Screening and interventions for developmental fluency disorders

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Abstract

This chapter considers work aimed at addressing the characterization of stuttering and its developmental changes. It starts by examining the EXPLAN model of developmental stuttering and justifies its use by considering supportive evidence. Specific fluency failure patterns are described that, according to EXPLAN, account for how different symptom types are associated with different types of communicative disorders. Phonological performance, measured by the universal non-word repetition task, is proposed as a sensitive screening procedure that can identify children who stutter, and separate them from children who have word-finding difficulty alone that affects their speech. The latter part of the chapter looks at extending the non-word repetition tests to accommodate languages with different phonetics and phonological features from English, such as Arabic.

Introduction

Howell's (2010) chapter on fluency disorders in the previous edition of this handbook looked at the pros and cons of different accounts of stuttering including the Covert Repair Hypothesis (CRH) and the Vicious Cycle account. Both these theories propose that errors in generating language forms are detected by the perception system and speakers correct the utterance. Such accounts link speech production and perception (often called feedback theories), the speech symptoms of stuttering and of fluency failures more generally, reflect breakdown in production planning and repair processes when errors occur. For instance, the CRH maintains that in an utterance such as "I, I spilt," the sentence starts (the first "I") an incorrect word was selected, this was detected internally leading to a pause in speech, the error was repaired covertly (the incorrect verb was not produced) and the sentence restarted and the utterance was then produced fluently. Fluency failures like “I, I” (a whole-word repetition) occur frequently in the speech of people who stutter (PWS) and CRH maintains that this is because PWS make many word selection errors that require repair. A number of problems that feedback theories face were discussed in Howell (2010) and it was argued that a non-feedback perspective was required to account for known features of stuttering and other childhood fluency issues.

To this end, Howell (2010) outlined the EXPLAN theory, which shares some features with feedback theories but which differs, importantly, concerning whether symptoms of fluency breakdown signify underlying (internal) word selection errors that are detected and repaired covertly. According to EXPLAN, “I, I spilt” and “I sspilt” (prolongation of the initial /s/) reflect two distinct types of fluency breakdown in response to the same problem (insufficient time to plan the word “spilt”). One version of EXPLAN applies across languages and first distinguishes words that are short, have limited complexity at onsets, and are comprised of phones that are simple (indicated by early acquisition in the speaker’s language) from those words with the converse properties (Howell & Rusbridge, 2011). The two-word classes correspond approximately to content and function words for languages such as English (for simplicity, we use content and function words when reviewing evidence from English and languages that distinguish content and function words). Stutters and fluency failures on content words (such as “sspilt”) are reflections of insufficient time being available for generating the complete plan of “spilt” (not a word selection error) and prolonging the /s/ gains time for completing the plan for this word. Another way of gaining time to complete the plan is to hesitate or repeat simple words prior to the content word (as in the function word repetition “I, I”) called here stalling. Stalling avoids up-coming planning-time problems by speech prior to the problem by repeating motor forms of function words that have already been produced.

Evidence for differences between stalls and stutters like prolongations that result from advancing through speech rapidly and the different roles they may play in fluency development has accrued since Howell (2010) and this is presented after EXPLAN is outlined. EXPLAN maintains that fluency problems in early childhood mostly correspond to stalling type patterns and stuttering that persists to later ages involves advancing symptoms that affect onsets of words. Moreover, the early-developmental pattern is a form of fluency problem also commonly seen in children who do not stutter. In this chapter, we discuss alternative forms of fluency failure (e.g., word-finding) that show this specific pattern and raise the practical issues of how to separate this from stuttering in early life (screening in schools). Our work in schools in the UK (screening for word-finding and stuttering) is reviewed. Issues faced in UK schools arise because of the large number of children who start school not speaking English who often experience word-finding problems when required to use this language which is a further reason why procedures are needed for separating these two forms of fluency failure. Our work on equitable assessment of fluency for heterogeneous language groups is reviewed. Also, application of our assessment approach that focuses on children who speak Arabic and English is described. Finally, some experimental interventions for word-finding difficulty (WFD) that have been applied to English and Arabic cohorts are reviewed.

EXPLAN

The speech of PWS contains relatively fluent episodes of speech interspersed with dysfluencies. According to Johnson and associates (1959), the main dysfluencies in stuttered speech are: (1) Interjections (silent or filled pauses); (2) Word repetitions; (3) Phrase repetitions; (4) Part-word repetitions; (5) Prolongations; (6) Broken words; (7) Incomplete phrases (abandonments); and (8) Revisions. Only the first six events are consistent with the ICD-10 definition of stuttering (World Health Organization, 1992) which maintains that speakers know what they wish to say but are unable to do so. None of these six categories includes an overt speech error. This is one reason why EXPLAN does not assume fluency problems are a result of speech errors. Event types (7) and (8) are usually disregarded in fluency assessments.

The first six event-types tend to be associated with particular linguistic structures for English and related languages. Pauses occur, according to different theorists, around the onsets of either grammatical or prosodic units. Word and phrase repetitions occur (again depending on theoretical position) around onsets of prosodic words or at points prior to a presumed word error. Part-word repetitions, prolongations, and broken words occur on content words rather than being linked to the start of syntactic or prosodic units (Howell, 2007)**.**

All these events occur in fluent speakers' speech, although their incidence is low and their distribution differs relative to speakers who stutter (in particular, fluent speakers have a low proportion of event-types (4)–(6), Howell, 2007). The overlap in event-types seen in fluent and stuttered speech makes diagnosis of the disorder difficult. Both fluent children (Clark & Clark, 1977) and children who stutter show a high proportion of word and phrase repetitions, which adds to the problem of differential diagnosis. The incidence of stuttering when Johnson's symptoms (1)–(6) are included is at its peak at ages at which language development is maximal. Thus, modal onset ages of three and five years were reported by Andrews and Harris (1964) and onset around these ages has been confirmed in a number of other studies. Andrews and Harris also reported that the incidence of the disorder up to 15 years was about 5% and recovery rate was about 80%. Recovery rate declines with age (Andrews and Harris's study reported no new cases occurred in their study after age 12). The incidence of different dysfluency events changes over ages as the proportion of event-types (4)–(6) is higher in older, compared to younger, speakers who stutter (Howell, Davis, & Williams, 2008). A satisfactory theory of stuttering should address all these points.

Feedback monitoring of speech for fluency control would only be needed if errors occur frequently whilst speech is generated. However, types (1)–(6) do not contain errors. This is not to deny that occasional errors occur during speech generation (Dell, 1986), some of which could be detected by a feedback monitor like that proposed in CRH. However, the ideas that language is continuously monitored for errors in real time and that speech progresses fluently until one is detected (Levelt, 1989) present many problems (Howell, 2010). If language-monitoring is dismissed as a means of online speech control, the perceptual mechanism need not necessarily be linked to production to achieve speech control. The fundamental distinguishing characteristic of EXPLAN is that it does not require feedback-monitoring for ongoing speech control.

