school year, according to my experience as a teacher (see also Ferreiro, 1985).. However, just by being immersed in an alphabetic environment, it is

[1] The word "interpretant", was used by Ferreiro (1997) to distinguish the person who provides an interpretation to someone (roughly like a translator) as opposed to the person who interprets an object, the "interpreter" - in this case, the child who is constructing his/her interpretation of the script. We will use *mediator* with the same meaning.

very unlikely that they would be able to grasp the arbitrary rules of the writing system used in their community without interaction with a *mediator*. When working in adult education, I met a large number of teenagers and adults who had never attended school or had abandoned it before becoming literate. For some reason, many of them had stuck to a syllabic representation. They were aware of the discrepancy between their spellings and the conventional ones, but this did not seem to be enough to urge the construction of more adequate hypotheses. They returned to school hoping to get the information they needed to learn to read and to write, as, clearly, they couldn't understand the printed materials they had to deal with. We might then ask: what kind of information should the school (and the wider literate community) provide in order to help children (and older illiterate people) to move beyond the syllabic level of representation and grasp the alphabetic principle?

Several studies have investigated the essential information, or feedback, which children need to receive from the *mediators,* as well as the cognitive factors which underpin the assimilation of this information, during the process of changing from a non-analytic (pre-syllabic) stage to the alphabetic stage. Some of these will be reviewed later.

2.6.4. The development of lexical representations

The developmental theories presented above aim to describe and to explain how the understanding of the alphabetic principle is constructed. However, they do not explain how children become proficient readers and writers, able to recognise a word instantly and to write it without going through the painful process of converting each phoneme into the corresponding grapheme. This means that they do not give a satisfactory account of how the knowledge constructed in the process of becoming literate (and afterwards) is stored and how it becomes available every time the subject is involved in literacy activities.

The process of becoming a proficient user of written language would be better understood if we thought of a model where the orthographic representations of the words were built up gradually.

The most prominent work on the construction of orthographic representations has been carried out by Ehri (1980, 1992, 1997) and Ehri & Wilce (1985, 1987a). Instead of asking what kind of an object the alphabetic system is for a child, as

Ferreiro did, or what strategies children use when learning to read and to write, as Frith and Marsh did, Ehri investigates the development of orthographic representations in the lexicon.

She suggests (Ehri, 1997) that orthographic representations are built up gradually as children increase not only their knowledge about the alphabetic system but also their knowledge about the spellings of specific words which become familiar enough to be stored in memory. Knowledge of the spellings of specific words is also determined by knowledge about the alphabetic system. To Ehri (1997), this knowledge includes, but is not restricted to, the understanding of the alphabetic principle:

> Knowledge about the alphabetic system and how it works may include a variety of capabilities and types of information: the names of letters, how to group letters into functional units called graphemes that symbolize phonemes (smallest units of speech), which graphemes typically symbolize which phonemes, how to segment words into phonemes so that they correspond to graphemes in spellings, how to blend phonemes symbolized by graphemes so that reconizable words result, and how to group letters into larger units comprising spelling patterns and morphographs that symbolize syllabic units including common rime stems, root words, and affixes (p.243).

The author identifies four levels in the development of children's knowledge of the alphabetic system, as shown in table 2.6-3 (Ehri, 1989, 1997).

Table 2.6-3 Levels in the development of children's knowledge of the alphabetic system, according to Ehri

Levels of word reading/spelling	Knowledge of the writing system
Pre-alphabetic, logographic reading Pre-communicative spelling	No connection between writing and speech sounds.
Partial alphabetic reading Semiphonetic, letter-name spelling	Rudimentary knowledge: names or sounds of some alphabet letters; detection of some sounds within words.
Full alphabetic reading Phonetic, phonemic spelling	Ability to segment words into phonemes; knowledge of conventional grapheme-phoneme rules; decoding skills.
Consolidated alphabetic, orthographic reading Transitional, morphemic spelling	Knowledge of recurring larger units (letter strings); Internalisation of orthographic rules.

At the logographic level, children recognise familiar words by relying on visual non-phonetic features; they are unable to read unfamiliar words; they do not often use conventional letters but, when they do, these are not related to the word sounds.

At the partial alphabetic or semiphonetic level, children form connections between the letters they know (often just the names of the letters) and the sounds detected in pronunciations (phonetic-cue reading). As their repertoire of letters is still very small, these connections are partial, producing confusion between different words with the same salient letters. They may guess unfamiliar words when contextual support is available, by using the same process of phonetic-cue reading. They are unable to use analogies either in reading or in spelling, unless the analogous words are visible. Even when the analogous words are available, they often fail to detect the letters which correspond to the shared sounds, in spelling, or misread the unknown word as a known word which contains the same letter-cues. When inventing the spelling for a word, children at this level detect and include only some of the word sounds, often those which are similar to the sound of the name of the letters they know.

At the full alphabetic level, children know most grapheme-phoneme correspondences and their phonemic segmentation skills are sufficient to read and produce the spellings of orthographically transparent words. Their knowledge of the writing system also enables them to remember familiar words, even when the orthography is less transparent. As their repertoire of words whose spellings are fully stored in memory grows, they are likely to be successful when using analogies either in reading or spelling unfamiliar words.

The consolidated alphabetic level is the level of skilled reading and spelling of words. Children are able to make connections between common letter-strings and their sounds, as they recur in different words. So, most words are read and spelled in chunks, such as syllables, rimes or morphemes, rather than on a letter-to-sound basis. They are able to internalise some spelling rules as well. This facilitates the reading and spelling of unfamiliar words, the storage of the spellings of known words, as well as the use of analogies both in reading and in spelling.

We can see that, although Ehri's framework is computational and Ferreiro's is psychogenetic, the description of Ehri's pre-alphabetic, partial alphabetic and full alphabetic levels is very similar to Ferreiro's pre-syllabic, syllabic / syllabic-alphabetic and alphabetic levels.

2.6.4.1. The amalgamation theory

Ehri's research has shown that dual route models, as well as both top-down and bottom-up models fail to provide a satisfactory account of the processes of word recognition and word spelling, either from the perspective of skilled reading or from a developmental perspective. She strongly opposed the idea of both phonological recoding on a letter-by-letter basis (Gough & Hillinger, 1980) and the use of visual cues for sight word reading (see Barron, 1981) to access lexical representations. Instead, she proposes access to the lexicon through the visual-phonological route, which connects spellings to pronunciations rather than to meanings. These are likely to be activated automatically, as soon as the pronunciations of the words are retrieved.

The efficiency of the visual-phonological route for retrieving the correct pronunciation depends on the quality of the orthographic image of the spelling which is stored in the memory, as explained in Ehri (1980):

> The lexicon is conceptualised as consisting of abstract word units having several different facets or identities. Every word has a *phonological* identity which consists of information about acoustic, articulatory and phonemic properties of the word (...). In addition, every word has a *syntactic* identity specifying characteristic grammatical functions of the word in sentences (...). And most words have a *semantic* identity, that is, a 'dictionary definition'. All of the foregoing identities are thought to be acquired and known implicitly as a consequence of achieving competence with the spoken language.
>
> In the course of learning to read, another identity is added to the lexicon, the word's *orthographic* form. This written unit is thought to be incorporated not as a rotely memorised geometric figure but rather as a sequence of letters bearing systematic relationships to phonological properties of the word. The term 'amalgamation' is used to denote the special way in which orthographic identities get established in lexical memory. Since beginners already know how words are pronounced, their task is to assimilate the word's printed form to its phonological structure. They do this by matching at least some of the letters to phonetic or phonemic segments detected in the word. These segments serve as 'slots' in lexical memory which are filled by images of letters seen in the word's spelling. To process and remember letter-sound correspondences effectively, readers must already be familiar with those letters as *symbols* for the relevant phonological segments they map in the word. If at least some of these letter-sound relationships are known and recognised, then there will be enough 'glue' to secure this visual symbol in lexical memory. Very likely, readers who possess more systematic knowledge about mapping relationships between letters and sounds will be better able to form a match between conventional spellings and word pronunciations and to store a complete amalgam in lexical memory. (p. 313)

So, the construction of orthographic images depends on phonological awareness to create the 'slots' according to the number of segments detected in the pronunciation of the word. It also depends on letter knowledge to 'fill up' these slots with the appropriate letters.

Bowey (1994) also points to letter knowledge as a fundamental factor to mediate the relationship between phonological sensitivity and word recognition.

> In puzzling over the 'meaning' of letters, children may begin to understand that letters symbolise sounds. At least some of the time, their attention may be focused on both individual phonemes and rhyming letter sounds and names. It is possible that this informally acquired knowledge of letters stimulates sensitivity to both subsyllabic and phonemic units (...). Children who are sensitive to the phonological structure of words may more readily understand the function of letters in print as representing sounds and thereby find it easier both to remember letters and to use letters as phonetic cues to word identity. (p. 154).

As a word can be segmented at different levels (syllables; onset-rimes; phonemes etc.), different layers of orthographic representation can be constructed. The bigger the segment, the bigger the letter string which is amalgamated to it. The difficulty for beginners is that they often produce bigger slots (syllabic, for instance), which they try to fill up with single letters (for example, by mapping a letter to a syllable which sounds like its name). This provokes the conflict between children's hypotheses about the number of letters in words and the number of letters that compose the conventional spelling, as explained by Ferreiro et al. This conflict compels children to create new hypotheses about the quality of the sounds that are represented by each letter.

However, Bryant (1982) claims that it is agreement and not conflict between strategies which produces intellectual change in young children. It is difficult to see how this would happen in literacy acquisition if we focus on children's strategies, as in Frith's model described above. Nevertheless, if we focus on orthographic representations, instead of strategies, we may consider that Ehri's amalgamation theory makes a strong contribution in favour of the agreement argument (Ehri, 1992). Provided that a model of parallel representations is accepted, the pronunciation amalgamated to a string of letters which forms a whole syllable is likely to agree with the blend of the pronunciations amalgamated to the string that represents the onset, plus the string that represents the rime. Similarly, this pronunciation should coincide with the pronunciation amalgamated to the string of graphemes that form the word.

Therefore, the final pronunciation is the same, no matter whether the word is read in chunks or as a single string. This strengthens the orthographic representation of the word and the connections between the different levels of representation, (see the redundancy principle, in the next section) and reinforces the use of different strategies (such as reading the word in chunks, rather than letter-by-letter, for example).

Ehri offers several different kinds of evidence to support her amalgamation theory, such as:

1. Reader's conceptualisation of the phonemic structure of the words is affected by the word's orthography: fourth graders identified one extra phoneme in the words where the same sound is represented by one extra letter (e.g: pitch was perceived as having one more phoneme than rich) (Ehri & Wilce, 1980).

2. Contrary to pre-readers, (who could read no words), novice readers (who could read a few words), as well as veterans (who could read several words), found it easier to learn simplified phonetic spellings (whose letters corresponded to sounds) than visual spellings (whose letters did not correspond to the sounds, but had more visually distinctive features). The main difference between pre-readers and the other two groups was letter knowledge. Pre-readers did not know the names of the letters and knew just a few letter sounds (about 7 out of 26); both novices and veterans mastered the names of the letters and knew some letter sounds (about 21 out of 26). Since novices did not have any decoding skills, these results support the suggestion that novice readers access the representation of the words stored in memory by relying on phonetic-visual rather than on purely visual cues or on decoding skills. (Ehri & Wilce, 1985; see also Rack, Hulme, Snowling, & Wightman, 1994 and Abreu & Cardoso-Martins, 1998).

3. Beginning readers use graph-phonetic cues rather than visual cues both to read and to spell words. This provides some success, but, without decoding skills, their ability to read and to spell novel words is quite limited, as the orthographic representation of the word stored in memory is not complete. Learning isolated letter-sound relationships is not enough

> to improve the connections between the letters in the spelling and the pronunciation of the word, so improving the orthographic representation. However, teaching children to spell phonetically, by stressing the relationship between the letters and the pronunciation, is fundamental to improving the orthographic representations of the words and, therefore, to promoting word learning. (Ehri & Wilce, 1987; Ehri, 1989; Ehri & Wilce, 1987a).

What makes the amalgamation theory so interesting for the understanding of literacy development is that it is compatible with the developmental theories which focus on children's understanding of the writing system, such as Frith's and Ferreiro's and, at the same time, it can be incorporated into an interactive model of skilled reading, as discussed next (see Perfetti, 1992). This is a major contribution to bridging the gap between theories of skilled literacy and theories of literacy development.

2.6.4.2. Qualitative development of orthographic representations

The acquisition of orthographic representations of words is further discussed by Perfetti (1992). He suggests that there are two components of the acquisition of lexical expertise: the *functioning* lexical representation system and the *autonomous* lexical representation system. (It is not very clear why the author suggests the existence of two systems instead of just two types of representation, the autonomous being the mature and the functioning being the developing orthographic representation).

Of special interest for developmental purposes is the functioning lexical representation system, as it is the "building site" of orthographic representations: in there, the quality of representations is improved and new entries are added to the lexicon each time the reader encounters a new written word. Functioning lexical representations are incomplete and unstable. Their qualitative development is characterised by two principles: *precision* and *redundancy*.

The *precision* principle establishes that fully specified representations are superior to partially specified ones. "Precision is the probability that specific letter constituents are represented as part of a word in the reader's lexicon" (Perfetti, 1997, p. 29). To use again Ehri's "slots" metaphor, partially specified representations are the ones where: 1) the number of "slots" does not correspond to the number of letters in the word spelling; 2) the number of slots is correct but there are some empty slots which, eventually, are filled up with variable letters. This means that the learner is sure about some letters (for instance, the first and last letters in the word) but is not sure about the others. In English, the vowels are usually the last letters to be correctly represented, whereas in Spanish and in Portuguese, they are usually the first (syllabic children often use the correct vowels and no consonants to spell novel words, as found by Ferreiro & Teberosky, 1983). During the process of acquiring an orthographic representation for a specific word, constants gradually replace variable letters and fill up the empty slots.

The *redundancy* principle determines that lexical access is strengthened and gets faster when information from different sources is activated at the same time. "Redundancy is the formation of word-specific grapheme-phoneme connections. These connections are developed by the convergence of generalised grapheme-phoneme correspondences and specific orthographic forms." (Perfetti, 1997, p. 29). As phonology and orthography become amalgamated, the visualisation of a written word not only activates the corresponding sequence of phonemes, but also the orthographic representation, as well as the blend of phonemes (phonemic strings) which constitute the pronunciation of the word and parts of the word, such as syllables and rimes. Redundancy reduces ambiguity (such as many-to-one correspondences between graphemes and phonemes and vice-versa) and eliminates the need for decoding, resulting in faster word recognition.

Fully precise and fully redundant orthographic representations are stored in an autonomous lexical representation system. This comprises all the words whose pronunciation is already amalgamated (the author uses the term *bonded*) to a complete and well-established orthographic representation. These are the familiar words which can be accessed instantly through the visual-phonological route, as suggested by Ehri, (1992). Because the orthographic representations are complete and stable, the identification of the words in the autonomous lexicon is hardly affected by the reader's expectations or other contextual influences. This is why Perfetti (1992) proposes a restricted-interactive model rather than a fully interactive model of skilled word recognition, as described in section 2.5.2.

As we have seen, fully precise and redundant representations are a function of the *bond* between orthographic and phonological information, at different levels.

However, even though phonological information has been recognised by most researchers as an essential component of the literacy process, the exact nature and role of this information is still a focus of debate, as we will see next.

2.7 Phonological Processing in Literacy Development

2.7.1. Phonological awareness

As discussed above, the ability to detect the sound segments which are represented by the graphic units of a writing system seems to be fundamental to understanding how that system works. In the historical evolution of writing systems, systems based on meaningless, phonographic (as opposed to meaningful, logographic) units are a recent acquisition. As explained by Liberman et al., 1974:

> Among writing systems that use the meaningless kind of segment, the segment size that was represented in all the earliest examples was, at least approximately, that of the syllable. An alphabet, representing segments of phonemic size, was developed later. It is clear, moreover, that the alphabet developed historically out of a syllabary and, furthermore, that this important development occurred just once. (p. 202)

As shown by Ferreiro (1985, 1986, 1987) and Ferreiro & Teberosky (1983) (see section 2.6.3.) children interpret the alphabetic writing system as if it were syllabic, before they discover its alphabetic basis (at least in languages where the syllable is well defined). In an exploratory study, Cordeiro & Roazzi (1994) suggested that, for Portuguese speakers, the passage from the pre-syllabic to the syllabic stage (according to Ferreiro's classification) is more natural and more independent of instruction than the passage from the syllabic to the syllabic-alphabetic stage. This suggests that it is less problematic to consider the syllable than to consider the phoneme as being the basic phonological unit mapped by letters (or, eventually, by graphemes).

This issue was investigated by Liberman et al. (1974) in a classic study where they compared the performance of nursery, kindergarten and first grade children (mean age range = 59-84 months), in two phonological tasks: syllabic segmentation and phonemic segmentation. The children used a wooden dowel to tap the number of syllables in words or the number of phonemes in syllables pronounced by the experimenter. The results showed that segmenting words into syllables is easier for young children than segmenting syllables into phonemes and, although both abilities develop with age, phonemic segmentation develops later. Moreover, the development is most apparent in first grade. These results are explained by the authors:

> (...) the difficulty a child might have in explicit segmentation is not necessarily related to his problems, if any, with ordinary speech perception. (...). If the acoustic structure of speech bore a simple one-to-one relation to the phonemic structure (...) it would indeed be hard to see why phonemic analysis should pose special problems.(...). However,(...) the segmentation of the acoustic signal does not correspond directly or in any easy determined way to the segmentation at the phonemic level. (...). Instead, the phonemic segments are encoded at the acoustic level into larger units of approximately syllabic size. (...) the consonant segments of the phonemic message are typically folded, at the acoustic level, into the vowel, with the result that there is no acoustic criterion by which the phonemic segments are dependably marked. However, every syllable that is formed in this way contains a vocalic nucleus and, hence, a peak of acoustic energy. These energy peaks provide audible cues that correspond very simply, if somewhat imperfectly, to the syllable centers. Though such direct auditory cues could not in themselves help a listener to define exact syllable boundaries, they ought to make it easy for him to discover how many syllables there are and, in that sense, to do explicit syllable segmentation. (pp. 203-204).

Liberman et al. (1974) suggest that "if a writer is to represent a segment of whatever kind of size, he must first have succeeded in explicitly abstracting it from the acoustic stream of speech". So, it is reasonable to expect "that [both] the historical and [the individual] development of writing might reflect the ease (or difficulty) with which explicit segmentation can be carried out": first syllables and then phonemes (p. 202).

This study inspired numerous investigations into the relationship between literacy acquisition and children's ability to focus on a word's sounds rather than on its meaning. The main question was to decide whether the ability to abstract the sound segments from the acoustic stream of speech was a pre-requisite for learning to read and to write and, in that case, what was the size of the segments (syllables, onset/rimes or phonemes) involved in literacy acquisition.

Some of these investigations will now be reviewed in more detail.

2.7.1.1. Evidence that phonemic awareness is a product of learning to read

In the study previously mentioned, Liberman et al. (1974) suggested that further studies would be necessary to investigate whether the ability to carry out phonological segmentation in the first grade was a product of maturation, or the result of systematic instruction in reading and writing in an alphabetic system.

To investigate this issue, Morais, Cary, Alegria, & Bertelson (1979) compared the performance of Portuguese illiterate adults with the performance of a similar group of subjects who had learnt to read in adolescence or adulthood. The results showed that only the ex-illiterate subjects could succeed on tasks of initial phoneme addition and initial phoneme deletion (more than 70% success for ex-illiterates against less than 20% success for illiterates). The authors concluded that the capacity to manipulate phonemes explicitly, which was necessary for success on this kind of task, was triggered by learning to read rather than being a product of maturation. These results were confirmed by another study (Morais, Bertelson, Cary, & Alegria, 1986) where the performance of ex-illiterates and illiterates on tasks involving rhyme detection and syllable deletion was also compared. This showed that the superior ability of ex-illiterates to carry out phoneme deletion could not be attributed to their greater general ability to infer the deletion rule from examples.

Another study by Read, Zhang, Nie, & Ding (1986) compared the performance of two groups of Chinese adults on the same kind of phonemic manipulation task used by Morais et al. (1979). The group which was literate only in Chinese characters did not succeed on these tasks (about 20% success), but the group which was literate both in Chinese characters and in alphabetic spelling had no difficulty in performing the tasks (more than 80% success). These results confirmed that the ability to manipulate phonemes develops in the process of learning to read and write an alphabetic system.

2.7.1.2. Evidence of phonological awareness as a predictor of reading

If Liberman et al.'s study (1974) brought hopes to researchers of being close to finding the key to the origins of reading difficulties, Morais et al's study (1979) was like a "bucket of cold water". In fact, if learning to read in an alphabetic system triggered phonological awareness, this couldn't be a cause or, at least, a pre-requisite, of reading. Hence, it would be difficult to argue that reading difficulties were provoked by deficits in phonological awareness. Moreover, the promotion of phonological games in pre-school would be unlikely to prevent problems in literacy acquisition.

These conclusions also clashed with the evidence of several studies, which showed that the performance of young children on phonological awareness tasks was strongly related to their progress on literacy acquisition (Fox & Routh, 1975, 1976, 1984; Juel, Griffith, & Gough, 1986; Stanovich, Cunningham, & Cramer, 1984; Tunmer & Nesdale, 1985; Williams, 1980).

The position of Morais and his colleagues was based on the view that, since phonemes are the basis of any alphabetic system, the connection between phonology and literacy is established by the correspondence between graphemes and phonemes. Therefore, the ability to detect and manipulate phonological segments other than the phoneme is not relevant for literacy development.

This assertion was disputed by other authors, in particular by Bradley & Bryant (1983); Bryant & Bradley, (1985/1987); Bryant & Goswami, (1987), who claimed that the connection between phonological awareness and literacy acquisition involves phonological units greater than the phoneme.

Bradley & Bryant (1978) compared children with the same reading levels but with different chronological age. They showed that the children who were backward readers did worse than their younger counterparts with the same reading level, on tasks involving rhyme production and rhyme detection (detecting the non-rhyming word, from a set of four different words). Therefore, the lower levels of phonological awareness of the backward readers were likely to be a cause of their difficulties on literacy rather than having been produced by them. The connection between early phonological abilities, in particular sensitivity to rhymes, and literacy acquisition was confirmed in other studies (Bryant, Maclean, Bradley, & Crossland, 1990; Ellis & Large, 1987; Maclean, Bryant, & Bradley, 1987).

It is possible that the relationship between children's ability to detect rhymes, in pre-school, and their later performance on literacy activities is an indirect one: it may be mediated by the development of phonemic awareness. In other words, sensitivity to rhymes may promote the development of more sophisticated phonological skills (involving manipulation of phonemes) and this, in turn, may promote the acquisition of literacy.

In fact, Rego's longitudinal study (1991) showed that the performance on the rhyme and alliteration oddity tasks used by Bradley & Bryant (1983) at 4 years 11 months was a strong predictor of the performance on a phoneme tapping task and a phoneme categorisation task at 5 years 6 months and 5years 11months. In turn, the performance on the phoneme categorisation task, at 5 years 6 months, was a strong predictor of reading words and non-words at 5 years 11 months and 6 years 11 months, as well as of invented spelling levels, at 5 years 11months.

However, Bryant & Goswami (1987) maintained that the connection between sensitivity to rhyme and alliteration and literacy acquisition is also a direct one. Early experiences with rhymes develop children's ability to detect phonological identity between words. This will help them to realise, later, that the rhyming words, which share sound segments, also share graphic segments. In English, these graphic segments correspond to the rimes and, as most words are monosyllabic, the identification of the rime allows the separation of the onset, which, in many words, comprises a single consonant. Thus, although the correspondence between phonemes and graphemes is the basis of the alphabetic system, the early connection between phonological skills and literacy does not necessarily involve the phonological analysis at the phonemic level. The initial connections occur at the sub-syllabic level, involving the relationship between sounds and strings of letters, rather than between graphemes and phonemes. This connection was shown in studies by Goswami (1986, 1988, 1993) and Goswami & Bryant (1990, 1992) that showed that children could read and spell novel words by using analogies, when the analogous words shared rimes or onsets with the dictated words. The ability to use analogies was stronger when the (written) clue-word was available (see Muter, Snowling, & Taylor, 1994), showing that children are able to take advantage of the relationship between graphic identity and phonological identity before they have constructed complete orthographic representations for the segments involved.

The relationship between rhyme and literacy is possibly specific to orthographies such as English, where the rhyme is based on the rime. In Portuguese, most words are either di- or multi-syllabic and the stress is generally on the last but one syllable (paroxytone words). Therefore, rhyming requires the words to share the rime of the last but one syllable, plus the whole last syllable, as in "r<u>ato</u> - g<u>ato</u> - pr<u>ato</u> - p<u>ato</u>", or_"v<u>ela</u> -pan<u>ela</u>". Thus, rhymes are units greater than the syllable and can be achieved by a global sensitivity to sound identity. In fact, Cardoso-Martins (1995) found that rhyme detection (odd word out, as in Bradley & Bryant, 1983) when the children were 6 years old on average (time 1) predicted the ability to read words four months later (time 2), but not eight months later (time 3) and was not a good predictor of spelling at any time. Initial syllable detection (when the odd syllable had no segments in common with the others) predicted reading at time 2 and time 3, but did not predict spelling.

However, she found a different result when the explanatory variable was the ability to detect the odd word in items in which the first syllable in the odd word differed from the first syllable in the other words only with respect to the initial consonant. In this case, the difference between the syllables was, actually, the difference between the initial phoneme, which, in CV and CVC syllables corresponds to the onset. Therefore, this was a measure of alliteration rather than syllable detection. This measure was a significant predictor of word reading and word spelling at time 2 (four months after the measure was taken) as well as at time 3 (eight months after the measure was taken), even after the variation on phonemic segmentation was controlled. Moreover, the effects of both rhyme detection and syllable detection lost significance after the variation on alliteration was controlled.

These results suggest that the ability to detect phonological identity of the initial consonant plays an important role in literacy acquisition, which is probably related to the ability to "break" the syllable or, in other words, the awareness of phonological units smaller than the syllable (but not necessarily of phonemes).

2.7.1.3. The reciprocity between phonological awareness and reading

Morais, Alegria, & Content, (1987a) claimed that, in our culture, there is no situation other than literacy related activities where people need to be aware of phonemes. Training people to perform on specific phonological tasks allows them to develop strategies to cope with these tasks, so they display some level of segmentation abilities in solving them. However, to demonstrate a real improvement in segmental (phonemic) awareness it is necessary to observe an improvement in performance on several kinds of phonological tasks (or the transfer of the abilities acquired during training, from one task to another). The authors also stressed that there is a difference between phonetic awareness and phonemic awareness.

> Phonetic awareness is awareness of speech as a sequence of phonetic segments, i.e. the minimal units of expression which are relevant for perceptual differentiation.(p.427) Phonemic awareness is the conscious representation of speech] as a sequence of phonemes, rather than phones (...). The conscious representations of phones are presumably more like mental images than concepts. (...) Unlike representations of phones, representations of phonemes cannot be derived by simply inspecting perceptual outputs, mental images of phonological strings, or articulatory cues. They can only be derived by disregarding phonetic variations. Some external representational system that does not represent these variations may be necessary in order to elaborate conscious representations of phonemes. (p. 428)

Therefore, as phonemes do not have acoustic reality, their manipulation requires them to be "materialised" in some way. The materialisation of phonemes is possible by using letters to represent them. Thus, learning to read supports the development of phonological awareness (phonemic awareness). However, "since alphabetic orthography maps onto phonemic structure, phonemic awareness is necessary to progress in alphabetic literacy" (p. 428). Hence, the relationship between phonological awareness and reading is reciprocal.

The issue nº 7 of the Cahiers de Psychologie Cognitive, 1987, assembled the arguments of several researchers in response to Morais et al.'s claims. Although most authors supported an interaction between phonological awareness and reading, there were still some polemic issues, mainly surrounding the definition of phonological awareness. Morais et al. had suggested a distinction between phonetic awareness, phonemic (or segmental) awareness and segmental ability, as cited above, but this distinction was challenged by other authors. For the purposes of this thesis, there are two issues that deserve mention. The first is whether there is a continuum between awareness of phonological strings (phonological awareness) and phonemic awareness; the second concerns the status of *consciousness* attributed by Morais et al. to segmental (phonemic) awareness.

Stanovich (1992) suggested that the term "phonological awareness" should be replaced by the term "phonological sensitivity". This "should be viewed as a continuum, ranging from *deep* sensitivity to *shallow* sensitivity. Tasks indicating deeper levels of sensitivity require more explicit reports of smaller sized units". The idea of a continuum from phonological awareness (in this case, shallow sensitivity) to phonemic awareness (deep sensitivity) was supported by several authors (Bryant & Goswami, 1987; Read, 1987; Stuart, 1987; Treiman, 1987). They argued that different phonological tasks, such as those involving rhyme detection and rhyme production, or syllabic segmentation, also involved different levels of segmental analysis. Moreover, phonological segmentation ability progressed from bigger (syllabic) segments to smaller ones (phonemes) and the role of sub-syllabic units, such as onsets and rimes, was particularly important in the connection between phonological awareness and literacy (as discussed in the previous section). However, Morais et al. disagreed with this position. For them, the essence of the distinction between the two forms of awareness was the consciousness of phonemic (segmental) awareness, versus the unconsciousness of phonological awareness and it would be difficult to maintain this distinction if one was accepted as a refinement of the other. However, Morais, Alegria, & Content, (1987b) also stated that "there would be no way of developing conscious segmental analysis until phonetic segments are extracted within speech processing" (p. 538), which presupposes that some level of phonological awareness has to be achieved for phonemic awareness to develop.

> Segmental awareness results from access to segmented phonological or morphophonological representations rather than to internal processes. (...) In the constructive act that yields the conscious representation of a segment, one particular type of information that may serve to map this representation to the alphabet in an appropriate way is the phonetic, kinaesthetic and visual information from articulation. (p. 548)

Therefore, this controversy revolves around a theoretical difference concerning the processing of speech and its relationship with the processing of the visual information extracted from print. In particular, Morais et al.'s position involved epistemological issues that have been a focus of great controversy in psychology since its foundation, such as the relationship between knowledge and consciousness and the possibility of gaining access to (and assessing) the contents of consciousness.

Fortunately, deciding whether phonetic awareness is a pre-requisite for developing phonemic awareness or whether both are different levels of the same construct (phonological awareness) need not affect instructional practices. In fact, no matter what definition of phonological awareness they embrace, most authors agree that the development of both phonemic awareness and literacy is stimulated by encouraging the children to focus on the sounds within words as they try to understand how these sounds are represented by letters (Bradley, 1981, 1983; Bryant & Bradley, 1985/1987; Byrne & Fielding-Barnsley, 1989, 1990; Cunningham, 1990; Ehri, 1989; Ehri & Wilce, 1987a).

Therefore, it is not surprising that the contribution of phonological sensitivity as a predictor of literacy development is less for children who are receiving systematic training in decoding by their teachers. As found by Perfetti, Beck & Hughes (1987); Cardoso-Martins (1991) and Rego (1995), the teaching of letter-to-sound correspondences (even at the syllabic level) during the initial stages of learning to read, improves phonological awareness, reducing the individual differences found at the beginning of the school year. By contrast, children taught with less emphasis on decoding skills have to rely more heavily on their initial elementary phonological skills to make progress.

This controversy is resolved for the purpose of instruction because the relationship between phonological awareness and literacy should not be a question of cause and effect, or what is the pre-requisite for what, as stated by Nunes (Carraher, 1987):

> Having symbols to represent phonological segments provides children with a conventional way of representing and thinking about them. This is how learning to read may provoke segmental analysis - by providing representations for phonological units which often are not even pronounceable in isolation. This hypothetical process still implies that segmental analysis is a necessary condition for learning alphabetic literacy but it also shows why it may be developed during reading instruction, there being *no reason to treat it as a pre-requisite.* (p. 460) (emphasis in original)

In summary, literacy development and phonological awareness are completely integrated. Whether they are different interacting processes, or different components of a unique process (the development of the understanding of the alphabetic system), is still an open question to be answered by further research.

2.7.1.4. Phonological awareness and orthographic representations

Ehri's amalgamation theory, discussed above, gives an account of an interactive process where the ability to segment sound units larger than the phoneme enables the construction of partial orthographic representations, which are effective for identifying some words accurately, by using graph-phonetic cues. This reflects the understanding that letters represent the sounds of words. However, this is not sufficient to read and spell most words, as only certain letters are linked to a specific pronunciation. According to Ferreiro (see section 2.6.3), it is the struggle to write readable words (and to read what others have written) that encourages children to try to understand the function of individual letters within the word, by matching the word's spelling to its pronunciation. Children already know that the spelling of specific words is a social convention, which cannot be modified, but, eventually, they realise that the pronunciation of words can be distorted so that the number of sounds produced matches the number of letters in the spelling. This effect of orthography on the phonological representation of words was also shown by Ehri & Wilce (1980).

a. Phonological segmentation and spelling

The relationship between orthographic representations and phonological awareness was further explored by Vernon (1998) in a cross-sectional study where children's performance on invented spelling and on two phonological tasks (free segmentation and blending) was assessed. According to Perfetti (1992), "spelling is the purest indicator of lexical quality", because "while reading can be accomplished with incomplete word representations, spelling requires the retrieval rather than the recognition of letter constituents". Therefore, the quality of orthographic representations can be assessed by using an invented spelling task.

Vernon compared the performance of 48 children (36 kindergarteners and 12 first-graders), all monolingual Spanish speakers, on three tasks:

- Writing (invented spelling) accompanied by verbalisation and followed by reading while finger-pointing, of one monosyllabic, two disyllabic and four multisyllabic nouns. Children were classified into four groups, according to their performance. "S1" (initial syllabic) produced any string of letters and, when reading, tried to make a correspondence between the letters and the number of syllables of the word, by grouping two or more letters per syllable. "S2" (strictly syllabic without correspondence) wrote as many letters as the number of syllables in the word, but there was no match between the letters and the sounds they represented. "S3" (strictly syllabic with correspondence) produced as many letters as the number of syllables and used one correct letter per syllable, generally the vowel. "A" (alphabetic) produced alphabetic spellings (one letter per phoneme, with letter-to-sound correspondence).
- Reconstruction - a phonological synthesis task, where the experimenter produced the "bits" of the words and children were invited to provide the normal pronunciation of the word. Four types of segmentation were provided for eight CVC monosyllabic nouns, such as SOL (sun): SO-OL; SO-L; S-OL; S-O-L) and four types for 10 CVCV disyllabic noun words, such as SOPA (soup): SO-P-PA; SO-P-A; S-O-PA; S-O-P-A. These types included segmentations that had been frequently observed when children

(Spanish speakers) verbalise or attempt to read their own writing productions.

- Oral segmentation - children were asked to produce the segments of the words (six disyllabic and four monosyllabic nouns), so that the researcher could guess the word. The researcher encouraged them to make it as hard as possible. The children produced seven types of segmentation for monosyllabic words, such as PAN (bread); PA-AN; PA-A-AN; PA-N-AN; PA-N OR PA-A-N; P-AN and P-A-N, as well as for disyllabic words, such as GATO (cat); GA-TO; GA-A-TO; GA-T-TO; GA-T-O or GA-A-T-O; G-A-TO and G-A-T-O.

The results of this study showed that children did not have difficulty in synthesising segments when the onset and the vocalic nucleus of the first (or only) syllable was undivided, such as SO-OL, SO-L; SO-P-PA and SO-P-A. Their average score was 89% correct for syllabic children and 98% for alphabetic children, for both monosyllabic and disyllabic words.

The synthesis of onset/rime segments in monosyllabic words was more difficult for all the children, especially for those who produced syllabic spellings. Surprisingly, this type of segmentation was as difficult as phonemic segmentation, for the same words (about 33% correct for syllabic children and 82% correct for alphabetic, but the alphabetic first graders found it easier to synthesise phonemes than onset/rime segments).

For disyllabic words, the synthesis of the first syllable (as in S-O-PA) was also more difficult for syllabic than for alphabetic children (48% and 86% correct, respectively). The synthesis when all the segments were phonemes also discriminated S3 (37% correct) from S1 and S2 (14% correct) and alphabetic first graders (85% correct) from alphabetic kindergarteners (65% correct). This suggests that the knowledge of letter-to-sound correspondences (which distinguished S3 from S1 and S2 children) as well as the experience of formal reading instruction (first graders) are both likely to contribute to the performance on this task.

In the segmentation task, most syllabic children produced segments where the syllables were intact, in disyllabic words, or transformed the monosyllabic CVC word into a disyllabic CVVC word (doubling the nucleus, as in PA-AN). Only alphabetic children were able to produce phonemic segmentation (more than 60% of the alphabetic kindergarteners and more than 80% of the alphabetic first graders). However, some syllabic children (about 22%, mainly from those at the S3 level) were able to produce sub-syllabic segments. As in the synthesis task, the preferred segmentation preserved the unity of onset/nucleus of the first syllable (as in PA-N or GA-T-O), rather than segmenting onset and rime of the first syllable (as in P-AN and G-A-TO), as is frequently observed in English speakers.

It is interesting to note that, if a tapping task had been used to assess children's ability to segment phonemes, segmentations such as PA-A-AN, PA-N-AN PA-A-N and GA-A-T-O would have been considered correct, as the number of sounds detected would match the number of phonemes. This means that at least 36% of the S2 and nearly 20% of the S3 children would have been misclassified as possessing full phonemic segmentation skills.

Vernon suggests a hypothetical developmental course for word segmentation, in Spanish, as shown in table 2.7-1. However, we must be careful, as this was not a longitudinal study. So, further studies are necessary to confirm (or disconfirm) Vernon's suggestion.

Table 2.7-1 Hypothetical developmental course for word segmentation, in Spanish, according to Vernon's suggestion

Spelling level	Disyllabic words segmentation	Monosyllabic words segmentation
S1, S2 and S3 children	Syllabic segmentation (GA-TO)	Transformation of the word into a disyllable (SO-OL)
Mostly S2 children	Repetition of the vowel nucleus (GA-A-TO)	Repetition of the vowel (SO-O-OL)
S2 and S3 children	Anticipation of the onset of the second syllable (GA-T-TO)	Anticipation of the coda (SO-L-OL) (rare answer)
Mostly S3 and alphabetic kindergarteners	Full segmentation of the second syllable (GA-T-O)	Isolation of the coda (SO-L)
Only S3 and alphabetic children (transition)	Full segmentation of the first syllable (G-A-TO)	Onset-rime segmentation (S-OL)
Only alphabetic children	Full phonemic segmentation (G-A-T-O)	Full phonemic segmentation (S-O-L)

This study shows a strong relationship between the way children represent the words in their invented spellings and their ability to segment and synthesise sounds. It is interesting to notice that children succeed on syllabic segmentation before they show any concern for considering the number of syllables when deciding on the number of letters they need to spell a word. However, they use this phonological ability to segment the written words *a posteriori*, as they try to read them, revealing an understanding that letters represent word segments (syllables, in this case). Subsequently, they are able to use this phonological ability to control the number of letters they use in their invented spellings, as they write the word.

Therefore, as shown by Ferreiro (1986), when children struggle to understand why some words have more letters than others, they carry out phonological segmentation of the words, trying to find a match between the number of sounds and the number of letters. The first attempts to carry out this segmentation rely on the most salient phonetic segments, the syllables. However, this does not solve the problem, as the number of letters is always greater than the number of syllables.

So, children try to refine the segmentation by breaking up the syllable. This can be achieved by relying on articulatory features. Breaking up the syllable is very difficult and probably depends on some knowledge of the sound value of the letters (S1 and S2 children could not split the syllable). However, as shown by Vernon's results, the production of parts of the syllable is likely to depend on its position within the word, rather than on its letters (initial syllables proved to be most difficult to segment). So segmenting syllables is not just a function of knowing the sound value of the constituent letters involved. Likewise, children do not immediately use the ability to segment syllables (even partially) to produce spellings where sub-syllabic units are represented, in spite of the fact that breaking up the syllable would solve the "quantitative" problem of words composed of CV syllables: each unit would be mapped to one letter. So, it seems that the ability to detect at least some segments smaller than the syllable does not immediately translate into the way children spell words. However, this is not very clear in Vernon's study as the data for individual children were not presented and the words used in the invented spelling task were not the same as in the phonological segmentation task. Besides, it is puzzling that Vernon does not report the production of syllabic-alphabetic spellings by her subjects. Syllabic-alphabetic representations should be produced by those children who can segment at least one syllable per word.

Finally, at least for Spanish speakers, phonemic segmentation does not seem to be a necessary condition for producing alphabetic spellings. Vernon's study shows that it is possible for children to learn the orthographic representation of many syllables before being aware of phonemes. This is not surprising if we consider that Vernon's subjects had not been offered phonic training. Spanish speakers are generally taught to read by learning the "syllabic families" (the combination of the consonants with all the five vowels, as if it was a syllabary), thus considering the syllable as a phonological unit represented by two letters (most syllables are CV).[2] Anyway, Ehri's amalgamation theory (section 2.6.4.1) also accounts for the possibility of amalgamating the orthographic representation of the syllables with their pronunciation before being able to segment the phonemes.

It is possible that both the identity of the consonants in each "syllabic family" (eg: BA-BE-BI-BO-BU) and the dissimilarity across different "families" which share the same vowel (BA-CA-DA-FA, etc) provide the clue for the child to grasp the sound value of the consonants. This discovery is probably reinforced by the coincidence between onset (or coda) and initial (or final) phoneme, in CVC syllables. So, by realising the function of each grapheme, children can construct a stable representation of phonemes, triggering off the development of phonemic awareness. This, in turn, supports the further development of alphabetic literacy, allowing the improvement of the orthographic representation of specific words.

The development of the ability to segment words, as suggested above for Spanish speakers, is likely to be related to the specific features of Spanish orthography. We might expect the same pattern to be observed in similar orthographies, such as Portuguese or Italian, where most words are multisyllabic, the syllables are well defined and the vowels are quite transparent, but it is less likely that the same process would be found in English orthography.

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[2] This also applies to Portuguese speakers, but it is unlikely that children could produce correct spellings for more complex syllables (CCV, VC or CVC) before they grasp the phonemes. These syllables are not as frequent as CV syllables and some teachers teach them, after all the CV syllables have been taught, by exaggerating the pronunciation of the last consonant (in VC and CVC syllables) or the onset (CCV syllables).

b. Rhyme sensitivity and the use of analogies

One of the strategies which may lead to an increase in the number of orthographic representations and boost the knowledge of letter-to-sound correspondences is the transfer of knowledge about the sound value of a letter string from a familiar to a novel word. This kind of inference is generally called analogy. In English, most research on this subject focuses on the use of analogy to associate the sound of sub-syllabic units (rimes and/or onsets) to their orthographic representations.

There are two main reasons to consider onsets and rimes as the critical units to be considered when using analogies in English. The first reason is that these units constitute an intermediate level of segmentation between syllables and phonemes, (see Treiman, 1992). Since, as previously discussed, many English words (especially those used in early readers) are monosyllabic, analysing the word is analysing the syllable. Analysing the syllable into its phonemes proves to be too difficult for many children and especially for beginners. On the other hand, the sensitivity to rhyme and alliteration is achieved very early (Bradley & Bryant, 1983; Bryant et al., 1990; Maclean et al., 1987) and is thought to foster awareness of rimes and onsets because, in oxitone (words with the last syllable stressed) and monosyllabic words, the rhyme is based on the rime. Therefore, children should find it easier to learn the orthographic representations of the phonological units they are aware of (onset and rime) than of phonemes, which they are not aware of.

The second reason for considering rimes and onsets as the critical units in the use of analogies is the structure of English orthography. In English, the sound value of rimes is more stable than that of phonemes and many words cannot be read on the basis of grapheme-to-phoneme correspondences. So, if children could learn to match rimes and onsets to their orthographic forms, they should be able to read words more easily. Besides, this would show that phonological mediation is used even in learning and retrieving opaque spellings (Goswami & Bryant, 1992).

Although Vernon (1998) has found that, for Spanish children, segmenting monosyllabic words into onset and rime was almost as difficult as segmenting them into phonemes, we are aware of no study which had used similar tasks, in English. So, we have no reason to doubt that, in English, the most salient feature of the syllable is the onset-rime distinction and children should grasp this feature quite early.

In fact, Goswami (1986) and Goswami (1988) showed that beginners are able to read and to spell words by using analogies, especially when the analogous words are rhyming words. Goswami & Bryant (1990, 1992) also found that an oddity test for rhyme strongly predicted the effective use of rime analogies, even after children's ability to carry out phoneme deletion was controlled statistically. However, this was a cross-sectional study. In a longitudinal study, Muter et al. (1994) found that although the concurrent contribution of rhyming skills to analogising was significant, rhyming skills at age 4 and 5 did not make a significant contribution to analogising at age 6 (see also Muter, Hulme, Snowling, & Taylor, 1997). Moreover, Nation & Hulme (1996) found that seven year-olds (range 6;5-7;7), independently of their spelling age, (range 6;0-10;1) were able to use analogies based on the rime, on the initial CV and on the vowel. Although the mean number of words spelled correctly by children varied according to spelling age, there was no effect of word type (classified according to the analogous segment). Nation & Hulme argued against the primacy of rhyme in favour of an explanation based on connectionist models of the development of reading and spelling skills, which account for the simultaneous and automatic activation of different orthographic representations connected to the phonological information. (see sections 2.5.2. and 2.6.4.).

Nation & Hulme (1996) also argued against Marsh's and Frith's stage developmental theories (see sections 2.6.1. and 2.6.2.), which propose that children would only make use of analogies in the later stages of literacy development, but they had not mention whether the framework proposed by Ferreiro (see section 2.6.3) would account for their findings. According to this framework, the question about the sensitivity to rhymes and the use of analogies should not be reduced to the connection between phonological and orthographic information. From the constructivist perspective, what is involved in the capacity to use analogies is the child's conception about how the writing system works. We could explain the connection between rhyme and children's use of analogies as follows:

1. Rhyming and other phonological games carried out by young children in different cultural environments may reflect children's capacity to think about the spoken language as a distinct object, whose characteristics are independent from the meaning it conveys. Being able to think of words

separately from their meaning is fundamental to the establishment of connections between sounds and letters.

2. According to Ferreiro (Ferreiro, 1985, 1987; Ferreiro & Teberosky, 1983), children's first connections are syllabic. They enable children to construct orthographic representations, which may be relatively stable but still incomplete. Being able to go beyond syllabic representations involves the acceptance that syllables are generally composed of more than one letter, coupled with the capacity to decompose the syllable into smaller units, so that the one-to-one correspondence between sounds and letters can be preserved.

3. Experience with rhymes in English, where many words are monosyllabic, probably promotes the ability to decompose the syllable. This is a feature of English that is not present in other languages, such as Portuguese. However, in Portuguese, the most common syllables, the CV type ones, are easily transformed by changing the vowel and preserving the consonant and vice-versa. The important point is that decomposing or "transforming" the syllable involves the capacity to rely on both auditory and articulatory cues and this is fundamental to grasping the different role of consonants and vowels.

4. It is possible that the children who are comfortable at playing with spoken words, and establishing different criteria for categorising them according to their constituent sounds, will find easier to think about written words as objects that may also be categorised according to the similarity between their constituent parts. As soon as they discover that there is a correspondence between letters and sound segments, these children are prepared to establish the connection between sound identity and graphic identity. This allows them to realise that identical sounds often correspond to a string of letters rather than to a single letter. Establishing correspondences between sounds and strings of letters enables children to realise that the letter may sound different when in isolation or as part of a string. This is necessary to make inferences about graphic-phonetic segments, such as those involved in the use of analogies.

Therefore, at this level, the use of analogies is not merely a problem of linking sounds segments to orthographic representations. It is also a logical operation of "grouping" or "chunking" that requires children to solve problems involving part-whole relationships (see Mounoud, 1987 and also Moustafa, 1995). If they cannot solve these problems, they will not be able to understand that graphemes correspond to phonemes and, differently from the graphemes, most phonemes do not exist (as acoustic entities) outside the words they belong to. In English, the results of teaching programmes (or experiments) which encourage children to focus on spelling the "chunks" corresponding to the rime have produced very promising results in helping children with reading difficulties (Bradley & Bryant, 1983; Bryant & Bradley, 1985/1987; Greany, Tunmer, & Chapman, 1997). These results show that some children need specific tuition to overcome problems related to part-whole relationships in reading.

Once children have grasped the alphabetic principle, the use of analogies does not involve the same logical problems of part-whole relationships as in the early stages. Children (and adults) who are able to construct alphabetic representations of words use analogies to retrieve or to spell words whose orthographic representations are not transparent according to the rules of grapheme-phoneme correspondences, or to learn the grapheme-phoneme correspondences of segments they do not yet know. At this level, children have to understand that the relationship between graphemes and phonemes is rather one-to-many (and many-to-one) than one-to-one.

2.7.2. The role of phonological recoding

As shown in the previous section, being aware of phonological sub-lexical segments is a big step, but it is not sufficient to ensure literacy. To construct and retrieve orthographic representations it is necessary to understand the relationship between sounds and letters.

Usually, phonological recoding is defined as the ability to use the knowledge of spelling-sound correspondences to identify and spell unfamiliar words. This ability has been called "Phonological recoding in lexical access" (Wagner & Torgesen, 1987) "cipher reading" (Gough, Juel, & Griffith, 1992) and "decoding" or "sounding out and blending". (Ehri & Wilce, 1985; Ehri & Wilce, 1987b)

Share (1995) states that the process of lexicalisation needed to support the orthographic knowledge reflected in children's representations, is dependent on phonological recoding, together with underlying cognitive factors and print exposure. He proposes a *self-teaching hypothesis,* which "emphasises the primacy of phonological processes in word identification but also acknowledges the secondary roles of orthographic processing and contextual knowledge." (p. 200).

> (...) the self-teaching mechanism involves two component processes: phonological and orthographic. (...) The phonological component is simply the ability to use knowledge of spelling-sound relationships to identify unfamiliar words. This ability represents the sine qua non of reading acquisition. However, over and above the ability to decode unfamiliar words, there exist individual differences in the ability to store and retrieve word-specific orthographic information. Differences in visual/orthographic processing will determine how quickly and accurately orthographic representations are acquired. These visual/orthographic factors, however, will depend heavily on the successful operation of the phonological component. (p. 156)

Therefore, according to Share, an increase in the quantity and improvement in the quality of orthographic representations, will rely heavily on phonological recoding.

2.7.2.1. Development of phonological recoding

Generally, phonological recoding is measured by the ability to read simple CVC pseudo-words. However, Vandervelden & Siegel (1995) proposes that phonological recoding is developed as a continuum, both within and across tasks. They suggest that English speakers are first able to use the initial consonant, then the final consonant and lastly the vowels, when recoding CVC words. Likewise, the internal consonants are only used after children are able to use the boundary consonants in CCVC or CVCC words. Across tasks, the use of phonological recoding as a strategy in word recognition is achieved before its use in retrieval. Activities considered as requiring recognition are those where sufficient redundancy is provided, that is, strong contextual support is available so that information other than print can be used (not to be confounded with the redundancy principle presented in section 2.6.4.2.). These include tasks such as speech-to-print matching tasks (with or without the support of pictures to represent the words), reading a written word to complete a sentence presented verbally (cloze tasks), identifying words within a thematic category, asking the subject to read words that (s)he has just spelled etc. Retrieval activities are those with a low level of redundancy, where no cue is provided to limit the repertoire of words which could be presented. For instance, reading a list of words not included in any specific thematic category, reading a list of pseudo-words etc.

Whether phonetic cue reading described in section 2.6.4 (Ehri & Wilce, 1987b) should be considered as the first step in this continuum, was investigated by the authors in the study above-mentioned (Vandervelden & Siegel, 1995), with a sample of 36 kindergarteners, 36 grade 1 and 36 grade 2 children. A speech-to-print matching task was used to assess phonological recoding in recognition and a pseudo-word reading task was used to assess phonological recoding in retrieval. It was found that the use of phonological recoding in recognition develops before the use of phonological recoding to retrieve unknown words (or pseudo-words). However, the difference between the two tasks was of just one level. This means that, when children used the initial and the final consonant in recognition tasks, they used only the initial consonant in retrieval tasks; when they used both consonants and the vowel in recognition tasks, they used only the boundary consonants in retrieval tasks and so on. The results suggest that at least part of the cue reading strategies (when letters other than the initial consonant are used as cues on recognition of words) rely on partial cipher (partial use of letter-sound correspondences). The authors suggest that "the experience of matching speech to print stimulates the development of phonological recoding as a retrieval strategy for reading pseudo-words or unknown printed words" (p. 864). Therefore, the authors suggest that cue-reading is considered as the first step in the development of phonological recoding.

There is a slight problem with this study when evaluating the use of the initial consonant in retrieval tasks (pseudo-word reading). Children who read "sock" for *sut*, for example, might be using the knowledge of the sound value of the letter S to produce any word beginning with the sound /s/, as interpreted by the authors. But they could also use the S to pronounce the known word SOCK, which they might have learnt to recognise by using a paired-associate strategy. In this case, the results of the use of the initial consonant in pseudo-word reading might have been affected by the existence of false-positives. Fortunately, this does not seem to have affected the results, as partial pseudo-word reading was found to be achieved after partial recognition. Moreover, the study also showed that all the children, who attained a score of at least 80% on the use of the initial consonant on pseudo-word reading, reached criterion on learning to read novel words (see next section). Therefore, even if some of the words had been produced based on a paired associate strategy, this number would have been too small to affect the results. Anyway, we would not expect children to be able to store many words if they were unable to use at least partial phonological recoding. However, this is an issue to be considered when using partial retrieval to identify the level of phonological recoding.

Interesting differences between the use of phonological recoding in recognition and in retrieval were also observed by Ruiz (1988) in a study with 91 Portuguese speakers, from disparate socio-economic backgrounds, attending pre-school, kindergarten and first grade. Children were asked to read and to spell two lists of words with different numbers of syllables. Each word from one of the lists was also read by the child as soon as it was written. The words in the other list were read by the child when s/he had finished writing the whole list. So, one task had no redundancy at all (reading the list written by the experimenter). The other task had a low level of redundancy (reading the list after all the words were written) and one task had a high level of redundancy (reading each word after it was written). The most interesting results concern the comparison between the reading with no redundancy and the reading with high levels of redundancy. It was observed that:

- When reading with no redundancy, the most frequent answer was naming the letters without being able to blend them, or pronouncing any word without considering the letters identified. With high levels of redundancy, only three children gave this type of answer.
- Without redundancy, the second most frequent answer was the pronunciation of a word for each letter. With redundancy, just one child gave this type of answer.
- Without redundancy, only 46% of the subjects showed any level of word analysis, trying to make some correspondence between letters and sounds whereas, with redundancy, this proportion was 65% of the subjects.
- Among the subjects who showed any level of word analysis, 40% of the children used the syllable, either initial or final (also central in a few cases) as a cue to recognise the word, when there was a high level of redundancy. With no redundancy, just 23% of the children used cues to retrieve the word and these cues were restricted to the initial letter.

The problem with the high redundancy recognition task used by Ruiz (reading the word immediately after it was written by the child) is that, for most children, because of their difficulty with spelling the words, the word that was actually written was not the same as that dictated. So, either children tried to match the pronunciation of the dictated word to a non-conventional orthographic representation, or they interpreted the experimenter's request for them to read what they had spelled as a warning that they had written something different from what was dictated. In this case, the effect of redundancy was hard to evaluate because we cannot know whether the dictated word was used as a cue to limit the repertoire of possible words (for instance, children might, or might not, try to guess a word which sounded similar to the dictated one).

2.7.2.2. Phonological recoding and literacy

The relationship between phonological recoding and literacy was also investigated in Vandervelden & Siegel's study (1995). The assessment of literacy comprised: 1) learning a list of six words, over a maximum of 10 trials, by using a paired associate approach; 2) word reading of 60 one-syllable high frequency words; 3) word reading of a standardised test (WRAT); 4) spelling (standardised test).

It was found that speech-to-print matching was the best predictor of learning, while partial pseudo-word reading was the best predictor of reading high frequency words and complete pseudo-word reading was the best predictor of performance on standardised tests of reading and spelling.

Therefore, the development of phonological recoding and its relationship with literacy could be described as follows:

1. Use of partial phonological recoding (initial consonant) for learning and recognising words from a limited repertoire (with a high degree of redundancy). This probably draws children's attention to the relationship between sounds and letters and, eventually, develops letter-sound skills, which are essential to trigger the next phases.
2. Use of partial recoding (initial and final consonants) to spell and to recognise words with a high degree of redundancy, to recognise known high frequency one-syllable words, even without a high degree of

redundancy; use of partial recoding (initial letter) to partially retrieve pseudo-words.

3. Use of complete phonological recoding to spell and recognise novel words with a high level of redundancy; use of partial recoding (initial and final consonants) to retrieve non-words.

This suggests that partial letter-sound skills (partial cipher) are enough to construct and store orthographic (probably partial) representations of high frequent words, provided that there is a high degree of redundancy. This increases the reading vocabulary, which, in turn, provides the information necessary to learn an increasing number of letter-to-sound correspondences, which are necessary to achieve the highest level of phonological recoding:

4. Use of complete phonological recoding to retrieve accurately both pseudo-words and novel words out of context.

All these studies provide evidence for the development of phonological recoding, from a very elementary level, where it is restricted to the use of the initial letter in recognising words, up to the ability to sound out and blend all the letters in unknown words and pseudo-words. The important issue is that even partial recoding, which often is not sufficient for completely accurate recognition, retrieval or spelling of words, plays a key role in the construction, improvement and retrieval of orthographic representations.

Considered together, these studies also suggest that there is a strong relationship between children's hypotheses about the alphabetic system, the quality of their orthographic representations and their level of phonological recoding.

2.7.2.3. The understanding of the alphabetic principle and the self-teaching mechanism

Now, we can return to Share (1995) and try to consider his proposal for a self-teaching mechanism in light of the findings described above.

> According to the self-teaching hypothesis, each successful decoding encounter with an unfamiliar word provides an opportunity to acquire the word-specific orthographic information that is the foundation of skilled word recognition. (...) phonological recoding acts as a self-teaching mechanism or built-in teacher enabling a child to independently develop both word-specific and general orthographic knowledge. (p.155).

> For the beginner, an initial set of simple one-to-one correspondences may represent the logical point of entry since it offers a minimum number of rules with the maximum generative power. (...) But this simpler, more manageable set is sufficient to kick-start the self-teaching mechanism which is then able to refine itself in the light of expanding orthographic knowledge. (P.156).
>
> In sum, there is a considerable volume of reading and spelling data indicating that an initially incomplete and oversimplified representation of the English spelling-sound system becomes modified and refined in the light of print experience, progressively evolving into a more complete, more accurate and highly sophisticated understanding of the relationship between orthography and phonology (p. 165).

Share's proposal for the existence of a self-teaching mechanism assumes the understanding that each phoneme has at least one graphic representation and each grapheme can be translated into at least one phoneme. It also assumes the understanding that words can be analysed into smaller units, the phonemes, and a small number of phonemes can be shared by an infinite number of words (phoneme identity).

Based on these assumptions, we suggest that the use of the knowledge of spelling-sound relationships to identify unfamiliar words, the phonological component of the self-teaching mechanism proposed by Share, is likely to be affected by children's hypotheses about the alphabetic system. More precisely, we suggest that the self-teaching mechanism is activated by the understanding of the alphabetic principle.

Byrne & Fielding-Barnsley (1989, 1990) used transfer tasks to assess whether children had grasped the alphabetic principle. The tasks consisted of training pre-school children (about five years old) to identify two words which differed only on one sub-syllabic segment (eg: fat and bat). Then children were tested on identifying a word from a pair (eg: fun and bun;) which shared the initial segment with the training words. The authors considered that success on this kind of transfer task revealed that children had acquired the alphabetic principle (see also Byrne, 1991, 1992, 1993 for a series of experiments which complement the conclusions of the initial studies). The authors concluded that, in order to succeed on a transfer task, children had to be able to segment or to detect the phonological identity of the segments involved and to know the sound value of the target letters (generally initial consonants).

Comparing this transfer task with the speech-to-print task used by Vandervelden & Siegel, (1995) to assess partial phonological recoding (initial consonant) in recognition, we see that both involve the knowledge of the sound value of the initial consonant and the ability to detect identity of the initial phoneme (or rather initial onset) in different words. However, Vandervelden & Siegel's task should be slightly more dependent on letter knowledge, because children had to rely more heavily on their knowledge of the sound value of the initial letter. In Byrne & Fielding-Barnsley's transfer tasks, children might use the sound identity with the words that had just been learnt to remember the sound of the target letters. However, the ability to transfer this knowledge involves the understanding of the alphabetic system, which was shown to depend on a minimal knowledge of letter-to-sound correspondences. Therefore, the use of partial phonological recoding (initial consonant) for learning and recognising words with a high degree of redundancy, as measured by the speech-to-print matching task in Vandervelden & Siegel's study, is likely to require the same understanding of the alphabetic principle as the transfer tasks used by Byrne & Fielding-Barnsley.

Moreover, in Byrne & Fielding-Barnsley (1990) it was found that, once children were able to detect phoneme identity and had learnt the alphabetic principle applied to a situation, they would transfer their knowledge to another situation. Therefore, the understanding of the alphabetic principle, shown by the ability to make inferences about graph-phonetic segments, enables children to recognise novel words. This transfer of the knowledge of the sound value of a graphic segment from a known word to a novel word is the same as using analogies in the very early stages of reading acquisition, as discussed in section 2.7.1.4.b.

The orthographic component of the self-teaching mechanism, defined by Share as "the ability to store and retrieve word-specific orthographic information", enables children to reconstruct and create graphic representations of spoken words.

This means that the ability to use the initial consonant for partial recognition (speech-to-print matching task), is not enough to trigger the self-teaching mechanism. As shown by Vandervelden & Siegel (1995), at this level (level 1), children are not likely to construct a sufficient number of orthographic representations to increase their reading vocabulary.

Therefore, we suggest that phonological recoding starts to function as a self-teaching mechanism when children make use of partial phonological recoding to recognise known high-frequency words, even without a high degree of redundancy and to partially retrieve pseudo-words. This would correspond to step 2 in the hypothetical development of phonological recoding, proposed in section 2.7.2.2.

In summary, we suggest that the understanding of the alphabetic principle triggers the self-teaching mechanism via the improvement of phonological recoding. The difference (in time) between these two steps (steps 1: understanding of the alphabetic principle; step 2: kick-start of the self-teaching mechanism) should not be large and it is even possible that they occur almost simultaneously. The gap between the two probably depends on children's knowledge of letter-to-sound correspondences.

The understanding of the alphabetic principle has the power to trigger the self-teaching mechanism because the main property of an alphabetic system is its productivity or generative power: with a small number of signs and a limited number of orthographic rules, it is possible to generate an infinite number of words. The self-teaching mechanism is the acceleration of the developmental process resulting from the possibility of taking advantage of the productivity of the alphabetic system.

2.7.2.4. Partial phonological recoding and the syllabic hypothesis

The development of cue reading and its relationship with children's representations of script, as reflected in their invented spelling, was also investigated by Cordeiro (1994) and Cordeiro & Roazzi (1995), in a study with 40 first graders, all monolingual Portuguese speakers (mean age = 96.5 months; range = 68-114 months). No children could read or spell alphabetically when the study began. As we saw in section 2.7.2.1., cue reading involves minimal levels of phonological recoding. Cordeiro's study can be considered as an investigation of the relationship between phonological recoding and children's understanding of the alphabetic principle.

A word recognition task, where children had to identify a novel word by using just one or a few of its graphic segments as graph-phonetic cues, was used to assess cue reading. Cue reading (or partial phonological recoding) was the only strategy available, as all the letters except the target segments were replaced by small squares, forcing the child to use these segments as cues to identify the partially hidden word. Different types of cues were used (syllables, vowels and consonants in different positions within the word). These segments were shared with a previously trained word (clue word), which was exposed during the whole test, allowing children to learn the sound of the target segments by analogy with the clue word. In other words, this task was similar to the tasks used in Byrne & Fielding-Barnsley's studies in the sense that children could transfer the knowledge of the sound value of the target segment from the clue-word to the target word. But the similarity stopped here, because, in this task, the clue word was present, so children could scan it when looking for the target segment. Moreover, the target segment was not always the first segment in the clue-word.

A high level of redundancy was obtained by using pictures for contextual support. Each item comprised five pictures and children had to choose which one of them illustrated the word being identified (target word). So, in spite of part of the word being invisible, this task can also be considered as a speech-to-print matching task, similar to the one used by Vandervelden & Siegel, in the study discussed previously.

It was observed that:

- Children who could understand that letters do not represent whole words but segments of words (or syllables) could identify a novel word by using the initial or the final vowel as a graph-phonetic cue.
- Children who were able to encode all the syllables of the word by using at least one correct letter could also identify a novel word using all the vowels of the word.
- Children who used consonants instead of or together with vowels because they had realised that they could not use the same letter to encode both syllables and vowels, were also able to identify a novel word by using its initial syllable.
- Children who used consonants together with (but not instead of) vowels because they had realised that they needed more than one letter to encode both syllables and vowels, were also able to identify a novel word by using its final syllable;
- Finally, those children who fully grasped the phoneme-to-grapheme relations, could also use the initial consonant of a novel word as a graph-phonetic cue to identify this word (at least when its first syllable was a CV or a CVC syllable).
- The successful use of all the consonants in the word as graph-phonetic cues seems to require not only the understanding of the alphabetic basis of the

writing system, but also a more sophisticated ability to segment and blend phonemes.

Therefore, it was observed that children could make use of vowels as cues for word identification as soon as they understood that letters represent phonological segments (although not yet phonemes). All the children knew the vowels, so it was not necessary for them to scan the clue word in order to learn the sound of the vowels.

The early use of vowels in both invented spelling and word identification is not found in English and seems to be related to the characteristics of the orthography. In Portuguese (especially Brazilian Portuguese), as in Spanish, the sound value of the vowels is quite transparent and their sound often coincides with their name. [3] The name of the vowel is heard every time a syllable is pronounced. Vowels are the first letters taught in school and many children already know them before being formally taught. Thus, it is not surprising that the vowels are used to represent syllables both in spelling and in word identification.

A few children also succeeded in using initial consonants while they were still trying to produce a stable graphic representation for syllables rather than for phonemes, in their invented spellings. This shows that, as has been found in studies with English speakers, for some Portuguese speakers, the use of the initial consonant in recognition precedes its use in spelling. However, for most children in this sample, the capacity to use the initial consonant as a graph-phonetic cue for word identification was related to the ability to produce accurate spellings of most CV syllables. (see also Stuart, 1990). Therefore, the ability to recognise words by phonologically recoding the initial consonant, in Portuguese, seems to coincide with the production of alphabetic spellings. This means that, as in English, phonological recoding of the initial consonant reveals the grasping of the alphabetic principle.

However, it is not so simple. Some children succeeded in discovering the sound of the initial and the final syllable in the target word, by analogy with the clue word, although they could not recode either the syllable, or the consonant. The use of the syllable as the target segment, in this task, could not be due to the recognition of the

[3] In Portuguese, except when they are nasalised by a "~" or by being followed by "n" or "m", vowels (except in one or two cases) correspond to just one phoneme, which can be either open or closed, depending on whether the syllable they belong to is stressed or not.

vowel, because the syllables (in the same position) of some or all the distracting words shared the same vowel with the target word. For example: target word LAGARTO (lizard); cue segment LA; distracting words: LAGARTO; MACACO (monkey); FANTOCHE (puppet); SAPATO(shoe); DANONE (children frequently replace the name of the product, yoghurt, by the name of the brand). So, to learn the sound of the syllable from the clue-word, children had to be aware that they would need a specific consonant, even though they did not know which. The strategy these children used is shown in the following example, where the target word is LAGARTO (lizard), the cue segment is LA and the clue word is PANELA (pan). Children segmented PA-NE-LA by pointing to the vowels. This allowed them to identify the segment LA as /la/ and not as /ma/, /fa/, /da/ or /sa/, the initial syllables of the distracting words.

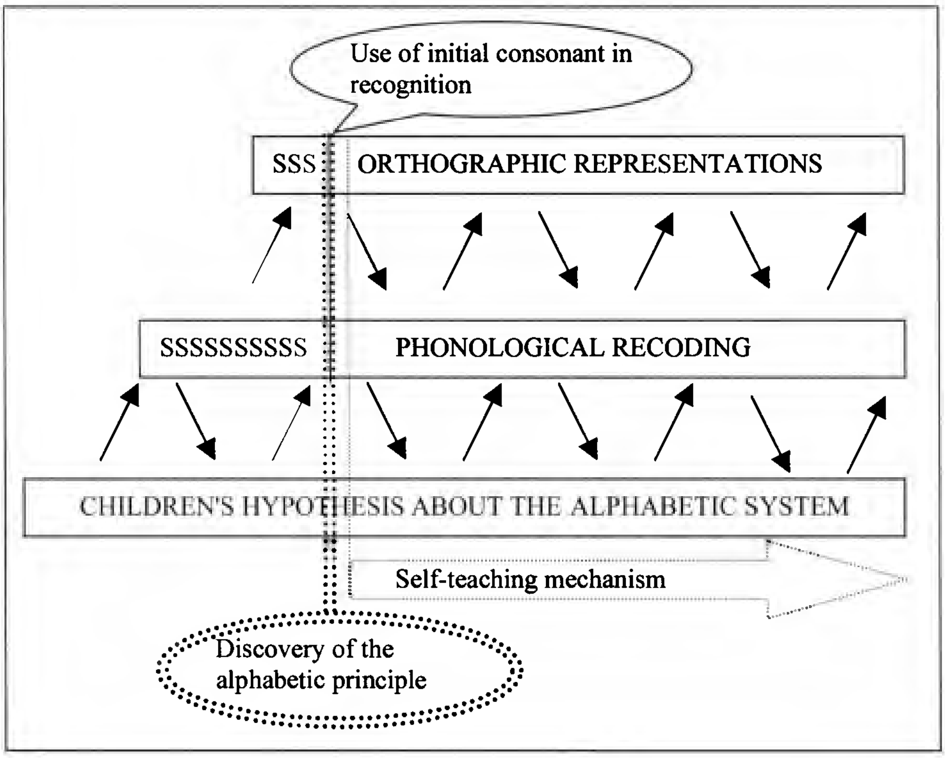
Therefore, it is possible that some children can learn to recode syllables by using this strategy, depending on whether they understand that they need letters other than only the vowel to compose a syllable. If they do not understand this, they will keep treating the vowel as the syllable and then the vowel will correspond to as many sounds as the syllables it stands for. In this case, children would not be able to decide whether LA was the initial or the final syllable in PANELA.

This shows that the roots of the understanding of the alphabetic principle lie in the late syllabic phase, according to Ferreiro classification (1985), when children realise that the vowel on its own is insufficient to represent the sound of the syllable. Often they start using the consonants to replace the vowels in those syllables where the name of the consonant matches the sound of the syllable. However, as there are not enough letters to match the pronunciation of all the possible syllables, children come to understand that they need both consonants and vowels to represent the sound of a syllable. Vernon's study (1998), described above, shows that, at this level, some children can segment either the onset or the coda of at least one syllable in the word. This leads to the production of syllabic-alphabetic spellings (according to Ferreiro's classification). Therefore, the syllabic-alphabetic, or even the late syllabic representation of words rather than the alphabetic representation, would reflect the onset of the understanding of the alphabetic principle.

This raises one question: is the partial representation of syllables (by using vowels or consonant names) a reflection of primitive phonological recoding? In other words, should the onset of phonological recoding imply representation of the initial phoneme (or initial onset), or should the definition of phonological recoding be broadened to include letter-to-syllable correspondences?

Figure 2.7-1 illustrates a possible model to help us understand the interrelation between children's hypotheses about the alphabetic system, phonological recoding and orthographic representations. This diagram is just an illustration. It is not intended to be an information-processing model, so the rectangles are not supposed to represent modules or units, nor does the size of the shapes indicate anything about their relative importance.

Figure 2.7–1 Diagram to illustrate the interrelation between children's hypotheses about the alphabetic system, phonological recoding and orthographic representations



We added a section to the representation of both phonological recoding and orthographic representations, which is marked SSSSS. This is to illustrate the question raised above, about whether the definition of phonological recoding should be broadened to include letter-to-syllable representations. If we decide that it should, the discovery of the alphabetic principle would not trigger phonological recoding, as suggested in the previous section. However, it would still trigger the ability to recode the initial consonant (in recognition), as shown in the diagram.

There is another question implicit in this discussion, which is why syllabic representation does not seem to be an issue in studies with English speakers. For Byrne, (1992) either children are non-analytic (logographic, according to Frith's classification, or pre-syllabic, according to Ferreiro), or they are alphabetic. There is no intermediate level. Even when phonological recoding is restricted to the initial consonant, it involves the understanding of the alphabetic principle, as shown above. There is no mention of any kind of phonological analysis other than phonemic.

The use of the name of the consonant to represent syllables is also observed in English, but Treiman (1997), for instance, considers this as a symptom of the fragility of the alphabetic principle. However, rather than reflecting a regression from the alphabetic representation, the mixture of syllabic and alphabetic representations either within or between words is more likely to reflect the transition from the syllabic to the alphabetic level, as suggested by Ferreiro (1985). So, this shows that the syllabic-alphabetic hypothesis can also be found in English.

Deciding whether there is a syllabic level similar to the one found in Portuguese, Spanish and other languages would require further research. I suggest that the main problem is not the opacity of English vowels, but the amount of monosyllabic nouns and the fact that this is the type of word used in most studies. The problem with monosyllabic words is that they do not allow a syllabic representation. As explained by Ferreiro (1984, 1985, 1986, 1987) and Ferreiro & Teberosky (1983), at this level, children cannot accept the existence of words with less than three letters (although this may vary according to the orthography). Therefore, monosyllabic words are the most difficult to represent syllabically, as they would require the use of just one letter, which is not considered adequate. Often children write down several letters randomly, just to make up a readable word. In the data collection of Cordeiro's study (1994), it was observed that several children were able to produce syllabic representations of three syllable words with no problem, whereas they had some difficulty with disyllable words and regressed to a pre-syllabic representation when spelling monosyllabic words. However, these data were never completely analysed, so it is not possible to know whether this was a significant trend. Even so, it shows that monosyllabic words are not adequate to assess levels of syllabic analysis. When stretching the pronunciation of a monosyllabic word to match the number of sounds to the number of letters, children end up becoming aware of sub-syllabic units and, eventually, of phonemes.

Therefore, as soon as children realise that letters represent sounds and not whole words, the salient sub-lexical segments available in monosyllabic words are not syllables but sub-syllabic units (onsets / rimes, or, as found by Vernon, onset + nucleus / coda). Where syllables have onsets, onsets are always consonants (one or two), so even the first partial phonological representation of monosyllabic words already requires both the sensitivity to sub-syllabic phonological segments, and the understanding of the role of letters (consonants and vowels) as marks to represent these segments. Vernon's study described in section 2.7.1.4.a showed that the segmentation of monosyllabic words (rather than their transformation into disyllables) was only achieved at the late syllabic or at the syllabic-alphabetic level. This means that the ability to segment monosyllabic words into sub-syllabic or phonemic units is related to the understanding of the alphabetic principle, as discussed above. This agrees with Byrne et al.'s findings, but does not mean that children "jump" from a non-analytic to an alphabetic strategy. Therefore, further research is necessary to investigate whether, when using words with two or three syllables, English speakers also show intermediate levels of phonological/orthographic representation.

2.8 Promoting Literacy Development

2.8.1. Inducing the understanding of the alphabetic principle

As discussed above, one of the most difficult steps (probably *the most* difficult) in literacy development is the understanding of the alphabetic principle (although this does not obviate subsequent difficulties). As soon as the alphabetic principle is acquired, the process of reading and writing acquisition is self-sustaining. It allows a rapid increase in the knowledge of letter-to-sound correspondences (including the distinction between letters on their own and letters as part of a string), as well as the development of phonemic awareness, in the sense used by Morais et al. (1987a). So, helping children to grasp the alphabetic principle has been a permanent feature of literacy research and teaching. Now we can return to the question first raised in section 2.6.3., about the role of *mediators.*

As mentioned above, the alphabetic principle is the understanding that each phoneme has at least one graphic representation and each grapheme can be translated into at least one phoneme. It is also the understanding that words can be analysed into smaller units, the phonemes, and a small number of phonemes can be shared by an infinite number of words (phoneme identity). So, the understanding of the alphabetic principle is underpinned by the development and coupling of (at least) two components: the knowledge of letter-to-sound correspondence and the capacity to detect phoneme identity between words. The coupling of the knowledge of letter-sound correspondences and the ability to detect phonological identity is displayed through the use of phonological recoding, which also involves the understanding of the part-whole relationship between letters and words ("chunking", see Mounoud, 1987).

Bradley (1981); Bradley & Bryant (1983); Bryant & Bradley (1985/1987), as well as Cunningham (1990) showed that significant reading progress is achieved when training in phonological awareness is coupled with the teaching of letter-to-sound correspondence. Byrne (1991, 1992) and Byrne & Fielding-Barnsley (1989, 1990) confirmed that the ability to couple these two components is the sine qua non for the grasping of the alphabetic principle (see also McGuinness et al., 1995).

Even if we consider that the ability to map the letters to syllables that sound like their names is a first step, it is not clear whether the alphabetic principle can be acquired without explicit information about letter-sound correspondences and phoneme identity. Byrne's study (1992) showed that explicit information is necessary, as children were not able to discover the rules of the alphabetic system by just being exposed to families of words organised to make the rule more salient.

However, most Portuguese and Spanish children are taught according to a syllabic approach, which consists of learning syllabic families (see section 2.7.1.4.b). Under this approach, the consonants are not sounded in isolation, although often children are taught the alphabet (as the names of the letters).

According to Byrne (1996), the presentation of the writing system as if it was syllabic would be likely to make children think that the basis of the writing system is syllabic, thus preventing them from grasping the alphabetic principle.

However, there is also a strong possibility that children may develop an awareness of sub-syllabic segments, as well as phonemic identity, by comparing the syllables of the same family, as well as the syllables, in different families, which share the same vowel. This is facilitated by the fact that most syllables (both in Portuguese and in Spanish) are of the CV type, the consonant coincides with the onset and the vowel with the rime. Thus, a sub-syllabic analysis is often enough to tap the phonemes. The analysis of the onset/phoneme (initial consonant) may be achieved by first relying on articulatory features, such as the position of the lips, the teeth and the tongue. Therefore, children can produce alphabetic spellings and grasp the alphabetic principle before they succeed on tasks such as phonemic segmentation, as shown in Vernon's study. In this case, segmental (phonemic) awareness builds on the analysis of the print (written syllable) to the analysis of the speech (spoken syllable).

