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## Abstract

A recurring question in the literature of heritage language acquisition, and more generally of bilingual acquisition, is whether all linguistic domains are sensitive to input reduction and to cross-linguistic influence and to what extent. According to the Interface Hypothesis, morphosyntactic phenomena regulated by discourse-pragmatic conditions are more likely to lead to non-native outcomes than strictly syntactic aspects of the language (Sorace, 2011). To test this hypothesis, we examined subject realisation and placement in Greek-English bilingual children learning Greek as a heritage language in North America and investigated whether the amount of heritage language use can predict their performance in syntax-discourse and narrow syntactic contexts. Results indicated two deviations from the Interface Hypothesis: First, subject realisation (a syntax-discourse phenomenon) was found to be largely unproblematic. Second, subject placement was affected not only in syntax-discourse structures but also in narrow syntactic structures, though to a lesser degree, suggesting that the difference between syntax-discourse and narrow syntactic phenomena with respect to their sensitivity to input reduction is gradient rather than categorical.

*Keywords:* child heritage language acquisition, heritage language use, input and output effect, Interface Hypothesis, syntax-discourse interface, narrow syntax, subject use in Greek

## **Input effects across domains: The case of Greek subjects in child heritage language**

### **1. Introduction**

Heritage speakers are early bilinguals whose first language, the heritage language they speak at home with their parents and siblings, is different from the majority/societal language of the community they live in (Valdés, 2000). Because they acquire their heritage language under reduced input conditions and under the influence of the dominant societal language, their performance in their heritage language is typically characterized by variability (Benmamoun, Montrul & Polinsky, 2013; Montrul, 2008, 2015; Polinsky & Kagan, 2007; Kupish & Rothman, 2016; Rothman, 2009b; Scontras, Fuchs & Polinsky, 2015). A recurring question in the literature of heritage language acquisition, and more generally of bilingual acquisition, is whether all linguistic domains are sensitive to input reduction and to cross-linguistic influence and to what extent (Benmamoun et al., 2013; Montrul, 2015; Rothman 2009b; Scontras, Fuchs & Polinsky, 2015). To address this question, Sorace and colleagues have proposed the Interface Hypothesis (IH), an influential account within generative approaches to language acquisition, which predicts that morphosyntactic phenomena regulated by discourse-pragmatic conditions are more likely to lead to non-native outcomes than strictly syntactic aspects of the language (see Sorace, 2006, 2011, 2012; Sorace & Filiaci, 2006; Sorace & Serratrice, 2009; Tsimpli & Sorace, 2006; for an overview and critical discussion of the IH, see Montrul, 2011; and White, 2011). The predictions of this hypothesis have been tested against different types of bilingual populations (Sorace, 2011), including heritage speakers (Montrul & Polinsky, 2011), with some studies supporting the inherent complexity of the syntax-discourse domain (Belletti, Bennati & Sorace, 2007; Flores, 2012; Sorace & Filiaci, 2006; Montrul, 2004; Tsimpli, Sorace, Heycock & Filiaci, 2004, among others) and others indicating that syntax-discourse phenomena are not

predetermined areas for fossilization (Domínguez, 2013; Donaldson, 2012; Judy, 2015; Judy & Rothman, 2014; Leal, Rothman, & Slabakova, 2014; Montrul & Rodríguez-Louro, 2006; Rothman, 2009a, among others).

However, the majority of these studies have been designed to determine the differential effect of cross-linguistic influence across domains. The potentially differential effect of input quantity has only been examined in an indirect way through comparisons between bilingual populations with different amounts of exposure to the target language. For instance, Argyri & Sorace (2007) and Sorace, Serratrice, Filiaci, & Baldo (2009) compared bilinguals of the same language combination acquiring the target language in two different contexts: in a minority context, where the amount of exposure to the target language is arguably limited, and in a majority context, where the amount of exposure to the target language is arguably greater. Accordingly, Kupisch and colleagues carried out a series of studies with heritage speakers (HSs) of French (Kupisch, Akpinar, & Stöhr, 2013; Kupisch, Lein, Barton, Schröder, Stangen, & Stöhr, 2014) and heritage speakers (HSs) of Italian (Kupisch, 2012, 2014) residing in Germany. Their results showed that the French HSs outperformed the Italian HSs, an outcome that was attributed to the fact that the first group had attended a French school during childhood, as opposed to the second group, which had attended a German school. As a result, HSs of French had quantitatively and qualitatively more opportunities to converge with native standards in their heritage language (for an overview of these studies, see Kupisch & Rothman, 2016).

The findings of these studies are particularly significant as they demonstrate the role of input quantity in heritage language acquisition through between-groups comparisons. To our knowledge, though, no study to date has examined the differential effect of input quantity, as a continuous variable, within the same group of heritage speakers. Furthermore, there are fewer

studies on child than on adult heritage language (Cuza, 2016; Jia & Paradis, 2015) and only a handful of studies has examined Greek as a heritage language (Kaltsa, Tsimpli & Rothman, 2015; Dosi, 2017; Zomboulou, 2011). To address this gap, in our study we examined subject realisation and placement in Greek-English bilingual children learning Greek as a heritage language in North America and investigated whether the amount of heritage language use can predict their performance in the syntax-discourse and narrow syntactic contexts.

## **2. Background**

### ***2.1 The Interface Hypothesis***

One of the most influential accounts of the vulnerability of syntax-discourse phenomena among bilingual speakers has been put forward by Sorace and colleagues and has come to be known as the Interface Hypothesis (Sorace & Filiaci, 2006). In its original formulation, the Interface Hypothesis assumed a bipartite division between syntax proper and interface syntax in general. Subsequently, Tsimpli and Sorace (2006) proposed a more fine-grained division between (i) internal interfaces, which involve operations between syntax and semantics, and (ii) external interfaces, which involve the mapping between syntax and pragmatic conditions of contextual appropriateness. Both versions maintained that phenomena belonging to the syntax-discourse interface, due to the added difficulty involved in the integration of the multiple layers of information, are more vulnerable in situations of language contact than strictly syntactic phenomena.