We assume that language planning (PLAN) and speech-motor programming and execution (EX) are independent processes (Levelt, 1989). The term EXPLAN signifies that both processes are implicated in fluent speech control. PLAN generates a symbolic language representation that takes different amounts of time to generate, depending on the complexity of the segments (e.g., whether dealing with difficult content words or easy function words) it contains, and EX implements each representation motorically and realizes it as vocal output.

The independence assumption allows planning for future words to continue whilst a speaker utters the current word. Fluency problems arise when the plan for material is not ready in time. This arises in two ways: (1) If the speaker utters the prior material fast this advances when the problem material is needed; (2) If the problem material is particularly difficult to generate, its plan may not be ready irrespective of the rate on the lead-in sequence. Fluency problems happen more often when both influences apply in a stretch of speech.

Phonological word (PW) units, as originally defined by Selkirk (1984) for English, are a unit within which the interacting processes can be examined. PW consist of an obligatory content word (C) and an arbitrary number of function words preceding and following the content word (F_nCF_m where n and m are positive integers). From the current perspective, the important features of PW for English are: (1) that each PW has a single locus of difficulty (a content word); (2) the difficult word can be preceded by function words which are executed quickly, hence the content word is approached rapidly.

The speaker can deal with the situation where the linguistic plan is not ready in time either by stalling or advancing, each of which leads to characteristic forms of dysfluency associated with them. Stalling delays the move to output the difficult word by pausing prior to the content word or repeating the motor plans for the simple function word or words (the F_n) that have been output previously (leading to whole-word, or phrase, repetitions). In stallings, the speaker deals with the situation where the content word plan is not ready by increasing the time taken up before its execution starts. Advancing arises when speakers start the difficult word with the part of its plan already available. This can result in part-word repetitions, prolongations, and word breaks if the plan runs out. According to EXPLAN, PW incorporate adjustments to motor rate (initial function words) and planning difficulty (on the content word). From this perspective, a PW is a unit that has elements that span between PLAN and EX processes.

Evidence for EXPLAN

Difficulty

In this and the following sub-section, work on the relationship between difficulty (language factor) and speech rate (motor factor) in stuttering in spontaneous utterances is reviewed to determine whether they operate as predicted by EXPLAN. Howell’s research group has used phonological and phonetic measures to quantify different levels of difficulty within function and content word classes. Content words usually contain material that is difficult (phonetically and phonologically). One way of showing the difficulty of content words is by comparison of their phonetic properties with function words. Figure 22.1 shows the incidence of manner, word length, and contiguous consonants, and that these vary across the age range from six years to adulthood as language develops (shown separately for content and function words).

Figure 22.1a shows significant increases over ages in use of each factor for content words whilst Figure 22.1b shows no such increase for function words. Figure 22.1a shows that content words that are acquired later are more complex than those acquired earlier.

When words are phonetically difficult, stuttering rate increases for content words. This is shown in Figure 22.2 where phonetic difficulty is represented as the sum total over eight features marked as easy/difficult by Jakielski (1998) in her Index of Phonetic Difficulty (IPC) scheme. An example for one feature is that words containing a contiguous string of consonants score a point, but words with just singletons score zero. There is a significant correlation for content, but not function words.

Figure 22.2 also shows that function words have a more limited range of phonetic difficulty. The lack of correlation with the difficulty measure for the function words underlines the importance of examining word types separately. Similar findings have been reported for the Arabic language; content words are phonologically more complex than function words (Al-Tamimi et al., 2013). To summarize, planning difficulty, as indicated by this phonetic measure, correlates with stuttering rate.

Rate

Variation in speech rate has been examined to see whether it affects stuttering in the way EXPLAN predicts (more problems when speech rate is high). Generally speaking, if speech is slow, there is less likelihood of planning getting out of alignment with execution. When dysfluencies start to occur, rate adjustments are needed, but only around the points where difficulty is high (local). Global changes are necessary when speakers have to make a long-term adjustment to rate (as, for instance, when a speaker is continuously producing advancings).

Howell, Au-Yeung, and Pilgrim (1999) showed that rate control operates locally in utterances. Spontaneous speech of adults who stutter was segmented into tone units (TU) and these were separated into those that were stuttered and those that were fluent. Syllable rate was measured in the section prior to the stuttering (the whole segment in the case of fluent TU). The TU were classified into fast, medium, and slow rate categories based on the rate in the fluent section. The TU that were spoken slowly had a lower rate of stuttering than those spoken more rapidly. These findings support the idea that fluency problems arise when speech rate is high locally to the content word (possibly because approach rate taxes planning of difficult words).

Howell and Sackin (2000) examined whether local rate change can occur independently of global rate change for conditions known to affect the fluency of speakers who stutter. Fluent speakers repeated the sentence “Cathy took some cocoa to the teletubbies” several times under frequency shifted feedback (FSF), in normal listening conditions, and when speaking and singing. The plosives in the utterance were marked and the duration of the intervals between the first and each of the subsequent plosives was measured. The interval-distributions were plotted for every interval and for all speaking conditions. Global slowing between speaking conditions occurs when the mean of the distribution shifts to longer durations. Local slowing between conditions occurs when there are fewer intervals at the short duration end of the distribution, but no shift in the overall mean. One statistic that reflects shifts at the lower end of the distribution is the duration at which the 25th percentile occurs (towards the lower end of the distribution).

The differences between the means of the distributions were significant for all pairs of speaking conditions (showing global slowing) except speaking versus singing in normal listening conditions. Howell and Sackin then calculated the time where the 25th percentile fell, and repeated the earlier analyses, this time to see whether the fast intervals shifted between the different conditions. Of particular note was the finding that there was a significant shift of the 25th percentile when speaking was compared with singing in normal listening conditions (singing produced local slowing). Thus, local slowing occurred between these conditions, although there had been no global slowing. This suggests that these are two distinct modes of changing rate. EXPLAN specifically requires speakers to have the option of making local rate changes to deal with fluency problems. Singing is known to enhance the fluency of speakers who stutter and this would have to derive from the local rate changes that speakers make in this mode of vocal control. To summarize, difficulty and speech rate operate in the way EXPLAN predicts.