In fact, as mentioned in section 2.7.1.3, there is some evidence that measures of phonological awareness are not significant predictors of children's achievement in literacy, when children are taught by a syllabic approach, in opposition to either a phonics approach (Cardoso-Martins, 1991) or a whole language approach (Rego, 1995; see also Signorini, 1997, for an exploratory study in Spanish). This means that, in Portuguese, individual differences in phonemic identity awareness can be compensated by teaching children to relate the sound of the syllables to their spellings. As suggested by Rego (1995):

> The syllabic method favours the transition to the alphabetic phase, neutralising the possible effects of differences in phonological awareness. A possible explanation for these results would be that, when the method is syllabic, the learner has more opportunities to undertake phonological analysis based on perceptible linguistic units, facilitating the phonological awareness necessary to the reading of Portuguese. (p. 58, *translated by the present writer).*

Although these findings show that the syllabic approach for teaching literacy in Portuguese is likely to be more effective than either the phonics or the whole-language approach, it is still possible that a small number of children would need explicit information about grapheme-phoneme correspondence to grasp the alphabetic principle.

Therefore, it is interesting to investigate the effects of adding explicit information about grapheme-phoneme correspondence to children who are being taught literacy using a syllabic approach.

2.8.2. Encouraging the use of analogies

As discussed in section 2.7.2.3, the same kind of inference required to succeed on Byrne & Fielding-Barnsley's transfer task is required when using analogies (see also section 2.7.1.4.b). However, the use of analogies without the availability of contextual support to increase redundancy involves the need to blend the analogous segment with the remaining segments of the word. This is not required on the transfer tasks of the speech-to-print type, where children have to decide which written word matches the word pronounced by the experimenter. Therefore, the use of analogies without contextual support involves retrieval, while the use of analogies to select one word out of a limited repertoire involves recognition. As discussed before, even though both operations require the understanding of the alphabetic principle, retrieval requires a slightly more advanced level of phonological recoding than recognition. Therefore, even the youngest children who succeeded in using analogies in Goswami's studies (Goswami, 1986, 1988, 1993 and Goswami & Bryant, 1990, 1992) should be aware of the alphabetic principle and should have some level of phonological recoding.

This issue was investigated by (Ehri & Robbins, 1992). The authors found that cue readers were not able to use analogies because they did not have enough decoding skills to blend the onset with the rime, nor did they have mental orthographic representations which were sufficiently complete to be used as clue words. In spite of this last point not being applicable to Goswami's experiment, where the clue word was exposed, it was a strong claim against the effectiveness of beginners' use of analogies to support the reading of novel words in everyday situations. In fact, Muter et al. (1994) and Savage (1997) found that children were more likely to use analogies successfully when the clue-word was exposed than when it was not. Moreover, Muter et al. found that children who succeeded without the availability of clue-words were those who had some level of reading and spelling skills. This goes against Goswami's claims that even non-readers can make use of analogies successfully.

Studies with more transparent orthographies (Lukatela, Carello, Shankweiler, & Liberman, 1995; Öney & Durgunoglu, 1997; Signorini, 1997; Sprenger-Charolles & Siegel, 1997; Wimmer & Goswami, 1994) show that beginners are more likely to rely on phonological recoding than any other strategy. This shows that, in languages where the mapping between graphemes and phonemes or between syllables and their pronunciations allows the effective identification and spelling of words, there is no need to construct a broad repertoire of specific orthographic representations to support the identification of unfamiliar less transparent words. This is achieved later, as the learner gains more experience of reading and spelling.

It is possible that, even in more transparent orthographies, analogies could be used as a learning strategy to increase the repertoire of known syllables. As suggested in section 2.7.2.4, Portuguese speakers who understand the alphabetic principle should be able to discover the spelling (or the sound) of unknown segments by relying on the vowels when scanning known words. This would allow them to speed up the process of literacy development by taking advantage of the self-teaching mechanism. The educational implications of this process are obvious, especially for the teachers who have to deal simultaneously with children at disparate levels of literacy development. More advanced children would not need to be taught all the letter-to-sound correspondences (either in syllables or phonemic segments). A bank of illustrated words could enable them to carry out reading and spelling tasks at their own pace, while freeing the teacher to give individual support to the children with difficulties.

The studies on the use of analogy have shown that the potential to make this kind of inference emerges very early and before children show full phonological recoding skills, although this ability is unlikely to emerge spontaneously in most children.

2.9 Summary

In this literature review, we have tried to articulate the findings and claims of different approaches to the study of literacy. We tried to show that the seeds of a more comprehensive theory of literacy are already implicit in some studies, but it is necessary to make them explicit so that the theory can be refined.

Ferreiro's work (section 2.6.3) shows that children's interpretations about the writing system underpin their spellings of words and word segments, as well as the strategies they adopt when constructing hypotheses about, first, the meaning and, later, also the sound of graphic segments. Hypotheses about the sound of sub-lexical segments are only formulated after children construct the syllabic hypothesis. Children test their hypotheses by checking the internal coherence of their system of interpretation and the correspondence between their productions and the conventional ones. When there is conflict within the system, or between children's representations and the conventional spellings, they formulate a new hypothesis, which allows them to produce a representation closer to the conventional one. Skilled readers play an important role in challenging children's interpretations as well as providing models of conventional reading and writing and demonstrations of different strategies for making inferences about graph-phonetic segments.

Perfetti (section 2.6.4.2) claimed that spellings reveal the quality of orthographic representations. Ehri and Perfetti (section 2.6.4) confirmed that orthographic representations of words and sub-lexical segments are not obtained by simply "copying" a written word into the brain. They are constructed through a process of gradually amalgamating the orthographic image of words and sub-lexical segments to their pronunciations. The process of amalgamation is not developed on a letter-by-letter (sequential) basis. First, children map more salient sound segments onto an orthographic representation that is often incomplete and/or unstable, such as representing syllables by letters whose names sound like the syllable. Ehri called this strategy "phonetic cue" reading. Only later are children able to use phonological recoding (decoding skills) to construct stable orthographic representations, which provide the basis for storing a reading vocabulary broad enough to support the production of inferences, such as the use of analogies.

Vandervelden (section 2.7.2.1/2) showed that the definition of phonological recoding should be broadened to include the partial and more elementary mappings between sounds and letters or letter strings, or, in other words, to include phonetic cue reading. In this sense, phonological recoding develops gradually and reflects children's attempts to find the perfect match between sounds and letters.

These attempts start at a syllabic level and progress till children succeed on mapping graphemes to phonemes, that is, till they grasp the alphabetic principle.

Based on Bryant & Bradley's studies on the importance of categorising spoken and written words according to onset and rime identity and following Ferreiro's theoretical framework, we suggest that grasping the grapheme-phoneme correspondence (the full understanding of the alphabetic principle) depends on children's capacity to chunk, which requires them to resolve the part-whole relationship between letters and words. In Portuguese, the most natural "chunks" are probably CV syllables. Therefore, we predict that the representation of both the vowel and the consonant in, at least, some CV syllables, (syllabic alphabetic representation) in children's invented spelling should be accompanied by a critical improvement on all the measures related to literacy acquisition.

The discovery of the alphabetic principle triggers the self-teaching mechanism, proposed by Share (section 2.7.2.3). This produces a dramatic improvement in the quantity and the quality of orthographic representations of both particular words and different kinds of sub-lexical segments, speeding up the process of literacy development.

Byrne (section 2.8.1) claimed that the understanding of the alphabetic principle is reflected in children's ability to make inferences about graph-phonetic segments. This is coherent with Ehri's findings on the use of analogies. However, it is not clear whether children are able to make inferences at a syllabic level, at least in more transparent orthographies, where the syllabic structure is well defined.

This study investigates whether the development of the understanding of the alphabetic principle, in Portuguese speakers, could be interpreted by using the theoretical framework summarised above. It focuses on the changes that occur in children's orthographic representations and in their ability to make inferences about graph-phonetic segments, suggesting that these reflect children's hypotheses about the alphabetic system. It also investigates how children's progress is affected by the cognitive processes underlying phonological recoding and by adults' explanations of how scripts represent speech, as well as by specific characteristics of the particular orthography which children are trying to learn.

3. METHODOLOGY

3.1. Introduction

The theoretical framework presented in the previous chapter suggests that children's interpretations of the writing system simultaneously affect and are affected by their capacity to match sub-lexical phonological segments to letters when spelling words.

This mutual influence could be schematically translated in the following developmental sequence:

1. Discovery that the letters represent sub-lexical phonological units, at the syllabic level (for the purposes of this study, we will ignore the development that leads to this discovery);
2. Gradual development of phonological recoding, which relies on the refinement of phonological awareness and an increase in letter knowledge;
3. Grasping the alphabetic principle, allowing the construction of orthographic representations of words and phonological segments (even though still partial and incomplete);
4. Development of the capacity to make inferences about graph-phonetic segments to improve reading and spelling (kick-start of the self-teaching mechanism);
5. Expansion of the understanding of the alphabetic system beyond grapheme-phoneme correspondence.

Taking into account evidence from previous research, discussed in the literature review, we argue that the discovery that letters represent sub-lexical units, at least in Portuguese and in Spanish, is initially expressed by the formulation of the syllabic hypothesis. This is reflected in children's attempts to match letters to syllables, both in invented spelling and in word recognition.

What is less clear, though, is whether the definition of phonological recoding should be extended to include the ability to produce syllabic representations of words, especially those where syllables are represented by their vowels, or by the consonants whose names sound similar to the pronunciation of the syllable. In other words, it is not clear whether the ability to match graphemes to phonemes emerges from the gradual evolution of the ability to match letters to syllables.

As phonological recoding involves the coupling of phonological awareness and letter knowledge, a better knowledge of the relationship between phonological awareness, letter knowledge and the production of syllabic spellings should elucidate this question. For instance, do children produce syllabic spellings because:

a) They are unaware of phonological units smaller than the syllable?

b) They are aware of these units but they do not know the letters to match them?

c) They are aware of sub-syllabic units and they know the letters to match them, but they still need explicit information about the alphabetic principle in order to integrate this information?

The other question that is not clear is whether children can make inferences about graph-phonetic segments before they move beyond the syllabic hypothesis.

To investigate these issues, it was decided to observe the changes that occur as children go through the process of understanding the alphabetic principle. The observation focused on invented spelling and on tasks requiring the ability to make inferences about graph-phonetic segments, as these were assumed to reflect children's understanding of the alphabetic principle and the quality of orthographic representations of words and sub-lexical segments.

3.2. Considerations About the Design

The design of this study was constrained by the limited financial resources as well as the short time available for the data collection. This created some problems, which determined the final design.

1. *Might the limited time available be too short for any changes to be found?*

   The time available to carry out the data collection was limited to a maximum of 10 weeks. This is too short for a longitudinal study. To guarantee that a significant amount of change would be observed within such a short period, it was necessary to accelerate the changes, if possible. A short intervention was thought to be the solution.

2. *What kind of intervention would be most appropriate?*

One of the questions that has not been answered in the literature was whether, at least in orthographies with a clear syllabic structure, it is necessary to provide explicit information about grapheme-phoneme correspondence, for children to grasp the alphabetic principle. It could be the case that explicit instruction about any kind of word analysis would do. An intervention study would contribute to clarifying this question, if different intervention groups were organised. In addition to the control groups and to a "phonemic analysis intervention group", where children were explicitly taught about the alphabetic principle, a "syllabic analysis group" could be created. In this group, children would be taught to analyse words in syllables, but not in phonemes. This would shed light on the effects of this type of information.

Moreover, since most activities in Brazilian classrooms emphasise the syllabic rather than the phonemic analysis of words, the syllabic intervention would help to shed light on children's development in regular school settings.

It is important to stress that the study was not designed to compare the effectiveness of different types of intervention or the effects of different school practices. The use of different types of instruction, during the intervention was intended, in the first place, to speed up the process of changing and, in the second place, to provide more information about the effects of readers' explanations on children's understanding of the alphabetic principle.

3. *How to guarantee that the effects of school activities, as well as the teaching provided by parents, at home, would not interfere with the effects of the intervention?*

This problem was unavoidable, so the solution would be to try to reduce it as much as possible and by means of statistical controls.

First, children should belong to families from a disadvantaged social background, as, in previous studies, these have been found less concerned to urge children to read before primary school (seven years old). The use of a low socio-economic sample was also preferred because this is more representative of the majority of the Brazilian school population. Second, children should stay in school as long as possible, to reduce the chances of parents providing additional homework. Third, the study should be carried out in a place where the educational policy requires children to learn to read during the first year of primary school (when children turn 7 years old) and not in pre-school. Two day-care centres, in Curitiba, Brazil, were found to fit all these requirements.

Another control group was created by selecting a group of Portuguese children, from similar economic backgrounds, which attended mainstream schools in London. These children did not attend Portuguese classes before they were seven years old and, in the pilot study, it was found that their parents were not concerned to encourage them to read Portuguese before this age. However, they participated in the normal school curriculum, which included learning the English alphabet and receiving some tuition in phonics. Therefore, it was possible to investigate the impact of the same experimental intervention on children immersed in school programmes which stressed the relationship between sounds and letters in different ways: one emphasising the sounds of syllables and the other emphasising the sounds of letters.

4. *How to interview a sufficient number of children in such a short period, without the support of research assistants?*

The studies that assess children's hypotheses about the writing system are generally based on intensive follow-up of a few cases. The researcher needs to interact with the children in order to interpret their hypotheses, generally using the clinical method. However, in this study, it was important to make sure that statistical inferences could be drawn about the effects of cognitive factors. Therefore, the sample should not be too small. The solution was to interview the children in small groups instead of individually, making sure that they wouldn't cheat when producing the answers. This solution had the advantage of creating situations closer to the ones the children were used to in the classroom.

5. *How to assess children's hypotheses if we couldn't ask them to explain or justify their answers?*

This was the most difficult problem. It was clear that children's hypotheses could not be inferred, but it was possible to investigate whether their performance on the different tasks was consistent with the interpretations provided in previous studies by other researchers. The important thing was to make sure that the number of tasks (and conditions within each task) would provide the data necessary to allow such conclusions.

Moreover, it was assumed that, if children's hypotheses underpin their performance on literacy activities, these hypotheses should be reflected in children's performance, on versions of the same task, in different languages. The sample of Portuguese bilingual children could be used to investigate this issue, by using an experiment where children's performance on Portuguese and English versions of the tasks was compared.

Taking into account these considerations, a quasi-experimental design, comprising two experiments, was carried out. The first experiment involved two samples: one of Brazilian children, attending Brazilian pre-schools (day-care centres) and the other involving Portuguese children, attending English schools.

The second experiment involved just the sample of Portuguese children attending English schools. It used the data of the first experiment for this sample, plus the English version of some of the Portuguese tasks, to provide the data necessary to show whether children's hypotheses were affected by the specific characteristics of different alphabetic orthographies, such as Portuguese and English.

3.3. *Aims*

This study aims to describe and to suggest an explanation for the changes which occur in children's production of orthographic representations of words, as well as in their ability to make inferences about graph-phonetic segments, in Portuguese. Special emphasis is given to trying to investigate how these changes are affected by:

- individual differences in the cognitive processes underlying phonological recoding;
- adults' explanations of how scripts represent spoken words,
- specific features of the orthography that children are trying to learn.

3.4. Research Questions

The following research questions were formulated:

1. Should the definition of phonological recoding be extended to include the letter-to-sound matches involved in producing syllabic representations of words?
2. How is the ability to make inferences about graph-phonetic segments related to the production of orthographic representations and to phonological recoding?
3. Do the adults' explanations of how scripts represent speech affect the development of children's understanding of the writing system?
4. What are the effects of orthographic transparency on the construction of orthographic representations and on the ability to make inferences about graph-phonetic segments?

3.5. Experiment 1: Method

This was a training study designed to answer all but the last research question, which were further detailed, as follows:

1 Should the definition of phonological recoding be extended to include the letter-to-sound matches involved in producing syllabic representations of words?

   a) What is the relationship between phonological awareness, letter knowledge and the production of syllabic spellings?

   b) Can children make inferences about graph-phonetic segments before moving beyond the syllabic hypothesis?

2 How is the ability to make inferences about graph-phonetic segments related to the production of orthographic representations and to phonological recoding?

3 Do adults' explanations of how scripts represent speech affect:

   a) children's capacity to detect sound identity between words?

   b) children's ability to decide whether a word begins with a specific letter?

c) children's ability to make inferences about graph-phonetic segments to identify and to spell unknown words?

d) children's orthographic representations of words and word segments?

If positive,

e) Is there any influence of the kind of word analysis used during intervention (either just into syllables or into both syllables and phonemes) on the size or on the quality of the observed changes?

f) Is there any interaction between the kind of word analysis used during intervention and children's previous skills and conceptions?

4 Is there any difference between Portuguese children (attending English schools) and Brazilian children:

a) on the performance of pre-test tasks;

b) on the effects of experimental training?

3.5.1. Subjects

The study used two samples of Portuguese speakers.

Sample I comprised 65 Brazilian children (4 years 10 months to 6 years 7 months, mean = 6 years), attending Jardim II and Jardim III (equivalent to Reception and Year 1 in England) in two day-care centres, in Curitiba, the capital of the State of Paraná, in the South of Brazil. However, only the data of 62 subjects will be included in most analyses, as three subjects left the day-care centres after the pre-test.

Sample II comprised 28 Portuguese children (4 years 10 months to 7 years 8 months, mean = 6 years 7 months), attending Reception, Year 1 and Year 2 in two mainstream schools, in London. Table 3.5-1 shows the number of children per school, according to school grade.

Table 3.5–1 Number of children, per school, according to school grade (in parenthesis, the children who left)

SAMPLE	SCHOOL	RECEP. / JARD. II	YEAR I/JARDIM III	YEAR II	TOTAL
I	Centre A	10 *(2)*	21		31 *(2)*
	Centre B		31 *(1)*		31 *(1)*
II	School A	4	6	3	13
	School B	3	3	9	15
TOTAL		17 *(2)*	61 *(1)*	12	90 *(3)*

As far as possible, we tried to make the Portuguese and the Brazilian samples equivalent in terms of socio-cultural background and in terms of the parents' expectations about the age their children should learn to read in Portuguese. In London, after-school Portuguese classes, under the responsibility of Portuguese teachers, are sponsored by the Portuguese Government only for children over seven years old (only the three children in year II, School A, were attending the Portuguese after-school classes regularly, two or three times a week). Similarly, the children in the Brazilian sample were not expected to learn how to read before the following academic year, in the first grade, when they would turn seven years old. In Brazil, the school day lasts only four hours, including break-time, and the schools have fewer resources than in England, so children's experiences in school are quite limited and it is impossible to control the effect of after-school experiences. Therefore, instead of using regular pre-schools, the study was carried out in two day-care centres. The children stayed in the day-care centres for about nine hours, but this included recreation, watching TV or video, having three or four meals and even a nap after lunch. The more systematic classroom activities lasted for about four hours, including break-time. Therefore, in the day-care centres, children had the opportunity to experience activities more similar to the activities usually provided by English schools but that are not generally available in most Brazilian pre-schools.

One day-care centre (here referred to as Centre B), was attended exclusively by children whose mothers were employed in private homes as nannies, cooks or cleaners. It was located in one of the city’s wealthiest neighbourhoods, so children’s mothers could work nearby, in the homes of middle class families. The Foundation that maintained the Centre also ran a private school for middle class children in an adjacent building. The profits of the private school helped to maintain the Centre and other social services provided by the Foundation. Children attending the Centre shared the facilities (such as the drama hall, the dance studio, the sports court and the playground) with the children attending the private school, at different times. There was a GP and a dental surgery in the same building so children were offered regular health and dental checks and were referred to specialists (such as ophthalmologists, psychologists and audiologists) when necessary. During the morning, children followed the regular classroom activities organised by a teacher. In the afternoon, they watched videos and were engaged in guided recreational and artistic activities. At the time when this study was carried out, a specialised teacher was initiating a programme of extra class tuition.

The more advanced children worked together in small groups to produce their own books, while children with difficulties in the morning classes were provided a daily session of forty five minutes of pedagogical support, in small groups. As it was expected that this extra tuition could affect the results, the children were allocated equally to different intervention groups.

The teaching approach in this Centre stressed the learning of decoding skills, according to a syllabic approach. Children had been taught the alphabet (recognising and naming the letters) and how to write and recognise their first name (using capital letters). During the period of this research, children were starting to be taught the syllabic "families". They were taught how to join the letter B with all the five vowels and, at the end of the data collection, they had started to learn about the C "family". They were also being taught to write their first name, using handwriting.

All the 32 children born in 1990 who attended Jardim III (this would be more or less comparable to year 1 in English schools) participated in this experiment, but one left, so only 31 children were considered in the analyses.

The other Centre (here referred to as Centre A) was located in a mixed social-class neighbourhood and was also attended by children from low-income families. Most mothers were also employed as domestic servants, but the Centre accepted children of mothers with different occupations, or even those who were unemployed. The Centre was also linked to a private school but children did not have access to the same facilities. Full-time trained carers cared for the children. They provided activities such as story telling, story reading, crafts with recycled materials, painting and drawing, but children spent most of the morning watching the educational programs broadcast by 'TV Cultura'. Sometimes, when the weather was fine, the children spent about forty-five minutes playing in a small yard. Six-year-old children also attended regular classroom activities organised by a trainee teacher, during the afternoon. She taught children to recognise and to write their names using capital letters. She also introduced the alphabet but children were expected to learn it and to improve their decoding skills incidentally, as they tried to read and to write their own words and sentences. Most of the activities involved different kinds of recycled materials such as labels, grocery packs, cartoon magazines and storybooks. However, the teacher did not feel prepared to promote phonological recoding; she had been required by her supervisor to avoid 'mechanical' activities but she was not sure what to do instead. The classroom activities for five-year-old children were organised by the same carer who took care of them in the morning. They were not explicitly taught about letters or their function in representing spoken words.

All the 21 children born in 1990, who attended Jardim III (corresponding more or less to Year 1 in Britain) and the 12 children born in 1991 who attended Jardim II (corresponding more or less to Reception class in Britain) participated in this experiment. However, one child from Jardim II left after the pre-test and another child from Jardim II was excluded from most training sessions due to disruptive behaviour, caused by emotional problems. Therefore, most analyses were carried out with 31 subjects.

The advantage of this sample is that, as children spent about 9 hours per day in the Centres, the interference of experiences outside school and the risk of truancy and attrition were reduced (especially in Centre B, whose regulations required mothers to prove that their children's absence was justified, otherwise the child would be excluded). Also, these children's social backgrounds were representative of the majority of Brazilian children.

On the other hand, the children differed from most working class Brazilian children who do not have access to well-resourced pre-schools. They were offered more opportunities to interact with peers and adults over different kinds of written text, within a school-like environment where they could develop the social skills required to succeed in primary school. Therefore, in this sense, they were more comparable to middle class children who live in more "literate" environments and whose parents can afford the fees of private pre-schools from an early age. They were also more comparable to the Portuguese children in Sample 2, because of their socio-economic background and the school experiences they enjoyed.

Most children in Sample II were born in Madeira and attended two schools in London. One school (hereinafter called School A) was a R. C. (Roman Catholic) school. The other school (hereinafter called School B) was maintained by the LEA. School A had a full-time Portuguese teacher who helped any children with difficulties to carry out the regular school activities, especially in Year II. During the period of the data collection, a Portuguese support teacher had also been provided for school B.

The parents of most children in this sample worked in hotels, restaurants, or were cleaners in private households. Therefore, children in Sample I and Sample II had similar socio-economic backgrounds.

3.5.2. Design

This is a short-term longitudinal study comprising pre-test, intervention and post-test.

The experiment was carried out in the morning session, in Centre A and repeated in the afternoon session, in Centre B, in Brazil. Similarly, in London, (sample II), it was carried out in the morning session in School A and repeated in the afternoon session in School B.

3.5.2.1. Pre and post-test

Based on the experience of the pilot study, the pre-test was carried out in 13 daily group sessions of about 30/45 minutes. In Sample I, four groups per Centre were organised, with 7/8 children per group; in Sample II, three groups per school were organised, with 4/5 children per group. The post-test took 11 sessions because the Familiarity with Graphic Conventions of Scripts task was not administered in the post-test. The interval between pre- and post-test was four weeks for Sample I and three weeks for Sample II (corresponding to the intervention period).

The order of presentation of the tasks was balanced between groups to neutralise the order effects. The WISC tests were administered individually, in spare time between the group sessions.

In all the tasks where pictures were used, the experimenter made sure that all the children knew the name of the objects represented by each picture, before allowing children to start a new item. This was done to prevent misinterpretations of the illustrations, which could mislead children to give wrong answers.

In the post-test, the groups were rearranged in order to include a balanced number of children from the experimental and the control groups. This was to avoid any bias of the experimenter in favour of any one of the trained groups, when giving the instructions for the post-test tasks.

3.5.2.2. Intervention

Two experimental (Group 1 and Group 2) and two control groups (Group 3 and Group 4) were organised in Sample I; one experimental (Group 5) and one control group (Group 6) were organised in Sample II. The number of children per group is shown in Table 3.5-2.

Table 3.5–2 Number of children per intervention group

SAMPLE	SCHOOL	Group 1 (control)	Group 2 (control)	Group 3	Group 4	Group 5 (control)	Group 6
I	Centre A	8	8	7	8		
	Centre B	8	8	7	8		
II	School A					7	6
	School B					7	8

Before starting the intervention, children were matched first by invented spelling, then by school grade and then by behaviour (to balance disruptive children between groups). Afterwards, they were randomly assigned to either one of the or the experimental groups. Children who attended the extra tutorial class, in Centre B, were also equally distributed between the groups. This was not a problem, as they had been assigned to the tutorials because they were either at the bottom or at the top of the class. Therefore, the matching according to the performance on invented spelling had already guaranteed a balanced distribution of these children. Other differences on pre-test scores were controlled *a posteriori,* by using the appropriate statistical procedures.

Age was one of the measures that were controlled statistically. Table 3.5-3 shows the mean age of the children per school and intervention group.

Table 3.5–3 Mean age of children per school and intervention group

SAMPLE	SCHOOL	Group 1 (control)	Group 2 (control)	Group 3	Group 4	Group 5 (control)	Group 6
I	Centre A	67.75	71.00	71.71	70.38		
	Centre B	73.75	72.75	71.29	74.13		
	Pooled	70.75	71.88	71.50	72.25		
II	School A					76.14	76.00
	School B					80.71	81.88
	Pooled					78.43	79.36

Table 3.5-4 summarises the intervention, but the full programme is shown in Appendix 1.

As far as possible, the same materials were used by all the groups (especially the three experimental groups), but the instructions on how to use them involved different explanations of how scripts relate to speech, depending on the intervention group that was being trained.

Table 3.5–4 Summary of the intervention programme

Sample	Group	Type of training
I	Group 1	No training: children were only submitted to both pre and post-test.
	Group 2	No analysis. Training on whole-word recognition and copying; word categorisation according to meaning.
	Group 3	Training on syllabic analysis and blending.
	Group 4	Training on syllabic and phonemic analysis and blending
II	Group 5	No analysis. Training on whole-word recognition and copying; word categorisation according to meaning.
	Group 6	Training on syllabic and phonemic analysis and blending

Group 1, ("no-intervention") received no training, so it was used to control the effects of development and instruction outside the experimental setting.

The control groups 2 and 5 ("no-analysis") where designed to ensure that any differences between the "no-intervention" and the experimental groups were not due to the extra instruction and attention children in the experimental groups had received, in relation to the children who received no training. These groups (2 and 5) were trained on whole word recognition and writing (copying the whole word), for the same amount of time as the experimental groups. No phonological analysis/blending was carried out and no explanation was provided about the correspondence between sounds and letters, or strings of letters. The training was not expected to challenge the children who believed that the writing system maps the speech at the word level and would not provide further information for those children who had already understood that letters represent sounds but did not know what kind of sounds.

Group 3 ("syllabic-analysis") was taught to identify and to spell words by analysing them into syllables and blending syllables to make up a novel word. Children were encouraged to be aware of the sounds (syllables) within the words and to understand that generally the same letter string represents the same sound, wherever it occurs (in this case the strings comprised either one or two letters because only V or CV syllables were used). So, the writing system was presented to this group as being syllabic rather than alphabetic. This would challenge the logographic conceptions of some children but, probably, would not enable children to understand why they generally need more than one letter to represent one syllable.

The difference between groups 4 or 6 ("phonemic-analysis") and group 3 ("syllabic analysis") was that groups 4 and 6 received further information on how to make up syllables by blending phonemes. These children were taught explicitly not only how to sound the vowels and the syllables, but also how the consonants corresponded to articulatory features such as the shape of the mouth and the position of the lips, the teeth and the tongue. This was expected to help them to understand why they need consonants as well as vowels to represent most syllables.

One issue related to the intervention was to decide the amount of training. It was clear that a small change would be more informative about the process of changing than a big jump and that ceiling effects should be avoided, in the post-test. However, the insufficiency of training was of more concern than the excess, as it was possible that no change would be found in such a short period. After the pilot study, it was found that 20 sessions of 45 minutes would be sufficient to induce a small change and that each training group should not exceed eight children. However, the training schedule clashed with unexpected activities of one school, in London. Therefore, while children from Sample I participated in 20 training sessions, the children from Sample II were offered only 15 training sessions. This is the main reason why the results of groups 2 and 5 ("no-analysis"), as well as groups 4 and 6, ("phonemic analysis") are not pooled during the data analysis, even though the groups were subject to similar training programmes.

All the groups were tested and trained by the same experimenter (the author[1]).

3.5.3. Measures

It is possible that differences in the improvement from pre-test to post-test were due to individual factors rather than, or interacting with, intervention effects. The control measures were used to control these factors statistically.

Table 3.5-5 shows the control measures used in this study.

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[1] The author had been a primary school teacher for 10 years, teaching kindergarten and first grade children as well as illiterate adults. She also had six years experience of training and supervising primary school teachers.

Table 3.5–5 Control measures

INDIVIDUAL INFORMATION	CONTROL TASKS
(Age) Grade or age group (1 to 3) Training group (1 to 6) School (1 to 4) Sample (1 to 2)	WISC analogies WISC digits Script conventions

Other measures were specifically devised to answer the research questions presented above. They were obtained by computing children's scores on the tasks shown in Table 3.5-6.

Table 3.5–6 Pre and post-test tasks

SET	TASK NAME	TASK STRUCTURE	TASK AIMS	CHANCE PER TRIAL	TASK SCORING
A*	LETTER RECOGNITION	Two sets (vowels and consonants) with 6 conditions each: vowels (5 trials); consonants 11 trials)	Decide whether true or false	50%	1 point per correct decision Max: vowels 30; consonants 66; total 96
	PHONOLOGICAL PAIRING	10 conditions with 4 trials each.	Select one out of four pictures	25%	1 point per correct choice (max: 40)
B**	INVENTED SPELLING	12/17 words:	Free spelling		Ordered categories Scale: 1 to 10
	WORD IDENTIFICATION	10 conditions with 4 trials each.	Select one out of four pictures	25%	1 point per correct choice (max: 40)
	ANALOGY SPELLING	16 words	Spell supported by clue words		Ordered categories Scale: 1 to 5

* **Set A :** Underpinning skills and knowledge
** **Set B:** Understanding and use of the writing system

The Underpinning Skills and Knowledge set was used to assess the skills and the knowledge that have been found, in the literature, to be critical for the understanding of the alphabetic principle.

The Understanding and Use of the Writing System set comprises the measures which, in this study, will be used to test the hypothesis that the quality of orthographic representations and the ability to make inferences about graph-phonetic segments reflect children's understanding of the alphabetic system.

3.5.3.1. *Control tasks*

Individual information about each subject was not sufficient to account for the interference of extraneous variables such as the working memory processing of verbal stimuli, the capacity to create categories and children's familiarity with scripts. These measures were obtaining by scoring children's performance on the control tasks presented next.

a. WISC

Intelligence tests are found to be good predictors of children's performance in school activities. As this is a longitudinal study with a school-like intervention, two tests from WISC (Digits and Analogies) were used to control for individual differences in the capacity to deal with school tasks).

WISC Digits was chosen because it accounts for working memory processing of verbal stimuli and this cognitive factor has been found to be related to phonological recoding. WISC Analogies (the equivalent to the English Similarities WISC sub-test) was chosen because it requires the capacity to create categories based on the meaning of the words. Therefore, it might be interesting to relate its results to the performance on the phonological pairing task, where children had to categorise words according to their sounds and on to children's ability to use analogies on spelling and word identification.

b. Script Conventions: familiarity with graphic conventions of scripts

This task was devised to provide information about children's knowledge of such writing conventions as the distinction between letters and numbers, conventional letter shapes, letter variety within words, letter variety between words in a sentence, word size and sentence segmentation.

It was expected that differences between subjects would be found, according to their previous experiences with written materials. Therefore, this task was expected to predict later achievement on word identification and spelling. Moreover, it was expected that this task would provide some information on the relationship between children's phonological recoding and their ability to detect odd orthographic features both in words and sentences.

There were three conditions in this task: Word Size (WS), Word Orthography (WO) and Sentence Orthography (SO).

(i) Word Size

Word Size was devised to assess children's conceptions about the relationship between word-size and object-size.

- **Materials**

Each child received one pencil and one booklet (see example in Appendix 2).

The booklet consisted of three sets of pictures and words. Each set was printed on one page of the booklet and comprised three pictures representing objects with different sizes, one blank frame and, separated from the pictures, three words of different sizes (the names of the pictures). Therefore, the probability of choosing the correct picture by chance was 25%. To keep this probability for each word (since there were three words per set), each page was repeated three times (alternating the sets) and children were asked to match only one word to the correct picture, per page.

The sets were:

BOI (*ox*)- MOSCA (*fly*)- CACHORRO (*dog*) + blank frame
AVIÃO (*plane*)- MONTANHA (*mountain*)- PÁ (*spade*) + blank frame
FORMIGUINHA (*ant*) - ANEL (*ring*)- CASTELO (*castle*) + blank frame

There was a relationship between word-size/object-size, in such manner that the sequence of correct matching was:

1) biggest object/smallest word (BOI);
2) biggest object/biggest word (MONTANHA);
3) biggest object/medium word (CASTELO);
4) smallest object/ medium word (MOSCA);
5) smallest object/biggest word (FORMIGUINHA);
6) medium object/biggest word (CACHORRO);
7) medium object/medium word (AVIÃO);
8) medium object/smallest word (ANEL);
9) smallest object/smallest word (PÁ);.

- **Procedures**

Children were told that Carol's teacher (see Appendix 7 to know who Carol is) had asked her to draw a line linking each word to its picture. However, Saci[2] (they were shown a puppet) had erased Carol's lines and now she would be in trouble for not having done her homework. So, they were invited to help Carol by drawing a line linking the target word (shown by the experimenter) to its picture. To avoid confusion, the experimenter controlled the completion of each page by pointing to each picture as she asked (example of page 1): "*what do you think is written here, in this word in the*

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[2] Saci is a mythological character in Brazilian folklore and a loveable character in children's tales. He is a black boy, with only one leg, in red shorts and a red beret, always smoking a pipe. He is not wicked but is very, very naughty: he loves teasing people, especially by smoking their pipes, hiding

middle: dog?... fly?...ox?... or is this word wrong, it does not exist? (blank picture)". She made sure all children had drawn just one line for the word in the middle before allowing them to turn to the next page.

(ii) Word Orthography

Word Orthography was devised to observe whether familiarity with English scripts would affect Portuguese speakers' conceptions of what a Portuguese written word looks like. It also allows us to examine children's knowledge about some conventions common to both languages such as: numbers cannot be mixed with letters in a word and repeating the same letter does not make a word.

• **Materials**

Each child received one pencil and one eight-page booklet (see example in Appendix 3). Each page contained six words from the lists of the following four conditions:

- 12 English words whose spelling does not violate Portuguese orthography:
  marble; police; tape; tiger; marmalade; garage; climber; finger; branches; pirate; teacher; house.
- 12 English words whose spelling violates Portuguese orthography (violations underlined):
  lorry; winter; shape; goose; collar; teapot (1 violation);
  balloon; bucket; coffee; story; sheep; butterfly (more than 1 violation);
- 12 Portuguese words whose spelling violates English orthography:
  criança; manhã; coelho; água; avô; máquina; xadrez; você; búzio, maçã; limão; formiguinha.
- 12 non-words, violating the conventions of both orthographies:
  mnmo - A8P5XU - iaoeu - CTPFMR - MMWWM - OOOO - pqfhsx -
  - p6n5t3 - mtg - IAOEU - OMOMOMO - πανελα

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things, frightening travellers and making them get lost in the woods. If you cannot find something, you can tell that Saci is around, hiding it.

• **Procedures**

Children were invited to pretend that they were Carol's teacher. The booklets were said to contain the words written by Carol. They would have to mark them, by drawing a circle around the words she had written correctly (words that were likely to exist) and drawing a cross over the words she had misspelled (odd words, which were unlikely to exist).

(iii) Sentence Orthography

The Sentences condition had 14 items. Most assessed sentence segmentation, but it also examined the children's knowledge about conventional letter shape and letter variety between words.

• **Materials**

The Sentences Orthography booklet had 14 pages (one item per page; see Appendix 4). Each item comprised a picture (the same picture for all the items) and a sentence or a pseudo-sentence, as follows:

1 - Pseudo-sentence: segmentation is the same as the correct sentence, but all the words are made by alternating only two letters (*n* and *o*):

"O nono onono no nono nono nonónono o nono no nonono."

2 - Pseudo -sentence: the correct letters are used but sentence segmentation is wrong - all words are the same size (four letters):

"O saci entr ouna mata para esco dera bola dome nino."

3 - Sentence: correct sentence, printed in capital letters:

"O SACI ENTROU NA MATA PARA ESCONDER A BOLA DO MENINO."

4 - Pseudo-sentence: Sentence segmentation was maintained, but only Greek letters were used in printing:

Ο Σαχι εντρου να ματα παρα εσχονδερ α βολα δο μενινο.

5 - Pseudo-sentence: the right letters were used but segmentation was suppressed, resulting in a 41-letter word:

"O Sacientrounamataparaesconderaboladomenino."

6 - Sentence: sentence segmentation is right and word spelling is right as well. However, only capital "Script" letters were used:

"O SACI ENTROU NA MATA PARA ESCONDER A BOLA DO MENINO."

7 - Pseudo-sentence: the right letters were used but sentence is segmented into syllables instead of words:

"O Sa ci en trou na ma ta pa ra es con der a bo la do me ni no."

8 - Sentence: right sentence using "Script" font for printing:

"O Saci entrou na mata para esconder a bola do menino."

9 - Pseudo-sentence: the correct letters are used but sentence segmentation is wrong - all words are roughly the same size (10/11 letters).

"Osacientrou namataparae sconderabo ladomenino."

10 - Sentence: correct sentence:

"O Saci entrou na mata para esconder a bola do menino."

11 - Inverted sentence 1- horizontal inversion.

12 - Inverted sentence 2 - vertical inversion.

13 - Pseudo-sentence: the same word was repeated five times:

O Saci Saci Saci Saci Saci entrou entrou entrou entrou entrou.

14 - English sentence: the English translation of the same sentence was presented:

Saci went into the bushes to hide the boy's ball.

The picture shows Saci hiding a ball in the bushes and three worried children looking for it. Except when otherwise stated, the sentences were printed on Arial Rounded Mt Bold font, size 20.

- **Procedures**

The instructions were similar to Word Orthography: Children were invited to draw a circle around or near the correct sentences (those likely to be seen in books or adult's work) and a cross over the incorrect ones (those unlikely to be seen in books or adult's work).

3.5.3.2. Measures of the set Underpinning Skills and Knowledge

a. The use of partial phonological recoding in recognition: Initial Letter Recognition task

This was a recognition task where children had to decide whether the name of the picture (always a noun) began with a target letter (see Appendix 5). It required not only the knowledge of letter-sound correspondence, but also the understanding that different words may share the same letter and one letter may sound differently when within a word or in isolation. In this sense, Initial Letter Recognition (and in particular the Consonant Recognition condition) assessed a very elementary level of phonological recoding.

This task comprised six conditions. However, the consonants CV condition could be presented twice if there were no suitable nouns in another condition (alternative words). Therefore, there were always six pictures to each letter. The number of incorrect matches was equal to the number of correct matches, so that the chance level was 50%. Also, whenever possible, the pictures represented the words used in other tasks.

(i) Materials

The pictures used for vowels are shown in Table 3.5-7.

Table 3.5–7 Pictures used for vowels on Initial Letter Recognition task

VOWEL	V SYLLABLE	CONSONANT	VC SYLLABLE	WRONG VOWEL	VC NASAL	ENGLISH NAME
A	alho *garlic*	fada *fairy*	árvore *tree*	onça *jaguar*	anjo *angel*	eixo *axle*
E	égua *mare*	flecha *arrow*	ervilha *pea*	isqueiro *lighter*	enxada *hoe*	igreja *church*
I	iogurte *yogurth*	tigre *tiger*	isqueiro *lighter*	ervilha *pea*	inseto *insect*	aipo *celery*
O	óculos *spectacles*	porta *door*	orca *orca*	unha *nail*	onça *jaguar*	ouriço *hedgehog*
U	unha *nail*	bruxa *witch*	urso *bear*	agulha *needle*	umbigo *navel*	iogurte *yoghurt*

Therefore, for the vowels, the conditions were as follow:

1. The object's name begins with a V (single vowel) syllable whose sound corresponds roughly to the name of the target vowel.

2. The first syllable in the object is a VC syllable. In this case, the sound of the vowel still corresponds roughly to its name.
3. The first syllable in the object is also a VC syllable, but, in this case, the sound of the vowel does not match its name (a nasal sound was used).
4. The object illustrated begins with a vowel other than the target one.
5. The object illustrated does not begin with the target vowel: it begins with a consonant, or a consonant cluster, followed by the target vowel.
6. The English name of the vowel matches the sound of the first syllable of the object (except for letters "O" and "U", as no Portuguese word begins with their name. In this case, words with a 'similar' initial sound were used).

The pictures used for the consonants are shown in Table 3.5-8.

Table 3.5-8 Pictures used for consonants on Initial Letter Recognition Task

CONSONANTS	PORTUGUESE NAME	CV SYLLABLE	INCORRECT LETTER	CCV SYLLABLE	ALTERNATIVE WORDS	SAME ART. POINT	ENGLISH NAME
B	berço *cot*	burro *donkey*	sorvete *ice-cream*	bruxa *witch*		padre *priest*	bicicleta *bike*
C	cenoura *carrot*	cobra *snake*	laranja *orange*	cravo *carnation*		garfo *fork*	cigarro *cigarrete*
F	Efigênia	folha *leave*	nuvem *cloud*	fruta *fruit*		vinho *wine*	Efigênia
G	gelo *ice*	galo *cock*	mosca *fly*	grade *railing*		cobra *snake*	girafa *giraffe*
L	helicóptero *helicopter*	laranja *orange*	burro *donkey*		limão *lemon*	raposa *fox*	helicóptero *helicopter*
M	Emília *Emily*	mosca *fly*	rocha *rock*		milho *maize*	nuvem *cloud*	Emília *Emily*
N	Ênio	nariz *nose*	folha *leave*		ninho *nest*	mosca *fly*	Ênio
P	pêssego *peach*	padre *priest*	taxi *taxi*	prato *plate*		burro *donkey*	pijama *pyjamas*
R	errado *wrong*	rocha *rock*	galo *cock*		rinoceronte *rhinoceros*	limão *lemon*	árvore *tree*
S	estrada *road*	sorvete *ice-cream*	padre *priest*		sino *bell*	zero *zero*	estrada *road*
T	Telha *tile*	taxi *taxi*	cobra *snake*	trilho *rail*		dominó *domino*	tigre *tiger*

Therefore, for consonants, the conditions were as follows:

1. The name of the letter matches (roughly) the sound of the first syllable of the object's name, or the first two syllables in the case of letters F, L, M, N, R and S. (These letter names are two-syllable words in Portuguese).
2. The first syllable in the object's name is a CV or CVC syllable, beginning with the target consonant.
3. The first syllable in the object's name is a CCV syllable, beginning with the target consonant.
4. The object's name begins with a letter whose place of articulation is the same as the target letter (for all the consonants, except for R, L, M and N. In these cases, L will be replaced by R and M will be replaced by N and vice-versa).
5. The object's name does not begin with the target letter (incorrect condition).
6. The English letter name matches the sound of the first syllable in the object's name.

Every child received one pencil and one eight-page booklet. Each page of the booklet comprised 12 pictures. Each picture was presented within a frame of 2.5 X 2.5 cm, alongside the respective letter, printed in Arial rounded MT bold, size 16, both in upper case and lower case.

The pictures were balanced so that neither a picture nor a letter was repeated on the same page.

(ii) Procedures

Children were told that Carol wanted to be sure about letter sounds. She had made a booklet to remember them, but Saci had changed some letters. Children were asked to help Carol, by making a circle around the right matches and a cross on the wrong ones. The experimenter always said the word represented by each picture to ensure that all children were considering the intended word.

b. The ability to detect phonological identity: Phonological Pairing task

The phonological pairing task measures the capacity to detect sound identity between different words. To avoid over-loading the memory, all the words were represented by pictures and children had to decide which word, out of four, shared a sound with the target word. Therefore, this is a matching-to-target stimulus-word task, with four possible choices per item. The conditions are defined according to the type of segment shared by the two pairing words: syllables, onsets, rimes and phonemes, in either the initial or the final position.

(i) Materials

The materials used in this task comprised the experimenter's book, which contained the illustration of the target words (one per A4 size page), and a set of four children's booklets, one set for each child, with the illustrations of the pairing and the contrasting words (see Appendix 6).

Booklets 1 and 2 contained the items of all conditions with the initial position. Booklets 3 and 4 contained the items of all conditions with the final position (two or three items per page). The booklets had five pages. The items were arranged in each page by alternating segment type, to avoid order effects, as shown in Table 3.5-9. The first page comprised three training items. The second and the third pages comprised the items numbered 1 or 3, depending on the booklet. The fourth and fifth pages comprised the items numbered 2 or 4, depending on the booklet.

Table 3.5–9 Items arrangement in Phonological Pairing Task booklets

	BOOKLETS 1 & 2	BOOKLETS 3 & 4	PAGES
	BOOKLET 1:	BOOKLET 3:	
Training items	PHISD0; PHIOS0; PHIPH0	PHFSS0; PHFRS0; PHFPH0	1
Testing items	PHISD1; PHISS1; PHIOD1; PHIOS1; PHIPH1; PHISD2; PHISS2; PHIOD2; PHIOS2; PHIPH2;	PHFSD1; PHFSS1; PHFRS1; PHFRU1; PHFPH1; PHFSD2; PHFSS2; PHFRS2; PHFRU2; PHFPH2;	2 3 4 5
	BOOKLET 2:	BOOKLET 4:	
Training items	PHISS0; PHIOD0; PHIPH0	PHFSD0; PHFRU0; PHFPH0	1
Testing items	PHISD3; PHISS3; PHIOD3; PHIOS3; PHIPH3; PHISD4; PHISS4; PHIOD4; PHIOS4; PHIPH4	PHFSD3; PHFSS3; PHFRS3; PHFRU3; PHFPH3; PHFSD4; PHFSS4; PHFRS4; PHFRU4; PHFPH4	2 3 4 5

The list of words used in this task are shown next.

- **Segments in the initial position:**

The list of words for the initial position is shown in Table 3.5-10.

Table 3.5–10 Words (pictures) used in Phonological Pairing task - initial segments

CONDITION	ITEM SORTING NUMBER	TARGET WORDS	SETS OF CONTRASTING WORDS
PHISD Initial Syllable different vowel: full contrast (all the letters in the syllable)	0 (training)	**trigo** *(wheat)*	flecha *(arrow)* **carta** *(letter)*
	2	**carne** *(meat)*	**trilhos** (*rails*)
	4	**Brutus**	**bruxa** (*witch*)
	1	copo *(glass)*	**cobra** *(snake)* barco *(boat)*
	3	filtro *(filter)*	**filme** *(film)* tromba (*elephant trunk*)
PHISS Initial Syllable same vowel: partial contrast (initial or final consonant)	0 (training)	copo *(copo)*	cobra *(snake)* **corda** (*rope*)
	1	porta *(door)*	pote *(jar)*
	3	corte *(cut)*	**porca** *(sew)*
	2	**barba** *(beard)*	**carta** *(letter)* bata *(smock)*
	4	**carne** *(meat)*	**barco** *(boat)* cabo *(handle)*
PHIOD Initial Onset different articulation: partial contrast (first or second consonant)	0 (training)	brinco *(earring)*	**braço** *(arm)* bata *(smock)*
	1	**brasa** *(live coal)*	**grade** *(railing)*
	3	**grilo** *(cricket)*	galo *(cock)*
	2	**Cristo** *(Christ)*	cabo *(handle)* **cravo** *(carnation)*
	4	**praça** *(square)*	padre *(priest)* **prato** *(plate)*
PHIOS Initial Onset same articulation: partial contrast (first or second consonant)	0 (training)	**prego** *(nail)*	**prato** *(plate)* padre *(priest)*
	1	**praça** *(square)*	**braço** *(arm)*
	3	**brasa** *(live coal)*	bata *(smock)*
	2	**Cristo** *(Christ)*	galo *(cock)* **grade** *(railing)*
	4	**grilo** *(cricket)*	cabo *(handle)* **cravo** *(carnation)*
PHIPH Initial Phoneme: (initial consonant contrast)	0 (training)	brinco *(earring)*	tromba *(elephant trunk)* **blusa** *(blouse)*
	1	fada *(fairy)*	**fruta** *(fruit)*
	3	bota (*boot*)	globo (*globe*)
	2	**bloco** *(block)*	**flecha** (*arrow*) **trilhos** *(rails)*
	4	**freira** *(nun)*	cravo (*carnation*) **bruxa** (*witch*)

Therefore, the conditions for the initial position are as follows:

PHISD *(initial syllable with different vowel)* - the pairing words share the whole initial syllable; the first syllable of the three contrasting words has no letters in common with the target syllable. Therefore, sensitivity to global phonological similarity between syllables is sufficient to perform this condition, as children can rely on the whole syllable, the onset, the rime, or just the vowel. Different types of syllables are used as targets: one CV (co-), one CCV (bru-) and two CVC (car- and fil-). The 'L' after the vowel sounds like 'W', in the Brazilian accent, so it sounds like a semivowel rather than a consonant.

PHISD *(initial syllable with different vowel)* - the pairing words share the whole initial syllable; the first syllable of the three contrasting words has no letters in common with the target syllable. Therefore, the sensitivity to global phonological similarity between syllables is sufficient to perform this condition, as children can rely on the whole syllable, the onset, the rime, or just the vowel. Different types of syllables are used as targets: one CV (co-), one CCV (bru-) and two CVC (car- and fil-). The 'L' after the vowel sounds like 'W', in the Brazilian accent, so it sounds like a semivowel rather than a consonant.

PHISS *(initial syllable with the same vowel)* - only the pairing words share the whole initial syllable (as in *porta/porca*). However, the contrasting words also share with the target word either the onset and the nucleus (initial consonant and vowel, as in *porta/pote*) or the nucleus and the coda (vowel and final consonant, as in *porta/corda*), of the initial syllable. Since it is necessary to rely both on the onset and on the rime of the initial syllable, a global sensitivity to phonological similarity between syllables is not enough to perform this condition. In the test items, all the target syllables are CVC type.

PHIOD *(initial onset with different place of articulation)* - only the pairing words share the initial onset, but one of the contrasting words in each item starts with the same consonant as the target word (as in *brinco/bata*). All the target words start with CCV or CCVC syllables; two contrasting words start with a CV syllable and the other starts with a CCV syllable. The vowel of the initial syllable in the contrasting words is always an "A". In all the items, children have to rely on the onset, to perform the task. However, in two items the pairing words share the whole initial syllable (both the onset and the vowel, as in brasa/braço), while in the other two, the pairing words share only the onset (as in brinco/braço). These are expected to be more difficult.

PHIOS *(initial onset with the same place of articulation)* - This condition is similar to PHIOD, except that the sets of contrasting words are rearranged so that the words in the same set start with the same consonant or one consonant with the same place of articulation as the first consonant of the target word. This is to investigate the importance of articulatory features as means to identify consonantal segments.

PHIPH *(initial phoneme)* - the shared segment is the initial phoneme. The initial syllable of the contrasting words is either a CCV or a CCVC syllable, so its onset has to be split off to find the initial phoneme. Two target words begin with a CV syllable (where the initial phoneme corresponds to the initial onset) and two begin with a CCV syllable (where the phoneme is part of the onset). These two are expected to be more difficult.

- **Segments in the final position**

The conditions for the final position are as follows:

PHFSID (final syllable with different vowel) - The shared segment is the whole final syllable. The final syllables of the contrasting words do not share any sound with the target syllable. Thus, it is enough to have a global sensitivity to phonological similarity between words to perform this condition. One set comprises CV syllables and the other set comprises CVC syllables, to match two target syllables of each type. All the words ending with CVC syllables are oxytone (last syllable stressed). The words ending in CV syllables are paroxytone (second last syllable stressed).

PHFSS (final syllable with the same vowel or the same onset) - The shared segment of the pair is also the final syllable. However, in one set, all the contrasting words also share the last vowel with two of the target words (such as *brinco / barco; pombo; prato; burro*). Thus, to perform the two items that correspond to these words, it is necessary to rely on the onset of the last syllable, rather than on the whole syllable. In the other set, all the contrasting words share the onset of the last syllable with the remaining two target words (such as *gato / pinto; patim; pista; pente*). To perform the two items that correspond to these words, it is necessary to rely on the last vowel, rather than on the whole last syllable. All the words used in this condition are paroxytone (except the contrasting word *patim*).

PHFRS (final rime with stressed vowel) - The pairing words share the rime of the final syllable. One rime coincides with the vowel (*caf**é**/bon**é***); another rime is a nasal sound, which means that it is represented by one vowel followed by the letter 'm', but the 'm' is not sounded (*jard**im**/pat**im***); the other rime comprises a vowel followed by 'l', which means that, in Brazilian Portuguese, it sounds like a dittoing (-ew), while in European Portuguese, both the vowel and the consonant maintain the original sound (-el: *an**el**/pinc**el***); in the remaining rime, both the vowel and the consonant are pronounced (*trat**or**/tamb**or***).

PHFRU (final rime with unstressed vowel) - The shared segment is the rime, which, in this case, is just the vowel. All the contrasting words are disyllable paroxytone finishing with a CV syllable (except 'patim' and 'lápis'). Two target words finish with a CV syllable (*gato; fita*) and two finish with a CCV syllable (*livro; pedra*).

PHFPH (final phoneme) - In spite of the shared segment being the final rime, all the contrasting words also share the vowel of the last syllable with the target word. So, it is necessary to rely on the final phoneme to perform this condition. Two final letters (consonants) are pronounced regularly (*rai**z**/nari**z*** and *alta**r**/cola**r***); one is not pronounced because it is used to nasalise the vowel (*jardi**m**/pati**m***) and the other one is pronounced differently in Brazilian and European Portuguese (-aw, -al: *parda**l**/jorna**l***).

The list of words for the final position is shown in Table 3.5-11.

Table 3.5–11 Words (pictures) used in Phonological Pairing Task - final segments

CONDITION	ITEM SORTING NUMBER	TARGET WORDS	SETS OF CONTRASTING WORDS
	0 (training)	**jardim** *(garden)*	pu**dim** *(pudding)*
			jor**nal** *(newspaper)*
PHFSD	1	**canal** *(canal)*	colher *(spoon)*
Final Syllable	3	**trator** *(tractor)*	pin**tor** *(painter)*
full contrast			
			táxi *(taxi)*
	2	**ferro** (*iron*)	bu**rro** (*donkey*)
	4	**sopa** (*soup*)	ves**pa** *(wasp)*
			pente *(comb)*
	0 (training)	**carro** (*car*)	pombo (*pigeon*)
			pra**to** *(plate)*
	1	**cinco** (*five*)	bu**rro** (*donkey*)
PHFSS	3	**cinto** *(belt)*	bar**co** (*boat*)
Final Syllable partial contrast			
			pin**to** (*chick*)
onset or vowel	2	**gato** *(cat)*	pa**tim** *(skate)*
	4	**fita** (*ribbon*)	pis**ta** (*track*)
			pente *(comb)*
	0 (training)	**limão** *(lemon)*	maçã *(apple)*
			bal*ão* *(balloon)*
	1	**anel** *(ring)*	pin**cel** *(brush)*
PHFRS	3	**jardim** *(garden)*	pa**tim** *(skate)*
Final Rime			
Stressed Vowel			tam**bor** *(drum)*
	2	**café** *(coffee)*	nariz *(nose)*
	4	**trator** *(tractor))*	peru *(turkey)*
			bo**né** *(cap)*
	0 (training)	**tigre** *(tiger)*	patim *(skate)*
			pis**ta** (*track*)
	1	**livro** *(book)*	pent*e* *(comb)*
PHFRU	3	**pedra** *(stone)*	pin**to** (*chick*)
Final Rime Unstressed Vowel			
			por**ca** (*sow*)
	4	**gato** (*cat*)	lápis *(pencil)*
	2	**fita** (*ribbon*)	bu**rro** (*donkey*)
			re**de** *(hammock)*
	0 (training)	**barril** *(barrel)*	pa**tim** *(skate)*
			Saci
	1	**jardim** *(garden)*	nari**z** *(nose)*
PHFPH	3	**raiz** *(root)*	fu**nil** *(funnel)*
Final Phoneme			
(constant vowel)			rapaz *(boy)*
	2	**pardal** *(sparrow)*	jor**nal** *(newspaper)*
	4	**altar** *(altar)*	sofá *(sofa)*
			co**lar** *(necklace)*

(ii) Procedures

This task was presented as a competition between each group of children and Saci (a puppet). After the completion of each item, the group was given a score according to the number of children that had succeeded (but they were not told who these children were). If no children had succeeded, Saci would score one point. Of course, the children would always beat Saci, but, especially during post-test, the groups were competing to see who scored more and this helped to maintain children's motivation in spite of the similarity of the tasks and the materials.

The experimenter explained the task: "*I have a picture of a* ....(says the name). *Which of the pictures in your booklet* (says the names) *starts* (or finishes) *like this one?* Please, l*isten carefully:*.. (she repeated the names of the pictures, alternating the target word and the contrasting words, such as: copo-cobra; copo-barco; copo-filme; copo-tromba). During training, children were instructed to pay attention both to the sound and to the position and shape of the mouth when pronouncing each word. Corrective feedback was given only on training items. Only three conditions per booklet were trained.

A whole booklet had to be completed per session.

3.5.3.3. Measures of the set Understanding and Use of the Writing System

The Understanding and Use of the Writing System set comprises the measures which, in this study, will be used to test the hypothesis that the quality of orthographic representations and the ability to make inferences about graph-phonetic segments reflect children's understanding of the alphabetic system.

a. The quality of children's orthographic representations: Invented Spelling task

In this study, Invented Spelling was considered a central task. It was expected that changes in children's representations of written words would be better understood if the developmental levels found in the construction of the understanding of the alphabetic system accounted for the relationship between invented spelling and other tasks.

(i) Materials

Invented Spelling was a dictation task, presented in the form of the story shown in Appendix 7.

From this story, children had to spell a list of 10 two-syllable and four three or four-syllable words. All three and four-syllable words were derived from two-syllable words, which preceded them immediately, in the list. All the two-syllable words were selected from the set of words used in the Phonological Pairing and Word Identification tasks, so that spelling strategies could be later related to word identification strategies and phonological analysis skills. The words had a variety of syllable types: CV, CCV, CVC, CVC (nasal) and consonant clusters.

(ii) Procedures

Invented spelling was the first task to be performed in the pre-test and the last task, or the last but one (see tests schedule), in the post-test.

Children were given a pencil and a ruled sheet of paper with a list of numbers so that they could spell each word in order. After listening to the first paragraph, children were invited to pretend that they were Carol, the main character of the story. They were encouraged to write the words in their own way, as Carol had done. A special mark (a circle with a cross inside it) was agreed with the experimenter, for the children to use whenever they felt that they needed a letter but did not know which was the correct one.

b. The ability to make inferences about graph-phonetic segments in spelling: Analogy Spelling task

To use analogies in spelling, it is necessary to be able to identify, in the clue-words, the letter or string of letters that make up the sound segment whose graphic representation one is trying to discover.

However, children do not necessarily know what letters correspond to each segment. Would they be able to discover a specific graphic segment (string of letters) within a word, before being able to decode the word, just by relying on some known letters, such as the vowels?

Analogy Spelling task was devised to investigate this question.

(i) Materials

In this task, a booklet similar to those used in the other tasks was used (see Appendix 8).

Each page comprised three rows of pictures. Each row contained two or three pictures with their name written below (the clue-words) and one or two pictures representing the target words which children were required to write down, in a blank frame.

The target words were the same as those used in Invented Spelling task, except the word ‘burrice’. This word was not used because it is not possible to draw a clear picture to represent it.

Table 3.5-12 shows how the clue-words and the target words were arranged in the booklet.

Table 3.5–12 Words and pictures used in Analogy Spelling task

CLUE-WORDS	TARGET WORDS	PAGE
BULE *(tea-pot)*; BÚZIO *(shell)*; CARRO *(car)*; FERRO *(iron)* CV.CV ; CV.CVV ; CV.(C)CV ; CV.(C)CV	1) BURRO *(donkey)*	1
BARBA *(beard)*; BRINCO *(earring)*; ARCO *(arch)* CVC.CV ; CCVC.CV ; CV.CV	2) BARCO *(boat)*	1
PARDAL *(sparrow)*; LEQUE *(fan)*; TANQUE *(tank)* CVC.CVC ; CV.CVV ; CVC.CVV	3) PARQUE *(park)*	1
BOTA *(boot)*; CANECA *(mug)* CV.CV ; CV.CV.CV	4) BONECA *(doll)*; 5) BONÉ*(cap)*	2
PONTE *(bridge)*; ESPONJA *(sponge)*; BORRACHA *(rubber)* CVC.CV ; VC.CVC.CV ; CV.(C)CV.CCV	6) POMBO *(pigeon)*	2
CABIDE *(hanger)*; GALINHA *(hen)*; UNHA *(nail)* CV.CV.CV ; CV.CV.CCV ; V. CCV	7) POMBINHA *(dove)*	2
ESCOLA *(school)*; SOMBRA *(shadow)*; BRINCO *(earring)* VC.CV.CV ; CVC.CCV ; CCVC.CV	8) COBRA *(snake)*	3
EMBRULHO *(pack)*; XADREZ *(chess)* VC.CCV.CCV ; CV.CCVC	9) BRUXA *(witch)*	3
MURO *(wall)*; PERA *(pear)*; FATIA *(slice)* CV.CV ; CV.CV ; CV.CV.V	10) BRUXARIA *(witchcraft)*	3
FLORES *(flowers)*; FLAUTA *(flute)*; CHAMINÉ *(chimney)* CCV.CVC ; CCVV.CV ; CCV.CV.CV	11) FLECHA *(arrow)*	4
FUNIL *(funnel)*; BARRIL *(barrel)*; MELANCIA *(water-melon)* CV.CVC ; CV.CVC ; CV.CVC.CV.V	12) FILME *(film)*	4
CARRUAGEM *(carriage)*; GELO *(ice)*; NUVEM *(cloud)* CV(C).CV.V.CVC ; CV.CV ; CV.CVC	13) FILMAGEM *(film setting)*	4
BOLO *(cake)*; BOLA *(ball)*; MÃO *(hand)*; FEIJÃO *(beans)*; CV.CV ; CV.CV ; CVV ; CVV CVV	14) BALÃO *(balloon)*	5
SAPATO *(shoe)*; JARDIM *(garden)* CV.CV.CV ; CVC.CVC ;	15) PATIM *(skate)*	5
TRATOR *(tractor)*; ANEL *(ring)*; PARDAL *(sparrow)* CCV.CVC ; V.CVC ; CVC.CVC	16) JORNAL *(newspaper)*	5

The words were presented in a fixed order, according to the difficulty of the cue segments to be detected (starting with those which were supposed to be easier, then increasing the level of difficulty from one page to the next).

The target words on pages 1 and 2 consisted of syllables, which could be found in the clue-words. However, different supports were provided to demarcate the syllables of each word. To find the syllables BU and (R)RO[3] to spell the word

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[3] 1. According to orthographic rules, double consonants would have to be split off: the first would be the last letter of the previous syllable and the second would start a new syllable. However, as children were not supposed to know this rule, they were expected either to keep the consonants together

BURRO, children were offered two words starting with BU and two words finishing with (R)RO.

To spell BARCO, two strategies could be adopted. 1) As ARCO is part of BARCO (actually, it is the Portuguese rhyme), children could just add a B at the beginning. To discover the B, they were provided with five words beginning with this letter (including the target word in the previous item and its clue-words). 2) BARCO can also be built by assembling BAR from the first clue-word with -CO from the second clue-word and using ARCO to confirm whether the syllables were correctly demarcated.

The first syllable of PARQUE could be found in PARDAL, using the previous words (BARCO, BARBA and ARCO) as a support to demarcate it. Two more words were provided to help children to spell -QUE.

On page 2, the clue-words still shared some syllables with the target words, but the position of the syllables within the words might be different. Only one clue-word was provided to support the spelling of CV syllables, so children had to know how to demarcate it by using the vowels or by counting two letters per syllable. The spelling PON for POM (in POMBO and POMBINHA) was accepted as correct as children were not offered any clue to discover the orthographic rule, which requires the use of M before -B and -P.

The word POMBINHA could be built by joining the syllables provided by the key words (including the previous target word), or by derivation, adding POMB(O)+INHA (from GALINHA).

Whole syllables were still used to build the words on page 3, but the syllable onset (BR-) was also used as a cue to support the demarcation of the syllables BRA and BRU. The word BRUXARIA could also be produced by derivation (BRUXA+RIA) but children had to segment the final syllable of the clue-words to discover how to spell the suffix.

On pages 4 and 5, most clue-words shared onsets or rimes rather than syllables, with the target words. Two words were used to support the discovery of the onset FL- (for FLECHA), as well as the rimes -IL (for FILME) and -ÃO (for BALÃO). When the shared segment was a syllable, only one word was used as a cue. It was expected

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in the second syllable or to suppress one of them. So, spelling BURO for BURRO was considered as correct.

that the children who know how to identify onsets and rimes would already be able to use the vowels to identify CV and CCV syllables.

The word FILMAGEM could be produced by derivation (FILM(E)+AGEM). Three words were used to support the spelling of the suffix -AGEM.

(ii) Procedures

Children were told that Carol wanted to tell her parents her adventure. However, something strange had happened to her notes. The words she had written had disappeared and, instead, there was a puzzling word game. To retrieve her words, she would have to be a good detective and complete the game successfully, by using the cues provided in the clue-words.

The children were then invited to help Carol by playing the game. It was explained that they would have to write the name of the target picture in the blank frame. To help them, there were some words on the same page, usually in the same row, which were similar to the target word. They could use them to discover how to spell each piece of the target word. Sometimes, they would also find it useful to look for cues in the word they had just written on the previous row.

They would circle the *pieces* they needed and then copy them into the blank frame. The first item was used to make sure children had understood the task, but no corrective feedback was given.

As children were doing the task on the first page, the experimenter asked them, individually, how they knew how to spell each word. If the child's explanation made reference to the use of the clue-words, the experimenter reminded her/him to draw a line around the 'pieces' of the clue-words (s)he used to spell the word. The experimenter also made sure that the children who were using the analogy with the clue-words kept identifying the 'pieces' until the task was completed.

c. The ability to make inferences about graph-phonetic segments in word recognition: Word Identification task

This task was devised to assess children's ability to use graph-phonetic cues for word identification (here used with the same meaning as word recognition). To enforce the use of the target segments as graph-phonetic cues, children were prevented from decoding the complete word, or recognising it by sight. This was achieved by replacing most letters with black squares, allowing only the target segments to be seen.

By doing so, it was possible to control the interference of factors such as the size of the word, the position and the type of the target segment.

Four pictures were used as a contextual support for word identification, in order to avoid the interference of individual differences in the ability to blend sounds or to use verbal context (if a text had been used instead of pictures). Therefore, children had to discover the sound of the target segments and then they had to select one word, out of the four represented by the pictures, which had that particular sound in the same position (either at the beginning or at the end).

Children might discover the sound of the target segments by using either phonological recoding or analogies. As most had not developed sufficient decoding skills by the time this experiment was carried out, we expected the use of analogies to be the strategy adopted most frequently.

The target segment (the only segment visible in the target word) was located in the same position as in the clue-word. Therefore, the children, who had already understood that the same letters or strings of letters generally represent the same sound, were not expected to have any trouble selecting the correct clue-word.

To be able to succeed by using analogies, children must have access to a complete orthographic representation of the clue-word. If they had to rely on their mental orthographic representations, their ability to use analogies would be dramatically reduced, not because they would be unable to make inferences about graph-phonetic segments, but because of the poor quality of their orthographic representations. As the aim of this task was to investigate how children's understanding of the alphabetic system controls their capacity to make inferences about graph-phonetic segments, it was important to distinguish this understanding from other factors that could affect their performance on this task. The presence of written known words (clue-words) during the performance of the task aimed to counteract differences in the mental representation of these clue-words.

The capacity to learn from a known word the sound value of an unknown graphic segment, may be analysed as a sequence of steps:

1. recognition of the visual identity between the graphic segment found in a word (in this case, the target segment), and a letter string found in a known word (in this case, this means the selection of the clue-word, out of the five words which were exposed);

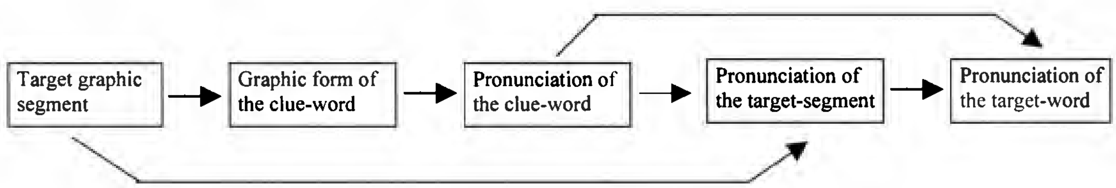
2. retrieval of the pronunciation of the known word (displayed or stored in the memory), which contains that segment, or, in this case, pronunciation of the clue-word which was available as a written word associated to its picture;
3. graph-phonetic segmentation of the known word (the clue-word), to discover the sound value of the particular graphic segment.

After discovering the sound value of the target segment, children had to analyse the pronunciation of the contrasting words, to identify the one containing the sound of the target segment.

In the specific case of this task, after selecting the appropriate clue-word, children might compare its pronunciation with the pronunciation of the four contrasting words, to discover which one shared the sound of the target segment with the clue-word (as in the Phonological Pairing task). In this case, they might succeed (at least theoretically) in identifying the correct word, without necessarily having discovered the sound value of the target segment.

Therefore, to perform this task, children are required to infer the pronunciation of the target word from the pronunciation of the target segments, either directly, by using phonological recoding, or indirectly, by a series of associations, based on the analogy between the clue-word and the target word, as shown in Figure 3.5-1.

Figure 3.5–1 Alternative processes for inferring the pronunciation of the target word in Word Identification task



Whatever the process involved in the selection of the target word, children are required to have understood the correspondence between phonological identity and graphic identity and to have grasped the interchange between letters and letter-strings and their pronunciations. We expect this task to provide the information needed to reveal whether this understanding really enables children to infer the pronunciation of the target word before they are able to decode the target segment.

(i) Materials

This task had the same conditions and words as the Phonological Pairing task, so that children's performance on both tasks could be compared.

The position of the pictures corresponding to correct choices was alternated between the items in the same way as in the Phonological Pairing Task.

The sets of contrasting words/pictures was the same as in the Phonological Pairing Task and the segments printed in bold in each trial of the Phonological Pairing Task (Tables 3.5-10 and 3.5-11) were used as target segments in this task (the remaining letters were replaced by black squares).

The target words in the Phonological Task were used as clue-words in this task. Each clue-word was printed in bold Arial font (all letters in bold and not just the target segments) below its picture, which was drawn on an A4 sheet. Five A4 sheets with the clue-words were stuck on the same laminated page of a flip-chart pad, which hung on the wall to be seen by all the children, during the completion of the task. Therefore, the child had to select the best word, out of five, to be used as a clue-word for that particular item. Each clue-word corresponded to an item, but children were not informed about this, so they sometimes used the same word as a clue for more than one item (incorrectly).

Training items were used only to improve familiarity with the task, but no feedback was given so that successful children could not reveal their strategies for performing the task.

As in the Phonological Pairing task, four five page booklets with printed pictures were used (see Appendix 9). Two booklets contained the items of initial segments and two booklets contained the final ones. Each page contained two or three items from different conditions, with the pictures of four contrasting words, which made up the contextual support for each item. The same pictures were repeated for two items in the same condition (on different pages). A target word per item was also printed on each page. In the target word, only the letters of the target segment could be seen. The other letters were replaced by small black squares.

(ii) Procedures

This task was presented as a competition between the groups, to see which group scored more against Saci. The children were told: "*Saci hid some letters from each word so that you were not able to help Carol to find what is written in each one. He bets that you will not find any of the words. Let's show him that you can find the correct words even without seeing all the letters? Let's make a competition: your team will win one point for each correct word found by any of you. Saci will win a point if* *no one finds the correct word. These clue-words can help you to find out what those letters say. Let's show Saci that this team is cleverer than he is!"*

The experimenter did not explain how to get help from the clue-words.

As in the Phonological Pairing task, a score was given to each group, according to the number of children who succeeded on each item but children were not told who were the children who succeeded or who failed.

d. Randomisation Plan for Exam Tasks

To avoid order effects, tasks were alternated both in pre and post-test. In the pre-test, the sessions in Centre A were as shown in Table 3.5-13.

Table 3.5–13 Randomisation plan for exam tasks - Sample I

SESSION	GROUP 1	GROUP 2	GROUP 3	GROUP 4
1st	Invented Spelling	Invented Spelling	Invented Spelling	Invented Spelling
2nd	PH-booklet 1	PH-booklet 3	ID-booklet 1	ID-booklet 3
3rd	ID-booklet 1	ID-booklet 3	PH-booklet 1	PH-booklet 3
4th	PH-booklet 3	PH-booklet 1	ID-booklet 3	ID-booklet 1
5th	ID-booklet 3	ID-booklet 1	PH-booklet 3	PH-booklet 1
6th	Letter recognition	Letter recognition	Letter recognition	Letter recognition
7th	PH-booklet 2	PH-booklet 4	ID-booklet 2	ID-booklet 4
8th	ID-booklet 2	ID-booklet 4	PH-booklet 2	PH-booklet 4
9th	PH-booklet 4	PH-booklet 2	ID-booklet 4	ID-booklet 2
10th	ID-booklet 4	ID-booklet 2	PH-booklet 4	PH-booklet 2
11th	Word Conventions	Sent. Conventions	Word Conventions	Sent. Conventions
12th	Sent. Conventions	Word Conventions	Sent. Conventions	Word Conventions
13th	Analogy Spelling	Analogy Spelling	Analogy Spelling	Analogy Spelling

PH - Phonological Pairing task ID - Word Identification task	Booklets 1 and 2 - Initial segments Booklets 3 and 4 - Final segments

In Centre B, a similar design was adopted, but the booklets used in sessions 7, 8, 9 and 10 were swapped with those used in sessions 2, 3, 4 and 5, respectively.

The plan used for Sample II includes the tasks used for experiment II, which will be presented next. Groups 1 to 3 were organised in School A and groups 4 to 6 were organised in School B. The plan is shown in Table 3.5-14.

Table 3.5–14 Randomisation plan for exam tasks - Sample II

SESSION	GROUP 1	GROUP 2	GROUP 3	GROUP 4	GROUP 5	GROUP 6
1st	Inv. Spell.	Inv. Spell.	Inv. Spell.	Inv. Spell.	Inv. Spell.	Inv. Spell.
2nd	PH-booklet 1	PH-booklet 3	ID-booklet 2	ID-booklet 4	PH-booklet 2	ID-booklet 3
3rd	ID-booklet 1	ID-booklet 3	PH-booklet 2	PH-booklet 3	PH-booklet 4	ID-booklet 2
4th	PH-booklet 3	PH-booklet 1	ID-booklet 4	ID-booklet 2	ID-booklet 1	PH-booklet 4
5th	ID-booklet 3	ID-booklet 1	PH-booklet 4	PH-booklet 1	ID-booklet 4	PH-booklet 2
6th	Letter recog.	Letter recog.	Letter recog.	Letter recog.	Letter recog.	Letter recog.
7th	PH-booklet 2	PH-booklet 4	ID-booklet 1	ID-booklet 3	PH-booklet 1	ID-booklet 4
8th	ID-booklet 2	ID-booklet 4	PH-booklet 1	PH-booklet 4	PH-booklet 3	ID-booklet 1
9th	PH-booklet 4	PH-booklet 2	ID-booklet 3	ID-booklet 1	ID-booklet 2	PH-booklet 3
10th	ID-booklet 4	ID-booklet 2	PH-booklet 3	PH-booklet 2	ID-booklet 3	PH-booklet 1
11th	Eng Inv Spell	Eng Inv Spell	Eng Inv Spell	Eng Inv Spell	Eng Inv Spell	Eng Inv Spell
12th	Word Conv.	Sent. Conv.	Word Conv.	Sent. Conv.	Word Conv.	Sent. Conv.
13th	Sent. Conv.	Word Conv.	Sent. Conv.	Word Conv.	Sent. Conv.	Word Conv.
14th	Port Anal Sp	Eng Anal Sp	Port Anal Sp	Eng Anal Sp	Port Anal Sp	Eng Anal Sp.
15th	Eng Anal Sp	Port Anal Sp	Eng Anal Sp	Port Anal Sp	Eng Anal Sp	Port Anal Sp

Inv. Spell. - Invented Spelling Eng. Inv. Spell - English Invented Spelling Port. Anal. Sp - Portuguese Analogy Spelling Eng. Anal. Sp - English Analogy Spelling	ID - Word Identification PH - Phonological Pairing Word Conv. - Word conventions Sent. Conv. - Sentence conventions

In the post-test, the design was very similar for both Samples, except that Word and Sentence Conventions were not administered. Thus, both Invented Spelling and Analogies Spelling were completed alternately in the last two sessions, in Sample I and in the last four sessions, in sample II, as the Portuguese and the English versions of these tasks were also balanced.

In both samples, the standardised tests (WISC) were administered individually, in the spare time after or before the group sessions.

3.6. Experiment 2: Method

Reading in Portuguese is generally taught with emphasis on decoding strategies, probably because most adults believe that "this is the way it works". So, it is sensible to expect that the conceptions of most children in experiment 1 are determined by their interaction with older readers outside experimental settings rather than (or, at least, together with) the training provided by the experimenter. Therefore, we expect that experiment 1 will provide some information about the development of children's hypotheses about how letters represent sounds in Portuguese. Nevertheless, it will not clarify how far extent these strategies are determined by the characteristics of the orthography itself or by the adults' explanations of "how writing works".