### ***2.2 Pronominal subject realization***

Evidence in support of the vulnerability of the syntax-discourse interface has come primarily from studies on pronominal subject realization. According to generative approaches, the rich

agreement morphology of the verbal paradigm in null subject languages syntactically licenses or allows for null (phonologically unexpressed) subjects (Rizzi, 1982). In these languages, the alternation between null and overt pronominal subjects is constrained by discourse factors, in that there is a preference for null pronouns to refer to topical subject antecedents and for overt pronouns to mark topic shift and contrastive focus (for Greek, see Kaltsa et al., 2015; Papadopoulou, Peristeri, Plemenou, Marinis & Tsimpli, 2015; Tsimpli et al., 2004; for Italian, see Belletti et al., 2007; Carminati, 2002; Sorace et al., 2009; for Spanish, see Alonso-Ovalle, Fernandez-Solera, Frazier & Clinton, 2002; see, also, Filiaci, 2010, for differences among Italian and Spanish). The Italian sentences in (1), taken from Carminati (2002), illustrate this point:

(1) a. *Marta* scrivera frequentemente a *Piera* quando era negli Stati Uniti

*Marta* wrote frequently to *Piera* when was in the United States

b. *Marta*<sub>i</sub> scrivera frequentemente a *Piera*<sub>j</sub> quando *lei*<sub>\*i/j</sub> era negli Stati Uniti

*Marta* wrote frequently to *Piera* when she was in the United States

Whereas the null pronominal subject of the embedded clause in (1a) is preferably associated with the subject/topic of the matrix sentence (i.e., with *Marta*), giving rise to a -Topic Shift reading, the overt pronominal subject *lei* ‘she’ in (1b) is preferably associated with the object of the matrix sentence (i.e., with *Piera*), giving rise to a +Topic Shift interpretation.

A large body of research has shown that, unlike monolinguals, who ultimately master both the syntactic and the discourse aspect of pronominal subject realization, Italian-English bilinguals (and, more generally, bilinguals learning a null subject language together with a non-null subject language) are often challenged by its pragmatic constraints. For example, Belletti et al. (2007), in line with Sorace and Filiaci (2006), found that near native speakers of Italian, under

the influence of their first language (L1) (English), were significantly more likely than native speakers of Italian to overextend the use and interpretation of overt pronouns in -Topic Shift contexts, where null pronouns are the pragmatically appropriate option. The pattern has been replicated with different types of bilingual populations speaking different combinations of null and non-null subject languages. These include L1 attriters (for Greek-English, see Tsimpli et al., 2004; for Greek-Swedish, see Kaltsa et al., 2015), bilingual children (for Spanish-English, see Paradis & Navarro, 2003; for Italian-English, see Serratrice, Sorace & Paoli, 2004; Serratrice, 2007, and Sorace & Serratrice, 2009; for Hebrew-English, see Hacoen & Schaeffer, 2007; for Turkish-English, see Haznedar, 2007; for Italian-Dutch, see Pinto, 2006), L2 learners at the intermediate level (for Spanish-English, see Montrul & Rodríguez-Louro, 2006; Rothman, 2009a), and adult heritage speakers (for Greek-Swedish, see Kaltsa et al., 2015; for Russian-English, see Polinsky, 2007; for Spanish-English, see Montrul, 2004). Despite differences in age and language combinations, but not independently of proficiency, as demonstrated by Montrul & Rodríguez-Louro (2006) and Rothman (2009a), all these bilingual populations have been shown to exhibit non-native-like uses or judgements of overt pronouns in their null subject languages.

Most of these studies, though, have been designed to determine the impact of cross-linguistic influence across domains. Hence, they have focused on language combinations that differ systematically with respect to pronominal subject realization (i.e., null subject languages and non-null subject languages) and have shown that bilinguals tend to make pragmatically non-felicitous uses of the overlapping option (i.e., of overt subjects) in their null subject language. Interestingly, non-felicitous uses of null subjects have also been reported among these populations (Domínguez, 2013; Clements & Domínguez 2017; Montrul, 2004; Montrul & Rodríguez-Louro, 2006; Rothman, 2009a; Wolleb, 2013) suggesting that cross-linguistic

transfer might not be the sole factor for non-convergence in the syntax-discourse domain. This possibility is further supported by studies showing that bilinguals speaking two null subject languages, with similar discourse conditions underlying pronominal subject realization, can also be challenged by the distribution of null and overt subjects in their L2 (for L1 Spanish-L2 Italian, see Bini, 1993; for L1 Farsi- L2 Spanish, see Judy 2015 and Judy & Rothman, 2014; for L1 Greek-L2 Spanish, see Lozano, 2006 and Margaza & Bel, 2006; for simultaneous Italian-Spanish bilinguals, see Sorace et al., 2009). In light of these results, other factors, including input quantity, have been hypothesized to modulate the vulnerability of the syntax-discourse domain (Sorace, 2011; Sorace & Serratrice, 2009, among others).

### ***2.3 The role of input quantity on subject realisation and placement***

The effect of input quantity across domains has only been indirectly investigated through comparisons between groups of bilinguals of the same language combination, who, depending on their country of residency, acquired the target language either as a majority or as a minority language (Argyri & Sorace, 2007; Sorace et al., 2009).

Sorace et al. (2009), for instance, compared a group of Italian-English bilingual children living in the UK with a group of Italian-English bilingual children living in Italy. Focusing on pronominal subject realization in Italian (a phenomenon that, as discussed above, requires the integration of both narrow syntactic and discourse pragmatic knowledge), the authors tested the acceptability of subject pronouns (overt and null) in -Topic Shift and +Topic Shift contexts. Their results confirmed the sensitivity of syntax-discourse to input quantity, since bilinguals

living in the UK, who arguably received more English input than Italian input, performed less accurately than bilinguals living in Italy, who received more input in Italian than in English.

In an earlier study, Argyri and Sorace (2007) had examined the role of input quantity by comparing Greek-English bilingual children born and raised in the UK with Greek-English bilingual children born and raised in Greece. Differently from Sorace et al. (2009), the authors tested the children's use and comprehension of Greek subjects and objects in both syntax-discourse and narrow syntactic domains. This allowed them to investigate not only whether input reduction would affect the syntax-discourse interface (a domain that was hypothesized to be sensitive to input quantity), but also whether it would affect it more than the narrow syntactic context (a domain that was hypothesized to be relatively immune). The syntax-discourse domains included (i) pronominal subject realization in -Topic Shift contexts, where subjects are preferably null and (ii) subject placement in wide focus contexts, where subjects are preferably post-verbal. The narrow syntactic domains concerned (i) subject placement in *wh*-embedded interrogatives, where subjects are always post-verbal (independently of discourse conditions), and (ii) placement of object clitics, which are always preverbal (independently of discourse conditions). Their results confirmed the role of input quantity, since the bilinguals living in the UK (who had a greater exposure to English) performed less accurately in Greek than the bilinguals living in Greece (who had a greater exposure to Greek). Interestingly, though, input effects were attested in both discourse-syntax and narrow syntactic domains, in different degrees. Thus, whereas both embedded interrogatives and wide focus were affected, wide focus was affected to a greater extent. The findings of this study are particularly interesting because they appear to suggest that the difference between narrow syntactic and syntax-discourse phenomena with respect to their sensitivity to input quantity is gradient rather than categorical. In other

words, instead of supporting a categorical dichotomy between an invulnerable syntactic domain and a vulnerable syntax-discourse domain, they indicate that both domains are vulnerable in different degrees.