Dysfluency-distribution

The proposal that whole word repetition serves the role of delaying the time at which the following word is produced has been made by several authors working on fluent speech (Blackmer & Mitton, 1991; Clark & Clark, 1977; Maclay & Osgood, 1959; MacWhinney & Osser, 1977; Rispoli, 2003). However, these accounts have not linked such delaying to function words nor examined how word repetition depends on the position they occupy in PW contexts. For word repetition to stall speech, only the function words before the content word should be involved, as reported in a number of studies on stuttering (Au-Yeung, Vallejo, Gomez, & Howell, 2003, for Spanish; Dworzynski, Howell, Au-Yeung, & Rommel, 2004 and Dworzysnki & Howell, 2004, for German; and Howell, Au-Yeung, & Sackin, 1999, for English). Repetition specific to function words prior to content words has been reported for selected constructs for fluent English speakers (Stenström & Svartvik, 1994). The latter authors reported that subject pronouns (which appear before verbs in English, i.e., PW-initial) have a greater tendency to be produced dysfluently than object pronouns (which appear after verbs in English). Overall, word repetitions tend to appear in the position in PW that EXPLAN requires.

Stalling/advancing reciprocity

EXPLAN predicts a reciprocal relationship between stalling on function words and advancing on content words. If a speaker stalls, there should be no need to advance and vice versa. Early findings confirmed this relationship as stalling and advancing occurred rarely in the same PW (Howell, Au-Yeung, & Sackin, 1999).

It has been reported for a number of languages (Au-Yeung et al., 2003; Dworzynski et al., 2004; Howell et al., 1999), that speakers who stutter show more dysfluency on function words (stalling) than on content words (advancing) in early development, but the opposite in later development (termed an exchange relation). This suggests that older speakers stop stalling and start advancing. Howell, Au-Yeung, and Sackin (1999) noted that the exchange to advancing at older ages corresponded with a reduced chance of recovering from stuttering and suggested that the advancing pattern may be a factor implicated in this change.

There are several other ways of characterizing the points where simple and complex material alternate as well as shifts from function to content words which would apply to other languages. For example, Howell (2004) looked at stressed and unstressed words. He reported that stressed function words and unstressed content words produced an exchange relation. From this, it also appears that stressing a word (irrespective of lexical type) can result in the exchange first reported on content and function words. Some authors have argued that word frequency effects could account for the exchange pattern (exchanges would then be expected between low and high frequency items). This account seems problematic in connection with stuttering, since word frequency is particularly difficult to measure in childhood and varies markedly between speakers at these early stages of language development.

The EXPLAN account maintains that exchanges reflect a change from stalling to advancing with age. Consequently, Howell (2007) examined these dysfluency categories directly in a longitudinal study on children who stuttered aged from about eight years up to teenage. They were independently assessed at teenage to see whether they were still stuttering (persistent) or not (recovered). For recovered speakers, the absolute level of dysfluencies decreased as they get older, but the ratio of stallings to advancings remained constant. Speakers whose stuttering persisted, on the other hand, showed a reduced rate of stalling and an increased rate of advancing. This is consistent with the EXPLAN predictions, but not CRH. CRH would predict that the pattern of dysfluencies produced by children whose stuttering persists would always differ from children who recover or who have always been fluent because of speech planning time differences across the groups.

Priming

Priming is a way of manipulating planning time. An auditory sentence or syllable is presented (the prime). Participants then describe a picture (the probe), and speech initiation time (SIT) is measured. When the auditory prime matches some aspect of the probe, the planning time needed for the production of different elements in the phrase is reduced. Past work has shown that SIT is shorter for children who stutter than children who do not stutter for material which is primed phonologically and syntactically (Anderson & Conture, 2004; Melnick, Conture, & Ohde, 2003) but not lexically (Pellowski & Conture, 2005).

All previous priming investigations looked for effects at the language level whereas EXPLAN stresses the importance of PW units that reflect operation at the language-motor interface. Savage and Howell (2008) used PW like “He is swimming” and “She is running” (both consist of two function words followed by a content word) in a priming study that tested EXPLAN. On a trial, a child was primed either with a function word (e.g., they heard and repeated “he is”) or a content word (e.g., they heard and repeated “swimming”). A cartoon (the probe) was then displayed depicting an action that had to be described, and SIT and dysfluency rate were measured. When the auditory prime matched an aspect of the probe (e.g., “he is” was primed and the picture was of a boy, or “swimming” was primed and this was the action), the planning time needed for the production of different elements in the phrase would be reduced.

EXPLAN predicts that priming either the function or the content word (the elements in PW) will have opposite effects (Savage & Howell, 2008). Priming a function word should reduce its planning time, allowing it to be produced more rapidly. When rate of production of a function word is increased, pressure is placed on having the content word plan ready earlier. If it is not ready, this increases the chance of stalling or advancing dysfluencies. Priming the content word reduces its planning time. But this time priming should reduce the dysfluency rate on function and content words (priming the content word accelerates planning and decreases the chances of plan-unavailability, which should be reflected in a reduction of stalling and/or advancing). In addition to the asymmetric effects of function and content word priming, EXPLAN predicts that there will be bigger effects in participants who stutter than in fluent controls though both speaker groups should show priming effects.

Savage and Howell (2008) confirmed these predictions in children who stuttered and controls (mean age six years). Priming function words increased dysfluencies on function and content words whereas priming content words reduced dysfluencies on function and content words. The additional prediction that these effects should be true of both groups of speakers was also confirmed and the effects for the children who stutter were greater.

The priming findings suggest that the same process underpins the production of dysfluencies for both children who stutter and controls, and that it takes the form of a timing misalignment between planning and execution. The primed production of a content word immediately before it is used in a picture description reduced the time needed to plan the content word online by activating its plan (so that it was available in advance). This reduced the discrepancy between the time needed to plan the content word (relatively long) and the time needed to execute the function words (relatively short), and in turn decreased the likelihood of speaking dysfluently.

Neuroimaging

Jiang et al.’s (2012) neuroimaging study reported that the activation pattern of one type of stalling (whole-word repetition) differs from that seen for other symptoms of stuttering. They classified types of disfluency into “clear” instances of stuttering (part-word repetitions, prolongations, and pauses), and instances of other dysfluency (phrase repetitions and revisions), and excluded whole-word repetitions. They established a model of brain areas that were active in “clear” instances of stuttering, compared to areas active in other types of dysfluent speech (excluding whole-word repetition). Distinctive brain areas were activated for the “clear” vs. other types of dysfluencies. Subsequently, whole-word repetitions were added into the model as “unknown examples,” to see whether they would be associated with clear stuttering or other dysfluencies. Whole-word repetitions showed activation of similar brain regions to those seen in other dysfluent speech (not stuttering), and as mentioned, these patterns differed from brain regions activated when people produced more typical symptoms of stuttering. This provides evidence that whole-word repetition has a different role (EXPLAN would maintain stalling rather than advancing) to clear instances of stuttering.

Symptom-based screening for stuttering

We return now to some of the issues that, as mentioned at the start, should be addressed by an adequate theory of stuttering (screening and intervention in particular). Next, we look at clinical ways of screening for stuttering before we progress to examining how we can apply EXPLAN ideas for the related purpose of screening for fluency issues more generally in school samples which include more children and considerable diversity in language background (Howell et al., 2017).

