Down two steps: Are bilinguals delayed in the acquisition of recursively embedded PPs?

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Abstract: The present study examines whether bilingual children are delayed in the ability to produce complex DPs. We elicited production of DPs containing two PP modifiers, in two conditions designed to tease apart the acquisition of an embedding rule from the acquisition of the recursivity of an embedding rule. In the recursive condition, one modifier PP was itself modified by an additional PP. In the non-recursive condition, both PPs sequentially modified the main noun. Participants were 71 English monolingual children and 35 bilinguals between the ages of four and six. The evidence suggested an overall difference between groups, however further analysis revealed that bilinguals differed from monolinguals only insofar as the onset of PP embedding. No specific additional bilingual delay arose from the recursive condition. This suggest that recursive embedding is a resilient domain in language acquisition and supports proposals that link morphosyntactic delays in bilingual children to domains of grammar that are heavily reliant on lexical learning, which would include learning the first instance of PP embedding.

Keywords: language acquisition, recursion, PP modifiers, bilingual delay

1. Introduction

Are bilingual children delayed in their ability to produce complex structures? Specifically, we focus on complex nominal expressions (determiner phrases, henceforth DPs), and comparing how English monolingual children and simultaneous Spanish-English bilinguals produce complex DPs in English. Using a controlled elicited production task, we targeted DPs with a sequence of two prepositional phrase (PP) modifiers, which can be recursive (when one modifier restricts the head noun, and the second modifier in turn restricts the head noun of the first PP modifier) or non-recursive, when both modifiers sequentially restrict the highest head noun. These complex DPs in (1) and (2) differ in depth of embedding. The structural representations in (3) schematize the main difference, which is essentially, the locus of attachment of the second modifier. This determines whether modification applies recursively (increasing the level of embedding) or sequentially, where the two modifiers simultaneously apply to the higher head noun (remaining first level embedding).

(1) Recursive modification: The dog [next to the tree [next to the house]

(2) Sequential (Non-recursive) modification: The mouse [with a tie] [inside the house]

(3) a. Recursive: $[_{DP}$ N $[_{PP}$ … $[_{PP}$ …]]]

b. Non-recursive $[_{DP}$ N $[_{PP}$ …] $[_{PP}$ …]]

Bilingualism is not considered to be generally detrimental to language development, although it often leads to different developmental trajectories from those of monolingual children (GENESEE, PARADIS, & CRAGO, 2004; PEARSON, 2008). The timing and patterns of bilingual development are diverse, and intricately shaped by the changing language histories of bilinguals (CASTILLA-EARLS ET AL., 2016; PARADIS, TREMBLAY, & CRAGO, 2014). Consider, for example, the case of vocabulary development: the word counts in one language of a bilingual child tend to be lower than those of monolinguals children at the same age. Crucially, such disadvantage is the result of considering only one language of the bilingual child. When the vocabularies of both languages are taken into account, a bilingual child is likely to have higher total word counts than monolinguals (PEARSON, FERNANDEZ, & OLLER, 1993). When conceptual vocabularies are calculated (counting words in both languages, but substracting translation equivalents) bilingual vocabulary sizes are found to be roughly comparable to those of monolinguals (MARCHMAN, FERNALD, & HURTADO, 2010).

The impact of bilingualism on grammatical development is more difficult to characterize. For children who start learning both languages simultaneously, many core properties of grammar are acquired in much the same fashion and in a comparable time frame as for monolinguals (PARADIS & GENESEE, 1996). This is the case, at least for the strong language of children growing up in environments that are supportive of bilingualism. This remains an impressive achievement when one considers that typical bilingual children spend less time in a given language than their monolingual peers. At the same time, it is clear that bilingualism leads to differences in the patterns of the acquisition of various grammatical properties (YIP & MATTHEWS, 2000). This is known as bilingual interdependence effects (MEISEL, 2007). Given grammatical markers and constructions are more or less vulnerable to bilingual effects (MÜLLER, 2003), which can express as either qualitative differences or patterns of delays or acceleration in the time of acquisition (MÜLLER & HULK, 2001; KUPISCH, 2007; PATUTO, REPETTO, & MULLER, 2011).