#### ***2.4 Open Issues***

Summing up, while both Sorace et al. (2009) and Argyri & Sorace (2007) provide support for the differential impact of input quantity across domains, they do so by relying on between-groups comparisons. Less is known about the impact of input fluctuations among speakers that belong in the same group of bilinguals. The methodological advantage of this alternative approach is that by keeping the status of the target language/country of residence constant, we may better control for the impact of other experiential variables commonly differentiating majority from heritage/minority language learning. These include the richness of input (e.g., diversity of sources), the quality of input (e.g., amount of code switching in the target language input), as well as access to formal instruction (for an overview of the experiential variables associated with bilingual acquisition and development, see Unsworth, 2016, 2017). Additionally, by studying the amount of language use as a continuous predictor within the same group, we can investigate how it differentially affects the various language domains or structures within the same group of heritage speakers, and avoid setting arbitrary cut-offs to create distinct learner groups.

#### **3. Present Study**

To address this gap, in the present study, we collected production data from Greek-English bilingual children learning Greek as a heritage language in North America and examined whether the amount of heritage language use at home would be a predictor of the children's

performance in the domain of Greek subjects, in both discourse-syntax and narrow syntactic contexts.

The amount of heritage language use at home was calculated as the mean proportion of heritage language input and output to better capture the children's experience with the heritage language, similarly to previous studies with bilingual children (Bedore, Peña, Summers, Boerger, Resendiz, Greene, Bohman, & Gillam, 2012; Paradis, 2011a). The domain of subjects was chosen because it has been shown to be problematic for other bilingual populations speaking Greek alongside a non-null subject language (for Greek-English simultaneous bilingual children living in the UK, see Argyri & Sorace, 2007; for adult heritage speakers of Greek living in Sweden, see Kaltsa et al., 2015; for Greek attriters, see Tsimpli et al., 2004). As to the selection of heritage speakers, it was motivated by the empirical observation that they differ significantly from each other in their daily amount of heritage language use (Montrul, 2015; Unsworth, 2017). As a result, they provide a good testing ground for hypotheses concerning how variation in input/output quantity affects different grammatical domains. Two research questions were addressed:

1. Do Greek heritage children differ from Greek monolingual children in their choices of subject form and subject placement as a function of syntactic and discourse factors?
2. Does the amount of heritage language use in the home affect children's performance on subject form and placement? If so, are subjects at the syntax-discourse interface more sensitive to the amount of heritage language use than subjects constrained exclusively by syntactic factors?

To answer these questions, we replicated Argyri and Sorace's (2007) design, in examining subject use in two syntax-discourse structures and one narrow syntactic structure. The syntax-

discourse structures involved subject form, in -Topic Shift contexts, where subjects are preferably null, and subject placement in wide focus contexts, where subjects are preferably postverbal. The syntactic structure involved subject placement in *wh*-embedded interrogatives, where subjects are obligatorily postverbal and dissociated from discourse functions. In all three structures, subject use in Greek differs from subject use in English. These systematic differences enabled us to investigate the role of language use across domains, while keeping the likelihood of cross-linguistic transfer constant. In what follows, we will first present the syntactic literature and the properties of the target structures and we will then turn to our predictions.

### ***3.1 Target Structures***

#### *Subject Form in -Topic Shift (-TS) contexts*

Being a typical null subject language with rich verbal agreement, Greek can leave the subject of a finite sentence phonologically unexpressed. Thus, overt pronominal subjects may alternate with null pronominal subjects, as shown in (2):

(2) a. Aftos efije.

he left.3SING

“He left.”

b. *pro* efije.

left.3SING

“He left.”

However, as discussed in section 2, the alternation between these two forms is constrained by discourse factors, in that null subjects are preferably interpreted as coreferential with the most salient linguistic antecedent (that is with the subject/topic of a previous sentence), whereas overt pronominal subjects typically mark topic shift (for Greek, see Kaltsa, et al., 2015; Papadopoulou et al., 2015; and Tsimpli et al., 2004). This is illustrated with (3), below.

- (3) a. Pote            efije        o Kostas;<sub>i</sub>?  
       when            left.3SING the Kostas.NOM  
       “When did Kostas leave?”
- b. Otan *pro*<sub>i</sub> teljose            tin omilia    tu.  
       when    finished.3SING    the talk        his.GEN  
       “When he finished his talk.”
- c. Otan *aftos*<sub>j</sub> teljose            tin omilia    tu.  
       when he finished.3SING    the talk        his.GEN  
       “When he finished his talk.”

Whereas the null pronominal subject (*pro*) in (3b) is associated with the subject of the previous utterance (i.e., *Kostas*) leading to a -Topic Shift interpretation, the overt pronominal subject (*aftos* ‘he’) in (3c) is most naturally understood as referring to an extra-linguistic entity, leading to a +Topic Shift interpretation.

In English, on the other hand, subjects are typically overt, except for some restricted contexts (Haegeman, 1997), and are used regardless of whether there is a shift of topic (4):

- (4) a. When did Kostas<sub>i</sub> leave?  
       b. \*When *pro* finished his talk.

c. When he<sub>i/j</sub> finished his talk.

*Subject Placement in Wide Focus (WF)*

The second syntax-discourse property that we considered concerned subject placement in finite declarative clauses. In this context, subjects may appear both pre-verbally, as shown in (5a) and post-verbally, as shown in (5b):

(5) a. O Kostas                    chalase            ti fotoghrafiki.  
           the Kostas.NOM        broke.3SING    the camera.ACC

b. Chalase        o Kostas            ti fotoghrafiki.  
           broke.3SING the Kostas.NOM the camera.ACC

“Kostas broke the camera.”

The alternation between preverbal and postverbal subjects though, similarly to the alternation between null and overt subjects, rather than being random, is regulated by discourse factors (Alexopoulou, 1999). To simplify a rather complex picture, Verb-Subject-Object (VSO) is the most natural answer to wide focus questions of the ‘What happened with X?’ type (Alexopoulou, 1999). This is shown in (6):<sup>1</sup>

(6) a. Ti    ejine                    me        tin fotoghrafiki tu Petru?  
           what happened.3SING with    the camera.GEN the Peter.GEN

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“What happened with Peter’s camera?”

b. tin chalase o Kostas.

CL.ACC broke.3SING the Kostas.NOM

“Kostas broke it.”

c. # O Kostas ti chalase.

the Kostas.NOM CL.ACC broke.3SING

“Kostas broke it.”

Subject-Verb-Object (SVO), on the other hand, obtains higher felicity judgements than Verb-Subject-Object (VSO) in all new contexts (Keller & Alexopoulou, 2011), as well as in contexts where the preverbal subject receives a topic or a narrow/contrastive focus interpretation (Alexiadou, 1999; Alexopoulou, 1999; Tsimpli, 1990; Tsimpli, 1995). The latter possibility is illustrated with the dialogue in (7):

(7) a. Pjos chalase ti fotografiki, o Janis i o Kostas?

who broke.3SING the camera.ACC, the Janis.NOM or the Kostas.NOM

“Who broke the camera? Janis or Kostas?”

b. O KOSTAS ti chalase.

the Kostas CL.ACC broke.3SING

“Kostas broke it.”

c. #Ti            chalase            O KOSTAS.  
 CL.ACC        broke.3SING        the Kostas.NOM

“Kostas broke it.”