Clinical assessment

A widely used standardized tool for the identification of stuttering is Riley’s Stuttering Severity Instrument “SSI” (Riley, 1994; Riley & Bakker, 2009). Inter- and intra-judge reliability have been reported (Riley, 1994), and good validity is claimed (Davidow, 2021). The SSI is an objective assessment method that focusses on observable behaviour rather than self-reported information. The assessment is usually audio- or video-recorded. Picture materials are used to elicit spontaneous speech comprising a minimum of two hundred syllables (Todd et al., 2014). Three parameters are assessed: the percentage of stuttered syllables (i.e., the frequency of occasions of stuttering), the duration of instances of stuttered speech (by identifying and averaging the time duration of the three longest stuttering events), and physical concomitants, which include distracting sounds, facial grimaces, head movements, and movements of the extremities. An overall score is calculated based on the three parameters; scores correspond to severity of stuttering ranging from "very mild" to "very severe."

The SSI has also been extensively used in large, unselected samples of children, and generally is reported to be sensitive to identifying children who stutter (e.g., Davis et al., 2007; Mirawdeli, 2015) or to differentiate between persistent and recovered stuttering in children when used in combination with caregiver and child (self-)assessment reports (Howell et al., 2008). SSI is also an appropriate measure for use with children who have English as an additional language (Howell, 2013). Such children may be more prone to having word-finding difficulties (WFD) and hence produce a higher occurrence of whole-word repetitions in their speech. SSI does not include whole-word repetitions as events of stuttered speech; hence these children would not be classed as "stuttering."

Reliability

The usefulness and reliability of SSI notwithstanding, there are some criticisms and practical issues with the SSI and practical concerns when considering its use as an assessment tool for stuttering or fluency issues in children starting school. The way in which the SSI classifies stuttered speech has been criticized by some researchers. For example, it has been argued that stuttering events are highly variable and may differ from one day to the next (Constantino et al., 2016). In addition, the percentage of stuttered syllables may not always reflect the severity of an adult's stutter; reports of psychological processes regarding the experience of stuttering can also indicate stuttering severity, but may not always correlate with the percentage of stuttered syllables as measured in SSI (Manning & Beck, 2013). In contrast to these reservations about SSI, one study found that the percentage of stuttered syllables on its own is sufficient (i.e., without the additional SSI measures of duration of dysfluencies and physical concomitants) and more reliable when assessing risk of speech difficulties in children than is SSI (Mirawdeli & Howell, 2016). These exclusions would make SSI a shortened, more clinically viable tool for assessing children.

Most current measures of speech disorders classify a person as having a speech difficulty or not based on specific cut-off criteria. There is no dimensional questionnaire concerning fluency for children and/or adults which provides a general rather than a condition-specific indication of fluency. Furthermore, thresholding is not desirable for those who consider speech disorders as lying on a continuum (Johnson, 1955; Widiger & Samuel, 2005).

There are several additional established and validated questionnaires which focus on specific speech disorders. Examples for assessments of stuttering include the “Overall Assessment of the Speaker’s Experience of Stuttering” (OASES) (Yaruss & Quesal, 2006), the “Wright & Ayre Stuttering Self-Rating Profile” (WASSP) (Wright & Ayre, 2000), and the “Communication Attitude Scale” with 24 items (CAS-24) (Andrews & Cutler, 1974).

Most of these reflect the World Health Organization’s Classification of Functioning, Disability and Health framework (2007). A notable fact regarding existing instruments is that they were developed and established for English. Whilst translations into some other languages have been done (e.g., Persian SSI; Bakthiar et al., 2010), these may not be fully reliable or valid measures (Karimi et al., 2011). This highlights the lack of resources for use with speakers with diverse language backgrounds.

When screening children in a school environment, there is a need for short and efficient procedures which ideally do not require special training to carry out the assessment (data collection and analysis). Existing types of assessment are labor-intensive and, along with training, can make assessments time-consuming and prohibitive for use in schools. Finally, with the rising numbers of children who speak English as an additional language, there is a need for universally standardized measures of fluency that are easily administered in schools.

SSI does not count whole-word repetitions as stutters and EXPLAN maintains that this is appropriate for identifying stuttering that will persist. The pauses and whole-word repetition that EXPLAN considers as ways of stalling are also indicators of word-finding issues in children (Clark & Clark, 1977). Together, advancing symptoms can be used as an indication of stuttering that persists and stalling to be used as an indication of word-finding difficulty provided no advancing symptoms are also present. Before empirical work on screening is discussed, the link between positioning pauses and whole-word repetitions in PW is considered, as this is crucial for separating symptom types associated with word-finding and stuttering during screening.

Pauses

EXPLAN predicts that pauses should occur prior to the content word in a PW (the positions where they can delay onset of the following content word). To fill this role, pauses should appear around the start of PW more often than they occur at the start of syntactic units (as some other authors have maintained). Pinker (1995) used the examples "[The baby]$_{np}$ [ate [the slug]$_{np}$]$_{vp}$" and "[He]$_{np}$ [ate [the slug]$_{np}$]$_{vp}$" to show that pauses do not occur at syntactic boundaries. He stated that pausing is allowed after the subject NP "*the baby,*" but not after the subject NP, in the pronominal "*he*." Note that both these positions involve the same major syntactic boundary, a subject NP, so syntactic factors alone cannot account for this difference in pause occurrence.

It is possible that pauses occur at PW boundaries as they do not always coincide with syntactic boundaries. The PW boundaries in the examples are "[The baby] $_{PW}$ [ate]$_{PW}$ [the slug]$_{PW}$" and "[He ate]$_{PW}$ [the slug]$_{PW}$" respectively. If the PW boundaries in the two sentences are examined, pausing between "*baby*" and "*ate*" is allowed in the first sentence (as Pinker observed), as they are in two separate PW. Pausing should not occur in the second sentence (again as Pinker observed) because there is no PW boundary at the corresponding point. Thus, it seems that PW are preferred units for specifying boundaries where pauses occur. Gee and Grosjean (1983) offer a related analysis to the current one using units related to PW. It has also been proposed that pause-location is determined by both syntactic and prosodic factors (Ferreira, 1993; Watson & Gibson, 2004).

To summarize, based on the link between onset of PWs and pausing, pauses are things that speakers do in anticipation, or as a result of material that is time-consuming to prepare such as the content word in a PW (consistent with EXPLAN).

Whole-word repetitions (WWR)

Researchers such as Johnson (1955) consider WWR to be a symptom of stuttering; however, they might actually be a sign of WFD due to a language barrier when, for example, speaking English as an additional language, rather than a sign of a speech disorder. This highlights the need for tasks for assessing fluency that are applicable to speakers of many languages.