Certain grammatical properties are more vulnerable to delay than others in bilingual development. Null objects, for example, are one such case: bilingual children will have more object omissions than monolingual children acquiring the same language, independent of whether the other language is a null object language or not (PÉREZ-LEROUX, PIRVULESCU,

& ROBERGE, 2009, 2017). Young English-speaking children have more null objects if they are also learning French (a language where object pronoun omission is extended in acquisition), but the same children will not see a benefit from the early pronoun realization of English in French. Such consistent delay effects might result, not from language influence, but from the relative reduction in the input inherent to the bilingual experience (PIRVULESCU, PEREZ-LEROUX, ROBERGE, STRIK, & THOMAS, 2014). Pirvulescu and colleagues propose that each instance of parametric learning depends specifically on given signatures or linguistic structures relevant for the selection of a grammar over the competitors (YANG, 2002). If the signature utterances are of lower frequency, input reduction in the bilingual context might lead to general delays. Therefore, studying which grammatical domains are vulnerable to general bilingual delays provides crucial data on the workings and potential limits of the language learning capacity. This has inspired a growing body of work comparing the developmental patterns of bilinguals across different linguistic dimensions. For example, Thordardottir (2014) found that grammatical accuracy, and lexical diversity were sensitive to input conditions in bilinguals, but non-word repetition skills and mean length of utterance were not (THORDARDOTTIR, 2014). Unsworth takes this a step further by proposing that lexically sensitive measures of grammar are more prone to be delayed in bilingual development, given the typical (single-language) vocabulary lag in bilinguals (UNSWORTH, 2014). In her view, more formal/compositional aspects of sentence form and interpretation are likely to remain unaffected in bilingual acquisition. Her study concentrated two properties of Dutch morphosyntax: gender marking, which is highly dependent on lexical development, and scrambling, which pertains to the interaction of word order and meaning, and does not possess a lexically-specific dimension. Two groups of bilinguals that differed in the intensity of exposure to Dutch were compared. The results established that gender marking was sensitive to levels of input in bilinguals. In contrast, for scrambling they found no differences between the high exposure/low exposure bilingual groups.

A different line of work links the vulnerability of bilingual syntax to structural complexity. Complexity in these studies is defined in terms of number of steps in a grammatical derivation, including a contrasting role for external and internal merge (STRIK, 2012; STRIK & PÉREZ-LEROUX, 2011; PRÉVOST, TULLER, SCHEIDNES, FERRÉ, & HAIDEN, 2010). Presumably, more complex structures are more vulnerable in acquisition.

Our goal is to examine whether there are bilingual effects in the acquisition of complex, recursive DPs. Recursion is a fundamental property of grammar that underlies the hierarchical structure of the human language (HAUSER, CHOMSKY, & FITCH, 2002). It also serves as the foundation for structural elaboration by allowing recursive embedding of phrasal categories (TROTZKE & ZWART, 2014). These represent two different senses of recursion: in the broad sense, it represents the endocentric, hierarchically structured nature of syntax; in the narrower sense, it refers to iterated self-embedding of phrasal categories.

In its broad sense recursion is considered to be a resilient property in language development (GOLDIN-MEADOW, 1982). Studies of deaf children of hearing parents who develop their own communication systems, show that hierarchical structure will develop in the absence of exposure to a conventional language system (HUNSICKER & GOLDIN-MEADOW, 2012).

Recursive self-embedding, in contrast, appears difficult for language learners. Recursive modification, as in (4) and recursive possession structures, such as (5), are difficult for monolingual children and for adult L2 learners (LIMBACH & ADONE, 2010; NELSON, 2016).

(4) The baby with the woman with the flowers

(5) Maria's father's bicycle

It seems that the specific step of recursive embedding increases the level of difficulty, beyond the number of constituents inside complex DPs. Both monolingual child and adult speakers of English seem to find instances of recursive modification such as (1) more difficult to produce that those with sequential modification (2) (PETERSON, PEREZ-LEROUX, CASTILLA-EARLS, MASSAM, & BEJAR, 2015).