Therefore, another experiment was devised to answer the last research question of this study, which was as follows:

> What are the effects of orthographic transparency on the construction of orthographic representations and on the ability to make inferences about graph-phonetic segments?
>
> a) Do children rely on different types of graph-phonetic units to spell Portuguese and English words?
>
> b) Do children's spelling strategies in different alphabetic orthographies reflect the same hypotheses about the writing system?

In this experiment, the performance of the children in sample II on Portuguese tasks was compared to their performance on English versions of the same tasks.

3.6.1. Subjects

The subjects in this experiment were the children of Sample II in Experiment I. This group of children, was not exposed to Portuguese writing at school. They were unlikely to be receiving much explanation concerning Portuguese orthography at home. However, they were familiar with reading materials in English, where the focus on word analysis is not generally favoured as the most effective reading strategy

3.6.2. Design

This experiment was an extension of experiment I. Only two new measures were created, by adding an English version of two tasks (Invented Spelling and Analogy Spelling) to both pre and post-test.

3.6.3. Measures

English Invented Spelling and English Analogy Spelling Tasks were introduced in order to investigate whether children were aware of the differences in letter-to-sound correspondence between Portuguese and English orthographies, especially in the syllable rime.

3.6.3.1. English Invented Spelling

The last paragraph of Portuguese Invented Spelling task was changed and more paragraphs were added to include more words with CCV syllables and to make a link with the English Invented Spelling task. This task was similar to the Portuguese Invented Spelling task, except that the words were written in English.

a. Materials

Only pencils and ruled sheets of paper were used by children to perform this task. Some erasers were also available whenever required. The sheet of paper had the numbers 1 to 12 in a column next to the left margin. The text is shown in Appendix 10).

b. Procedure

Children were told that Carol was trying to write a letter to an English friend, telling her adventure. They were asked to help with the translation, as Carol's friend could not read Portuguese words.

The experimenter told the story in Portuguese and, whenever a target word appeared in the text, she asked: "how do we say ... (Portuguese word) in English?"

Then she repeated or corrected children's translation and invited them to spell the word on the ruled sheet of paper, next to its number.

The text told the story of what happened to Carol and her friends when they were searching for Sofia.

3.6.3.2. English Analogy Spelling

The materials and procedures of this task were similar to those used in the Portuguese version.

The booklet used in this task consisted of four pages. Each page comprised three rows of pictures. Each row contained three or four pictures with their name written below (the clue-words) and one picture representing the target word, which children were required to write down, in a blank frame.

The target words were the same as those used in the Invented Spelling Task. The words were produced in a fixed order, according to the difficulty of the segments to be detected (starting with those which were supposed to be easier, then increasing the level of difficulty from one page to the next).

The list of words is shown in Table 3.6-1.

Table 3.6–1 List of words used in English Analogy Spelling task

KEY-WORDS	TARGET WORDS	PAGE
FIRE; MAN	1) FIREMAN	1
TEA; POT	2) TEAPOT	1
BUTTER; FLY	3)BUTTERFLY	1
RATTLE; RADISH; SOCKET; CRICKET	4) RACKET	2
BUBBLE; BUTTER	5) BUCKET	2
LOLLY; CHERRY	6) LORRY	2
TILE; GOAT; BURGER	7) TIGER	3
FOX; COFFIN	8) FINGER	3
CAP; TOY; MOUNTAIN	9) CAPTAIN	3
BANANA; LAMP; SPOON; MOON	10) BALLOON	4
PEAS; RAIN; TRAIN; WINTER	12) PAINTER	4
SLEEP; RIDE	11) SLIDE	4

On the first page, the target words could be spelled just by assembling the spellings of the two clue-words.

On the second page, syllable-like segments were used to produce the target word. As syllabic segmentation is not as clear in English as it is in Portuguese and different approaches state different segmentation rules, the shared segments are sometimes considered as syllables, according to a phonetic point of view, but would not be considered as syllables according to a linguistic approach, such as ‘ra’ for ‘rat’ (in rattle), ‘rad’ (in radish) or ‘rack’ (in racket); ‘cket’ for ‘-ck/et’ (in cricket, racket, socket and bucket); ‘-rry’ for ‘-r/ry’(in lorry and cherry).

For the first and second words, two clue words were provided to help the demarcation of each segment. From the third word on, just one clue-word was provided, if the shared segment looked like a CV or a CCV Portuguese syllable (in this case, children needed to rely on the vowel to know where each syllable finished.

On the third page, whole syllables were still used. However, an extra clue-word with the shared syllable was not offered to support the demarcation of the target syllable. Instead, an extra clue-word sharing the onset of the target syllable was provided. Therefore, children had to rely on the onset to know where the shared syllable started (for example, ‘ger’ in *burger* or ‘tain’ in *mountain*, supported by *goat* and *toy*, respectively).

In the two first items of the fourth page, three monosyllabic and one multisyllabic clue-word were offered. One of the monosyllabic words shared the onset and the two others shared the rime with the target-word. The multisyllabic clue-word shared the remaining syllable with the target word.

Finally, just two monosyllabic clue-words were used to support the spelling of the onset and the rime of the last target-word (this was also a monosyllabic word).

4. DESCRIPTION OF THE MEASURES

4.1 Introduction

In this chapter, children's performance on each measure will be analysed separately. Most tasks comprised different conditions. It was expected that a comparison of these conditions would provide more information about children's strategies as well as about the developmental processes involved in carrying out each condition. This comparison will be carried out for both pre-test and post-test, to investigate whether the relationship between the conditions changes as a function of time and/or intervention.

All the analyses will be carried out by sample, as well as for the pooled samples. The comparison of the two samples was designed to investigate the effects of orthographic transparency and school experience on children's strategies. However, there are two other reasons why the results of each sample will be analysed separately: the difference in the length of the intervention period and the inclusion of seven-year-old children in Sample II.

4.2 Script Conventions: a Control Measure

This is a measure used as a control of the quality of children's previous experience with written text. Higher scores in this task suggest that children are already involved in thinking about scripts as conceptual objects, which they are starting to differentiate from other types of graphic stimuli.

Script Conventions comprised three tasks: Word Size, Word Orthography and Sentence Orthography. Children's scores on these tasks are shown in Appendix 12.

Word Size

Word Size task was created to investigate whether children would consider that the written name of an object was related to its size (nominal realism). Table 4.2-1 shows this was not the case for either of the samples.

Table 4.2–1 Proportion of choices based on: 1) correct speech-to-print matches, 2) hypotheses about the minimum number of letters necessary to make up a word and 3) the matching between the size of the word and the size of the object, per condition, per sample

TRIALS	SAMPLE I						SAMPLE II					
	Correct choice		Blank frame		Size match		Correct choices		Blank frame		Size match	
	%	p	%	p	%	p	%	p	%	p	%	p
smaller word / bigger object	26	n.s.	22	n.s.	17	n.s.	43	**	14	n.s.	21	n.s.
bigger word / bigger object	32	n.s.	9	***	32	n.s.	64	***	14	n.s.	64	***
medium word / bigger object	31	n.s.	8	***	28	n.s.	54	***	18	n.s.	7	*
smaller word / smaller object	22	n.s.	17	n.s.	22	n.s.	61	***	21	n.s.	61	***
bigger word / smaller object	22	n.s.	9	***	34	n.s.	59	***	7	*	7	*
medium word / smaller object	25	n.s.	11	***	34	n.s.	52	***	15	n.s.	15	n.s.
smaller word / medium object	28	n.s.	9	***	39	*	67	***	15	n.s.	7	*
bigger word / medium object	35	*	6	***	29	n.s.	46	***	12	n.s.	15	n.s.
medium word / medium object/	54	***	6	***	54	***	57	***	11	*	57	***

* p<.05; ** p<.01; *** p<.001 [either below or above chance level (25%) - using the proportions test].

For both samples, there was no significant relationship between the size of the object and the size of the word (except "smaller word / medium object", for sample I). Examining individual cases, it was found that only two children in sample I were likely to chose the picture according to the size of the word. They matched the target word to the object of corresponding size on four out of six incorrect trials (significantly above chance). No Sample II child consistently considered the size of the word when selecting the picture.

Most Sample I children chose the words by chance, but clearly considered that they were real words, except for BOI (smaller word / bigger object) and PÁ (smaller word / smaller object). The number of children who considered these words as non-existent (blank frame) was not significantly different from the number of children who chose any of the pictures by chance. This is probably an indication that some children still have difficulty accepting the existence of words with less than four letters, regardless of the size of the object that these words represent. There were only two correct choices selected significantly above chance level: the word AVIÃO (*plane*), probably because this word is frequently associated with letter A and the word CACHORRO (*dog*).

Most children in Sample II chose the correct picture for each word, probably relying on the initial letter.

Therefore, this task could be another measure of word identification skills (partial recoding in word recognition), rather than to assess children's hypotheses about the relationship between the size of the objects and the number of letters in their names. This measure, Word Matching (WORDMAT), reflects the number of correct matches and ranges from 0 to 9. Its distribution shows a slight positive skew (skewness = 1.12), mainly because of the low scores obtained by Sample I children. However, we will not use this measure further in this study.

4.2.1. Word Orthography

The Word Orthography task was designed to observe whether children were sensitive to specific features of the particular orthography to which they were most frequently exposed. The performance of the children in Sample I (only familiar with Portuguese writing) was compared to the performance of children in Sample II (more exposed to English than to Portuguese writing). If children were already sensitive to particular orthographic features, we would expect Sample I children to reject more English words and to accept more Portuguese words than Sample II children. Alternatively, we would expect to find differences between conditions within each sample, showing a tendency for Sample I children to reject non-words as well as English words, whilst Sample II children would reject non-words and perhaps also Portuguese words which violate English orthography.

Table 4.2-2 shows the average number of words accepted by each sample, per condition. The number of subjects included in this analysis was only 86 (61 from Sample I and 25 from Sample II), due to some missing data and to the exclusion of two subjects from the analysis. These two children (one from each sample) were outliers in the "Portuguese Violated" condition (one accepted only one word and the other rejected all of them).

Table 4.2–2 Average number of words accepted per condition

	NO VIOLATIONS	PORTUGUESE VIOLATED	ENGLISH VIOLATED	BOTH VIOLATED	POOLED CONDITIONS
SAMPLE I	7.70	7.90	7.56	6.08	7.31
SAMPLE II	6.52	7.24	6.68	4.76	6.30
POOLED SAMPLES	7.11	7.57	7.12	5.42	6.80

Note: Number of words per condition = 12

The means show a slight but general tendency to accept rather than to reject most words (overall mean = 6.8). This tendency was stronger for Sample I than for Sample II children, in all conditions.

The comparison between conditions in both samples shows that, in the non-word condition (where both orthographies were violated), children were less inclined to accept words.

A repeated measures analysis of variance was carried out, having condition as the within subjects factor and sample as the between subjects factor. It showed a significant effect of both Sample [$F(1, 84)=7.42$; $p=.008$] and Condition [$F(3,252)=4.71$; $p=.001$]. No significant interaction effect of Sample by Condition was found [$F(3,252)=.36$; $p=.79$]. The Tukey post-hoc test confirmed that the significant effect of condition was due to the difference between the non-word (both English and Portuguese violated) condition and all the other conditions.

Therefore, the results show that neither of the two samples was aware of the specific characteristics of either Portuguese or English orthographies. However, some children in both samples were already aware of some script conventions common to both orthographies. Table 4.2-3 gives a clearer idea of the conventions which most children had already acquired.

Table 4.2–3 Frequency of acceptance of non-words per sample

NON-WORDS	SAMPLE I				SAMPLE II			
	Sample size	Frequency of acceptance			Sample size	Frequency of acceptance		
		n	%	p		n	%	p
mnmo	64	30	47	n.s.	28	14	50	n.s.
A8P5XU	64	35	55	n.s.	28	9	32	p<.05
iaoeu	64	36	56	n.s.	28	14	50	n.s.
CTPFMR	63	33	52	n.s.	27	10	37	n.s.
MMWWM	63	28	44	n.s.	28	9	32	p<.05
OOOO	64	20	31	p<.05	28	4	14	p<.05
pqfhsx	64	31	48	n.s.	28	16	57	n.s.
p6n5t3	64	29	45	n.s.	28	7	25	p<.05
mtg	64	38	59	n.s.	28	12	43	n.s.
IAOEU	64	38	59	n.s.	28	9	32	p<.05
OMOMOMO	64	35	55	n.s.	28	13	46	n.s.
πανελα	64	36	56	n.s.	28	11	39	n.s.

Note: Proportions test was used to determine the level of significance

The most rejected "non-word" was [OOOO]. Many children interpreted this pattern as a drawing and some found difficult to accept that it was not an error in their booklets, whispering to the experimenter: "What is this? This is not a word! These are balls!" Therefore, many children might have rejected this pattern because they were already making a distinction between writing and drawing. However, this rejection also shows that most children had already grasped the need for internal differentiation in written words, as can be confirmed by the rejection of [MMWWM]. They also realised that words are made up of letters but not of numbers, as in [p6n5t3].

In spite of not reaching significance, the rejection of the other non-words in this condition was greater than the rejection of the words in the other conditions. Only seven non-words were accepted by more than 50% of the children from Sample I and only one was accepted by more than 50% of the children in Sample II. In the other conditions, most words were accepted by more than 60% of the children in Sample I and by more than 50% of the children in Sample II. This shows that many children already considered words without vowels or without consonants and those made up of Greek letters as unacceptable.

In the next sections, the relationship between the capacity to detect odd words and the performance on the other tasks will be investigated, to observe whether this measure is a predictor of the post-test achievement. To prevent some types of odd features from having more weight than others, the proportion of acceptance of the non-words according to the different features was considered. This proportion was obtained by dividing the number of words children had accepted by the number of words with the same type of odd features, as follows:

ODDLET - Words with odd letters (three words: πανελα; A8P5XU; P6N5T3)

NOVOW - Words without vowels (three words: CTPMFR; pqfhsx; mtg)

NOCONS - Words without consonants (two words: iaoeu; IAOEU)

NODIF - Words with no internal differentiation (four words: mnmo; MMWWM; OOOO; OMOMOMO)

Thus, a new variable, Word Orthography (WORDORT), was created by adding up the proportion of accepted words per type of odd feature and taking this total away from the number of types of odd features (four), to avoid negative numbers:

$$\text{WORDORT} = 4 - (\text{ODDLET} / 3) + (\text{NOVOW} / 3) + (\text{NOCONS} / 2) + (\text{NODIF} / 4)$$

Therefore, the scores on WORDORT range from 0 to 4 and the highest scores correspond to the lowest acceptance of odd words. This variable has a normal distribution for the pooled samples (mean = 2.09; SD=.93; N=92).

In summary, the results of this task show that, at the time the data collection was carried out, children were not yet aware of specific features of the orthography they were most frequently exposed to. However, most children already considered some properties of written text, such as the shapes of the letters and the need for internal variety, as criteria to categorise a graphic stimulus as a script. This suggests that these children were already pondering what scripts are about. This is likely to have enhanced their understanding of adult's explanations of how scripts represent speech.

4.2.2. Sentence Orthography

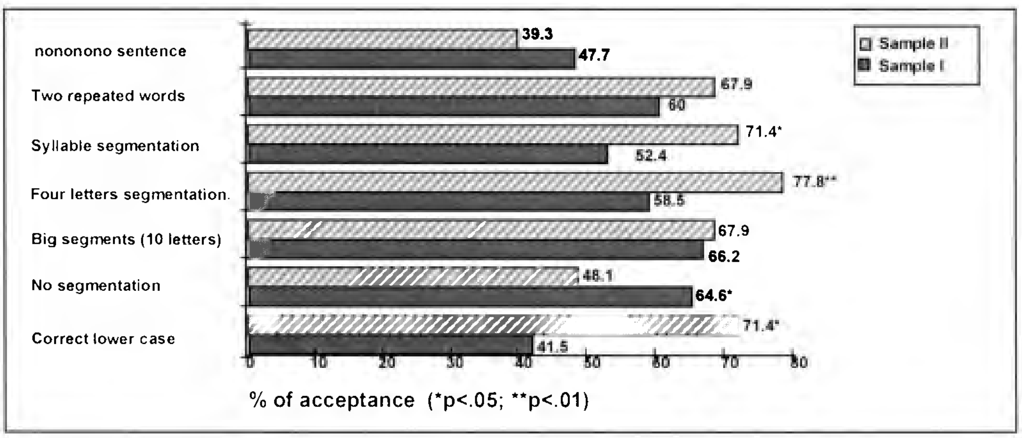
A test of sentence orthography was devised to assess children's familiarity with printed sentences, expressed through the recognition of some features common to all printed sentences, such as:

- sentences are composed of words with different sizes and made up of different letters. These words are separated by spaces;
- there are different types of letters, but some graphic marks, although looking like letters, do not belong to our alphabet and can not be used to write words;
- there is only one acceptable orientation for letters and words (they cannot be inverted).

Children's notions of word size and word separation, as well as letter differentiation within words and word differentiation within sentences were investigated first, followed by the investigation of children's knowledge of conventional letter shapes and letter orientation.

Figure 4.2-1 shows the percentage of acceptance of each sentence according to word separation (type of segmentation), per sample.

Figure 4.2–1 Percentage of acceptance of each sentence, per segmentation, per sample



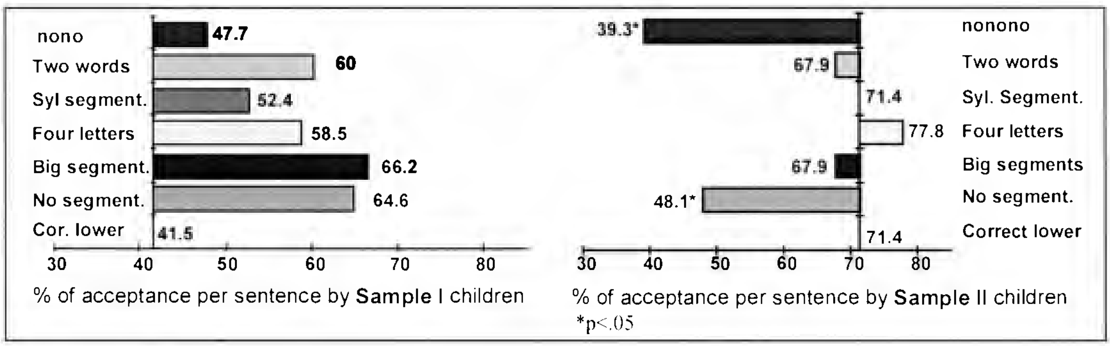
Note: the values of p refer to 50% chance level

To avoid the interference of letter type in children's judgements, all sentences were printed in Arial lower case letters. This created a problem: as this type of letter was familiar to Sample II but not to Sample I children, it is possible that some children in Sample I rejected the sentences because they were not familiar with this type of font. To solve this problem, the correct lower case printed sentence was used as a base line in relation to which children's acceptance of the other sentences was compared.

Therefore, for the analysis shown on Figure 4.2-2, the cut-off point was the proportion of acceptance of the correct lower case sentence (different for each sample), instead of 0.50 defined by chance level. Hence, the probability values refer to the difference between the acceptance of each sentence and the acceptance of the correct lower case sentence and not to the probability of accepting each sentence alone by chance.

It was not expected that any other sentence would be more acceptable than the correct one, but the results show that Sample I children were more likely to accept the sentences where there was not much variation both within and between words, as shown in Figure 4.2-2 (left). These children considered the sentence made of big "words" (10/11 letters) and the sentence with no separation between words as significantly more acceptable than the correct sentence.

Figure 4.2–2 Proportion of acceptance of each sentence relatively to the correct lower case sentence



The children in Sample II (Figure 4.2-2 right) considered the "four letter segmentation" sentence more acceptable than the correct sentence, but the difference was very small. These children tended to reject both the "nonono" sentence and the "no segmentation" (no separation between words) sentence. This rejection was significant, when compared to the correct sentence. Therefore, most Sample II children had already realised the need for differentiation between words, as well as the need to separate words within sentences.

To assess whether these notions of word differentiation and word separation are good predictors of reading and writing acquisition, a new variable, Sentence Differentiation (SENTDIF) was created. This variable measured the tendency to accept conventional sentences and to reject unconventional ones. As there was only one conventional sentence against six unconventional ones, the proportion of acceptance in each case was considered. To avoid negative numbers, one unit was added to the results, as shown in the formula:

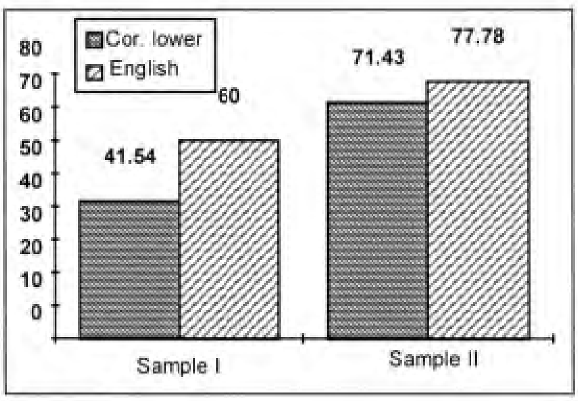
SENTDIF = 1+ [points on "correct lower case" sentence] - [sum of points in the other 6 sentences] / 6

Note: the number of "points" refers to the number of sentences accepted by the child, regardless of whether the child's choice was correct.

The scores on SENTDIF range from 0 to 2 and it was expected that they would correlate positively with the other measures. This variable is roughly normally distributed for the pooled samples.

In addition to the investigation of children's notions about word size and sentence segmentation, an English sentence was introduced to explore whether some specific features of English orthography (such as the use of apostrophes, "y", "th" and double "l") would make a sentence more acceptable for Sample II than for Sample I children. Figure 4.2-3 shows the proportion of children in each sample who accepted the English sentence, compared with the Portuguese "correct lower case" sentence.

Figure 4.2-3 Comparison between the proportion of children accepting the English sentence and the proportion accepting the Portuguese "correct lower case" sentence, by sample



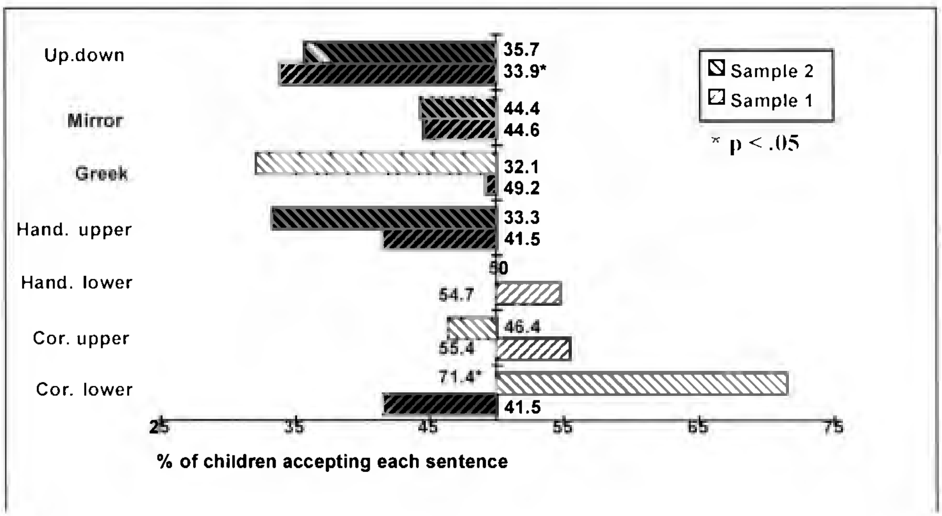
In spite of the fact that the proportion of children accepting the English sentence is greater in Sample II than in Sample I, the children in Sample I were more likely to accept the English than the Portuguese sentence. This shows that they were unaware of the differences between Portuguese and English orthographies. Similarly, the difference between the proportion of children accepting the Portuguese and the English sentences was very small in Sample II, providing no indication that Sample II children have relied on any specific orthographic feature to decide on the acceptability of the English sentence.

To investigate children's knowledge about the conventional letter shapes, the acceptance of sentences printed with different types of letters was compared relatively to chance level (50%), as shown in Figure 4.2-4.

The results show that Sample I children were more familiar with upper case printed letters and lower case handwriting. These were the only types of letters they were likely to accept. However, this acceptance could have been based on chance. In spite of tending to reject all the sentences with other types of letters, the only sentence whose rejection was significantly greater than chance was the one printed upside-down.

Sample II children were likely to accept only the lower case printed letters and to reject all the others. However, this rejection could have been based on chance, even for the sentence printed upside-down.

Figure 4.2-4 Percentage of children accepting each sentence relative to chance level (50%), per sample



Therefore, most children already distinguished the letters they were used to seeing in their classroom from other types of letters. The low level of rejection of the other types could show either that they were keeping an open mind about different types of graphic symbols or that many children were not yet sure about conventional letter shapes. Even so, Sample II children are likely to have a clearer idea of what a printed text looks like than Sample I children.

As for sentence differentiation (SENTDIF), a new variable, Sentence Oddity (SENTODD) was created to assess children's notions about conventional letter shapes. This variable was a composite of the scores for both the correct and the odd sentences. The "handwriting capital letters" sentence was excluded from this composite because it was both correct and odd. It would be considered correct if the decision was based on the existence of the component letters but it would be odd if the decision was based on the likelihood of finding a similar sentence in commonly-encountered written materials.

To avoid SENTODD from being given more weight than SENTDIF, a similar formula was used:

SENTODD = 1 + [sum of points on conventional sentences] / 3 - [sum of points on odd sentences] / 3

Note.: the number of "points" corresponds to the number of sentences accepted by the child. It does not indicate whether the child's choice was correct.

Therefore, the scores in SENTODD range from 0 to 2 and we also expect them to correlate positively with the other measures which assess the acquisition of the alphabetic principle. The distribution of the scores on this variable is roughly symmetrical for the pooled samples.

The total score for Sentence Orthography (SENTORT) is a composite of SENTDIF and SENTODD:

SENTORT = SENTDIF + SENTODD

This variable is normally distributed for the pooled samples and its values range from 0 to 4 (mean = 2.02; SD = .83).

Finally, the familiarity with script conventions (SCRIPTCON) reflects children's notions of what is acceptable for writing both isolated words and sentences:

SCRIPTCON = WORDORT + SENTORT

This variable is also normally distributed for the pooled samples and its values range from 0 to 8.

Table 4.2-4 shows the descriptive statistics for SCRIPTCON, for each sample, as well as for the pooled samples.

Table 4.2–4 Descriptive statistics for SCRIPTCON, per sample

	N	Minimum	Maximum	Mean	SD	Skweness	Kurtosis
Sample I	65	1	6.17	3.84	1.22	-.13	-.42
Sample II	28	2.75	7	4.74	1.20	-.47	-.68
Pooled	93	1	7	4.11	1.28	.04	-.14

There was a significant difference between the means of the two samples [F(1,91) = 6.413; p=.013], even after the effects of age were controlled. This means that Sample II children were more aware of the differences between scripts and other graphic stimuli. Within samples, the means of the intervention groups were also slightly different, as shown in Table 4.2-5.

Table 4.2–5 Descriptive statistics for SCRIPTCON per intervention group

	N	Minimum	Maximum	Mean	Std. Deviation
GROUP 1	16	2.08	5.67	3.65	1.07
GROUP 2	16	1.00	5.83	3.66	1.39
GROUP 3	14	1.58	6.17	4.14	1.29
GROUP 4	16	1.58	6.17	3.91	1.05
GROUP 5	14	2.75	6.67	4.82	1.14
GROUP 6	14	3.00	7.00	4.65	1.30

4.2.3. Summary: Do we need SCRIPTCON in this study?

In spite of the general tendency to accept rather than to reject any "word" or "sentence", SCRIPTCON proved to be sensitive to differences in children's knowledge about graphic conventions of scripts.

It was observed that children were not yet aware of the specific orthographic features that distinguish Portuguese and English. However, some children (especially in Sample II) had started to differentiate between letters and other graphic shapes and to acknowledge some script conventions, such as sentence segmentation and the need for internal and external differentiation (variety within and between words), which are shared by both orthographies.

This knowledge can be assumed to reveal both the quantity and the quality of children's experience with written materials, since it must be acquired as children try to understand what writing is about. Thus, knowledge of script conventions is expected to affect children's performance on tasks involving literacy. Therefore, SCRIPTCON will be used as a control measure in the regression analysis presented in the next chapter, where the variables affecting the development of children's understanding and use of the alphabetic system will be investigated.

4.3 Measures of Underpinning Skills and Knowledge

As explained in the previous chapter, this set includes the measures of Initial Letter Recognition and Phonological Pairing. The first assesses a very elementary use of phonological recoding (matching words to their initial letters) and the second assesses children's ability to detect phonological identity between words. We expect these measures to predict children's understanding and use of the alphabetic system, so we need to make sure that they are sensitive to different degrees of ability.

4.3.1. Initial Letter Recognition

In the tasks assessing initial letter recognition (Initial Consonant Recognition) and Initial Vowel Recognition) children had to decide whether a word started with a given letter. They were asked to mark each item with a circle, if the letter was correct, or a cross, if it was incorrect. Children's scores on this task are shown in Appendix 13.

4.3.1.1. Initial Consonant Recognition

Different conditions were created for this task, to investigate two hypotheses, related to the sound value of the consonants:

1. At the most rudimentary levels of phonological recoding, children think of the letters as graphic representations of the syllables that sound like the letter's names;
2. Children initially rely on physical features, such as the place of articulation, to discriminate consonantal sounds.

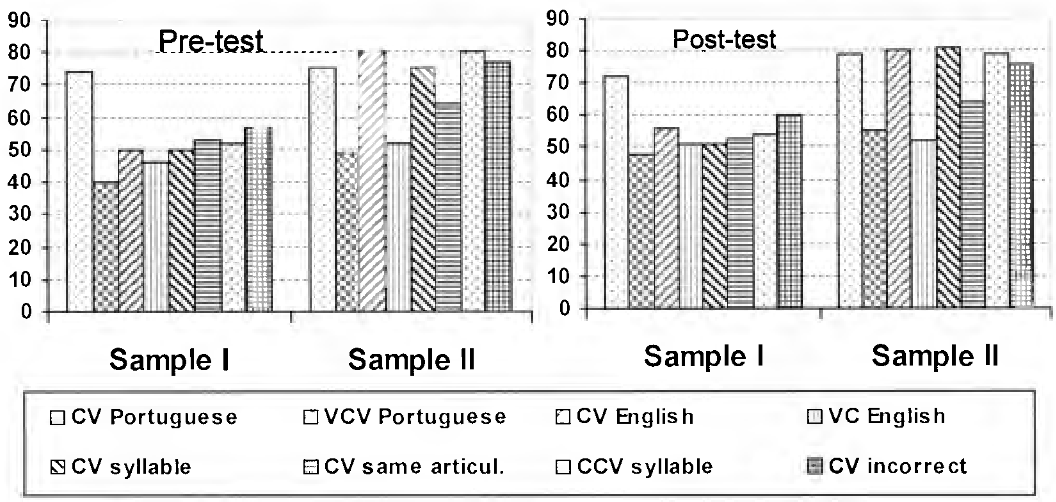
The conditions used to investigate the first hypothesis were CV-Portuguese and VCV-Portuguese (words starting with a syllable, or two syllables, corresponding to the name of the letter in Portuguese, such as "telha", for letter T or Énio, for letter N) as well as CV-English and VC-English (words starting with a syllable corresponding roughly to the name of the letter in English, such as "pijama", for letter P or "árvore", for letter R). It was expected that Sample I children would get better scores on CV-Portuguese than on VC-English. Sample II should get better scores on CV-English if they only knew the names of the letters in English, but this had not been assessed. On the other hand, it was expected that both samples would get lower scores on both

VCV-Portuguese and VC-English than on any other condition, because these were the words starting with syllables corresponding (roughly) to the names of the letters F, L, M, N, S and R. Rather than being a clue for the phonemes, the names of these letters might distract children from their sound values. The scores on VCV-Portuguese and VC-English were expected to be roughly the same, as both conditions used the same words (except for letter R) and the names of these letters are the same in Portuguese and in English.

The second hypothesis was investigated by including the condition CV-same-articulation, comprising words starting with the letter which had the same place of articulation as the target letter, such as "garfo" for letter C and "padre" for letter B (see methodology chapter for further details). It was expected that this condition would negatively affect the scores of the children from both samples.

The differences between conditions are more clearly shown in figure 4.3-1.

Figure 4.3–1 Mean percentage of correct answers, per sample, in each condition of Initial Consonant Recognition, in both pre-test (left) and post-test (right)



Sample I scored at chance level (50%) on most conditions. As expected, children got higher scores on CV-Portuguese (the name of the consonant is a CV syllable word beginning with this consonant) and lower scores on both VCV-Portuguese and VC-English (the name of the letter starts with a vowel instead of the consonant it refers to). Therefore, children from this sample still relied on the names of the letters rather than on their sounds and this explains why they were not affected by the similarity of the place of articulation in the CV-same-articulation condition.

Sample II scored above chance on most conditions, showing that they already relied on grapheme-phoneme correspondence to perform this task. However, they were confused by letter names starting with VC syllables (F, L, M, N, R and S), as well as by letters with the same place of articulation (CV-same-articulation condition). This means that they still relied on both auditory and articulatory cues to decide the sound of the letters and the auditory cues prevailed over the articulatory ones when discriminating consonants whose names began with a vowel.

We expected the CCV-syllable condition (word beginning with a CCV syllable) to be more difficult than the CV-syllable condition (word beginning with a CV syllable). In CV syllables the initial consonant coincides with the syllable onset, whereas in CCV syllables the onset is a consonant cluster which has to be segmented for identifying the initial consonant. The results showed that this was not the case. Therefore, for discriminating consonants, their position within the syllable is likely to be a more important variable than being or not part of a cluster.

Table 4.3-1 shows the mean percentage of correct scores of both samples on all the consonant conditions of this task, both on the pre-test and on the post-test.

Table 4.3-1 Mean percentage and SD of correct scores on all the conditions of Initial Consonant Recognition task, per sample

	CONDITIONS	SAMPLE I			SAMPLE II			POOLED		
		N	Mean %	SD	N	Mean %	SD	N	Mean %	SD
PRE-TEST	CV Portuguese	47	74	25	26	75	21	73	75	24
	VC Portuguese	47	40	25	26	49	31	73	43	27
	CV English	47	50	33	26	80	20	73	61	32
	VC English	47	46	25	26	52	30	73	48	27
	CV syllable	47	50	24	26	75	24	73	59	27
	CV same articulation	47	53	28	26	64	57	73	57	28
	CCV syllable	47	52	27	26	80	25	73	62	29
	CV incorrect	47	57	28	26	77	25	73	64	28
POST-TEST	CV Portuguese	55	72	27	28	79	22	83	74	26
	VC Portuguese	55	48	25	28	55	32	83	51	27
	CV English	55	56	28	28	80	26	83	64	30
	VC English	55	51	23	28	52	33	83	51	27
	CV syllable	55	51	22	28	81	24	83	61	27
	CV same articulation	55	53	27	28	64	29	83	57	28
	CCV syllable	55	54	26	28	79	27	83	63	29
	CV incorrect	55	60	24	28	76	30	83	65	27

The number of subjects included in this analysis was only 73 in the pre-test and 83 in the post-test, not only because of some missing data, but mainly because several subjects, from Sample I, gave stereotyped answers, especially in the pre-test. Overall, they used less than 10% of either crosses (meaning incorrect) or circles (meaning correct), scattered over different items. Since, in some conditions, all the items are correct, while, in others, all the items are incorrect, stereotyped answers would lead to misinterpretations in comparisons between conditions, generally favouring those where all the items are correct, because children tend to use more marks meaning correct (circles) than incorrect (crosses).

The results were further analysed by carrying out a Repeated Measures Analysis of Variance (MANOVA), having Conditions as the within subjects factor and Sample as the between subjects factor. Due to the variances not being homogeneous, we considered the results of the multivariate tests for the within subjects analysis. As expected, this analysis showed a significant effect of both Sample [$F(1,71)=38.08$; $p<.001$] (pre-test); [$F(1,81)=38.08$; $p<.001$] (post-test), due to the better performance of Sample II, and Condition [$F(7,65)=10.46$; $p<.001$] (pre-test); [$F(7,75)=7.84$; $p<.001$] (post-test), as well as a significant interaction effect of Sample X Condition [$F(7,65)=3.47$; $p<.003$] (pre-test); [$F(7,75)=3.25$; $p=.005$] (post-test). The significant interaction effect confirms the different effects of the CV-Portuguese condition, which was the easiest task for Sample I but not for Sample II, as well as the effects of CV-same-articulation condition (same place of articulation), which had a negative effect on Sample II but not Sample I.

Therefore, the results on Initial Consonant Recognition confirmed the hypotheses that:

(1) At the most rudimentary attempts to carry out phonological recoding, children conceive of letters as graphic representations of the syllables that sound like the letters' names. This was the prevailing conception of children in Sample I.

(2) Children initially rely on physical features, such as the place of articulation, to discriminate consonantal sounds. This strategy shows that children already understand that letters correspond to sub-syllabic units. Although this was the prevailing strategy of children in Sample II, some of them had not abandoned completely the previous conception (letters

matching the sound of the syllable) and were baffled by letters whose names begin with a vowel.

In the next chapters we will investigate the relationship between this ability to carry out phonological recoding of the initial consonant and the performance in tasks assessing children's understanding of the alphabetic principle.

4.3.1.2. Initial Vowel Recognition

The recognition of initial vowels was also expected to depend on different factors, so six conditions were devised to investigate the following hypotheses:

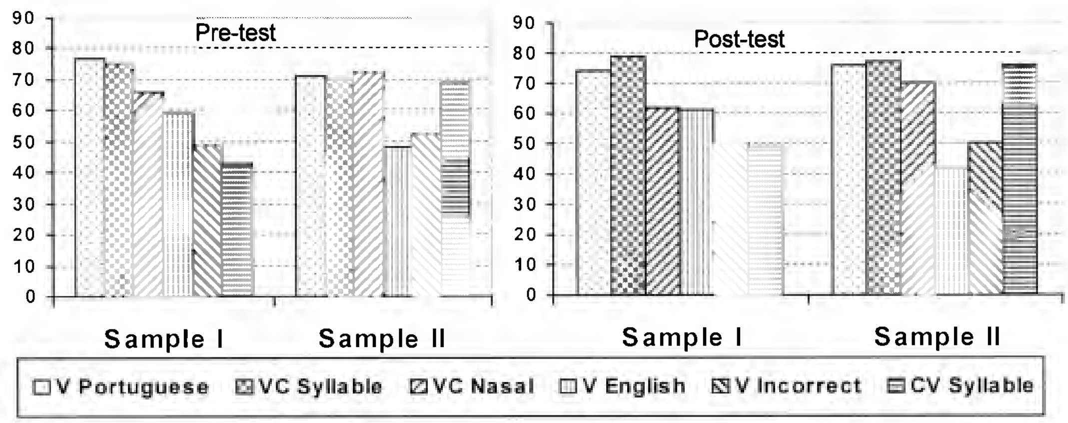
1. The vowel is more easily recognised when the first syllable of the word coincides with its name.
2. Children who know the names of the vowels in English (Sample II) tend to use these names as the sound value of the letters, even in Portuguese.
3. Some children match the vowel with the sound of the syllable it belongs to, even when it is a CV syllable.

The conditions used to investigate the first and the second hypotheses were V-Portuguese (words starting with a syllable that sounds like the name of the vowel in Portuguese, such as "alho", for letter A) and V-English (words starting with a syllable that sounds roughly like the name of the letter in English, such as "igreja", for letter E). It was expected that all the children would get higher scores on V-Portuguese than in all the other conditions and that children from Sample II, by contrast with children from Sample I, would get lower scores on V-English than on any other condition. As the nasal sound does not correspond to the name of the letter, the VC-nasal condition (such as "anjo", for letter A) allows further investigation of whether children are only using the name of the letters, or whether they are already aware of different phonemes represented by the same vowel. It was expected that the scores on this condition would be lower than on VC-syllable condition, whose first syllable was also the VC type, but where the name of the vowel would still be heard (such as árvore for A).

The CV-syllable condition (using words such as "fada" for the letter A) was devised to test the third hypothesis. It was expected that children who matched the vowels to the syllables would get lower scores on this condition than on VC-syllable or V-Portuguese conditions. Contrary to CV-syllable, in these conditions, the first letter is the vowel, so they would get correct answers even when considering the vowel as representing the whole syllable instead of just its nucleus.

Figure 4.3-2 shows the percentage of correct scores on all the vowel conditions, by sample, both in the pre-test and in the post-test.

Figure 4.3–2 Mean percentage of correct scores on all the vowel conditions, by sample, in the pre-test (left) and in the post-test (right)



Sample I children got higher scores on the conditions where the name of the vowel could be heard, such as in "alho" (V-Portuguese) and "árvore" (VC-syllable). The scores on VC-nasal (such as anjo) were slightly lower, but they were better than the scores on all the incorrect "conditions" (V-English, V-incorrect and CV-syllable), so some children were already considering the sound value of the vowel and not only its name. The lowest scores on CV-syllable (such as in "fada", for letter A), show that some children were relating the vowel to the syllable. However, we have to be careful about drawing conclusions from this result, as the low scores on all the incorrect conditions may be showing that, overall, children tended to use more "correct" (circles) than "incorrect" marks (crosses). Nevertheless, as all the vowels and consonant conditions were alternated throughout the booklet, there is no apparent reason why children should use more "correct" marks on vowels than on consonants.

In contrast to Sample I children, who got higher scores on vowels than on consonants, Sample II children did slightly worse on vowels. As expected, they had trouble dealing with the V-English condition, showing the interference of having been taught the vowels in English. However, it is not possible to know whether they were considering the name of the vowels in English or the alternative long vowel pronunciation. As they were not receiving instruction in Portuguese, they might not know that this is not a legitimate sound for the vowels in Portuguese, as it is in

English. Anyway, this shows that, from the earliest stages, the knowledge of letter-to-sound correspondences is affected by the orthography that children are learning and/or the way this orthography is taught.

Table 4.3-2 shows the proportion (mean percentage) of correct scores of both samples on all the vowel conditions, both on the pre-test and on the post-test.

Table 4.3–2 Mean percentage and SD of correct scores on all the conditions of Initial Vowel Recognition task, per sample, in both pre- and post-test

	CONDITIONS	SAMPLE I			SAMPLE II			POOLED		
		N	Mean %	SD	N	Mean %	SD	N	Mean %	SD
PRE-TEST	V Portuguese	47	77	22	26	71	22	73	75	22
	V English	47	59	33	26	48	21	73	55	29
	VC Syllable	47	75	23	26	70	22	73	73	22
	VC nasal	47	66	24	26	72	27	73	68	25
	CV syllable	47	43	32	26	69	31	73	53	34
	V incorrect	47	49	37	26	52	25	73	50	33
POST-TEST	V Portuguese	54	74	16	27	76	.21	81	75	.18
	V English	54	61	27	27	42	.21	81	55	.27
	VC Syllable	54	79	23	27	77	.21	81	78	.22
	VC nasal	54	62	25	27	70	.27	81	64	.26
	CV syllable	54	49	27	27	76	.32	81	58	.31
	V incorrect	54	50	32	27	50	.25	81	50	.30

These results were further analysed by carrying out a Repeated Measures Analysis of Variance (MANOVA), having Conditions as the within subjects factor and Sample as the between subjects factor. As expected, this analysis showed a significant effect of Condition [$F(5,355)=9.72$; $p<.001$] (pre-test) and [$F(5,395)=18.47$; $p<.001$] (post-test), as well as a significant interaction effect of Sample X Condition [$F(5,355)=3.97$; $p<.005$] (pre-test) and [$F(5,395)=7.79$; $p<.001$] (post-test). No significant effect of Sample was found [$F(1,71)=.40$; $p=.53$] (pre-test) and [$F(1,79)=.53$;$p<.47$] (post-test).

The more interesting result is the interaction effect, due to the low scores obtained by Sample I on the CV-syllable condition and the low scores obtained by Sample II on V-English condition. It shows that the learning of the vowels in Portuguese supports the conception of the syllabic hypothesis (children tend to use the vowel to represent the whole syllable). However, learning the vowels in English does not have the same effect, probably because, in English orthography, one letter can represent many different vowel sounds. Moreover, the name of the letter is not a good cue for most of these sounds and the vowels are not usually taught before the consonants.

4.3.1.3. Descriptive statistics

Due to the differences between the knowledge of vowels and the knowledge of consonants, two measures of Initial Letter Recognition were considered in this study. Initial Vowel Recognition was obtained by adding up the scores on all the vowel conditions (max = 30); Initial Consonant Recognition was obtained by adding up the scores on all the consonant conditions (max = 66).

The pre and post-test descriptive statistics of both Initial Vowel Recognition (VOWPRE and VOWPOST, respectively) and Initial Consonant Recognition (CONSPRE and CONSPOST, respectively), are shown on Table 4.3-3.

Table 4.3–3 Pre and post-test descriptive statistics of both Initial Vowel Recognition (VOWPRE and VOWPOST) and Initial Consonant Recognition (CONSPRE and CONSPOST)

	Measure	N	Minimum	Maximum	Mean	SD	Skweness	Kurtosis
SAMPLE I	CONSPRE	62	26	46	34.03	4.19	1.06	1.19
	CONSPOST	62	27	55	35.85	5.38	1.44	2.68
	VOWPRE	62	11	25	17.94	3.61	.62	-.75
	VOWPOST	62	11	29	18.40	4.25	.71	-.14
SAMPLE II	CONSPRE	27	32	62	46.48	10.65	.10	-1.63
	CONSPOST	27	28	65	47.96	12.80	-2.00	-1.63
	VOWPRE	27	12	26	19.19	3.58	-.17	-.56
	VOWPOST	27	12	27	19.52	3.56	-.16	-.21
POOLED	CONSPRE	89	26	62	37.81	8.88	1.44	1.12
	CONSPOST	89	27	65	39.53	9.99	1.22	.33
	VOWPRE	89	11	26	18.31	3.63	.36	-.92
	VOWPOST	89	11	29	18.74	4.07	.46	-.35

The distribution of the means on Initial Vowel Recognition was approximately symmetrical for the pooled samples, in both pre-test and post-test. On the contrary, Initial Consonant Recognition was positively skewed for the pooled samples, in both pre-test and post-test.

There was a significant difference between samples on Initial consonant recognition, both in the pre-test [$F(1,90)=27.92$; $p<.001$] and in the post-test [$F(1,89)=14.41$; $p<.001$], even after the effects of age were controlled.

4.3.2. Phonological Pairing Task

The different conditions of Phonological Task were designed to detect both quantitative and qualitative differences in children's sensitivity to sound identity between words. Children's raw scores on this task are shown in Appendix 14.

4.3.2.1. Initial segments

Table 4.3-4 shows that, for initial segments, the children performed better when the shared segment was the whole syllable and there were no common sounds in the contrasting words (full contrast). The difference between the other conditions was very small.

Table 4.3–4 Means and SD on the initial conditions of Phonological Pairing task, in pre- and post-test, per sample

		Initial Syllable full contrast		Initial Syllable part. contrast		Initial Onset dif. articullation		Initial Onset same articul.		Initial Phoneme	
		mean	*SD*	mean	*SD*	mean	*SD*	mean	*SD*	mean	*SD*
SAMPLE I	Pre-test (n=65)	2.42	*1.38*	1.80	*1.18*	1.69	*1.05*	1.62	*1.09*	1.59	*1.00*
	Post-test (n=64)	2.69	*1.15*	1.89	*1.09*	1.89	*1.06*	1.36	*.98*	1.53	*.96*
SAMPLE II	Pre-test (n=28)	3.29	*.94*	2.29	*1.21*	2.07	*1.33*	1.82	*.91*	2.39	*1.34*
	Post-test (n=28)	3.54	*.88*	2.43	*1.26*	2.75	*1.21*	2.11	*1.17*	2.57	*1.32*
POOLED	Pre-test (n=93)	2.68	*1.32*	1.95	*1.20*	1.81	*1.15*	1.68	*1.03*	1.83	*1.17*
	Post-test (n=92)	2.95	*1.14*	2.02	*1.17*	2.14	*1.17*	1.59	*1.09*	1.85	*1.18*

In both the pre-test and the post-test, these results were further analysed by carrying out two Repeated Measures Analysis of Variance (MANOVA), having Conditions as the within subjects factor and Sample as the between subjects factor. As expected, this analysis showed a significant effect of both Sample [F(1,91)=8.87; p=.004] (pre-test) and [F(1,90)=21.47; p<.001] (post-test), due to the better performance of Sample II, and Condition [F(4,364)=18.46; p<.001] (pre-test) and [F(4,360)=28.64; p<.001] (post-test). The Tukey post-hoc test confirmed that the significant effect of condition was due to the difference between "initial syllable" (full contrast) and all the other conditions, both on the pre-test and on the post-test. On the post-test, the mean on "initial onset with the same place of articulation" was also significantly lower than the means on all the other conditions, except "initial phoneme". No significant interaction effect of Sample by Condition was found [F(4,364)=1.92; p=.11] (pre-test) and [F(4,360)=.76; p=.55] (post-test). Therefore, for both Sample I and Sample II children, it was easier to detect sound identity between syllables than between any kind of sub-syllabic units. The extra difficulty produced by the use of consonants with the same place of articulation shows that children were likely to rely on the physical features of the phonemes as a strategy to detect sound identity between words.

The analysis of the errors on each condition provides some information about the difficulties encountered when detecting sound identity between different words.

For instance, to succeed on "initial syllable with partial contrast" condition, children had to pay attention to all the segments within the syllable. Table 4.3-5 shows that, although 89% of the children were able to pay attention to the nucleus and at least one consonant (either the onset or the coda), only 49% of the children were able to focus on all the phonemes.

Table 4.3–5 Percentage of sub-syllabic segments children took into account, when comparing initial syllables which shared the same nucleus (partial contrast; pre-test results)

Target word	onset + nucleus + coda		onset + nucleus		nucleus + coda		only nucleus	
example: porta	example: porca	% 49	example: pote	% 23	example: corda	% 17	example: cobra	% 11

The results show that Portuguese speakers tend to maintain the onset, ignoring the coda (transforming CVC syllables into CV syllables, as in **porta-pote**), rather than maintaining the rime and ignoring the onset (as in **porta-corda**).

What happens when children have to detect onset identity when the onset of the target word is a consonant cluster? Are they able to consider both consonants simultaneously?

As we can see in Tables 4.3-6 and 4.3-7, this ability depends on other features of the syllable.

Table 4.3–6 Percentage of shared segments which children took into account when matching the onset, in syllables with different nuclei (pre-test results)

Target word	whole onset (correct)		first phoneme		second phoneme		none	
grilo	example	%	example	%	example	%	example	%
dif. artic.	grade	38	galo	22	braço	22	bata	19
same artic.	grade	41	galo	22	cravo	24	cabo	13
pooled		39		22		23		16

Table 4.3-6 shows that, when the contrasting syllables had different nuclei (vowels), only about 40% of the children were able to take into account both consonants in the onset. Children's choices were not affected by having the same place of articulation in the initial consonants in the contrasting words. The same percentage

of children chose either a CCV syllable with a different initial consonant (taking into account only the second consonant, as in **gr**ilo-bra**ç**o, or **gr**ilo-**cr**avo) or transformed the CCV syllable into a CV syllable (ignoring the second consonant, as in **gr**ilo-**g**alo).

A different picture emerges when all the contrasting words share the same nucleus. In this case, the correct choice shares the whole syllable and not only the initial onset with the target word.

As shown in Table 4.3-7.children's choices depend on the place of articulation of the initial consonant of the contrasting words.

Table 4.3–7 Percentage of shared segments which children took into account when matching the onset, in syllables with the same nucleus (pre-test results)

Target word	whole onset (correct)		first phoneme		second phoneme		none	
praça	example	%	example	%	example	%	example	%
dif. artic.	prato	53	padre	20	cravo	16	cabo	12
same artic.	prato	43	padre	11	braço	29	bata	17
pooled		48		16		22		14

When the first consonants of the contrasting words have different places of articulation, 53% of the children were able to make the correct choice, considering both the consonants. The analysis of the incorrect choices shows that children tended to match a CCV syllable to a CV syllable with the same initial consonant (as in **pr**aça-**p**ato), rather than to another CCV syllable with the same second consonant (as in **pr**aça-c**r**avo). Therefore, they tended to ignore the second consonant.

However, when the syllables share the same initial place of articulation, children tend to match two CCV syllables that share the second consonant (as in **pr**aça-b**r**aço). At first sight, we could conclude that children are paying attention to the second consonant of the cluster, ignoring the first consonant. However, the results of Letter Recognition showed that children find it difficult to detect the difference between two consonants with the same place of articulation. Therefore, it is likely that, instead of ignoring the initial consonant, they are taking into account its similarity with the first consonant of the target word.

These results are interesting because they show that the ability to detect phonological identity is not a straightforward one. Even when only segments in the initial position are considered, children's ability is strongly affected by the features of shared segments. Moreover, the detection of the identity of sub-syllabic segments also depends on the structure of the syllable they belong to. This includes the similarity of both the nucleus and the place of articulation of the initial consonant of the shared segments.

This confirms that children rely strongly on both auditory cues (provided by the vowel) and articulatory cues (provided by the consonant). Moreover, it shows that the common errors of transforming CCV and CVC into CV syllables, both in reading and in writing, frequently made by beginners, are likely to be rooted in the difficulty of discriminating each phoneme within such syllables.

4.3.2.2. Final segments

The comparison between the means of the final segments (Table 4.3-8) shows that children got better scores when matching words which shared the rime of the final syllable, but only if this syllable was the stressed one (such as caf**é**-bon**é**). In unstressed final syllables, the rime, (which, in Portuguese, is generally reduced to the vowel) was the segment which children found most difficult when selecting the matching words such as (gat**o**-burr**o**).

Table 4.3–8 Means and SD on the final conditions of Phonological Pairing task, in pre- and post-test, per sample

		Final Syllable full contrast		Final Syllable part. contrast		Stressed final rime (rhyme)		Unstressed final rime		Final consonant	
		mean	*SD*	mean	*SD*	Mean	*SD*	mean	*SD*	mean	*SD*
SAMPLE I	**Pre-test** (n=65)	1.69	*1.20*	1.40	*.92*	2.02	*1.29*	1.22	*1.07*	1.79	*1.29*
	Post-test (n=64)	1.84	*1.31*	1.34	*1.00*	2.45	*1.26*	1.47	*1.13*	1.91	*1.18*
SAMPLE II	**Pre-test** (n=28)	2.07	*1.33*	1.86	*1.33*	2.32	*1.16*	1.57	*.96*	1.68	*1.02*
	Post-test (n=28)	2.54	*1.20*	2.18	*1.25*	2.43	*1.10*	1.82	*1.28*	2.04	*1.43*
POOLED	**Pre-test** (n=93)	1.81	*1.25*	1.54	*1.07*	2.11	*1.26*	1.32	*1.04*	1.75	*1.21*
	Post-test (n=92)	2.05	*1.31*	1.60	*1.14*	2.45	*1.21*	1.58	*1.18*	1.95	*1.25*

This is not surprising because, in oxytone words (with the stress on the last syllable), the rime of the last syllable is the segment used to produce a rhyme, in poetry. So, when considering the stressed final rime children are actually making judgements about the rhyming words. On the contrary, in paroxytone words (with the stress on the last but one syllable), it is necessary to use the rime of the last but one syllable plus the whole last syllable to produce a rhyme. Therefore, to decide whether two words share the same final unstressed rime, children have to take into account only the final phoneme (which is a vowel). Obviously, this is a less salient and less natural unit than the rhyme. Moreover, in Portuguese, the vowel of a stressed syllable sounds like its name, whereas the vowel of an unstressed syllable has got a closed sound (eg: caf**é** versus tigr**e**)

Again, to provide a clearer picture of the differences between the means, a Repeated Measures Analysis of Variance (MANOVA) was carried out, having Condition as the within subjects factor and Sample as the between subjects factor. This analysis showed only a significant effect of Condition [$F(4,364)=11.10$; $p<.001$] (pre-test) and [$F(4,360)= 10.72$; $p<.001$] (post-test). No significant effect of Sample was found [$F(1,91)=1.72$; $p=.19$] (pre-test) and [$F(1,90)=3.63$; $p=.06$] (post-test). In the pre-test, no interaction effect of Sample by Condition was found [$F(4,364)=1.63$; $p=.17$]. However, in the post-test, there was an interaction effect of Sample by Condition [$F(4,360) = 3.43$; $p=.009$], mainly due to the better performance of Sample II in the syllable conditions only. The Tukey post-hoc test showed that, both in the pre-test and in the post-test, the significant effect of Condition was due to the difference between the stressed rime and all the other conditions (except Final Syllable with Full Contrast). There was also a significant difference between the unstressed rime (final vowel) and all the other conditions (except Final Syllable with Partial Contrast). In the post-test, there was also a significant difference between the scores on Final Syllable with full contrast and both Final Syllable with partial Contrast and Unstressed Rime.

However, we have to be cautious when comparing the Final Phoneme (Final Consonant) condition with the others. It is likely that many children got higher scores on the Final Phoneme condition due to a non-phonological strategy: in one particular item, many children, especially in Sample I, chose the picture of a necklace because they liked it and not because they were able to detect the shared segment. By chance, the preferred picture happened to be the correct choice, so they got an "unfair" pass mark in the item concerned. A closer observation of children's answers allowed us to identify these children. If we recoded the mark of these children in this particular item, from pass to fail, the mean on Final Phoneme condition would not be significantly different from the mean of Unstressed Rime condition and will become significantly lower than Final Syllable with Full Contrast, in the post-test.

Therefore, for both Sample I and Sample II children, we found two levels of difficulty when detecting sound identity between final segments. The easiest level included detecting the rhyming words (common rime of the stressed final syllable, such as in an**el**-pinc**el**) and detecting the shared final syllable (provided that there were no common sounds between the target word and the contrasting words, such as in ca**nal**-jor**nal**). A global sensitivity to sound (based on auditory cues) is sufficient to detect the identity between these segments.

Detecting similarities between sub-syllabic units proved to be the most difficult challenge, especially when the shared segment was only the vowel of a CV unstressed syllable (such as in fit**a**-porc**a**). It is interesting that, in this case, the vowel does not provide relevant auditory cues for children to rely on, as previous research has shown that, from an early age, children are able to represent the vowel of the last syllable of disyllabic words, in their invented spellings.

4.3.2.3. Descriptive statistics

Comparing the means in the different conditions of Phonological Categorisation task allowed us to observe different levels of ability to detect sound identity between words. We found that, in general, the bigger the segment, the easier it was to detect.

However, in some analyses, a unique measure of phonological sensitivity was used. The correlation between the different conditions shows that it was quite appropriate to make a composite by adding up the scores in all the conditions (Table 4.3-9 and 4.3-10).

Table 4.3–9 Pearson's correlation of both the initial and the final conditions of Phonological Pairing, in the pre-test

(N=93)	**PHISD**	**PHISS**	**PHIOD**	**PHIOS**
PHISS	.61 *p<.001*			
PHIOD	.52 *p<.001*	.48 *p<.001*		
PHIOS	.35 *p<.001*	.30 *p<.001*	.43 *p<.001*	
PHIPH	.34 *p<.001*	.41 *p<.001*	.41 *p<.001*	.15 *p=.147*

(N=93)	**PHFSD**	**PHFSS**	**PHFRS**	**PHFRU**
PHFSS	.48 *p<.001*			
PHFRS	.74 *p<.001*	.52 *p<.001*		
PHFRU	.54 *p<.001*	.48 *p<.001*	.55 *p<.001*	
PHFPH	.66 *p<.001*	.43 *p<.001*	.71 *p<.001*	.51 *p<.001*

PHISD - Initial Syllable with full contrast.
PHISS - Initial Syllable with partial contrast.
PHIOD - Initial Onset with different articulation.
PHIOS - Initial Onset with the same articulation.
PHIPH - Initial Phoneme.

PHFSD - Final Syllable with full contrast.
PHFSS - Final Syllable with partial contrast.
PHFRS - Final stressed rime (rhyme).
PHFRU - Final unstressed rime (vowel).
PHFPH - Final phoneme (consonant).

Table 4.3–10 Pearson's correlation of both the initial and the final conditions of Phonological Pairing, in the post-test

PHISS	.48 *p<.001*			
PHIOD	.49 *p<.001*	.37 *p<.001*		
PHIOS	.44 *p<.001*	.36 *p<.001*	.49 *p<.001*	
PHIPH	.48 *p<.001*	.40 *p<.001*	.54 *p<.001*	.50 *p<.001*
(N=92)	**PHISD**	**PHISS**	**PHIOD**	**PHIOS**

PHFSS	.46 *p<.001*			
PHFRS	.57 *p<.001*	.36 *p<.001*		
PHFRU	.54 *p<.001*	.42 *p<.001*	.47 *p<.001*	
PHFPH	.58 *p<.001*	.35 *p=.001*	.56 *p<.001*	.47 *p<.001*
(N=92)	**PHFSD**	**PHFSS**	**PHFRS**	**PHFRU**

PHISD - Initial Syllable with full contrast.
PHISS - Initial Syllable with partial contrast.
PHIOD - Initial Onset with different articulation.
PHIOS - Initial Onset with the same articulation.
PHIPH - Initial Phoneme.

PHFSD - Final Syllable with full contrast.
PHFSS - Final Syllable with partial contrast.
PHFRS - Final stressed rime (rhyme).
PHFRU - Final unstressed rime (vowel).
PHFPH - Final phoneme (consonant).

PHINPRE (Phonological Pairing, initial segments; pre-test) and PHINPOST (Phonological Pairing, initial segments; post-test), ranging from 0 to 20, were created by adding up the scores on the Initial Conditions. Table 4.3-11 shows the descriptive statistics for these variables, by sample as well as for the pooled samples.

Table 4.3–11 Descriptive statistics for PHINPRE and PHINPOST, by sample

	PHINPRE (Phonological Pairing - initial segments - pre-test)						PHINPOST (Phonological Pairing - initial segments - post-test)					
	MEAN	SD	MIN.	MAX.	SKEWN.	KURT.	MEAN	SD	MIN.	MAX.	SKEWN.	KURT.
SAMPLE I	9.11	4.02	2.00	17.00	.15	-1.04	9.30	3.44	2.00	19.00	.17	-.12
SAMPLE II	11.86	4.24	3.00	19.00	-.48	-.39	13.39	4.81	1.00	20.00	-.77	.23
POOLED	9.94	4.25	2.00	19.00	.01	.50	10.54	4.32	1.00	20.00	.19	-.44

Two other variables were created (PHFIPRE, for pre-test and PHIFIPOST, for post-test) by adding up de scores on the Final Conditions. The possible scores for these variables ranged from 0 to 20. Table 4.3-12 shows the descriptive statistics for these variables, by sample, as well as for the pooled samples.

Table 4.3–12 Descriptive statistics for PHFIPRE and PHFIPOST, by sample

	PHFIPRE (Phonological Pairing - final segments - pre-test)						PHFIPOST (Phonological Pairing - final segments - post-test)					
	MEAN	SD	MIN.	MAX.	SKEWN.	KURT.	MEAN	SD	MIN.	MAX.	SKEWN.	KURT.
SAMPLE I	8.11	4.81	.00	18.00	.78	-.41	9.02	4.48	1.00	19.00	.44	-.91
SAMPLE II	9.50	4.43	2.00	18.00	.54	-.64	11.04	4.83	5.00	20.00	.52	-1.11
POOLED	8.53	4.72	.00	18.00	.66	.50	9.63	4.65	1.00	20.00	.47	-.83

The correlation coefficient between PHINPRE and PHFIPRE was $r = .60$; p<.001 and between PHINPOST and PHFIPOST was $r = .61$; p< .001

To create a unique measure for phonological sensitivity, the two variables of each pair were combined, making up PHPRE and PHPOST, which ranged from 0 to 40. The descriptive statistics for these variables are shown in Table 4.3-13.

Table 4.3–13 Descriptive statistics for PHPRE and PHPOST, by sample

	PHPRE (Phonological Pairing - all segments - pre-test)						PHPOST (Phonological Pairing - all segments - post-test)					
	MEAN	SD	MIN.	MAX.	SKEWN.	KURT.	MEAN	SD	MIN.	MAX.	SKEWN.	KURT.
SAMPLE I	17.21	7.87	4.00	33.00	.59	-.69	18.31	6.92	6.00	35.00	.43	-.52
SAMPLE II	21.36	7.74	9.00	36.00	.22	-.91	24.43	8.91	6.00	38.00	-.10	-.86
POOLED	18.46	8.02	4.00	36.00	.44	.50	20.17	8.04	6.00	38.00	.41	-.59

These variables are approximately normally distributed for the pooled samples. There was a significant difference between the means of the two samples on PHPRE [F (1,92)=5.47; p=.02] and PHPOST [F(1,90)=12.72; p=.001]. However, this difference lost significance when the children's age was controlled: [F(1,91) = .31; p=.577], for PHPRE and [F (1,90) = 3.35; p = .071], for PHPOST.

4.3.3. Summary of the set Underpinning Skills and Knowledge

Table 4.3-14 shows a summary of the results presented in section 4.3.

Table 4.3–14 Summary of the conclusions about the measures in the set Underpinning Skills and Knowledge

Tasks	Sample II > Sample I	Conclusions based on the differences between conditions
Initial Consonant Recognition	Yes	1) Correspondence between the sound of the syllable and the name of the letter (both samples) 2) Use of articulatory cues to discriminate consonants (Sample II)
Initial Vowel Recognition	No	1) Correspondence between the sound of the syllable and the name of the letter (both samples) 2) Use of the vowel to represent the syllable (Sample I)
Phonological Pairing	Yes, but No (after age is controlled)	1) Initial segments are easier to detect than final ones; 2) The use of auditory cues (vowels) is sufficient to detect identity between initial syllables with full contrast and rhymes 3) The use of articulatory and auditory cues is necessary to detect initial onset, initial syllable with partial contrast, initial phoneme and probably final syllable with full contrast 4) Detecting identity of initial onset with the same articulation was so difficult as detecting final syllable with partial contrast, final phoneme and final unstressed rime. The performance on these conditions is likely to involve the construction of mental representations for the segments involved.

The results of this section suggest that there is a possible evolution of the capacity to detect phonological identity as well as in the use of phonological recoding. This evolution is reflected in the use of increasingly sophisticated strategies based, successively on auditory cues, articulatory cues and, probably, mental representations of phonological segments. In the next chapters we will investigate whether this evolution is related to the development of children's understanding of the alphabetic system, in particular to the construction of orthographic representations.

4.4 *Measures of the set Understanding and Use of the Writing System*

As explained in the previous chapter, this set includes the measures which we assume reflect children's understanding of the alphabetic system. These measures are: the construction of orthographic representations, assessed by the Invented Spelling task and the ability to make inferences about graph-phonetic segments, assessed by Analogy Spelling and Word Identification.

4.4.1. Invented Spelling

Three aspects were considered in the categorisation of children's invented spellings:

1. The quantitative aspect: how many letters are thought to be necessary to make up a word;
2. The qualitative aspect: what kind of speech segment is represented by each letter, or in other words, what level of match between sounds and letters is systematically achieved;
3. The conventional aspect: what shapes are likely to be accepted as letters and how the letters are arranged within the word (the aspects assessed were the placement and sequence of the letters).

It was observed that these three aspects were inter-related. The number of letters per word was a difficult issue for those children who were starting to represent syllables but not sub-syllabic units. Most children used more than one letter per syllable. As children were not interviewed individually, it was difficult to decide whether: 1) they were effectively adding letters to make up an "acceptable word"; 2) they had already realised that they needed more letters than just a vowel to represent the syllable, or 3) they were definitely not worried about the number of letters. Therefore, the number of letters did not provide clear information about children's conceptions, except in those cases where the children used one letter per syllable systematically. When this happened, it was considered that the children were already trying to represent the syllables, even when they weren't able to use the correct letter in more than one syllable within the word.

Likewise, the understanding that the sequence of the letters within the word should match the order of the sound segments they are supposed to represent was related to the mastery of letter-to-sound correspondences. The children who were able to represent sub-syllabic units in most syllables were unlikely to swap the syllables, but might swap the letters within each syllable; the children who could spell phonetically were unlikely to swap letters, even within syllables. However, the accomplishment of the correct sequence of letters within each word did not prove to be a useful measure to distinguish children within the same level of letter-to-sound correspondence. In other words, the performance on the other tasks was related to the number of letter-sound matches, regardless of the sequence and the orientation of the correct matches achieved in children's invented spellings. Consequently, it was decided not to consider this aspect.

Therefore, qualitative features were used to construct the following ten-point ordinal scale, which was devised to categorise children's invented spellings.

Invented Spelling Scale (see examples in appendix 17):

1. The child shows no idea of writing conventions: letters are mixed with numbers and scribbles, or the child uses correct letter shapes but uses the same letters, in the same order, for different words.

2. The child uses only letters and varies their arrangement between words. However, there is no quantitative or qualitative relationship between sounds and letters. All the words are about the same size (some children use just one letter per word and others fill the whole width of the paper).

3. The child shows a hazy idea that letters represent sounds, but this is still at the word level: one correct letter is used to match either the first or the last syllable of the word. However, this letter is not necessarily the first or the last one. Also, the number of letters is not related to the number of

syllables, although some children may consistently use four to seven letters to make up something that "looks like" a word.

4. The number of letters matches the number of syllables, but there is a maximum of one letter matching one sound within the word. Therefore, the child seems to be using the syllabic hypothesis to control the number but not the quality of the letters (this is the only category where the number of letters must be considered).

5. The child starts using the letters to represent syllables more consistently. There is generally one correct letter in two different syllables of each word. However, the same letters may still be used elsewhere with no sound correspondence. In addition, the number of letters per syllable may vary, as does the position of the letters representing each syllable within the word. Therefore, although some children use one letter per syllable consistently, most seem to have difficulties using the syllabic hypothesis to control both the quality and the number of letters within the word. A plausible explanation is that the child is adding up letters to make up an "acceptable" word (with more than two letters), but it is also possible that the child is not worried about controlling the number of letters.

6. The letters are clearly used to represent the syllables: one correct letter per syllable in most words. The number of letters per syllable may vary between one and three, so most children do not reconcile their ideas about the size of the words with the limitation of using just one letter to represent the sound of each syllable. The orientation of the syllables within the word may be inverted as if the word had been written from right to left.

   Alternatively, in three-syllable words, the child may use two or three correct letters to represent one syllable (as in level 7), one correct letter to represent the other syllable and yet fail to represent the third syllable of the same word by any of its letters.

7. Letters represent either the syllable or sub-syllabic units. In most words, onsets and rimes are represented in one syllable, at least. However, the same or other letters may still be used with no sound correspondence (although many children reduce the number of letters with no

corresponding sound as soon as they realise the possibility of using more than one correct letter to represent each syllable). The position of the syllables or the letters within the syllables may still be swapped.

8. Most onsets and rimes are represented by one correct letter each. Eventually, some onsets or some rimes may be represented by using more than one correct letter. Letters may be swapped within the syllable, but rarely between syllables. The number of letters with no sound correspondences is reduced. Generally the child converts CCV and CVC syllables to CV syllables.
9. The spelling is mostly phonetic. Most errors are made by using graphically or phonetically similar letters or by ignoring orthographic rules. The letters are rarely swapped and extra letters with no sound correspondence are seldom used.
10. The writing is mostly orthographic with just a few errors, when the correspondence between letters and sounds is not transparent.

This scale was used to classify each word spelled by the child. Then, an overall score was attributed to each child. This was based on the scores for each word and should express the way the child spelled most words. It was found that the median of the scores obtained on all the words was the most suitable measure to be used as the overall score. In some cases, it was necessary to adjust the overall score because the median fell between two categories. Both the experimenter and a blind examiner classified children's spellings independently. Cohen's kappa coefficient was used to measure the agreement between the two examiners. It was found that κ=1.00, in the pre-test and κ=0.77, in the post-test, so the scale was considered quite reliable. The disagreements were due to different interpretations of ambiguous letter-shapes.

Table 4.4-1 shows the frequencies at each level of the scale, both in pre- and post-test (INSPPRE and INSPPOST, respectively). Children's scores on this task are shown in Appendix 16.

Table 4.4–1 Frequencies at each level of the invented spelling scale, in pre- and post-test, per sample

	SAMPLE I				SAMPLE II				POOLED			
	INSPPRE		INSPPOST		INSPPRE		INSPPOST		INSPPRE		INSPPOST	
LEVEL	Count	%	Count	%	Count	%	Count	%	Count	%	Count	%
1	11	17.7	3	4.8	4	14.3			15	16.7	3	3.3
2	12	19.4	7	11.3	3	10.7	1	3.6	15	16.7	8	8.9
3	21	33.9	14	22.6	6	21.4	7	25.0	27	29.9	21	23.4
4	4	6.5	0	.0	1	3.6	0	.0	5	5.6	0	.0
5	12	19.4	16	25.8	4	14.3	3	10.7	16	17.8	19	21.1
6	2	3.1	16	25.8	4	14.3	3	10.7	6	6.7	19	21.1
7			4	6.5	3	10.7	6	21.4	3	3.3	10	11.1
8			2	3.2	1	3.6	4	14.3	1	1.1	6	6.7
9					2	7.1	3	10.7	2	2.2	3	3.3
10							1	3.6	0	.0	1	1.1
N	62	100	62	100	28	100	28	100	90	100	90	100

Most children (71% of Sample I and 46% of Sample II) spelled at levels one, two and three, in the pre-test. This proportion was substantially reduced in the post-test (to about 39% of Sample I and just 6% of Sample II). These levels could be considered as pre-syllabic, as children were not relying on any kind of word segment to produce them.

Children who scored from four to six were trying to represent the syllable as a whole, rather than relying on its parts, so they might be considered as syllabic. Only 30% of the children (29% of Sample I and 32% of Sample II) scored at these levels in the pre-test, but this proportion increased to about 42% (52% of Sample I and 21% of Sample II) in the post-test.

Level 4 proved to be a transitory level, probably skipped by most children. This level includes the spellings where the number of letters matches the number of syllables in the word, but with the maximum of one match between sounds and letters. This means that, at least when children have some information about the sound value of the letters, they are less likely to be concerned with the number of segments before they can represent some letter-to sound correspondences. In Sample II, just one child spelled at this level, in the pre-test. This is not surprising because children in Sample II had a better knowledge of letter-to-sound correspondences and were less often involved in activities where words were segmented into syllables orally. We would expect to find a larger number of children at this level, had they been interviewed individually and asked to finger-point to their spellings while "reading" them, immediately after they had been written. This would probably have drawn their attention to the relationship between sounds and letters and facilitated the construction of the syllabic hypothesis. However, since in this study the tasks were performed in small groups, it was not possible to explore this possibility.

Children at levels 7, 8 and 9 were likely to have understood the alphabetic principle, although they sometimes still used just one single letter to represent units greater than the phoneme. The proportion of children scoring at these levels increased from about 7%, in the pre-test, to about 21% in the post-test. This suggests that about 10% of Sample I and 29% of Sample II children discovered the alphabetic principle, during the period of intervention. Whether the intervention was related to this discovery will be investigated in the next chapters.

Only one child reached level 10 in the post-test, which could be considered as an orthographic level, but this is not a problem as the development beyond the acquisition of the alphabetic principle is beyond the scope of this study.

Therefore, 29 children moved beyond the pre-syllabic and 14 children moved beyond the syllabic stages, between pre- and post-test. This is a large enough number to permit further investigation of children's development, although we would have liked to have had more children moving beyond the syllabic hypothesis.

Table 4.4-2 shows the descriptive statistics for Invented spelling in both pre and post-test, by sample.

Table 4.4–2 Descriptive statistics for Invented Spelling, in both pre- and post-test, by sample

	INSPPRE (Invented Spelling - pre-test)						**INSPPOST** (Invented spelling - post-test)					
	MEAN	SD	MIN.	MAX.	SKEWN.	KURT.	MEAN	SD	MIN.	MAX.	SKEWN.	KURT.
SAMPLE I	3.00	1.44	1	6	.31	-.84	4.50	1.82	1	8	-.23	-.94
SAMPLE II	4.40	2.46	1	9	.27	-.96	5.96	2.33	2	10	-.18	-1.20
POOLED	3.43	1.91	1	9	.78	.29	4.96	2.09	1	10	.07	-.71

The distributions of both INSPPRE and INSPPOST are positively skewed, although in the post-test this is very slight.

There was a significant difference between the two samples, both in pre-test [F(1,89)=5.51; p=.021] and in the post-test [F(1,89)=10.44; p=.002]. However, this difference was no longer significant after the effects of age were controlled [F(1,89)=.18; p=.670], for pre-test and [F(1,89)=1.51; p=.223] for post-test. For this analysis, INSPPRE was transformed by using natural log. to correct the distributions.

In the next chapters, the levels of children's invented spellings will be related to their performance on the other tasks, so that we can have a clearer idea of children's understanding about the writing system.

4.4.2. Analogy Spelling

As explained before, the words that children had to spell in this task were the same as in the Invented Spelling task, as we wanted to observe whether the availability of the cue-words would make a difference to children's spellings. So, their performance on this task was classified into five categories, by taking into account their performance on Invented Spelling. The categories were as follows:

Analogy Spelling Scale:

1. There is no relationship between the dictated word and the written word. Children either wrote the words by chance or copied parts of the cue-words according to a non-phonological criterion. The most common strategies when using the cue-words were copying one of the cue-words or copying the first or the two first letters of each cue-word.

2. Children tried to make use of the cue-words by selecting some segments of each word. However, they mostly selected the wrong segments. One frequent error was to select the second letter of the word as if it represented the sound of the second syllable. Some children also looked for the consonant next to the vowel they thought to be part of a syllable, but they selected the next consonant, instead of the previous one. In some cases, there was no apparent criterion for most of the segments, except for the first or the last vowel or a few other known letters.

   The children who scored less than 3 on Invented Spelling, benefited from this strategy by including one correct letter-to-sound match in their spellings. It is likely that the cue-words acted as a letter bank, facilitating the task of recalling the letters. However, some children who scored more than 4 in their invented spellings (at least two correct letter-to-sound matches in most words), spelled at a lower level in this task. This shows that they lacked a sound graph-phonetic strategy to select the correct segments. In fact, most of them improved over the first pages, when the shared syllables were clearly positioned at the beginning or the end of the cue-words. However, they got confused when the shared syllable was in the middle of the cue-word or they had to select the sub-syllabic units from different syllables. Thus, they chose the wrong letters or gave up and copied any letters by chance. This resulted in a lower number of correct matches than they had achieved on Invented Spelling.

3. At this level, children were very confident about their own spelling hypotheses and were not affected by the presence of the cue-words. Sometimes they replaced a vowel by the consonant of the same syllable (or vice-versa), but they kept the same number of letter-to-sound correspondences as they had done on Invented Spelling. Most of them used the cue-words just to confirm their own spellings and some circled the letters within the cue-words after having written the dictated word. This means that, in fact, they were not using analogies in order to improve their spellings, but, at least, they were not inhibited by the presence of the cue-words.