Several studies have suggested that assessments for stuttering might be more accurate when WWR are not considered symptoms of stuttering. A risk factor model for predicting whether stuttering in eight-year-old children would persist or recover by teenage was developed (Howell & Davis, 2011) and adapted to screen school-aged children for risk of stuttering (Howell, 2013). The model showed higher sensitivity and specificity once WWR were excluded in analyses; this is likely due to the fact that WWR are common in all children's speech before vocabulary is fully developed suggesting that WWR are not sensitive indicators of stuttering (Howell, 2013). Recently, a longitudinal study described a measure (stuttering-like disfluency index; SLD) using spontaneous speech samples for assessing the likelihood of persistence in stuttering in children (Walsh et al., 2020). Whilst specific occurrences of stuttered speech such as part-word repetitions or blocks, prolongations, and broken words were significantly more frequent in children whose stutter persisted compared to those who recovered, whole-word repetitions were not specifically associated with persistence (Walsh et al., 2020) as predicted by EXPLAN. This again highlights that assessments arguably should not focus on WWR as indicators of stuttering. The appropriate type of intervention should then be given before the problem exacerbates. Research has shown that interventions are most effective when given early in life (i.e., usually at school age in the case of stuttering; Bercow, 2008; Howell, 2010). Hence, any speech dysfluency should be identified at an early age (Yairi & Ambrose, 1992, 2004)

Practical consideration when screening unselected samples for WFD and stuttering

Failure to identify a disorder may lead to several challenges in terms of educational attainment as well as on a mental health level due to bullying or isolation from others (Antoniazzi et al., 2010). Existing measures of assessment of stuttering have several constraints: they are often labor-intensive, time-consuming, and require training for the person carrying out the assessment, therefore they are not practically appropriate for use in schools.

When analyzing dysfluency, researchers need to consider that incidence of types of dysfluencies differ between children who do and do not stutter. Also, statistical procedures need to be sensitive to non-normally distributed data (e.g., negative binominal distributions of the data) and have to tackle covariates such as gender imbalances (Tumanova et al., 2014).

Recently, the number of children speaking a language other than English as their native language, as well as the number of children who use English as an additional language (EAL; i.e., using English predominantly at school but not at home) in UK schools has increased significantly. Similar situations apply internationally. Many of the affected children will not speak the language spoken in their home country before starting school. For the UK, the percentage of use of additional languages other than English in schools has doubled since 1997, rose to 18.1% in 2013 (Strand et al., 2015), and by 2018, rose again to 21.2% (DfE, 2018).

Children with EAL often have word-finding difficulties (WFD), which are characterized as the difficulties when pronouncing a word whilst being able to identify the referent of that word (e.g., Julie et al., 1998). WFD is frequently associated with whole-word repetitions (WWR) (Clark & Clark, 1977; Westbury & Bub, 1997). This is a different pattern to that in stuttering. A child whose first language is not English might experience word retrieval in their non-native language and produce a high number of whole-word repetitions (WWR). It is important to distinguish WFD from stuttering as the former do not have speech fluency problems (Yan & Nicoladis, 2009) and the two forms require different interventions. Appropriate intervention can be very efficient even after a short period; for example, phonological skills and fluency of EAL children at high risk of dysfluency improve following a two-week working memory intervention (Howell et al., 2020). Effective screening measures that can accurately assess stuttering and WFD in children with various linguistic backgrounds is essential, so that appropriate intervention can be facilitated.

When there is heterogeneity in first languages spoken, a universal test for fluency would be beneficial for use in schools. Most importantly, the needs of teachers and schools need to be taken into consideration, with testing needing to be quick, efficient, and easy to administer for someone not trained as a speech and language pathologist (SLP), so that effective testing and intervention for children can take place (Dockrell, 2001; Dockrell & Lindsay, 2001; Dockrell & Marshall, 2015). To this end, several authors advocate using an alternative assessment (in contrast to symptom-based assessment) such as a non-word repetition task like UNWR (Howell et al., 2017). UNWR is discussed in detail in the following section of this chapter. Such tests may distinguish between stuttering and WFD in children including in samples with diverse language backgrounds.

Non-word repetition (NWR) based methods in English

NWR provides information about potential issues with phonological processing. If a person has difficulties accurately repeating non-words, this can indicate a speech fluency impairment such as stuttering (Howell et al., 2017). However, the performance of a person who has WFD is not expected to be affected in UNWT or other NWR tasks. UNWR is recommended as a screening procedure for children with fluency problems since typical children who use any of the native languages covered would not have NWR problems whereas children who stutter would have problems.

Non-word repetition test (NWR) performance in children who stutter (CWS)

Non-word repetition tests other than UNWR could partially overcome shortcomings of traditional screening methods such as the SSI since NWR procedures are more concise than SSI; children are instructed to repeat non-words immediately after hearing them (e.g., Piazzalunga et al., 2019). Hence, there is no requirement for assessing several components as with SSI, since NWR performance is only based on the accuracy or reaction time (Hakim & Ratner, 2004) of pronunciation of non-words. The time-efficiency is beneficial for use in schools. On a theoretical basis, it has been suggested that NWR enables schools to assess children's phonological abilities as it imitates the mechanism by which children learn languages, which is the instant repetition of novel sound forms (Archibald, 2008). Studies have also found that repeating the novel non-words involves several underlying processes, including speech perception (Coady & Evans, 2008), motor articulation, phonological processing (Bowey, 1996), and short-term phonological memory (Masoura & Gathercole, 1999). Therefore, children with fluency difficulties are predicted to have NWR deficits due to impaired phonological processing (Gathercole et al., 1994). Several studies have reported deficits in NWR in children who stutter (CWS) compared to control groups of the same age (Anderson & Wagovich, 2010; Bakhtiar et al., 2007; Hakim & Ratner, 2004; Howell et al., 2017). This supports the idea that the NWR test is a sensitive measure for distinguishing CWS and fluent speakers.

NWR languages other than English

NWR tests have been developed and applied with children who stutter (CWS) for several single languages other than English. For example, Bakhtiar et al. (2007) examined NWR performance amongst Persian children. However, their results contradicted previous findings: they found that although CWS performed slightly poorer than children who did not stutter in the NWR test, no significant differences in NWR performance between groups were found. It is not clear whether this was due to the NWR test for Persian having faults or a genuine difference between Persian CWS and those who speak English. The conflicting findings might be due to the stimulus materials and, hence, present low complexity to both groups of children and hence yield no differences. NWR tests have been developed for adoption with other targeted languages, such as Spanish (Summers et al., 2010), Greek (Windsor et al., 2010), and Italian (Schindler, 1962). One study reported the reliability and validity of the Italian version of the NWR test developed by Schindler (1962) for Italian-native children (Piazzalunga et al., 2019). However, since a language-specific NWR test was used it would only be appropriate for children with a monolingual language background. Hence, it might be less sensitive when used for screening children with diverse language backgrounds such as those in the UK with EAL. In support of this, Greek-native children performed more accurately on the Greek version of the NWR test than an English NWR test (Masoura & Gathercole, 1999). Related findings have been reported by Windsor et al. (2010); they noted that Spanish children showed better performance on the Spanish NWR test than peers who spoke English only. However, when the English NWR test was applied, the results reversed. Therefore, the NWR test is not sufficient to satisfy schools' needs where a more sensitive language test that applies to children with diverse language backgrounds is needed.