As indicated by the grammaticality judgements, the most natural answer to a narrow focus question introducing a contrast between two entities (that are realized as subjects) (7a) involves a preverbal (7b) rather than a postverbal subject (7c) (Alexopoulou, 1999; Kapetangianni, 2011; Tsimpli, 1995).<sup>2</sup>

English differs from Greek in that it does not normally license postverbal subjects. Thus, preverbal subjects are licit, and actually obligatory, in both wide focus (8) and narrow focus contexts (9):

(8) a. What happened with Peter’s camera?

b. John broke the camera.

c. \*Broke John the camera.

(9) a. Who broke the camera? John or Peter?

b. JOHN broke the camera.

### *Subject Placement in Embedded Interrogatives (EI)*

Finally, we considered subject-verb inversion in Greek *wh*-interrogatives. Unlike the type of subject-verb inversion instantiated in Greek declaratives, subject-verb inversion in Greek interrogatives is dissociated from discourse functions and its violation leads to strong

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<sup>2</sup>

ungrammaticality. This is shown in (10) and (11) with matrix and embedded interrogatives, respectively:<sup>3</sup>

(10) a. Ti echase o Kostas?  
 what lost.3SING the Kostas.NOM

b. \*ti o Kostas echase?

what the Kostas.NOM lost.3SING

“What did Kostas lose?”

(11) a. Dhen ksero ti echase o Kostas.  
 NEG know.1SING what lost.3SING the Kostas.NOM

b. \*Dhen ksero ti o Kostas echase.

NEG know.1SING what the Kostas.NOM lost.3SING

“I don’t know what Kostas lost.”

Once again, English differs from Greek in that subject-verb inversion only takes place in matrix interrogatives. In embedded interrogatives, subjects are obligatorily preverbal (12):

(12) a. \*I don’t know what lost Kostas.

b. I don’t know what Kostas lost.

### ***3.2 Predictions***

We made two sets of predictions based on the Interface Hypothesis. Under a strong/categorical interpretation of the Hypothesis, heritage children were predicted to be less accurate than monolingual children in the syntax-discourse contexts (i.e., in -Topic Shift and in Wide Focus) but not in the narrow syntactic context (i.e., in Embedded Interrogatives). Furthermore, heritage language use was expected to have an impact on heritage children's accuracy in -Topic Shift and in Wide Focus, but not in Embedded Interrogatives.

Under a gradient/less categorical interpretation of the Interface Hypothesis, heritage children were predicted to be less accurate than their monolingual peers in both syntax-discourse and narrow syntactic contexts, but in different degrees. As to the impact of heritage language use on heritage children's accuracy, it was expected to be stronger for the syntax discourse contexts than for the narrow syntactic one. In view of the results obtained in Argyri and Sorace (2007), we treated the second set of predictions as more likely than the first one.

## **4. Methods**

### ***4.1 Participants***

Two groups of Greek-speaking children participated in our study: one group of heritage children and one group of monolingual children residing in Greece. The heritage children were tested in the same period in two different locations: (i) a group of 43 six-to-seventeen-year-old Greek heritage children was tested in Western Canada, and (ii) a group of 35 six-to-twelve-year-old Greek heritage children was tested in New York City. The Greek heritage children were recruited from Greek language schools (Saturday and weekday, afternoon schools) operating in Western Canada (Alberta, Saskatchewan, and British Columbia) and New York City. A group of 45 six-to-fourteen monolingual children residing in Greece served as the control group.

To collect information on the timing and length of exposure to the two languages, parental concerns about the child's language development, the child's and the guardian's place of birth and year of immigration, we used a parental questionnaire that was based on the *Alberta Language Environment Questionnaire* (ALEQ) (Paradis, 2011a). This information was used to include and exclude participants from the group. Children from the two heritage groups were excluded from the study if they spoke languages other than Greek and English or if they failed to answer any of the questions in Greek during informal interaction. Children were included in the group if they were exposed to Greek from birth, if they had all immigrated to North America by the age of three years in the case of first generation immigrant children, and had started sustained and consistent exposure to English in a daycare, or a preschool programme by the age of five years. This resulted in eleven children from the Canadian group and five from the NYC group being excluded. The final numbers of children in each group are reported in Table 1. In terms of immigration generation, the Canadian heritage children were predominantly third generation immigrants. There was only one child that belonged to the second generation and thirteen children whose one parent was first and the other parent was second generation. In the NYC group, two children had migrated to the US before the age of three years and were first generation immigrants. In addition, there were eleven children whose one parent was first and the other second generation immigrant, fifteen children, who were second generation immigrants, and three children, who belonged to third generation heritage speakers.

Independent samples t-tests showed that the heritage group did not differ from the monolingual control group in terms of age ( $t(100)=-.88, p=.38$ ), even though the NYC group was the youngest of both groups (vs. Canadian children:  $p<.001$ ; vs. monolingual children:  $p=.016$ ), whereas the Canadian group did not differ from the monolingual control group ( $p=.28$ ),

as pairwise comparisons with Bonferroni correction revealed. The Canadian children did not differ from the NYC children in terms of early exposure to Greek ( $t(49.1)=-1.37, p=.17$ ), current use of Greek ( $t(48.2)=-1.41, p=.16$ ), or socioeconomic background (SES) as measured through years of maternal education, and all three groups having mid-to-high SES levels. The heritage children were also matched on SES with the monolingual control children (Table 1).

Table 1. Mean age, Greek expressive vocabulary, English receptive vocabulary, current use of Greek and use of Greek in early childhood in the North American (Canadian and NYC) and the monolingual Greek-speaking groups.

Background Variables		CA Group ( $n=32$ )	NY Group ( $n=30$ )	North American Greek Group ( $n=62$ )	monolingual children ( $n=45$ )
Age (in months)	Mean	136.3	113.4	125.1	130.2
	Range	72-203	78-134	72-203	75-177
	SD	30.5	15.1	26.7	24
GR-EXPR (RS)	Mean	17.3	24.4	20.7	45.6
	Range	4-32	8-45	4-45	39-49
	SD	8.7	9.5	9.7	2.3
PPVT-4 (SS)	Mean	106.3	109.3	107.7	
	Range	85-136	87-135	85-136	
	SD	13.7	11.4	12.7	
CurGrUse	Mean	.42	.50	.46	
	Range	.25-90	.25-1	.25-1	
	SD	.21	.24	.22	

GrUseEC	Mean	.83	.74	.79	
	Range	.33-1	.33-1	.33-1	
	SD	.23	.29	.25	
SES	Mean	16.77	18.04	17.4	17.3
	Range	12-24	12-20	12-24	6-24
	SD	2.95	3.05	3	4.7

Notes: GR-EXPR = Greek expressive vocabulary (Vogindroukas et al, 2009); RS = Raw scores; PPVT-4 = English receptive vocabulary (Dunn & Dunn, 2007); SS = standard scores; CurGrUse = Current Use of Greek; GrUEC = Greek-use-Early Childhood is the proportion of Greek spoken to the child by family members in early childhood (0 to 36 months); SES = socioeconomic status as measured by years of maternal education.