4. This level includes all children who were able to take advantage of the cue-words to increase the number of letter-to-sound correspondences in their spellings. However, they rarely used the cue-words to correct orthographic errors. This means that they would stick to the letter they used on the invented spelling if that letter matched the dictated sound, even when the same sound was represented by another letter in the cue-words. For example, children replaced (1) "**bn**sro**aca**" by "**boneca**" (the correct word); (2) "**pecar**" (unordered letters) by "**parque**" (the correct word); (3) "**ao**" by "**baco**" (for "barco"); (4) "**pteid**" by "**padim**" (for "patim"); (5) "**colol**" by "**jardal**" or "**Gra**" by "**jaorne**" (both for "jornal"); (6) "**poea**" by "**pobea**" (for "pombinha", keeping the letter "e", which, in English, sounds like "i" in Portuguese); (7) **fes** by **flch**, or **va** by **floa** (for "flecha", in these cases replacing "s", from the English "sh" by the equivalent Portuguese "ch" and "v" by "f", which has the same place of articulation, respectively); (8) **bcoa** (for bruxa) and **bcoa**eu (for bruxaria) were replaced by **brxa** and **brxara,** respectively, by the same child, who showed some understanding of the graph-phonetic identity of derivative words (several children displayed the same ability).

5. The spellings of the children at this level improved when compared to the Invented Spelling task. Most did not spell all the words correctly, but they were able to use the cue-words to correct their spellings, by changing the

letters, which they had used previously to represent a specific sound. For instance, they might have replaced "brosha" by "bruxa" or "fiwmajing" by "filmagem" and some even added the tilde on "balão", replacing previous spellings like "balaw". As in these examples, most of the orthographic errors that children were able to correct were based on English orthography, as most children who scored 5 in this task belonged to Sample II (especially in the pre-test).

Table 4.4-3 shows the frequencies for each category, in both pre- and post-test. (ANSPPRE and ANSPPOST, respectively). Children's scores on this task are shown in Appendix 16.

Table 4.4–3 Frequencies at each level of the Analogy Spelling scale, in pre- and post-test, per sample

	SAMPLE I				SAMPLE II				POOLED			
	ANSPPRE		ANSPPOST		ANSPPRE		ANSPPOST		ANSPPRE		ANSPPOST	
LEVEL	Count	%	Count	%	Count	%	Count	%	Count	%	Count	%
1	31	48.4	22	35.5	13	46.4	7	26.9	44	47.8	29	33.0
2	29	45.3	19	30.6	4	14.3	3	11.5	33	35.9	22	25.0
3	2	3.1	13	21.0	1	3.6	1	3.8	3	3.3	14	15.9
4	2	3.1	5	8.1	7	25.0	11	42.3	9	9.8	16	18.2
5			3	4.8	3	10.7	4	15.4	3	3.3	7	8.0

Approximately 84% of the children (representing 94% of Sample I and 61% of Sample II) scored at levels one and two in the pre-test. This percentage was reduced to 58% in the post-test (66% of Sample I and 38% of Sample II), showing that a large proportion of the children learned either how to take advantage of the cue-words or, at least, not to be confused by them. Later we will investigate whether the vulnerability of children's representations, which allows them to be confused by the presence of the clue-words, is restricted to specific levels of invented spelling.

The proportion of children who took advantage of the cue-words increased from about 3% to 13% in Sample I and from about 36% to 58% in Sample II. The changes from pre-test to post-test will be further investigated in the next chapters.

Table 4.4-4 shows the descriptive statistics for this measure in both pre and post-test, by sample.

Table 4.4–4 Descriptive statistics for Analogy Spelling, in both pre- and post-test, by sample

	ANSPPRE (Analogy Spelling - pre-test)						ANSPPOST (Analogy Spelling - post-test)					
	MEAN	SD	MIN.	MAX.	SKEWN.	KURT.	MEAN	SD	MIN.	MAX.	SKEWN.	KURT.
SAMPLE I	1.63	.71	1	4	1.25	2.31	2.16	1.15	1	5	.82	-.05
SAMPLE II	2.38	1.55	1	5	.55	-1.42	3.08	1.52	1	5	-.36	-1.53
POOLED	1.85	1.08	1	5	1.43	1.38	2.43	1.33	1	5	.48	-1.03

The distributions of the means on Analogy Spelling were positively skewed, especially in the pre-test.

There was a significant difference between the two samples, both in pre-test [F(1,91)=5.46; p=.022] and in the post-test [F(1,87)=5.95; p=.017], but this difference was no longer significant, after the effects of age were controlled: [F(1,90)=.01; p=.939] for pre-test and [F(1,86)=.29; p=.59], for post-test. For these analyses, both ANSPPRE and ANSPPOST were transformed by using the natural logarithm to correct the distributions.

4.4.3. Word Identification Task

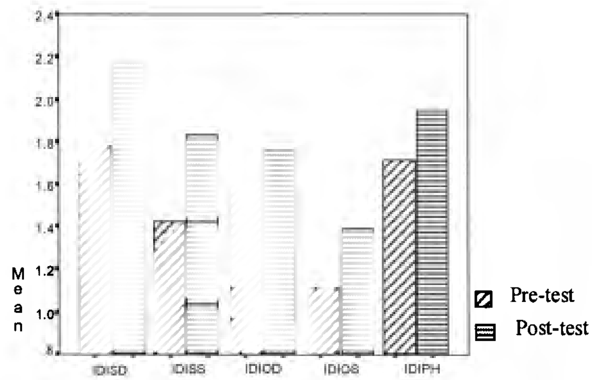
The different conditions on the Word Identification task matched those in the Phonological Task, so that the relationship between the two tasks could be explored.

Children's scores on this task are shown in Appendix 15.

4.4.3.1. Initial segments

Figure 4.4-1 compares the means between all the conditions on the Word Identification task for the pooled samples both in the pre-test and in the post-test.

Figure 4.4–1 Means on the initial conditions of the Word Identification task, for the pooled samples, in both pre- and post-test.



IDISD - Initial syllable with full contrast
IDISS- Initial syllable with partial contrast
IDIOD - Initial onset with different place of articulation
IDIOS - Initial onset with the same place of articulation
IDIPH - Initial phoneme

In the pre-test, children performed better when they only had to rely on the first letter to identify the word correctly. The difference between the "syllable with full contrast" condition and the other conditions (except syllable with partial contrast and onset with the same place of articulation) was negligible. However, this difference increased in the post-test, suggesting that children somehow discovered how to take advantage of the identity of the initial syllable to identify a novel word.

The most difficult condition was the initial onset with the same place of articulation, in both pre- and post-test. This is consistent with the results of Consonant Recognition and suggests that the children found difficulty in deciding which was the correct letter to represent a sound, when there were no physical cues differentiating the options available.

Table 4.4-5 shows the means and SD in all the conditions, per sample, as well as for the pooled samples.

Table 4.4–5 Means and SD on the initial conditions of Word Identification task, in pre- and post-test, per sample

		Initial Syllable full contrast		Initial Syllable part. contrast		Initial Onset dif. articul.		Initial Onset same articul.		Initial Phoneme	
		mean	*SD*	mean	*SD*	mean	*SD*	mean	*SD*	mean	*SD*
SAMPLE I	**Pre-test** (n=64)	1.53	*0.91*	1.20	*0.95*	1.39	*0.97*	.91	*0.66*	1.59	*0.90*
	Post-test (n=64)	1.67	*1.13*	1.42	*1.00*	1.31	*.87*	.97	*.80*	1.39	*.99*
SAMPLE II	**Pre-test** (n=28)	2.43	*1.26*	1.93	*1.12*	2.07	*.90*	1.57	*1.07*	2.00	*1.25*
	Post-test (n=28)	3.21	*1.20*	2.68	*1.09*	2.75	*1.14*	2.32	*1.28*	3.11	*1.23*
POOLED	**Pre-test** (n=92 -)	1.80	*1.10*	1.42	*1.05*	1.60	*1.00*	1.11	*.86*	1.72	*1.03*
	Post-test (n=92)	2.14	*1.35*	1.80	*1.18*	1.75	*1.16*	1.38	*1.15*	1.91	*1.32*

These results were further analysed by carrying out a Repeated Measures Analysis of Variance (MANOVA), having Conditions as the within subjects factor and Sample as the between subjects factor. As expected, this analysis showed a significant effect of both Sample [$F(1,90)=23.41$; $p<.001$] (pre-test) and [$F(1,90)=103.58$; $p<.001$] (post-test) due to the better performance of Sample II, and Condition [$F(4,360)=8.86$; $p<.001$] (pre-test) and [$F(4,360)=8.17$; $p<.001$] (post-test). The Tukey post-hoc test showed that the significant effect of condition was due to the difference between IOSS (initial onset with the same place of articulation) and all the other conditions (except initial syllable with partial contrast, in the pre-test, where the difference was only marginal). The performance on Initial Syllable with full contrast was also significantly better than on Initial Syllable with partial contrast, in the pre-test and than Initial onset with different place of articulation, in the post-test. No significant interaction effect of Sample by Condition was found [$F(4,360)=.88$; $p<.48$] (pre-test) and [$F(4,360)=.73$; $p<.57$] (post-test). Therefore, both Sample I and Sample II children found it difficult to distinguish between letters representing phonemes with the same place of articulation. The main difference between samples, in the post-test, was in the "syllable with partial contrast" condition, which children in Sample I found the easiest but one, whereas children in Sample II found it the hardest but one.

For both samples, the results of Word Identification were consistent with the results on Phonological Pairing: similar conditions were equally difficult (or easy) in both tasks, in relation to the other conditions.

The difficulty of comparing syllables sharing the same vowel and onsets sharing the same place of articulation was further investigated and the results compared with those obtained by analysing the similar conditions ofthe Phonological Pairing task. Table 4.4-6 shows the percentage of choices per contrasting word, in the pre-test.

Table 4.4–6 Percentage of choices per contrasting word, when the cues are initial syllables which shared the same nucleus (partial contrast; pre-test results)

Cue segm.	onset + nucleus + coda		onset + nucleus		nucleus + coda		only nucleus	
example	example	%	example	%	example	%	example	%
por(ta)	porca	35	pote	28	corda	18	cobra	19

As in the similar condition on the Phonological Pairing task, children tended to maintain the onset, ignoring the coda (transforming CVC syllables into CV syllables, such as in "**pote**") rather than maintaining the rime and ignoring the onset (as in "**corda**"). This was likely to happen because they took into account only the first letter or the onset-nucleus string.

However, the tendency to consider only the initial letter was less clear when the graphic cue was a consonant cluster (the onset of the first syllable).

Table 4.4-7 shows the percentage of choices per contrasting word, when all the contrasting words shared the nucleus of the first syllable in the target word.

Although children had to rely on the onset to succeed, when all the contrasting words shared the nucleus of the first syllable with the clue-word, the matching words shared the whole first syllable and not just the onset (as in praça - prato). Thus, this could be considered an intermediate condition between syllable and onset.

Table 4.4–7 Percentage of choices per contrasting word, with syllables sharing the same nucleus, when using the onset as a cue (pre-test results)

Cue segm. pr(aça)	whole onset (correct) example	%	first phoneme example	%	second phoneme example	%	none example	%
dif. artic.	prato	48.0	padre	24.0	cravo	19.0	cabo	9.0
same artic.	prato	37.0	padre	21.0	braço	26.0	bata	16.0
pooled		42.5		22.5		22.5		12.5

There was a tendency of children to rely on the first consonant, (converting the CCV syllable into a CV syllable, as in **pr**aça - **p**adre), when the contrasting word had a different place of articulation from the initial consonant in the cue segment. When the two initial consonants had the same place of articulation, there was a slight tendency for children to confound them and chose the word beginning with the "wrong" CCV syllable.

Table 4.4-8 shows the percentage of choices per contrasting word, when the contrasting words did not share the nucleus of the first syllable in the clue-word.

In this case, the difference between the number of children who chose each of the "incorrect" contrasting words was very small and did not depend on the place of articulation.

Table 4.4–8 Percentage of choices per contrasting word, with syllables with different nuclei, when using the onset as a cue (pre-test results)

Cue seg. gr(ilo)	whole onset (correct) example	%	first phoneme example	%	second phoneme example	%	none example	%
dif. artic.	grade	39	galo	16	braço	19	bata	26
same artic.	grade	32	galo	23	cravo	28	cabo	17
pooled		35.5		19.5		23.5		21.5

It is interesting to observe that this result was consistent with the results ofthe Phonological Pairing task on the equivalent trials. The main consistencies were:

1- The identity of the nucleus helped children to detect phonological identity of the onset, when the contrasting words began with a different place of articulation than the target-word (53% correct for items with the same vowel against 38% for items with different vowel). Similarly, in word identification, the similarity of the vowel facilitated the use of the onset as a cue to identify the target word (48% correct for items with the same vowel against 39% correct for items with different vowels). This reinforces the suggestion that this condition is intermediate between the syllable and the onset: children have to focus on the onset to contrast the different options, but the identity between the syllable of the target (or clue) word and the correct word provides redundant information to confirm their choice.

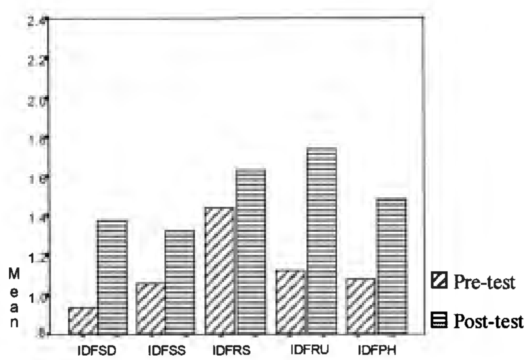
2- In both tasks, children showed a tendency to transform CCV into CV words when the contrasting words shared the same nucleus and the initial consonants had different places of articulation.

3- In the Phonological Pairing task, the lowest scores on the "same articulation" point condition were explained by the confusion between the consonants with the same place of articulation, in the items where the contrasting words also shared the same vowel. In the Word Identification task, this also occurred, but the difference was much smaller and did not depend on the identity of the nucleus.

4.4.3.2. Final segments

The comparison between the means for the final segments (Figure 4.4-2) shows a different picture between pre-test and post-test.

Figure 4.4–2 Means on the final conditions of Word Identification task, for the pooled samples, in both pre- and post-test



IDFSD - Final syllable with full contrast (onset <u>and</u> rime)
IDFSS- Final syllable with partial contrast (contrast on the onset <u>or</u> on the nucleus)
IDFRS - Final stressed rime (rhyme)
IDFRU - Final unstressed rime (vowel)
IDFPH - Final phoneme (consonant)

In the pre-test, as in the Phonological task, the children got better scores when identifying words which shared the rime of the final syllable, but only if this syllable was the stressed one. The results for all the other segments were quite similar, but it is interesting that children found it so difficult to use the final syllable with full contrast as a graph-phonetic cue. In the post-test, there were no big differences between the conditions, as children improved more in the conditions which were the hardest ones in the pre-test.

Table 4.4-9 shows that the means of Sample II were higher than the means of Sample I in all the conditions.

Table 4.4–9 Means and SD on the final conditions of word Identification task, in pre- and post-test, per sample

		Final Syllable full contrast		Final Syllable part. contrast		Stressed final rime (rhyme)		Unstressed final rime		Final consonant	
		mean	*SD*	mean	*SD*	mean	*SD*	mean	*SD*	mean	*SD*
SAMPLE I	Pre-test (n=65)	.74	*.80*	.89	*.83*	1.29	*.84*	1.02	*.91*	.98	*.76*
	Post-test (n=64)	.94	*.96*	1.00	*.78*	1.38	*.86*	1.55	*1.25*	1.30	*.95*
SAMPLE II	Pre-test (n=28)	1.43	*1.26*	1.54	*1.26*	1.82	*1.16*	1.50	*1.35*	1.36	*1.06*
	Post-test (n=28)	2.39	*1.37*	2.04	*1.32*	2.18	*1.09*	2.14	*1.53*	1.86	*1.43*
POOLED	Pre-test (n=93)	.95	*1.00*	1.09	*1.02*	1.45	*.97*	1.16	*1.08*	1.10	*.87*
	Post-test (n=92)	1.38	*1.28*	1.32	*1.08*	1.62	*1.00*	1.73	*1.36*	1.47	*1.14*

In the pre-test, the average of children in Sample I scored below chance on all the conditions except those where the cue segment was the rime (either stressed or not).

To further analyse the differences between all the means, a Repeated Measures Analysis of Variance (MANOVA) was carried out, having Condition as the within subjects factor and Sample as the between subjects factor. This analysis showed a significant effect of Sample [$F(1, 91) = 13.24$; $p<.001$] (pre-test) and [$F(1, 90) = 23.77$; $p<.001$] (post-test). The effect of Condition was significant on the pre-test [$F(4,364)=4.14$; $p<.01$], but not on the post-test [$F(4,360)=2.03$; $p=.09$]. The Tukey post-hoc test showed that the significant effect of Condition, in the pre-test, was due to the difference between Final Stressed Rime and all the other conditions except Final Unstressed Rime.

No significant effect of Sample by Condition was found in the pre-test [$F(4,364)=.52$; $p<.73$]. However, in the post-test, the significant interaction between Sample and Condition [$F(4,360)=3.75$; $p=.005$] reflects the different performance of both samples in some conditions: while children in Sample I found the unstressed rime the easiest condition and the syllable with full contrast the hardest one, the opposite happened with children in Sample II. For these children, the syllable with full contrast was the easiest condition and the unstressed rime was the hardest (except for final phoneme). This suggests that children in Sample I found the conditions where they had to pay attention to more than one letter more difficult, probably because most children in this sample did not know a sufficient number of consonants. On the contrary, children in Sample II were likely to use the phonological identity of similar letter strings to identify the novel words. This suggestion is supported by the fact that the results of Word Identification are consistent with the results of Phonological Pairing, for the final segments: the easiest conditions in one task (syllable with full contrast and stressed rime) are also the easiest in the other one and the same happens with the hardest conditions (unstressed rime and final phoneme).

4.4.3.3. Descriptive statistics

The correlation between the different conditions for both the initial and the final segments shows that it is appropriate to make a composite by adding up the scores in all the conditions (Table 4.4-10).

Table 4.4–10 Spearman's correlation of both the initial and the final conditions of Word Identification, in both pre and post-test

PRE-TEST

(N=92)	IDISD	IDISS	IDIOD	IDIOS
IDISS	.31 $p<.01$			
IDIOD	.23 $p<.05$	.27 $p<.05$		
IDIOS	.21 $p<.05$	.14 $p=.18$	.33 $p=.001$	
IDIPH	.34 $p=.001$	.39 $p<.001$	.38 $p<.001$	-.05 $p=.62$

(N=93)	IDFSD	IDFSS	IDFRS	IDFRU
IDFSS	.31 $p<.01$			
IDFRS	.33 $p=.001$	.29 $p<.01$		
IDFRU	.41 $p<.001$	.26 $p<.05$	.19 $p=.07$	
IDFPH	.32 $p<.01$	.28 $p<.01$	.28 $p<.01$	.12 $p=.25$

IDISD - Initial Syllable with full contrast.
IDISS - Initial Syllable with partial contrast.
IDIOD - Initial Onset with different articulation.
IDIOS - Initial Onset with the same articulation.
IDIPH - Initial Phoneme.

IDFSD - Final Syllable with full contrast.
IDFSS - Final Syllable with partial contrast.
IDFRS - Final stressed rime (rhyme).
IDFRU - Final unstressed rime (vowel).
IDFPH - Final phoneme (consonant).

POST-TEST

(N=92)	IDISD	IDISS	IDIOD	IDIOS
IDISS	.37 $p<.001$			
IDIOD	.40 $p<.001$	.27 $p<.01$		
IDIOS	.45 $p<.001$	.31 $p=.002$	.49 $p<.001$	
IDIPH	.50 $p=.001$	.47 $p<.001$	.38 $p<.001$	.31 $p=.003$

(N=92)	IDFSD	IDFSS	IDFRS	IDFRU
IDFSS	.51 $p<.001$			
IDFRS	.48 $p=.001$	.25 $p<.05$		
IDFRU	.55 $p<.001$	.56 $p<.001$	.37 $p<.001$	
IDFPH	.31 $p=.003$	.24 $p<.05$	.22 $p<.05$	.45 $p<.001$

IDISD - Initial Syllable with full contrast.
IDISS - Initial Syllable with partial contrast.
IDIOD - Initial Onset with different articulation.
IDIOS - Initial Onset with the same articulation.
IDIPH - Initial Phoneme.

IDFSD - Final Syllable with full contrast.
IDFSS - Final Syllable with partial contrast.
IDFRS - Final stressed rime (rhyme).
IDFRU - Final unstressed rime (vowel).
IDFPH - Final phoneme (consonant).

Two variables were created by adding up the scores on the Initial Conditions: IDINPRE, for pre-test and IDINPOST, for post-test. Their scores range from 0 to 20. Table 4.4-11 shows the descriptive statistics for these variables, per sample, as well as for the pooled samples.

Table 4.4–11 Descriptive statistics for IDINPRE and IDINPOST, by sample

	IDINPRE (Word Identification - initial conditions- pre-test)						IDINPOST (Word Identification - initial conditions- post-test)					
	MEAN	SD	MIN.	MAX.	SKEWN.	KURT.	MEAN	SD	MIN.	MAX.	SKEWN.	KURT.
SAMPLE I	6.63	2.45	2.00	14.00	1.12	1.83	6.77	2.29	2.00	14.00	.67	1.04
SAMPLE II	10.00	4.19	4.00	20.00	.67	.05	14.07	4.60	6.00	20.00	-.34	-1.08
POOLED	7.65	3.44	2.00	20.00	1.30	1.91	9.00	4.62	2.00	20.00	1.04	.15

As can be seen, these variables are positively skewed, mainly due to the results of Sample I children.

The scores on the final segments were also added up to create a single variable (IDFIPRE, for pre-test and IDFIPOST, for post-test), whose descriptive statistics are shown in Table 4.4-12.

Table 4.4–12 Descriptive statistics for IDFIPRE and IDFIPOST, by sample

	IDFIPRE (Word Identification - final conditions- pre-test)						IDFIPOST (Word Identification - final conditions- post-test)					
	MEAN	SD	MIN.	MAX.	SKEWN.	KURT.	MEAN	SD	MIN.	MAX.	SKEWN.	KURT.
SAMPLE I	4.92	2.55	.00	13.00	.79	1.02	6.16	3.20	1.00	16.00	.98	.85
SAMPLE II	7.64	4.64	2.00	19.00	1.13	.53	10.61	5.50	2.00	20.00	.30	-1.29
POOLED	5.74	3.52	.00	19.00	1.55	3.14	7.51	4.51	1.00	20.00	1.09	4.13

The scores on this variable also ranged from 0 to 20 and their distribution was also positively skewed.

There was a significant positive correlation between children's performance when using initial and final segments as cues for word identification ($r_s = .44$; $p < .001$ for the pre-test measure and $r_s = .54$; $p < .001$, for the post-test measure).

Single measures of word identification (variables IDPRE, for pre-test and IDPOST, for post-test) were created by adding up the results on the initial (IDIPRE or IDIPOST) and on the final segments (IDFIPRE or IDFIPOST). The scores on these measures ranged from 0 to 40 and their distributions were positively skewed. The descriptive statistics for these variables are shown in Table 4.4-13.

Table 4.4–13: Descriptive statistics for IDPRE and IDPOST, by sample

	IDPRE (Word Identification - all segments - pre-test)						IDPOST (Word Identification - all segments - post-test)					
	MEAN	SD	MIN.	MAX.	SKEWN.	KURT.	MEAN	SD	MIN.	MAX.	SKEWN.	KURT.
SAMPLE I	11.59	4.18	6.00	27.00	1.20	1.94	12.92	4.53	7.00	26.00	.96	.58
SAMPLE II	17.64	7.97	8.00	39.00	1.27	1.13	24.68	9.49	11.00	39.00	.11	-1.37
POOLED	13.44	6.23	6.00	39.00	1.80	4.13	16.50	8.40	7.00	39.00	1.25	.79

There was a significant difference between the means obtained by each sample, even after children's age was taken into account, both in the pre-test [$F(1,90) = 6.28$; $p = .014$] and in the post-test [$F(1,90) = 29.06$; $p < .001$]. For these analyses, the measures were transformed by using the natural logarithm to correct the distributions.

4.4.4. Summary of the set Understanding and Use of the Writing System

Table 4.4-14 shows a summary of the results presented in section 4.4.

Table 4.4–14 Summary of the conclusions about the measures in the set Understanding and Use of the Writing System

Tasks	Sample II > Sample I	Conclusions
Invented Spelling	Yes, but No after age is controlled	1) Ten levels were identified in children's invented spellings, based on the number of correct letter-sound matches per syllable. 2) Most children in Sample I and about half of Sample II were at the lowest levels in the pre-test. 3) 6 children (about 10%) in Sample I and 8 children (about 29%) in Sample II moved beyond the syllabic hypothesis from pre-test to post-test.
Analogy Spelling	Yes, but No after age is controlled	1) Five levels were identified on children's ability to use analogies in spelling, according to the improvement on children's orthographic representations provided by the presence of clue-words. 2) 10% of children in Sample I and 22% of children in Sample II learnt how to take advantage of the cue-words, between pre-test and post-test. This is about the same proportion who moved beyond the syllabic hypothesis in Invented spelling.
Word Identification	Yes	1) Initial segments were easier to use as cues than final ones; 2) There was a parallel between the performance on the conditions of the Phonological Pairing task and comparable conditions on the Word Identification task: syllables with full contrast were the easiest initial segments, whereas onsets with the same place of articulation were the hardest. In the final position, syllables with full contrast and rhymes were the easiest segments and single letters (either vowels or consonants) were the hardest ones, but not for children in Sample I, who found it more difficult to pay attention to more than one letter at a time. 3) The confusion between consonants with the same place of articulation was also observed in this task, but its effects were smaller than on the Phonological Pairing task

The results presented in this chapter suggest that there are several levels of development, which were tapped by all the measures. It is likely that all these measures are related and progress on all of them occurs simultaneously. In the next chapter, we will investigate this further. We will investigate whether a significant change from pre-test to post-test occurred, which variables are involved in children's progress and whether it is possible to describe children's development in such a way that the changes on all the measures are accounted for.

5. ANALYSIS OF THE CHANGES

5.1 *Introduction*

This study aims to describe and to suggest an explanation for the changes that occur in the process of literacy acquisition in Portuguese speakers. According to the theoretical framework described in chapter 2, we are proposing that measures, such as the quality of orthographic representations and the ability to make inferences about graph-phonetic segments reflect children's hypotheses about the writing system. If this is true, the development of children's hypotheses about the writing system should account for the changes that occur in each one of these measures. Therefore, before trying to interpret these changes, we need to investigate whether they really occurred.

Although the description of the measures in chapter 4 has shown that the means of all the variables were higher in the post-test than in the pre-test, we do not know whether this difference represents a significant change. As anticipated in chapter III (methodology), one concern when carrying out this study was the possibility of not obtaining any significant change, due to the short length of the intervention period (only 20 sessions for Sample I and 15 sessions for Sample II). Therefore, first, we need to make sure that significant gains occurred on each task. Where significant changes occurred, we need to know how much of the change was due to individual differences and how much (if any) was due to the intervention. Thus, in this chapter, the analysis of the results on each measure, is organised in three parts:

1) Investigation of whether there was a significant change between pre- and post-test.

2) Investigation of the effects of individual differences on the progress on the measures where a gain has occurred.

3) Investigation of the effects of intervention on children's progress.

For all the tasks analysed in the next sections of this chapter, the Repeated Measures Analysis of Variance (MANOVA) will be used to investigate the size of the changes, by comparing the pre and post-test means; Time, with two levels: time 1 (pre-test) and time 2 (post-test) will be considered as the within-subjects factor. To investigate whether there was an interaction between time and the type of intervention, Type of Intervention will be considered as the between-subjects factor, with six levels corresponding to the intervention groups 1 to 6: (1) no intervention; (2) no analysis Sample I; (3) syllabic analysis; (4) phonemic analysis Sample I; (5) no analysis Sample II; (6) phonemic analysis Sample II. The main effect of this factor is not relevant for this analysis as, in the previous chapter, we have already found that Sample II children (intervention groups 5 and 6) had better results on most tasks, both in the pre-test and in the post-test. However, an interaction between Time and Type of Intervention would indicate that different types of intervention provoked different amounts of change between pre and post-test and this is an important result to be further analysed later.

For the measures where a significant change is observed, we will investigate the variables that may have contributed for this change. Two separate analyses will be carried out: one investigating the effects of individual differences and the other investigating the effects of the intervention. Several multiple regression models will be used in this investigation and the contribution of each variable will be measured by using the fixed step method, as follows:

- The first variables to be included in these analyses are the control measures: Age, WISC analogies, WISC digits and SCRIPTCON (which assesses children's familiarity with graphic conventions of scripts). School grade will not be included because children were assigned to a grade according to their age, so the two variables (school grade and age) are not independent. Sample will not be included either, because the intervention groups were organised by sample, so this variable will be considered when analysing the effects of intervention. Moreover, sample overlapped with age, as there were no seven-year old children in Sample I.

- In the next step, the differences in the pre-test measure of the response variable will be partialled out. The pre-test measure will be included because we are investigating the contribution of the explanatory variables to the changes and not whether the pre-test measures are good predictors of the performance on the post-test.

- In the last step we will investigate, one at a time, the effects of the variables included in the set "underpinning skills and knowledge" (initial vowel recognition, initial consonant recognition and phonological pairing).

In the regression models that investigate the effects of intervention, the variables which were found to make a significant contribution in the previous analyses, will be entered first, followed by the dummy variables for the intervention groups.

5.2 Changes in the Skills and Knowledge Underpinning Children's Understanding and Use of the Writing System

The coupling of the ability to detect phonological identity and the knowledge of letter-to-sound correspondences has been considered an essential condition for the grasping of the alphabetic principle. Therefore, it is interesting to investigate whether there were any changes in these measures, over time, and, if positive, which were the factors affecting these changes. The analysis of each one of these measures will be presented in the next sub-sections.

5.2.1. Changes in Initial Letter Recognition

Initial Letter Recognition measured not only children's knowledge of letter-to-sound correspondences, but also their understanding that letters may sound differently when in isolation or as parts of a word. In this sense, this was a measure of a very elementary level of phonological recoding: the ability to decide on the adequacy of a specific grapheme to represent the initial phoneme within a word.

Initial Letter recognition comprised two measures: Initial Vowel Recognition and Initial Consonant Recognition. As suggested in chapter 2, vowels and consonants may play a different role in the development of the understanding of the alphabetic principle, in Portuguese. While the use of the vowels alone, in children's invented spellings, is a characteristic of the syllabic hypothesis, the consistent use of consonants together with vowels is generally considered as a demonstration that children have moved beyond the syllabic hypothesis. Moreover, it was shown in chapter 4 that Initial Vowel Recognition was the only measure where the overall scores of Sample I and Sample II children were very similar. For these reasons, these measures will be kept separate in all the analyses.

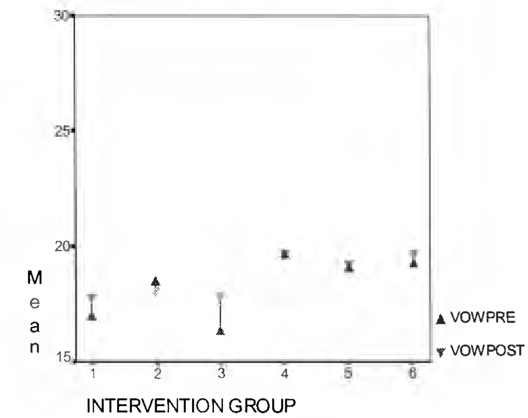
5.2.1.1. Changes over time in Initial Letter Recognition

Sample I children were not receiving instruction on letter-to-sound correspondences (except for vowels and, in one day care centre, for the "syllabic family" of letter "B"). Moreover, the number of letter-to-sound correspondences taught to children during the intervention period was very small. Therefore, we did not expect a significant improvement in this measure, at least for Sample I children.

a. Changes over time in Initial Vowel Recognition

The small size of the changes in this measure is clear in Figure 5.2-1.

Figure 5.2–1 Gains on Initial Vowel Recognition between pre-test (VOWPRE) and post-test (VOWPOST)

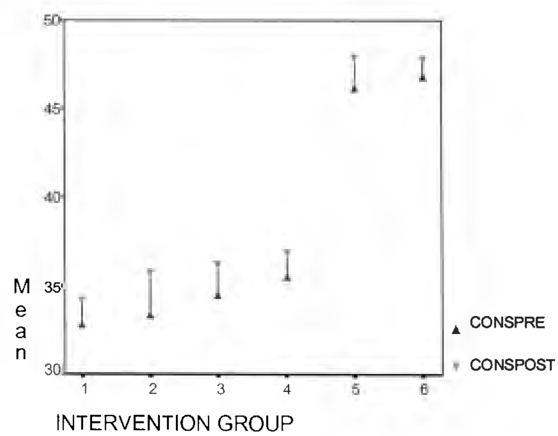


The comparison of pre and post-test means on Initial Vowel Recognition produced no significant differences [$F(1,83) = 1.69$; $p=.20$], showing that, as expected, there was no significant improvement in this measure. Similarly, no interaction was observed between type of intervention and time [$F(5,83)=.61$; $p=.69$], showing that the intervention produced no significant effect on this measure.

b. Changes over time in initial consonant recognition

The gains on this measure are shown in Figure 5.2-2.

Figure 5.2–2 Gains on Initial Consonant Recognition between pre-test (CONSPRE) and post-test (CONSPOST)



To investigate whether these gains were significant, a Repeated Measures Analysis of Variance (MANOVA) was carried out, having Time as the within-subjects factor and Type of Intervention as the between-subjects factor (as described above). The distributions of the means on the two variables CONSPRE (pre-test measure) and CONSPOST (post-test measure) were positively skewed, so the natural logarithm was used to correct the distributions. The MANOVA produced a significant effect of Time, showing that there was a significant gain from pre-test to post-test [$F(1,83)= 5.91$; $p<.02$]. The absence of an interaction effect Type of Intervention X Time [$F(5,83)=.25$; $p=.94$] shows that this improvement was not related to the type of intervention, but this does not take into account the pre-test scores on other variables.

Next we will investigate the variables involved in the significant improvement that was observed on Initial Consonant Recognition.

5.2.1.2. Individual differences affecting the progress in Initial Consonant Recognition

Table 5.2-1 shows four regression models having the post-test measure of Initial Consonant Recognition (CONSPOST) as the response variable. In spite of being positively skewed, CONSPOST distributions were not corrected because this did not affect the results (no problems were found when inspecting the residual plots).

Model 1 shows that only AGE and SCRIPTCON (familiarity with conventions of written texts) had a significant effect on the changes in Initial Consonant Recognition, after the differences in the pre-test scores on this variable were controlled. It is likely that the effects of AGE are related to teaching, as children were organised in different school grades according to their age. The effect of SCRIPTCON shows that the development of the most elementary levels of phonological recoding is strongly related to children's ability to reflect upon what makes scripts different from other graphic materials.

Model 2a investigates whether Initial Vowel Recognition affects the changes on Initial Consonant Recognition. Since in Portuguese children learn the vowels earlier than the consonants it was possible that this knowledge would encourage them to learn the consonants as well. The results show that this is not the case and the ability to recognise these two categories of letters is likely to develop separately. This is not surprising, because the recognition of the vowels can be achieved by relying on auditory cues, whereas the recognition of the consonants requires children to rely on articulatory cues and, in many cases, to have grasped the grapheme-phoneme correspondence.

In model 2b we investigate the effects of the ability to detect phonological identity. As mentioned above, Initial Consonant Recognition assessed a very elementary level of phonological recoding. Hence, it was expected that the ability to detect sound identity between words (measured by Phonological Pairing task) would affect the changes in this task. Therefore, the pre-test measure of Phonological Pairing was entered in the regression equation as the last step, after the control measures and the differences in the pre-test scores on Initial Consonant Recognition were controlled. The results show that PHPRE (Phonological Pairing - pre-test) did not have a significant effect on the performance of CONSPOST. Therefore, it is likely that the level of phonological sensitivity required to be able to recognise the initial consonant of a word is lower than that measured by the Phonological Pairing Task. It is even possible that some level of letter recognition is required to perform the Phonological Pairing task, rather than the opposite.

Table 5.2–1 Regression models showing the effects of individual differences on the progress in Initial Consonant Recognition (CONSPOST)

Model	Variables entered	R square	Std. Error of the estimate	B	Std. Error	Beta	T	Sig.
1	(Constant)			-16.614	6.087		-2.730	.008
	AGE	.335	8.1955	.280	.093	.198	3.004	.004
	WISC DIGITS	.429	7.6343	.676	.414	.103	1.634	.106
	SCRIPT CONVENTIONS	.514	7.0835	1.252	.470	.159	2.665	.009
	CONS REC. (pre-test)	.737	5.2472	.696	.083	.619	8.421	.000
2a	(Constant)			-17.695	6.166		-2.870	.005
	AGE	.335	8.1955	.265	.094	.187	2.823	.006
	WISC DIGITS	.429	7.6343	.601	.419	.091	1.432	.156
	SCRIPT CONVENTIONS	.514	7.0835	1.255	.470	.159	2.673	.009
	CONS REC. (pre-test)	.737	5.2472	.673	.085	.598	7.875	.000
	VOWEL REC. (pre-test)	.740	5.2431	.189	.177	.068	1.064	.291
2b	(Constant)			-17.535	6.434		-2.725	.008
	AGE	.335	8.1955	.292	.097	.206	2.999	.004
	WISC DIGITS	.429	7.6343	.721	.427	.109	1.689	.095
	SCRIPT CONVENTIONS	.514	7.0835	1.283	.477	.163	2.691	.009
	CONS REC. (pre-test)	.737	5.2472	.706	.086	.627	8.246	.000
	PHON. PAIR. (pre-test)	.737	5.2719	-4.205E-02	.091	-.033	-.461	.646
3	(Constant)			-15.039	6.069		-2.478	.015
	AGE	.335	8.1955	.289	.094	.204	3.081	.003
	SCRIPT CONVENTIONS	.427	7.5820	1.243	.475	.158	2.619	.010
	CONS REC. (pre-test)	.728	5.2985	.745	.078	.662	9.545	.000

Finally, model 3 includes only the variables that affected the changes in CONSPOST significantly. Age and the pre-test scores on consonant recognition make a contribution of about 63% of the variance in CONSPOST. Children's familiarity with conventions of the written text explains a further 9% of the change. This shows that children's efforts to distinguish scripts from other types of graphic stimuli help them to understand the role of the letters within words. Next, we will investigate whether Initial Consonant Recognition was affected by intervention.

5.2.1.3. Effects of intervention on Initial Consonant Recognition

Table 5.2-2 shows the regression models including the effects of intervention. As the period of intervention was very short and it was not focused on learning specific letter-to-sound correspondences, no effect of intervention was expected.

Model 1 compares the gains of all the intervention groups against the control group that was not trained. Model 2 compares the gains of all the intervention groups against the Sample II "no-analysis" group. As the period of intervention was longer for Sample I than for Sample II, model 1 is useful to compare the groups in Sample I, whereas model 2 is more appropriate to compare the groups in Sample II, as well as to observe the differences between samples, by comparing the gains of the "no-analysis" groups of both samples.

Table 5.2-2 Regression models showing the effects of intervention on Initial Consonant Recognition

Model	Variables entered	R square	Std. Error of the estimate	B	Std. Error	Beta	T	Sig.
1	(Constant)			-16.370	6.923		-2.365	.020
	CONS REC. (pre-test)	.676	5.7225	.765	.093	.680	8.237	.000
	AGE	.706	5.4760	.296	.099	.209	3.007	.004
	SCRIPT CONVENTIONS	.728	5.2985	1.282	.497	.163	2.577	.012
	NO ANALYSIS I			.731	1.927	.028	.380	.705
	SYLLABIC ANALYSIS			-.152	2.009	-.006	-.075	.940
	PHONEMIC ANALYSIS I			-.301	1.942	-.012	-.155	.877
	NO ANALYSIS II			-.186	2.392	-.007	-.078	.938
	PHONEMIC ANALYSIS II	.730	5.4414	-.961	2.392	-.035	-.402	.689
2	(Constant)			-16.557	7.833		-2.114	.038
	CONS REC. (pre-test)	.676	5.7225	.765	.093	.680	8.237	.000
	AGE	.706	5.4760	.296	.099	.209	3.007	.004
	SCRIPT CONVENTIONS	.728	5.2985	1.282	.497	.163	2.577	.012
	NO TRAINING			.186	2.392	.007	.078	.938
	NO ANALYSIS I			.918	2.356	.035	.389	.698
	SYLLABIC ANALYSIS			3.461E-02	2.350	.001	.015	.988
	PHONEMIC ANALYSIS I			-.115	2.263	-.004	-.051	.960
	PHONEMIC ANALYSIS II	.730	5.4414	-.775	2.102	-.028	-.369	.713

The regression models confirmed the hypothesis that no intervention effects would be observed, either in Sample I (model 1) or in Sample II (model 2). It is interesting to note that the effects of intervention on the "phonemic analysis" groups in both samples were slightly smaller than all the other groups. We expected the opposite to happen, as the "phonemic analysis groups" were trained to pay attention to grapheme-phoneme correspondences within syllables.

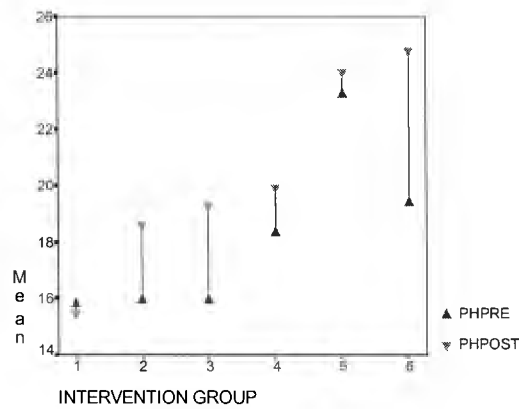
5.2.2. Changes in the capacity to detect phonological identity

As explained before, the ability to detect phonological identity was measured by the Phonological Pairing task. This ability was assumed to be a component of phonological recoding, so it was expected it to be a good predictor of the quality of orthographic representations (measured by Invented Spelling), as well as of the capacity to make inferences about graph-phonetic segments (measured by Word Identification and Analogy Spelling). Therefore, Phonological Pairing will be treated as an explanatory variable in the analysis of the changes on Invented Spelling, Word Identification and Analogy Spelling.

5.2.2.1. Changes over time in the capacity to detect phonological identity

The comparison of the pre- and post-test means on the Phonological Categorisation task showed a significant improvement [F(1,84)=14.74; p<.001]. There was no significant interaction between Time X Type of Intervention [F(5,84)=1.97; p=.091], although, as shown in Figure 5.2-3, the "non intervention" group (group 1) had no gains and the gains of the "no analysis - Sample II" group (group 5) were negligible when compared to the other groups.

Figure 5.2-3: Gains on Phonological Pairing task between pre-test (PHPRE) and post-test (PHPOST)



It is possible that the effect of intervention would reach significance had the period of intervention been longer. The effects of intervention after individual differences are controlled will be further investigated later.

5.2.2.2. Individual differences affecting the progress in children's capacity to detect phonological identity

Phonological skills develop with the improvement of literacy, so it was likely that familiarity with scripts as well as knowledge of letter-to-sound correspondences would affect the gains on phonological pairing.

To investigate this question, a fixed step regression analysis was carried out, using the sum of the scores on all the conditions of the Phonological Pairing task, in the post-test (PHPOST), as the response variable. The corresponding pre-test measure (PHPRE) was included to control the differences in pre-test scores. Table 5.2.-3 shows different regression models. They include AGE, WISC Digits and SCRIPTCON (familiarity with graphic conventions of scripts) as the control measures. WISC Analogies was not significantly correlated to PHPOST (the post-test measure of Phonological Pairing task), so it was not included.

In a previous model (not shown) WISC Digits and SCRIPTCON proved to be significant predictors of performance on the Phonological Pairing task, even after the pre-test scores were taken into account, so these variables were included in the models shown in the table.

Models 1a and 1b show that both the pre-test measures of Initial Letter Recognition (VOWPRE for vowels and CONSPRE for consonants) contribute significantly to the changes in Phonological Pairing, even after the pre-test scores in this measure and the control measures are partialled out.

However, model 2 shows that Initial Vowel Recognition (VOWPRE) is no longer significant when entered together with Initial Consonant Recognition (CONSPRE). This suggests that they both explain a common part of the variance. The inclusion of VOWPRE in the regression equation as the last step added only 1% to the amount of variance on PHPOST already explained by the other variables (74%).

In this study, the knowledge of letter-to-sound correspondences was measured by the Initial Letter Recognition task, which, as stated above, assesses not only letter knowledge but also a very elementary level of phonological recoding. Thus, both Initial Vowel and Initial Consonant Recognition involve a minimal level of phonological skills. Therefore it is not possible to know whether the significant effect of both measures of Initial Letter recognition is due to this phonological component or to the knowledge of letter-to-sound correspondences.

Table 5.2-3 Regression models showing the effects of individual differences on Phonological Pairing

Model	Variables entered	R square	Std. Error of the estimate	B	Std. Error	Beta	T	Sig.
1a	(Constant)			-9.117	5.172		-1.763	.082
	AGE	.219	7.1371	6.136E-03	.078	.005	.078	.938
	WISC DIGITS	.379	6.4016	.845	.343	.159	2.462	.016
	SCRIPT CONVENTIONS	.500	5.7746	1.325	.383	.209	3.458	.001
	PHON. PAIR. (pre-test)	.694	4.5479	.491	.073	.480	6.696	.000
	CONS REC. (pre-test)	.737	4.2382	.255	.069	.282	3.705	.000
1b	(Constant)			-14.132	5.452		-2.592	.011
	AGE	.219	7.1371	7.533E-02	.078	.066	.970	.335
	WISC DIGITS	.379	6.4016	1.047	.349	.198	3.000	.004
	SCRIPT CONVENTIONS	.500	5.7746	1.643	.389	.259	4.230	.000
	PHON. PAIR. (pre-test)	.694	4.5479	.509	.077	.497	6.625	.000
	VOWEL REC. (pre-test)	.714	4.4175	.367	.149	.166	2.456	.016
2	(Constant)			-11.275	5.228		-2.157	.034
	AGE	.219	7.1371	-5.734E-03	.077	-.005	-.074	.941
	WISC DIGITS	.379	6.4016	.768	.341	.145	2.253	.027
	SCRIPT CONVENTIONS	.500	5.7746	1.350	.378	.213	3.571	.001
	PHON. PAIR. (pre-test)	.694	4.5479	.463	.074	.452	6.266	.000
	CONS REC. (pre-test)	.737	4.2382	.228	.069	.252	3.292	.001
	VOWEL REC. (pre-test)	.748	4.1768	.268	.144	.121	1.860	.067

Another result that deserves mention in this analysis is that the effect of familiarity with SCRIPT conventions remained when entered together with the measures of Initial Letter Recognition. Children who did better on distinguishing conventional scripts from other forms of graphic stimuli were more likely to develop a stronger interest in knowing what letters represent. The discovery of the relationship between letters and sounds within words might, in turn, have improved their awareness of sound segments. Therefore, we expected the effect of SCRIPTCON on phonological categorisation skills to be mediated by the knowledge of letter-sound correspondences. As the effect of SCRIPTCON remained significant after the effects of letter-sound knowledge were taken into account, we suspect that the direct relationship between SCRIPTCON and PHPOST was due to the element of categorisation involved in both tasks. However, this interpretation is tentative because PHPOST was not correlated to WISC Analogies, which also involved categorisation.

5.2.2.3. *Effects of intervention on children's capacity to detect phonological identity*

Table 5.2-4 shows two other regression models, which include the effects of intervention.

Although the effects of age were not significant, this variable was included in these new models because it prevents the effects of intervention from being confounded with the effects of age (and school grade), as only groups 5 and 6 included some seven-year old children.

As can be seen, intervention added only 2% to the amount of variance that was already explained by the other variables.

Table 5.2–4 Regression models showing the effects of intervention on Phonological Pairing

Model	Variables entered	R square	Std. Error of the estimate	B	Std. Error	Beta	T	Sig.
1	(Constant)			-11.597	5.704		-2.033	.045
	AGE	.219	7.1371	1.979E-03	.080	.002	.025	.980
	WISC DIGITS	.379	6.4016	.874	.346	.165	2.524	.014
	SCRIPT CONVENTIONS	.500	5.7746	1.372	.388	.216	3.533	.001
	PHON. PAIR. (pre-test)	.694	4.5479	.508	.075	.496	6.761	.000
	CONS REC. (pre-test)	.737	4.2382	.278	.080	.308	3.478	.001
	NO ANALYSIS I			2.832	1.485	.136	1.908	.060
	SYLLABIC ANALYSIS I			2.030	1.558	.093	1.302	.197
	PHONEMIC ANALYSIS I			1.508	1.500	.073	1.005	.318
	NO ANALYSIS II			-.787	1.845	-.035	-.426	.671
	PHONEMIC ANALYSIS II	.758	4.1916	1.585	1.894	.072	.837	.405
2	(Constant)			-12.384	6.383		-1.940	.056
	AGE	.219	7.1371	1.979E-03	.080	.002	.025	.980
	WISC DIGITS	.379	6.4016	.874	.346	.165	2.524	.014
	SCRIPT CONVENTIONS	.500	5.7746	1.372	.388	.216	3.533	.001
	PHON. PAIR. (pre-test)	.694	4.5479	.508	.075	.496	6.761	.000
	CONS REC. (pre-test)	.737	4.2382	.278	.080	.308	3.478	.001
	NO INTERVENTION			.787	1.845	.038	.426	.671
	NO ANALYSIS I			3.619	1.817	.174	1.991	.050
	SYLLABIC ANALYSIS I			2.816	1.813	.128	1.554	.124
	PHONEMIC ANALYSIS I			2.295	1.745	.110	1.315	.192
	PHONEMIC ANALYSIS II	.758	4.1916	2.372	1.680	.108	1.412	.162

Model 1 compares the performance of group 1 (no intervention) against all the other groups. It shows no significant differences between the groups. Model II shows the comparison of the two groups in Sample II. It also shows no significant differences. However, the difference between group 2 (no analysis - Sample I) and group 5 (no analysis -Sample II) nearly reached significance. This means that the children from Sample I who received a no-analysis intervention progressed more than their Sample II counterparts, who got equivalent scores on all the pre-test measures, and received the same type of training.

There was the possibility of these results having been distorted by the number of variables included in the equation, relative to the sample size (N=90). However, similar results were obtained when AGE was excluded from the equation to reduce the number of variables.

5.2.3. Summary: variables affecting the progress on the skills that underpin the understanding and use of the alphabetic system

The results presented above show that, in spite of the short period of intervention and the proximity between pre-test and post-test, there was a significant improvement in children's ability to recognise the initial consonant within words, as well as in their ability to detect phonological segments shared by different words.
These two abilities have been considered as the most important factors underpinning the development of the understanding of the alphabetic system.

The investigation of the variables involved in children's progress shows that this was not related to the intervention carried out in this study.

The variables involved in the progress on Initial Consonant recognition were AGE and SCRIPTCON. The effect of age probably reflected the effect of school instruction (as the children were assigned to different grades according to their age). The effect of SCRIPTCON (familiarity with the conventions of scripts) shows that children's reflections on what makes scripts different from other graphic stimuli are critical for discovering the correspondence between graphemes and phonemes.

The development of the capacity to detect phonological identity was mainly affected by WISC DIGITS, the familiarity with graphic conventions of scripts, as measured by SCRIPTCON and the capacity to recognise the first consonant within a word, measured by CONSPRE.

This suggests that:

- Children's early reflections about printed text, trying to differentiate letters and texts from other graphic stimuli and wondering about the meaning of scripts (what do the letters "say" and how they "say" it) are likely to encourage children to pay attention and to categorise the sounds within words. This would explain why SCRIPTCON is a good predictor of the development of the ability to detect phonological identity between different words.
- Although the use of pictures had minimised the load on short-term memory, the Phonological Pairing task still required the ability to segment words and to keep the segments in short-term memory long enough to allow them to be matched to the segments of other words. It is likely that WISC Digits entails similar requirements, especially when children have to repeat the

digit sequences in the reverse order. This could explain the relationship between WISC Digits and performance on the Phonological Pairing task;

- Knowing some letter-to-sound correspondences allows children to create orthographic representations of some sounds, decreasing the load on short-term memory and facilitating the comparison of the sounds within different words. Hence, it is not surprising that WISCDIG and CONSPRE explain a common part of the variance in PHPOST and that CONSPRE is such a good predictor of the performance on this task.

In summary, SCRIPTCON was the only variable that affected simultaneously children's ability to detect phonological identity between words and their capacity to decide whether a consonant is adequate to represent the onset of a word. This capacity, in turn, also affects the ability to detect phonological identity. Therefore, children's familiarity with the graphic conventions of scripts, or, in other words, their quest to discover what scripts are about, is crucial for the development of the abilities that underpin the understanding and use of the alphabetic system.

5.3 Changes in the Understanding and Use of the Writing System

We assumed in this study that it was possible to assess children's understanding of the alphabetic principle by studying the use they make of it. In other words, we hypothesised that the production of orthographic representations and the ability to make inferences about graph-phonetic segments are guided by children's conceptions about the writing system. To investigate this hypothesis, we needed to investigate how children change the way they use the writing system over time.

Therefore in this section we will start by investigating whether there was any change in children's use of the writing system, between pre- and post-test. If such a change has occurred, the factors that affected it will be investigated. This analysis will be carried out separately for each of the variables included in the set "understanding and use of the writing system": Invented Spelling, Analogy Spelling and Word Identification. The distributions of the three variables in this set were positively skewed, so their natural logarithms were used to correct the distributions for the Repeated Measures Analysis of Variance (MANOVA) presented below. For the regression analyses, it was necessary to correct the distribution of Analogy Spelling, but not of Invented Spelling or Word Identification, because there was no problem with the residuals. The data from 90 subjects were used for all the analyses, except for those involving Analogy Spelling, where the data from only 87 subjects was used, due to missing values.

5.3.1. Invented Spelling

Invented Spelling was used to assess the quality of orthographic representations. In situations where we cannot interview each child individually, this is the task where children's hypotheses about the writing system are expressed most clearly. In this study, children's invented spellings were categorised in 10 levels, as described in chapter 4. Table 5.3-1 shows how children changed between these levels, from pre- to post-test.

Table 5.3–1 Changes in children's invented spelling, from pre-test to post-test

		INVENTED SPELLING POST-TEST										
		1	2	3	4	5	6	7	8	9	10	Total
INVENTED SPELLING PRE-TEST	1	2	5	7		1						15
	2	1	2	6		2	4					15
	3		1	6		11	5	2	2			27
	4					2	2	1				5
	5			2		3	6	4	1			16
	6						2	3	1			6
	7								2	1		3
	8									1		1
	9									1	1	2
	Total	3	8	21	0	19	19	10	6	3	1	90

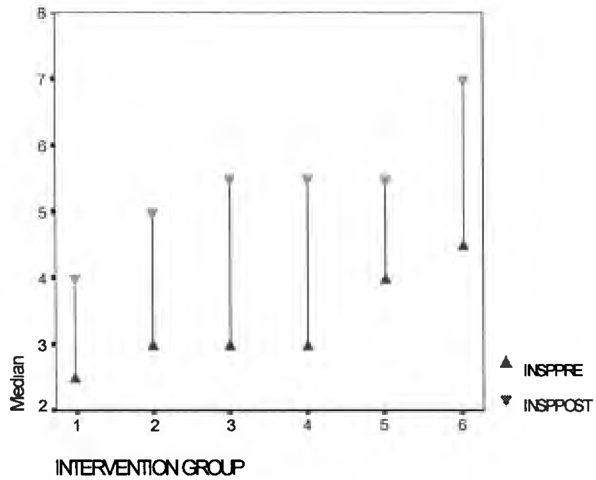
As can be seen, only four children regressed from a more advanced to a lower level and 16 children stayed at the same level; 26 children advanced one level; 24 children advanced two levels; nine children advanced three levels; seven children advanced four levels and only two children advanced five levels. Did these changes result in a significant gain for the whole group? What makes some children progress more than others? Does intervention produce an effect on children's invented spelling?

The analyses presented next provide the answers to these questions.

5.3.1.1. Changes over time in Invented Spelling

Figure 5.3-1 shows that there was a substantial gain in Invented Spelling between pre-test and post-test, for most groups. On average, the groups in Sample I started at level 3 (pre-syllabic) and progressed to level 4 or 5 (syllabic). The only exception was group 1 who made less progress. Most children in Sample II started at the lowest level of the syllabic hypothesis (between level 4 and level 5) and progressed to the highest level of the syllabic hypothesis (level 6). The differences between the groups were very small, except for group 1, which progressed least.

Figure 5.3–1: Improvement on Invented Spelling from pre-test (INSPPRE) to post-test (INSPPOST), according to intervention group.



As seen in Table 5.3-2, there was a positive effect of intervention on all age groups, but reception class children (age group 1) were the ones who benefited most.

Comparing training groups 2 and 5 (no-analysis training), we can see that the gains were similar for children from the two samples. However, the gains achieved by being trained on Phonemic Analysis were bigger for Sample 2 children, especially for age group 1 (reception class). This suggests that this kind of intervention somehow complemented the information that the children were receiving in the classroom.

In general, it seems that the intervention helped the children to improve their invented spelling to reach the pre-test levels of the age group above.

Table 5.3–2 Difference between pre-test and post-test means, per age group, according to the type of intervention

TRAINING GROUP	AGE GROUP								
	1			2			3		
	PRE-TEST	POST-TEST	GAIN	PRE-TEST	POST-TEST	GAIN	PRE-TEST	POST-TEST	GAIN
1	1.5	1.8	.3	3.3	4.3	1.0			
2	2.3	3.7	1.4	3.2	4.7	1.5			
3	1.0	3.0	2.0	3.2	5.1	1.9			
4	1.5	3.5	2.0	3.4	5.2	1.8			
5	2.6	4.0	1.4	4.5	6.0	1.5	5.3	6.4	1.1
6	2.5	5.0	2.5	4.7	6.7	2.0	5.2	6.7	1.5

The difference between the progress of all the intervention groups was analysed by carrying out a repeated Measures Analysis of Variance (MANOVA).

The MANOVA produced a significant effect of Time [F(1,84)=86.94; p<.001], showing a remarkable improvement from pre-test to post-test. There was no significant interaction effect of Time X Type of Intervention. Therefore, the improvement was probably not related to the type of intervention [F(5,84)=.61; p=.69], but these results do not take into account the differences in pre-test scores in other measures. This will be further analysed below.

5.3.1.2. *Individual differences affecting the progress in children's invented spelling*

Several multiple regression models were carried out to investigate the factors that might have affected the changes from pre-test to post-test. Table 5.3-3 shows the bivariate correlation between invented spelling and the explanatory variables to be entered in the regression models.

Table 5.3–3 Pearson's correlation between Invented Spelling (post-test) and all the possible explanatory variables

	AGE	WISC Analogies	WISC Digits	SCRIPT CONV.	VOWEL RECOGN Pre-test	VOWEL RECOGN Post-test	CONSON. RECOGN Pre-test	CONSON. RECOGN Post-test	PHONOL. PAIRING Pre-test	PHONOL. PAIRING Post-test	INVENT. SPELL. Pre-test
r	.467	.320	.451	.258	.482	.581	.638	.633	.660	.763	.745
p	.001	.002	.001	.015	.001	.001	.001	.001	.001	.001	.001

Table 5.3-4 shows a summary of the regression models, with the respective coefficients.

The control measures: AGE, WISC Analogies, WISC Digits and SCRIPTCON (Familiarity with Script Conventions) were entered in the regression equation as first, second, third and fourth step, respectively (model 1). Although all these variables have produced a significant effect when considered separately (not shown), only the effects of WISC and AGE remained significant when they were entered together in the regression equation. Altogether, they accounted for about 42% of the variance on Invented Spelling.

However, model 2 shows that the effect of AGE was no longer significant when this variable was entered in the equation together with the pre-test measure of Invented Spelling. This was the most important predictor, as it accounted for 20% of the variance, over and above the effects of the control measures.

The next models were used to test the effects of the variables from the set "Underpinning Skills and Knowledge" on progress on Invented Spelling, after controlling for the differences in AGE, WISC Digits and pre-test scores in Invented spelling. It was decided to test for both the predictive effects (using the pre-test scores - models 3a/b/c) and the concurrent effects (using the post-test scores - models 4a/b/c) of these variables.

Table 5.3–4 Fixed step regression analysis showing the effects of individual differences on the progress of Invented Spelling (post-test)

Model	Variables entered	R square	Std. Error of the estimate	B	Std. Error	Beta	T	Sig.
1	(Constant)			-7.089	1.852		-3.828	.000
	AGE	.246	1.829	.105	.026	.354	4.026	.000
	WISC ANALOGIES	.312	1.757	.146	.084	.155	1.724	.088
	WISC DIGITS	.402	1.648	.435	.123	.315	3.534	.001
	SCRIPT CONV.	.418	1.635	.222	.146	.135	1.526	.131
2	(Constant)			-1.556	1.715		-.908	.367
	AGE	.246	1.829	3.3E-02	.024	.110	1.372	.174
	WISC ANALOGIES	.312	1.757	3.6E-02	.070	.038	.512	.610
	WISC DIGITS	.402	1.648	.277	.103	.201	2.702	.008
	SCRIPT CONV	.418	1.635	-1.1E-02	.123	-.007	-.091	.927
	INV. SPEL. (pre-test)	.622	1.326	.668	.100	.609	6.684	.000
3a	(Constant)			-2.252	1.583		-1.423	.158
	AGE	.246	1.829	1.950E-02	.023	.066	.851	.397
	WISC DIGITS	.368	1.684	.219	.099	.159	2.220	.029
	INV. SPELL. (pre-test)	.620	1.313	.642	.088	.585	7.327	.000
	VOWEL REC. (pre-test)	.657	1.256	.123	.041	.213	2.974	.004
4a	(Constant)			-2.382	1.557		-1.530	.130
	AGE	.246	1.829	1.697E-02	.023	.057	.752	.454
	WISC DIGITS	.368	1.684	.160	.101	.116	1.580	.118
	INV. SPELL. (pre-test)	.620	1.313	.609	.088	.555	6.952	.000
	VOWEL REC. (pre-test)	.657	1.256	6.830E-02	.049	.118	1.390	.168
	VOWEL REC. (post-test)	.672	1.234	9.543E-02	.048	.185	1.995	.049
3b	(Constant)			-1.514	1.578		-.959	.340
	AGE	.246	1.829	1.544E-02	.024	.052	.652	.516
	WISC DIGITS	.368	1.684	.213	.101	.154	2.106	.038
	INV. SPELL. (pre-test)	.620	1.313	.575	.096	.524	5.970	.000
	CONS. REC. (pre-test)	.649	1.270	5.513E-02	.021	.234	2.606	.011
4b	(Constant)			-1.351	1.601		-.844	.401
	AGE	.246	1.829	1.140E-02	.024	.038	.466	.642
	WISC DIGITS	.368	1.684	.203	.102	.147	1.982	.051
	INV. SPELL. (pre-test)	.620	1.313	.562	.099	.512	5.708	.000
	CONS. REC (pre-test)	.649	1.270	4.286E-02	.028	.182	1.543	.127
	CONS. REC (post-test)	.651	1.274	1.778E-02	.026	.085	.686	.495
3c	(Constant)			-.894	1.578		-.567	.572
	AGE	.246	1.829	1.932E-02	.023	.065	.839	.404
	WISC DIGITS	.368	1.684	.223	.099	.162	2.259	.026
	INV. SPELL. (pre-test)	.620	1.313	.543	.099	.494	5.467	.000
	PHON. PAIR. (pre-test)	.654	1.260	6.792E-02	.024	.254	2.871	.005
4c	(Constant)			-.923	1.498		-.617	.539
	AGE	.246	1.829	1.865E-02	.022	.063	.853	.396
	WISC DIGITS	.368	1.684	.129	.098	.093	1.309	.194
	INV. SPELL. (pre-test)	.620	1.313	.395	.105	.360	3.773	.000
	PHON. PAIR. (pre-test)	.654	1.260	2.691E-02	.026	.101	1.041	.301
	PHON. PAIR. (post-test)	.692	1.196	9.316E-02	.029	.357	3.202	.002

Models 3a and 4a test the effects of Initial Vowel Recognition. Model 3a shows that the predictive effect of this variable is significant. However, when both the pre-test (VOWPRE) and the post-test (VOWPOST) measures are entered in the equation, only the effects of the post-test measure are marginally significant. This suggests that Invented Spelling is more affected by children's concurrent knowledge than by their previous knowledge about the sounds of the vowels, but most of the variance is shared by the two measures.

Models 3b and 4b test the effects of Initial Consonant Recognition. Model 3b shows that the predictive effect of this variable is significant. Model 4b shows that the pre-test and the post-test measures explain a common part of the variance in Invented Spelling.

Finally, models 3c and 4c test the effects of the capacity to detect phonological identity (Phonological Pairing). Model 3c shows that Phonological Pairing is a good predictor of the progress on Invented Spelling. However, the concurrent effects of this variable are stronger than the predictive effects, suggesting that the progress on Invented Spelling accompanies the improvement on Phonological Pairing.

Therefore, Initial Vowel Recognition, Initial Consonant Recognition and Phonological Pairing contribute significantly to progress on Invented Spelling. The measures of Phonological Pairing and, to a lesser extent, of Initial Vowel Recognition, taken at the time Invented Spelling was assessed (post-test) explained not only a common part, but also an extra proportion of the variance that had been already accounted for by the pre-test measure.

The next models (Table 5.3-5) were constructed to investigate whether the effects of these variables would remain significant when they were entered together in the regression equation.

Model 5 shows that Initial Consonant Recognition was no longer significant when entered together with the other pre-test variables. Part of the variance it accounted for was shared with WISC Digits, as Consonant Recognition regained significance when this variable was excluded, as shown in the next models.

Model 6 shows that the effect of the post-test measure of Initial Vowel Recognition does not interfere with the effects of the other variables (except the pre-test measure of the same variable).

Model 7 shows that the effect of the post-test measure of Phonological Pairing is so powerful that it takes much of the variance explained by all the pre-test variables. This is not surprising because the improvement on Phonological Pairing is affected by children's ability to recognise the initial letter within words. The surprising result is that the post-test measure of Phonological Pairing still explains a significant proportion of unique variance.

Table 5.3-5 Fixed step regression analysis investigating the effects of the variables of the set Underpinning Skills and Knowledge on Invented Spelling (post-test)

Model	Variables entered	R square	Std. Error of the estimate	B	Std. Error	Beta	t	Sig.
5	(Constant)			-1.595	1.538		-1.038	.303
	AGE	.246	1.829	1.109E-03	.023	.004	.049	.961
	WISC DIGITS	.368	1.684	.139	.098	.101	1.414	.161
	INV. SPELL. (pre-test)	.620	1.313	.470	.101	.428	4.666	.000
	VOWELS (pre-test)	.657	1.256	8.476E-02	.042	.147	2.037	.045
	CONSON. (pre-test)	.673	1.233	4.035E-02	.021	.172	1.959	.053
	PHONOL. (pre-test)	.692	1.203	5.261E-02	.023	.197	2.267	.026
6	(Constant)			-1.519	1.497		-1.015	.313
	AGE	.246	1.829	-7.329E-04	.022	-.002	-.033	.974
	INV. SPELL. (pre-test)	.585	1.313	.453	.100	.413	4.543	.000
	VOWELS (pre-test)	.636	1.256	3.786E-02	.048	.066	.785	.435
	CONSON. (pre-test)	.661	1.233	4.195E-02	.020	.178	2.099	.039
	PHONOL. (pre-test)	.685	1.203	5.254E-02	.023	.197	2.311	.023
	VOWELS (post-test)	.701	1.187	9.346E-02	.045	.181	2.095	.039
7	(Constant)			-1.465	1.462		-1.002	.319
	AGE	.246	1.829	4.473E-03	.022	.015	.202	.840
	INV. SPELL. (pre-test)	.585	1.365	.371	.104	.338	3.568	.001
	VOWELS (pre-test)	.636	1.285	2.387E-02	.047	.041	.502	.617
	CONSON. (pre-test)	.661	1.247	2.702E-02	.021	.115	1.310	.194
	PHONOL. (pre-test)	.685	1.210	2.589E-02	.025	.097	1.027	.307
	VOWELS (post-test)	.701	1.186	8.171E-02	.044	.159	1.862	.066
	PHONOL. (post-test)	.718	1.159	6.718E-02	.030	.258	2.231	.028

In summary, the best predictors of improvement on Invented Spelling from time I (pre-test) to time II (post-test) were the Phonological Pairing task and the Initial Letter Recognition task (both vowels and consonants). Moreover, the improvement on Phonological Pairing from pre-test to post-test made an additional contribution to the performance on Invented Spelling.

5.3.1.3. Effects of intervention on Invented Spelling

The regression models displayed in Table 5.3-6 show that the intervention accounted for 4% of the variance in Invented Spelling, even after controlling for the effects of all the relevant variables (pre-test measures) selected from the previous regression models.

Model 2a compares the performance of the "no-intervention" group against the performance of all the other groups. Although the comparison to the "no-intervention" group has shown that all the groups in Sample I have benefited from the intervention, this effect was significant only for the group trained on syllabic analysis.

Model 2b shows that the difference between the two groups in Sample II was significant: the "phonemic-analysis" training was more helpful than the "no-analysis" training to improve children's orthographic representations. Moreover, the impact of intervention on the "no-analysis" group in Sample II was smaller than the impact of intervention on all the other groups. In fact, after the pre-test measures were partialled out, the progress of the "no-analysis" group in Sample II was even smaller than the progress of the "no-intervention" group (Sample I), showing that this was not due to the intervention in Sample II having been shorter than in Sample I.

Table 5.3–6 Fixed step regression analysis investigating the effects of the intervention on the progress in Invented Spelling (post-test)

Model	Variables entered	R Square	Std. Error of the estimate	B	Std. Error	Beta	t	Sig.
1	(Constant)			-1.199	1.519		-.789	.432
	AGE		1.829	2.853E-04	.023	.001	.012	.990
	INV. SPELL. (pre-test)	.585	1.365	.478	.101	.435	4.723	.000
	VOWELS (pre-test)	.636	1.285	9.202E-02	.042	.159	2.216	.029
	CONSON. (pre-test)	.661	1.247	4.696E-02	.020	.199	2.321	.023
	PHONOL. (pre-test)	.685	1.210	5.756E-02	.023	.216	2.496	.015
2a	(Constant)			-1.700	1.593		-1.067	.289
	AGE	.246	1.829	-2.082E-03	.023	-.007	-.091	.928
	INV. SPELL. (pre-test)	.585	1.365	.455	.098	.414	4.644	.000
	VOWELS (pre-test)	.636	1.285	8.851E-02	.043	.153	2.071	.042
	CONSON. (pre-test)	.661	1.247	4.857E-02	.024	.206	2.048	.044
	PHONOL. (pre-test)	.685	1.210	6.937E-02	.023	.260	3.025	.003
	NO ANALYSIS I			.587	.414	.108	1.417	.160
	SYLLABIC ANALYSIS			1.179	.428	.206	2.755	.007
	PHONEMIC ANAL. I			.684	.422	.126	1.622	.109
	NO ANALYSIS II			-7.100E-02	.510	-.012	-.139	.890
	PHONEMIC ANAL. II	.729	1.159	.886	.518	.155	1.712	.091
2b	(Constant)			-1.771	1.765		-1.003	.319
	AGE	.246	1.829	-2.082E-03	.023	-.007	-.091	.928
	INV. SPELL. (pre-test)	.585	1.365	.455	.098	.414	4.644	.000
	VOWELS (pre-test)	.636	1.285	8.851E-02	.043	.153	2.071	.042
	CONSON. (pre-test)	.661	1.247	4.857E-02	.024	.206	2.048	.044
	PHONOL. (pre-test)	.685	1.210	6.937E-02	.023	.260	3.025	.003
	NO INTERVENTION			7.100E-02	.510	.013	.139	.890
	NO ANALYSIS I			.658	.514	.121	1.280	.204
	SYLLABIC ANALYSIS			1.250	.503	.218	2.484	.015
	PHONEMIC ANAL. I			.755	.500	.139	1.510	.135
	PHONEMIC ANAL. II	.729	1.159	.957	.463	.167	2.069	.042

Therefore, there was a positive contribution of intervention to the development of children's invented spellings, over and above the effects of children's individual differences and previous knowledge. This contribution was greater for the groups where some kind of word analysis was carried out. In Sample I, the most positive effect was obtained in the "syllabic analysis group", which was significantly different from the "no-intervention" group ($p<.01$). In Sample II, the "phonemic analysis" group proved to have benefited more from intervention than the "no-analysis" group ($p<.05$).

5.3.2. Analogy Spelling

It is worth stressing that this is a measure of children's early capacity to make inferences about graph-phonetic segments. We expected this capacity to be reflected in the use of analogies in spelling. However, we did not expect the children to spell the words correctly, even when clue-words were provided. Instead, we expected most children would improve their spellings in comparison to what they had produced in the

Invented Spelling task. A scale was designed to reflect the improvement (or its absence) in the spellings of the majority of the words, as explained in chapter 4.

Table 5.3-7 shows the changes in Analogy Spelling from pre- to post-test.

Table 5.3-7: Changes in Analogy Spelling from pre-test (ANSPPRE) to post-test (ANSPPOST)

		ANSPPOST					TOTAL
		1	2	3	4	5	
ANSPPRE	1	24	8	5	3	1	41
	2	5	12	8	5	3	33
	3			1	2		3
	4		2		6		8
	5					3	3
TOTAL		29	22	14	16	7	88

Five children regressed from level two to level one, confirming that the strategies used at level two are not dependent on a sound understanding of the relationship between sounds and letters. Two children dropped from level four to level two. This does not necessarily mean that they forgot how to take advantage of the clue-words. However, they had improved their invented spelling from pre-test to post-test. It is possible that the same strategies that had helped them to increase the number of letter-to-sound correspondences at a lower level of invented spelling were in conflict with their hypotheses at a higher level, impairing their spellings in the presence of clue-words.

It is also interesting to notice that four children who reached level five at the post-test had scored at the lowest levels at the pre-test. This may indicate that many children were affected by the novelty of the task during the pre-test. However, this does not explain why six children remained at level four. Level four means that children are using the clue-words to increase the number of letter-to-sound correspondences but not to solve orthographic problems, such as replacing one grapheme with another which is conventionally used to represent the same phoneme. The children who were stuck at level 4 were unlikely to have understood that the relationship between graphemes and phonemes is of one-to-many or many-to-one rather than one-to-one.

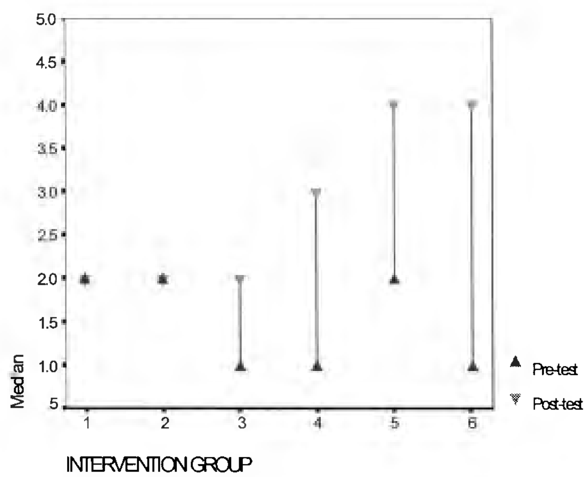
Next, we will investigate whether the changes in Analogy Spelling are significant and, if they are, which factors affect these changes.

5.3.2.1. Changes over time in Analogy Spelling

The Repeated Measures Analysis of Variance was used to compare the pre-test and post-test means. As explained above, the natural logarithm was used to correct the distributions of both variables, which were positively skewed.

The Manova produced a significant effect of Time [$F(1,81)=23.81$; $p<.001$], showing that it was very unlikely that the improvement between pre-test and post-test had been reached by chance. The significant interaction effect of Type of Intervention X Time [$F(5,81)=2.61$; $p=.031$] showed that this improvement was related to the type of intervention. As shown in Figure 5.3-2, in each sample, the groups trained on analysing words seem to have improved more than the other groups. Only in groups 5 and 6 (Sample II) did most children improve from a level where they were not able to use analogies (levels 1 and 2) to a level where they could use analogies to increase the number of letter-sound correspondences (level 4). However, this analysis does not take into account the differences in the pre-test measures, so the effects of intervention will be further analysed later in this chapter.

Figure 5.3-2: Improvement on Analogy Spelling, from pre-test to post-test, per training group (points represent the median of the scores)



5.3.2.2. Individual differences affecting children's progress on Analogy Spelling

To achieve a clearer picture of the factors involved in the changes from pre-test to post-test, different regression models were carried out. Due to missing data, the number of subjects was reduced to 87 in all these analysis. The distribution of the post-test scores on Analogy Spelling was strongly positively skewed. To correct the distribution, the natural logarithm of Analogy Spelling (post-test) was used as the response variable in all these regression analysis. The inspection of the residual plots showed that this transformation had solved the problem.

Table 5.3-8 shows the correlation between the performance at post-test and the variables possibly involved in the children's progress.

Table 5.3–8 Pearson's Correlation between Analogy Spelling (post-test) and all the possible explanatory variables

	AGE	**WISC Analogies**	**WISC Digits**	**SCRIPT CONV.**	**VOWELS RECOGN.** Pre-test	**VOWELS RECOGN** Post-test	**CONSON. RECOGN** Pre-test	**CONSON. RECOGN** Post-test	**PHONOL. PAIRING** Pre-test	**PHONOL. PAIRING** Post-test	**ANAL. SPEL.** Pre-test
r	.442	.279	.590	.300	.479	.575	.661	.661	.512	.699	.575
p	.000	.004	.000	.002	.000	.000	.000	.000	.000	.000	.000

All the control measures and the variables comprising the set "underpinning skills and knowledge" correlated significantly and positively to Analogy Spelling

To further investigate the effects of these variables, several fixed step regression models were carried out, as shown in Table 5.3-9.

Model 1 shows that, apart from WISC Digits, no control measures had a significant effect on Analogy Spelling after the pre-test scores on this variable were controlled.

Models 2a, 2b and 2c investigate the predictive effects of the pre-test measures in the set "underpinning skills and knowledge", after the control measures and the differences in the pre-test scores on Analogy Spelling were partialled out. Models 3a, 3b and 3c investigate whether the same variables produced any concurrent effect, after the effects of the pre-test measures had been controlled.