In sum, previous findings suggest that the NWR test resolves some of the issues encountered by the SSI. However, the practical application of the NWR test among children with diverse language backgrounds is an ongoing challenge. Whilst NWR tests could effectively identify CWS in the forms discussed so far, they are not sensitive when classifying CWS with diverse language backgrounds.

"Universal" non-word repetition test (UNWR)

To address the shortcomings of SSI and traditional monolingual NWR tests, a new form of NWR test ("Universal" *Non-word* repetition (UNWR) test) was developed (Howell et al., 2017). The design of the UNWR test matched schools' demands for a screening test to detect fluency difficulties. It takes into account the phonotactics (i.e., which segments and sounds can be combined in a language) of 20+ languages, hence making it quasi-"universal," and offering a fair screening for many children with EAL.

The UNWR's development included assessing word-likeness between non-word stimuli and words for 20 languages; high word-likeness occurs when non-words have phonotactic constraints that are similar to words in a targeted language, and this could affect NWR performance (Munson et al., 2005). For this reason, word-likeness of non-word stimuli were checked by native speakers of the 20 targeted languages. In addition, the lexicons were also checked computationally for five targeted languages examined in the study. Also, extraneous factors that can bias the UNWR test's performance, such as IQ and lexical knowledge, were controlled for. Archibald (2008) reported that compared to traditional language assessments, which rely heavily on the existing knowledge of languages, assessing children's phonological abilities using non-words can moderate such influences. Conti-

Ramsden et al. (2001) also noted no significant correlation between NWR deficit and Intelligent Quotient performance.

UNWR has served as a basis for creating an Arabic-English NWR test to help identify speech dysfluency in speakers of Arabic and English (Alsulaiman et al., 2022), which is described in more detail in the following section of this chapter. All the above highlight the scientific rigor that informed the design of the UNWR, and its reliability.

Practically, the UNWR test also matches schools' needs for a language test that relates to fluency. Schools desire for a brief language test to ensure students' learning time will be little affected. Thus, the stimuli used in the UNWR test were small in number, which only consisted of seven non-words per syllable length (with syllable length ranging from two to five). In addition, to ensure teachers can deliver the test efficiently without the help of professionals, the procedures should be easy to understand, and the equipment used to conduct the test should be minimal. Together these design factors enable the UNWR test to effectively discriminate children with word-finding difficulty, CWS, and those who do not stutter, irrespective of children's language backgrounds, thus facilitating future assessments of people with a range of language backgrounds in clinics or schools (Howell et al., 2017).

As administered at present, the UNWR requires an experimenter who is phonetically trained to score a person's responses on the task as correct or incorrect in real time. Live assessments may not always be accurate, and may be less time-efficient and accurate compared to an automated analysis. Automated scoring processes would provide useful information more quickly and efficiently. Since speech production and speech perception are tightly linked (Casserly & Pisoni, 2010) an automated speech recognition system would need to be highly sensitive to variations in speech production. Despite various previous studies using live-scoring as part of their methodology, none has mentioned the difficulties this might pose, and there is a lack of studies on the assessment of live scoring procedures and what factors might influence live judgments of the person scoring the task. While previous phonetic training will most probably play a role in being able to correctly identify the response of a participant on the UNWR, it is unclear what other underlying factors might contribute to deciding whether a non-word is scored as pronounced correctly or incorrectly. A deeper understanding of manual live scoring techniques is required so that a clearer profile of children's speech, language, and cognitive profiles can be attained, allowing speech and language therapists to target detailed issues, which might have been missed during live scoring, with suited interventions.

Application of screening approach to Arabic

Few instruments are appropriate for assessing speech fluency of speakers of Arabic. As noted, direct translations of English instruments into Arabic without re-standardization is not appropriate (Karimi et al., 2011). Moreover, for existing instruments to be adapted for use in clinics and in research in other languages, they first need to be translated into the target language and the translation needs to be checked. The newly formed instrument then needs to be validated and standard scores re-estimated (Karimi et al., 2011). Generally speaking, re-standardization for target languages is not undertaken when instruments are employed in other languages. For this reason and because Arabic is very different to, for example, the languages UNWR addresses, the above steps need taking for Arabic (i.e., develop tests from scratch).

To this end, an attempt to systematically develop a speech-based fluency measure to account for many unique phonological, morphological, and syntactic features of Arabic has been initiated by Alsulaiman (2022). It was noted that there were no indications about what to count as disfluency in Arabic, which, if such disfluencies differ from those in English, would require re-standardization of instruments as with Arabic forms of SSI. In other words, there was no scheme for analysis of stuttered speech in Arabic that shows which types of disfluencies should be counted. Therefore, Alsulaiman used the Arabic index of phonetic complexity as a basis (AIPC), which was adapted from the IPC which applies to English (Al-

Tamimi et al., 2013). The AIPC was developed to account for the unique phonological, phonotactic, and morphological features of Arabic. It took into consideration the complexity in articulating certain consonant phonemes that are identified as difficult sounds due to either late age mastery or complex articulatory movements that they involve. The idea was to use AIPC to inform parts of speech analysis for the purpose of developing a new disfluency scheme. AIPC was devised as a framework that provides detailed assessment of which Arabic words are phonologically complex. This was achieved by attributing difficulty of words to the phonetic factors that a word may possess, which might make it more susceptible to stuttering. The AIPC then gives an aggregated complexity score based on summing up the number of phonological factors within each word. Additionally, an important feature of AIPC is that it accounts for geminated consonants through a new category "consonants by length." It is worth noting here that gemination has been defined as "the prolongation of the continuants and a longer closure of Stops" (Al-Ani, 1970).

The rationale behind adopting the AIPC was to minimize arbitrary decision making when assessing spontaneous speech samples. An empirical investigation was then carried out to determine (1) what should be counted when measuring stuttering; and (2) what and how disfluency symptoms should be quantified. As a first step, two preliminary algorithms were proposed based on our investigation of syllabic, phonological, and morphological features of the Arabic language. This gave the basis for the development of a formal scheme, which is intended to provide a framework for the characterization of syllabic and phonological structure of words in spontaneous samples. The empirical work involved analysis of conversational speech samples of at least 200 syllables; these were obtained from Arabic adult and child speakers who stutter. Speech samples were transcribed using Arabic orthography and moments of disfluency were marked on the transcripts. The stuttering symptoms used were part-word repetition, prolongation, or a break as in Riley's (1994) stuttering symptoms. The main goal of the analysis was to highlight areas where potential changes in counting the number of syllables and the number of disfluencies is needed to accommodate the requirements of the Arabic language.