## 4.2 Materials

### *Baseline tasks*

**Proficiency in English:** To assess children's proficiency in English, we used the Peabody Picture Verification Task (4<sup>th</sup> edition) (PPVT-IV) (Dunn & Dunn, 2007), which is a receptive vocabulary task standardized with English-speaking monolingual children in the United States and Canada. In this task, children are shown a four-picture panel and are asked to point to the picture that corresponds to the word spoken by the experimenter. Raw scores were converted to standard scores (Table 1). All bilingual heritage children met monolingual age-appropriate norms, confirming their good competence in English. The two groups of heritage children did not differ in their proficiency in English ( $F(1,60)=160.6, p=1$ ).

**Proficiency in Greek:** Children's proficiency in Greek was assessed using the only currently available task for this age range (Vogindroukas, Protopapas & Sideridis, 2009). This is an expressive vocabulary test, which is an adaptation of Renfrew's (1997) picture naming task. In this task, children are presented with a total of 50 black-and-white flashcards and are asked to

name the object depicted on the flashcard. There is no discontinue rule and all items need to be administered (Table 1). A one-way ANOVA with the raw vocabulary scores as the within participants factor and Group as the between groups factor revealed a main effect of Group ( $F(2, 104) = 169.4, p < .001, \text{partial } \eta^2 = .69$ ) Post hoc tests with Bonferroni correction revealed that the NYC heritage children had higher accuracy on the Greek expressive vocabulary task than their Canadian counterparts ( $p < .001$ ). Both groups had a statistically significant lower accuracy than the monolingual controls ( $p < .001$  in both cases), even when collapsed into the combined heritage group ( $p < .001$ ). For the analysis, we converted the raw scores into proportions with the maximum score of 50 as the denominator and the number of correct items as the numerator.

Language background questionnaire: To collect information regarding Greek language use with family members at home (parents and siblings, both at the time of testing and in early childhood), children's input and output in Greek, time of immigration to the US or Canada, and parental education, we administered a parental questionnaire that was based on the *Alberta Language Environment Questionnaire* (ALEQ) (Paradis, 2011a). Whereas the original ALEQ was designed to measure the current *English* language use (input and output) in the child's environment, the adaptation that we used (ALEQ Heritage) measured the current *heritage* (i.e., *Greek*) language use.

Information about the child's input was measured using questions about how frequently the parents, guardians (including grandparents) and other siblings spoke Greek to the child on a scale from 0 (Greek almost never/English almost always) to 4 (Greek almost always/English almost never). Output was measured as the frequency with which the child spoke Greek to the same family members and guardians. Greek language use at home was then calculated as the

mean proportion of Greek input and output that the child received from and directed to other family members (mother, father, siblings and grandparents).

Additionally, we calculated Greek language use in early childhood, that is before the age of three years, by asking about the frequency of interaction in Greek (same scale as above for input). Children's Age of Onset (AoO) and length of systematic exposure (LoE) to English was also measured and this usually coincided with the child's attendance of daycare/preschool/school. The Canadian heritage children were exposed to English at the mean age of 41.1 months (range: 12-60, SD: 11.68) and had a mean LoE to English of 95.5 months (range: 36-155, SD: 29.35), and the NYC children were exposed to English at the mean age of 41.8 months (range: 12-96, SD: 14.7) and had a mean LoE to English of 70.3 months (range: 33-115, SD: 19). Finally, information about the socioeconomic status of the family was calculated based on years of maternal education. All heritage children belonged to mid-to-high SES families.

### *Experimental task*

To examine children's use of subjects in syntax-discourse and narrow syntactic contexts, we adapted Argyri and Sorace's (2007) elicited production task that was designed to target: (i) subject form in -Topic Shift contexts, as in (13), (ii) subject placement in Wide Focus (WF) contexts, as in (14), and (iii) subject placement in embedded *wh*-interrogative (EI) contexts, as in (15). For each context, participants were shown a picture of animated characters on a laptop screen, and were, subsequently, asked a question that was meant to prompt the production of the target structure (see Appendix for a detailed presentation of the task).

In the -Topic Shift condition (example 13), participants were shown a picture of a character involved in a certain activity (e.g., a woman going to the bakery) and were prompted with a lead-in question to give a reason for the character's activity. They were then instructed to begin their response with the word *epidhi* 'because'. The felicitous response in this condition involved the use of a null subject pronoun to refer to the already prominently introduced topic/discourse antecedent.

(13) Experimenter: Jati pi je sto furno i kiria Sofia?

why went.3SING to the bakery the miss Sofia.NOM

“Why did Miss Sofia go to the bakery?”

Expected response: Epidhi ithele na agorasi psomi.

because wanted to buy.3SING bread

“Because she wanted to buy bread.”

In the WF condition (example 14), participants were presented with a picture depicting an activity between two animated characters (e.g., a dog playing with a ball and a little girl, Maria, who was looking at the dog, clearly upset). They were then asked a wide focus question about the activity. This context in Greek was expected to induce a postverbal subject, as in (14):

(14) Experimenter: Ti ejine i bala tis Marias?

what happened.3SING the ball.NOM the Maria.GEN

“What happened to Maria’s ball?”

Expected response: Tin       pire       o skilos.

It CL.ACC took.3SING the dog.NOM

“The dog took it.”

In the EI condition (example 15), participants were presented with a picture depicting a forgetful grandparent, who complained about not remembering his/her grandchild’s activities. After each picture, participants were prompted to complete a lead-in sentence of the sort *i jaja/o papus den thimate* ‘Grandmother/grandpa doesn’t remember...’, which again elicits postverbal subjects in Greek:

(15) Experimenter: I   egoni                   mu i   Maria   mu ipe       ti   forese,  
   the granddaughter.NOM my the Maria.NOM me told.3SING what put on.3SING  
   alla den thimame       tora.  
   but NEG remember.1SING now

“My granddaughter Maria, told me what she put on but I don’t remember.”

Experimenter: Ti   den thimate       i   jaja?

what NEG remember.3SING the grandmother.NOM

“What doesn’t the grandmother remember?”

Expected Response: Den thimate ti forese i egoni tis.

NEG remember.3SING what put on.3SING the granddaughter her.GEN

“She doesn’t remember what her granddaughter put on.”

There were eight items per condition, which resulted in twenty-four items. The items were the same as the ones developed by Argyri and Sorace (2007), but were increased in number from six to eight per structure. The added items were comparable to the ones borrowed from Argyri and Sorace (2007).