Model 2a shows that the pre-test measure of Initial Vowel Recognition (VOWPRE) accounted for a significant amount of the variance (3.3%). Model 3a shows that the post-test measure of this variable (VOWPOST) made a small (marginally significant) contribution of about 2.3%, over and above the variance explained by VOWPRE.

Model 2b shows that the pre-test measure of Initial Consonant Recognition was a strong predictor of the increased use of analogies in spelling. Model 3b shows that, in contrast to the other explanatory variables in this set, the post-test measure of Initial Consonant Recognition did not account for a significant amount of the variance over and above that explained by the pre-test measure.

Model 2c shows that the pre-test measure of Phonological Pairing was not a good predictor of the later ability to use analogies in spelling. However, model 3c shows that there was a significant effect of the concurrent measure, over and above the effect of the pre-test measures.

Table 5.3–9 Fixed step regression analysis showing the effects of the explanatory variables on Analogy Spelling

Model	Variables entered	R square	Std. Error of the estimate	B	Std. Error	Beta	T	Sig.
1	(Constant)			-1.766	.546		-3.233	.002
	AGE	.203	.52107	1.495E-02	.008	.181	1.948	.055
	WISC ANALOGIES	253	.52107	2.065E-02	.022	.080	.937	.352
	WISC DIGITS	.449	.43850	.153	.034	.406	4.553	.000
	SCRIPT CONV.	.461	.43633	3.386E-02	.039	.074	.862	.391
	ANALOGY SPEL. (pre-test)	497	.42390	.130	.054	.243	2.412	.018
2a	(Constant)			-1.813	.527		-3.438	.001
	ANALOGY SPEL. (pre-test)	.298	.48883	.135	.051	.253	2.634	.010
	AGE	.337	.47812	1.180E-02	.008	.143	1.546	.126
	WISC DIGITS	.484	.42426	.141	.033	.375	4.278	.000
	VOWEL RECOG. (pre-test)	.517	.41306	3.200E-02	.014	.201	2.347	.021
3a	(Constant)			-1.777	.518		-3.428	.001
	ANALOGY SPEL. (pre-test)	.298	.48883	.135	.050	.252	2.680	.009
	AGE	.337	.47812	9.937E-03	.008	.121	1.316	.192
	WISC DIGITS	.484	.42426	.119	.034	.316	3.469	.001
	VOWEL RECOG. (pre-test)	.517	.41306	1.263E-02	.017	.080	.765	.447
	VOWEL RECOG. (post-test)	.540	.40558	3.154E-02	.016	.223	2.003	.049
2b	(Constant)			-1.671	.516		-3.238	.002
	ANALOGY SPEL. (pre-test)	.298	.48883	8.750E-02	.055	.163	1.590	.116
	AGE	.337	.47812	9.966E-03	.008	.121	1.301	.197
	WISC DIGITS	.484	.42426	.134	.033	.356	4.049	.000
	CONS. RECOG. (pre-test)	.527	.40860	1.900E-02	.007	.284	2.721	.008
3b	(Constant)			-1.534	.525		-2.922	.005
c	ANALOGY SPEL. (pre-test)	.298	.48883	8.929E-02	.055	.167	1.628	.107
	AGE	.337	.47812	7.147E-03	.008	.087	.899	.371
	WISC DIGITS	.484	.42426	.126	.033	.336	3.777	.000
	CONS. RECOG. (pre-test)	.527	.40860	1.086E-02	.009	.162	1.151	.253
	CONS. RECOG. (post-test)	.537	.40704	1.061E-02	.008	.179	1.274	.206
2c	(Constant)			-1.461	.537		-2.718	.008
	ANALOGY SPEL. (pre-test)	.298	.48883	.108	.056	.201	1.912	.059
	AGE	.337	.47812	1.198E-02	.008	.145	1.528	.130
	WISC DIGITS	.484	.42426	.146	.033	.389	4.376	.000
	PHON. PAIR.. (pre-test)	.503	.41910	1.353E-02	.008	.181	1.741	.086
3c	(Constant)			-1.280	.499		-2.564	.012
	ANALOGY SPEL. (pre-test)	.298	.48883	8.816E-02	.052	.164	1.683	.096
	AGE	.337	.47812	8.949E-03	.007	.109	1.227	.223
	WISC DIGITS	.484	.42426	.108	.032	.288	3.336	.001
	PHON. PAIR. (pre-test)	.503	.41910	-7.140E-03	.009	-.096	-.796	.429
	PHON. PAIR. (post-test)	.580	.38740	3.369E-02	.009	.469	3.847	.000

It is interesting to notice that the pre-test measure of Analogy Spelling (ANSPPRE) was no longer significant when entered together with either Phonological Pairing or Initial Consonant Recognition. This suggests that Analogy Spelling was such an unfamiliar task that, in the pre-test, the children did not use their skills to the full extent, to take advantage of the clue-words.

To further analyse the effects of the set "Underpinning Skills and Knowledge", another regression model was carried out, including all the variables of this set together in the equation.

Table 5.3-10 shows that model 1, which includes only AGE and the pre-test measures which contributed significantly to the progress on Analogy Spelling (ANSPPOST), explains about 54% of the variance in this variable. Most of this variance is due to the effects of WISC Digits (27%) and Initial Consonant Recognition (8%). These are the only variables whose effects remain significant after controlling for the effects of all the other variables. Even without controlling for the effects of ANSPPRE, age was no longer significant when entered together with CONSPRE, but, as explained above, we will retain this variable in the equation to separate the effects of intervention from the effects of age and school grade.

In model 2, the pre-test measure of Initial Vowel Recognition (VOWPRE) was replaced by the post-test measure of the same variable (VOWPOST). This made a significant contribution of 3% to the variance in ANSPPOST.

Model 3 explains about 60% of the variance in Analogy Spelling. It shows that the effects of both CONSPRE and VOWPOST were no longer significant when the post-test measure of Phonological Pairing (PHPOST) was included in the regression equation. Thus, PHPOST explained a common part of the variance accounted for CONSPRE and VOWPOST and contributed an extra 5% of the variance.

Table 5.3–10 Fixed step regression analysis showing the predictive and the concurrent effects of Initial Vowel Recognition and Phonological Pairing on Analogy Spelling

Model	Variables entered	R square	Std. Error of the estimate	B	Std. Error	Beta	T	Sig.
1	(Constant)			-2.093	.474		-4.412	.000
	AGE	.173	.533	1.069E-02	.007	.130	1.502	.137
	WISC DIGITS	.439	.441	.139	.032	.374	4.317	.000
	CONS. RECOG. (pre-test)	.518	.412	2.042E-02	.007	.303	3.073	.003
	VOWEL RECOG. (pre-test)	.535	.407	2.430E-02	.014	.152	1.752	.084
2	(Constant)			-2.045	.461		-4.433	.000
	AGE	.173	.533	1.005E-02	.007	.123	1.432	.156
	WISC DIGITS	.439	.441	.122	.033	.327	3.660	.000
	CONS. RECOG. (pre-test)	.518	.412	1.957E-02	.007	.290	3.005	.004
	VOWEL RECOG. (post-test)	.549	.400	3.106E-02	.013	.219	2.390	.019
3	(Constant)			-1.618	.460		-3.516	.001
	AGE	.173	.533	7.582E-03	.007	.092	1.128	.263
	WISC DIGITS	.439	.441	9.667E-02	.033	.260	2.962	.004
	CONS. RECOG. (pre-test)	.518	.412	9.877E-03	.007	.146	1.423	.159
	VOWEL RECOG. (post-test)	.549	.400	1.975E-02	.013	.139	1.532	.129
	PHON. PAIRING (post-test)	.597	.381	2.394E-02	.008	.336	3.100	.003

The significant concurrent effects of Phonological Pairing suggest that the progress in Analogy Spelling was accompanied by improvement in the ability to detect phonological identity. Among the pre-test measures, only WISC and CONSPRE predicted significantly the progress on Analogy Spelling. Thus, only these variables and AGE will be included in the next regression models, which investigate the effects of intervention.

5.3.2.3. Effects of intervention on Analogy Spelling

To investigate the effects of intervention on Analogy Spelling, two regression models were carried out (Table 5.3-11). They show that intervention explains about 3% of the variance in Analogy Spelling.

It is interesting to notice that AGE regained significance when entered together with the dummy variables of the intervention groups, showing that, within each intervention group, the eldest children progressed more than the youngest, even after the effects of WISC Digits and CONSPRE were partialled out. This effect was probably due to differences in children's capacity to detect phonological identity, as AGE is no longer significant when entered together with PHPRE (not shown).

In spite of the gains of group 4 (phonemic analysis) being greater than the other groups in Sample I (as shown in Figure 5.3-2), model 1a shows that this difference was not significant, or, at least, it was not significantly due to intervention. The effect of intervention on the "syllabic analysis" group was smaller than the effect of intervention on the other groups in Sample I.

In Sample II, in spite of the progress of the "phonemic analysis" group being slightly better than the progress of the "no analysis" group, the difference was not significant, as shown in model 1b.

Table –5.3–11 Effects of intervention on Analogy Spelling

Model	Variables entered	R square	Std. Error of the estimate	B	Std. Error	Beta	T	Sig.
1a	(Constant)			-2.451	.515		-4.763	.000
	AGE	.173	.53255	1.6E-02	.007	.196	2.215	.030
	WISC DIGITS	.439	.44111	.144	.032	.386	4.469	.000
	CONS. RECOG. (pre-test)	.518	.41163	3.1E-02	.007	.458	4.158	.000
	WTRAIN1			9.2E-02	.143	.061	.644	.522
	STRAIN			-3.0E-02	.151	-.019	-.200	.842
	PHTRAIN1			.163	.144	.109	1.130	.262
	WTRAIN2			-.314	.177	-.194	-1.777	.079
	PHTRAIN2	.567	.40240	-9.1E-02	.178	-.056	-.513	.609
1b	(Constant)			-2.765	.589		-4.053	.000
	AGE	.173	.53255	1.6E-02	.007	.196	2.215	.030
	WISC DIGITS	.439	.44111	.144	.032	.386	4.469	.000
	CONS. RECOG. (pre-test)	.518	.41163	3.1E-02	.007	.458	4.158	.000
	NOTRAIN			.314	.177	.210	1.777	.079
	WTRAIN1			.406	.173	.272	2.341	.022
	STRAIN			.284	.179	.175	1.588	.116
	PHTRAIN1			.477	.168	.319	2.836	.006
	PHTRAIN2	.567	.40240	.223	.159	.137	1.406	.164

Model 1a also shows that the effects of intervention on the two groups in Sample II was smaller than the effects on all the groups in Sample I. The comparison between the groups from both samples, per type of intervention, shows that the effect of intervention on the "no analysis" group in Sample I was significantly greater than the effect of intervention on the corresponding group in Sample II. The same happens when we compare the results of the "phonemic analysis" groups, although in this case the difference is not significant.

Therefore, the intervention seemed to be more helpful for Sample I than for Sample II children. This is interesting because we would have reached the opposite conclusion from the information in Figure 5.3-2. However, this information did not take into account children's age and their scores on Initial Consonant Recognition. In fact, Sample II children showed more ability to recognise the initial consonants in words and this placed them in a better position to learn how to take advantage of the clue-words to improve their spellings. Therefore, although their progress was greater than the progress of Sample I children, this progress was not due to intervention. On the contrary, if it were not for the intervention, the post-test differences between the two samples, in Analogy Spelling, would have been greater.

5.3.3. Word Identification

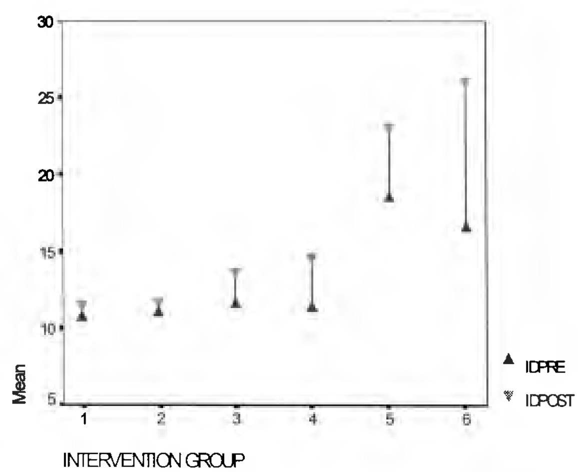
Word Identification also assessed children's capacity to make inferences about graph-phonetic segments.

This task comprised ten conditions, five concerning segments in initial position and five concerning segments in final position. However, this analysis uses the pooled scores of all the conditions together. As each condition comprises four trials, the task scores range from zero to 40.

5.3.3.1. Changes over time in Word Identification

Figure 5.3-3 shows the progress of each intervention group.

Figure 5.3–3 Changes in Word Identification per intervention group between pre-test (IDPRE) and post-test (IDPOST)



The Manova produced a significant effect of Time [$F(1,81)=29.59$; $p<.001$], as well as a significant interaction effect of Type of Intervention X Time [$F(5,81)=2.54$; $p=.034$].

Therefore, there was a significant improvement on this measure, from pre-test to post-test and the size of this gain seems to be related to sample rather than to the type of intervention. However, within Sample II, the improvement was bigger for the group which practised word analysis during training (group 6).

This effect will be further analysed later in this chapter.

5.3.3.2. Individual differences affecting children's progress in Word Identification

For a child who could translate the graphic segments provided by the experimenter into the corresponding sounds or phonemes, this task was a kind of print-to-speech matching task, which might be performed by using partial recoding. The only difference was that, in this task, children were forced to use the graph-phonetic cues provided by the experimenter.

The great majority of children, who could not immediately translate the graphic cues into sounds or phonemes, performed this task by using analogies. In this case, the children were encouraged to use the support of clue-words to discover the sounds of the graphic segments. Afterwards, they had to select the word that started or finished with the sound they had discovered.

In both cases - when using partial phonological recoding (cue reading) or when using analogies - children had to be able to detect sound identity between different words and to understand that:

- The letters which were used as graphic cues corresponded to a phonological segment and not to the whole word;
- As parts of a whole, the letters in the cues would sound different from how they sounded in isolation (such as letter names, or in phonic games).
- The same graphic segment might be part of different words and, if so, it was likely to correspond to the same phonological segment (this was particularly important for using analogies).

Therefore, we expected a strong relationship to be found between Word Identification and both Initial Consonant Recognition and Phonological Pairing task

As shown in Table 5.3-12, except for the WISC Analogies, all the potential explanatory variables were significantly correlated to the performance on Word Identification (post-test).

Table –5.3–12: Pearson's Correlation between Word Identification (post-test) and all the possible explanatory variables

	AGE	WISC Analogies	WISC Digits	SCRIPT CONV.	VOWELS RECOGN. Pre-test	VOWELS RECOGN Post-test	CONSON. RECOGN Pre-test	CONSON. RECOGN Post-test	PHONOL. PAIRING Pre-test	PHONOL. PAIRING Post-test	WORD IDENTIF . Pre-test
r	.605	.154	.439	.282	.385	.417	.821	.760	.657	.748	.725
p	.001	.077	.001	.001	.001	.001	.001	.001	.001	.001	.001

Several fixed step regression models were tested for their fitness to account for the changes in children's ability to use graphic phonetic cues to identify novel words. Table 5.3-13 shows a Summary of this analysis with the respective coefficients.

Table 5.3–13 Fixed step regression analysis showing the effects of individual differences on the progress in Word Identification (post-test)

Model	Variables entered	R square	Std. Error of the estimate	B	Std. Error	Beta	T	Sig.
1	(Constant)			-44.431	6.690		-6.642	.000
	AGE	.405	6.5818	.622	.094	.517	6.608	.000
	WISC DIGITS	.498	6.0795	1.678	.435	.300	3.855	.000
	SCRIPT CONV.	.531	5.9080	1.252	.508	.187	2.463	.016
2	(Constant)			-24.443	6.742		-3.625	.000
	AGE	.405	6.5818	.304	.098	.253	3.095	.003
	WISC DIGITS	.498	6.0795	1.199	.382	.214	3.134	.002
	SCRIPT CONV.	.531	5.9080	.669	.448	.100	1.494	.139
	WORD IDENT. (pre-test)	.660	5.0631	.655	.116	.486	5.633	.000
3a	(Constant)			-23.552	6.690		-3.521	.001
	AGE	.405	6.5818	.281	.100	.234	2.809	.006
	WISC DIGITS	.498	6.0795	1.103	.395	.197	2.789	.007
	WORD IDENT. (pre-test)	.651	5.0997	.679	.114	.504	5.941	.000
	VOWEL RECOG. (pre-test)	.657	5.0835	.207	.167	.089	1.242	.218
4a	(Constant)			-23.510	6.727		-3.495	.001
	AGE	.405	6.5818	.278	.101	.232	2.746	.007
	WISC DIGITS	.498	6.0795	1.061	.420	.190	2.527	.013
	WORD IDENT. (pre-test)	.651	5.0997	.678	.115	.503	5.894	.000
	VOWEL RECOG. (pre-test)	.657	5.0835	.172	.204	.074	.843	.402
	VOWEL RECOG. (post-test)	.657	5.1112	5.948E-02	.195	.029	.305	.761
3b	(Constant)			-23.860	5.008		-4.764	.000
	AGE	.405	6.5818	.176	.076	.146	2.301	.024
	WISC DIGITS	.498	6.0795	.479	.305	.086	1.573	.120
	WORD IDENT. (pre-test)	.651	5.0997	.402	.093	.299	4.307	.000
	CONS. RECOG. (pre-test)	.803	3.8502	.511	.063	.534	8.070	.000
4b	(Constant)			-23.260	5.060		-4.597	.000
	AGE	.405	6.5818	.162	.078	.134	2.065	.042
	WISC DIGITS	.498	6.0795	.438	.309	.078	1.418	.160
	WORD IDENT. (pre-test)	.651	5.0997	.388	.095	.288	4.094	.000
	CONS. RECOG. (pre-test)	.803	3.8502	.462	.084	.484	5.507	.000
	CONS. RECOG. (post-test)	.805	3.8553	6.895E-02	.078	.081	.883	.380
3c	(Constant)			-20.625	6.366		-3.240	.002
	AGE	.405	6.5818	.268	.096	.223	2.802	.006
	WISC DIGITS	.498	6.0795	.937	.381	.167	2.461	.016
	WORD IDENT. (pre-test)	.651	5.0997	.533	.122	.395	4.368	.000
	PHON. PAIR. (pre-test)	.684	4.8797	.267	.090	.247	2.973	.004
4c	(Constant)			-18.155	5.666		-3.204	.002
	AGE	.405	6.5818	.227	.085	.189	2.668	.009
	WISC DIGITS	.498	6.0795	.375	.356	.067	1.053	.295
	WORD IDENT. (pre-test)	.651	5.0997	.487	.109	.361	4.486	.000
	PHON. PAIR. (pre-test)	.684	4.8797	-6.669E-03	.097	-.006	-.069	.946
	PHON. PAIR. (post-test)	.755	4.3261	.464	.095	.439	4.886	.000

Models 1 and 2 tested the effects of the control variables. AGE and WISC Digits were entered in the regression equation as first and second step, respectively and Familiarity with Script Conventions (SCRIPTCON) was entered as the third step. Model 1 shows that the control measures accounted for 53% of the variance in the post-test measure of Word Identification (IDPOST).

Model 2 shows that SCRIPTCON lost significance when entered together with the pre-test measure of Word Identification (IDPRE), because most (2.4%) of the variance explained by SCRIPTCON was also explained by IDPRE. This variable explained an extra 12.9% of the variance on the post-test measure.

Models 3 and 4 (a, b and c) investigate the effects of each variable of the set "Underpinning Skills and Knowledge", on Word Identification. SCRIPTCON was dropped from these models, because it was no longer significant.

Models 3a, 3b and 3c investigate the predictive effects (using the pre-test scores) and the concurrent effects (using the post-test scores) of these variables.

Models 3a and 4a show that Initial Vowel Recognition does not explain a significant amount of the variance over and above the one that was explained by the variables included in model 2.

Model 3b shows that the pre-test measure of Initial Consonant Recognition was a strong predictor of the progress in IDPOST. It accounted for 15% of the variance, even after the effects of the control measures and the pre-test scores in Word Identification were partialled out. It is interesting to notice that the concurrent effects of the post-test measure of this variable did not neutralise the predictive effects of the pre-test measure, as shown in model 4b. This suggests that any improvement in the most elementary level of phonological recoding (measured by Initial Consonant Recognition) does not immediately boost the ability to use graphic phonetic cues to identify novel words.

On the contrary, models 3c and 4c show that the concurrent sensitivity to sound identity seems to be more important than the same measure at time 1 (pre-test). Model 4c shows that PHPOST explains about 7% of the variance in IDPOST over and above the variance already explained by PHPRE and the other measures included in the regression equation.

The next models (Table 5.3-14) investigate whether the predictive effects of Initial Consonant Recognition and Phonological Pairing remain significant when they are entered together in the equation. WISC Digits was excluded because it was no longer significant when entered together with Initial Consonant Recognition.

Table 5.3–14 Fixed step regression analysis showing the predictive and the concurrent effects of Initial Consonant Recognition and Phonological Pairing on Word Identification

Model	Variables entered	R square	Std. Error of the estimate	B	Std. Error	Beta	T	Sig.
1	(Constant)			-21.634	4.738		-4.566	.000
	WORD IDENT. (pre-test)	.564	5.6327	.297	.097	.221	3.062	.038
	AGE	.609	5.3619	.155	.074	.129	2.108	.003
	CONSON. (pre-test)	.797	3.8835	.504	.059	.528	8.527	.000
	PHONOL. (pre-test)	.818	3.6993	.209	.067	.193	3.110	.003
2	(Constant)			-20.651	4.560		-4.528	.000
	WORD IDENT. (pre-test)	.564	5.6327	.311	.093	.231	3.328	.001
	AGE	.609	5.3619	.152	.071	.127	2.152	.034
	CONSON. (pre-test)	.797	3.8835	.417	.064	.436	6.468	.000
	PHONOL. (pre-test)	.818	3.6993	7.027E-02	.081	.065	.871	.386
	PHONOL. (post-test)	.835	3.5509	.239	.084	.227	2.858	.005

To control the differences in the pre-test scores on Word Identification, IDPRE was entered in the regression equation as the first step. AGE was entered as the second step and made a significant contribution, explaining an extra 5% of the variance.

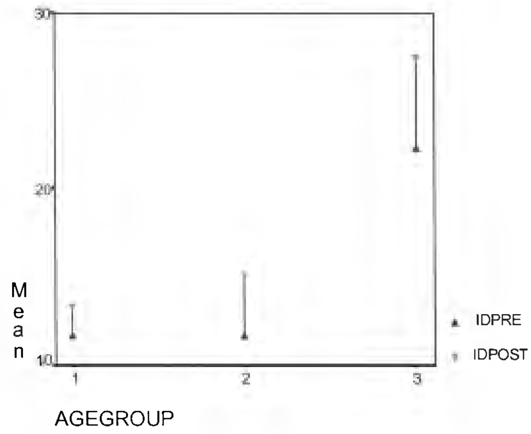
The regression models confirmed that Initial Consonant Recognition and Phonological Pairing made an independent and significant contribution to the variance on Word Identification, even after the initial differences in the pre-test scores on this task and AGE were controlled.

Initial Consonant Recognition proved to be the most powerful predictor of the progress in IDPOST, accounting for about 19% of the variance (model 1).

The pre-test scores on Phonological Pairing accounted for 2% of the variance, but, when considering both the pre-test and the post-test scores, Phonological Pairing explains about 4% of the variance (model 2).

In contrast to the findings for Invented Spelling, the effects of Age on Word Identification remained significant after controlling for the pre-test measures. This means that the gains on this task were greater for older children. Since the children were assigned to different school grades according to their age and the amount of systematic activities involving writing and reading increased in the higher grades, it is likely that the effects of Age are, indeed, reflecting the effects of school teaching, as shown in Figure 5.3.4.

Figure 5.3–4 Progress in Word Identification between pre-test (IDPRE) and post-test (IDPOST) according to age group



5.3.3.3. Relationship between Word Identification and Phonological Pairing

As explained above, it is likely that the improvement on Word Identification requires not only an improved ability to detect Phonological Identity, but also the capacity to make inferences about graph-phonetic segments, as suggested by the correlation between pre and post-test measures on both variables. As can be seen in Table 5.3-15, the correlation between PHPRE and IDPOST was slightly greater than the correlation between PHPRE and IDPRE, showing that in the post-test children were more likely to take advantage of their Phonological Pairing abilities to make inferences about graph-phonetic segments. Moreover, the strongest correlation was between PHPOST and IDPOST, showing that there was a parallel development in both variables.

Table 5.3–15 Pearson's correlation between the pre- and the post-test measures of Phonological Pairing (PHPRE and PHPOST, respectively) and the pre-and post-test measures of Word Identification (IDPRE and IDPOST, respectively)

	IDPRE	IDPOST
PHPRE	.636	.675
PHPOST	.573	.764

The relationship between Phonological Pairing and Word Identification may be further analysed by comparing children's performance on the matching conditions of both tasks. Table 5.3-16 shows the number of children who passed each condition, per task, both in the pre-test and in the post-test. The criterion to score a "pass" was to answer correctly three out of four items per condition ($p<.06$).

Table 5.3–16 Number of children who passed each condition of Phonological Categorisation and Word Identification task

		N	Pass None (n)	Pass Only PH (n)	Pass Only ID (n)	Pass Both (n)	Total Passes PH *	Total Passes ID *	Proportion of "Pass only PH" *
ISD	Pre	92	37	35	2	18	53	20	.66
	Post	92	27	31	3	31	62	33	.50
ISS	Pre	92	59	21	4	8	29	12	.72
	Post	92	54	15	9	14	29	25	.51
IOD	Pre	92	54	22	10	6	28	16	.79
	Post	92	49	23	8	12	35	20	.66
IOS	Pre	92	67	20	4	1	21	5	.95
	Post	92	66	10	7	9	19	16	.53
IPH	Pre	92	57	15	9	11	26	20	.58
	Post	92	56	7	12	17	24	29	.29
FSD	Pre	93	64	22	0	7	29	7	.76
	Post	92	52	22	4	14	36	18	.61
FSS	Pre	93	73	11	3	6	17	9	.65
	Post	92	71	9	3	9	18	12	.50
FRS	Pre	93	54	24	7	8	32	15	.75
	Post	92	44	33	3	12	45	15	.73
FRU	Pre	93	76	7	4	6	13	10	.54
	Post	92	64	3	7	18	21	25	.14
FPH	Pre	93	63	24	2	4	28	6	.86
	Post	92	55	21	7	9	30	16	.70

*** "Total Passes" = "Pass Only" + "Pass Both"**
Proportion of "Pass Only PH" = "Pass Only PH" ÷ "Total Passes PH"

It was expected that, to pass on each condition of Word Identification, it would be necessary to pass on the corresponding condition of Phonological Pairing. The data confirmed this hypothesis only partially, as on all the conditions, there were a few children who only passed on Word Identification. However, a closer inspection of individual cases shows that this was not due to different strategies adopted consistently by a small number of children. On the pre-test, only two children from Sample I passed more than two conditions of Word Identification and failed the same conditions of Phonological Pairing. On the post-test, this happened to three different children, from Sample II. Interestingly, all these children attended the same school and two of them were in a year II class. These two children passed four conditions of Word Identification, but failed them on Phonological Pairing. It is possible that these children were using partial phonological recoding rather than using analogies to discover the sounds of the graphic cues. It is not surprising that they passed some conditions on the Word Identification task. What is surprising is that they failed the corresponding conditions of Phonological Pairing task, especially in the post-test, as phonological recoding is thought to involve the capacity to detect phonological identity between words.

These data also show that the increase in the number of children who passed each condition on both tasks was greater than the decrease in the number of children who passed none, so some children who passed only one task in the pre-test, passed both tasks in the post-test.

Moreover, the number of children who improved on Word Identification was greater than the number of children who improved on Phonological Pairing, as can be seen by the reduction in the proportion of "Pass only PH".

This confirms that, somehow, many children learnt to take advantage of their phonological sensitivity to make inferences about graph-phonetic segments, especially in initial position. Therefore, for many children, the improvement on IDPOST was probably due to a better understanding of the alphabetic principle, rather than to an improvement in the ability to detect phonological identity.

It is interesting that the transference of the ability to detect sound identity from a phonological task to a word identification task was stronger on the most difficult conditions, such as "initial onset with the same place of articulation" and "Final Unstressed Rime".

The unexpected result concerned the stressed rime condition. It was expected that children would find it easy to match the vowel they saw in the target segment to its name, which they heard when the last segment of the target word was pronounced. Moreover, it was expected that they would identify the target word easily because it rhymed with the clue-word. This happened in the pre-test. However, there was no improvement in this condition from pre-test to post-test, in the Word Identification task. This shows that the number of children who used their ability to identify the rhyming words, in order to make inferences about the written form of the rhyming segments did not increase from pre-test to post-test. Consequently, in the post-test, the proportion of children who could detect the rhyming words but were not able to relate the rhyming segment to its written form was greater in the stressed rime condition than in all the other conditions, including the unstressed rime. In this condition, the name of the vowels was not heard so clearly and there were no rhyming words. Therefore, there is no apparent reason for the failure to progress in the stressed rime condition.

5.3.3.4. Effects of intervention on children's progress in Word Identification.

Table 5.3-17 shows the effects of intervention on Word Identification, after controlling the effects of all the pre-test measures.

Table 5.3–17 Fixed step regression analysis investigating the effects of intervention on children's progress on Word Identification

Model	Variables entered	R square	Std. Error of the estimate	B	Std. Error	Beta	T	Sig.
1	(Constant)			-14.639	4.764		-3.073	.003
	WORD IDENT. (pre-test)	.564	5.6327	.293	.092	.218	3.193	.002
	AGE	.609	5.3619	9.088E-02	.070	.076	1.294	.199
	CONSON. (pre-test)	.797	3.8835	.377	.064	.395	5.902	.000
	PHONOL. (pre-test)	.818	3.6993	.270	.064	.249	4.185	.000
	NO ANALYSIS I			-.293	1.213	-.013	-.241	.810
	SYLLABIC ANALYSIS			1.111	1.258	.048	.883	.380
	PHONEMIC ANAL. I			1.035	1.224	.047	.845	.400
	NO ANALYSIS II			2.035	1.500	.085	1.357	.179
	PHONEMIC ANAL. II	.924	3.4234	5.800	1.524	.250	3.806	.000
2	(Constant)			-12.604	5.180		-2.433	.017
	WORD IDENT. (pre-test)	.564	5.6327	.293	.092	.218	3.193	.002
	AGE	.609	5.3619	9.088E-02	.070	.076	1.294	.199
	CONSON. (pre-test)	.797	3.8835	.377	.064	.395	5.902	.000
	PHONOL. (pre-test)	.818	3.6993	.270	.064	.249	4.185	.000
	NO INTERVENTION			-2.035	1.500	-.093	-1.357	.179
	NO ANALYSIS I			-2.328	1.479	-.106	-1.574	.120
	SYLLABIC ANALYSIS			-.924	1.486	-.040	-.622	.536
	PHONEMIC ANAL. I			-1.000	1.440	-.046	-.694	.489
	PHONEMIC ANAL. II	.924	3.4234	3.765	1.370	.163	2.749	.007

Model 1 shows that the intervention had no significant effect on children in Sample I. However, model 2 shows that Phonemic Analysis training was more effective than No Analysis training for Sample II children. As training on Phonemic analysis was significantly more effective for Sample II than for Sample I children, (in spite of being shorter), it is likely that this kind of intervention had enhanced the impact of the information children were receiving in the classroom.

Table5.3-18 shows that this could well have been the case, as the improvement was much higher for five and six year olds in intervention group 6. The differences on the pre-test scores in age group 2 (year 1, about six years old) shows that there was a difference in the initial ability to identify novel words, between the two samples. This was probably due to more classroom activities on reading and phonological analysis provided by the British schools. It is worth noting that the children in Sample II were at the end of the school year, while the children in Sample I were in the middle and this could mean a difference on the amount of systematic activities connected with reading and writing experienced in the classroom. In Sample II, training on phonemic analysis increased children's scores to a higher level than the pre-test scores of the age-group above. In sample I, although the difference between groups did not reach significance, this type of intervention also helped to speed up the development of the capacity to make inferences about graph-phonetic segments.

Table 5.3–18 Gains on Word Identification per intervention group, according to age group.

TRAINING GROUP	AGE GROUP 1 PRE-TEST	1 POST-TEST	1 GAIN	AGE GROUP 2 PRE-TEST	2 POST-TEST	2 GAIN	AGE GROUP 3 PRE-TEST	3 POST-TEST	3 GAIN
1	10.25	9.50	-.75	10.92	12.25	1.33			
2	12.00	12.00	.00	10.85	11.69	.84			
3	15.00	14.00	-1.00	11.38	13.69	2.31			
4	9.50	11.00	1.50	11.71	15.21	3.50			
5	12.40	14.60	2.20	18.50	26.00	7.50	23.14	28.57	5.43
6	12.00	19.50	7.50	13.50	28.17	14.67	21.33	26.33	5.00

5.4 Summary

Table 5.4-1 summarises the results shown in this chapter.

Table 5.4–1 Summary of the results on the individual differences that affected children's progress towards the understanding of the alphabetic system.

			Underpinning skills and Knowledge			Understanding and use of the alphabetic principle.		
			VOWEL RECOGN.	CONSON. RECOGN.	PHONOL. PAIRING	INVENT. SPELLING	ANALOGY SPELLING	WORD IDENTIF.
GAINS			No (p=.20)	Yes (p<.02)	Yes (p<.001)	Yes (p<.001)	Yes (p<.001)	Yes (p<.001)
EXPLANATORY VARIABLES	Control measures	AGE	___	P<.01	n.s.	n.s.	n.s.	p<.01
		WISC DIGITS	___	n.s.	p<.05	n.s.	.000	n.s.
		SCRIPT CONVEN.	___	p<.01	p=.001	n.s.	n.s.	n.s.
	Underpinning skills and knowledge	INITIAL VOWEL RECOGNITION	___	n.s.	n.s.	p<05	n.s.	n.s.
		INITIAL CONSON. RECOGNITION	___	p<.001	p=.001	p=.05	p<.01	p<.001
		PHONOLOGICAL PAIRING (PRE)	___	n.s.	p<.001	p<.05	n.s.	p<.01
		PHONOLOGICAL PAIRING (POST)	___	___	___	p<.05	p<.01	p<.01

Some of the findings of this chapter deserve further discussion:

1) *The strong relationship found between children's early experiences with scripts and their progress in the skills and knowledge that underpin the development of the understanding of the writing system.*

Children's early quest to differentiate scripts from other graphic stimuli and to discover what letters are about, contributes significantly to their knowledge of letter-to-sound correspondences and their capacity to detect phonological identity between different words. These two abilities, in turn, are critical for progress in all the measures that assess children's understanding and use of the alphabetic principle. This result confirms the findings of several studies (see chapter 2) about the importance of early experiences with scripts on the development of literacy.

2) *The different contribution of Initial Vowel Recognition and Initial Consonant Recognition to progress on tasks which measure the understanding and use of the alphabetic system.*

This result supports the suggestion that, for Portuguese speakers, the discovery of the role of consonants within syllables and words is necessary in order to go beyond the syllabic hypothesis. Discovering the "role" of consonants is the same as being able to use the most elementary levels of phonological recoding, such as initial consonant recognition or the use of the initial consonant in recognition.

Initial Vowel Recognition was a good predictor of the spelling activities (invented spelling and analogy spelling), although in Analogy Spelling it was no longer significant when entered together with Initial Consonant Recognition and/or Phonological Pairing. It is interesting to notice that the spelling tasks are those where the gains made by Sample I were greater than the gains of Sample II, after controlling for the differences in the pre-test measures. Considering that, in Sample I, no child in the pre-test and only six children in the post-test had developed beyond the syllabic hypothesis (levels 4 to 6), this suggests that Sample I children actually used their knowledge about the vowels to support their spellings and to make progress through the different levels of the syllabic hypothesis.

3) *The simultaneous but unique contribution of Initial Consonant Recognition and Phonological Pairing to all the tasks that were designed to assess children's understanding of the alphabetic system.*

This supports the claim that all these tasks measure different aspects of the same construct and confirm the findings of previous studies about the simultaneous contribution of letter knowledge and the ability to detect phonological identity to the understanding of the alphabetic principle (see chapter 2).

4) *The powerful concurrent effect of Phonological Pairing.*

The strong concurrent relationship between Phonological Pairing and tasks that assess the understanding of the alphabetic principle suggests that the ability to detect phonological identity is part of this understanding, rather than a pre-requisite for it. This would explain the reciprocity between phonological awareness and literacy found in several studies (see chapter 2).

5) *The effects of intervention*

It is important to stress that, in this study, the intervention was primarily intended to speed up children's progress so that significant changes could be observed.

Different types of intervention were included in order to provide information about the impact of adults' explanations on children's understanding of the writing system. Therefore this study was not designed to compare teaching methods and the conclusions about the effects of intervention cannot be used to support any specific teaching practice without further investigation.

Only a few significant results were observed when investigating the effects of intervention after the differences on all the pre-test measures were controlled. However, the results show that, in general, the intervention improved the progress of Sample I children in Invented Spelling, in spite of this contribution being significant only for the group trained on syllabic analysis, compared to the "no-intervention" group.

For Sample II, the intervention produced a positive effect on Invented Spelling and Word Identification for the "phonemic analysis" group, which improved significantly compared to the "no-analysis" group. On most measures, the "no-analysis" group, in Sample II, showed less progress than the "no-intervention" group in Sample I (after the effects of other variables were controlled).

To understand these results, we have to remember that, at the pre-test, the majority of Sample I children scored at the lowest levels on all the tasks. An inspection of their results on Invented Spelling shows that most of them were at the pre-syllabic level (see chapter 4). Therefore, any increase in the quantity and the quality of their experiences with literacy materials would be likely to help them (albeit slightly) to formulate the syllabic hypothesis. In contrast to Sample I, many Sample II children had already constructed the syllabic hypothesis when they were assessed at the pre-test. The results of the intervention suggest that only the increase in activities involving phonemic analysis helped them to progress within or beyond the syllabic level. However, there was no other "analysis" group in Sample II, to investigate whether the contribution was due to working specifically with phonemes or whether working with any kind of sub-lexical segment would produce the same effect.

In the next chapter, we will consider simultaneously children's performance on Invented Spelling, Analogy Spelling, Word Identification and Phonological Pairing, to investigate whether children's hypotheses about the writing system account for their performance on all the tasks.

6. TOWARDS THE UNDERSTANDING OF THE WRITING SYSTEM

6.1. Introduction

In the previous chapters, the quality of children's orthographic representations (measured by Invented Spelling) and their capacity to make inferences about graph-phonetic segments (measured by Analogy Spelling and Word Identification tasks) were investigated as independent skills. However, it was argued in chapters 2 and 3 that the performance on these tasks was assumed to reflect children's hypotheses about the writing system, or, at least, children's implicit answers to the question "how do scripts represent speech?" If this is true, it should be possible to represent the level of understanding of each child by a profile whose components, or facets, are the child's scores on each task. Moreover, it should be possible to identify developmental levels by grouping together those subjects whose profiles can be accounted for by a single (qualitative) description. In this chapter, we will investigate whether the development of children's understanding of the alphabetic system might be described comprehensively by their performance on the three tasks mentioned above. Moreover, we will investigate whether the child's ability to detect phonological identity should be considered as another component of the child's profile, rather than a pre-requisite to its development. Finally, we will investigate whether different types of intervention produce different developmental patterns.

6.2. Are the Abilities to Analyse, Represent and Make Inferences About Graph-Phonetic Segments Different Aspects of the Same Construct?

Invented Spelling and Analogy Spelling were ordinal measures, so it was not difficult to combine them in order to get a meaningful description of a child's performance on the two tasks. However, Word Identification and Phonological Pairing ranged from zero to forty and the mean was a meaningless score, in qualitative terms. Therefore, both Phonological Pairing and Word Identification were re-scored by replacing the number of correct answers by the number of conditions that the child passed. The criterion for passing a condition was to get three correct answers (out of four items per condition). Therefore, on both Phonological Pairing and Word Identification, the new scores ranged from zero to 10. This was not very informative in qualitative terms, but, at least, it made it possible to have an idea of the child's ability to deal with different types of segments.

Thus, the performance of each child could be summarised on a profile consisting of four digits, each one representing a component (herein after also called facet) of children's understanding of the writing system. The first digit was the score on the Phonological Pairing task (number of passes); the second digit was the score on the Invented Spelling task; the third digit was the score on the Analogy Spelling task and the fourth digit was the score on the Word Identification task (number of passes). Due to missing data, only eighty-six subjects were included in this analysis.

The POSAC (Partial Order Scalogram Analysis with Base Co-ordinates) was used in order to observe whether it was possible to organise groups of children, according to their profiles. The POSAC ordered and mapped the profiles, producing the two-dimensional diagrams showed in figure 6.2-1 (pre-test) and 6.2-2 (post-test).

The profiles located in the Southwest region of the diagram always represent the lowest levels of all the components (or facets) of the construct that is being measured (in this case, the scores on each task, or, in other words, the values of each digit). The profiles located in the Northeast region always represent the highest levels. Therefore, the Southwest-Northeast direction (called joint direction) orders the total scores on the profiles, according to the levels of the construct or behaviour that is being measured. The Southeast-Northwest direction (called lateral direction) shows the non-comparable profiles. What makes two profiles non-comparable is that one profile has a lower score on one facet but a higher score on another facet. Therefore, they are qualitatively different, even when the sum of the scores on all the facets is the same.

In the spatial diagrams produced by the POSAC, the profiles are also mapped in such a way that the diagram can be partitioned in different regions, by tracing lines separating the levels of each component, or facet[1]. Each region combines the profiles that are similar to each other. Therefore, it is possible to define different levels of the development of children's understanding of the writing system, if the diagrams produced by the POSAC represent separate regions which can be clearly distinguished, both quantitatively and qualitatively. If it is not possible to demarcate such regions, we

[1] These regions can have different shapes, which can be interpreted to provide more information about the role of each facet to the overall concept, but a more detailed analysis of the meaning of each shape will be left for next studies.

may infer that the facets we are considering (the capacity to detect phonological identity, the construction of orthographic representations and the ability to make inferences about graph-phonetic segments) are not facets of the same construct (the understanding of the writing system), or are not related in the way we suggest they are.

6.2.1. Identifying groups in the pre-test

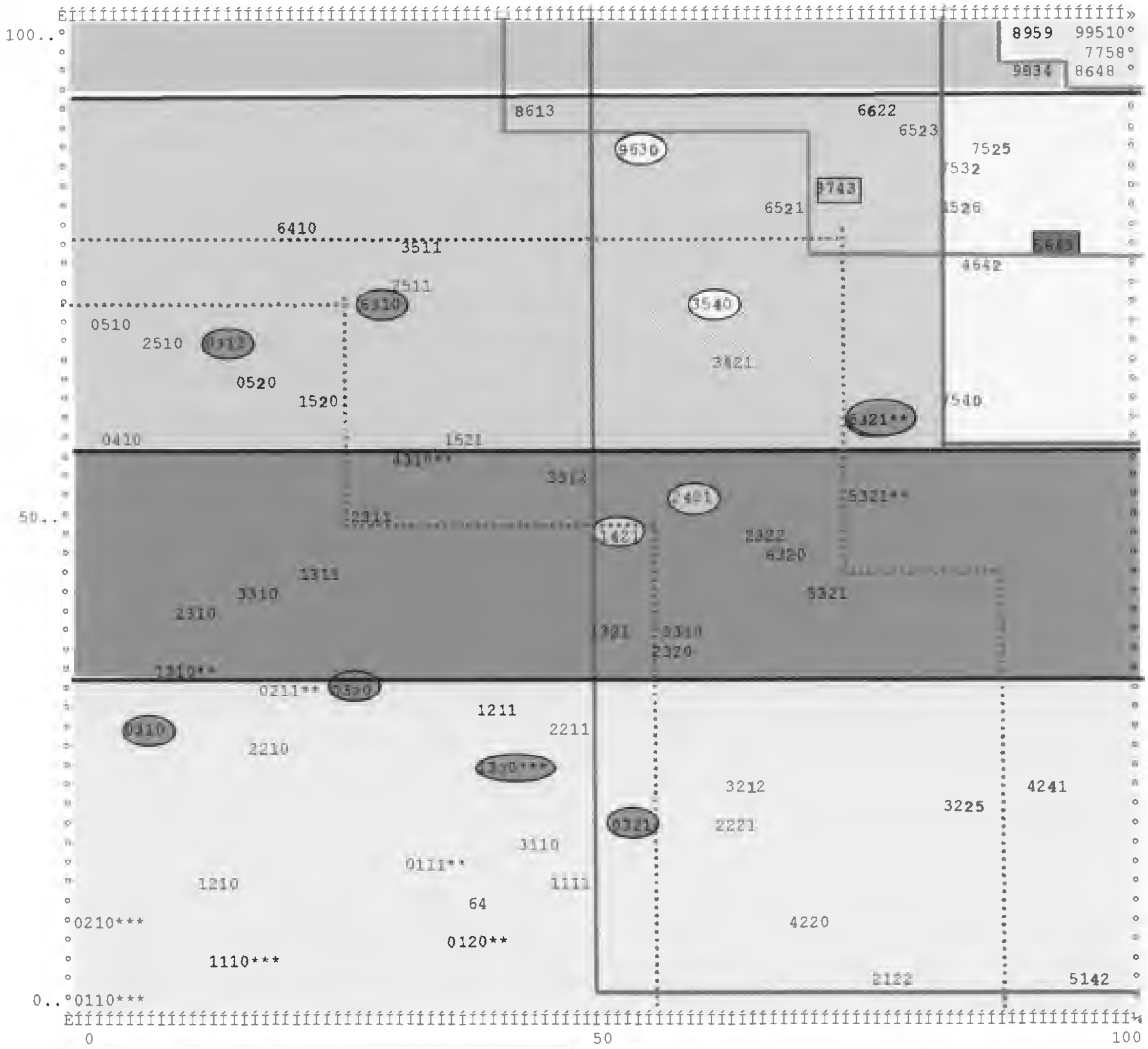
The diagram mapping the pre-test profiles (Figure 6.2-1) shows that the scores on Invented Spelling (2nd digit) define four roughly horizontal regions (separated by the dark green lines, in the plot). These regions comprise (from bottom to top) the scores 0 to 2, 3, 4 to 6 and above 6, respectively.

The scores on Analogy Spelling (3rd digit) define the partition of the diagram in three L-shaped regions, separated by the blue lines. These regions comprise the scores 1, 2 and above 2, respectively, ordered from West to East.

The arrangement of the regions defined by the scores on Invented Spelling and on Analogy Spelling (horizontal and vertical) show that, for scores 1 and 2 on Analogy spelling, the two measures were not related. However, the children with scores above 2 on Analogy Spelling were at least at Level 5 on Invented Spelling. This means that only the children who were able to represent at least one letter correctly in two syllables of most words benefited from the presence of clue-words in Analogy Spelling. There are two exceptions: the subjects who got profiles "4241" and "5142". They took advantage of the presence of clue-words to increase the number of letter-to-sound correspondences, from zero to one, but they still produced pre-syllabic spellings, even with the support of the clue-words.

The dark-red dashed lines demarcate the regions defined by the scores on Phonological Pairing. The partitions show that the children could reach Level 5 on Invented Spelling with very low scores on Phonological Pairing. However, their progress on Analogy Spelling was related to improvement in their ability to detect sound identity between words. It is interesting to notice that the two subjects considered as exceptions in the previous paragraph got relatively good scores on Phonological Pairing. It is likely that their ability to detect sound identity between words helped them to take advantage of the clue-words in Analogy Spelling.

Figure 6.2-1 Spacial diagram of pre-test profiles of children's understanding of the writing system



Invented Spelling:
Turquoise - pre-syllabic
Green - syllabic: representation of the syllable
Yellow - syllabic alphabetic and alphabetic: representation of subsyllabic units.

Profiles:
1st digit - Phonological Pairing
2nd digit - Invented Spelling
3rd digit - Analogy Spelling
4th digit - Word Identification
* number of subjects with the same profile.

Obs: Bold dark blue digits mean a score too high or too low for the level where the profile was mapped.

Pre-test groups, considering the scores on all the variables:

GROUP 1A	LEVEL 1
GROUP 1B	LEVEL 1
GROUP 2	LEVEL 2
GROUP 3	LEVEL 2
GROUP 4	LEVEL 3
GROUP 5	LEVEL 3
GROUP 6	LEVEL 4

Partitions of Invented Spelling

Partitions of Analogy Spelling

Partitions of Word Identification

.... Partitions of Phonological Pairing

The red L-shaped lines on the Northeast region demarcate the areas defined by the scores on Word Identification. This means that high scores on Word Identification are associated with high scores on all the other tasks.

Based on the partitions created by the scores on the four tasks, it is possible to define different groups according to children's understanding of how scripts represent speech.

The first group (in turquoise), hereafter called group 1, contains the pre-syllabic children - the ones who, in their invented spellings, did not show any realisation that there is a relationship between the letters and the sound segments within the word. It was possible two identify two sub-groups within group 1. Sub-group A, the lighter turquoise area in the plot, consists of the children who did not use a single correct letter per word in their invented spellings. The other group (sub-group B, the plain darker turquoise area) consists of the children who managed one correct letter per word in their invented spellings. While these children had come to realise that writing is related to the sound of the words, they still thought that one letter might function as a token for the whole word.

Although a few children in group 1 passed five or six conditions on the Phonological Pairing task, they did not use their phonological skills to make inferences about graph-phonetic segments, either on spelling or on word identification (their maximum score was 2 in both tasks). This confirms that they were not relating letters to phonological segments.

The children who produced syllabic spellings were congregated in the green region of the plot. The area on the left comprises the subjects of group 2, who are still unable to make inferences about graph-phonetic segments, either on spelling or on word identification, although they show some partial syllabic analysis in their invented spellings. Their spellings show fewer letter-to-sound correspondences on Analogy Spelling tasks than on Invented Spelling. This suggests that they are likely to write down the letters whose names they recognise, when a word is pronounced, without actually carrying out a consistent phonological analysis of the word. As this is not a sound phonological strategy, they are confused by the presence of clue-words, adopting a less efficient strategy (or even giving up and writing down any letter).

Children in the lighter green area, on the right, also produced syllabic spellings, but they were not confused by the presence of the clue-words and some of them were even able to take advantage of them. However, the number of children in this area and in the yellow one (which comprises the children who produced syllabic-alphabetic spellings) is too small to allow any further interpretation. It is likely that the spatial diagram of the post-test scores will provide a clearer idea of the conceptions of the children in these regions, as we shall see next.

6.2.2. Identifying groups in the post-test

The spatial diagram of post-test scores is shown in figure 6.2-2. As shown in the legend, the same codes (lines and colours) as in the diagram of pre-test scores were used. The mapping of post-test scores clarifies the developmental changes which occur between the pre-syllabic and the alphabetic conceptions.

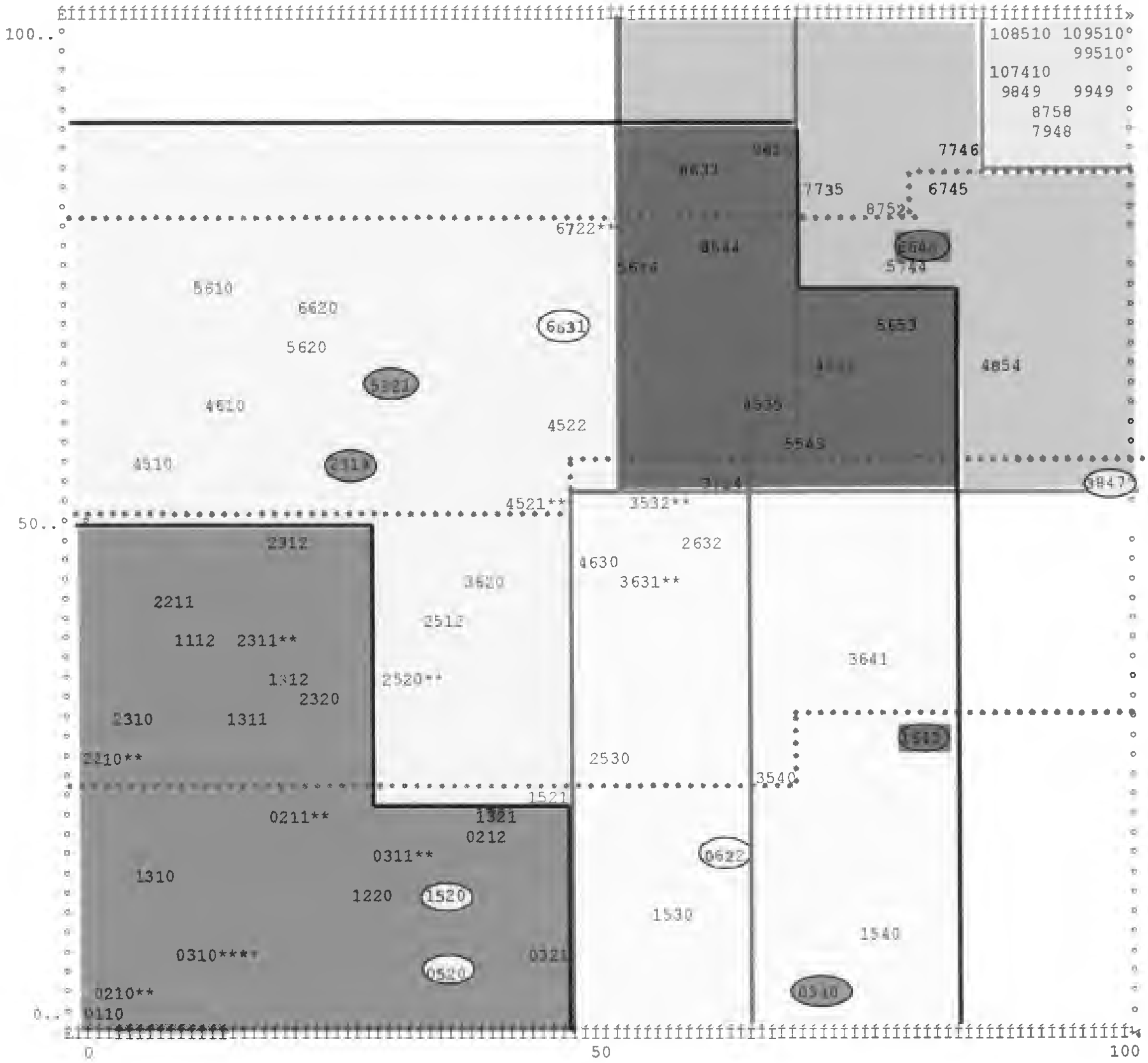
The pre-syllabic children (group 1) are found in the Southwest of the plot, in the region demarcated by the dark green line, which separates scores 1, 2 and 3 from the higher scores on Invented Spelling. In this diagram, the sub-groups 1A and 1B are no longer clearly separated. The children in group 1 achieved maximum scores of 2 on Phonological Pairing, 2 on Analogy Spelling and 1 on Word Identification, confirming that they were not able to analyse the words phonologically.

The green area, which comprises the children that produced syllabic spellings (Levels 4, 5 and 6 on Invented Spelling), may be sub-divided according to their scores on Analogy Spelling and Word Identification.

The children who produced syllabic spellings but did not succeed on making inferences about graph-phonetic segments are found in the top-left area (group 2). It is interesting to notice that many of these children passed on five or six conditions of Phonological Pairing but were unable to relate the sound segments of the spoken word to the letters of the written word.

Qualitatively different from group 2, group 3 (bottom-right green area) combines those children who produced syllabic spellings and were able to take advantage or, at least avoided being confused by, the clue-words on the Analogy Spelling Task. Unlike most subjects in group 2, only one child in group 3 passed more than three conditions ofthe Phonological Pairing Task. However, like the children in group 2, their maximum score on Word Identification task was 2.

Figure 6.2-2 Spacial diagram of post-test profiles of children's understanding of the writing system



Invented Spelling:
Turquoise - pre-syllabic
Green - syllabic: representation of the syllable
Yellow - syllabic alphabetic and alphabetic: representation of subsyllabic units.

Profiles:
1st digit - Phonological Pairing
2nd digit - Invented Spelling
3rd digit - Analogy Spelling
4th digit - Word Identification
* number of subjects with the same profile.

Obs: Bold dark blue digits mean a score too high or too low for the level where the profile was mapped.

Post-test groups, considering the scores on all the variables:

GROUP 1	LEVEL 1
GROUP 2	LEVEL 2
GROUP 3	LEVEL 2
GROUP 4	LEVEL 3
GROUP 5	LEVEL 3
GROUP 6	LEVEL 4

Partitions of Invented Spelling

Partitions of Analogy Spelling

Partitions of Word Identification

.... Partitions of Phonological Pairing

The top right corner of the green area (plain green) combines all the children who produced syllabic spellings and were already able to make some inferences about graph-phonetic segments. Their scores on Phonological Pairing ranged from 4 to 9. They scored 3 or more on Analogy Spelling and passed between three and six conditions on the Word Identification task, showing that they were able to analyse the words phonologically (not necessary at the phonemic level) and to relate the phonological segments to the letters within the word, at least partially. The profiles in this area were classified as group 4.

The profiles included in the darker yellow area are very similar to the ones in the plain green area. The difference is that the children in this region produced spellings at levels 7 and 8. This means that they were able to represent some sub-syllabic units. Moreover, most children in the yellow area scored 5 or 4 on Analogy Spelling, while most children in the green area scored only 3. Children in this area comprised group 5.

Finally, the lighter yellow area contains the profiles of the children who had higher scores on all the tasks (the minimum scores were as follows: Phonological Pairing: 7; Invented Spelling: 7; Analogy Spelling: 4; Word Identification: 7). The performance of these children showed that they had grasped the alphabetic principle and some of them were already aware of some orthographic features, which contradict the purely phonetic relationship between sounds and letters. The children whose profiles fell in this region comprised group 6.

In summary, the POSAC showed that it is possible to distinguish at least six groups reflecting different degrees of development from a non-analytic conception to the understanding of the alphabetic principle. However, for a qualitative description of each group it is necessary to have a clearer idea of the meaning of the scores on both the Phonological Pairing and the Word Identification tasks. This will be investigated in the next section.

6.2.3. Untangling the differences between groups on Phonological Pairing and Word Identification

The Phonological Pairing and Word Identification tasks comprised several conditions, with different degrees of difficulty. Therefore, it was likely that the conditions on which children were successful would tell us something about the types of segments they were able to analyse at each developmental level. Was there any trend towards passing or failing one specific condition, according to the group in which children were included?

Tables 6.2-1 and 6.2-2 show the proportion of passes on each condition of the Phonological Pairing task and the Word Identification task, respectively. The binomial test was used to investigate whether the trend towards passing or failing each condition was significant, although we would not expect most results to be significant in groups 4, 5 and 6, due to the small number of subjects.

Table 6.2–1 Proportion of passes per condition, per group, on Phonological Pairing task (post-test)

Phonological Pairing task	Group 1 (N=30)	Group 2 (N=19)	Group 3 (N=12)	Group 4 (N=10)	Group 5 (N=6)	Group 6 (N=9)
Initial Syllable Full Contrast	.30 (p=.045)	.84 (p=.004)	.83 (p=.039)	.80 (p=.109)	.83 (p=.219)	1.00 (p=.004)
Initial Syllable Partial Contrast	.03 (p<.001)	.21 (p=.019)	.33 (p=.388)	.70 (p=.344)	.50 (p=1.00)	.78 (p=.180)
Initial Onset Different Articulation	.13 (p<.001)	.32 (p=.167)	.42 (p=.774)	.60 (p=.754)	.67 (p=.688)	.89 (p=.039)
Initial Onset Same Articulation	.03 (p<.001)	.16 (p=.004)	.17 (p=.039)	.40 (p=.754)	.33 (p=.688)	.78 (p=.180)
Initial Phoneme	.03 (p<.001)	.11 (p=.001)	.25 (p=.146)	.50 (p=1.00)	.50 (p=1.00)	.89 (p=.039)
Final Syllable Full Contrast	.07 (p<.001)	.53 (p=1.00)	.25 (p=.146)	.50 (p=1.00)	.83 (p=.219)	.89 (p=.039)
Final Syllable Partial Contrast	.03 (p<.001)	.16 (p=.004)	.00 (p<.001)	.20 (p=.109)	.50 (p=1.00)	.78 (p=.180)
Final Stressed Rime	.20 (p=.002)	.53 (p=1.00)	.42 (p=.774)	.70 (p=.344)	.83 (p=.219)	.89 (p=.039)
Final Unstressed Rime	.00 (p<.001)	.11 (p=.001)	.08 (p=.006)	.50 (p=1.00)	.67 (p=.688)	.89 (p=.039)
Final Phoneme	.07 (p<.001)	.53 (p=1.00)	.08 (p=.006)	.40 (p=.754)	.50 (p=1.00)	.56 (p=1.00)

The children within group 1 tended to fail all the conditions of the Phonological Pairing task. This tendency was significant for all the conditions. In groups 2 and 3, the children were likely to pass on "initial syllable - full contrast", but not on the other conditions. Group 4 children were likely to succeed on detecting phonological identity between words which shared the initial syllable, or the initial onset (with different articulation point), as well as on words sharing the final stressed rime (rhyming words). However, they were likely to fail on "initial onset - same articulation point", as well as on "final syllable - partial contrast" and "final phoneme". Due to the small number of subjects in this group, these tendencies did not reach significance. Group 5 children showed a greater ability to detect sound identity between final segments and they tended to succeed not only on detecting the identity of stressed rimes, but also of unstressed rimes and whole final syllables (with full contrast). They were still likely to fail on detecting the identity of initial onsets, when the contrasting words started with consonants with the same articulation point. Finally, group 6 children tended to succeed on all the conditions. In spite of the small number of subjects, this tendency reached significance for all segments except initial and final syllables with partial contrast, initial onset with the same articulation point and final phoneme.

Table 6.2–2 Proportion of passes per condition, per group, in Word Identification task (post-test)

Word Identification task	Group 1 (N=30)	Group 2 (N=19)	Group 3 (N=12)	Group 4 (N=10)	Group 5 (N=6)	Group 6 (N=9)
Initial Syllable Full Contrast	.07 (p<.001)	.32 (p=.167)	.17 (p=.039)	.80 (p=.109)	1.00 (p=.031)	1.00 (p=.004)
Initial Syllable Partial Contrast	.13 (p<.001)	.05 (p<.001)	.17 (p=.039)	.40 (p=.754)	.33 (p=.688)	1.00 (p=.004)
Initial Onset Different Articulation	.10 (p<.001)	.11 (p=.001)	.08 (p=.006)	.30 (p=.344)	.33 (p=.688)	.89 (p=.039)
Initial Onset Same Articulation	.07 (p<.001)	.05 (p<.001)	.00 (p<.001)	.20 (p=.109)	.50 (p=1.00)	.78 (p=.180)
Initial Phoneme	.10 (p<.001)	.21 (p=.019)	.08 (p=.006)	.70 (p=.344)	.67 (p=.688)	1.00 (p=.004)
Final Syllable Full Contrast	.00 (p<.001)	.11 (p=.001)	.00 (p<.001)	.30 (p=.344)	.50 (p=1.00)	1.00 (p=.004)
Final Syllable Partial Contrast	.00 (p<.001)	.00 (p<.001)	.08 (p=.006)	.10 (p=.021)	.17 (p=.219)	.89 (p=.039)
Final Stressed Rime	.10 (p<.001)	.05 (p<.001)	.00 (p<.001)	.40 (p=.754)	.00 (p<.031)	.56 (p=1.00)
Final Unstressed Rime	.07 (p<.001)	.16 (p=.004)	.17 (p=.039)	.50 (p=1.00)	.50 (p=1.00)	.89 (p=.039)
Final Phoneme	.00 (p<.001)	.05 (p<.001)	.08 (p=.006)	.10 (p=.021)	.33 (p=.688)	1.00 (p=.004)

The results on Word Identification showed that groups 1, 2 and 3 were unlikely to succeed on making inferences about graph phonetic segments and this tendency was significant for all the segments (except “initial syllable - full contrast” in group 2). Some children in groups 4 and 5 succeeded in using the initial syllable with full contrast and the initial phoneme, as a cue to identify novel words, but this tendency was not very strong, due to the small number of children in these groups. They were likely to fail all the other conditions, especially the final syllable with partial contrast and the final phoneme. (group 4) and the final stressed rime (group 5). Only the children belonging to group 6 were likely to succeed on most conditions, but were still confused by consonants with the same articulation point. There is no apparent reason why children had difficulty with the final stressed rime, which was one of the easiest segments in Phonological Pairing task.

6.3. *Towards the Understanding of the Alphabetic Principle*

Being able to assign the children to different groups, according to their ability to analyse, represent and make inferences about graph-phonetic segments does not necessary imply that these groups represent developmental levels. The definition of developmental levels involves the idea of differences between groups that are simultaneously quantitative and qualitative. Moreover, it rules out the possibility of regression from a more advanced to a lower level and it is preferable (although not absolutely necessary) that most children go through all the levels, without skipping any steps.

As mentioned above, the difference between group 2 and group 3 was more qualitative than quantitative: group 2 had higher scores on Phonological Pairing, whereas group 3 had higher scores on Analogy Spelling. This difference did not seem to reflect an evolution in children's hypotheses about the writing system, as children in neither group were clear about the relationship between letters and sounds. Both used single letters to represent the sound of some syllables (mostly initial and final) and both failed to realise (or, at least, to take advantage of the understanding) that two words with common phonological segments also contain common graphic segments.

Similarly, the difference between groups 4 and 5 was mainly quantitative. Both groups, in spite of having problems analysing and representing syllables beyond their boundaries, showed an understanding that the orthographic representations they produced were not complete and tried to use the clue-words to improve them. As a whole, group 5 performed better on all the tasks, but, again, this seemed to be rather a refinement of children's abilities than an evolution of their conceptions about the writing system. A larger number of subjects in both groups, especially in the pre-test, would be needed to be sure that these quantitative differences did not involve a different conception of how scripts represent speech. From the present data, it would appear that they did not.

Table 6.3-1 shows how children changed between groups, from pre-test to post-test and Table 6.3-2 shows the same data if the groups were collapsed to constitute developmental levels that differ both quantitatively and qualitatively, as suggested above (Level 2 = groups 2+3; Level 3 = groups 4+5).

Table 6.3–1 Changes between groups, from pre- to post-test

	group	POST-TEST 1	2	3	4	5	6	Total
PRE-TEST	1	28	14	8	4	2		56
	2	1	5	4	3	3	1	17
	3		1		3		1	5
	4					1	1	2
	5						2	2
	6						4	4
	Total	29	20	12	10	6	9	86

Table 6.3–2 Changes between Levels, from pre- to post-test

	Level	POST-TEST 1	2	3	4	Total
PRE-TEST	1	28	22	6		56
	2	1	10	9	2	22
	3			1	3	4
	4				4	4
	Total	29	32	16	9	86

Level 2 = group 2 + group 3
Level 3 = group 4 + group 5

The only child who regressed from Level 2 to Level 1 was likely to have been misclassified in the pre-test. The child's profile, "1520", shows a score of 5 on Invented spelling, which is too high if we take into account the scores on the other tasks. On the post-test, the child's profile was "0321". The score of 3 on Invented Spelling is more consistent with the other scores, showing that the child was not analysing the words phonologically. It is likely that the two correct matches per word on invented spelling, in the pre-test, were produced by chance.

Of course, when the groups are collapsed, the number of steps in the developmental process between pre- and post-test is reduced, decreasing considerably the number of subjects who skipped one step (from 23 to 8 subjects). This suggests that groups 2 and 3 as well as groups 4 and 5 should be considered as sub-levels within the same developmental level. However, it is not sensible to draw any conclusion with only four children in groups 4 and 5 initially.

6.3.1. Grasping the alphabetic principle: a developmental process

The results presented above suggest that detecting phonological identity, constructing orthographic representations of words and making inferences about graph-phonetic segments are components (or facets) of the same construct - the understanding of the alphabetic principle. Therefore, based on the results on tasks that assessed children's performance on these components, it was possible to identify four developmental levels for children's construction of the alphabetic principle. The assignment of the children to the different levels was based on the mapping of children's profiles produced by the POSAC. A Discriminant Function Analysis, having Phonological Pairing, Invented Spelling, Analogy Spelling and Word Identification as independent variables, confirmed that 98.9 % of the cases in the pre-test and 97.7 % in the post-test were correctly classified. Tables 6.3-3 and 6.3-4 show the number and the proportion of cases correctly classified, per level.

Table 6.3–3 Number and proportion of cases correctly assigned to pre-test levels

ACTUAL	PREDICTED (PRE-TEST)				
	N	1	2	3	4
1	57	57 100%			
2	24	1 4.2%	23 95.8%		
3	5			5 100%	
4	4				4 100%

Table 6.3–4 Number and proportion of cases correctly assigned to post-test levels

ACTUAL	PREDICTED (POST-TEST)				
	N	1	2	3	4
1	29	29 100%			
2	32	1 3.1%	30 93.8%	1 3.1%	
3	16			16 100%	
4	9				9 100%

Another question is raised when considering the measures mentioned above as components, or facets, of the same construct, instead of independent skills: do the predictors of each component (investigated in chapter 5) also predict children's assignment to a developmental level?

Several Discriminant Function Analyses were carried out to investigate this question. The best solution was found by considering as predictors of post-test levels the following variables:

- Pre-test developmental level (standardised coefficient = .62)
- Initial Consonant Recognition - pre-test (standardised coefficient = .68)
- WISC Digits (standardised coefficient = .15)
- Age (standardised coefficient = .12)

These variables, considered together, predict the post-test level of 70.9% of the cases. The number and proportion of cases correctly (and incorrectly) predicted, per level, is shown in Table 6.3-5.

Table 6.3–5 Number and proportion of cases correctly predicted by the explanatory variables, per level

ACTUAL	PREDICTED				
	N	1	2	3	4
1	29	22 75.9%	7 24.1%		
2	32	8 25%	22 68%	2 6.3%	
3	16		5 31.3%	10 62.5%	1 6.3%
4	9			2 22.2%	7 77.8%

Therefore, although further research is needed to confirm these conclusions, it is now possible to suggest that, as they move along the developmental process from a non-analytic conception to the discovery of the alphabetic principle, children pass through different levels defined by their capacity to analyse, represent and make inferences about graph-phonetic segments. These developmental levels can be described as follows:

Level 1 - At this level, children do not show any ability to analyse words phonologically. Some were able to detect the phonological identity between two words sharing the initial syllable, if there were no other phonological similarities between the stimulus word and the contrasting words; a few were able to identify oxytone rhyming words. However, they did not use these abilities to perform the other tasks, showing that they had not grasped the relationship between the phonological segments of the spoken word and the letters within the written word. This prevented them from benefiting from the support provided by the clue words, in Analogy Spelling and Word Identification. Similarly, even when they used one correct letter per word in their invented spellings (group 1-B), this letter was used as a token of the whole word rather than as a representation of a phonological segment (pre-syllabic hypothesis).

Level 2 - At this level, children were likely to succeed on detecting phonological identity of the initial syllable (with full contrast) and some were able to detect the similarity of more salient final segments, such as rhymes and final syllables with full contrast. They were able to use one correct letter in two syllables of the words, probably by adopting a strategy of segmenting the words (syllabically) in search of the sounds that matched the letters they knew (probably based on the names of the letters). This shows that the children had started paying attention to the sounds within the words and they had realised that the letters represented these sounds. However, they had not yet constructed stable (even if incomplete) orthographic representations of phonological segments, as shown by their tendency to fail on all the conditions of Word Identification Task. Therefore, they did not seem to have realised that the sound segments shared by different words are likely to be represented by the same string of letters.

It was possible to distinguish two sub-levels within this level (groups 2 and 3), according to children's performance on Analogy Spelling. In contrast to group 2, the children in group 3 were very confident about their spelling hypotheses and most stuck to them even when support was available from the clue-words. They used the clue-words to confirm their spellings, by searching for the letters they intended to use. A few children did derive benefit from the availability of the clue-words, increasing the number of syllables with correct letter-to-sound matches, probably using the clue-words as letter banks, which helped them to recall the shapes of the letters. Group 3 comprised children from Sample I, who relied on the match between the names of the vowels in Portuguese and their sounds to represent each syllable by its corresponding vowel. Sample II children did not adopt this strategy, probably because they knew the names of the vowels in English and not in Portuguese. Therefore, the qualitative differences between group 2 and group 3 were probably due to the specific features of the orthographies they were being taught.

Level 3 - The children at this level showed that they had realised that the words which share sound segments also share graphic segments. They were likely to use at least one correct letter per syllable in most words, in their invented spellings, so they could be considered as fully syllabic or syllabic-alphabetic. Most were aware of the incompleteness of their spellings and were able to take advantage of the clue-words to increase the number of correct letter-to-sound matches. Most children were able to take into account the most salient phonological segments, such as "syllables - full contrast" (initial and final), and rhymes, to detect phonological identity and to identify novel words. Some relied on articulatory cues to detect initial onsets (with different articulation) or to identify novel words based on the initial phoneme. However, they had trouble paying attention to more than one letter or phonological segment at a time.

It was possible to identify two groups within this level (groups 4 and 5). Group 5 differed from group 4 mainly because the children already used one correct letter per sub-syllabic unit (onset or rime), at least in some syllables, in their invented spellings and they were more capable of detecting phonological identity between final segments (syllables with full contrast and rimes). Some children in this group could overcome some orthographic difficulties by identifying the correct graphic segments within the clue-words.

Level 4 - The children in this level already used at least one correct letter per sub-syllabic unit in most syllables. They were able to use the clue-words to improve their spellings by increasing the number of correct letter-to-sound matches or overcoming orthographic difficulties. They also tended to succeed when using graphic-phonetic cues to identify novel words. This tendency was significant for all conditions except initial onset, when the contrasting words started with the same articulation point, and final stressed rime. The difficulty of dealing with onsets with the same articulation point suggests that most children in this group still relied on articulatory features to identify the sound value of the consonants. Therefore, at least for consonants, the onset of the "amalgamation" process is likely to require the mediation of these articulatory features.

It is interesting to notice that, in contrast to the other groups, the children in this group tended to get the same or even slightly better scores on Word Identification than on Phonological Pairing. This suggests that these children were resorting to the mental orthographic representation of sound segments to carry out their phonological analysis, at least for the more complex (or less salient) ones, such as syllables with partial contrast (both initial and final) and final phonemes (consonants). The construction of orthographic representations renders the phonemes concrete, making them easier to manipulate.

6.3.2. The kick-start of phonological recoding

Initial Consonant Recognition measures children's knowledge of letter-to-sound correspondences when the letter is at the beginning of the word, which is different from just sounding the letters. It also requires children to have understood that the letters match sounds and are not tokens for words: if "B" is for ball it could not be the first letter of other words presented in the task. Therefore, deciding whether a word begins with a specific letter involves a very elementary level of partial phonological recoding, probably the same level that allows children to use initial consonants for learning and recognising words with a high degree of redundancy.

Since Initial Consonant Recognition was a good predictor of the performance on the other tasks, it is interesting to investigate how the performance on this task is related to the development of children's understanding of the alphabetic principle, in particular to their ability to make inferences about graph-phonetic segments.

Table 6.3-6 shows the number of children who scored below and above chance on Initial Consonant Recognition, according to the four suggested developmental levels.

Table 6.3–6 Number of children who scored below and above chance on Initial Consonant Recognition, according to the level of understanding of the writing system

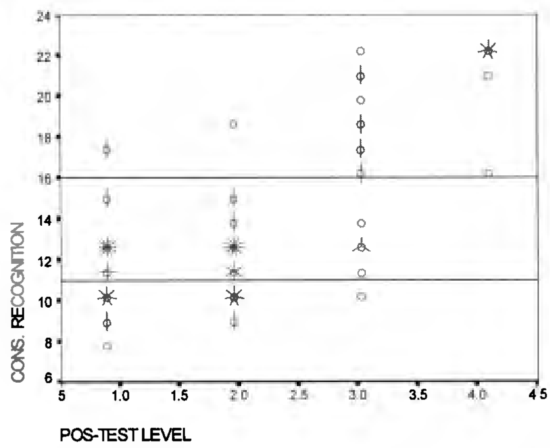
		Number of correct items in Initial Consonant Recognition					
		Pre-test			Post-test		
		40 or less p = n.s.	Between 41 and 45 $P < .05$	46 or more $p < .001$	40 or less p = n.s.	Between 41 and 45 $P < .05$	46 or more $p < .001$
Pre-test levels	**1**	51	4	2			
	2	18	1	5			
	3	0	0	5			
	4	0	0	4			
	Total	69	5	16			
Post-test levels	**1**	30	0	0	28	1	1
	2	28	3	0	27	3	1
	3	8	2	6	6	2	8
	4	0	0	9	0	1	8
	Total	66	5	15	61	7	18

In spite of having been classified at Level 1 in the pre-test, six children scored above chance on Initial Consonant Recognition. However, three of them scored below chance in the post-test, which suggests that they might have achieved a high initial score by chance. The three remaining children progressed to Level 3 in the post-test. All the children who were classified in Level 2 in the pre-test and scored above chance on Initial Consonant Recognition, also progressed to Level 3 or 4 in the post-test. These results confirm that the performance on Initial Consonant Recognition is a good predictor of the development of the understanding of the alphabetic principle. Being able to decide whether a word begins with a specific consonant helps children to get beyond Level 2. However, this does not mean that this ability is essential for children to reach Level 3, as it is possible to reach this Level and still score below chance on Initial Consonant Recognition, as happened to six children (about 38% of children in Level 3), in the post-test.

Figure 6.3-1 shows more clearly the relationship between Initial Consonant Recognition and children's understanding of the alphabetic system.

The measure of consonant recognition considered in this analysis (herein after called CONSREC) was obtained by adding up the scores on the "CV syllable" and the "CV incorrect" condition of Initial Letter Recognition task. We used only the "cleanest" conditions, which were the ones with no extra difficulties, such as articulation point, the name of the letter or syllable complexity. Both the "correct" and the "incorrect" conditions were considered, because some children used only circles (the mark for "correct") and other children used only crosses (the mark for "incorrect") on all the items. Therefore, a child who used only circles got a score of 11 (which is the number of items) on the CV syllable condition and a score of zero on the CV incorrect condition. The opposite happened to the children who used only crosses. Thus, from 22 "false-true" items, 11 is the chance level and 16 is the cut-off which defines the "significantly above chance" level.

Figure 6.3–1 Scores on Initial Consonant Recognition in CV syllables (CONSREC) per level of understanding of the alphabetic system



As can be seen in the scatterplot, all the children at Level 4 scored significantly above chance, confirming that they had mastered letter-sound correspondence, at least for initial consonants in CV syllables. It is interesting to notice that the subject who scored 16 is the same one who was slightly out of place on the POSAC diagrams due to a score of only 3 on the Phonological Pairing task.