With respect to phonological factors, the analysis also took some aspects of AIPC and incorporated those when designing the scheme. A commendable feature of AIPC is that it has a way of deriving a numerical value across all AIPC factors to characterize a word's difficulty. Consequently, two algorithms have been proposed: one for counting the number of syllables and one for counting disfluencies. These were presented with clear guidelines on how they should be applied. Overall, it was deemed advisable to analyze words of different lexical categories separately as these word types tend to have different phonological characteristics and involve different types of stuttering. However, more research on Arabic is needed on the role of different lexical categories to see how it affects stuttering on different parts of speech (e.g., adjectives and adverbs which have specific inflectional structures). To explain, Arabic has unique inflectional structures on different parts of speech that potentially makes the link between word type and stuttering more complex (Vahab et al., 2013). Adjectives and adverbs in Arabic use a system of agreement on number and gender with the noun or pronoun that they modify. That is, this creates lexical flexibility in combining words of different forms, which in turn could have an impact on stuttering rate (Vahab et al., 2013). Furthermore, whilst English has a classic subject-verb object structure, the word order in Arabic is mostly verb-subject-object, but other forms are also acceptable such as the subject-verb-object (Watson, 2007). In fact, in many dialects of Arabic word order usually depends on factors such as the dynamism of the verb. Arabic also accommodates almost all patterns and word-forming processes that are used in inflectional languages, as well as ones that are specific to isolated languages (Vahab et al., 2013). There is obviously a much greater flexibility with respect to the position of the subject in Arabic, which necessitates further investigations on the effect of specific morphological variables on stuttering. It would be of interest also to examine the role of inflections in the forms of suffixes and prefixes on stuttering rate in Arabic.

A non-word repetition task for Arabic and English speakers

UNWR does not apply to the Arabic language; because of its unique phonological structure that varies markedly from English. Alsulaiman et al. (2022) designed and developed a language specific Arabic and English non-word repetition task (AEN_NWR) that can equally assess children who speak either of the languages, or a mixture of both languages. The AEN_NWR is based on the same phonologically informed approach used with UNWR. The list of the stimuli in the AEN_NWR conform to accepted standards for NWR tasks including the following: language-specific phonotactic constraints of Arabic and English, avoiding later-developing consonants, and minimizing potential resemblance between real words and nonwords. The test also does not require knowledge of lexical semantics for either of the two languages.

To assess the AEN_NWR is a reliable measure of phonological skills and speech fluency, the relation between AEN_NWR scores, and the percentage of stuttered syllables (%SS) was examined. AEN_NWR scores were associated with a higher %SS indicating higher levels of stuttering. The strong correlation between AEN_NWE and the %SS was interpreted as an indication that the test has a high potential for identifying preschool children with speech disfluency. At present, no conclusion can be made until the current results are compared with results of a control group. This then would ensure that the AEN_NWR is a sensitive marker of fluency difficulty.

WFD interventions for English and Arabic

The question that may arise is when stuttering is identified and distinguished from WFD, is what can be done to improve word-finding and speech fluency. Children who show stuttering symptoms need to be referred to SLPs for full evaluation and intervention. Procedures for training working memory to enhance fluency could be delivered in schools and should not preclude intervention administered by SLPs whether or not a child has WFD or stutters. For example, Howell et al. (2020) addressed disfluency using WM training. Two-hundred-and-thirty-two reception class children from five primary schools were assessed by obtaining measures of their %SS and %WWR. Twelve were at high-risk of fluency difficulty and received WM training over two weeks. The results showed marked improvements; children's %SS dropped from pre-test to post-test and these improvements lasted for at least a week after the intervention.

WFD can also be addressed by giving them phonological or semantic training. It is unfortunate that despite the negative consequences of WFD, there is a scarcity of well-controlled intervention studies for preschool children. Moreover, the available studies are inconsistent in their methodologies, including participant numbers, intervention intensity and its duration. All of this make it challenging to compare these studies or draw general conclusions. Furthermore, the current WFD interventions are not sensitive to children's specific demands raised by our work (heterogeneous language background) due to the materials being language specific. The majority of research focuses on monolingual English speakers; and there is a need for interventions for children with different languages profiles (Ebbels, 2014). Current and novel treatment procedures for WFD must be rigorously designed to direct treatment practices for this population. For instance, Best et al. (2018) carried out a phase one randomized control trial (n=20) study to demonstrate the effect of a WFD intervention with children with WFD in schools. The study compared phonological and semantic interventions and children were assessed three times before and once after the intervention. The intervention was carried out over six weeks and employed a word-web protocol where children were encouraged to generate semantic or phonological features of words. The intervention was effective in improving retrieval of treated items. Children in the experimental group gained on average four times as many items as the control group. This was a small-scale rigorously designed study that employed a clinically realistic intervention in terms of intensity and duration. Another important aspect of the study was that it took place at a mainstream primary school where WFD is a common problem. It should also be noted that this study has not targeted children with EAL. Children were English speakers who either have been exposed to English at home from birth, or have been in an English speaking nursery at the age of three and continued to be exposed to English after that at home. Moreover, Best et al. (2018) pointed out a critical point concerning factors that may have affected the effectiveness. That is, the child background could have an influence on WFD which might affect their lexical retrieval, which in turn is likely to change over time. This reinforces the idea that WFD is a vocabulary problem (Howell et al., 2017) and that it should be treated separately from stuttering. It is important to emphasize that there are only a few studies on treating WFD, and the results of these studies differ with respect to the appropriateness of phonological vs. semantic training (Wright et al., 1993). This indicates that caution must be exercised before selecting the most suitable treatment. Further support on the equivocal results come from work by Bragard et al. (2012) who stated that the issue about the effectiveness for semantic vs. phonological intervention is open to debate. It is possible that both types of intervention are needed; or it could be that one type of treatment outperforms the other. In Wright et al.'s (1993) study, eight children received semantic training and seven children received phonological training as a WFD intervention. The phonological treatment group made significant improvement post intervention in naming untrained pictures, whilst the semantic group did not. This study focused only on phonological training to treat WFD. This allowed testing of whether phonological training is effective; and whether or not semantic training may also be needed.