#### ***4.3 Coding and scoring***

In the -Topic Shift condition, all responses with a null subject were coded as correct and given a value of “1”, and all responses with an overt subject, either a pronoun or a full lexical DP, were coded as incorrect and were given a value of “0”. In the WF and the EI conditions, all responses with postverbal subjects were coded as correct and were given a value of “1” and responses with preverbal subjects as incorrect and were given a value of “0”. Responses containing intersentential code-switching, responses with missing verbs or null responses were excluded from the calculation. This amounted to 11.02% of the data for the Canadian group, 9.6% of the data for the NYC group. There were no such responses in the monolingual Greek group.

#### ***4.4 Procedure***

Children were tested in their homes (21 out of the 62 children) or at their Greek schools (41 out of the 62 children). Each child participated in an hourly session that included a battery of other

tasks on a laptop and in a shorter session where the PPVT was administered. All tasks were administered by a Greek-English bilingual researcher. Parents were administered the questionnaire over the phone, through face-to-face interviews or were asked to complete it on their own.

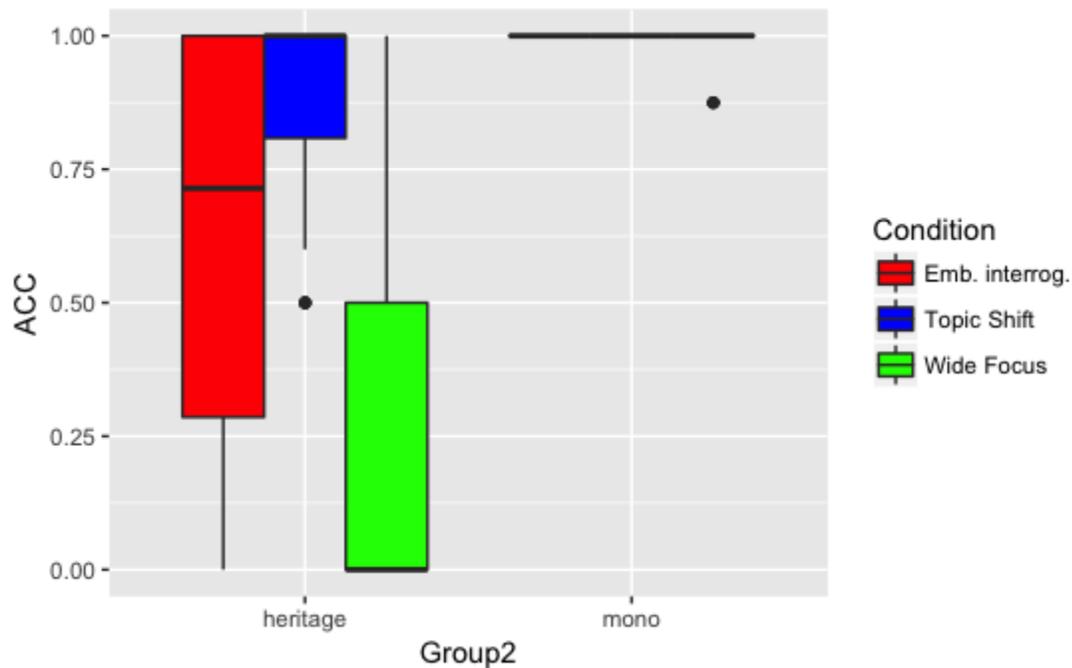
## **5. Results**

We statistically analysed the results using a generalized linear mixed model with a logistic link function given the binomial nature of the dependent variable: correct (VS in the WF and EI conditions, null subject in the -TS condition) and incorrect responses (SV in the WF and EI conditions and overt subject in the -TS condition). Statistical analysis was carried out using the lme4 package in R (Baayen, 2008). We opted for mixed-effects logistic regression models over repeated-measures ANOVAs because we wanted to consider individual variability on the participant and item level affected the results (Baayen, 2008). The mixed effects logistic regression allows using a larger number of data-points to include a more complete and theoretically-motivated random effects structure: specifically, one that specifies a random intercept for subject and a random slope for condition by subject (Barr, Levy, Scheepers & Tily, 2013; Dixon, 2008). This random effects structure follows the hypothesis that performance not only varies between individuals, but also individual performance varies across conditions. Visualisation of the results was carried out using ggplot and visualisation of the regression results using the effects package (Fox, 2016).

### *Accuracy*

Figure 1 presents the accuracy results on the -TS, the EI and the WF conditions. In the -TS condition, the dependent variable is the proportion of null pronouns, whereas in the EI and the WF conditions the dependent variable was the proportion of VS structures that the children produced.

Figure 1: *Mean Accuracy per Group and Condition*



To address the first research question, we fitted a mixed-effects regression model with Group (heritage, monolingual) and Condition (-TS, EI and WF) as the fixed-effects predictors. The models were built up incrementally with Group and Condition included as the main effects in the first model, followed by a model with the interaction between Condition and Group. Random intercepts for subjects and items were also included in the models. The optimal model included the maximal random effect structure justified by the data, and this resulted in including the by-subject intercept and a condition by subject slope. Model comparisons using chi square tests

were carried out to ascertain whether the inclusion of a main effect or an interaction improved the fit of the model. In the first model, the embedded interrogative condition was used as the reference level since this is the only purely syntactic condition out of the three, and we wanted to establish whether the two discourse conditions differed from the strictly syntactic condition. Pairwise comparisons between the conditions were carried out by changing the reference level. To judge the fit of the logistic model, we calculated the Concordance Index (C; Chatterjee & Hadi, 2006) and Somers' Dxy rank correlation between the predicted probabilities and the observed responses (Harrell, 2015). A C-index and a Somers' Dxy rank correlation of above 0.8 indicates that the model is good.

Table 2. *Optimal model with Group, Condition and Use as predictors*

	Estimate	SE	t	p
(Intercept)	-1.38	0.51	2.67**	.007
Monolingual	10.28	1.32	7.78***	< .001
Topic Shift	1.81	0.65	2.78**	.0055
Wide Focus	-4.17	0.65	-6.43***	< .001

*Note:* SE = standard error

\* $p < .05$ , \*\* $p < .01$ , \*\*\*  $p < .001$

The optimal model was the one with the main effects of Group and Condition and the Condition by participant slope and participant intercept. This model provided a good fit ( $C = .91$ ,  $D_{xy} = .83$ ) and is presented in Table 2.<sup>4</sup> The optimal model revealed that the monolingual children were at

ceiling across conditions and differed overall from the heritage children. The WF condition had the lowest accuracy and differed from both the -TS (Table 2) and the EI (<.001) conditions, whereas the -TS condition had higher accuracy than the EI condition (Table 2). In the -TS condition, the heritage children produced primarily full lexical DPs when not producing a null subject. These responses amounted to 8.9% off all responses (34/381 total items).