Why should this be the case? Recursion is complex: embedding and the embedded XPs exhibit different behavior at the semantic interface (ARSENIJEVIĆ & HINZEN, 2012). At the moment of composition of the higher DP a fully intersective interpretation is available between all three predicates in (2) that is unavailable in (1). The example in (2) constitutes two instances of single PP modification; the mouse is both *with a tie* and *inside the house*. Conversely, in (1) intersection is only possible between the simple predicate denoted by the head noun (i.e., the property of being a dog) and the complex predicate resulting from the composition of the two modifiers (i.e., the property of being next to the tree that is next to the house). In (1) the nominal under the first PP is itself restricted by a second PP modifier; the dog is next to the tree, but it is the tree that is next to the house (see PÉREZ-LEROUX et al., to appear).

In addition to issues of complexity at the semantic interface, variation and processing must be taken into consideration. Recursion varies across languages: as highlighted by Roeper and Snyder, German and English share the cognate possessive ‘s, but this grammatical rule is only recursive in English (ROEPER & SNYDER, 2005). Therefore, the recursivity of a rule has to be, in some sense, learned as a distinct step (ROEPER & PÉREZ-LEROUX, 2011). One expects to find a stage where learners fail to generalize to a second level of embedding, despite having mastered the single-level embedding rule (Pérez-Leroux et al., 2012).

Processing may provide a complementary explanation for learner's difficulty. Given that depth of embedding is associated with planning difficulties in production (MCDANIEL, GARRETT, & MCKEE, 2010), increased cost of referential accessibility (GORDON, HENDRICK, LEDOUX, & YANG, 1999), and a general bias for high attachment (PEREZ-LEROUX, CASTILLA-EARLS, BEJAR, MASSAM, & PETERSON, in press), it is possible that the observed stage with no recursion may result from performance constraints.

Recursive structures are rather infrequent. If direct experience is necessary to learn recursive modification, we might expect bilingual children to be substantively delayed with these structures. To date the only recursion study on bilingual children is by Amaral and Leandro, who studied child, adolescent and adult speakers of Wapichana, an Arawak language spoken in the border between Brazil and Guyana (AMARAL & LEANDRO, In press). They found that speaking Wapichana appeared to confer an early bilingual advantage in English; i.e. child bilinguals had better performance with multiple levels of recursive possession than English monolinguals. They also found a bilingual delay in Wapichana, by those speakers who had Portuguese as the majority language. According to the authors, these results can be predicted from the congruence in directionality pattern. Possession is left branching in both English and Wapichana, but right branching in Portuguese.

2. Questions and Hypotheses

Our study explored the possibility of a bilingual delay absent a contrast in directionality in the modification structures across the two languages. For that purpose, we focused on recursive modifiers in English in a group bilingual children simultaneously acquiring English and Spanish. These two languages have DP internal right branching modifiers, which can be either PPs or relative clauses (RCs), as in (6):

(6) a. The dog [next to the tree] PP

b. The dog [standing next to the tree] RC

c. The dog [that is standing next to the tree] RC

Our main questions are: i) Do bilingual children have a general delay with the acquisition of embedding? and ii) Do bilingual children have a specific delay related to recursive embedding?

We speculate that if bilingual delays are restricted to lexically-sensitive acquisition steps, there might be a bilingual delay in the acquisition of embedding strategies. Prepositions are relational terms, which are acquired by means of syntactic bootstrapping, an input-sensitive mechanism for lexical learning (GLEITMAN et al, 2005). Furthermore, there appear to be restrictions on which lexical prepositions are allowed in Spanish in DP internal position (MOREIRA-RODRÍGUEZ, 2006). Since PP modification is sensitive to lexical factors, the reduced input inherent to bilingual acquisition may affect the onset of PP embedding. This would manifest as a difference between bilinguals and monolinguals in sequential modification, where both PPs independently modify the head noun. Importantly, this is independent of whether or not there is a bilingual delay in the acquisition of recursive embedding, which is a purely structural step, of recursively applying the same embedding strategy twice. There seems to be no need to learn extra lexical restrictions on additional iterations of an embedding rule.

These predictions can be expressed by contrasting the following three hypotheses.

I. **Null Hypothesis:** There is no difference between bilinguals and monolinguals.

II. **Complexity Hypothesis**: Bilinguals differ significantly from monolinguals in their ability to produce both types of complex DPs. Furthermore, since each embedding step increases structural complexity, bilinguals may be further delayed for recursively modified DPs.