Four children who scored below 16 at Level 3 belonged to Sample I and the two remaining children attended the reception class in one of the schools in London. Therefore, we can assume that these children had not received much instruction on letter-sound correspondence by the time the data collection was carried out. This suggests that understanding of the alphabetic system may improve up to Level 3, regardless of the knowledge of letter-sound correspondence, but this knowledge is probably necessary to go beyond this level and perhaps to progress within it. In fact, only two children who scored below 16 were classified in group 5, which means that they were able to use the few consonants they knew to produce syllabic-alphabetic spellings. Thus, for the majority of children, insufficient knowledge of letter-sound correspondences probably prevented them from representing sub-syllabic units in their invented spellings (or, in other words, going beyond group 4).

On the other hand, it is likely that the understanding of the alphabetic system achieved at Level 3 enables children rapidly to acquire an increasing knowledge of letter-sound correspondences, by making inferences about the sound of graphic segments from known words.

The results presented above show that a few children could make use of analogies both in spelling and in word identification in spite of lacking phonological recoding skills. Therefore, they could infer the sound of a segment from a known word. Was this ability restricted to certain types of graph-phonetic segments?

Table 6.3-7 shows the performance of children at Levels 3 and 4 on the different conditions of Word Identification task, according to their performance on the measure of consonant recognition in initial CV syllables, described above (CONSREC).

Table 6.3–7 Performance of children at Levels 3 and 4 on all the conditions of Word Identification task, according to their scores on CONSREC

CONDITIONS OF WORD IDENTIFICATION TASK	LEVEL 3				LEVEL 4	
	CONSREC <16		CONSREC >15		CONSREC >15	
	n=6		n=10		n=9	
	n	%	n	%	n	%
Initial syllable-full contrast	5	*83*	9	*90*	9	*100*
Initial syllable-partial contrast	1	*17*	5	*50*	9	*100*
Initial onset-different articulation	3	*50*	2	*20*	8	*89*
Initial onset - same articulation	2	*33*	3	*30*	7	*78*
Initial phoneme	3	*50*	8	*80*	9	*100*
Final syllable-full contrast	2	*33*	4	*40*	9	*100*
Final syllable - partial contrast	2	*33*	0	*00*	8	*89*
Final stressed rime	0	*0*	4	*40*	5	*56*
Final unstressed rime	3	*50*	5	*50*	8	*89*
Final phoneme	1	*17*	2	*20*	9	*100*

The results confirm that some children with a low knowledge of letter-sound correspondences, at Level 3, succeeded on several conditions of Word Identification (three to five, according to the POSAC diagram of post-test scores). The condition where this occurred more frequently was the "initial syllable - full contrast", but the small number of children does not allow us to draw any firm conclusions. However, we might suggest two factors that might be involved in children's performance: the difficulty to discriminate the correct graphic segment within the clue words and the difficulty to detect phonological identity between the clue-word and the target word. In this sense, initial syllables should be the easiest segments, followed by single-letter segments at the boundaries of the word (especially in the initial position), which could be detected by using articulatory cues. Further research is needed to confirm this suggestion.

Table 6.3-7 also shows that many children, even at Level 4, scored significantly above chance on CONSREC and yet failed some conditions of Word Identification. It is possible that the children who were more capable of using phonological recoding tried to associate the cue-segment with the target word directly, without following the longer path required by the use of the analogy with the clue-word (see section 3.5.3.3.c).

Therefore, these analyses suggest that, regardless of letter knowledge, children at Level 3 are, to some extent, capable of making inferences about graph-phonetic segments, which enable them to succeed when using analogies on word identification. This does not mean that children use this capacity spontaneously, in most situations. It is possible that they need to be encouraged to take advantage of this capacity to increase their knowledge of letter-sound correspondences, which they need to go beyond Level 3.

6.3.3. Effects of reader's explanations on the evolution of children's conceptions about the writing system

The POSAC was used to map the pre- and the post-test profiles, presenting the changes on each child's profile, according to intervention group. The changes were represented by arrows. The arrows following the Southwest-Northeast direction show that there was an improvement on all the tasks, while the arrows following the opposite direction (Northeast-Southwest) show a decline in all the tasks. The other directions show that there was an improvement in some tasks but not in the others.

Figures 6.3-2 to 6.3-5 show the changes of the children who were at Level 1 in the pre-test and Figures 6.3-6 to 6.3-8 show the changes of the children that scored at higher levels in the pre-test.

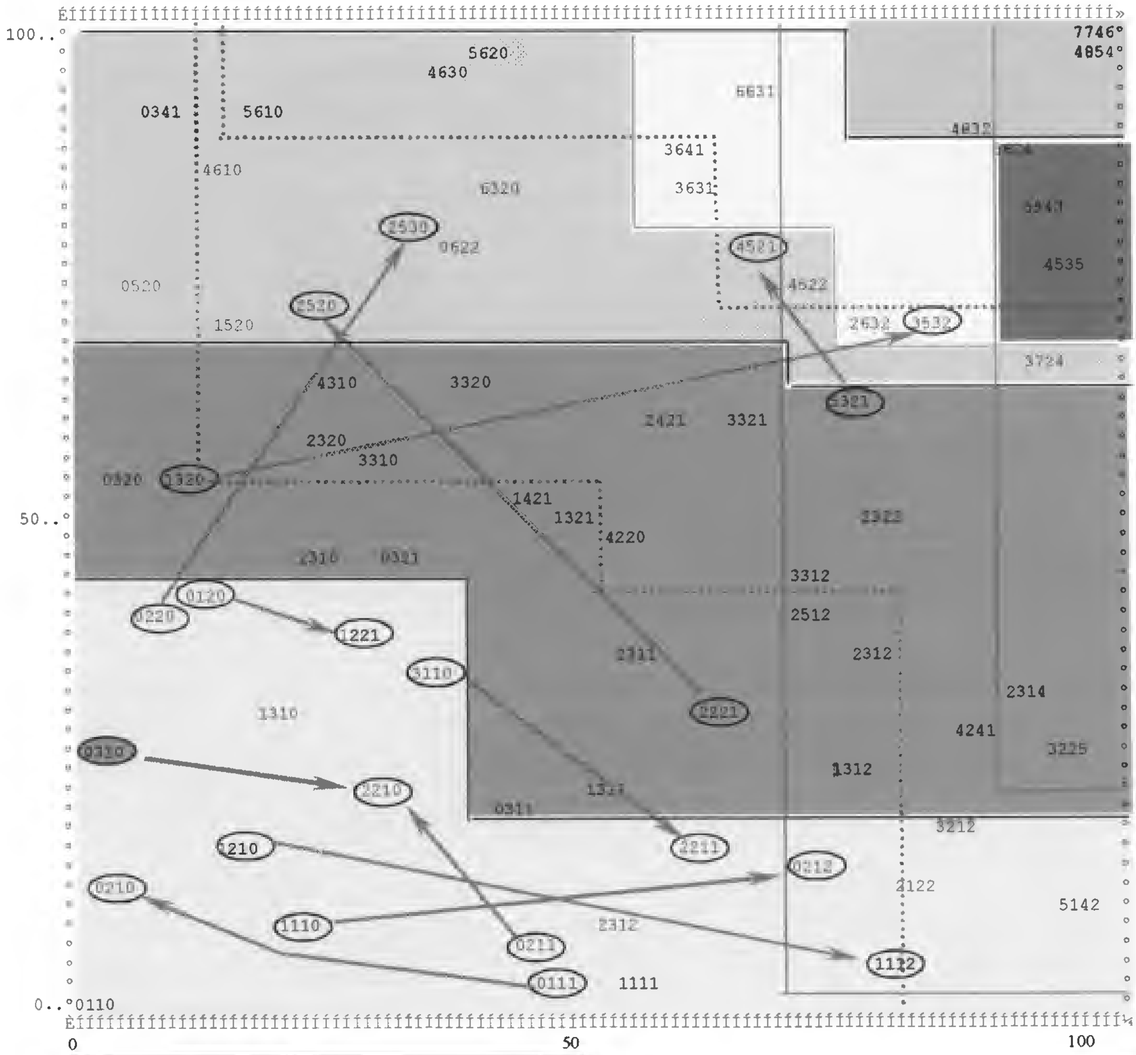
The first thing we notice when examining the diagrams is that the arrows follow different directions. This shows that the process of development is not homogeneous: in some children the development is "pulled" by one component, for example, phonological pairing, while in other children it is "pulled" by another component, for example, invented spelling. Therefore, it is not possible to identify one component as being a pre-requisite for the development of the other components. For example, the children who had higher scores on Phonological Pairing, at the pre-test, were no more likely to improve their initial scores than their counterparts with lower scores on Phonological Pairing who started at the same level and received the same kind of training.

Of course, the weight of each component depends on the features that distinguish the different levels. For example, by definition, the difference between Level 1 and Level 2 was the performance on Invented Spelling, so this was the only relevant component producing change between these two levels.

The "no intervention" group produced the smallest rate of improvement, from Level 1 to Level 2 (Figure 6.3-2), mainly because the children in group 1-A did not improve on Invented Spelling. Therefore, the extra amount of experience with written materials provided by the intervention (of any type) was enough to benefit the children at the lowest level. This means that increasing children's experiences with written materials allows them to realise that there is a relationship between the sounds within the spoken words and the letters of the written words, even when no explicit information about this relationship is offered. This agrees with the findings presented in chapter 5, of a connection between the familiarity with graphic conventions of scripts and both Phonological Pairing and Initial consonant recognition.

Although the largest proportion of children moving from Level 1 to Level 2 was found in the "no-analysis" groups, the diagram of the "phonemic analysis" groups (Figure 6.3-5) displays the greater proportion of arrows following the Southwest-Northeast direction. This means that the children in these groups tended to improve on all the tasks simultaneously. Somehow, the training on phonemic analysis helped them to integrate different pieces of information about the writing system. This is probably why this group showed a better rate of improvement from Level 2 (Figure 6.3-8), as well as a greater number of subjects skipping Level 2 or Level 3. To move beyond Level 2 and Level 3, towards a better understanding of the alphabetic principle, children must improve on all the measures and not only on Invented Spelling. Therefore, receiving explicit information about how letters represent the sounds within each word helped the children to get beyond the syllabic hypothesis. This was clearer for Sample 1 children because they received very little or no information about the sound value of the consonants, outside the experimental settings. However, further research with a larger number of children is necessary to confirm this trend.

Fig 6.3-2 Spatial Diagram showing the changes of the children from the "no intervention" group who started at Level 1



Invented Spelling:
Turquoise - pre-syllabic
Green - syllabic: representation of the syllable
Yellow - syllabic alphabetic and alphabetic: representation of subsyllabic units.

Profiles:
1st digit - Phonological Pairing
2nd digit - Invented Spelling
3rd digit - Analogy Spelling
4th digit - Word Identification
* number of subjects with the same profile.

Obs: Bold dark blue digits mean a score too high or too low for the level where the profile was mapped.

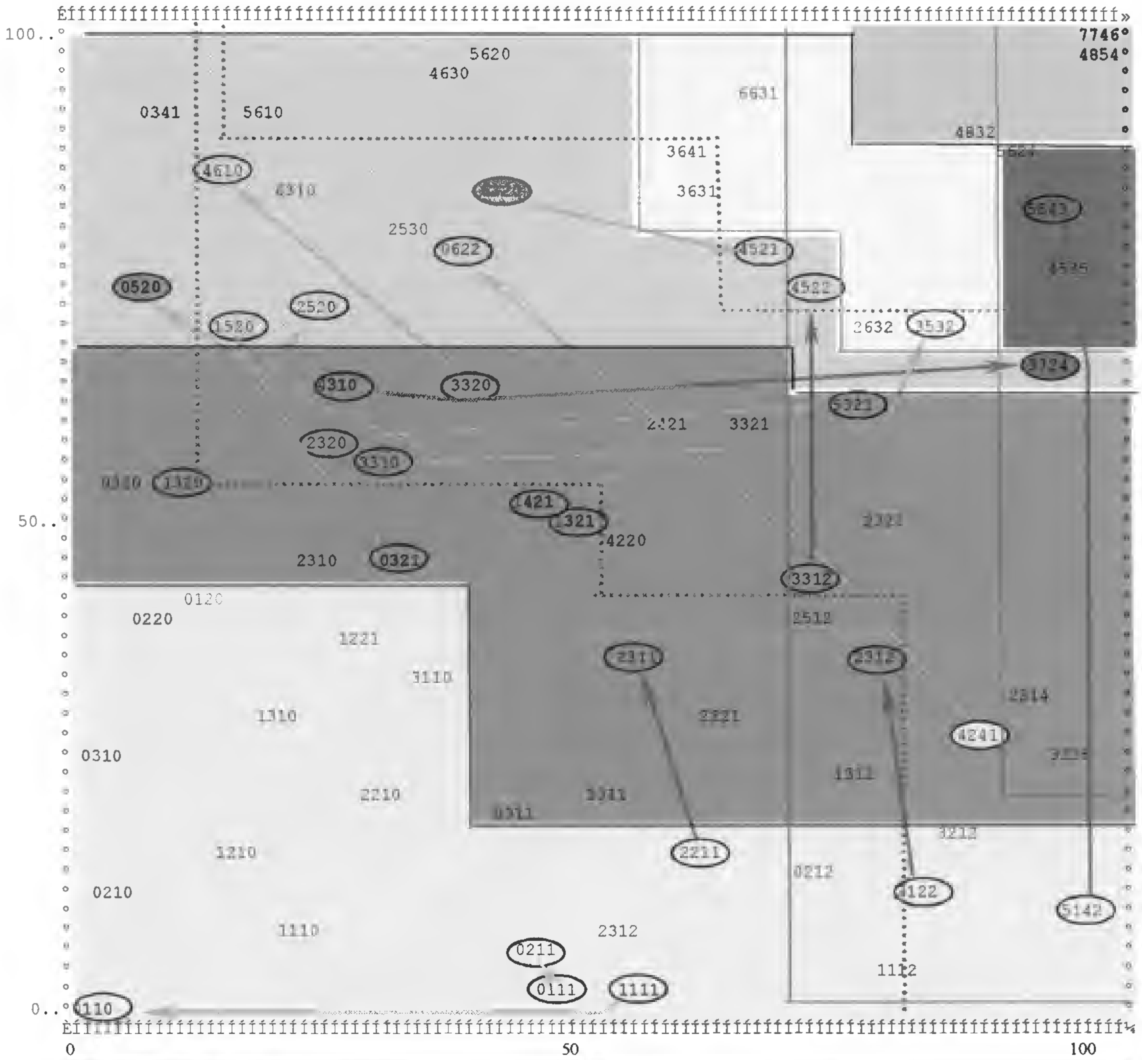
Developmental groups:

GROUP 1A	}	LEVEL 1
GROUP 1B		
GROUP 2	}	LEVEL 2
GROUP 3		
GROUP 4	}	LEVEL 3
GROUP 5		
GROUP 6		LEVEL 4

Partitions of Invented Spelling
Partitions of Analogy Spelling
Partitions of Word Identification
...... Partitions of Phonological Pairing

Intervention Groups:
Group 1

Fig 6.3-3 Spatial Diagram showing the changes of the children from the "no analysis" groups who started at Level 1



Invented Spelling:
Turquoise - pre-syllabic
Green - syllabic: representation of the syllable
Yellow - syllabic alphabetic and alphabetic: representation of subsyllabic units.

Profiles:
1st digit - Phonological Pairing
2nd digit - Invented Spelling
3rd digit - Analogy Spelling
4th digit - Word Identification
* number of subjects with the same profile.

Obs: Bold dark blue digits mean a score too high or too low for the level where the profile was mapped.

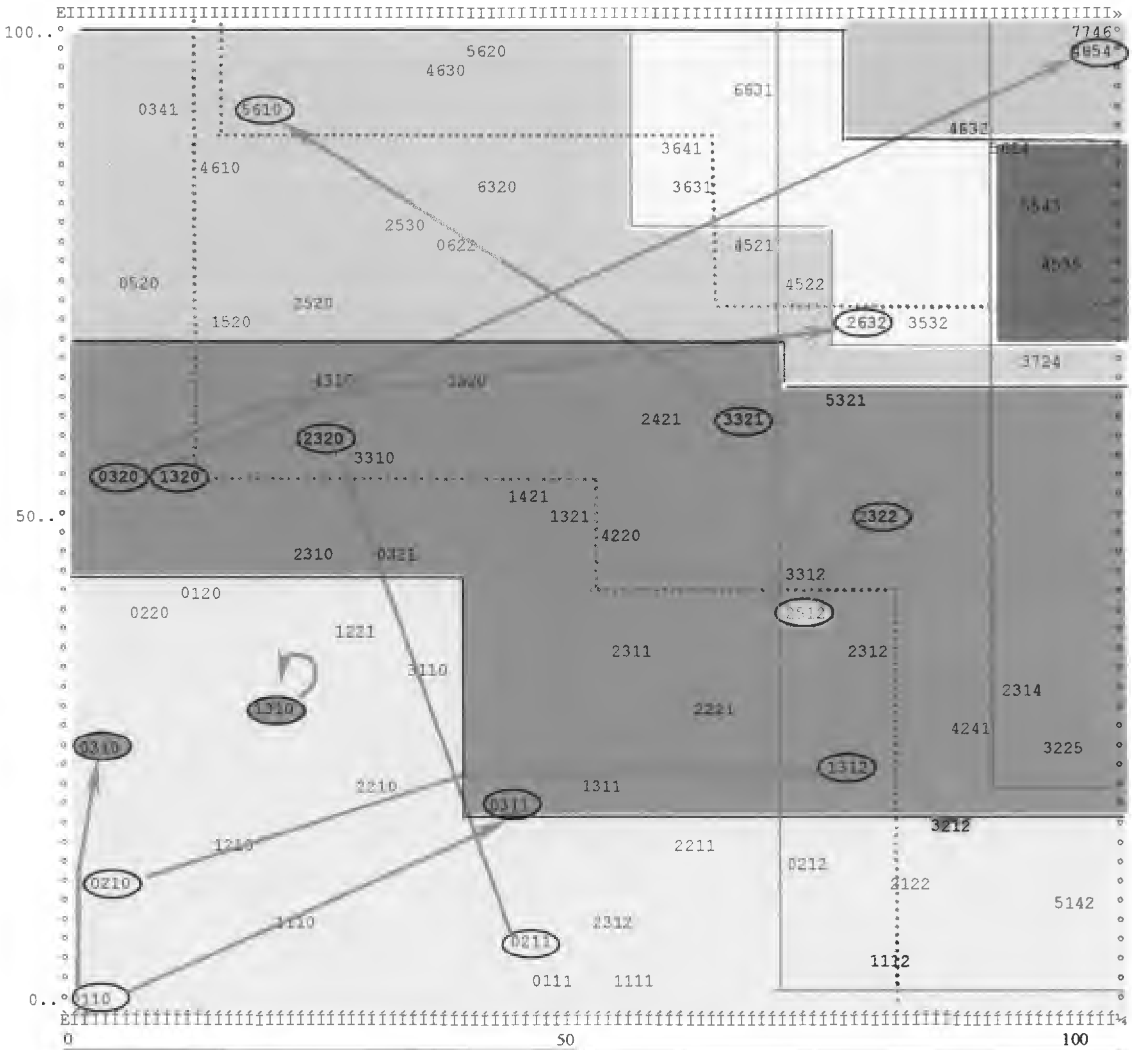
Developmental groups:

GROUP 1A	} LEVEL 1	
GROUP 1B		
GROUP 2	} LEVEL 2	
GROUP 3		
GROUP 4	} LEVEL 3	
GROUP 5		
GROUP 6	LEVEL 4	

Partitions of Invented Spelling
Partitions of Analogy Spelling
Partitions of Word Identification
Partitions of Phonological Pairing

Intervention Groups:
Group 2
Group 5

Fig 6.3-4 Spatial Diagram showing the changes of the children from the "syllabic analysis" group who started at Level 1



Invented Spelling:
Turquoise - pre-syllabic
Green - syllabic: representation of the syllable
Yellow - syllabic alphabetic and alphabetic: representation of subsyllabic units.

Profiles:
1st digit - Phonological Pairing
2nd digit - Invented Spelling
3rd digit - Analogy Spelling
4th digit - Word Identification
* number of subjects with the same profile.

Obs: Bold dark blue digits mean a score too high or too low for the level where the profile was mapped.

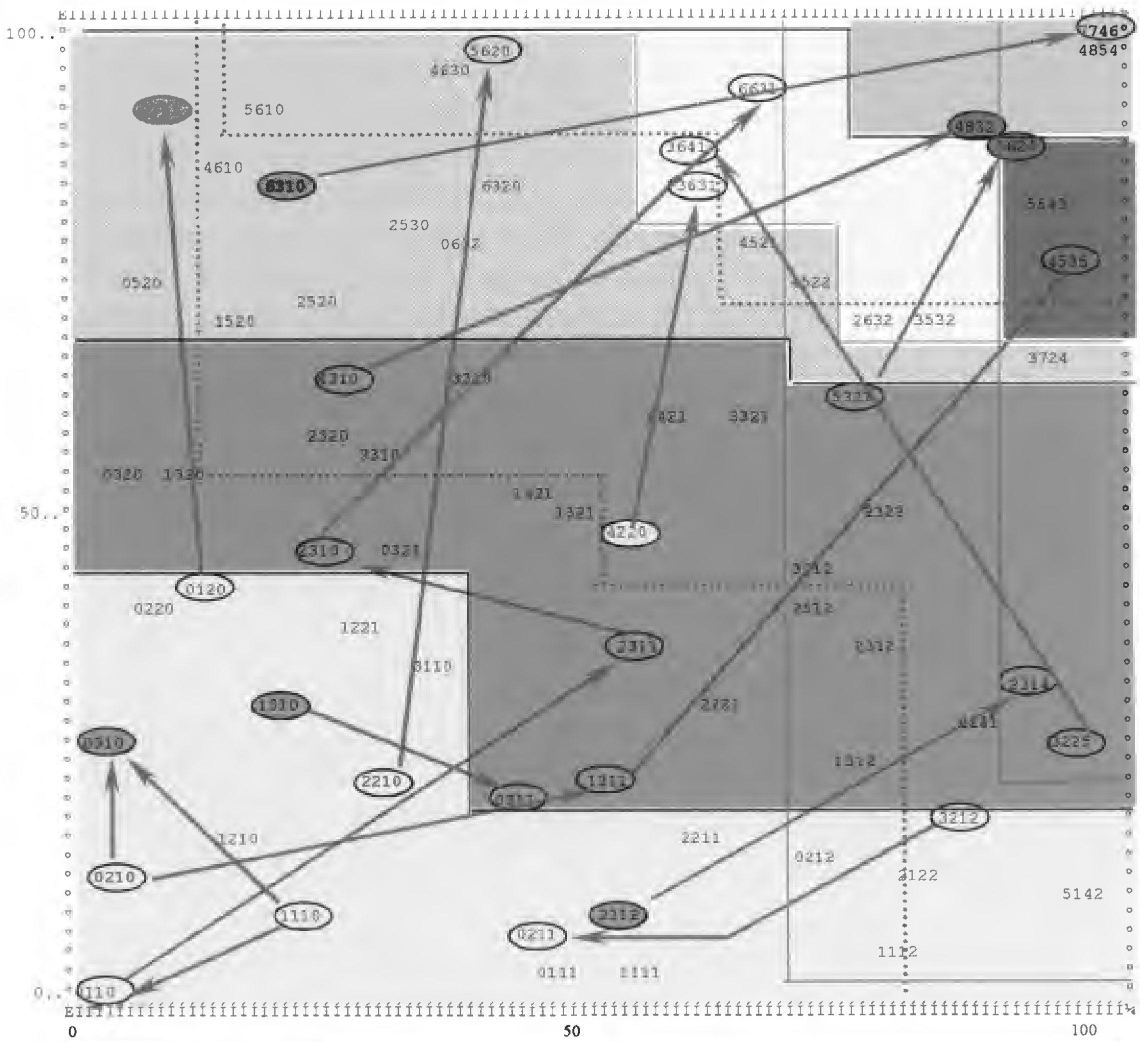
Developmental groups:

GROUP 1A	LEVEL 1
GROUP 1B	
GROUP 2	LEVEL 2
GROUP 3	
GROUP 4	LEVEL 3
GROUP 5	
GROUP 6	LEVEL 4

Partitions of Invented Spelling
Partitions of Analogy Spelling
Partitions of Word Identification
Partitions of Phonological Pairing

Intervention Groups:
Group 3

Fig 6.3-5 Spatial Diagram showing the changes of the children from the "phonemic analysis" groups who started at Level 1



Invented Spelling:
Turquoise - pre-syllabic
Green - syllabic: representation of the syllable
Yellow - syllabic alphabetic and alphabetic: representation of subsyllabic units.

Profiles:
1st digit - Phonological Pairing
2nd digit - Invented Spelling
3rd digit - Analogy Spelling
4th digit - Word Identification
* number of subjects with the same profile.

Obs: Bold dark blue digits mean a score too high or too low for the level where the profile was mapped.

Developmental groups:

GROUP 1A	LEVEL 1
GROUP 1B	
GROUP 2	LEVEL 2
GROUP 3	
GROUP 4	LEVEL 3
GROUP 5	
GROUP 6	LEVEL 4

Partitions of Invented Spelling

Partitions of Analogy Spelling

Partitions of Word Identification

Partitions of Phonological Pairing

Intervention Groups:

Group 4

Group 6

Fig 6.3-6 Spatial Diagram showing the changes of the children from the "no intervention" and "syllabic analysis" groups who started at Level 2

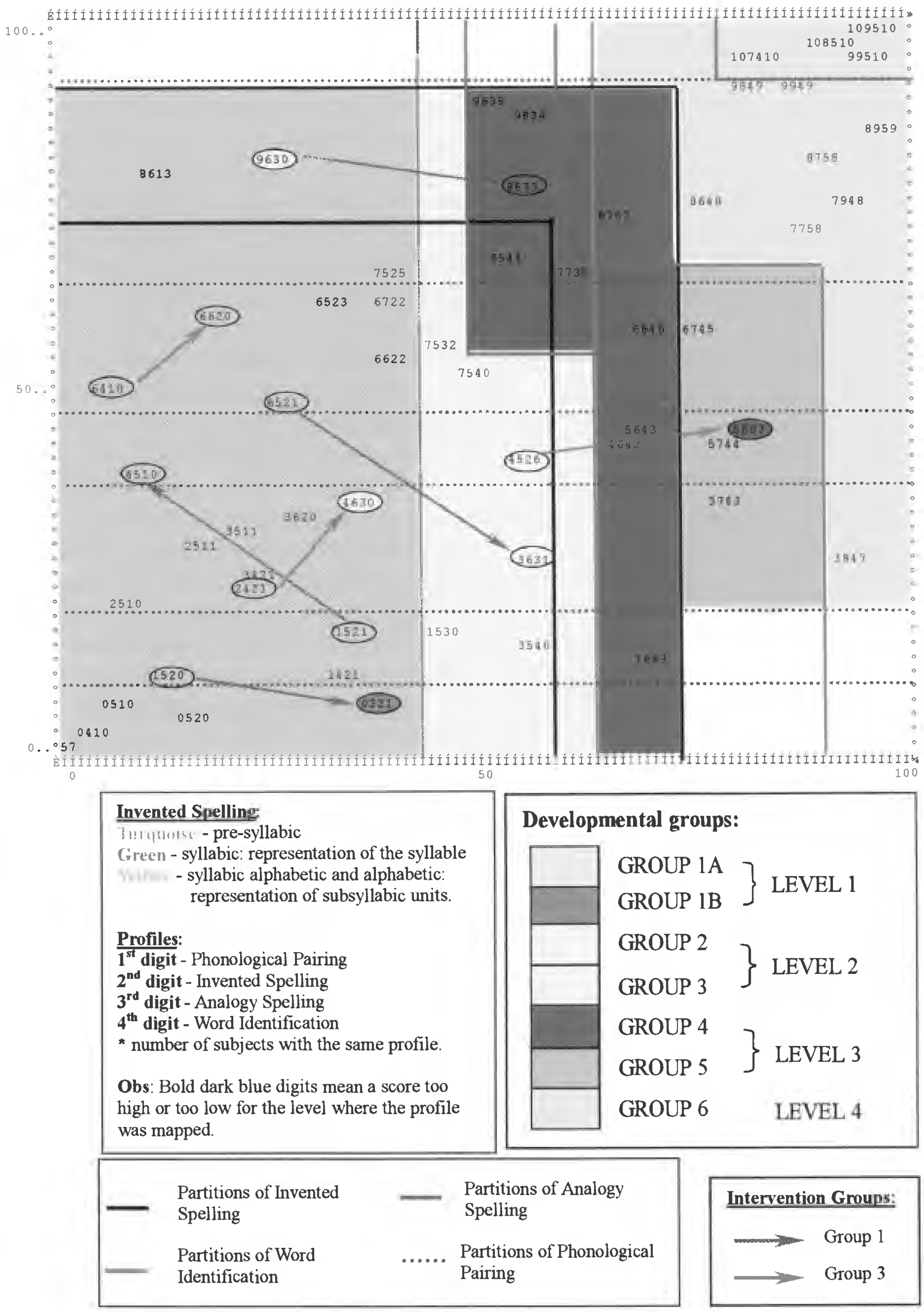
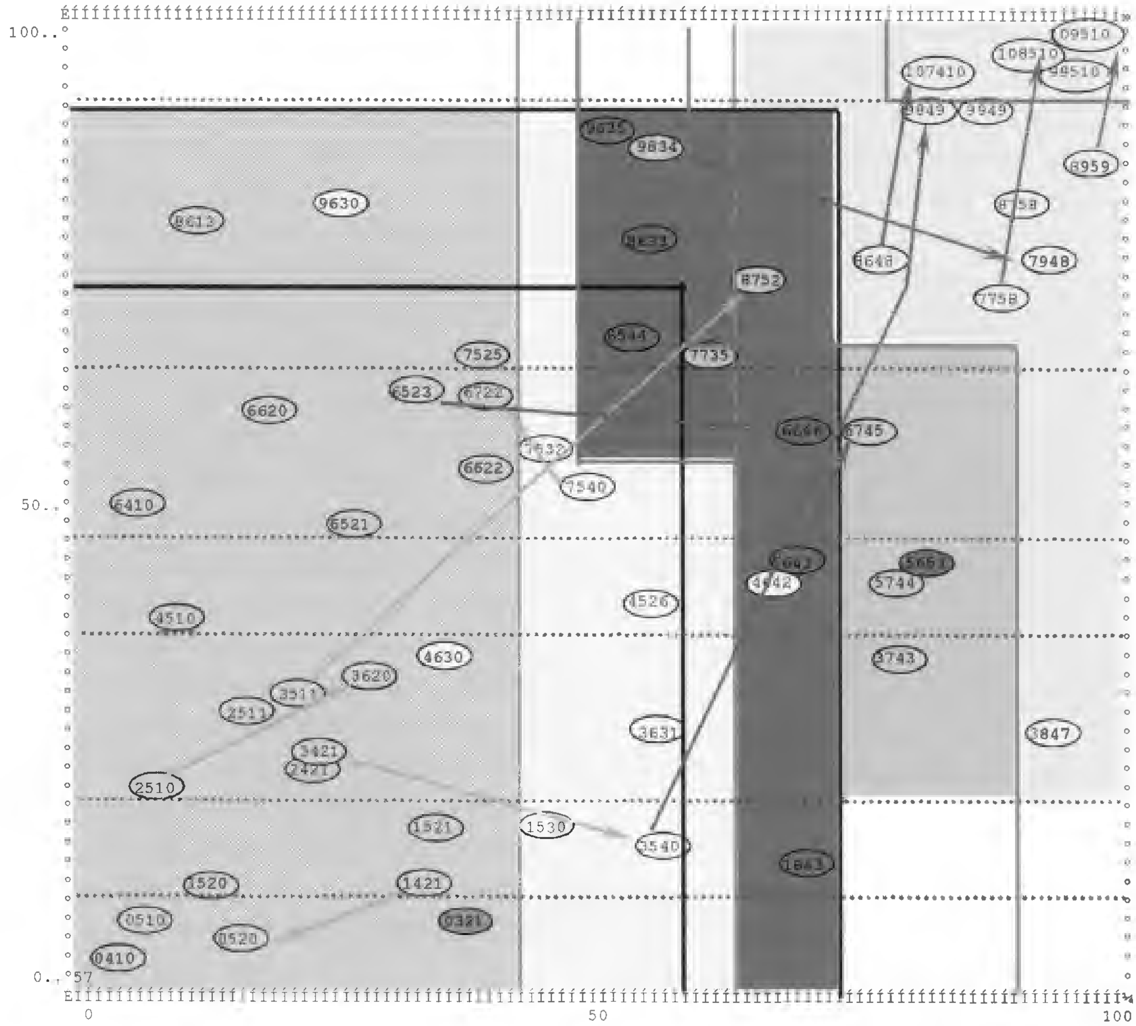


Fig 6.3-7 Spatial Diagram showing the changes of the children from the "no analysis" groups who started at Level 2



Invented Spelling:
Turquoise - pre-syllabic
Green - syllabic: representation of the syllable
Yellow - syllabic alphabetic and alphabetic: representation of subsyllabic units.

Profiles:
1st digit - Phonological Pairing
2nd digit - Invented Spelling
3rd digit - Analogy Spelling
4th digit - Word Identification
* number of subjects with the same profile.

Obs: Bold dark blue digits mean a score too high or too low for the level where the profile was mapped.

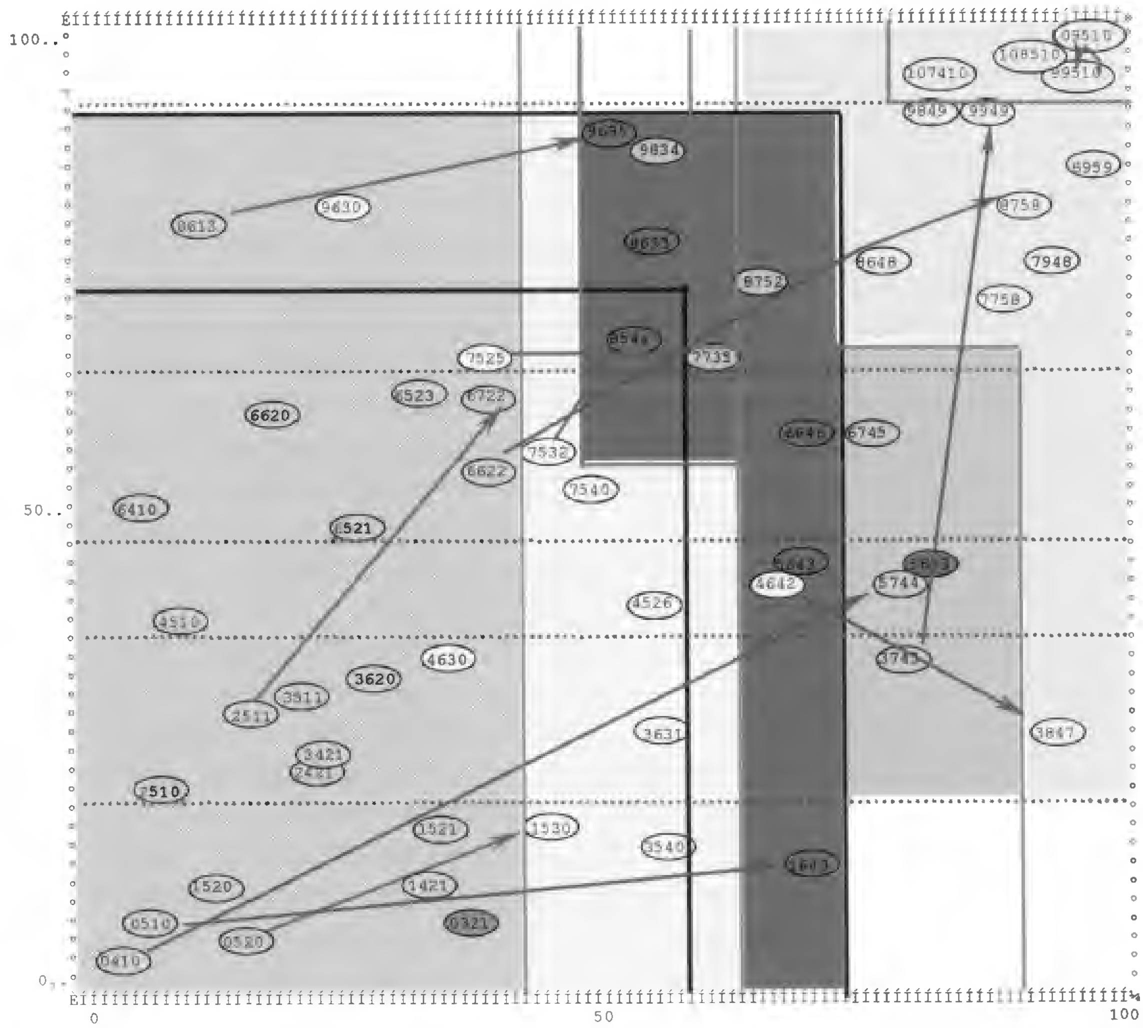
Developmental groups:

GROUP 1A	LEVEL 1
GROUP 1B	LEVEL 1
GROUP 2	LEVEL 2
GROUP 3	LEVEL 2
GROUP 4	LEVEL 3
GROUP 5	LEVEL 3
GROUP 6	LEVEL 4

Partitions of Invented Spelling
Partitions of Analogy Spelling
Partitions of Word Identification
Partitions of Phonological Pairing

Intervention Groups:
Group 2
Group 5

Fig 6.3-8 Spatial Diagram showing the changes of the children from the "phonemic analysis" groups who started at Level 2



Invented Spelling:
Turquoise - pre-syllabic
Green - syllabic: representation of the syllable
Yellow - syllabic alphabetic and alphabetic: representation of subsyllabic units.

Profiles:
1st **digit** - Phonological Pairing
2nd **digit** - Invented Spelling
3rd **digit** - Analogy Spelling
4th **digit** - Word Identification
* number of subjects with the same profile.

Obs: Bold dark blue digits mean a score too high or too low for the level where the profile was mapped.

Developmental groups:

GROUP 1A		LEVEL 1
GROUP 1B		
GROUP 2		LEVEL 2
GROUP 3		
GROUP 4		LEVEL 3
GROUP 5		
GROUP 6		LEVEL 4

Partitions of Invented Spelling

Partitions of Analogy Spelling

Partitions of Word Identification

...... Partitions of Phonological Pairing

Intervention Groups:

Group 4

Group 6

Tables 6.3-8 and 6.3-9 show the frequencies at each level, according to age group (which involves age and school grade). Age group 1 corresponds to reception class, age group 2 corresponds to year 1 and age group 3 corresponds to year 2.

Most children who reached level 3 or 4 in the pre-test belonged to age group 3 (seven years old), probably because most of the systematic explicit information about the writing system is provided by schools in year 2. The post-test results show that many children in age group 2 (six years old - year 1) and three children in age group 1 (five years-old - reception class) got beyond level 2 between pre-and post-test, probably due to the effects of intervention, or to the interaction between intervention and school teaching.

Table 6.3–8 Frequencies at each level, according to age group, in the pre-test

AGE GROUP	PRE-TEST LEVELS				
	N	1	2	3	4
1	17	15 88.2%	2 11.8%		
2	60	37 61.7%	21 35%	2 3.3%	
3	13	5 38.5%	1 7.7%	3 23.1%	4 30.8%
TOTAL	90	57 63.3%	24 26.7%	5 5.6%	4 4.4%

Table 6.3–9 Frequencies at each level, according to age group, in the post-test

AGE GROUP	POST-TEST LEVELS				
	N	1	2	3	4
1		11 68.8%	2 12.5%	3 18.8%	
2	58	17 29.3%	27 46.6%	10 17.2%	4 6.9%
3	12	2 16.7%	2 16.7%	3 25.0%	5 41.7%
TOTAL	86	30 34.9%	31 36.0%	16 18.6%	9 100%

6.4. Summary

In this chapter we investigated whether it is possible to define developmental levels in children's understanding of the writing system which would account for the changes which occur in their ability to detect, represent and make inferences about graph-phonetic segments. We found four developmental levels.

The first level comprises children who do not perform any kind of word analysis and do not realise that letters represent sounds within words, or consider them as tokens of the word.

Most children do not need any explicit information about the relationship between sounds and letters, in order to improve from the first to the second level. However, the quality of their experiences with written materials, enabling them to find answers to the question "what are scripts about?" proved to be a very important factor in fostering this development. When children discover that scripts represent the sounds of speech, the next question is "how do scripts represent the sounds?" or "what are letters about?"

The second level is characterised by the realisation that letters represent sounds, but still at a syllabic level. Children rely mostly on auditory cues to analyse words in syllables and writing is still conceived as a juxtaposition of letters, which are used as tokens of the sound of the syllable, generally by establishing a correspondence between the sound of the syllable and the name of the letter.

The progression from the second to the third level reflects a crucial development in children's conceptions about the writing system: the realisation that writing is not a juxtaposition of letters that function as tokens of sounds. Now children realise that letters may sound differently when they are in isolation or as parts of a string. This discovery kick-starts the ability to make inferences about graph-phonetic segments, as well as the ability to use phonological recoding, because these two abilities depend on "chunking", which is not possible without this understanding that the whole (word) is not merely a juxtaposition of the parts (letters). Now children need to find the answers to a different question: "what is the role of each letter within a word or a letter string?" Explicit information provided by expert readers, as well as the information resulting from children's inferences about the letter-sound correspondences within words is likely to be readily assimilated and to boost children's progress towards the full understanding of the alphabetic principle. This is reflected in their grasp of grapheme-phoneme correspondences, which is achieved in the fourth level.

In this study, the small number of children who started at Level 3 did not allow us to explore fully the developmental process involved in changing from Level 3 to Level 4, in particular the effect of providing explicit information about the role of the letters within words. Furthermore, the number of children assigned to Level 3 in the post-test was also insufficient to draw a clear picture of children's abilities at this level. Further research is necessary to fill these gaps and to confirm, or not, the suggestions presented in this chapter.

7. EFFECTS OF ORTHOGRAPHIC TRANSPARENCY
RESULTS OF EXPERIMENT II

7.1. *Introduction*

The purpose of Experiment II was to enable the performance of Sample II children in Portuguese and English to be directly compared. The aim was to investigate whether their construction of orthographic representations and their ability to make inferences about graph-phonetic segments in spelling novel words were affected by differences in the orthography of English and Portuguese. Since the children in Sample II were attending school in England, their approach to representing sounds might be affected by their experiences of learning to read and write English. Details of the English Invented Spelling and Analogy tasks were given in section 3.6.

7.2. *Children's Progress on the English Tasks*

It was possible to use the same scoring criteria for the English tasks as for the corresponding Portuguese Invented Spelling and Portuguese Analogy Spelling tasks (see section 4.4). This shows that the types of segments represented by the children were the same and appeared in the same order: word, syllable (partial), syllable (total), sub-syllabic units; phonemes (phonetic representation) and finally, orthographic representation.

As happened in Portuguese, there was some progress between pre- and post-test for the English measures. The difference between pre-test and post-test means was 0.75 for English Invented Spelling and 0.97 for English Analogy Spelling.

Table 7.2-1 shows that no child regressed and about half of the children progressed in English Invented Spelling, between pre-test and post-test.

Table.7.2–1 Changes in English Invented Spelling, from pre-test to post-test

		POST-TEST							
		2	3	5	6	7	8	9	TOTAL
PRE-TEST	1	2							2
	2		1	1					2
	3		4						4
	4				1				1
	5			3		1	1		5
	6				1	3	1		5
	7						1	1	2
	8						1		1
	9							6	6
TOTAL		2	5	4	2	4	4	7	28

In English Analogy Spelling, only one child regressed and about 46% of the children made progress, between pre-test and post-test, as shown in Table 7.2-2.

Table 7.2–2 Changes in English Analogy Spelling, from pre-test to post-test

		POST-TEST					
		1	2	3	4	5	TOTAL
PRE-TEST	1	6	1		4		11
	2		2	1	1	1	5
	3		1	1	2	1	5
	4				1	1	2
	5					3	3
TOTAL		6	4	2	8	6	26

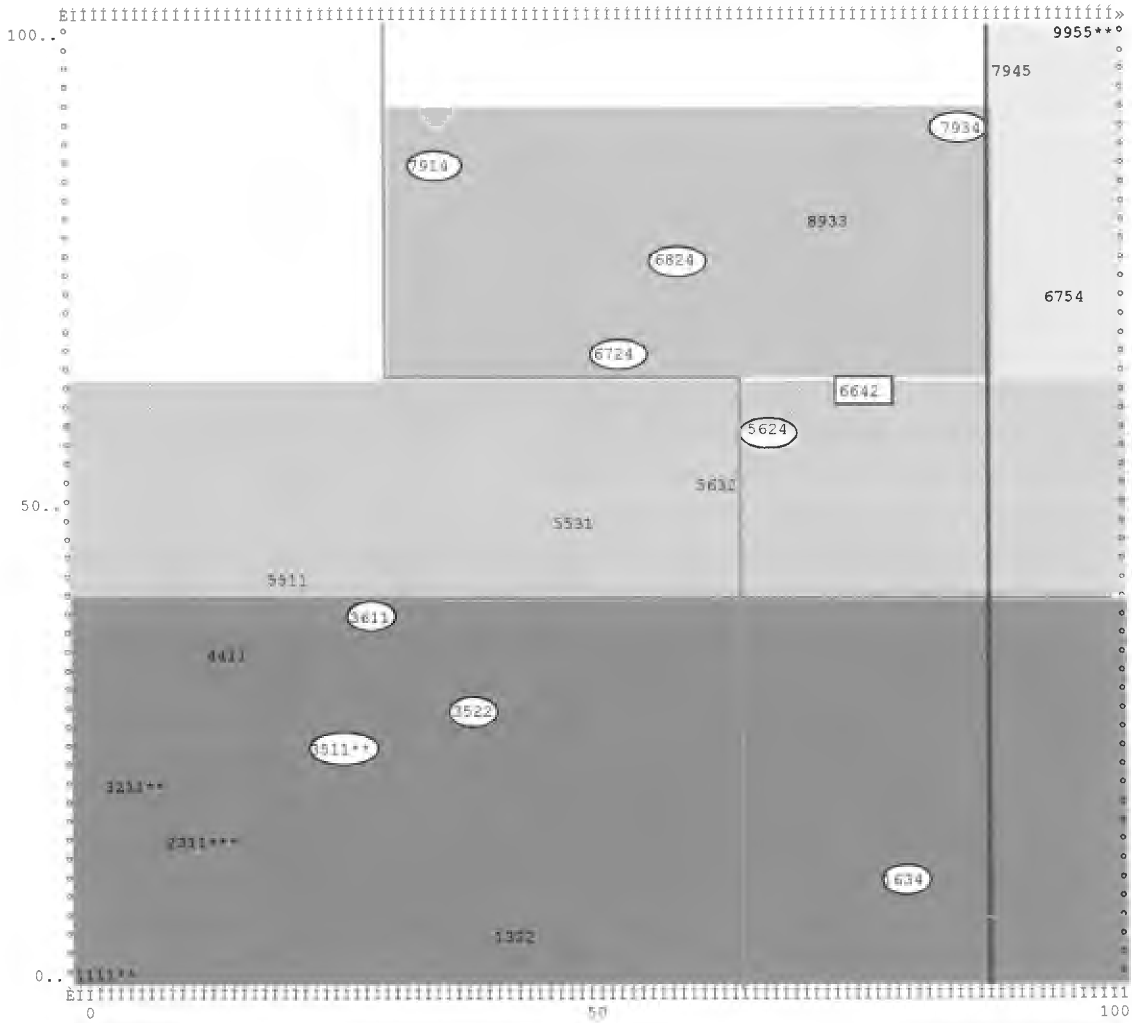
7.3. Comparison Between Portuguese and English

A profile was constructed for each child to allow the comparison of children's performance in both languages. The profile comprised the child's score on each task: 1st digit: Portuguese Invented Spelling; 2nd digit: English Invented Spelling; 3rd digit: English Analogy Spelling; 4th digit: Portuguese Analogy Spelling (see individual scores on all the tasks in Appendix 15).

The POSAC was used to plot children's profiles, so that the relationship between the four tasks could be portrayed visually, taking into account the developmental level each child was assigned to in the previous chapter. Two diagrams were produced: one for the pre-test and another for the post-test.

Figure 7.3-1 shows that, in the pre-test, for Invented Spelling most children had higher scores in English than in Portuguese. This difference was marginal for children at Levels 2, 3 and 4. However, at Level 1, the five subjects whose profiles are emphasised in the plot, at the right of the lime (light green) line, were able to produce two or three correct matches between sounds and letters in English. This would place them in Level 2, instead of Level 1.

Fig 7.3-1 Spatial Diagram of pre-test profiles, comprising children's scores in Portuguese and in English on the spelling tasks



Profiles:

1st digit - Portuguese Invented spelling
2nd digit -English Invented Spelling
3rd digit - English Analogy Spelling
4th digit - Portuguese Analogy Spelling

* number of subjects with the same profile.

Partition of Port. Invented Spelling

Partition of Eng. Invented Spelling

Partition of Port. Analogy Spelling

Partition of Eng. Analogy spelling

Pre-test levels:

LEVEL 1

LEVEL 2

LEVEL 3

LEVEL 4

The comparison between children's scores on both Portuguese and English Invented Spelling is also shown on Table 7.3-1, which shows clearly the better performance in English, in particular of children who scored 1 to 3 in Portuguese (Level 1).

Table 7.3–1 Comparison of children's performance on Portuguese and English Invented Spelling task, in the pre-test

PRE-TEST		ENGLISH INVENTED SPELLING									
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**Total**
PORTUGUESE INVENTED SPELLING	**1**	2		1			1				4
	2			3							3
	3		2			3	1				6
	4				1						1
	5					2	2				4
	6						1	2	1		4
	7									3	3
	8									1	1
	9									2	2
	Total	2	2	4	1	5	5	2	1	6	28

There are two possible reasons why children got higher scores in English. The first one is their greater familiarity with English orthography. However, it is unlikely that this would have produced large differences, because the letter-to-sound matches that would be correct in English were accepted as if they were correct in Portuguese (for example, the use of "e" or "ee" instead of "i", or "sh" instead of "ch"). The second reason was that Portuguese Invented Spelling was administered in the first session, while English Invented Spelling was carried out in the 11th session. Thus the children could have benefitted from familiarity with the experimenter, the experimental setting and the type of task.

By contrast with Invented Spelling, most children found the use of graph-phonetic cues in Analogy Spelling easier in Portuguese than in English (see the profiles emphasised within an oval shape between the blue and the violet lines, in Figure 7.3-1). Three subjects in the yellow area (Level 3) would have been classified as at Level 2 from their scores in English Analogy Spelling. Only one subject (whose profile is emphasised by a rectangle) scored higher in English than in Portuguese. The comparison of children's performance on both tasks is also shown in Table 7.3-2.

Table 7.3–2 Comparison of children's performance on the Portuguese and the English Analogy Spelling task, in the pre-test

PRE-TEST		ENGLISH ANALOGY SPELLING					Total
		1	2	3	4	5	
PORTUGUESE ANALOGY SPELLING	1	12		1			13
	2		2	1	1		4
	3			1			1
	4	1	3	2		1	7
	5				1	2	3
	Total	13	5	5	2	3	28

The Diagram of post-test scores (Figure 7.3-2) also shows that a few children had higher scores in English Invented Spelling than in Portuguese Invented Spelling, but this difference would not affect their assignment to the developmental levels described in chapter 6.

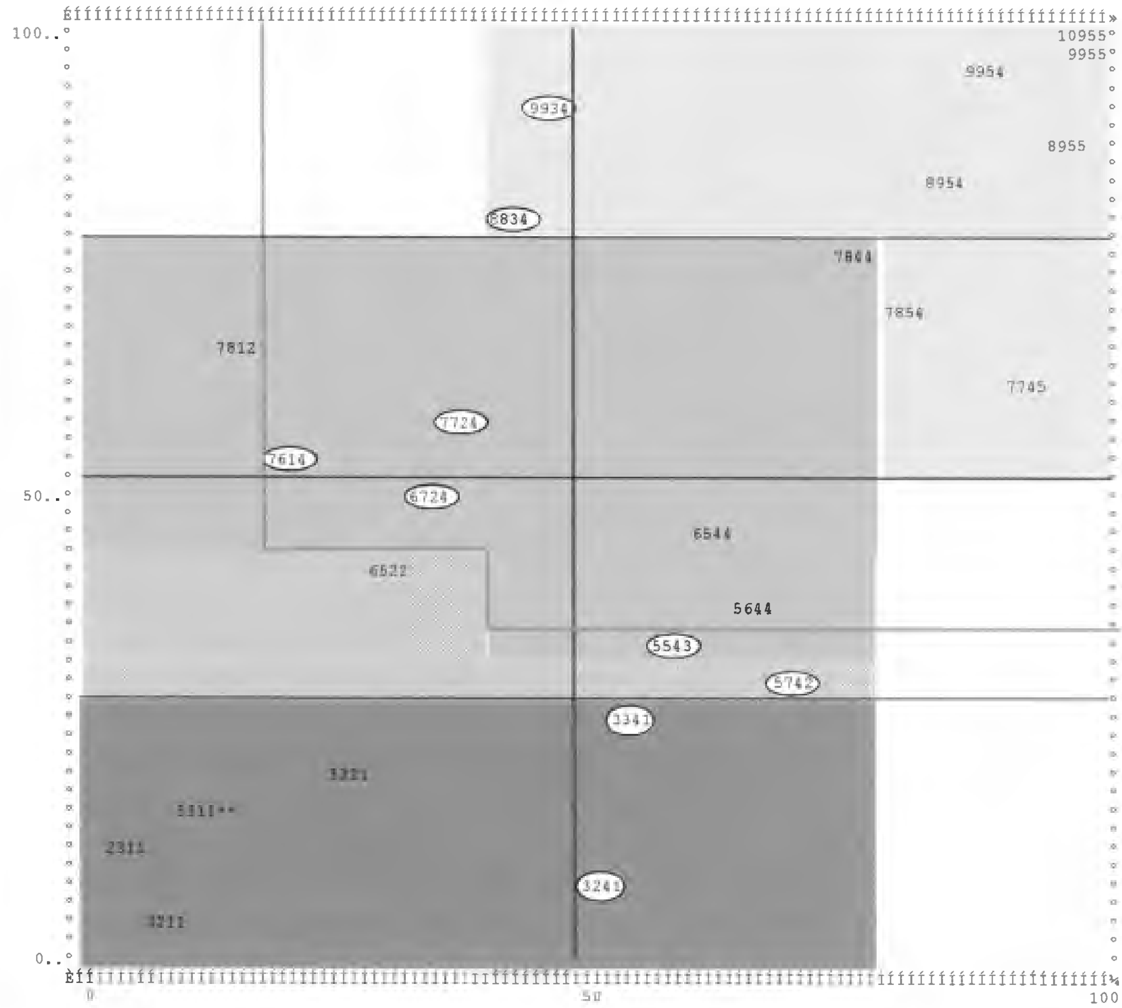
Table 7.3-3 shows children's consistent performance on Invented Spelling, in both languages, in the post-test.

Table 7.3–3 Comparison of children's performance on the Portuguese and the English Invented Spelling task, in the post-test

POST-TEST		ENGLISH INVENTED SPELLING							Total
		2	3	5	6	7	8	9	
PORTUGUESE INVENTED SPELLING	2		1						1
	3	2	4	1					7
	5			1	1	1			3
	6			2		1			3
	7				1	2	3		6
	8						1	3	4
	9							3	3
	10							1	1
	Total	2	5	4	2	4	4	7	28

Three children in level 3 and two children in Level 4 (profiles emphasised between the blue and the violet lines of Figure 7.3-2) were able to benefit from the clue-words in Portuguese, but not in English.

Fig 7.3-2 Spatial Diagram of post-test profiles, comprising children's scores in Portuguese and in English on the spelling tasks



Profiles:

1st digit - Portuguese Invented spelling
2nd digit -English Invented Spelling
3rd digit - English Analogy Spelling
4th digit - Portuguese Analogy Spelling

* number of subjects with the same profile.

Partition of Port. Invented Spelling

Partition of Eng. Invented Spelling

Partition of Port. Analogy Spelling

Partition of Eng. Analogy spelling

Post-test levels:

LEVEL 1

LEVEL 2

LEVEL 3

LEVEL 4

The profiles emphasised at the right of the violet line show that one child in level 2 and one child in level 3 performed better in English than in Portuguese. The same happened to two children in level 1, but it is unlikely that these were really using analogies, which involves a level of phonological analysis which they had not yet reached, since they passed only two conditions of Phonological Pairing. It is more likely that they used the clue-words as letter-banks to remember the shapes of the letters and this helped them to produce more letter-sound matches. Table 7.3-4 shows children's performance on Analogy spelling, in both languages, in the post-test.

Table 7.3–4: Comparison of children's performance on the Portuguese and the English Analogy Spelling task, in the post-test

POST-TEST		ENGLISH ANALOGY SPELLING					
		1	2	3	4	5	Total
PORTUGUESE ANALOGY SPELLING	1	4	1		2		7
	2	1	1		1		3
	3				1		1
	4	1	2	2	3	3	11
	5				1	3	4
	Total	6	4	2	8	6	26

Therefore, the orthography of the language does not seem to affect the construction of orthographic representations. Orthographies that are more transparent may ease the acquisition of graph-phonetic cues in spelling, accelerating the onset of children's ability to make inferences about graph-phonetic segments. However, it is unlikely that differences in orthographic transparency will alter the course of the developmental process that culminates with the grasping of the alphabetic principle.

8. GENERAL DISCUSSION

8.1. Discussion of the Results

This study focused on the period of development from the discovery that letters represent sounds within words, up to the full understanding of the alphabetic principle. In other words, the focus was children's quest to find the answer to the question "how do letters represent sounds?"

Most studies on literacy acquisition investigate abilities that are triggered during this period. However, often there is no common ground to interpret the different findings within a broad theoretical framework. What we want to argue is that it is very difficult to reach any conclusion about what children can or can't do in literacy-related activities if we do not take into account their understanding of how the writing system works. We suggest that children's understanding of the writing system can provide the unifying framework within which different findings can be understood.

This study aimed to investigate whether the development of the understanding of the alphabetic system in Portuguese speakers could be interpreted in the light of the theoretical framework presented in the literature review (chapter 2).

One of the bases of this framework was Ferreiro's assertion that the writing system should be considered as an object of thought, which children construct hypothesis about (Ferreiro, 1984, 1985, 1986, 1987, 1997; Ferreiro & Teberosky, 1983). From this standpoint, the development of the understanding of the writing system was considered as a process which involves conceptual change and cannot be reduced to the incremental growth of information about the relationship between sounds and letters.

As it was not possible to examine each child individually, we used different measures to assess children's understanding of the alphabetic system: the construction of orthographic representations and their ability to make inferences about graph-phonetic segments both in spelling and in word identification. We assumed that these measures assessed different aspects of children's understanding. In chapter 6, we decided to consider the ability to detect phonological identity as another aspect of this understanding, because the concurrent effects of the task that assessed this ability on the other measures were stronger than the predictive effects.

Based on these measures, four levels of the development of children's understanding of the alphabetic system were distinguished, which correspond roughly to the levels of conceptualisation identified by Ferreiro. Level 1 corresponds to the pre-syllabic hypothesis; Level 2 corresponds to the syllabic hypothesis; Level 3 corresponds to the syllabic-alphabetic hypothesis and Level 4 corresponds to the alphabetic hypothesis. However, in Ferreiro et al.'s studies, children at the syllabic level usually produced only one letter per syllable in their invented spellings. In this study, very few children showed this behaviour in its pure form. If they had been interviewed individually and had been asked to read each word after writing it, it might have been possible to know whether they were using such a criterion to decide the number of letters to use per word. As this was not feasible, children's spellings were considered as syllabic (invented spelling Levels 5 and 6) if a correct letter-to-sound match was found in at least two syllables of most words, regardless of the number of letters that the children used to write each syllable. The quantitative criterion was adopted only to give a score of 4 (on the Invented Spelling scale) to the spellings where one letter per syllable was used, with less than two letter-to-sound correspondences per word.

Moreover, it was found that children's hypotheses might not have an immediate impact on their invented spellings. For a short period, children at Level 3 continued to produce syllabic spellings. Similarly, at Level 4, they might still produce syllabic-alphabetic spellings for a while. The Invented Spelling task may perhaps be too conservative when used alone to assess the level of understanding of the writing system. Because of this slight discrepancy, we decided to use the term "Level" when referring to the development of children's understanding and the terminology proposed by Ferreiro (pre-syllabic, syllabic etc) to refer to children's invented spellings or to children's hypotheses.

At Level 1, children did not understand that letters represent sounds within words, because their concept of words is as wholes and not as compounds. Being able to understand that the word is a compound of smaller units is the first step towards understanding the alphabetic principle. It does not matter whether the kick-start of this process is being confronted with written words which are clearly composed of smaller units, the letters, or grasping that spoken words can be pronounced slowly "in pieces". Children move beyond Level 1 when they discover that both the written and the spoken words comprise smaller units, which are related systematically to each other.

At Level 2, they strive to refine the connection between these units, by relying on auditory cues. Because the syllable is the most salient sub-lexical phonological segment, they generally find it easy to carry out a syllabic segmentation of the spoken word, as shown by Vernon (1998). This allows them to establish the early connections between letters and sounds within words which are syllabic, at least in languages with a high frequency of multi-syllabic words. These connections are generally based on the names of the letters, in particular the vowels, in languages where the vowel sounds like its name. Therefore, the syllabic representation of words is straightforward: there is a direct connection between sounds and letters. The juxtaposition of sounds (syllables) produces a spoken word; the juxtaposition of letters produces a written word. There is no need for children to compare words because the sound of a letter within a word is the same as it is alone.

Therefore, at Level 2, children may be able to detect phonological identity between words whose common segments (such as initial syllable) can be based on auditory cues. However, they do not yet use this ability in literacy-related activities, as they do not realise that words that share phonological segments also share the corresponding graphic segments. Even if they try to make this connection, the syllabic hypothesis prevents them from succeeding, since they will try to match the analogous sound to the wrong letter, as happened to the children who scored 2 on the Analogy Spelling task.

Therefore, the problem of the syllabic conception of children at Level 2 is that the writing system does not work like this. They can write any word, but other people cannot read most of what they have written. Likewise, they cannot read many of the words written by other people. Thus, they cannot use the system to achieve social communication. This may provide the necessary motivation to encourage them to change their approach to the writing system.

To go beyond Level 2, children need to reconcile their hypothesis of one-to-one correspondence between sounds and letters with the reality that they encounter too many letters in conventional spellings compared to their own writing, according to Ferreiro's explanation. This comes about when children realise that the sound of the salient phonological segment (in this case, the syllable) is represented by a string of letters rather than by a single letter. This represents a great achievement in terms of the understanding of the role of the letters within words, as children have to realise that the whole - the string of letters - is not produced by the juxtaposition of its parts - the individual letters. Understanding the correspondence between strings of letters and sounds allows children to realise that sound identity corresponds to graphic identity. This enables them to make inferences about graph-phonetic segments. Although we did not interview the children individually to question them about their productions, there was evidence of children's reluctance to write one letter per syllable and their ability to use the clue-words to correct their spellings. For example, some children spelled words like "**b**rnsh**b**dcae" for "burro", which was replaced by "**buo**", in the Analogy Spelling task; "**bn**sroa**ca**" or "**bon**alc**a**nk" for "boneca", which were spelled correctly in the Analogy Spelling task. These children realised that they needed more than one letter per syllable, in spite of not knowing exactly how many and which letters they should use. This enabled them to find in the clue-words the correct "chunks" for the syllables they wanted to represent or, at least, to produce spellings closer to the conventional ones. Thus the Analogy Spelling task allowed us to distinguish between the children who were reluctant to abandon the syllabic hypothesis (for example, maintaining spellings such as "**uo**" for "burro" and "**ao**" for "barco") and those who were already rejecting it (replacing "**uo**" by "**buro**" and "**ao**" by "**baco**"). The first group scored 3 on Analogy Spelling, while the second group scored 4.

Grasping that syllables are represented by a string of letters prepares the ground for children to search for the answer to the question "which is the role of each letter within a string?" However it cannot provide an adequate answer; this is the greater challenge for Level 3.

Children may adopt the strategy of focusing on pronunciation, stretching it to differentiate letters within strings. This provides the articulatory cues necessary to identify some consonants, at least at the beginning of the word. It is likely that the ability to recognise the initial consonant within words hastens the transition between Level 2 and Level 3. All the children that scored above chance on Initial Consonant Recognition in spite of having been assigned to Level 2 in the pre-test, were classified at Level 3 or Level 4 in the post-test. On the other hand, nearly half of the children assigned to Level 3 in the post-test did not score significantly above chance on Initial Consonant Recognition. As these children had received very little instruction on letter-sound correspondence by the time the data were collected, we suggest that the slight discrepancy in either direction, between the transition to Level 3 and the onset of phonological recoding, depends on explicit instruction. Further research is required to confirm this suggestion. The results of this study suggest that the development of phonological recoding, as proposed by Vandervelden & Siegel (1995), is triggered at Level 3, or during the transition from Level 2 to Level 3, depending on children receiving explicit instruction on letter-sound correspondences.

When children have developed the understanding which characterises Level 3, the lack of knowledge about specific letter-sound correspondences may be compensated for by children's ability to make inferences about the sounds of graphic segments, or in other words their ability to use analogies, both in spelling and in word identification. In word identification, children's ability to use graph-phonetic cues based on the analogy between the cue-segment of the target and the clue words was most common for initial syllables, but each child succeeded in making this kind of inference for at least three segments. However, it is not clear that children would use this kind of strategy if they were not encouraged to do so by the demands of the task. The fact that, at Level 3, higher scores on Initial Consonant Recognition did not produce a better performance on most conditions of the Word Identification task suggests that these children may have tried to use either phonological recoding or analogies rather than combining both strategies to discover the sound of the cue segments. As phonological recoding is a more economical strategy, it is possible that children abandon the use of analogies (or don't even start to use them) as soon as they realise that they are able to decode some segments. Alternatively, it is also possible that they do not realise how to exploit the elementary phonological recoding abilities which they already have. Therefore, both phonological recoding and the use of analogies at this level may not be a question of children being able to use them or not. Instead, it may be a question of children being aware that they are able to use them, at least to some extent. This may explain the divergences found in studies which have investigated the use of analogies in young children (Bryant & Goswami, 1987; Goswami, 1986, 1988; Goswami & Bryant, 1990, 1992; Muter, Hulme, Snowling, & Taylor, 1997; Muter, Snowling, & Taylor, 1994; Nation & Hulme, 1996). In the present study we used the term "making analogies" to mean the same as making inferences about graph-phonetic segments, to investigate whether children were able to make inferences before they had fully grasped the alphabetic principle. Hence, both the tasks and the criteria used are different from the ones used in the studies on analogy mentioned above.

Knowing what children have the potential to do at this level is an important issue to be investigated in further research, because of its educational implications.

Children may improve their knowledge of letter-to-sound correspondences by using analogies. A better knowledge of letter-to-sound correspondence means a more efficient use of phonological recoding. This, in turn, allows children to use analogies based on more complex graph-phonetic segments, located in different positions within the words, and so on. Therefore, if children are encouraged to use both strategies, they are more likely to progress in literacy, as shown by (Bradley, 1981; Bradley & Bryant, 1983; Bryant & Bradley, 1985/1987). The problem is that, elementary as these abilities are at this level, they seldom result in successful encounters with novel words in everyday situations. Thus, it is likely that we need to provide appropriate materials and much encouragement for children to work at their improvement. The significant effects of the "phonemic analysis" training on the progress of children in Sample II shown on their Word Identification scores may be an indication of the importance of providing explicit instruction about how the phonemic segments are bounded within "chunks" of letters.

The Word Identification task involved two types of inferences: recognising a word based on graph-phonetic segments (cue-reading) and inferring the sound value of the cue-segment, based on its graphic identity with another segment within a known word (analogy). The fact that children could make some of these inferences showed that they were able to teach themselves the role of each letter within the strings. In Portuguese, this means grasping the role of consonants, as most children already know the sounds of the vowels by the time they reach Level 3.

Therefore, the self-teaching mechanism is likely to be triggered by grasping that the writing system is based on "chunking" and not on the juxtaposition of letters. This understanding is first reflected in the discovery of the relationship between letters and sub-syllabic units (which in CV syllables coincides with grapheme-phoneme correspondence). This has implications for re-reading (Share, 1995) 's claims about the kick-start of the self-teaching mechanism, discussed in section 2.7.2.3. His claims that "For the beginner, an initial set of simple one-to-one correspondences may represent the logical point of entry..." (p.155), were interpreted, in the Literature Review, to be referring to grapheme-phoneme correspondences. However, the capacity to make inferences about graph-phonetic segments in order to identify novel words emerges at Level 3, when the one-to-one correspondence involves sub-syllabic units rather than graphemes and phonemes.

Although children proved to be able to make inferences about graph-phonetic segments, both in spelling and in word identification, at Level 3 this ability was still very rudimentary and restricted to certain segments. This corroborates Ehri et al.'s findings (Ehri, 1980; Ehri & Robbins, 1992; Ehri & Wilce, 1987b) that, at this level, children have not yet constructed stable and complete orthographic representations of sub-lexical units. An inspection of children's invented spellings confirms these claims. The poor quality of orthographic representations makes it difficult to define the letters that correspond to the phonological segment whose orthographic representation they need to learn. To overcome this difficulty, they need to grasp the relationship between graphemes and phonemes, which is necessary for them to be promoted to Level 4.

Therefore, although Ferreiro (1985) has considered the syllabic-alphabetic representation as a transitional level, the results of this study show that Level 3 (which puts together some fully syllabic and the majority of syllabic-alphabetic children) is characterised by crucial discoveries which are essential for the complete grasping of the alphabetic principle. Level 3 marks the shift from the syllabic to the alphabetic conception, so a detailed study of the dramatic changes that occur at this level will help us to understand the obstacles that prevent children from grasping the alphabetic principle.

The crucial conceptual change observed at this level involves the shift from conceiving words as a juxtaposition of letters to conceiving them as "chunks", as explained by Mounoud (1987):

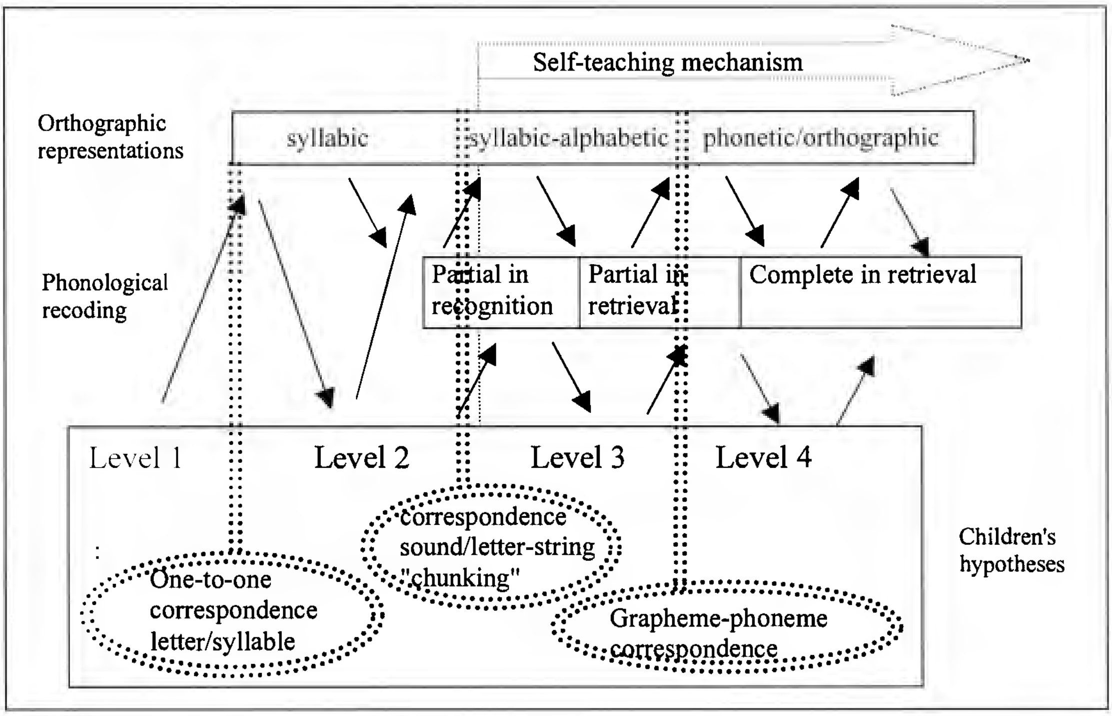
> (...) syllabic components would be organised in words as unbounded totalities by means of rules for juxtaposition or reduplication, whereas phonemic components would be organised in bounded wholes by means of relationship systems (phonological rules).
>
> Between these two levels of organisation, a radical transformation should occur. This transformation is a kind of integration or synthesis of previous constituents corresponding to what is also called "grouping" or "chunking". (p. 496)

Children's performance on all the tasks showed that it was this conceptual change which allowed them to develop phonemic awareness and to use phonological recoding, rather than the opposite. Therefore, Level 3 is the stage for a dramatic conceptual change, which cannot be reduced to an improvement on segmenting and blending skills.

In this study, we considered the ability to make inferences as an indication that this change had occurred. If we agree with Byrne et al. that the ability to make inferences about graph-phonetic segments is a demonstration of having grasped the alphabetic principle, we have to extend the meaning of "having grasped the alphabetic principle". This would include the discoveries achieved at Level 3 and not merely the understanding of the relationship between graphemes and phonemes, which is only accomplished at Level 4.

Based on the results of this study, we suggest that the diagram presented in section 2.7.2.4, should be re-drawn as shown in Figure 8.1-1.

Figure 8.1–1 Diagram to illustrate the interrelation between children's hypotheses about the alphabetic system, phonological recoding and orthographic representations (2nd version)



In summary, the present study shows that it is possible to interpret children's development of the understanding of the writing system in the light of a broad developmental approach, which assembles the findings and the theories of authors who have carried out their research from many different perspectives.

One of the main limitations of this study was the impossibility of interviewing the children individually, preventing the use of the clinical method, which would provide a clearer understanding of the hypotheses that guided children's performance in the different tasks. The other equally important limitation was the short time available for the intervention. Further research is necessary to confirm the claims about children's evolution from Level 2 to Level 4. The small number of children who progressed from Level 2 to Level 3, as well as from Level 3 to Level 4 in this study (especially in Sample I), provided sufficient information for speculating about this evolution, but more evidence is needed to construct a solid theory. This problem was especially acute when investigating the impact of readers' explanations on children's hypotheses about the writing system where the results were inconclusive. We hope that further research focusing on children's difficulty in getting beyond Level 3 will provide more valuable information about this transition.

8.2. Conclusions

The results presented in the previous chapters allow us to answer the research questions raised at the beginning of this study:

1 *Should the definition of phonological recoding be extended to include the letter-to-sound matches involved in producing syllabic representations of words?*

   a) *What is the relationship between phonological awareness, letter knowledge and the production of syllabic spellings?*

   b) *Can children make inferences about graph-phonetic segments before moving beyond the syllabic hypothesis?*

   c) *How is the ability to make inferences about graph-phonetic segments related to the production of orthographic representations and to phonological recoding?*

As shown in chapter 6, the children who produced syllabic spellings could be at different levels concerning their understanding of the alphabetic principle.

Level 2 children either produced partial syllabic spellings (generally one correct letter-to-sound match in the first and in the last syllable) or produced fully syllabic spellings (one correct letter per syllable). They were likely to succeed in detecting the phonological identity of syllables with full contrast and some also managed to detect final stressed rimes (rhyming words). Therefore, they were able to carry out some phonological analysis of the words but only when the most salient segments were involved, although a few children managed to detect phonological identity of other segments. Most had a limited knowledge of consonants and were likely to rely on the name rather than on the sound of the letter (generally the vowel) to spell the words. The difficulty of making inferences about graph-phonetic segments, both in spelling and in word identification, was the principal characteristic that distinguished this level from the more advanced ones. Some children even refused to accept that their invented spellings were incomplete and tended to disregard the letters that did not fit into their orthographic representations.

This suggests that, at this level, children had started to establish a direct connection between sounds and letters (one-to-one correspondence at the syllabic level) and considered that words were constructed by collating letters. This shows their grasp of a fundamental property of the writing system: the one-to-one correspondence between sounds and letters. At the same time, it shows that children did not yet grasp other essential features of the alphabetic system, such as:

(1) The sound of a letter within a string is not the same as sound of the same letter in isolation.
(2) Although sound identity generally corresponds to graphic identity, the graphic identity between words that share the same sound is often based on strings of letters, rather than on isolated letters.

We can summarise these features by saying that words are readable by translating strings of letters into sounds. The onset of phonological recoding depends on understanding that the sounds are not collated but merged in the "chunks".

The most natural "chunk" in Portuguese is the syllable (especially the most frequent and the simplest, the CV syllable). Children got beyond Level 2 when they realised that one letter was not enough to represent the syllable, even though sometimes they continued to produce syllabic spellings (one correct letter per syllable). Level 3 was characterised by children's efforts to reconcile their hypothesis of one-to-one correspondence between sounds and letters with the evidence that one sound (syllable) generally corresponds to a string of letters (which could be just two letters in CV syllables).

The main result of these efforts was children's openness to information about how letters represent sounds and their capacity to understand what was expected from them when they were invited to use clue-words to spell and to identify novel words.

Therefore, in spite of still producing syllabic spellings, some children were classified at Level 3 because their understanding did not differ substantially from that of the children who produced syllabic-alphabetic spellings (by representing at least one sub-syllabic unit in most words). They were ready to accept that their spellings were incomplete and were keen to improve them. Generally relying on articulatory cues, they were likely to detect the phonological identity of some segments smaller than the syllable, such as the onset of the first syllable within the word. They then used the clue-word in search of the graphic representation for these segments in order to spell novel words. Like the other children at Level 3, these children were starting to make use of partial phonological recoding in recognition tasks.

However, their ability to make inferences about some graph-phonetic segments was still very rudimentary and not always effective, reflecting their difficulty in carrying out a thorough analysis of both the spoken and the written word. In other words, they made use of partial phonological recoding and this was not sufficient to enable them to succeed in making inferences about segments that required a complete grasp of the relationship between graphemes and phonemes.

As discussed in the Literature Review, phonemes do not have acoustic reality. Therefore, children take some time to discover the role of each grapheme within a string. Till they discover this, it is very difficult for them to define the string of letters that corresponds to a specific sound. This discovery relies primarily on articulatory cues, which allow the differentiation of some consonants. As these cues are most salient at the beginning of the word, the first graph-phonetic inferences are likely to focus on the initial segments. A minimal knowledge of letter-to-sound correspondence is necessary to help children to grasp the role of each letter within a word, but further letter knowledge is acquired as children are offered opportunities to inspect and compare the sound and the graphic form of words and letter-strings.