*Effects of language use on interface and narrow-syntactic conditions in the heritage group*

To examine whether heritage language use affected the performance of the heritage group across the three conditions, we ran a mixed-effects logistic regression with Condition and Use as fixed effects in the heritage group only. Random effects included the participant intercept and the Condition by Participant slope. Language Use was entered in the model as a continuous variable. The optimal model is presented in Table 3 and it provided a good fit ( $C=.84$ ,  $D_{xy}=.69$ ).<sup>5</sup>

Table 3. *Optimal model with heritage language Use as predictor for the heritage children's accuracy across the three conditions*

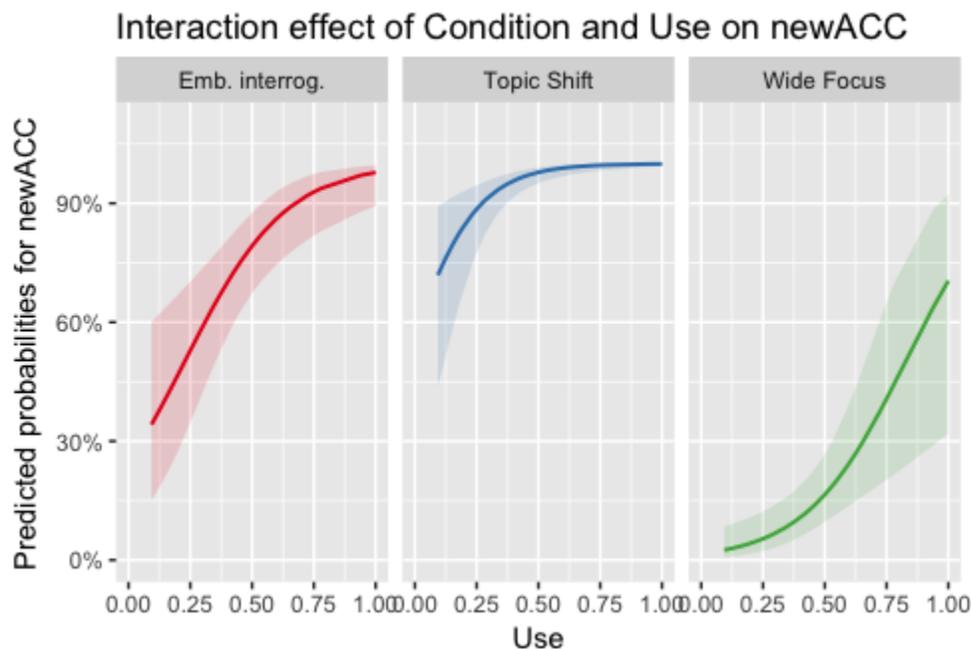
	Estimate	Std. Error	t	p
(Intercept)	-1.46	0.65	-2.24*	.025
Topic Shift	1.63	0.51	3.17**	.0016
Wide Focus	-4.05	0.59	-6.83***	< .001
Use	5.88	1.19	4.91***	< .001

*Note:* SE = standard error

\* $p < .05$ , \*\* $p < .01$ , \*\*\*  $p < .001$

Across all three conditions, performance in the heritage group improved with increased language use (Figure 2).<sup>6</sup> However, the three conditions differed in terms of how much heritage language use is required for the heritage children's accuracy to improve across the three conditions. In the -TS condition, the heritage children with very little input (less than 25%) had approximately 75% accuracy and reached ceiling performance with approx. 40% input, whereas heritage language use seems to matter more in the case of the two conditions tapping into word order, EI (approximately 35% accuracy when use is less than 25%) and WF (less than 10% accuracy when use is less than 25%). Heritage children reached ceiling performance on EI with approximately 75% of language use, whereas they failed to reach ceiling accuracy on the WF condition even when their heritage language use was above 75%.

Figure 2: *Relationship between Use and Condition in the Heritage Group*



## 6. Discussion

The main goal of this study was to investigate whether the amount of language use in heritage contexts equally affects narrow syntactic and interface phenomena. To this end, we investigated the relationship between the amount of heritage language use at home and heritage children's accuracy across two different grammatical domains: syntax-discourse and narrow syntax. More specifically, we tested Greek-English bilingual children learning Greek as a heritage language in two syntax-discourse (subject realization in -TS; subject placement in WF) and one narrow syntactic structure (subject placement in EI). Our research questions were aimed at determining (i) differences between monolingual and heritage children, as well as (ii) differences between heritage children associated with their daily amount of heritage language use at home.

Regarding the comparison between heritage children and the monolingual controls, heritage children showed variable performance in all three structures, although in different degrees, unlike their monolingual peers, who performed at ceiling across the board. More precisely, heritage children opted for:

- (i) preverbal subjects in WF (a context, where post-verbal subjects are preferred)
- (ii) preverbal subjects in EI (a context, where post-verbal subjects are required)
- (iii) (to a much lesser degree) overt lexical subjects in -TS (a context, where null subjects are preferred)

Importantly for our purposes, heritage children's accuracy varied depending on the structure. The -TS structure was the least challenging of the three, with heritage children performing almost at ceiling. Of the remaining two subject placement structures, the EI was shown to be less challenging than the WF.

Turning to our second research question, results revealed a non-linear relationship between the amount of heritage language use in the home and all three structures. More specifically, the structures differed in terms of how much heritage language use was required for the heritage children's performance to improve and what the starting point in terms of accuracy for each structure was. In the -TS structure, heritage children even with limited language use (less than 25%) achieved high performance (approx. 75%). The structures tapping into subject placement, on the other hand, displayed a different degree of dependence on language use. Thus, with less than 25% heritage language use, children had 35% accuracy in the EI structure and less than 10% accuracy in the WF structure. This suggests that when language use is limited, the WF structure (a syntax-discourse structure) is more vulnerable compared to the EI structure (a narrow-syntactic structure). Interestingly, the accuracy difference between the two subject placement conditions remained as the proportion of language use increased. Namely, heritage children reached almost ceiling accuracy on the EI condition when the proportion of language use was approximately 60%. Conversely, even with 100% heritage language use in the home,

heritage children did not reach more than 75% accuracy on the WF condition. A possible interpretation for these results is that the WF condition, being dependent on the coordination of both syntactic and discourse knowledge, is inherently more challenging and, consequently, requires language use beyond the home environment to be fully acquired. It is also possible that it is more vulnerable to cross linguistic influence as in this context, the overlapping option between Greek and English (i.e., preverbal subjects) is merely dispreferred, not disallowed.

### ***6.1 Implications for the Interface Hypothesis***

What are the implications of these findings for the Interface Hypothesis? Overall, our study – in line with Argyri and Sorace’s (2007) study on simultaneous Greek-English bilingual children raised in the UK – suggests two deviations from the strong version of the Interface Hypothesis.

First, one of the two syntax-discourse structures (i.e., distribution of overt and null pronominal subjects in -TS contexts) was found to be largely unproblematic. Even children with a minimum of heritage language use (less than 25%) made appropriate uses of null subjects in -TS contexts (approx. 75%). There were very few uses of overt lexical DPs (lower than 10%) and no uses of overt pronominal subjects. Second, subject placement in EI (a narrow syntactic context) was also found to be challenging for heritage children and dependent on language use though to a lesser degree than subject placement in WF.