III. **Lexically-dependent Vulnerability Hypothesis:** Bilingual children may show a delay in the acquisition of the first level of modification (as evidenced by the double non-recursive condition), but not in recursive modification, as the second step is not dependent on the acquisition of new functional vocabulary.

3. Methods

3.1 Participants

A total of 106 children between the ages of 4 and 6 participated. Thirty-five Spanish-English bilinguals participated in the study. The control group were 71 monolingual English-speaking children previously reported in PÉREZ-LEROUX et al. (to appear).

Table 1. Age descriptive statistics for participants

	Monolinguals				Bilinguals			
	N	Range	Mean Age	SD	N	Range	Mean Age	SD
4 year olds	25	4;00-4;10	4;04.3	(2.4)	10	4;00-4;11	4;04.2	(3.1)
5 year olds	25	5;00-5;11	5;04.4	(3.3)	12	5;00-5;11	5;06.0	(3.2)
6 year olds	21	6;00-6;11	6;05.2	(3.1)	13	6;00-6;11	6;05.4	(3.7)

Most children were recruited in local preschools and summer camps in Toronto ON and Western New York. A substantial number of the bilingual children were recruited through personal networks, churches and community centers and were interviewed at home. All but seven bilingual children were from Toronto, an intensely multilingual city with a relatively low percentage of Spanish-speaking households (1.9% in the 2011 Census, City of Toronto, 2011). Children completed all tasks in English and Spanish. The present study reports the English results.

3.2 Tasks

The study employed a referential elicitation task similar to the one in Pérez-Leroux et al. (2012), where participants hear a short story context accompanied by a picture. The purpose of the descriptive preamble was twofold: to highlight the multiple referential competitors present in the picture scenario, and to introduce all the relevant vocabulary items that the child would need to provide a complete response, without modelling the target syntax. These competitors are chosen so that to uniquely identify the target referent a speaker would need to use double modification. A brief referential question (*Which X is ….?)* was used to prompt for the response.

The entire elicitation task included five different referential elicitation conditions, plus twelve distractor items. Children also received standardized language tests in both Spanish and English (CELF, PPVT-IV, TVIP), a standard non-word repetition task (Dollaghan & Campbell 1998), and the Non-Verbal Scale of the Kauffman Assessment Battery for Children Second Edition (KABC-II; Kaufman & Kaufman, 2004). The entire test battery was administered over two sessions.

The present study only reports on two tasks: the recursive locative PP elicitation and the double non-recursive modification condition described below. The goal of the study was to compare performance across those conditions. In the recursive condition, the target description was a recursively modified DP, as in (7), where the highest DP headed by the noun *dog* contains a PP modifier *next to the tree*. The head of this second DP is itself modified by another embedded PP. In the non-recursive condition illustrated in (8), the two embedded PP modifiers modified directly the referent of the highest DP, the mouse. The arrows in text indicate when the experimenter was pointing at elements in the pictures.

(7) Recursive condition

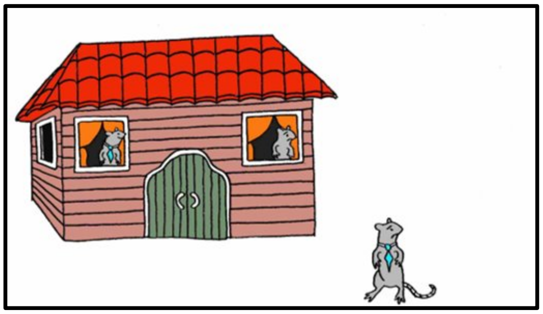
Story: In the yard of this house, there are two trees.
One is ➘far from the house, one is ➘near the house.

They let the dogs out, in the yard (➘each), but one of
the dogs started to bark.

Prompt: Which dog is barking?

Target: The dog [next to the tree [next to the house]]

(8) Non-recursive condition



Story: These little mice live in a doll house↵.
Some mice are wearing a tie (➘each), some are not.

Prompt: Which mouse is happy?

Target: The mouse [with a tie] [inside the house]

As described above, both conditions require double modification but in the former case the two modifiers are nested; in the latter, they are sequentially inserted into the structure and do not interact with each other. As a consequence, these can be reordered within the complex DP without altering the meaning.