The effectiveness of a language-specific phonological training intervention for improving WFD in Arabic children with EAL has been examined in work by Alsulaiman (2022). The training materials were NWR stimuli that are considered difficult because they include English-specific features that are absent from the Arabic language. Thus, the aim was to use the difficult non-words in a phonological training task using the priming effect, and then to determine whether this training transfers to real English words with similar sound structure as the non-word primes. Sixty-three reception class children were tested (31 males, 32 females, M_{age} 5;1). Of the total 63 children, 33 children were in the experimental groups; they were all Arabic speakers with EAL. The control group comprised 30 children who spoke English predominantly, although some had exposure to French through one of their parents. Children's language, literacy, and phonological performance (using the AEN_NWR) were assessed individually at pre-, post-, and follow-up assessments about two weeks post-intervention. The results showed that children in the experimental and control groups generally performed better post intervention: they showed higher accuracy in phonological performance, faster reaction times, and a decline in WFD (as indicated by WWR); and this was partly sustained at the follow-up session. The results also showed that there were no significant changes in %SS over the assessment phases for both groups. This suggests that %SS was not affected by the WFD training, and that the intervention did not improve articulation, but rather it works at the phonological and lexical levels. Thus, as indicated earlier, WFD and speech disfluency are two communication difficulties, and each requires a different type of intervention. The WFD procedure suggested here could be offered in schools. Overall, the intervention showed effects for Arabic children with EAL and for English children. Thus, the study provided a good approach to improving word-finding in preschool EAL children with other first languages, given that the right intervention materials are used, and the procedures could be easily and efficiently administered by teachers.

Conclusions and future work

We started with work that investigated how to characterize stuttering and its development over age by looking at the EXPLAN model and reviewing the evidence that supported it. An important detail that emerged in this evaluation was the different role played by WWR and agree/agreed stutters as supported by various empirical studies. Our original proposal for screening children for stuttering used a symptom set that excluded WWR as suggested by EXPLAN. This showed some success. WWR were not dismissed in our assessments since, it was argued, they could play an important role in identifying WFD. Moreover, WFD is commonly seen in school cohorts where children are required to use non-native languages. We successfully used WWR as a way of identifying children with WFD, including those using English as an additional language. Whilst these symptom-based methods were successful, we went on to seek more concise methods for use in schools. NWR was chosen, but current tests had to be modified to tackle language diversity in schools, which led to the UNWR test. UNWR proved successful at screening children with WFD, CWS, and children with typical fluency. However, issues remain about the robustness of NWR scoring procedures in general which we are addressing. This approach was developed for UK school contexts where English has to be spoken. A parallel procedure has successfully been conducted for children who speak mixed variations of Arabic and English. In-school interventions for children with fluency problems are starting to be examined; however, care should be taken that these procedures do not conflict with anything SLPs might subsequently need to do with a child who is treated.

Further reading

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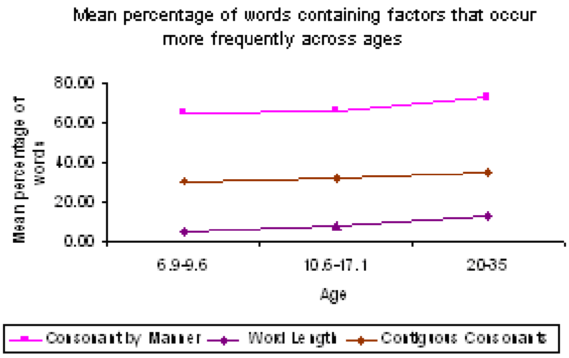
Figure 22.1 Mean percentage of content (section a) and function (section b) words containing difficult manners, long words, or contiguous consonants that occur more frequently in the speech of speakers who stutter aged 18+.

Figure 22.2 Adjusted stuttering rate (ordinate) versus number of times the four factors marked as difficult occurred (abscissa) for speakers aged over 18 years. The straight line is fitted to the content words and the upper and lower bounds around this line are indicated by the dashed line. The function word points are connected by a solid line.

Figure 22.1

Section a



Section b

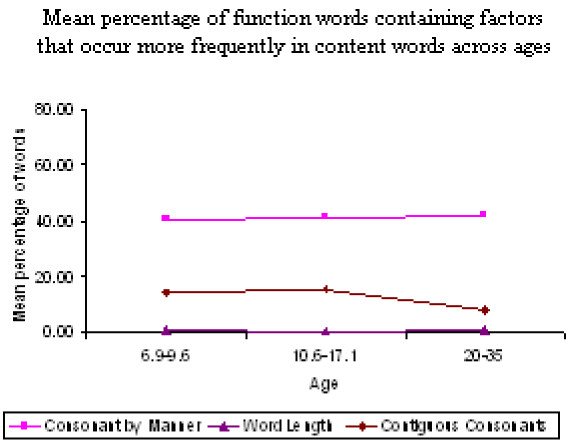
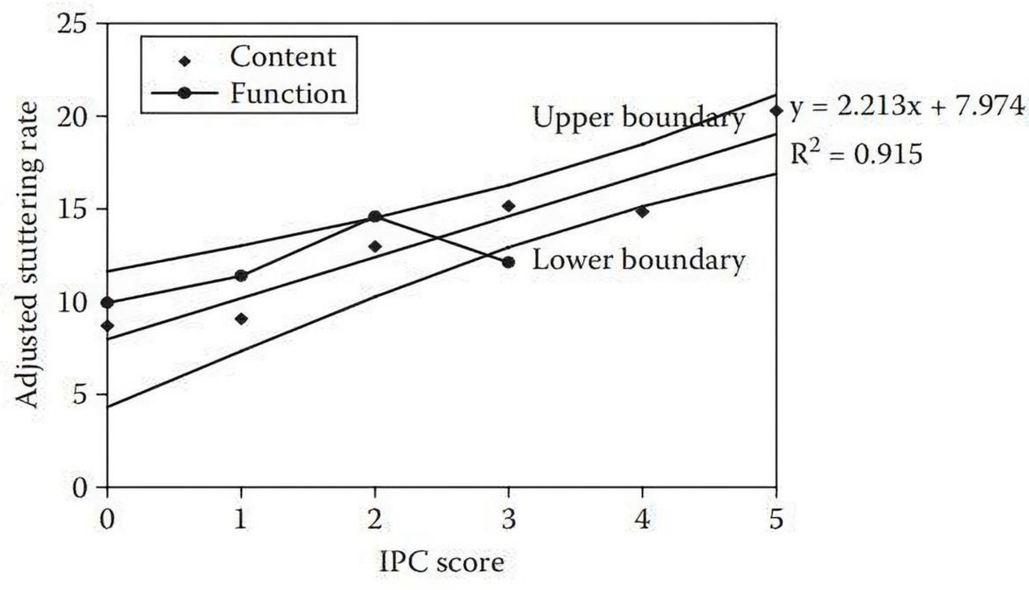


Figure 22.2


Content
Function
Upper boundary
y = 2.213x + 7.974
R2 = 0.915
Lower boundary
Adjusted stuttering rate
IPC score
25
20
15
10
5
0
0
1
2
3
4
5