To progress to Level 4, it was necessary a sound knowledge of letter-to-sound correspondence. It was at Level 4 that children achieved the ability to relate graphemes to phonemes and vice-versa; in other words, they started to make use of complete phonological recoding. This means that it was only at Level 4 that the alphabetic principle was fully understood, even if this understanding was not immediately displayed in their orthographic representations; a few children reached this level of understanding before they were able to produce fully alphabetic spellings. Their understanding of how letters represent sounds allowed some children to realise that the relationship between graphemes and phonemes is not always transparent and that they could use known clue-words to correct their spellings according to orthographic conventions.

Furthermore, in Level 4, the ability to use graph-phonetic cues to identify novel words matched almost perfectly the ability to detect phonological identity between the clue-word and the target word. It is interesting to notice that in the few cases where this did not happen the children got slightly higher scores on Word Identification than on Phonological Pairing. This suggests that the ability to detect phonological identity of less salient segments may require the ability to produce orthographic representations of the segments involved. Therefore, the full understanding of the alphabetic principle and the use of complete phonological recoding support further development of phonological (phonemic) awareness.

The relationship between children's hypotheses, the use of phonological recoding, the construction of orthographic representations and the capacity to detect phonological identity are summarised in Table 8.2-1:

Table 8.2–1 Summary of the relationship between children's hypotheses, the use of phonological recoding, the construction of orthographic representations and the capacity to detect phonological identity

	Level 2	**Level 3**	**Level 4**
Hypothesis	Letters represent sounds within words: one-to-one correspondence between sounds (syllables) and letters	The letter in isolation does not sound the same as the letter within the word - need to reconcile the hypothesis of one-to-one correspondence with the evidence of correspondence between sounds and strings of letters.	Full understanding of the alphabetic principle
Phonological recoding	The connection between syllables and letters (mostly vowels and letter names) does not involve phonological recoding;	Efforts to discover the sound correspondence of the letters within strings. Use of graph-phonetic cues (especially initial consonant) to identify and spell novel words.	One-to-one correspondence between graphemes and phonemes.
Orthographic representations	Syllabic: one letter-to-sound correspondence on at least two syllables	Syllabic-alphabetic: representation of sub-syllabic units in, at least, one syllable per word, in most words	Mostly phonetic; eventually orthographic
Detection of phonological identity	Initial syllable - relying on auditory cues	Syllable boundaries - relying on auditory and articulatory cues	Most segments - relying on auditory and articulatory cues as well as on orthographic representations

Children's hypotheses about the writing system orchestrate the use of phonological recoding and the construction of orthographic representations. Thus for a short period children's invented spelling may reflect orthographic representations typical of a previous developmental level.

The most elementary levels of phonological recoding - the ability to recognise the initial letter of words and syllables - may be improved by explicit instruction. This helps children to get beyond Level 2. However, it is important that the instruction should enable children to grasp the sound value of letters in different words. Just "sounding out" the letters may reinforce the conception, typical of Level 2 children, that each letter must be sounded separately to make up a word. Similarly, associating one letter to a single word (as in "A for apple") may reinforce the conception typical of Level 1 children that the letter is a token for the word

2 *Do the adults explanations of how scripts represent speech affect:*
   a) *Children's capacity to detect sound identity between words?*
   b) *Children's ability to decide whether one word begins with a specific letter?*
   c) *Children's ability to make inferences about graph-phonetic segments to identify and to spell novel words?*
   d) *Children's orthographic representations of words and word segments?*

   If positive,

   a) *Is there any influence of the kind of word analysis used during intervention (either just on syllables or on both syllables and phonemes) on the size or the quality of the observed changes?*
   b) *Is there any interaction between the kind of word analysis used during intervention and children's previous skills and conceptions?*

The results presented in chapter 5 show that, after controlling the individual differences, the effects of intervention were not equally significant across the different measures which assessed the understanding of the writing system.

The performance on Initial Letter Recognition (both Consonant and Vowel) and Phonological Pairing was not significantly affected by intervention.

In Sample I, the progress in Invented Spelling was significantly larger for the group trained on syllabic analysis than for the group that had not been submitted to any kind of intervention, but there were no significant differences between the different types of intervention. The results in Chapter 6 suggest that training on syllabic analysis is particularly effective in helping children to improve their spellings from pre-syllabic to syllabic representations. The training on phonemic analysis was significantly more effective than the "no-analysis" training in helping Sample II children to improve their invented spellings. It was not possible to decide whether phonemic analysis training was more effective than syllabic training to improve the invented spellings of children who started at Levels 2 or 3, as the number of children who produced syllabic spellings in the pre-test in Sample I was very small.

Progress on Word Identification was not significantly affected by training in Sample I probably because most children scored at chance level, both in the pre-test and in the post-test. In Sample II, the "phonemic analysis" training group improved significantly more than the "no-analysis" training group, but we have to be cautious in interpreting these results, as three children in the "no-analysis" group had very high scores in the pre-test. Even so, the effect on Word Identification is important because the main distinction between Level 2 and Level 3 was the performance in this task, which was related to good performance on all the other measures.

There was no effect of intervention on Analogy Spelling, for either Sample.

Therefore, the results of this study are inconclusive about the effects of readers' explanations on children's understanding of the alphabetic principle, probably due to the short duration of the intervention. Nevertheless, the diagrams in Chapter 7 suggest that the training that involved both syllabic and phonemic analysis of the words ("phonemic analysis" training groups) was more likely to speed up the development of children's understanding of the alphabetic principle, by balancing their progress on all the measures. This is not surprising if we consider that this kind of training helped to make explicit the explanations implicit in children's hypotheses underlying each developmental level, by focussing simultaneously on all the components involved in the understanding of the writing system, as showed next:

1. Children were offered a meaningful clue-word to become familiar with.
2. The clue-word word was segmented into syllables, both graphically and phonologically, and children were encouraged to compose novel words by joining up different syllables. This allowed the pre-syllabic children (Level 1) to realise that the letters correspond to sub-lexical segments and the syllabic children (Level 2) to observe that one sound unit corresponded to a string of letters rather than to a single letter.
3. Each syllable was pronounced separately, always stressing the correspondence between the pronunciation of the sub-syllabic units and the

corresponding letters; children produced new syllables by changing either the vowel or the initial consonant (most syllables were of the CV type). This allowed Level 3 children to grasp the role of each letter within the syllable.

4. Children were encouraged to compare words, as well as to write and to read some words and sentences on their own, by using the clue words, so that they became aware of the relationship between phonological identity and graphic identity.

Further research is needed to confirm the suggestion that this kind of intervention, which allows children to contrast the hypotheses at one level with the hypotheses that characterise the next level, provides a more balanced and possibly faster progress through the developmental levels towards an understanding of the alphabetic principle.

3 *Is there any difference between Portuguese children (attending English schools) and Brazilian children participating in experiment 1:*

a) on the performance of pre-test tasks;

b) on the effects of experimental training?

Sample II children had higher scores on all the pre-test measures except Initial Vowel Recognition. This could be due to three reasons: 1) The mean age of Sample II was higher, as this sample included some seven year olds. 2) The children from Sample I were assessed in the middle of the school year, whereas the children from Sample II were assessed at the end of the school year. 3) Children in Sample II had received instruction on letter-sound correspondence from the age of five years, at school, whereas only the six year old children in Sample I had received instruction on the sound value of the vowels and some syllables.

The effects of intervention were not significantly different for the two samples, after the differences in both the control and the pre-test measures were controlled. The sole exception was Analogy Spelling, where Sample I progressed more than Sample II.

4 *Do children rely on different types of graph-phonetic units to spell Portuguese and English words?*

In the spellings of Sample I children, the vowels were more often used appropriately, whereas the spellings of Sample II children showed a more accurate use of the consonants. This was probably due to differences in the instruction received in school. Even so, it was possible to identify the same levels of evolution of children's invented spelling in both languages; the establishment of letter-to-sound correspondences went through the same successive stages: the word, the syllable, the sub-syllabic units and the phoneme.

5 Do children's spelling strategies in different alphabetic orthographies reflect the same hypotheses about the writing system?

The results of experiment II, presented in chapter 7, showed that most children reached slightly higher levels in English Invented Spelling than in Portuguese Invented Spelling in the pre-test. However, as this did not happen in the post-test, these differences were probably due to order effects in the administration of the tasks, rather than to orthographic differences.

Nevertheless, the comparison of the performance on Analogy Spelling showed that some children made use of analogies in Portuguese before they were able to do so in English. This result suggests that the greater transparency of the Portuguese orthography might have helped children to understand that they could find, within the clue-words, the string of letters that corresponded to the sound they wanted to represent. This does not provide enough evidence for the transfer of conceptions or strategies between the two languages, as it was not possible to compare the performance of this group with the performance of monolingual English children.

In summary, the results presented in chapter 7 suggest that children's hypotheses about the writing system guide the construction of orthographic representations in different (alphabetic) orthographies. For Portuguese speakers, even for those who were being taught literacy in English, the first step towards understanding how letters represent sounds was the correspondence between sounds and letters, at the syllabic level. In Portuguese, the high frequency of CV syllables may ease children's progress to Level 3, because it makes clear that most syllables comprise at least one consonant and one vowel. It also helps children to grasp the role of consonants. In this study it was not clear whether the analysis of words into onsets and rimes plays the same role as in English, as claimed by several authors (Bryant & Bradley, 1985/1987; Goswami, 1986, 1988; Goswami & Bryant 1990, 1992; Treiman, 1992). However, the low scores obtained on the Final Stressed Rime condition of the Word Identification task suggest that, even when the rime corresponds to the rhyme, children do not benefit from the salience of the phonological segment to grasp the corresponding orthographic representation. Likewise, the initial onset was no easier than the initial phoneme.

8.3. Educational Implications

In spite of the different training procedures carried out during the intervention period, the aim of this study was not the comparison of different teaching methods. Of course, any conclusion about the impact of the different procedures would have value for educational purposes. Nevertheless, this study was designed to verify whether it is possible to bring together within a broad theoretical approach different perspectives that may sometimes seem contradictory. In doing so, our main preoccupation was to provide teachers with a theoretical framework which allows them not only to understand children's performance (and, especially, children's "errors") on different literacy tasks, but also to offer the child the appropriate feedback at the right moment.

One of the problems of classroom practices is that the same technique may not be equally suitable for different children, or even for the same child at different times. At the same time, apparently contradictory techniques may be equally efficient.

Out of context, one technique is not right or wrong. It can be more or less adequate, but its adequacy depends on which challenges or answers it is able to offer to a specific child at a specific moment. Therefore, the construction of different tasks, or the use of different techniques, must be guided by relevant assessment of what the child is already able to do, as well as by a solid knowledge of the developmental process that controls literacy acquisition.

The diversity of (and controversy between) perspectives on literacy has been a source of perplexity, which has blurred their contributions for education. It is time to pave the path towards their integration. As researchers, we owe this to practitioners. We hope this study may contribute to this venture.

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APPENDIX 1

INTERVENTION PROGRAM

Description of the Training Sessions

Description of the Training Sessions

Session 1

Groups 2, 3, 4, 5 and 6:

The children worked with their own names, the articles "a" (*the*, fem.) and "o" (*the*, masc.) and the conjunction "e" *(and)*. They drew pictures of themselves with a friend and wrote down the title, such as "O Robson e a Denise". They always had to decide whether they should use "a" or "o", before a girl's or a boy's name, respectively, or "e", between two names. As the two articles and the conjunction are also vowels, children were learning indirectly how to sound these vowels. However, in this session, all the groups were required to work with words as a whole, without any mention to the relationship between sounds and letters. Eventually, some children could already recognise all the vowels, because this had been taught by their teachers, specially in centre B. Even so, most children could only recognise capital letters and, in the training sessions, both capital and small letters were used.

Session 2

Groups 2, 3, 4, 5 and 6:

Children built up simple sentences. The words were printed in individual cards in different colours: red for the verb "gosta" *(likes)*, black for nouns (children's names) and blue for other grammatical categories: the articles "o" and "a", the conjunction "e" and the preposition "de"*(of)*. Then the children chose their own names and the names of their best friends, to form sentences such as "O Kauê gosta de Jacqueline." The children played with the words by mixing and rearranging the cards to form correct sentences. All the children were also asked to pay attention to some sentence conventions such as starting with a capital letter and finishing with a full stop. After building the sentence with the cards, the children copied it and illustrated it on a sheet of paper.

Session 3

Groups 2, 3, 4, 5 and 6:

The children continued working with sentences. The conjunction "e" *(and)* was presented, as well as the contractions of the preposition "de" with the articles "o" and "a", forming "do" and "da". This meant that children had to spot the differences between the single letter words "a", "o" and "e" and between the two letter words "de", "do" and "da", to form sentences like "A Dulce gosta do Carlos e da Samanta" *(Dulce likes Charles and Samantha)* or "O Ricardo gosta da Allana e do Felipe" *(Richard likes Allana and Philip).* Children could also build sentences about the things they liked, by using a drawing to represent the noun, such as "O Wagner gosta de bolo e a Amanda gosta de chocolate" *(Wagner likes cake and Amanda likes chocolate).* Afterwards, the experimenter wrote down the name of the object under the picture.

Children of groups 3, 4 5 and 6 were asked to observe the differences between "da", "de" and "do" and to notice that they finished with the letters "a", "e" and "o", respectively.

Children of groups 4 and 6 (phonemes) were also asked to observe the relationship between sounds and letters by comparing the words "a"/ "da"; "o"/do and "e"/"de", paying attention to their mouths as they pronounced them. They were also showed the difference between the sound of the vowels and the consonant "d". At the end, each child, or group of two children, wrote and illustrated a sentence on a sheet of paper, to be read by the other children.

Sessions 4 and 5

Groups 2, 3, 4, 5 and 6:

The children were given a worksheet with pictures of animals, where they had to:

1 - decide whether they should use “o” or “a” (feminine and masculine article, respectively) before the names of the animals represented by each picture and write the correct letter next to the picture *(all the groups)*;

2 - count the number of legs of each animal and write the number in a square next to the picture *(groups 2 and 5),* or
count and write the number of syllables of the name of each animal *(groups 3, 4 and 6)*;

3- categorise the animals and colour them using the same colour for animals belonging to the same group, according to:
- free classification *(groups 2 and 5)*;
- the number of syllables in their names *(group 3)*;
- the last sound of their names *(groups 4 and 6).*

4 - chose an animal to create a flip-flap with a sentence such as “Anna Carolina gosta da... (over the flap) ...girafa (name and picture, under the flap).” *(All the groups).*

Session 6

Groups 2, 3 and 4:

The children illustrated some of the materials to be used in the next sessions:

- small posters with a picture with its name written in capital and small letters: MATO - RATO - PATO - GATO - FOTO - MOTO; BOCA - BOTA -BOLO - BODE - BOLA; ROSA - RODA - ROCHA *(group 2)*;
- booklets where different words were produced by changing one syllable. The following sets were produced: MA/TO - RA/TO - PA/TO - GA/TO - FO/TO - MO/TO; BO/CA - BO/TA -BO/LO - BO/DE - BO/LA ; RO/SA - RO/DA - RO/CHA *(group 3)*;
- booklets where different words were produced by changing the first M/ATO - R/ATO - P/ATO - G/ATO or the last consonant BO/C/A - BO/T/A -BO/L/A *(group 4).*

From session 7 on, the word posters illustrated by group 2 children were displayed on the wall so that all children could remember the words.

Sessions 7 and 8

Groups 2 and 5:

The children were given a worksheet with words to read, copy and illustrate, from the sample they had illustrated in session 6 (group 2) or words they wanted to learn (group 5).

Groups 3,4 and 6:

Children were shown how the sounds of the words corresponded to the pieces in the syllables booklets. Group 3 children were shown how to segment the syllables by relying on the vowels, whilst groups 4 and 6 were shown how the pronunciation of the syllable was represented by each one of its letters. Then, they were given cards with the syllables that they had to assemble to form the words. They were allowed to look at the posters to check and correct their performance.

Afterwards, each child tried to segment the syllables of CV words that they had suggested and that were written on a board by the experimenter. They could get help from the group or the experimenter, if necessary. They also made a sketch on the board to illustrate the words.

Sessions 9 and 10

Children were offered a worksheet with food words and their illustrations.

Groups 2 and 5:

The children were asked to categorise the pictures and use the same colour to colour all the elements of the same category (drinks, fruits, vegetables, animal products, cooked food - some elements belonged to more than one category, so they should be painted using two or more colours. When they finished colouring, they wrote down and illustrated sentences using their names and the words in the work sheet. Some cards were provided with two novel verbs printed in red: "come" *(eats)* and "bebe" *(drinks)*. So, children produced sentences like "Danielle come batatas e ovo e bebe suco." *(Danielle eats chips and egg and drinks juice)*.

Groups 3, 4 and 6:

The children were required to segment the words in syllables. Most children were expected to be able to segment V, CV and CCV syllables by relying on the vowels. However, some VC and CVC syllables were introduced to provide groups 4 and 6 children with different samples, to improve the awareness of consonantal phonemes. In these cases, group 3 children were only shown the correct segmentation, without mentioning the relationship between the letters and the phonemes within the syllable. Children who finished the task first, wrote sentences like children in groups 2 and 5 children.

Session 11

Groups 2, 3 and 4:

Children learnt to play a memory game with cards where the words mentioned above were printed, both in small and capital letters (without the illustrations). Each child had to identify the word that she/he had picked up. As before, they were encouraged to use the posters to remind them of the words.

Children in group 2 repeated the game with the same words twice, but children from groups 3 and 4 changed the material after the first game, by replacing the words with their syllables. They also had to sound the syllables as they picked them up, and were encouraged to get support from the posters to find the sound of each syllable.

Children in group 4 were also shown how to sound the syllable by blending the phonemes represented by its letters.

Session 12

A look-cover-write-check spelling task was carried out with all the groups, but the procedures were slightly different between groups.

Groups 2 and 5:

Children were shown the whole written word, identified by the experimenter and the children. Then, the experimenter named and pointed each letter within the word, in sequence and repeated the whole word again. Children kept looking to the word while the experimenter counted up to 10 (silently). Then, they picked up their pencils and wrote the word.

Group 3:

Children were also shown the whole word, but then the experimenter covered the second syllable and read the first, counting up to 5 silently; then, covered the first syllable and showed the second, counting up to 5 again; finally, she showed and read the whole word again, counting up to 5 once more. Only then were children allowed to pick up their pencils and write the word.

Groups 4 and 6:

The word was shown and identified as in the other groups. Then, the experimenter slipped her finger under each letter as she repeated it very slowly, exaggerating the pronunciation of each phoneme, but keeping the sounds in a continuum. She repeated this once more and then repeated the word in a natural way and counted to 5 silently before allowing the children to write it down.

Finally, all the children of all the groups, checked and corrected their writing. These procedures were repeated for each word.

Session 13

Group 2:

Children drew pictures freely, writing down the names of the pictures or sentences about them. Most children used known words which they copied from the posters or the cards. If a child required a novel word, the experimenter wrote it on a paper for the child to copy. Two new posters were also produced displaying the most popular words: CASA *(house)* and CARRO *(car)*.

Groups 3 and 4:

Children were required to suggest words containing the syllables “BO”, “RO” and “TO” they had learnt from the posters and the booklets (these were the syllables shared by the different words of the same booklet). The experimenter wrote the suggested words on the board, leaving a blank space where the syllables were supposed to be. Then, all the children copied the words on a sheet of paper, filling the blank spaces with the correct letters.

Children of group 3 were offered some small square cards with different syllables printed on them, so that they could choose and copy the correct one.

Children of group 4 were offered some small square cards with different printed letters to choose those which should be used to make up the correct syllable.

Session 14

Groups 2 and 5:

Children were required to illustrate more word posters, with novel words (starting with letters B and R): BAÚ-BEIJO-BICICLETA-BULE; RÁDIO-RELÓGIO-REDE-RIO-RUA. Afterwards they drew pictures comprising one or more of these or other objects from the posters and wrote their names on them.

Groups 3, 4 and 6:

Children were given a table with the vowels in the first row and the consonants in the first column. The cells inside the table contained all the possible CV syllables made up by the “meeting” of each consonant (moving to the right) with each vowel (moving down).

Children of group 3 were shown how to find all the B “family”, by finding the letter B and going along the same row, to the right, in sequence: BA-BE-BI-BO-BU.

Groups 4 and 6 children were shown how to blend the phoneme represented by letter B with each vowel, in a random sequence. The amalgamation between the letters was dramatised by the experimenter (pretending to be letter B by producing its “sound”) and a child (pretending to be one vowel, by producing its sound), bumping against each other, while the group produced the sound of the syllable. This was repeated with different children pretending to be different vowels.

Then each child from groups 3, 4 and 6 played a look-and-say game, where each child was required to identify the different CV syllables starting with B, printed on cards which were presented to them in random order. The child could get the support of the word posters, if needed. If a child could not identify the syllable, another child was asked to help.

Session 15

Group 2 and 5:
Children played the word memory game (now including the words last introduced).

Groups 3, 4 and 6:
Children performed a task similar to that of session 13, where they had to find and write down the missing syllables (this time using only syllables starting with B).

Session 16

Groups 2, 3 and 4:
All groups performed a look-cover-write-check spelling task as in session 12, now including the new words.

Session 17

Group 2:
Children drew a picture and created one or two sentences about it, which were written by the experimenter on a piece of paper. The sentences were then copied by the children under their pictures.

Groups 3 and 4:
Children in these groups repeated the activities of session 14, but now with letter R instead of letter B.

Session 18

Groups 2 and 5:
Children played a version of memory game where they were given a sheet of paper divided in 24 squares which corresponded to the places of the word cards. Each time a word was revealed, children copied it on the paper to remind them of its place. The game went on following the same rules as usual.

Groups 3, 4 and 6:
Children performed a dictation task where they listened to a word, found and marked its syllables in the table of syllabic "families", by sticking a bit of blu-tack on them and then wrote down the syllables together on paper, to form the word. For syllables starting with a consonant other than R, the experimenter pointed to the poster displaying the word where this consonant could be found. If there was no word with the consonant, the experimenter showed it in the table so that children could find the syllable in the same row.

Session 19

Group 2 and 5:
Children coloured the pictures in a work sheet.

Groups 3,4 and 6:
The same work sheet was used, but children were required to:
1- write the missing syllables of some words (printed under their pictures);
2- copy some syllables of different words, putting them together to make up a novel word (syllables were numbered so that children could know what syllables they were supposed to copy).
3 - read and illustrate the novel word

Session 20

The dictation tasks were repeated.

Groups 2 and 5:
Children performed again a look-cover-write-check spelling task.

Groups 3, 4 and 6:
Children were asked to write novel words with the support of the tables, if necessary.

Whenever there was enough time left, the last minutes of each session were used by all the groups to draw and write about the drawing (picture names, titles...).

All sessions lasted approximately 45/50 minutes.

	a	e	i	o	u
b	ba	be	bi	bo	bu
c	ca			co	cu
c	ça	ce	ci	ço	çu
d	da	de	di	do	du
f	fa	fe	fi	fo	fu
g	ga	gue	gui	go	gu
g		ge	gi		
j	ja	je	ji	jo	ju
l	la	le	li	lo	lu
m	ma	me	mi	mo	mu
n	na	ne	ni	no	nu
p	pa	pe	pi	po	pu
r	ra	re	ri	ro	ru
s	sa	se	si	so	su
t	ta	te	ti	to	tu
v	va	ve	vi	vo	vu
x	xa	xe	xi	xo	xu
z	za	ze	zi	zo	zu

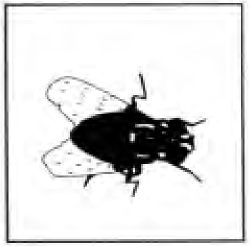
	a	e	i	o	u
br	bra	bre	bri	bro	bru
cr	cra	cre	cri	cro	cru
dr	dra	dre	dri	dro	dru
fr	fra	fre	fri	fro	fru
gr	gra	gre	gri	gro	gru
pr	pra	pre	pri	pro	pru
tr	tra	tre	tri	tro	tru
vr	vra	vre	vri	vro	vru
bl	bla	ble	bli	blo	blu
cl	cla	cle	cli	clo	clu
fl	fla	fle	fli	flo	flu
gl	gla	gle	gli	glo	glu
pl	pla	ple	pli	plo	plu
ch	cha	che	chi	cho	chu
lh	lha	lhe	lhi	lho	lhu
nh	nha	nhe	nhi	nho	nhu
a	a	e	i	o	u
qu	qua	que	qui	quo	o

ar	er	ir	or	ur	b	am	em	im	om	um	r
as	es	is	os	us	d	an	en	in	on	un	s
al	el	il	ol	ul	p	ã	ãe	ão	õe		ui
az	ez	iz	oz	uz	t	ai	au	ei	eu	oi	ou

APPENDIX 2

SAMPLE OF THE MATERIAL USED FOR WORD SIZE TASK

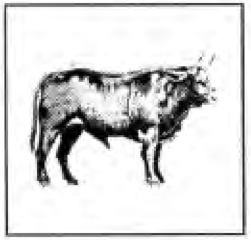
1

cachorro

boi

mosca

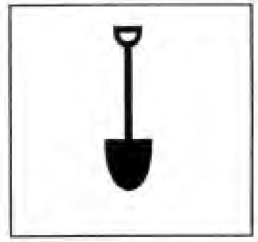
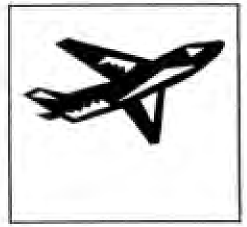


2

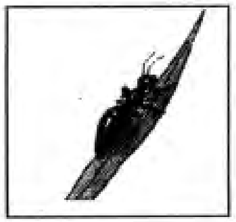
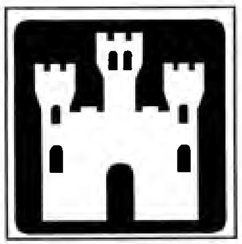
pá

montanha

avião

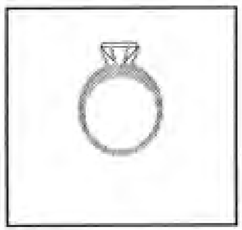
3

anel

castelo

formiguinha



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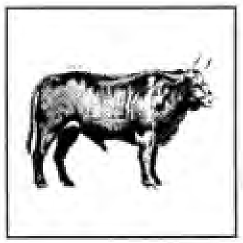
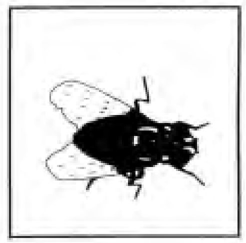


boi

mosca

cachorro

APPENDIX 3

SAMPLE OF THE MATERIAL USED FOR WORD ORTHOGRAPHY TASK

5

búzio	mtg
branches	goose
maçã	IAOEU

7

A8P5XU	police
coelho	iaoeu
OOOO	garage

6

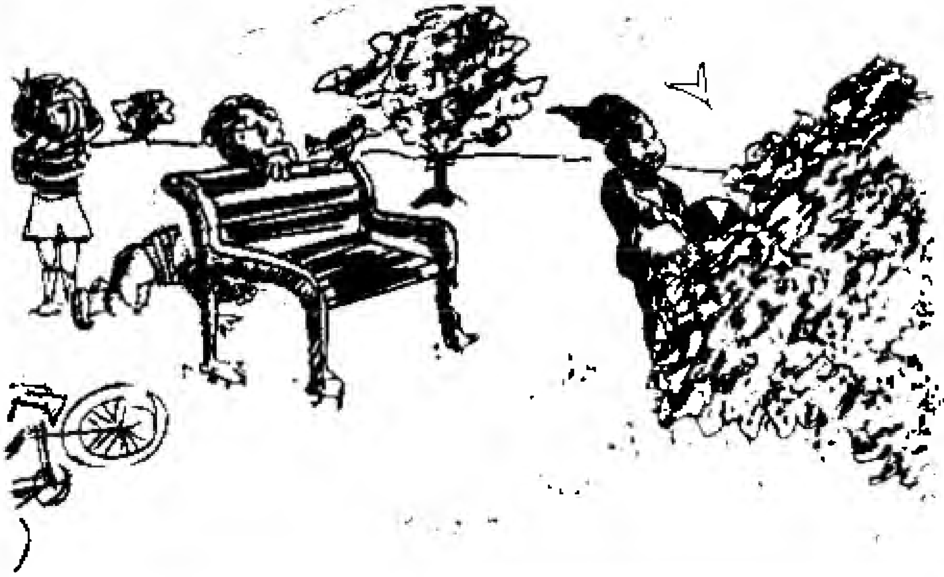
teacher	teapot
formiguinha	πανελα
house	balloon

8

xadrez	pqfhsx
pirate	sheep
limão	OMOMOMO

APPENDIX 4

SAMPLE OF THE MATERIAL USED FOR SENTENCE ORTHOGRAPHY TASK



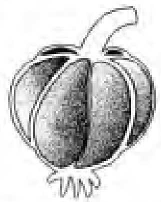
O Saci entrou na mata para esconder a bola do menino

Saci went into the bushes to hide the boy's ball.

APPENDIX 5

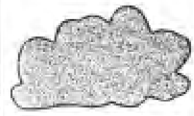
SAMPLE OF THE MATERIAL USED FOR INITIAL LETTER RECOGNITION TASK

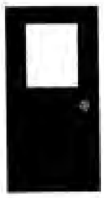
1

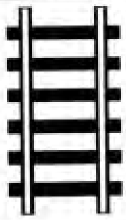
a A 

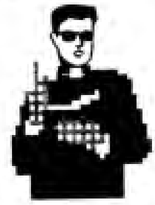
r R 

c C 

f F 

o O 

t T 

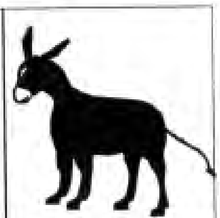
b B 

s S 

e E 

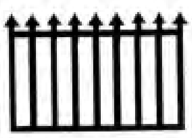
p P 

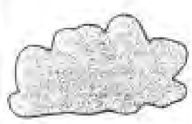
n N 

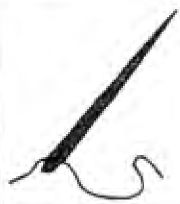
l L 

2

i I 

g G 

m M 

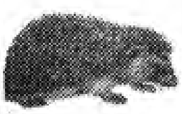
u U 

a A 

r R 

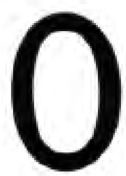
c C 

f F 

o O 

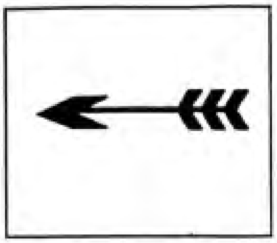
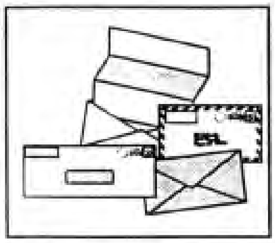
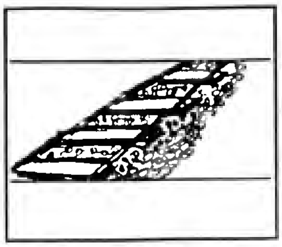
t T 

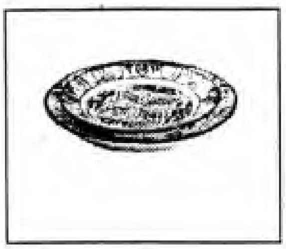
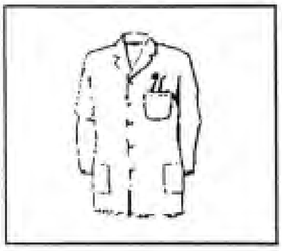
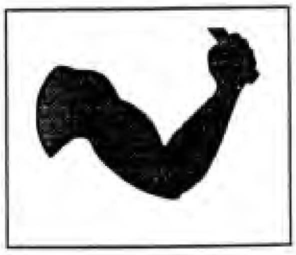
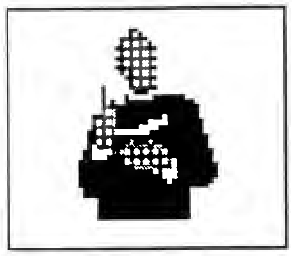
b B 

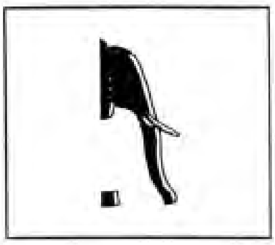
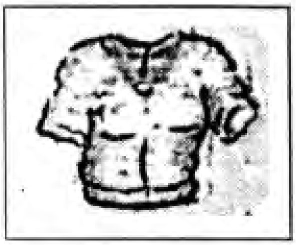
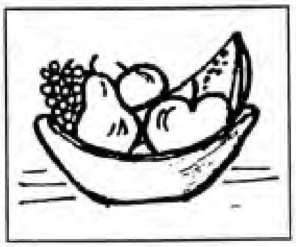
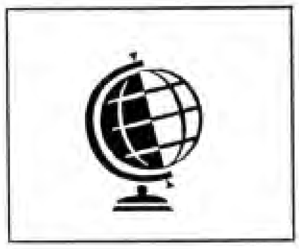
s S 

APPENDIX 6

SAMPLE OF THE MATERIAL USED FOR PHONOLOGICAL PAIRING TASK

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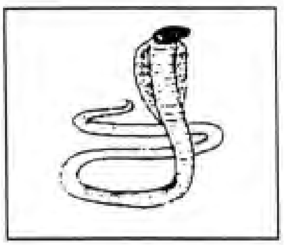
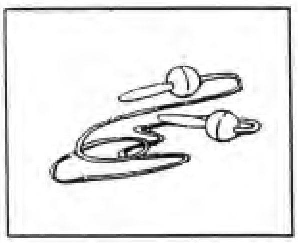
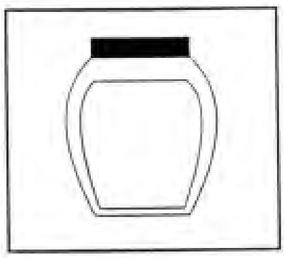
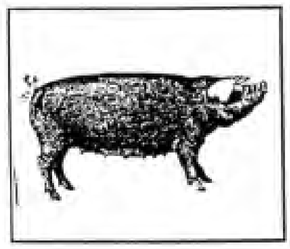

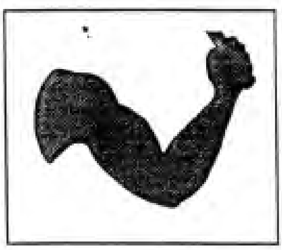
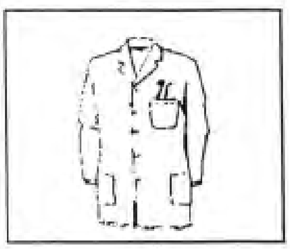
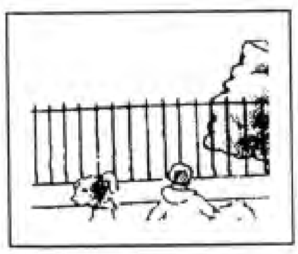
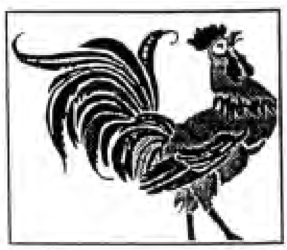

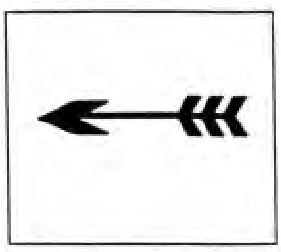
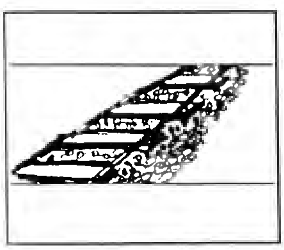
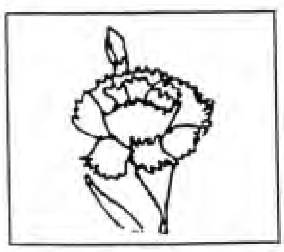
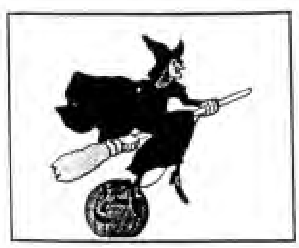

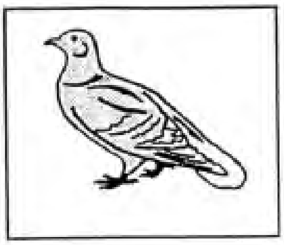  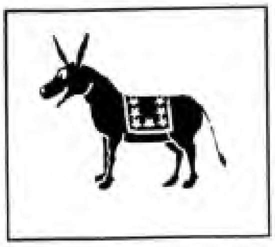 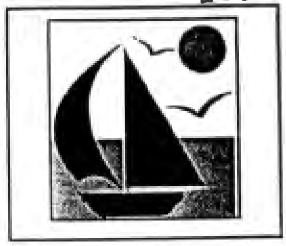

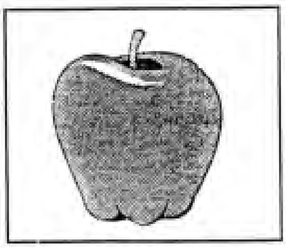  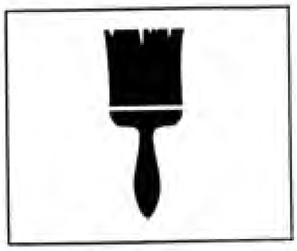 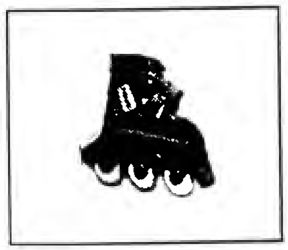

  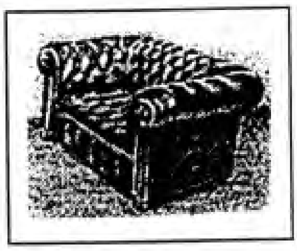 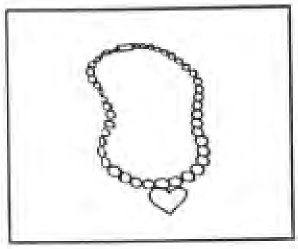

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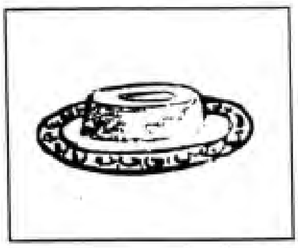
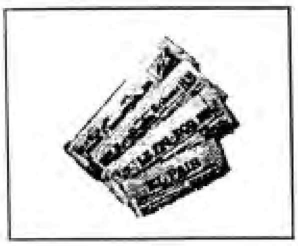
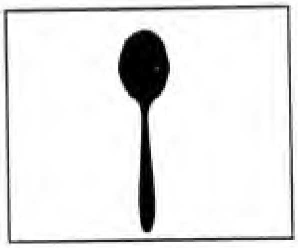
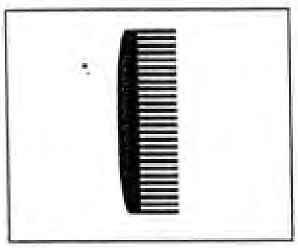
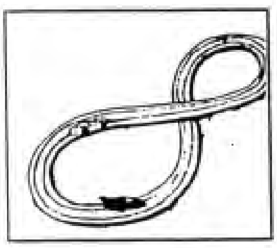
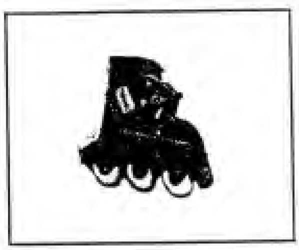
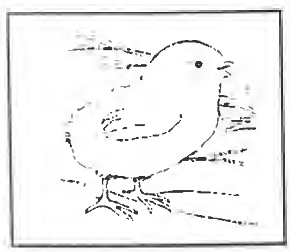
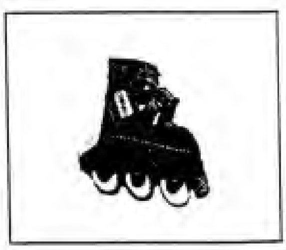
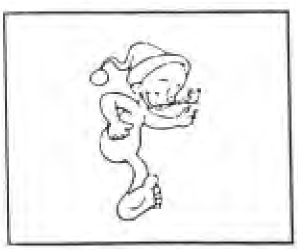
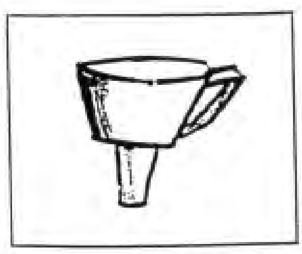
   

APPENDIX 7

TRANSLATION OF THE TEXT USED FOR PORTUGUESE INVENTED SPELLING TASK

Translation of the story used for the Portuguese Invented Spelling task

Once upon a time, there was a girl called Carol, who often got involved in strange adventures. She was very pleased to tell her parents and her friends everything what happened to her. So that she won't forget a thing, she used to make notes about whatever she thought interesting. This is why she always took everywhere a pencil and her secret diary. Actually, she was only five years old and she could not write properly. Even so, she spelled the way she thought it was correct and afterwards she could remember almost everything she wanted to.

(Let's pretend you are Carol? I'll tell you the words that Carol wrote and you write them on that sheet of paper, following the numbers in that list, OK? Don't worry, Carol was only five and she wrote the way she knew. You can do the same. Nobody cares whether it is right or wrong. We are only playing).

One day, Carol was awaken very early by a strange knock on her bedroom window. She got out of the bed and peeped behind the curtains. She saw a couple of pigeons on the window sill, "kissing" each other. She thought they were very funny, so she wrote in her diary *(1)* **POMBO** *(pigeon)* and *(2)* **POMBINHA** *(dove).*

Then she wondered "today is a beautiful day. I will take my doll outside to play with my friends in the park".

In no time, she was in the lobby, ready to go out, but she reminded herself that her mum did not allow her to go outside in the sun without a hat. She went back to her bedroom to get a cap. Then she thought: "It is better to make a list of the things I'm taking with me. I don't want my mum to get cross because I lost them as I did with my jumper and several of my toys. So, she wrote in her diary: *(3)* **BONÉ** *(cap)* and *(4)* **BONECA** *(doll).*

Her mummy was still asleep. Carol knew she had worked till late in the night and she wanted to take the Saturday morning off to rest. Even so, Carol was sure that she would be very worried if she woke up and could not find her daughter. Just in case, Carol tore a sheet of paper off her diary and wrote: *(5)* **PARQUE** *(park).* She fixed the message on the fridge door and off she went.

When Carol arrived at the park, the other children where playing near the pond. Carol found an old newspaper. She suggested to use it to make paper boats. Her mates agreed, so she wrote in her diary: *(6)* **BARCO** *(boat)* and *(7)* **JORNAL** *(newspaper).*

Soon, all the paper boats were soaked and torn, so children decided to start another game. One boy suggested they could hire some donkeys to ride through the wood. There were some tame little donkeys for children to hire in that park and children could afford them.

However, only Carol had brought her pocket money. The other children had to collect it at home. Someone got an idea: "Carol could go ahead. She should leave some clues for us to follow her trail". Everybody agreed with excitement. Before they left, one girl advised: "Take care and don't go deep into the wood, Carol. You could get lost. And please, make easy clues, OK?"

Carol rushed to get the donkey. She saw a signboard with the word "burro" and decided to copy it in her diary: (*8*) **BURRO** *(donkey).*

She chose the cleverest donkey and paid the hire to the caretaker. The donkey was so happy for being released that he started bumping into everything that was in front of him, knocking everything down. Carol laughed and said: "You do a lot of silliness, you fool!" Then, she wrote in her diary (*9*) **BURRICE** *(silliness).*

In the wood, Carol chose a hidden path among the trees. When she hopped off the donkey to draw the first clue, a shadow came from behind the bushes and dragged her into an abandoned hut.

It was a wicked witch!

The witch began stirring a soup in a cauldron and threatened to throw Carol into it if she tried to run away.

The girl started screaming for help but nobody could hear. Only the donkey, who had stayed outside, put his head through the window, into the hut. So the girl had an idea. She tore off a sheet of paper from her diary and wrote two words: (*10*) **BRUXA** *(witch)* and (*11*) **BRUXARIA** *(witchcraft).*

When the witch was not looking, she gave the paper to the donkey and whispered him to get help.

The witch carried on her enchantments. She threw an old rope into the cauldron and turned it into a snake. Carol decided to make notes of the recipe of the witch's soup and wrote in her diary: (*12*) **COBRA** *(snake).*

(To continue next page)

(continued from the previous page)

As soon as the witch finished cooking, she poured a bit of that disgusting soup into a small bottle. Green smoke started to spread out. She said some magic spells; she burst out laughing frightfully and she hold the girl to force her to drink all the liquid.

Carol started kicking, but the witch was stronger and managed to immobilise her. When she was nearly pouring the bottle into the girl's mouth, a golden arrow entered through the window and shot the witch's heart.

The girl looked at the window and realised that the donkey had brought a little Indian.

The little Indian had thrown that magic arrow, which had the power to break the enchantments of wicked people.

The girl thought: "this arrow really saved my life". So, she wrote in her diary: (*13*) **FLECHA** *(arrow).*

The little Indian came into the hut. He recited some magic spells and pulled out the arrow. A black smoke spread out from the witch's heart and she turned into ashes. Quickly, the little Indian threw the ashes into the cauldron and used the golden magic arrow to stir that soup, as he sang a magic Indian song.

Suddenly, the cauldron started to glow and turned into a colourful balloon which floated up to the sky, destroying the hut's straw roof. Carol was completely amazed but she did not forget to write in her diary: *(14)* **BALÃO** *(balloon).*

She wanted to know from the little Indian how he did it, but he had vanished mysteriously. So, she decided to run away before any more odd things happened.

....

Last paragraph of the story used with Sample I:

....

When she pulled the door, she felt a hand shaking her shoulder. She was so frightened that she closed her eyes and didn't dare to breath. Then, she heard her mum's soft and friendly voice: "wake up , Carol. Your friends are outside inviting you to play in the park". She opened her eyes without understanding what was going on. How could she be in her bed? Would it be possible that everything had been a dream?

Continuation of the story used with Sample II:

....

She ran towards the door and she heard a voice shouting: "Cut! It is very good!"

Only then she realised that she was in a movie set. She was very happy: "Wow! I'll be in a movie!". She wrote in her diary: (*15*) **FILME** *(movie)* and (*16*) **FILMAGEM** *(shooting).*

The film director went to meet her, but he stopped astounded when he saw her face. He could hardly ask: "Who are you? Where is Sofia?"

Sofia was the movie star. She was a girl of about the same age as Carol and she looked like her. Nobody could explain how Carol was there, playing Sofia's role. Carol couldn't also understand what was happening and, to worsen her situation, everybody thought she was involved in Sofia's disappearance. The police were called immediately.

Fortunately, Carol's friends arrived at the same time as the police, so everything was sorted out and the children were allowed to help in the search for Sofia.

Carol and her friends started their search near a stream. Now, it was not a game. They were searching for real clues! And they got it: they found the first clue. It was a white and pink roller skate with a name on it: "Sofia".

Carol said: "This is really weird. How could this skate be in here? You can't even use skates in this wood, with such an uneven floor! Don't touch anything. We must inform the police. I'll take notes of everything in my diary." She made a picture of the skate and wrote: *(17)* **PATIM** *(skate).*

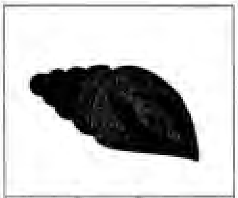
Two children returned to inform the police. Carol and the other children followed Sofia's trail down the stream. Would they find her?...

APPENDIX 8

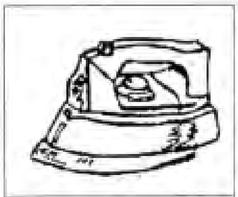
SAMPLE OF THE MATERIAL USED FOR PORTUGUESE ANALOGY SPELLING TASK

1


bule


buzio


carro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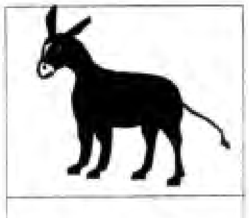
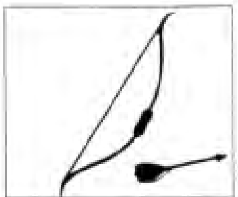


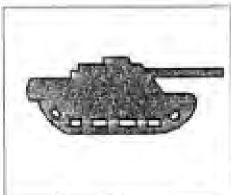

barba


brinco


arco


pardal


leque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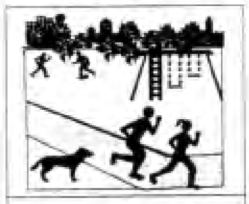
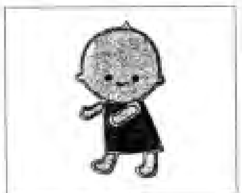
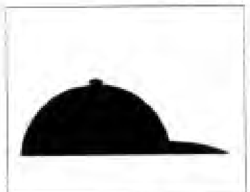


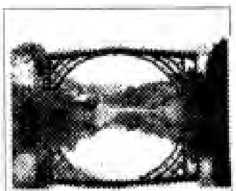
2


bota


caneca



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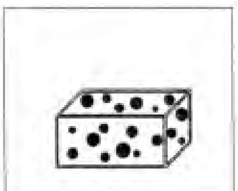
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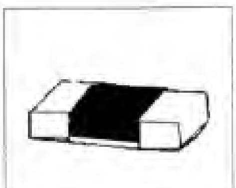
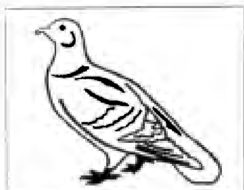
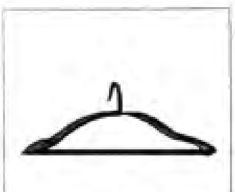

borracha

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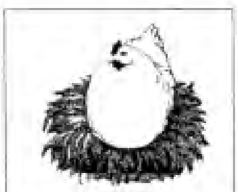
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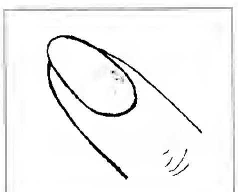
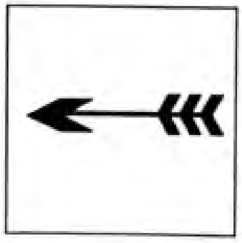
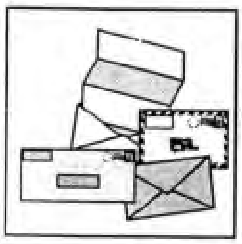
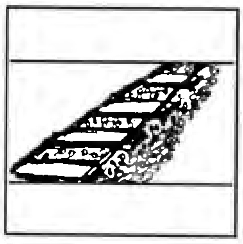

unha

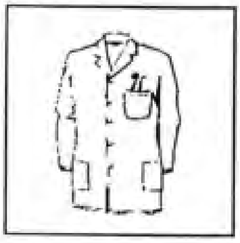
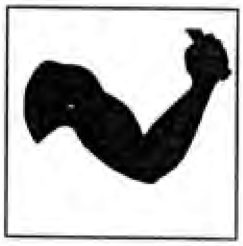
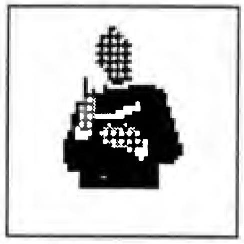
APPENDIX 9

SAMPLE OF THE MATERIAL USED FOR WORD IDENTIFICATION TASK

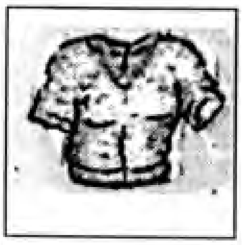
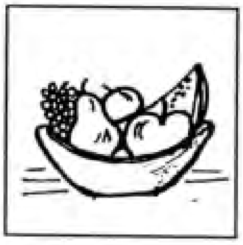
tri■■■


pr■■■

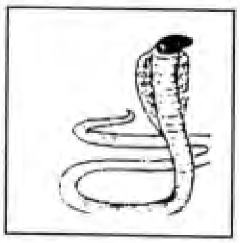





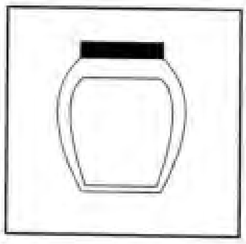
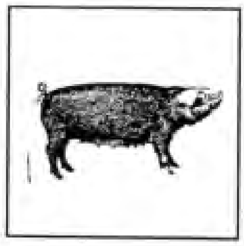
b■■■■


1.1

co■■



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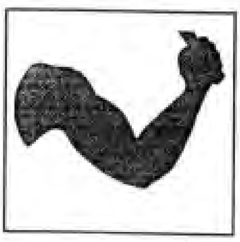
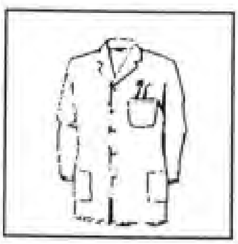
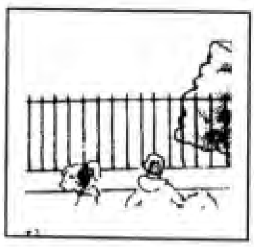
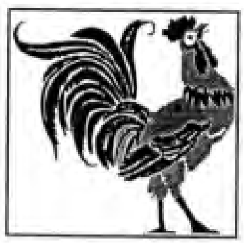

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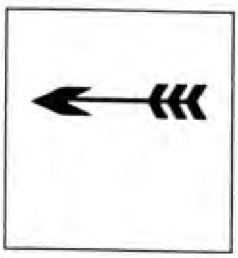
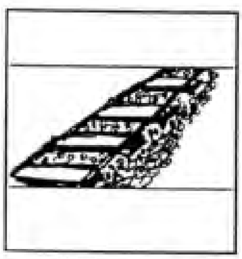
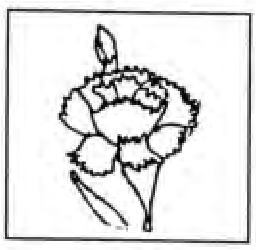


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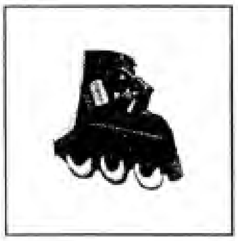
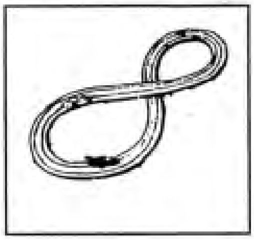

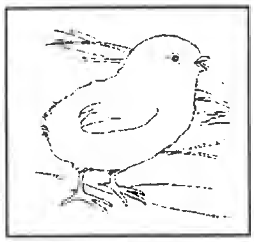

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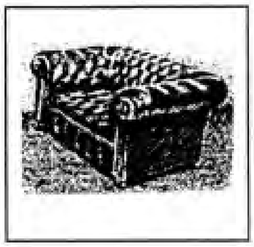


3.1

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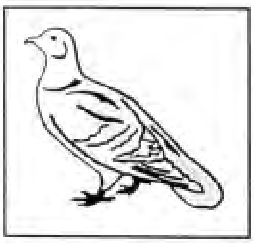

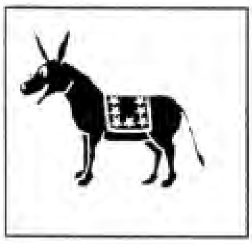


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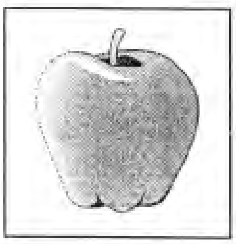
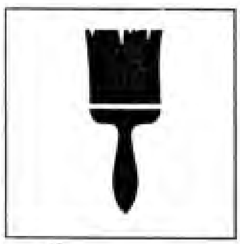
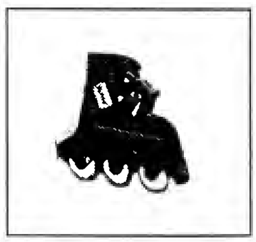
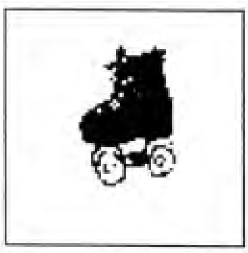
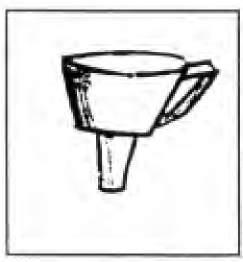


■■■il



APPENDIX 10

TRANSLATION OF THE TEXT USED FOR ENGLISH INVENTED SPELLING TASK

Story used for English Invented Spelling task (Experiment II)

Now Carol has decided that she wanted to write a letter to an English friend, telling her how her adventure has finished. Her friend can't read Portuguese, so Carol has to write the words in English. Can you help her to write the words? Every time I say the word that Carol wants to write, you tell me how we say that word in English and then you write it down on that list, OK?

It was such a hot day that the children decided to go paddling in the water. Soon they felt that the stream bed was so slippery that it looked like a water **SLIDE** *(1)*. They could not help sliding down the stream, till they fell on a very soft lawn. Well, they thought it was a lawn, but actually it was more like a green cloud, as they sank into it slowly and landed softly in a strange place.

The children looked around amazed. The sky was green, the trees were colourful and the flowers shone like diamonds. There were all sorts of things spread about and children soon recognised them: "Look, the car I lost last year." "That is the doll I lost in the park!"; "Here is the jumper I lost in school!"; "And there are my gloves!"; "I can't believe it!"- said Carol - "Look, there is my lost racket!". It was hanging on a tree. Carol hold it and the racket started glowing and pulling Carol along a pathway. "Wow! What a **RACKET** *(2)!*", exclaimed the children. The racket took them to a place where a girl and a Saci were sitting at a table, drinking a cup of tea. Carol whispered: "That girl may be Sofia... and that Saci has got a gold star on his beret and is smoking a golden pipe. I bet he is the Saci's **CAPTAIN** *(3)*."

The Captain saw them and said: "Welcome, children. We were waiting for you. Would you like a cup of tea? Please, take a chair and sit down." The children looked around wondering where would they sit, as all they could see were lots of little doll's chairs spread about. The Captain burst out laughing. He picked up a chair and it grew to fit a child. Everybody did the same and all the chairs grew larger. Children couldn't believe they were in such a magic place. "Let's have some tea", said the Captain. He put his finger up and it started glowing. "He has got a magic **FINGER** *(4)*", said Sofia.

The Captain put his finger into the teapot spout and the teapot started glowing too. "Look! He is pouring his magic into the **TEAPOT** *(5)*!" said a boy.

Then the Captain poured the tea into the tiny doll's cups which were on the table. The tea fell in small colourful shiny drops. Each time a drop touched the cup, it turned into a butterfly. Soon, hundreds of butterflies were flying around and children were trying to catch them. "Let's go on a **BUTTERFLY** *(6)* hunt.", said the children.

The children were laughing happily, running after the butterflies. Suddenly, they heard a loud scary roar. They stopped, frightened: "What is that?" The Captain answered: "That is a **TIGER***(7)*". He continued: "He is harmless for Sacis, but if he bites you, you will become a Saci. This means you'll have to live here forever. You'll be allowed to go back to your world just to frighten people, hide things, smoke their pipes and so on. But your parents will never see you again because you'll be invisible for most adults."

The children cried: "We don't want to stay here forever. We want to go home." "So, hurry up" - said the Captain - "hop on this lorry ". A boy argued: "You're kidding! This is just a toy. My toy! I lost it in the playground. How could it take all of us?" But the Captain wasn't kidding. As he touched the lorry with his magic finger, it grew up. Now it was a big **LORRY** *(8)*. It had room for all the children.

In no time, the Captain was driving at high speed. The children yelled: "Faster, faster! The tiger is catching us!". He drove to a beach where small Sacis were playing with sand, using buckets and spades. He said: "Quickly, jump into this bucket". Carol thought: "This is my **BUCKET** *(9)*. I lost it in the beach last Summer". But she said nothing because the Captain had already touched the bucket with his magic finger so that all the children could fit inside.

However, the children didn't feel safe inside the giant bucket. The tiger might jump into it and bite them. So the Captain introduced a small Saci: "This is the **PAINTER** *(10)*. He will save you."

The painter drew a big circle in the air, above the giant bucket. When he finished, all the Sacis pointed to it with their magic fingers. They puffed and puffed and puffed till the circle turned into a beautiful air **BALLOON** *(11)*. Just in time! The balloon carried the bucket up to the sky, escaping from the tiger's jump. The tiger plunged on the sand.

Up the balloon went, through the green clouds... There it was, above the trees in the park. The children saw the police, the firemen and lots of people looking for them. They waved and yelled "Hey, here we are. We are back! And Sofia is here too".

Unfortunately, the Saci's magic wasn't powerful in children's world. The balloon turned into Carol's bucket and children fell down.

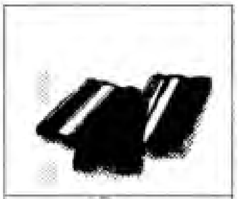
They hang on to the branches of the trees, crying for help. Fortunately, a fireman was nearby. He took a ladder and helped the children down. "Thank you, **FIREMAN** *(12)*", they said.

Soon, there was a crowd around the children. Their parents were there, too. But nobody believed their story. Did you?

APPENDIX 11

SAMPLE OF THE MATERIAL USED FOR ENGLISH ANALOGY SPELLING TASK

3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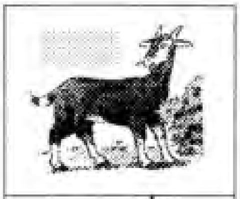
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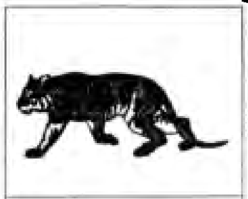
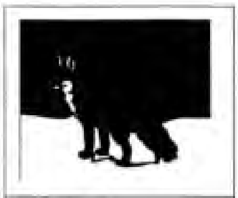
burger

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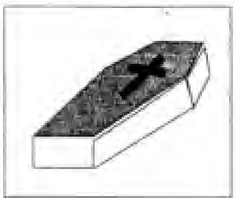
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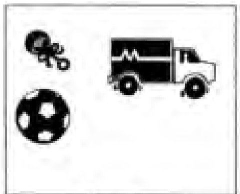
cap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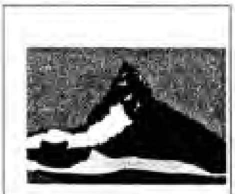
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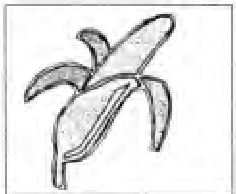
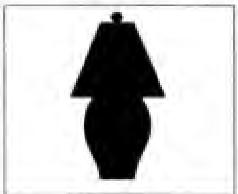
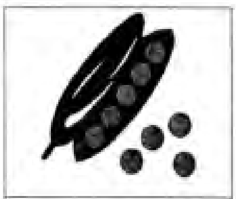
4

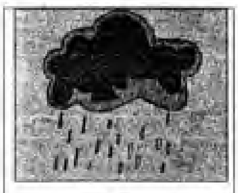

banana


lamp


spoon


moon


peas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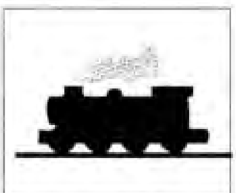
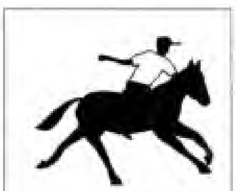

train


winter


slippers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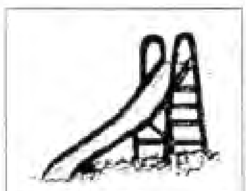

APPENDIX 12

RAW DATA ON CONTROL MEASURES

CONTROL MEASURES: RAW SCORES:

SUBJECTS	SCHOOL	AGE	INTERVENTION GROUP	WISC ANAL.	WISC DIGITS	WORD ORTHOG..	SENTENCE ORTHOG.	SCRIPT CONVENTIONS
1	1	72	3	8	3	1.17	2.67	3.83
2	1	73	1	5	7	2.33	1.50	3.83
3	1	74	2	3	2	2.42	1.50	3.92
4	1	73	3	5	7	2.33	2.33	4.67
5	1	79	1	2	5	1.00	1.17	2.17
6	1	72	1	4	5	2.42	1.17	3.58
7	1	65	1	5	5	3.08	1.33	4.42
8	1	71	1	5	8	1.08	1.00	2.08
9	1	75	4	6	5	.50	1.83	2.33
10	1	79	4	5	7	1.83	1.33	3.17
11	1	62	1	3	6	1.50	2.50	4.00
12	1	76	2	9	7	3.08	1.67	4.75
13	1	77	3	8	7	.25	1.33	1.58
14	1	74	3	8	5	3.00	2.33	5.33
15	1	71	3	5	7	2.75	1.17	3.92
16	1	65	2	6	5	1.67	2.83	4.50
17	1	62	-1	-1	-1	2.58	1.50	4.08
18	1	61	4	2	5	2.25	2.50	4.75
19	1	-1	-1	4	6	.25	1.67	1.92
20	1	76	2	8	7	.00	1.00	1.00
21	1	63	2	6	6	2.83	2.00	4.83
22	1	70	3	5	6	2.33	1.50	3.83
23	1	68	4	6	7	2.00	1.67	3.67
24	1	73	2	5	5	2.00	1.33	3.33
25	1	67	2	4	3	.92	3.33	4.25
26	1	74	2	6	4	.58	1.33	1.92
27	1	62	4	8	7	.92	2.83	3.75
28	1	72	4	7	5	2.33	2.50	4.83
29	1	75	4	8	7	2.50	3.67	6.17
30	1	71	4	5	2	2.67	1.33	4.00
31	1	65	3	3	6	.92	1.17	2.08
32	1	58	1	4	6	1.50	1.50	3.00
33	1	62	1	3	5	1.67	1.50	3.17
42	2	76	1	7	5	2.67	3.00	5.67
43	2	70	3	4	6	2.58	2.33	4.92
44	2	77	2	5	7	-1.00	.60	2.60
45	2	79	4	4	8	1.17	2.17	3.33
46	2	71	4	4	6	1.75	2.83	4.58
47	2	72	4	4	7	.75	.83	1.58
48	2	73	4	3	5	2.50	1.00	3.50
49	2	73	2	2	5	1.67	1.00	2.67
50	2	74	2	6	7	2.92	1.00	3.92
51	2	71	4	2	7	2.42	1.83	4.25
52	2	69	3	3	6	2.67	3.33	6.00
53	2	71	2	8	7	.58	1.83	2.42
54	2	72	1	5	3	1.67	3.33	5.00
55	2	70	3	5	6	1.00	3.00	4.00
56	2	74	4	8	6	1.42	2.73	4.15
57	2	73	1	8	8	3.50	1.50	5.00
58	2	79	1	9	7	3.42	1.17	4.58
59	2	67	3	2	6	1.42	3.00	4.42
60	2	78	4	7	6	1.67	2.33	4.00
61	2	72	3	4	6	2.00	1.83	3.83
62	2	76	1	7	7	2.50	.83	3.33

TABLE CONTINUES

CONTROL MEASURES: RAW DATA (CONTINUED)

SUBJECTS	SCHOOL	AGE	INTERVENTION GROUP	WISC ANAL.	WISC DIGITS	WORD ORTHOG..	SENTENCE ORTHOG.	SCRIPT CONVENTIONS
63	2	72	1	5	1	1.75	1.50	3.25
64	2	69	1	6	5	.50	2.33	2.83
65	2	73	1	3	5	1.77	.67	2.44
66	2	70	2	9	7	3.67	2.17	5.83
67	2	72	2	6	5	2.17	2.50	4.67
68	2	72	2	6	5	.83	1.50	2.33
69	2	76	3	8	8	2.75	.67	3.42
70	2	79	-1	-1	-1	4.00	2.00	6.00
71	2	75	3	11	6	2.67	3.50	6.17
72	2	75	4	8	7	2.25	2.17	4.42
73	2	73	2	6	6	2.00	3.67	5.67
81	3	78	5	3	7	.92	1.83	2.75
82	3	68	5	5	6	2.33	3.50	5.83
83	3	84	5	3	7	1.25	2.83	4.08
84	3	69	5	2	5	2.08	2.67	4.75
85	3	70	6	2	7	3.50	.83	4.33
86	3	77	6	7	8	3.17	3.33	6.50
87	3	79	6	8	6	4.00	3.00	7.00
88	3	74	6	2	6	.92	3.17	4.08
89	3	87	5	7	8	3.67	3.00	6.67
90	3	68	6	7	7	2.83	.83	3.67
91	3	88	6	11	8	3.17	3.67	6.83
92	3	89	5	3	7	1.92	2.50	4.42
93	3	58	5	8	7	3.17	1.67	4.83
101	4	88	5	5	8	2.33	2.00	4.33
102	4	67	6	3	3	2.25	1.83	4.08
103	4	85	6	7	6	2.58	1.50	4.08
104	4	86	6	3	3	1.58	3.33	4.92
105	4	88	6	4	6	1.92	2.17	4.08
106	4	78	6	6	7	1.25	2.00	3.25
107	4	85	5	6	7	3.17	2.33	5.50
108	4	85	6	2	6	2.75	1.17	3.92
109	4	68	5	3	8	2.58	2.92	5.50
110	4	79	5	4	7	2.17	1.67	3.83
111	4	85	5	7	3	2.83	2.00	4.83
112	4	81	6	4	7	2.00	1.00	3.00
113	4	85	6	8	6	2.92	2.50	5.42
114	4	68	5	7	4	1.42	2.00	3.42
115	4	92	5	9	9	4.00	2.67	6.67

VALUE LABELS FOR SCHOOL:

1- CENTRE A (SAMPLE I)
2- CENTER B (SAMPLE I)
3- SCHOOL A (SAMPLE II)
4- SCHOOL B (SAMPLE II)

MISSING DATA FOR ALL THE VARIABLES = -1

WORD SIZE TASK: RAW SCORES

SUBJECTS	BOI	MONTANHA	CASTELO	MOSCA	FORMIGUINHA	CACHORRO	AVIAO	ANEL	PA	SIZE MATCHES	CORBB	CORBS	CORBM	CORSB	CORSS	CORSM	CORMB	CORMS	CORMM	WORDMAT
1	2	3	1	4	2	1	2	2	1	1	0	0	0	0	0	1	1	0	1	3
2	2	4	2	2	2	3	3	2	2	1	0	0	1	0	0	0	0	0	0	1
3	1	4	4	4	3	3	2	4	1	1	0	0	0	1	0	1	0	0	1	3
4	2	4	2	2	1	3	2	4	1	2	0	0	1	0	0	0	0	0	1	2
5	2	4	1	2	1	4	2	2	1	3	0	0	0	0	0	0	0	0	1	1
6	1	3	4	2	1	3	4	2	2	2	0	0	0	0	0	0	0	0	0	0
7	1	3	4	3	1	1	2	4	1	3	0	0	0	0	0	0	1	0	1	2
8	3	4	4	4	1	4	1	3	4	4	0	1	0	0	0	1	0	0	0	2
9	1	1	1	2	2	1	2	2	2	0	1	0	0	0	0	0	1	0	1	3
10	4	4	1	3	2	3	1	3	2	2	0	0	0	0	0	0	0	0	0	0
11	1	1	1	2	2	3	1	3	1	1	1	0	0	0	0	0	0	0	0	1
12	3	3	2	1	2	1	2	4	1	0	0	1	1	0	0	0	1	0	1	4
13	3	3	2	3	2	3	2	2	2	1	0	1	1	0	0	0	0	0	1	3
14	3	2	4	2	3	4	2	2	3	2	0	1	0	1	1	0	0	0	1	4
15	1	4	2	3	2	4	2	2	3	2	0	0	1	0	1	0	0	0	1	3
16	1	2	4	4	1	4	4	4	4	3	0	0	0	0	0	1	0	0	0	1
17	3	3	4	4	1	1	2	2	1	2	0	1	0	0	0	1	1	0	1	4
18	1	3	1	2	2	1	2	2	2	0	0	0	0	0	0	0	1	0	1	2
19	1	1	1	3	1	1	1	3	1	3	1	0	0	0	0	0	1	0	0	2
20	4	1	2	4	3	4	1	3	1	1	1	0	1	1	0	1	0	0	0	4
21	4	3	4	2	4	3	3	4	1	1	0	0	0	0	0	0	0	0	0	0
22	3	4	1	3	2	4	1	3	4	3	0	1	0	0	0	0	0	0	0	1
23	3	4	4	2	1	4	2	4	2	3	0	1	0	0	0	0	0	0	1	2
24	4	2	4	4	1	4	2	4	3	3	0	0	0	0	1	1	0	0	1	3
25	1	3	2	2	1	1	2	2	1	1	0	0	1	0	0	0	1	0	1	3
26	3	4	4	3	3	3	2	2	1	2	0	1	0	1	0	0	0	0	1	3
27	2	4	4	2	2	4	2	2	2	3	0	0	0	0	0	0	0	0	1	1
28	1	3	2	3	1	1	1	4	1	1	0	0	1	0	0	0	1	0	0	2
29	4	4	4	4	3	4	2	4	1	2	0	0	0	1	0	1	0	0	1	3
30	1	3	3	3	3	4	2	4	2	2	0	0	0	1	0	0	0	0	1	2
31	1	1	1	2	2	1	1	2	1	0	1	0	0	0	0	0	1	0	0	2
32	3	4	4	2	2	4	2	3	2	3	0	1	0	0	0	0	0	0	1	2
33	1	3	4	3	2	1	1	3	2	3	0	0	0	0	0	0	1	0	0	1
42	3	4	2	3	2	3	1	2	2	1	0	1	1	0	0	0	0	0	0	2
43	3	3	2	2	1	4	1	3	4	3	0	1	1	0	0	0	0	0	0	2
44	4	2	3	1	2	4	2	2	1	1	0	0	0	0	0	0	0	0	1	1
45	2	1	1	4	3	1	1	3	3	2	1	0	0	1	1	1	1	0	0	5
46	1	1	1	3	1	1	1	4	1	2	1	0	0	0	0	0	1	0	0	2
47	2	4	1	4	2	3	4	3	3	1	0	0	0	0	1	1	0	0	0	2
48	3	4	2	1	2	3	4	2	3	0	0	1	1	0	1	0	0	0	0	3
49	3	1	4	3	1	3	2	2	3	3	1	1	0	0	1	0	0	0	1	4
50	3	1	1	2	2	3	2	3	3	1	1	1	0	0	1	0	0	0	1	4
51	2	4	2	3	2	1	2	3	1	3	0	0	1	0	0	0	1	0	1	3
52	4	1	3	1	4	1	1	3	4	1	1	0	0	0	0	0	1	0	0	2
53	3	1	2	2	1	3	2	2	3	1	1	1	1	0	1	0	0	0	1	5
54	4	4	4	1	4	2	3	1	4	1	0	0	0	0	0	0	0	1	0	1
55	4	2	3	1	4	2	3	1	4	0	0	0	0	0	0	0	0	1	0	1
56	2	3	1	4	4	4	2	4	1	2	0	0	0	0	0	1	0	0	1	2
57	1	1	4	2	1	3	1	2	1	2	1	0	0	0	0	0	0	0	0	1
58	4	1	3	3	2	2	2	1	4	1	1	0	0	0	0	0	0	1	1	3
59	4	4	4	3	4	1	1	1	2	2	0	0	0	0	0	0	1	1	0	2
60	3	1	1	4	3	1	2	4	3	0	1	1	0	1	1	1	1	0	1	7
61	4	2	1	4	3	2	4	1	3	0	0	0	0	1	1	1	0	1	0	4
62	1	1	1	1	2	1	1	2	1	0	1	0	0	0	0	0	1	0	0	2
63	1	1	4	2	2	3	2	4	3	1	1	0	0	0	1	0	0	0	1	3

64	1	1	1	3	3	3	4	4	2	1	1	0	0	1	0	0	0	0	0	2
65	1	1	4	3	3	1	2	2	3	2	1	0	0	1	1	0	1	0	1	5
66	4	3	2	3	1	4	2	1	4	3	0	0	1	0	0	0	0	1	1	3
67	1	1	2	3	1	1	1	4	4	2	1	0	1	0	0	0	1	0	0	3
68	1	1	2	4	1	4	2	3	1	3	1	0	1	0	0	1	0	0	1	4
69	4	4	2	2	3	3	4	2	4	0	0	0	1	1	0	0	0	0	0	2
70	3	1	2	4	3	1	2	4	3	0	1	1	1	1	1	1	1	0	1	8
71	1	3	2	4	1	4	2	2	2	2	0	0	1	0	0	1	0	0	1	3
72	2	4	2	3	1	1	2	3	2	4	0	0	1	0	0	0	1	0	1	3
73	2	3	4	3	3	1	1	2	2	3	0	0	0	1	0	0	1	0	0	2
81	3	1	4	4	3	4	2	4	3	2	1	1	0	1	1	1	0	0	1	6
82	1	1	4	2	4	4	2	4	4	2	1	0	0	0	0	0	0	0	1	2
83	3	3	4	4	3	4	4	4	4	2	0	1	0	1	0	1	0	0	0	3
84	2	3	4	4	3	3	4	4	3	2	0	0	0	1	1	1	0	0	0	3
85	1	1	4	2	3	3	2	3	3	2	1	0	0	1	1	0	0	0	1	4
86	3	1	2	4	3	1	2	4	3	0	1	1	1	1	1	1	1	0	1	8
87	3	1	2	4	3	1	2	4	3	0	1	1	1	1	1	1	1	0	1	8
88	2	4	4	2	2	1	2	4	3	2	0	0	0	0	1	0	1	0	1	3
89	3	1	2	4	3	1	2	4	3	0	1	1	1	1	1	1	1	0	1	8
90	4	2	3	4	2	4	2	4	3	1	0	0	0	0	1	1	0	0	1	3
91	3	1	2	4	3	1	2	4	3	0	1	1	1	1	1	1	1	0	1	8
92	3	1	2	4	3	1	2	4	3	0	1	1	1	1	1	1	1	0	1	8
93	1	1	1	3	1	3	1	3	3	2	1	0	0	0	1	0	0	0	0	2
101	3	1	2	4	3	1	2	4	3	0	1	1	1	1	1	1	1	0	1	8
102	2	2	2	2	2	2	2	2	2	1	0	0	1	0	0	0	0	0	1	2
103	3	4	2	.	1	.	4	4	2	1	0	1	1	0	0	0	0	0	0	2
104	2	1	2	1	2	1	4	1	2	1	1	0	1	0	0	0	1	1	0	4
105	1	1	3	3	.	.	2	.	4	1	1	0	0	0	0	0	0	0	1	2
106	1	3	2	2	2	3	2	2	3	0	0	0	1	0	1	0	0	0	1	3
107	3	1	2	4	3	1	1	4	1	0	1	1	1	1	0	1	1	0	0	6
108	2	1	2	4	3	4	2	4	3	2	1	0	1	1	1	1	0	0	1	6
109	4	1	1	1	2	1	3	1	4	0	1	0	0	0	0	0	1	1	0	3
110	1	1	3	3	3	4	4	3	3	3	1	0	0	1	1	0	0	0	0	3
111	4	2	3	1	2	2	3	1	4	0	0	0	0	0	0	0	0	1	0	1
112	4	2	3	1	4	2	3	1	4	0	0	0	0	0	0	0	0	1	0	1
113	3	1	2	4	3	1	1	4	1	0	1	1	1	1	0	1	1	0	0	6
114	2	3	2	3	3	4	4	4	3	3	0	0	1	1	1	0	0	0	0	3
115	3	1	2	4	3	1	2	4	3	0	1	1	1	1	1	1	1	0	1	8