3.3 Coding

Our coding strategy combined a syntactic coding that characterized the DP in terms of level of embedding, with an evaluation of the descriptive content and referential characteristics of the response.

(9) Levels of embedding

Single DP: *the dog*

Level 1: *the mouse with a tie*

2-Level 1: *The mouse with a tie inside the house*

Level 2: *The dog next to the tree next to the house*

The referential coding considered whether the target referential expressions (for example, dog, tree and house, for (7) were used in the description, and how they were used. This referential coding had five categories, as shown in (10):

(10) Referential coding

a. Incomplete: These consisted of simpler or level 1 DPs. Responses made reference to one or two but not all three of the target referents.

Example: *Big tree.* (C225, 4;5) *The tree that is close to the house.* (C220, 5;0)

b. Sequential: These were sequences of incomplete responses that combined together provided a full description, but were not integrated into a single utterance. They either resulted from the speaker pausing and then starting a new utterance incorporating new information, or from the use of a second or third prompt.

Example: *The one in the other side and this one is happy. The one that has the-the one that has the thing here (the tie?) yeah in the house*. (C219, 5;9)

c. Alternative: These consisted of simple descriptions, often stated on spatial terms (on the left, the highest one), which identified the referent correctly but not on the basis of the target PPs. Using these alternative descriptions allowed speakers to attain referential success without articulating DPs at the level of structural elaboration investigated in this study.

Example: *The one with the close tree.* (C217, 6;2)

d. Non-embedded. These were semantically complete descriptions, where the three referents were made mention in a single utterance, but were not integrated syntactically by means of embedding strategies. In the case of the recursive condition, this might include reordering of the referents.

Example: *The one beside the tree and the tree is next to the house* (C210, 6;9)

e. Target: We considered as target only responses that were descriptively complete, i.e., mentioned all three nouns, and where these were linked according to the target level of embedding (Level 2 for recursive modification, 2 Level 1 for non-recursive double modification).

Example: *The one that is on…the one that has the biggest…the big tree…on…in front of him* (C209, 6;8)

The data was coded by two researchers, and all discrepancies reconciled.

4. Results

The small age differences between the groups were not statistically significant (Wilcoxon's W=1352, p=.46). To test our hypothesis, we first conducted an individual analysis on level of embedding achieved by the children, followed by a group analysis on the effects of condition and language status in children's ability to produce targets. We then further explored the effect of age and group for the production of targets in the recursive condition. Finally, we compared error patterns across the two groups of participants.

To study the individual patterns of embedding, each child was classified according to the maximum level of embedding achieved in her responses in the recursive condition. Table 2 presents the distribution of bilingual and monolingual children classed according to the most embedded structure they were able to produce. The distributional differences between the two groups was significantly different (χ^2 (2, 106) =10.9, p = 0.004). The analysis of the residuals indicates that the asymmetry between the two groups is concentrated on the relatively higher number of bilinguals at the single DP stage in comparison to the monolinguals (i.e., the standardized residual value for the frequency of bilinguals at the single DP stage is higher than 2 SDs).

Table 2. Number of participants per group classified according to their most complex production, with percentages in parenthesis.

	Single DP	Level 1	Level 2
Bilingual (n=35)	7(20%)	12(34%)	16(46%)
Monolingual (n=71)	2(3%)	19(27%)	50(70%)

We then examined overall frequencies of target responses in monolinguals and bilinguals. As Figure 1 indicates, there was a trend for monolinguals to produce more targets than bilinguals. This trend was present in both conditions.