The observed dissociation between the two syntax-discourse contexts is in line with Tsimpli et al.’s (2004) study on Greek attriters and Argyri and Sorace’s (2007) study on simultaneous Greek-English bilingual children. In both studies, Greek bilinguals were shown to differ significantly from their monolingual peers in the rate of non-felicitous preverbal subjects,

but not in the rate of non-felicitous overt subject pronouns in -TS. At the same time, these results set Greek bilinguals apart from bilingual learners of other null subject languages such as Italian and Spanish, who, with the exception of high proficiency speakers (Montrul & Rodríguez-Louro, 2006; Rothman, 2009a) and the near natives of Judy (2015) and Judy & Rothman (2014), have been repeatedly shown to overextend the use of overt pronouns into pragmatically infelicitous contexts (for Italian-English bilinguals, see Belletti et al., 2007 and Serratrice et al., 2004, among others; for Spanish-English bilinguals, see Montrul, 2004 and Paradis & Navarro, 2003).

It is possible that the observed discrepancies are related to the lexical properties of third person personal pronouns in Greek (a possibility also discussed in Tsimpli & Sorace, 2006 to account for the fact that Russian near native speakers of Greek generally avoid the use of third person overt pronouns in -TS contexts). Unlike the Italian *lui* and the Spanish *él*, the Greek *aftos* is a demonstrative that may assume an anaphoric interpretation. Thus, its use in the -TS contexts of our study would introduce an ambiguity between an anaphoric reading (establishing co-reference with the subject antecedent) and a deictic reading (establishing an association with an extra-linguistic referent). In other words, it could be the case that due to the salience of its deictic reading, the Greek *aftos* is resilient to input reduction (and cross-linguistic transfer). If this explanation is on the right track, then we expect to find differences even among monolingual speakers of Greek, Italian, and Spanish in their use of third subject personal pronouns.

It is also possible that the reason why Greek heritage children are more likely to use non-felicitous preverbal than non-felicitous overt subjects is related to frequency of use. More precisely, while preverbal subjects (of transitive verbs) in Greek are more frequent than postverbal subjects (Skopeteas, 2016), overt subjects are less frequent than null subjects (Kapetangianni, 2011). If this explanation is on the right track, then we might expect that even

young monolingual learners of Greek will be more challenged by subject placement than by subject realization.

Setting aside, therefore, the complication raised from pronominal subject realization, which as suggested above could be due to frequency effects and/or to the lexical semantics of the Greek pronouns, the present study indicates that, at least in the case of heritage speakers, who have experienced a drastic reduction in exposure to their heritage language in early childhood, the amount of language use has an impact on subject placement not only in the syntax-discourse domain but also in the narrow syntactic domain (in different degrees). In this respect, our results align with Cuza's (2012, 2016) studies on heritage Spanish, showing that heritage speakers are challenged by subject placement in the narrow syntactic context of interrogatives.

Last but not least, in this study, we have only considered the effects of quantitative aspects of the input. Heritage children, though, differ from monolinguals and from each other, not only in terms of the quantity of input that they have received, but also in terms of its type (Paradis & Navarro, 2003; Paradis, 2011b; Kupisch & Rothman, 2016; Sorace, 2004, 2011; Unsworth, 2016, 2017). This is because their main source of the heritage language comes from their parents and grandparents, who, depending on the generation to which they belong, they might show different degrees of attrition. Whether different degrees of attrition have an effect on heritage language acquisition and whether this effect is relevant for both narrow syntactic and syntax-discourse properties is a question we aim to address in a follow up study by analyzing the parental input of our participants.

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1. Note that in all of our examples, the Object appears preverbally, because it is a clitic rather than a full DP.
2. In terms of their structural position postverbal subjects in Greek declarative clauses have been argued to occupy their thematic VP internal position (Alexiadou & Anagnostopoulou, 1998). Preverbal subjects, on the other hand, have been analysed as Clitic Left Dislocated elements occupying [Spec, Topic] (Alexiadou & Anagnostopoulou, 1998), as Foci moved to [Spec, FocusP] (Tsimpli 1990, 1995), as well as TP internal elements occupying [Spec, TP] (Spyropoulos & Revithiadou, 2009).
3. The phenomenon is typically analyzed as the result of V-to-C movement (for Greek, see Panagiotidis & Tsiplakou, 2004; Tsimpli, 1990. See also Anagnostopoulou, 1994 and Kotzoglou, 2006, for alternative accounts). According to this analysis, further to the displacement of the wh-phrase at the beginning of the sentences (i.e., in [Spec, CP]), the verb moves to T and subsequently to C, leaving the subject in a lower position. Hence, the surface effect of subject-verb inversion.
4. The optimal model was better than the model with the Condition by Group interaction and only random intercepts ( $\chi^2(5)=67.68$ ,  $p<.001$ ). The optimal model did not differ from the Condition by Group interaction model that also included the Condition by participant slope ( $\chi^2(2)=0.093$ ,  $p=.95$ ). The latter model did not give rise to a statistically significant Group effect or to a statistically significant Group by Condition interaction. This suggests that individual performance varied across conditions especially in the heritage group and this overrode the Condition by Group interaction.
5. Following a reviewer's suggestion, we also examined whether Age contributes to the heritage children's performance across the three conditions. First, we ran a correlation

between Age and Use and found a negative correlation between the two ( $t(60) = -3.13$ ,  $\rho = -.39$ ,  $p=.002$ ). Mixed-effects logistic regression with Age and Condition as fixed effects and Participant and Item intercepts revealed no main effect with Age ( $\beta=0.007$ ,  $SE= 0.012$ ,  $z\text{-value}= 0.592$ ,  $p= 0.554$ ). However, there was an interaction between Age and -TS ( $\beta=-0.048$ ,  $SE=0.009$ ,  $z\text{-value}=-5.102$ ,  $p<0.0001$ ) and Age and WF ( $\beta=-0.022$ ,  $SE=0.009$ ,  $z\text{-value}=-2.55$ ,  $p=0.011$ ) with EI as the reference level. This was because the older children had lower accuracy on the -TS and WF conditions compared to the EI condition, where performance improved with age. The model comparison between the one with Use and the one with Age showed that the one with Use is significantly better than the one with Age ( $\chi(5)=62.998$ ,  $p<0.0001$ ).

6. Figure 2 was built using the `sjp.int` function with `type= "eff"` from the 'effects' package (Fox, 2016). The `eff`-type plots the overall effects (even non-significant ones) of the interaction with all remaining covariates set to the mean, and both main effects of the interaction term are used to calculate the overall mean of the dependent variable (accuracy in this case). The `eff`-type produces one plot where all factor levels of Condition are included as moderator variable. This analysis allows us to visualise the interaction even when it is not significant, as in the present case.