CORBB - CORRECT MATCH BIG OBJECT / BIG WORD
CORBS - CORRECT MATCH BIG OBJECT / SMALL WORD
CORBM CORRECT MATCH BIG OBJECT / MEDIUM WORD
CORSB - CORRECT MATCH SMALL OBJECT / BIG WORD
CORSS - CORRECT MATCH SMALL OBJECT / SMALL WORD
CORSM - CORRECT MATCH SMALL OBJECT / MEDIUM WORD
CORMB - CORRECT MATCH MEDIUM OBJECT / BIG WORD
CORMS - CORRECT MATCH MEDIUM OBJECT / SMALL WORD
CORMM - CORRECT MATCH MEDIUM OBJECT / MEDIUM WORD
$\}$ 0 = INCORRECT / 1 = CORRECT
WORDMAT - TOTAL OF CORRECT MATCHES

VALUE LABELS:

	BOI	MONTANHA	CASTELO	MOSCA	FORMIGUINHA	CACHORRO	AVIÃO	ANEL	PÁ
CORRECT	3	1	2	4	3	1	2	4	3
SIZE MATCH	2	1	4	3	1	4	2	2	3
BLANK	4	2	3	1	4	2	3	1	4
OTHER	1	3 / 4	1	2	2	3	1 / 4	3	1 / 2

WORD ORTHOGRAPHY TASK: RAW SCORES:

SUBJECTS	marble	crianca	bucket	lorry	mnmo	manha	tape	ctpfmr	story	shape	tiger	agua	marmalade	avo	butterfly	collar	MMWWM	maquina	climber	voce	finger	winter	p6n5t3	coffee
1	1	0	1	0	1	0	0	1	0	1	0	0	0	1	0	1	1	1	1	1	1	0	0	1
2	1	0	1	0	1	0	1	1	1	0	1	1	1	1	1	1	0	1	1	1	1	1	0	1
3	1	0	1	1	0	1	1	1	0	1	0	1	1	0	1	0	0	0	1	1	0	1	1	0
4	0	0	0	0	1	1	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	1	0
5	1	1	0	1	1	0	1	1	0	1	0	1	1	1	1	0	0	1	1	1	0	1	1	0
6	1	0	1	0	1	1	1	0	1	0	0	1	0	1	1	1	1	0	0	0	1	1	0	1
7	0	0	1	0	0	1	1	0	1	0	0	0	0	1	0	0	1	0	1	0	0	0	1	0
8	1	1	1	1	0	1	0	1	1	1	1	1	1	1	1	1	1	0	1	1	0	1	0	1
9	1	1	0	1	0	1	1	1	1	1	1	1	1	1	1	1	0	0	1	1	1	1	1	1
10	1	0	1	0	1	0	1	0	1	0	1	1	1	1	1	0	0	0	1	0	1	0	0	0
11	1	0	1	1	0	1	1	0	1	1	0	1	1	0	1	1	0	1	1	0	1	1	0	1
12	1	0	1	1	0	1	0	1	0	1	0	1	1	0	1	1	0	1	0	1	1	1	0	1
13	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
14	1	1	1	0	0	1	1	1	1	1	1	1	0	0	0	0	0	0	1	1	1	1	1	1
15	1	0	1	1	0	1	0	1	0	1	0	1	0	1	0	0	1	0	1	0	0	1	0	1
16	0	1	0	1	0	1	1	1	0	1	1	0	0	1	0	0	1	0	1	0	1	1	0	1
17	1	0	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1
18	0	1	1	1	0	1	0	1	1	0	1	0	1	1	0	0	0	1	1	1	1	1	1	1
19	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
20	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
21	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	0	1	0	0
22	0	0	1	1	1	0	1	1	0	1	0	1	1	1	1	1	0	0	0	1	0	1	0	1
23	1	0	1	0	0	0	1	1	1	0	1	1	0	0	1	1	1	1	0	1	1	1	0	1
24	1	0	0	1	1	1	1	0	1	1	0	0	0	1	1	0	1	0	1	0	1	1	0	1
25	0	1	1	1	0	1	0	0	1	0	1	1	0	1	1	0	1	1	0	1	1	0	1	1
26	1	0	1	1	1	1	1	1	1	1	1	1	0	1	0	1	0	1	1	0	0	1	1	1
27	0	1	1	1	0	1	1	0	1	0	1	0	1	0	1	1	1	1	0	0	1	1	0	1
28	0	1	0	1	0	1	1	0	1	0	1	0	0	1	0	0	1	0	0	1	1	1	0	1
29	1	1	1	0	0	1	1	1	1	0	0	1	0	1	1	0	0	1	0	0	0	1	1	0
30	1	0	1	0	1	0	1	1	1	0	0	0	0	0	1	1	1	1	1	1	1	0	0	0
31	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0	1	1	1	1	0	1
32	0	1	1	1	0	0	1	0	1	0	0	1	1	0	1	0	1	0	0	1	1	0	0	1
33	1	1	1	0	0	0	1	0	0	1	1	1	1	0	1	1	0	1	0	1	0	1	1	1
42	0	1	0	1	0	1	1	0	1	0	1	0	1	0	1	0	1	0	0	1	0	1	0	1
43	1	1	0	0	1	0	1	1	0	1	0	1	1	1	0	0	0	1	0	1	0	1	0	0
44	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
45	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0
46	1	1	1	0	0	1	1	0	0	1	1	1	1	0	0	1	0	0	1	1	1	1	0	1
47	0	1	1	1	0	1	1	1	1	0	1	0	0	1	0	1	0	1	1	0	1	1	1	1
48	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1	1	1	0	0	1	0	1
49	1	1	0	0	0	1	1	0	1	1	0	1	1	0	1	0	1	0	1	0	1	0	1	0
50	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0	0	1	0	1	0	1
51	0	1	0	1	0	1	0	0	0	1	1	1	1	1	1	0	1	1	0	0	0	1	0	0
52	1	0	0	0	0	1	1	1	0	1	0	0	1	0	0	1	0	1	1	1	0	1	0	1
53	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
54	0	1	0	1	0	1	0	0	1	1	0	1	0	0	0	1	1	1	1	0	1	0	1	0
55	1	1	0	1	1	0	1	1	0	1	1	0	1	1	0	1	1	0	1	1	0	1	1	0
56	1	0	1	0	1	0	1	0	1	1	0	1	1	1	0	1	0	1	1	1	0	1	1	1
57	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0	0	1	0	1	0	1
58	0	1	0	1	0	1	1	0	1	0	1	0	0	1	0	1	0	1	0	1	1	1	0	0
59	1	1	1	0	0	0	0	0	0	1	1	1	1	1	1	0	0	0	0	0	0	1	1	1
60	0	1	1	0	1	0	1	0	1	1	1	0	1	1	0	1	0	1	1	0	1	1	0	1
61	0	1	0	0	1	0	0	1	0	0	1	0	0	1	0	0	1	0	0	1	0	1	1	0
62	1	0	0	1	0	1	0	1	0	0	1	0	0	1	0	1	0	1	1	1	1	0	1	0
63	0	1	0	1	1	1	-1	-1	-1	-1	-1	-1	1	0	1	1	0	1	1	0	1	0	1	1
64	1	1	0	1	1	1	1	1	0	1	0	1	1	0	1	0	0	1	1	0	1	1	1	1

TABLE CONTINUES

WORD ORTHOGRAPHY (CONTINUED)

SUBJECTS	marble	crianca	bucket	lorry	mnmo	manha	tape	ctpfmr	story	shape	tiger	agua	marmalade	avo	butterfly	collar	MMWWM	maquina	climber	voce	finger	winter	p6n5t3	coffee
65	1	0	1	1	1	0	0	1	0	1	0	1	-1	-1	-1	-1	-1	-1	1	0	1	0	1	0
66	0	1	1	0	0	1	1	0	1	1	1	0	0	0	1	1	0	1	0	1	1	1	0	1
67	1	0	1	0	1	0	0	1	1	0	1	1	0	1	1	0	0	1	0	1	1	1	0	1
68	1	1	0	1	1	1	1	1	1	1	1	1	1	1	0	1	0	0	1	1	1	0	1	1
69	1	0	1	0	1	0	1	0	1	1	1	0	1	1	0	1	0	1	1	1	0	0	1	0
70	0	1	1	0	0	0	0	0	0	0	1	1	1	1	1	1	0	1	1	1	1	0	0	0
71	1	0	1	1	0	1	1	0	1	1	1	1	1	1	1	1	0	1	1	0	1	1	0	1
72	0	1	0	1	0	1	1	0	1	0	1	0	0	1	0	1	0	1	1	0	1	1	0	1
73	1	0	1	1	0	1	1	0	1	1	0	1	1	0	1	1	0	1	1	0	1	1	0	1
81	0	1	1	0	0	1	0	0	0	0	0	0	0	1	0	1	1	0	0	0	0	0	0	0
82	1	1	0	0	1	0	1	0	0	0	1	1	0	1	0	1	0	1	1	0	1	1	0	0
83	1	0	1	0	1	0	1	0	1	1	1	0	1	1	0	1	1	0	1	1	1	0	0	1
84	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1	1	0	1
85	0	0	1	1	0	1	0	0	1	1	0	0	1	0	1	1	0	1	1	0	1	0	0	1
86	0	1	1	1	0	0	1	0	1	1	1	1	1	1	0	1	0	1	1	1	1	1	0	1
87	1	0	1	1	0	0	0	0	0	1	0	0	0	1	0	1	0	0	0	0	0	0	0	1
88	0	0	0	1	1	1	0	0	0	1	1	1	0	0	0	1	1	1	0	0	0	1	1	1
89	1	0	1	0	0	1	1	0	1	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1
90	0	1	0	0	1	0	0	1	0	0	1	0	0	1	0	0	1	0	0	1	0	1	0	1
91	1	1	1	0	0	1	0	0	1	1	0	1	0	1	1	1	0	1	0	1	0	1	0	1
92	1	0	0	1	1	1	1	1	0	0	1	0	0	1	0	1	0	1	0	0	0	0	1	1
93	1	0	0	0	1	1	0	0	0	0	0	0	1	0	0	0	1	1	0	0	0	0	0	0
101	0	1	1	1	0	-1	1	0	1	0	1	0	0	1	1	1	0	1	0	1	1	0	0	1
102	1	0	1	0	1	1	0	1	0	1	0	1	0	1	0	0	0	1	1	0	1	0	1	0
103	1	0	1	0	1	0	0	1	1	1	1	0	1	1	0	1	0	1	1	1	0	1	0	1
104	0	0	0	1	1	1	0	1	0	1	1	0	0	1	1	0	1	0	1	0	1	1	1	0
105	1	1	0	0	0	0	1	1	1	1	0	0	1	0	1	1	0	1	1	1	1	0	0	0
106	1	0	1	0	1	1	0	1	0	0	0	1	1	0	1	0	1	0	0	1	0	0	1	1
107	0	1	0	0	0	1	1	-1	1	1	1	1	0	0	1	1	0	1	1	1	1	0	0	1
108	0	1	0	1	0	1	1	0	1	0	1	0	0	1	0	1	0	1	1	1	0	0	0	1
109	1	1	1	0	1	0	0	1	0	0	0	0	1	0	1	1	1	1	1	1	0	0	1	1
110	1	1	1	0	0	0	1	1	1	0	1	1	1	1	0	1	0	0	0	1	1	0	0	0
111	0	1	1	0	1	0	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1
112	1	0	1	1	0	1	1	0	1	1	0	1	1	0	1	1	0	1	1	0	1	1	0	1
113	0	1	0	0	0	1	1	0	1	1	1	0	1	1	1	0	0	1	0	1	0	1	0	1
114	0	1	0	0	1	0	1	0	1	0	1	0	1	0	1	1	0	1	1	0	1	0	1	0
115	1	1	1	1	0	1	1	0	1	1	1	1	0	1	1	1	0	0	0	0	0	1	0	1

VALUE LABELS FOR ALL THE VARIABLES:

0 = REJECTED
1 = ACCEPTED
-1 = MISSING

WORD ORTHOGRAPHY TASK (CONTINUED - DIFFERENT VARIABLES)

SUBJECTS	Buzio	Branches	Maca	Mtg	Goose	IAOEU	Teacher	Formiguinha	House	Teapot	Greek	Balloon	A8p5xu	coelho	OOOO	police	iaoeu	garage	xadrez	pirate	limao	pqfhsx	Sheep	OMOMOMO
1	0	0	0	1	1	1	0	0	1	1	1	1	1	0	0	1	1	1	1	1	1	0	1	0
2	0	1	1	0	1	1	1	0	0	0	0	0	0	1	0	1	0	1	0	1	1	1	1	1
3	1	1	1	0	1	0	0	1	0	1	1	1	0	1	0	1	0	1	1	0	1	1	0	1
4	0	0	0	0	1	0	0	0	0	0	1	0	0	1	0	0	1	0	0	0	1	0	0	1
5	1	1	0	1	0	1	0	1	1	1	1	0	1	1	0	1	0	1	0	1	0	1	0	1
6	1	0	1	0	0	1	1	0	1	0	1	0	0	0	1	0	0	0	1	0	1	0	1	0
7	1	0	1	0	0	0	1	0	1	1	0	1	1	0	0	1	0	1	1	1	0	0	1	0
8	1	1	0	1	1	0	0	1	1	1	1	1	1	0	1	1	1	1	0	1	0	1	1	1
9	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
10	1	0	0	0	0	1	0	0	0	1	0	0	1	0	1	0	1	0	1	0	0	1	0	0
11	1	0	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1	0	1	1
12	1	0	1	0	1	0	1	0	1	1	0	1	1	0	1	1	0	1	1	0	1	0	1	0
13	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1
14	0	0	0	0	0	0	0	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0
15	1	0	1	0	1	0	0	1	0	0	1	0	1	1	0	1	0	0	1	0	0	0	1	0
16	1	0	1	1	0	1	1	0	1	1	0	1	1	0	1	1	0	1	1	1	0	1	1	0
17	1	0	1	0	1	0	0	1	0	1	0	1	1	0	1	0	1	0	1	0	1	0	1	0
18	1	1	1	0	1	0	0	1	0	1	0	1	0	1	0	0	1	0	0	1	0	1	0	1
19	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	0	1	1	1	1	1	1
20	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
21	0	0	1	0	0	0	1	1	1	1	1	0	0	0	0	0	0	0	1	0	0	0	0	1
22	1	0	1	0	1	0	1	0	1	1	0	1	1	0	1	0	1	0	1	0	1	0	1	0
23	1	0	0	1	0	1	1	1	1	1	0	1	0	1	0	1	0	0	1	1	1	1	1	1
24	0	1	1	1	1	0	1	0	1	0	1	0	1	0	0	1	1	1	1	0	1	0	1	0
25	0	0	1	1	1	1	1	1	1	0	1	1	0	1	1	0	1	1	1	0	1	1	0	1
26	1	0	1	1	1	1	0	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1
27	0	1	1	1	0	1	0	1	1	0	1	0	1	1	1	1	1	1	1	0	1	1	0	1
28	1	0	0	1	1	1	0	1	1	1	0	1	1	0	0	1	0	1	0	1	1	0	1	1
29	0	0	1	1	1	0	1	1	1	1	0	0	0	1	1	1	0	0	0	0	1	0	0	1
30	1	1	1	0	0	0	1	1	1	0	0	0	0	0	0	1	1	1	1	1	1	0	0	0
31	1	1	1	1	1	1	1	1	1	1	1	1	0	0	1	1	1	1	0	1	1	1	1	1
32	0	1	0	1	0	1	1	1	1	1	1	1	1	1	0	0	1	0	0	1	0	0	1	1
33	1	1	1	1	1	1	1	0	1	1	0	1	1	1	0	1	1	1	1	1	0	1	1	0
42	1	0	1	0	1	0	0	1	0	1	1	1	0	0	0	1	1	1	0	1	1	0	0	1
43	0	0	0	1	1	1	1	0	1	0	0	1	0	1	0	1	0	1	0	1	0	0	1	0
44	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
45	1	0	1	1	1	0	1	1	1	0	0	0	1	0	1	0	1	0	0	1	0	1	0	1
46	1	0	1	1	1	1	1	1	1	1	1	1	0	1	0	1	1	1	1	1	1	1	1	1
47	0	1	0	1	0	1	1	1	0	0	1	0	1	1	0	0	1	0	1	1	0	1	0	1
48	1	0	0	0	0	1	1	1	0	1	0	1	0	1	0	0	1	0	1	0	1	0	1	0
49	0	1	0	1	0	1	0	1	1	0	1	1	0	1	0	1	0	1	1	0	1	1	0	1
50	1	0	1	0	1	0	0	1	0	1	0	1	1	0	1	1	0	1	1	0	1	0	1	0
51	1	1	1	1	1	1	0	0	0	0	0	0	0	1	0	1	1	1	1	0	0	0	0	0
52	1	1	0	0	0	1	1	0	0	1	0	1	0	1	0	1	1	0	0	1	1	0	1	0
53	1	1	1	1	1	1	0	0	0	1	1	1	0	0	0	1	1	1	0	0	0	1	1	1
54	1	1	1	1	1	1	0	0	0	1	0	1	1	1	0	0	0	1	1	0	1	1	0	1
55	1	1	0	1	1	0	1	1	0	1	1	0	1	1	0	1	1	0	1	1	0	1	1	0
56	0	1	1	0	1	1	1	1	1	0	1	0	1	1	1	0	0	0	1	1	1	1	1	1
57	1	0	1	0	1	0	0	1	0	1	0	1	0	1	0	1	0	1	1	0	1	0	1	0
58	0	1	0	1	1	0	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0	0	1	1
59	1	1	1	1	1	1	0	0	0	1	1	1	0	0	0	1	1	1	1	1	1	1	1	1
60	0	1	0	1	1	1	1	1	1	1	1	1	1	1	0	1	0	1	1	1	0	1	1	1
61	1	0	1	0	1	1	0	1	0	1	1	0	0	1	0	1	0	1	0	1	0	0	1	0
62	1	1	1	0	1	0	0	1	0	0	1	0	0	1	0	1	1	1	1	1	1	0	1	0
63	1	1	1	0	0	0	1	1	1	1	1	1	1	1	0	1	1	1	0	1	1	1	1	0
64	0	0	0	1	1	1	0	0	0	1	1	1	1	1	0	1	1	1	1	0	1	1	0	1

TABLE CONTINUES

WORD ORTHOGRAPHY (CONTINUED)

SUBJECTS	Buzio	Branches	Maca	Mtg	Goose	IAOEU	Teacher	Formiguinha	House	Teapot	Greek	Balloon	A8p5xu	coelho	OOOO	police	iaoeu	garage	xadrez	pirate	limao	pqfhsx	Sheep	OMOMOMO
65	1	0	0	1	0	0	0	1	0	1	1	0	1	0	0	1	0	1	1	0	0	1	0	0
66	0	0	0	1	1	0	1	0	1	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0
67	0	1	1	0	0	1	0	1	1	1	0	1	0	1	0	0	1	1	1	0	1	0	0	1
68	0	1	1	1	1	1	1	0	1	0	1	1	1	1	0	1	1	1	1	1	1	0	1	1
69	1	0	1	0	1	0	1	0	1	0	1	0	1	0	0	1	0	1	1	0	1	0	1	0
70	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
71	1	0	1	1	1	1	1	0	1	1	0	1	0	1	0	1	1	1	0	1	1	0	1	0
72	0	1	0	1	0	1	1	0	1	0	1	0	1	0	1	1	0	1	1	0	1	0	1	0
73	1	0	1	1	0	1	1	0	1	1	0	1	1	0	1	1	0	1	1	0	1	1	0	1
81	1	1	1	1	1	1	1	0	0	0	1	0	1	1	1	0	1	1	1	1	1	1	1	1
82	0	1	0	0	1	0	0	1	0	1	1	0	1	0	0	1	1	0	0	0	1	0	0	1
83	1	0	1	1	1	1	0	0	0	1	1	1	0	0	0	1	1	1	0	0	0	1	1	1
84	1	0	1	0	1	1	1	0	1	0	1	0	0	1	0	1	0	1	0	1	0	1	0	1
85	1	0	1	0	1	0	1	1	0	0	0	1	0	0	0	1	1	1	1	0	1	0	1	0
86	0	1	0	1	1	0	1	1	1	0	0	1	0	1	0	0	1	1	0	1	1	0	1	0
87	1	0	0	0	0	0	0	0	0	1	0	1	0	1	0	1	0	1	0	1	0	0	0	0
88	0	0	0	1	1	1	0	0	0	1	1	1	0	0	0	1	1	1	0	0	0	1	1	1
89	1	0	1	0	1	0	1	0	1	1	0	1	0	1	0	1	0	1	0	1	0	1	1	0
90	1	1	1	0	0	0	1	0	1	0	1	1	0	1	0	1	0	1	0	1	0	0	1	0
91	1	1	1	0	0	0	1	0	1	0	0	1	0	1	0	1	1	1	1	1	1	1	1	0
92	1	1	1	1	0	0	0	1	0	1	0	1	1	1	0	1	1	0	1	1	1	0	1	0
93	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
101	0	1	1	1	1	1	1	1	1	0	0	1	0	1	0	1	1	0	0	1	0	1	1	0
102	1	0	1	0	1	0	0	1	0	1	0	1	0	0	1	1	0	1	1	0	1	1	0	1
103	1	0	1	0	1	1	1	1	0	1	0	1	1	0	0	1	0	1	1	1	0	0	1	0
104	1	1	0	1	1	0	0	1	0	1	0	1	1	1	0	1	0	1	1	0	1	1	0	1
105	0	1	0	1	1	0	1	1	0	1	1	0	1	1	0	1	1	1	1	0	1	0	1	1
106	1	1	0	0	0	1	0	0	1	0	0	0	0	1	0	0	1	1	1	0	0	1	0	1
107	0	1	0	0	1	0	1	0	0	1	1	1	0	1	0	1	0	1	0	1	0	1	-1	0
108	0	1	0	0	1	0	0	0	1	1	1	0	1	1	1	0	0	1	0	1	0	1	0	0
109	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
110	0	1	0	1	1	0	1	1	1	1	1	1	0	1	0	1	1	1	1	1	0	1	1	0
111	1	0	1	0	1	0	0	1	0	1	0	1	0	1	0	1	0	1	1	0	1	1	0	1
112	1	0	1	1	0	1	1	0	1	1	0	1	1	0	1	1	0	1	1	0	1	1	0	1
113	1	0	0	0	1	0	0	0	0	1	1	0	0	1	0	0	1	1	1	0	0	0	1	1
114	1	1	0	1	1	1	0	1	0	1	0	1	1	1	0	0	1	0	1	0	1	1	1	0
115	0	1	0	0	0	0	1	0	1	1	0	1	0	0	0	1	0	0	0	0	1	0	1	0

VALUE LABELS FOR ALL THE VARIABLES:

0 = REJECTED
1 = ACCEPTED
-1 = MISSING

SENTENCE ORTHOGRAPHY TASK: RAW SCORES

SUBJECTS	NO SEGMENT	ENGLISH	CORRECT LOWER CASE	GREEK	SYLLABIC SEGMENT.	HANDWRITING LOWER CASE	TWO WORDS REPEATED	MIRROR	HANDWRITING CAPITAL.	FOUR LETTERS SEGMENTATION	NONONO	BIG SEGMENTS	CORRECT CAPITAL	UPSIDE-DOWN
1	0	0	1	1	0	1	0	1	0	1	0	1	0	0
2	1	1	0	1	0	1	1	1	1	0	1	0	1	0
3	1	1	0	0	1	1	0	1	1	0	1	0	1	1
4	1	0	1	1	0	1	0	1	1	1	1	1	1	1
5	0	1	0	1	0	1	0	1	0	1	0	0	0	1
6	0	1	0	1	0	1	0	1	0	1	1	1	0	0
7	1	0	0	1	1	0	1	0	0	0	1	0	1	0
8	0	1	0	1	0	1	0	1	0	1	0	1	0	1
9	1	1	0	0	1	1	0	1	1	0	1	0	1	0
10	1	1	0	0	1	0	0	0	0	0	1	1	0	0
11	1	0	1	1	0	1	1	0	0	0	1	0	0	1
12	1	1	0	1	0	1	1	0	0	1	1	0	1	0
13	1	1	0	0	0	1	1	0	0	1	0	1	0	1
14	0	1	1	0	1	0	1	0	1	0	1	1	0	1
15	0	1	0	1	0	0	1	0	0	1	0	1	1	1
16	0	1	1	0	1	0	1	1	0	1	0	0	1	0
17	1	0	0	0	1	0	0	0	0	0	0	1	0	0
18	1	1	1	0	1	0	1	1	0	1	0	1	1	0
19	1	0	0	0	1	1	1	0	0	0	0	1	0	0
20	1	1	0	1	1	1	1	1	1	1	0	0	0	0
21	1	1	1	1	1	1	1	1	1	1	1	1	1	1
22	1	1	0	1	0	1	0	1	0	1	0	1	1	0
23	1	1	0	0	1	1	1	0	0	1	1	1	1	0
24	0	0	0	0	1	0	1	1	0	0	1	1	1	0
25	1	0	1	1	0	1	0	0	1	0	0	1	1	0
26	1	1	0	1	0	0	1	0	1	0	0	0	0	0
27	1	0	1	1	0	1	0	1	1	1	1	0	1	0
28	1	1	1	0	1	0	0	0	0	1	0	0	0	1
29	1	0	1	0	0	1	0	0	1	0	1	0	1	0
30	1	1	0	1	0	1	1	0	1	1	1	0	1	1
31	0	0	0	1	1	1	1	0	0	1	1	1	0	0
32	0	1	0	1	1	0	1	0	1	0	1	0	1	0
33	0	1	0	0	1	0	1	1	1	0	1	0	1	0
42	0	0	1	0	0	1	0	0	1	0	1	1	0	1
43	1	1	1	0	1	1	1	1	0	1	1	1	1	1
44	0	1	0	1	-1	-1	0	1	0	1	0	1	0	1
45	0	0	1	1	0	0	1	0	1	1	0	1	0	1
46	1	0	1	0	0	0	1	0	1	0	0	1	0	0
47	1	1	0	0	1	0	1	1	0	1	0	1	0	0
48	0	1	0	1	0	1	0	1	0	1	0	1	0	1
49	0	1	0	1	0	0	1	0	1	0	0	1	0	1
50	0	1	0	1	1	1	1	0	1	0	1	1	0	1
51	1	1	1	1	0	0	1	0	0	1	1	1	0	1
52	1	0	1	0	1	1	0	0	0	1	0	1	1	0
53	0	0	0	0	0	0	0	0	0	1	0	0	0	0
54	1	0	1	0	1	1	0	0	1	1	0	1	1	0
55	1	0	1	0	1	0	1	0	1	1	0	0	1	0
56	1	0	1	0	-1	1	0	1	0	1	0	1	0	0
57	0	1	0	1	0	1	1	0	1	0	1	1	1	1
58	1	0	0	0	0	0	1	1	0	1	1	1	1	0
59	1	0	1	0	1	1	0	1	0	1	0	1	1	0
60	1	1	1	1	1	1	1	1	1	1	1	1	1	0
61	1	0	0	1	0	1	1	0	0	0	1	0	1	0

TABLE CONTINUES

SENTENCE ORTHOGRAPHY (CONTINUED)

SUBJECTS	NO SEGMENT.	ENGLISH	CORRECT LOWER CASE	GREEK	SYLLABIC SEGMENT.	HANDWRITING LOWER CASE	TWO WORDS REPEATED	MIRROR	HANDWRITING CAPITAL.	FOUR LETTERS SEGMENTATION	NONONO	BIG SEGMENTS	CORRECT CAPITAL	UPSIDE-DOWN
62	0	1	0	1	0	0	1	1	0	1	0	1	0	0
63	1	1	0	0	1	0	1	0	1	0	1	1	1	0
64	1	1	1	0	1	0	1	1	0	1	1	1	1	0
65	0	1	0	1	1	0	1	0	0	1	0	1	0	1
66	0	1	0	0	1	0	0	0	1	0	0	0	1	0
67	1	1	1	1	1	1	1	1	0	1	0	1	1	0
68	1	1	0	0	1	0	1	0	1	1	0	1	1	0
69	1	1	0	1	0	0	1	1	0	0	1	1	0	0
70	1	0	0	0	0	0	0	0	0	0	0	1	1	0
71	0	0	1	0	1	1	1	0	0	0	0	1	1	0
72	1	0	1	0	1	0	0	1	0	0	1	0	0	1
73	1	0	1	0	0	1	0	0	1	1	0	0	1	0
81	0	1	1	0	1	0	1	1	1	1	1	1	0	1
82	1	0	1	0	0	1	1	0	1	0	1	0	1	0
83	0	1	1	0	0	1	1	1	0	1	0	1	0	0
84	0	0	1	1	1	1	1	0	0	0	0	0	0	1
85	1	0	0	0	1	0	1	0	0	1	0	1	0	1
86	0	1	1	0	0	0	1	0	0	1	0	0	1	0
87	0	1	1	0	1	0	0	0	0	1	0	0	0	0
88	1	1	1	0	1	1	1	0	0	1	0	1	1	0
89	0	1	1	0	1	0	1	0	0	1	0	1	1	0
90	0	1	0	0	1	0	1	1	0	0	0	1	0	1
91	0	0	1	0	1	1	0	0	0	1	0	0	1	0
92	1	1	1	0	1	0	1	1	0	1	0	1	1	0
93	0	1	0	1	0	1	0	0	0	1	1	0	0	0
101	0	1	0	0	0	0	0	0	0	0	0	0	0	0
102	1	1	1	1	1	0	1	1	1	0	1	1	1	1
103	1	1	0	0	1	1	1	0	0	1	0	1	0	0
104	0	0	1	0	1	1	0	1	1	0	1	0	1	0
105	1	1	1	0	1	0	1	1	0	1	0	1	1	1
106	1	1	1	0	1	0	1	1	0	1	1	1	1	1
107	1	1	1	0	1	0	0	1	0	1	0	1	0	0
108	0	1	0	1	0	1	0	0	1	1	1	1	0	1
109	-1	-1	1	0	1	0	1	-1	-1	-1	1	0	1	0
110	0	1	0	1	0	1	0	0	0	1	0	1	0	0
111	1	1	1	1	1	1	1	1	1	1	1	1	1	1
112	0	1	0	1	0	1	0	1	0	1	0	1	0	1
113	1	0	1	0	1	0	1	0	1	1	0	1	0	0
114	1	1	1	1	1	1	1	1	1	1	1	1	0	0
115	1	1	1	1	1	1	1	0	1	1	1	1	1	0

VALUE LABELS FOR ALL THE ITEMS:

0 = REJECTED
1 = ACCEPTED
-1 = MISSING

APPENDIX 13

RAW DATA ON INITIAL LETTER RECOGNITION

INITIAL LETTER RECOGNITION: RAW SCORES (PRE-TEST)

SUBJECTS	V PORTUGUESE	CV SYLLABLE (VOWELS)	VC SYLLABLE	V INCORRECT	VC NASAL	V ENGLISH	CV PORTUGUESE	VCV PORTUGUESE	CV SYLLABLE (CONSONANTS)	CV INCORRECT	CCV SYLLABLE	CV SAME ARTICULATION	CV ENGLISH	VC ENGLISH	CV ALTERNATIVE	CV SYLLABLE TOTAL
1	2	5	2	3	2	3	1	5	2	9	1	9	0	4	0	2
2	5	0	5	0	5	1	5	0	7	7	4	4	3	0	3	10
3	5	1	3	1	5	2	5	1	7	2	6	5	3	1	3	10
4	3	1	3	0	2	2	5	2	7	4	4	5	4	2	4	11
5	5	0	5	2	4	2	4	0	10	1	5	2	5	1	3	13
6	5	0	5	0	5	1	5	0	11	0	6	0	5	0	5	16
7	5	0	4	0	5	1	5	0	11	0	6	0	5	1	5	16
8	4	1	4	0	4	2	3	2	6	3	4	5	3	2	2	8
9	5	0	5	2	5	1	4	2	10	3	4	2	5	2	4	14
10	4	3	4	4	3	4	5	4	1	11	0	11	1	5	0	1
11	5	0	5	0	4	1	4	0	10	0	6	0	5	0	5	15
12	3	5	3	4	1	4	2	2	3	9	2	10	1	5	1	4
13	5	0	5	4	3	4	5	2	3	7	4	8	0	3	1	4
14	4	1	4	1	5	1	3	0	8	2	4	2	5	2	4	12
15	4	1	5	0	4	1	5	1	10	2	5	0	5	1	5	15
16	5	0	5	0	5	1	5	0	11	0	6	0	5	0	5	16
17	-1	-1.	-1.	-1.	-1.	-1.	-1.	-1.	-1.	-1.	-1.	-1.	-1.	-1.	-1.	-1.
18	5	0	5	0	5	1	5	0	11	1	5	0	5	1	5	16
19	.-1	-1.	-1.	-1.	-1.	-1.	-1.	-1.	-1.	-1.	-1.	-1.	-1	-1.	-1.	-1.
20	4	4	5	4	2	5	5	5	3	10	2	9	2	6	3	6
21	2	3	1	2	4	1	3	1	3	5	6	4	3	4	5	8
22	5	0	4	1	4	1	3	0	7	4	4	2	5	2	5	12
23	2	3	3	2	4	3	4	4	6	4	4	2	5	4	3	9
24	5	0	5	0	5	1	4	0	11	0	6	0	5	0	5	16
25	4	0	5	0	5	2	5	0	11	1	6	0	5	0	5	16
26	5	0	5	0	5	2	5	0	11	1	4	0	5	1	5	16
27	5	0	3	0	5	2	4	1	7	4	3	4	3	2	5	12
28	3	1	4	0	4	3	1	2	7	3	2	4	2	3	2	9
29	5	3	5	3	4	5	5	2	9	9	4	7	4	2	4	13
30	5	0	5	0	4	1	5	0	11	1	6	0	5	0	5	16
31	1	4	0	5	1	3	0	5	1	11	1	10	1	5	1	2
32	5	0	5	0	5	0	5	0	11	0	4	0	5	0	5	16
33	4	1	4	0	4	1	5	3	10	2	6	1	4	2	2	12
42	4	1	4	3	3	2	3	2	6	8	2	3	3	4	4	10
43	4	1	3	1	4	3	3	1	6	4	5	4	4	2	4	10
44	3	5	3	4	3	5	2	4	3	6	4	4	3	3	3	6
45	4	3	4	4	5	4	5	3	4	10	3	7	0	0	1	5
46	4	5	4	5	2	5	4	6	1	10	1	10	1	5	0	1
47	4	4	3	3	2	4	3	1	4	9	1	7	2	3	3	7
48	3	2	4	0	4	2	3	4	2	4	3	7	2	2	2	4
49	1	1	3	4	3	4	4	2	8	3	5	4	2	1	3	11
50	4	4	4	3	4	3	5	3	5	5	4	4	3	4	1	6
51	5	0	5	0	5	1	5	1	9	2	4	0	5	1	5	14
52	5	1	3	0	4	1	4	2	6	5	3	4	1	1	5	11
53	5	0	5	0	5	0	5	1	11	0	5	1	5	0	5	16
54	5	1	4	0	5	0	4	2	3	4	4	3	4	2	4	7
55	2	5	1	3	3	0	3	3	6	6	4	8	3	2	1	7
56	5	3	4	5	3	5	5	2	7	10	2	8	2	3	1	8
57	4	0	5	5	3	5	4	4	2	11	0	11	0	4	1	3
58	3	2	4	5	4	5	4	5	1	7	0	10	0	4	0	1
59	4	1	3	3	4	2	4	3	5	7	1	5	3	4	3	8
60	5	3	5	4	3	5	4	3	3	10	2	8	1	5	4	7
61	4	3	5	0	3	1	4	2	9	6	5	5	4	3	4	13

TABLE CONTINUES

INITIAL LETTER RECOGNITION: PRE-TEST (CONTINUED)

SUBJECTS	V PORTUGUESE	CV SYLLABLE (VOWELS)	VC SYLLABLE	V INCORRECT	VC NASAL	V ENGLISH	CV PORTUGUESE	VCV PORTUGUESE	CV SYLLABLE (CONSONANTS)	CV INCORRECT	CCV SYLLABLE	CV SAME ARTICULATION	CV ENGLISH	VC ENGLISH	CV ALTERNATIVE	CV SYLLABLE TOTAL
62	4	3	4	3	2	4	5	2	5	10	4	10	1	2	3	8
63	5	1	5	0	5	1	5	0	10	1	6	0	5	0	5	15
64	5	0	5	0	5	1	5	0	11	0	6	0	5	0	5	16
65	3	3	3	4	1	5	2	3	4	7	3	7	1	4	1	5
66	4	2	4	5	1	5	4	4	1	9	0	11	0	5	0	1
67	4	3	4	2	2	5	2	1	7	5	4	4	1	0	2	9
68	4	4	5	5	1	5	4	4	1	11	0	11	0	5	0	1
69	5	3	5	3	2	5	4	2	6	10	3	7	4	4	4	10
70	-1	-1.	-1.	-1.	-1.	-1.	-1.	-1.	-1.	-1.	-1.	-1.	-1.	-1.	-1.	-1.
71	3	4	3	4	3	3	3	2	6	6	3	5	1	2	3	9
72	4	2	4	5	3	4	5	3	3	11	3	10	2	2	4	7
73	5	0	5	0	5	1	5	0	11	0	6	0	5	0	5	16
81	3	5	4	3	5	1	5	5	10	10	6	11	4	5	5	15
82	5	2	4	0	5	1	4	1	9	5	6	2	3	4	4	13
83	5	2	4	1	2	2	4	1	6	8	6	3	5	2	4	10
84	5	1	4	1	3	4	5	1	9	2	5	2	4	0	4	13
85	4	4	3	2	4	2	4	5	6	11	5	7	5	4	3	9
86	4	5	4	3	4	3	4	3	10	11	5	9	4	4	3	13
87	4	5	5	3	5	2	5	4	11	11	6	11	5	4	5	16
88	3	5	5	2	5	3	3	6	10	11	6	10	5	5	4	14
89	4	5	4	2	3	2	4	4	11	7	6	7	5	3	5	16
90	4	5	4	3	4	2	1	1	10	7	5	6	5	1	2	12
91	4	4	5	4	5	4	4	5	11	10	6	11	3	5	4	15
92	2	5	4	1	3	3	4	4	11	11	6	10	4	3	5	16
93	5	1	5	2	4	3	5	1	10	5	6	3	5	0	3	13
101	3	5	3	2	4	2	4	4	11	11	6	8	4	4	5	16
102	4	1	3	1	3	2	3	4	6	6	4	4	3	3	2	8
103	3	2	3	4	2	1	4	1	2	11	2	7	3	3	3	5
104	4	3	3	3	5	4	3	2	4	5	3	8	2	4	2	6
105	2	3	2	4	1	3	3	4	1	7	2	8	4	3	3	4
106	2	1	1	3	3	2	3	2	7	8	4	5	3	6	1	8
107	1	4	1	2	3	2	3	4	9	10	4	9	5	1	2	11
108	3	3	4	2	5	1	5	0	11	10	6	4	5	0	5	16
109	4	4	4	5	4	2	4	3	10	10	5	9	4	2	5	15
110	5	2	3	3	5	2	4	0	9	3	2	4	4	3	4	13
111	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
112	3	3	3	3	3	3	5	1	10	11	5	5	5	1	5	15
113	4	5	4	3	3	1	4	6	10	11	6	11	3	6	4	14
114	2	5	2	5	0	5	1	4	4	7	2	8	2	5	1	5
115	5	5	5	3	4	2	5	4	11	11	6	8	5	4	5	16

*In some analyses, the post-test scores of this subject were used, to reduce the amount of missing data.

MAXIMUM VALUES:

V PORTUGUESE = 6
VC SYLLABLE = 6
V INCORRECT = 6
VC NASAL = 6
V ENGLISH = 6
CV SYLLABLE (VOWEL) = 6

CV PORTUGUESE = 5
VCV PORTUGUESE = 6
CV SYLLABLE (CONS.) = 11
CV INCORRECT = 11
CCV SYLLABLE = 6
CV SAME ARTIC. = 11
CV ENGLISH = 5
VC ENGLISH = 6
CV ALTERNATIVE = 5
CV SYLLABLE TOTAL = 11

INITIAL LETTER RECOGNITION: RAW SCORES (POST-TEST)

SUBJECTS	V PORTUGUESE	CV SYLLABLE (VOWELS)	VC SYLLABLE	V INCORRECT	VC NASAL	V ENGLISH	CV PORTUGUESE	VCV PORTUGUESE	CV SYLLABLE (CONSONANTS)	CV INCORRECT	CCV SYLLABLE	CV SAME ARTICULATION	CV ENGLISH	VC ENGLISH	CV ALTERNATIVE	CV SYLLABLE TOTAL
1	5	1	5	0	5	1	5	1	11	2	5	1	5	0	4	15
2	5	3	5	4	5	4	5	0	6	7	6	3	5	1	4	10
3	3	1	2	1	4	3	2	0	7	6	4	5	4	3	4	11
4	3	2	4	2	3	2	4	3	7	8	4	3	2	1	2	9
5	5	0	5	0	5	1	5	0	11	0	6	0	5	0	5	16
6	4	4	3	3	3	2	4	4	2	9	4	7	4	2	1	3
7	5	3	1	0	3	1	3	3	9	8	3	5	4	3	1	10
8	4	1	4	0	4	1	3	4	3	5	1	8	2	4	2	5
9	4	0	5	2	4	4	4	2	4	6	2	6	3	3	2	6
10	5	2	4	3	4	4	3	2	6	8	4	6	1	5	1	7
11	5	0	5	1	5	1	4	0	10	1	5	0	5	0	5	15
12	3	4	4	2	1	2	4	0	9	8	5	9	5	2	4	13
13	5	0	5	4	4	5	5	2	4	9	3	9	0	5	1	5
14	3	2	5	1	3	2	3	1	7	5	5	1	5	3	4	11
15	4	0	5	2	5	1	4	2	9	1	5	1	5	2	5	14
16	3	2	2	0	2	3	5	4	4	6	3	6	2	4	1	5
17	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
18	3	1	3	0	4	2	0	2	8	5	4	6	4	2	3	11
19	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
20	5	5	4	4	1	4	5	4	1	11	1	10	1	3	0	1
21	4	2	4	1	4	4	1	2	8	5	5	7	4	3	3	11
22	3	1	3	2	2	2	1	4	7	5	4	5	2	2	0	7
23	2	3	3	1	5	3	2	1	5	5	4	6	3	2	4	9
24	5	0	5	0	5	1	5	0	11	1	6	0	5	0	5	16
25	3	3	2	4	3	1	1	3	3	7	4	9	2	1	2	5
26	4	2	3	1	2	4	5	5	2	10	1	10	1	3	0	2
27	3	1	3	3	3	2	4	1	6	7	3	7	2	3	2	8
28	4	1	4	1	3	1	5	3	6	4	4	2	3	2	4	10
29	5	4	5	4	4	4	5	3	7	11	4	10	5	3	2	9
30	3	1	5	0	5	1	5	1	10	2	6	0	4	0	5	15
31	5	0	4	0	4	1	3	2	9	1	5	1	5	1	5	14
32	5	1	5	1	5	1	5	1	10	1	5	1	5	1	5	15
33	4	0	4	0	5	1	5	0	10	0	6	0	5	0	5	15
42	4	3	5	2	3	3	4	2	5	7	3	4	3	3	2	7
43	4	3	1	2	1	3	4	2	5	4	3	4	3	4	4	9
44	4	4	5	5	4	5	1	5	2	11	1	9	1	6	0	2
45	5	4	5	5	5	5	5	5	7	9	6	10	4	4	5	12
46	4	5	5	5	3	5	5	2	1	11	1	10	1	6	2	3
47	3	2	4	3	3	3	4	2	3	6	2	3	2	5	1	4
48	4	3	5	0	4	3	4	4	6	5	2	5	2	4	3	9
49	3	2	2	0	3	1	3	3	7	3	1	5	3	4	1	8
50	3	4	3	4	4	5	5	5	4	8	2	8	3	4	4	8
51	4	1	3	0	4	2	5	1	8	3	5	0	3	0	5	13
52	2	2	4	2	3	2	1	2	5	6	3	9	1	4	1	6
53	4	3	4	2	3	4	4	3	8	3	5	2	4	1	2	10
54	4	3	3	0	3	3	3	3	5	7	3	2	3	4	5	10
55	4	2	4	2	4	4	4	3	8	7	2	4	1	1	4	12
56	5	3	5	3	5	4	5	2	10	5	5	3	3	2	4	14
57	4	0	5	4	3	5	4	3	5	5	3	7	2	3	2	7
58	4	5	4	4	2	3	3	5	3	10	1	9	1	3	2	5
59	3	3	3	4	4	3	3	6	9	6	3	8	3	2	3	12
60	4	5	5	4	1	5	4	3	7	9	3	7	2	3	3	10
61	2	2	4	5	1	5	2	2	1	9	0	8	0	4	1	2
62	3	3	5	2	1	2	4	4	5	7	2	5	4	4	3	8

TABLE CONTINUES

INITIAL LETTER RECOGNITION: POST-TEST (CONTINUED)

SUBJECTS	V PORTUGUESE	CV SYLLABLE (VOWELS)	VC SYLLABLE	V INCORRECT	VC NASAL	V ENGLISH	CV PORTUGUESE	VCV PORTUGUESE	CV SYLLABLE (CONSONANTS)	CV INCORRECT	CCV SYLLABLE	CV SAME ARTICULATION	CV ENGLISH	VC ENGLISH	CV ALTERNATIVE	CV SYLLABLE TOTAL
63	3	3	3	3	3	2	2	6	5	5	3	5	5	3	2	7
64	4	1	5	2	3	3	2	4	9	2	5	4	4	3	1	10
65	5	0	5	0	5	3	5	0	10	0	5	0	5	0	5	15
66	4	3	5	5	1	5	5	4	1	11	1	11	0	4	1	2
67	3	1	5	3	1	3	5	2	2	7	5	9	2	3	3	5
68	3	2	5	4	3	4	4	2	5	4	1	4	4	4	3	8
69	5	4	5	5	4	5	5	5	7	10	3	9	3	5	4	11
70	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
71	4	3	3	3	1	4	4	5	6	8	3	7	3	3	4	10
72	4	2	5	3	4	1	5	2	7	7	5	4	3	3	3	10
73	4	2	4	4	2	1	3	4	3	7	3	5	2	5	2	5
81	4	5	5	1	5	1	5	5	11	11	6	11	5	6	4	15
82	2	5	4	3	1	0	3	3	6	2	2	5	3	1	3	9
83	3	4	5	2	5	1	5	6	8	11	6	7	5	5	4	12
84	3	2	4	2	3	1	3	2	6	6	5	7	2	3	3	9
85	4	5	4	3	4	3	3	6	10	11	4	10	4	5	4	14
86	3	5	4	3	3	3	4	5	10	11	6	11	5	4	4	14
87	4	5	5	3	5	2	5	4	11	11	6	9	5	3	5	16
88	4	5	4	3	4	2	4	4	11	11	6	8	5	5	5	16
89	4	5	4	3	4	2	4	6	11	11	6	11	5	6	5	16
90	5	4	5	1	3	2	4	1	11	10	6	2	4	1	4	15
91	5	5	5	4	5	3	4	6	11	11	6	10	4	6	5	16
92	5	5	5	1	3	3	4	3	9	11	5	10	5	2	5	14
93	4	1	4	1	5	0	5	1	10	3	3	1	4	0	5	15
101	5	5	2	3	2	3	4	4	11	11	5	9	5	4	5	16
102	5	2	4	1	4	2	4	3	5	4	4	3	2	1	4	9
103	3	2	4	4	3	3	2	3	2	9	1	8	3	2	3	5
104	2	3	1	3	1	2	3	3	7	8	4	5	1	4	4	11
105	3	1	3	2	4	1	4	2	4	7	4	5	3	4	4	8
106	3	3	2	5	1	4	4	5	3	9	1	6	1	3	1	4
107	2	5	4	3	4	2	4	4	8	11	5	7	5	4	4	12
108	5	0	5	0	5	1	5	0	11	5	6	4	5	0	5	16
109	5	4	4	2	3	3	4	3	11	6	6	9	4	1	5	16
110	4	2	4	0	5	1	5	0	11	2	6	2	5	0	4	15
111	5	0	3	1	4	1	5	0	11	2	4	1	5	1	4	15
112	4	5	3	2	3	3	5	2	11	11	6	8	5	2	5	16
113	4	5	4	3	4	2	3	6	11	11	6	10	4	6	5	16
114	2	4	3	5	1	4	0	2	3	7	2	7	3	3	3	6
115	5	5	5	3	5	2	5	4	11	11	6	11	5	5	5	16

MAXIMUM VALUE:

V PORTUGUESE = 6
CV SYLLABLE (VOWEL) = 6
VC SYLLABLE = 6
V INCORRECT = 6
VC NASAL = 6
V ENGLISH = 6

CV PORTUGUESE = 5
VCV PORTUGUESE = 6
CV SYLLABLE (CONS.) = 11
CV INCORRECT = 11
CCV SYLLABLE = 6
CV SAME ARTIC. = 11
CV ENGLISH = 5
VC ENGLISH = 6
CV ALTERNATIVE = 5
TOTAL CV SYLLABLE = 11

APPENDIX 14

RAW DATA ON PHONOLOGICAL PAIRING TASK

PHONOLOGICAL PAIRING TASK: RAW DATA

SUBJECTS	PHISDPRE	PHISSPRE	PHIODPRE	PHIOSPRE	PHIPHPRE	PHFSDPRE	PHFSSPRE	PHFRSPRE	PHFRUPRE	PHFPHPRE	PHISDPOST	PHISSPOST	PHIODPOST	PHIOSPOST	PHIPHPOST	PHFSDPOST	PHFSSPOST	PHFRSPOST	PHFRUPOST	PHFPHPOST
1	1	0	1	1	2	1	1	2	1	0	1	1	2	2	1	1	1	3	0	1
2	4	2	2	2	1	3	4	4	3	3	4	0	2	3	2	2	2	3	2	1
3	0	1	1	1	1	0	0	0	0	0	1	1	2	2	1	2	0	2	2	2
4	1	2	1	1	1	2	1	1	2	1	2	2	3	0	1	1	2	3	1	1
5	0	2	1	0	3	0	1	1	1	0	1	1	1	0	2	0	0	1	0	0
6	4	0	2	2	1	1	3	2	1	1	3	1	0	1	0	3	1	2	2	2
7	0	1	0	1	1	1	1	1	1	1	1	2	0	2	1	0	0	3	0	0
8	1	1	0	1	2	3	1	2	0	1	2	2	1	0	1	1	0	2	2	0
9	4	4	2	0	3	3	2	3	1	3	2	3	0	1	2	1	0	2	2	2
10	3	4	2	2	1	2	1	2	1	3	4	3	3	1	1	2	1	1	2	1
11	3	1	0	1	1	1	1	1	1	2	2	1	1	1	0	1	0	4	1	1
12	4	2	2	2	2	1	1	1	1	1	4	0	2	2	2	0	2	2	1	1
13	3	2	2	1	2	4	2	4	3	2	4	3	2	1	2	3	1	4	3	2
14	1	1	1	0	3	0	0	0	0	1	2	1	2	1	2	0	1	3	0	1
15	0	0	1	0	2	1	1	1	1	1	1	0	0	1	2	1	0	1	1	1
16	1	1	1	0	1	1	0	1	1	1	0	1	2	1	2	0	1	2	1	0
17	4	4	3	3	3	4	2	4	2	4	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
18	0	1	1	0	3	1	0	0	1	1	1	1	0	0	2	1	1	1	1	1
19	3	2	1	1	2	3	2	4	4	4	2	2	1	1	1	2	1	4	2	4
20	2	3	1	1	4	3	0	3	1	1	2	2	2	0	2	1	2	1	2	0
21	1	1	3	3	2	1	1	2	0	1	4	3	2	2	1	4	2	4	2	4
22	4	3	4	2	2	3	1	4	1	3	3	3	3	3	2	2	1	4	2	3
23	2	3	2	3	2	2	2	1	0	1	4	2	3	1	3	3	1	3	1	3
24	3	0	1	0	1	1	1	2	1	2	2	0	2	0	0	0	1	2	0	1
25	1	1	1	3	0	3	2	2	2	3	1	1	0	0	0	3	2	4	3	4
26	3	1	2	3	1	2	1	2	2	1	3	2	3	1	2	1	2	2	1	3
27	3	3	3	3	2	1	1	1	1	1	2	2	4	2	3	2	2	2	3	2
28	2	1	2	3	1	1	1	1	1	1	2	2	1	2	1	2	0	1	1	2
29	4	3	3	4	3	3	1	3	0	3	4	4	4	3	4	4	1	4	3	4
30	1	1	1	2	2	1	2	1	1	1	0	1	1	1	0	0	1	2	1	1
31	0	0	2	0	0	1	1	2	1	1	2	1	2	1	2	1	2	0	1	1
32	1	1	1	1	1	0	1	1	0	1	1	2	3	1	1	1	0	1	0	3
33	2	2	1	1	1	2	1	2	1	1	2	2	1	2	1	1	1	2	2	1
42	2	1	1	1	1	1	1	0	0	1	3	4	1	2	2	0	1	0	1	1
43	4	3	1	2	2	2	2	4	1	2	4	2	3	2	2	3	2	4	1	4
44	4	4	2	2	2	4	3	4	2	4	3	2	2	1	1	2	1	4	3	4
45	4	1	3	4	3	1	1	2	1	1	2	2	2	2	1	3	2	3	4	3
46	3	2	1	3	0	1	1	1	1	2	3	0	3	3	2	3	1	4	1	2
47	1	1	0	2	1	0	2	2	1	1	3	2	1	1	0	2	1	1	1	1
48	2	1	1	0	0	2	0	1	1	1	3	0	2	0	2	0	2	1	1	1
49	2	1	2	0	1	1	2	2	2	1	2	2	2	1	0	0	2	2	2	3
50	3	3	3	2	1	1	0	0	1	1	4	2	3	3	2	1	1	1	1	1
51	2	0	0	1	2	1	1	1	2	0	2	2	1	1	2	0	1	1	2	1
52	2	2	2	1	1	1	1	2	0	1	3	4	1	1	1	0	2	1	1	1
53	2	1	0	3	1	0	2	1	0	1	1	2	1	0	1	1	0	2	0	1
54	1	0	0	0	1	1	1	1	2	2	3	2	2	3	0	1	1	0	0	2
55	4	2	3	1	4	4	2	4	4	4	4	3	3	1	1	3	1	4	3	3
56	4	2	2	2	2	2	1	2	1	3	4	2	4	1	3	3	3	4	2	2
57	4	3	4	2	3	3	3	4	3	4	4	4	2	3	3	4	2	4	3	3
58	4	2	3	2	2	3	2	3	2	4	3	4	1	0	2	3	1	3	2	2
59	3	1	3	2	1	2	1	2	0	1	3	2	2	3	2	2	2	2	0	2
60	4	3	3	1	1	4	2	4	3	4	4	3	4	1	2	4	3	4	4	3
61	3	2	2	1	0	1	1	3	3	1	4	2	2	2	4	2	1	3	1	2
62	4	2	2	2	2	0	1	1	0	0	4	2	2	1	2	4	1	3	2	1
63	4	3	3	3	0	1	2	3	1	3	4	1	2	2	2	1	0	2	0	1

TABLE CONTINUES

PHONOLOGICAL PAIRING TASK (CONTINUED)

SUBJECTS	PHISDPRE	PHISSPRE	PHIODPRE	PHIOSPRE	PHIPHPRE	PHFSDPRE	PHFSSPRE	PHFRSPRE	PHFRUPRE	PHFPHPRE	PHISDPOST	PHISSPOST	PHIODPOST	PHIOSPOST	PHIPHPOST	PHFSDPOST	PHFSSPOST	PHFRSPOST	PHFRUPOST	PHFPHPOST
64	2	1	2	3	0	0	2	2	1	1	3	0	1	0	0	3	3	3	0	1
65	2	4	3	2	2	0	3	0	0	0	3	1	3	1	0	2	1	0	1	1
66	4	2	1	1	0	2	1	4	1	3	4	2	3	4	1	4	4	4	4	3
67	2	1	1	2	2	2	2	1	1	3	4	1	2	0	2	2	1	2	0	4
68	1	1	0	1	1	1	1	2	0	1	3	2	2	2	2	2	3	4	0	3
69	1	2	1	3	1	2	0	1	0	0	2	2	2	1	2	3	3	3	3	2
70	4	3	3	2	3	3	4	4	3	4	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
71	1	1	2	3	1	1	1	1	0	3	3	1	3	1	2	4	1	3	2	2
72	4	4	2	2	3	4	2	4	4	4	4	1	0	2	3	3	4	4	3	3
73	4	4	3	1	2	3	3	4	1	4	4	4	1	2	1	4	3	4	1	4
81	3	3	3	2	3	3	3	4	4	3	4	2	3	3	4	4	2	3	3	1
82	2	0	0	0	1	2	1	1	3	1	4	3	4	2	3	0	2	2	2	3
83	4	2	1	1	4	1	1	3	0	2	4	3	2	2	3	2	1	2	2	3
84	4	2	2	3	1	2	2	2	2	2	3	2	2	1	2	3	1	1	0	1
85	1	1	0	2	0	1	0	2	1	1	3	2	2	2	2	2	1	1	1	1
86	4	3	4	2	3	4	2	3	2	2	4	3	4	1	4	4	2	4	3	4
87	4	2	3	2	4	2	2	2	2	0	4	2	4	4	3	4	3	3	3	4
88	4	3	2	3	4	0	1	3	1	3	4	4	4	4	4	3	2	1	2	4
89	4	2	3	3	4	4	4	4	2	2	4	3	4	3	4	4	4	4	3	4
90	2	1	2	2	2	0	0	0	1	1	4	3	3	2	2	2	0	3	3	2
91	4	4	4	3	4	4	4	4	2	3	4	4	4	4	4	4	4	4	4	2
92	4	4	3	2	4	2	2	2	2	3	4	4	3	2	4	3	1	3	1	2
93	2	2	3	2	3	3	0	2	1	3	1	0	3	3	3	1	2	2	2	0
101	4	4	4	2	2	4	3	4	3	4	4	4	4	3	3	4	4	3	4	4
102	2	1	2	2	2	0	0	2	2	1	3	1	3	1	1	2	1	1	1	1
103	4	3	1	2	1	3	3	3	2	1	3	2	3	1	1	3	1	3	2	3
104	2	2	1	0	1	3	3	2	1	1	4	2	0	1	0	1	3	2	0	1
105	4	2	2	1	1	1	1	2	1	1	4	3	3	2	2	2	1	3	0	1
106	3	0	1	0	0	2	1	1	1	1	3	1	2	0	2	3	2	0	0	0
107	4	2	4	1	3	3	3	3	1	2	4	3	3	2	3	2	3	4	1	2
108	3	1	3	2	4	2	3	1	1	1	4	3	2	1	1	2	3	2	2	1
109	4	4	3	3	3	1	2	1	2	0	4	4	3	3	3	1	0	2	2	2
110	3	3	0	1	2	1	2	2	2	1	4	1	2	2	3	1	2	2	0	1
111	4	2	0	2	2	1	0	2	0	1	1	0	0	0	0	1	2	1	1	0
112	4	4	0	1	1	2	0	3	0	1	4	4	4	3	4	3	4	3	3	2
113	3	2	2	2	3	4	2	3	1	2	4	2	1	2	4	4	4	3	1	4
114	2	1	3	3	1	0	3	0	1	1	2	0	1	1	0	2	2	2	1	0
115	4	4	2	2	4	3	4	4	3	3	4	3	4	4	3	4	4	4	4	4

MAXIMUM VALUE = 4
MINIMUM VALUE = 0
MISSING DATA = -1

APPENDIX 15

RAW DATA ON WORD IDENTIFICATION TASK

WORD IDENTIFICATION TASK: RAW DATA

SUBJECTS	IDISDPRE	IDISSPRE	IDIODPRE	IDIOSPRE	IDIPHPRE	IDFSDPRE	IDFSSPRE	IDFRSPRE	IDFRUPRE	IDFPHPRE	IDISDPOST	IDISSPOST	IDIODPOST	IDIOSPOST	IDIPHPOST	IDFSDPOST	IDFSSPOST	IDFRSPOST	IDFRUPOST	IDFPHPOST
1	1	1	0	0	2	0	1	1	0	0	0	4	1	0	3	1	0	1	0	2
2	1	1	2	1	2	2	1	1	1	3	1	1	0	1	3	2	1	1	0	0
3	3	2	1	0	2	0	0	3	1	0	2	0	1	0	1	0	1	1	2	1
4	2	0	1	0	3	0	1	0	1	0	1	1	1	2	1	1	1	1	0	1
5	1	0	1	1	1	2	1	1	2	2	1	3	1	0	3	2	2	2	0	0
6	2	1	1	0	3	2	2	2	1	1	0	2	0	0	1	1	0	2	1	1
7	2	1	0	1	1	0	1	0	0	2	1	2	2	1	0	0	1	0	0	0
8	0	0	2	2	1	1	0	1	1	0	1	0	0	0	1	2	0	3	2	1
9	0	2	1	0	3	0	0	1	0	0	0	1	2	1	2	0	1	2	2	2
10	3	3	3	1	3	1	1	3	1	1	3	2	2	1	1	2	2	2	2	1
11	1	0	2	1	2	1	1	1	0	1	0	2	1	0	2	1	2	3	3	0
12	2	2	1	1	2	1	0	3	1	1	1	3	2	1	0	0	0	2	0	2
13	4	3	3	2	2	2	3	3	3	2	2	2	4	4	1	1	1	2	3	2
14	1	0	1	1	0	1	0	2	1	1	2	0	1	1	1	0	0	1	1	1
15	1	1	1	1	1	1	0	1	1	0	3	2	0	1	1	0	2	2	0	0
16	0	2	1	1	3	0	1	1	2	0	0	2	3	2	1	0	1	2	0	1
17	3	2	0	1	1	2	2	2	2	2	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
18	0	2	1	1	1	2	1	0	2	1	0	1	1	1	1	0	1	1	1	0
19	1	1	1	1	1	2	2	2	1	2	2	2	2	1	2	2	2	1	2	3
20	1	2	1	1	3	1	1	2	1	1	1	3	0	1	2	3	1	2	1	1
21	2	1	2	1	1	1	0	2	2	2	2	3	1	1	2	0	1	1	2	1
22	1	2	1	1	0	1	0	1	1	0	2	2	2	0	1	0	1	1	1	2
23	0	0	2	2	0	0	0	0	1	1	1	2	1	0	2	1	0	1	3	2
24	1	2	2	1	2	0	3	1	0	2	1	1	2	0	1	1	1	1	1	2
25	2	2	0	2	0	0	0	2	2	1	1	1	1	1	1	2	0	1	1	1
26	1	1	1	2	2	0	1	1	2	1	1	1	2	2	1	0	1	1	1	1
27	2	1	1	1	1	0	0	1	1	0	1	1	2	1	2	1	2	1	3	1
28	1	0	1	2	1	1	1	1	1	0	0	1	1	3	1	0	0	2	0	1
29	3	4	4	1	2	0	1	1	1	0	4	4	2	2	2	3	2	3	3	1
30	1	2	2	0	2	1	1	0	1	0	2	2	0	1	2	0	0	1	0	0
31	2	1	2	0	2	2	2	1	2	1	2	2	2	2	2	1	2	0	1	0
32	2	0	1	0	3	0	1	1	0	1	0	2	1	1	1	0	1	1	1	2
33	2	0	2	2	2	2	0	3	0	1	1	1	1	0	2	0	1	0	0	1
42	1	2	1	1	1	0	1	1	0	1	2	1	1	1	0	0	1	0	0	2
43	3	2	2	2	2	0	1	1	1	2	2	2	2	1	1	2	2	2	2	2
44	2	2	2	1	2	2	2	2	0	2	2	2	0	0	1	2	2	2	4	2
45	2	1	1	0	0	1	0	0	1	1	2	2	0	1	1	2	2	3	4	2
46	1	1	2	0	2	1	0	1	2	1	1	0	1	1	0	0	0	2	2	1
47	1	1	0	0	1	1	2	2	0	1	1	0	1	1	3	0	1	1	2	1
48	1	2	2	1	2	0	1	2	0	1	2	1	2	1	0	0	0	1	1	2
49	1	0	0	1	0	0	1	3	1	0	2	1	2	1	1	1	0	2	2	2
50	1	3	0	1	1	1	2	1	0	1	2	0	1	1	0	0	1	1	0	1
51	1	1	0	0	2	0	1	1	2	0	1	2	1	1	2	1	1	1	2	1
52	2	1	0	1	1	1	0	1	1	1	1	3	0	0	0	0	1	0	1	3
53	0	1	3	1	1	0	0	1	0	1	0	1	2	0	2	0	1	0	2	1
54	2	1	1	1	1	1	0	1	0	0	2	2	1	1	0	1	0	1	2	2
55	2	0	2	1	2	1	2	2	2	1	2	1	1	1	2	2	0	4	4	4
56	1	1	3	0	1	0	1	2	1	2	4	1	2	0	3	1	1	2	2	1
57	2	1	1	2	1	0	1	1	0	0	3	0	2	1	3	1	2	1	4	2
58	3	0	2	1	2	2	1	2	0	1	2	1	1	1	3	0	1	2	2	1
59	2	1	2	1	3	1	1	0	3	1	2	1	3	1	1	0	1	2	0	3
60	1	2	2	1	3	0	1	1	2	3	3	1	2	1	3	2	2	3	4	2
61	0	1	1	1	1	0	2	1	0	1	4	3	1	0	1	1	0	1	0	0
62	2	2	2	0	2	0	2	1	1	1	2	0	3	1	1	1	3	0	2	1
63	2	2	0	1	1	0	0	3	1	2	4	0	2	0	2	2	1	1	2	1

TABLE CONTINUES

WORD IDENTIFICATION TASK (CONTINUED)

SUBJECTS	IDISDPRE	IDISSPRE	IDIODPRE	IDIOSPRE	IDIPHPRE	IDFSDPRE	IDFSSPRE	IDFRSPRE	IDFRUPRE	IDFPHPRE	IDISDPOST	IDISSPOST	IDIODPOST	IDIOSPOST	IDIPHPOST	IDFSDPOST	IDFSSPOST	IDFRSPOST	IDFRUPOST	IDFPHPOST
64	3	0	1	2	1	0	0	0	0	1	1	0	2	1	2	1	0	0	0	1
65	1	1	0	1	1	0	1	1	1	1	3	2	1	2	2	0	1	1	1	2
66	1	1	3	0	1	0	0	0	0	0	4	0	1	3	0	1	0	1	1	1
67	1	0	2	2	2	1	0	1	1	1	1	1	2	2	0	2	1	1	2	2
68	-1	-1	-1	-1	-1	0	0	1	0	1	2	0	2	1	1	0	1	1	1	0
69	2	0	1	1	0	1	1	1	1	1	3	2	1	1	4	3	1	1	3	0
70	3	1	2	1	3	1	3	2	4	2	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
71	1	1	3	0	2	0	1	1	1	1	2	1	0	1	1	0	1	1	2	2
72	2	3	3	1	3	3	0	1	3	1	3	2	1	1	2	3	3	2	4	4
73	2	0	0	0	2	1	1	1	1	1	3	1	0	1	0	2	1	2	3	0
81	4	0	2	2	2	3	3	1	3	2	4	4	4	3	4	4	2	2	4	3
82	2	2	1	1	1	0	1	1	0	1	2	2	1	0	2	1	1	2	1	0
83	4	4	1	1	2	1	0	1	1	1	4	2	1	0	4	2	1	1	2	1
84	1	0	3	2	1	2	1	2	0	2	2	1	2	1	0	1	0	4	0	1
85	2	1	2	1	1	0	1	1	0	0	3	3	1	2	3	0	1	1	1	1
86	2	2	3	2	4	2	2	2	2	0	4	4	2	3	3	4	4	2	4	3
87	3	3	3	2	2	1	0	0	1	0	4	4	4	4	4	4	3	1	4	3
88	2	1	1	0	2	0	0	1	0	2	4	4	4	4	4	2	2	2	2	4
89	4	3	3	1	4	4	4	4	4	2	4	3	4	4	4	4	4	3	4	4
90	1	2	2	1	1	0	0	1	2	1	4	4	2	3	4	1	1	1	1	1
91	4	4	4	4	4	4	4	4	4	3	4	4	4	4	4	4	4	4	4	3
92	4	3	2	1	4	1	1	1	2	0	4	2	3	1	4	3	2	2	3	1
93	1	1	1	1	0	0	1	1	2	0	3	0	3	2	4	1	3	1	2	0
101	4	2	3	3	3	3	2	3	3	4	4	4	4	3	4	4	4	4	4	4
102	2	1	2	1	0	2	1	1	1	2	2	1	1	2	1	2	2	1	3	2
103	2	2	2	3	1	1	2	2	0	1	4	2	3	2	1	3	1	2	3	1
104	1	1	2	2	1	1	3	2	2	1	2	2	1	2	2	0	0	1	0	1
105	3	2	2	2	2	2	1	0	1	1	4	3	4	1	4	3	1	2	0	2
106	2	0	1	0	1	1	1	1	1	3	3	2	2	4	3	2	1	3	0	0
107	4	2	1	1	2	2	0	3	1	3	4	3	2	2	4	3	1	3	2	4
108	2	2	2	1	3	0	2	3	1	1	4	3	3	2	4	3	4	1	2	3
109	2	4	2	2	3	0	2	1	0	2	3	2	2	3	3	2	1	2	0	1
110	1	2	3	3	1	0	1	2	1	1	2	2	3	3	2	2	1	1	1	1
111	1	1	1	1	1	1	2	1	1	1	0	2	2	1	2	0	2	2	2	0
112	2	2	2	1	1	2	1	2	1	2	4	3	3	2	4	3	3	3	4	4
113	4	2	2	1	2	3	3	3	4	0	4	3	4	3	4	4	3	4	3	1
114	0	2	1	0	3	1	0	4	0	1	0	2	4	0	1	1	1	2	0	0
115	4	3	4	4	4	3	4	3	4	1	4	4	4	4	4	4	4	4	4	3

MAXIMUM VALUE = 4
MINIMUM VALUE = 0
MISSING DATA = -1

APPENDIX 16

RAW DATA ON

SPELLING TASKS

PORTUGUESE AND ENGLISH SPELLING TASKS: RAW DATA

SUBJECTS	INSPPRE (PORT.)	ANSPPRE (PORT.)	INSPPRE (ENGLISH)	ANSPPRE (ENGLISH)	INSPPOST (PORT.)	ANSPPOST (PORT.)	INSPPOST (ENGLISH)	ANSPPOST (ENGLISH)
1	2	1	.	.	3	1	.	.
2	5	2	.	.	6	3	.	.
3	3	1	.	.	3	1	.	.
4	2	1	.	.	3	2	.	.
5	1	1	.	.	2	1	.	.
6	2	2	.	.	5	2	.	.
7	1	2	.	.	2	2	.	.
8	5	2	.	.	3	2	.	.
9	3	2	.	.	5	4	.	.
10	2	2	.	.	6	4	.	.
11	2	1	.	.	1	1	.	.
12	3	2	.	.	3	2	.	.
13	5	2	.	.	6	5	.	.
14	3	1	.	.	3	1	.	.
15	1	1	.	.	3	1	.	.
16	1	1	.	.	2	1	.	.
17	-1	1	.	.	-1	-1	.	.
18	1	1	.	.	1	1	.	.
19	-1	1	.	.	-1	1	.	.
20	2	4	.	.	6	2	.	.
21	3	2	.	.	3	2	.	.
22	4	1	.	.	6	2	.	.
23	3	1	.	.	6	3	.	.
24	1	1	.	.	1	1	.	.
25	3	2	.	.	6	1	.	.
26	5	1	.	.	6	2	.	.
27	2	2	.	.	6	3	.	.
28	3	1	.	.	3	1	.	.
29	6	1	.	.	6	3	.	.
30	2	1	.	.	3	1	.	.
31	1	1	.	.	3	1	.	.
32	2	1	.	.	2	1	.	.
33	1	1	.	.	2	1	.	.
42	2	2	.	.	5	3	.	.
43	3	2	.	.	6	1	.	.
44	3	2	.	.	5	2	.	.
45	3	1	.	.	8	3	.	.
46	2	1	.	.	6	2	.	.
47	2	1	.	.	3	1	.	.
48	5	2	.	.	5	3	.	.
49	3	2	.	.	5	2	.	.
50	4	2	.	.	5	4	.	.
51	1	2	.	.	3	4	.	.
52	3	2	.	.	6	3	.	.
53	4	2	.	.	5	2	.	.
54	3	1	.	.	2	1	.	.
55	5	1	.	.	6	-1	.	.
56	5	1	.	.	7	2	.	.
57	6	3	.	.	6	3	.	.
58	3	2	.	.	5	2	.	.
59	3	2	.	.	5	1	.	.
60	5	3	.	.	5	4	.	.
61	3	1	.	.	5	3	.	.
62	3	2	.	.	5	3	.	.

TABLE CONTINUES

SPELLING TASKS (CONTINUED)

SUBJECTS	INSPPRE (PORT.)	ANSPPRE (PORT.)	INSPPRE (ENGLISH)	ANSPPRE (ENGLISH)	INSPPOST (PORT.)	ANSPPOST (PORT.)	INSPPOST (ENGLISH)	ANSPPOST (ENGLISH)
63	3	2	.	.	5	2	.	.
64	5	2	.	.	5	1	.	.
65	1	1	.	.	2	1	.	.
66	5	1	.	.	7	5	.	.
67	3	2	.	.	5	2	.	.
68	1	1	.	.	3	2	.	.
69	3	2	.	.	8	5	.	.
70	-1	-1	.	.	-1	-1	.	.
71	4	2	.	.	6	3	.	.
72	5	2	.	.	7	3	.	.
73	5	4	.	.	7	2	.	.
81	8	3	9	3	9	4	9	3
82	5	1	5	1	3	-1	5	-1
83	3	1	5	1	5	2	7	4
84	2	1	3	1	3	1	3	1
85	5	1	5	3	6	4	5	4
86	6	2	6	4	7	5	7	4
87	7	4	9	3	9	4	9	5
88	3	1	6	1	7	4	7	2
89	7	5	9	4	8	5	9	5
90	4	1	4	1	7	4	6	1
91	9	5	9	5	10	5	9	5
92	6	4	8	2	7	4	8	4
93	3	1	5	1	7	2	8	1
101	6	4	7	5	7	4	8	5
102	1	1	1	1	3	1	2	4
103	3	2	5	2	6	2	5	2
104	3	1	2	1	3	1	3	1
105	3	1	2	1	5	3	5	4
106	2	1	3	1	3	1	3	4
107	5	2	6	3	6	4	7	2
108	6	4	7	2	8	4	9	5
109	1	4	6	3	5	4	6	4
110	1	2	3	2	3	1	3	2
111	1	1	1	1	3	1	2	1
112	5	4	6	2	8	4	8	3
113	7	4	9	1	8	-1	9	-1
114	2	1	3	1	2	1	3	1
115	9	5	9	5	9	5	9	5

VARIABLE LABELS:

INSPPRE = INVENTED SPELLING - PRE-TEST
ANSPPRE = ANALOGY SPELLING - PRE-TEST
INSPPOST = INVENTED SPELLING - POST-TEST
ANSPPOST = ANALOGY SPELLING - POST-TEST

APPENDIX 17

EXAMPLES OF CHILDREN'S INVENTED SPELLINGS

EXAMPLES OF CHILDREN'S INVENTED SPELLINGS (PORTUGUESE)

SCORE	POMBO	POMBINHA	BONE	BONECA	PARQUE	BURRO	BURRICE	BRUXA	BRUXARIA	FILME	FILMAGEM
1	FoP3030	[illegible]	[illegible]	[illegible]		[illegible]	[illegible]	[illegible]	[illegible]		
	b1be1T	229LA2	D3221	040D	65CiEUG	o8PA	09UWAI	010106	9061		
			boo	book		boo	boo	book	boo	boo	boo
2	EOI	DBIS	ILSIL	SIISI	IOLST	SPLLS	LPIL	LISLS	LLI		
3	GBR	P	THE OAXX	CRALA TAXX	PLOY	PRRESS MERADCE POP ALR?	EAEI RRORO ERT?	BOIL	BRKB	ERKGSS NIAS	SSRG SARLA
4		TIO			BN	BL PX		UT		FO	OTO
5	PB OBG BASTB... BEBO......	PN BGRA BASTBY BEBOR	BN ONTA BRHSSAN OE	OGA	AGER ABEN RSSER PKLAN AE PGCG	UO BR BOH BOW BOSOES BRNSHBDCAE	ERRRES BOS	CRRNSS BLS BORA BECYEV BRO	BLY BCAL	FMN	FMO VPJ
6		PSNHEA PEAL OIA PBGA		OEA BNA ONOCT			BRS BHES		BROERA BOVXY		FMNG
7	OTOB POB PBOSHB	POEA POIA PBIGA POBA	BONA BENE BON	ONCA BOEKA BONK BNSROACA	PAEIT PARIX PECRK IACEABR PAK BRK	BROS BOR	BHEACDSE BRESA	BOSE........ BCCAR...... BROALIU BOCA	BOSEEA BCCARSEA	FNILM FEMA	FMAIAS FEMASEES
8	POBO	POMBEA	BONE	BONACA BNECA	PACE	BORO............... BORGO	BORORES BORIC	BOSHA BUXA	BROCARIY BRRSARRIVA	FEMEN FEMI FWOM....	FEMAGE FLMSE FWOMIJING
9	POBO PONHBO	POBINGA POINHA	BONE	BONEKA	PARCE PAREK	BORO BORRO	BORESE BORISE BORRISE	BROSA...... BROCA	BROSAREA	FELME FELM	FILMAJAN FELMAGA
10			BONE	BONECA	PARQUE			BRUXA		FILME	

Letters in bold were accepted as correct. These include some letters that were chosen based on the English letter-sound correspondence, which do not match the Portuguese orthography. Spellings scored 1 and 2, in the same row, were produced by the same child, as were the derived words connected by the dotted lines.