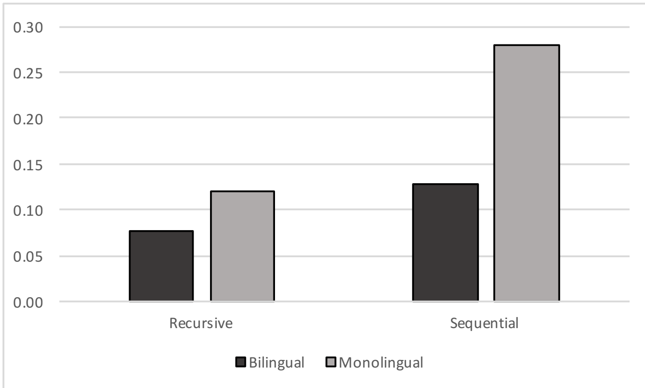


Figure 1: Proportion of semantic target responses by condition (recursive vs. sequential) by group (bilingual vs. monolingual)

To test whether this difference between monolinguals and bilinguals was significant, we classified children's responses as targets or non-targets. A generalized linear mixed-effect model using the maximum likelihood method in R (Laplace Approximation) was fitted on the frequencies of these responses, using the binomial distribution, with condition and language group as fixed effects, and participants as random effect.

Table 3. Generalized linear model testing the effects of group and condition in the production of target responses (Formula: Target~Group + Condition + (1|Participant)).

		Estimate	Std. Error	*p*
(Intercept)		-3.6377	0.384	<0.001 ***
Condition		1.175	0.184	<0.001 ***
Language Group		1.059	0.395	0.007 **
AIC	BIC	logLik	deviance	df.resid
980.9	1001.5	-486.5	973.0	1252

The model indicated a highly significant effect of Condition and a significant effect of Group. A second version of the model was analyzed to include the interaction between the two fixed effects. This manipulation failed to improve the fit of the model (AIC=980.9 vs. AIC=980.4, p=.11), or to reveal a significant interaction.

To explore the effect of age in the emergence of recursive modification, the number of target responses produced to the recursive condition were plotted as a function of the child's age. The trendline indicated the line of best fit between age and number of targets. As Figure 2 shows, monolingual and bilingual children follow similar developmental trajectories; their target responses increased with age. For both groups, production shifted between 60 and 70 months. Note that for all children production remains fairly low, but slightly lower for the bilingual group.

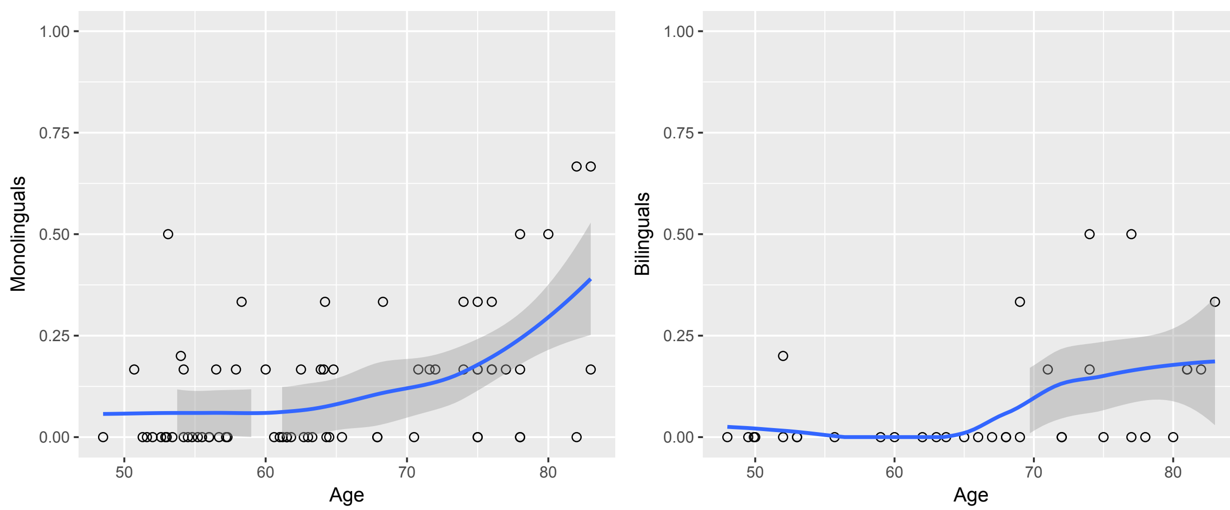


Figure 2: Proportion of target responses produced by monolinguals and bilinguals in the recursive condition plotted as a function of children's age in months.

We then assessed the effect of age across groups in the recursive condition. To that purpose, we fitted a second generalized linear model (logit) on the number of target responses, with participants as a random effect and two fixed effects, language group as a categorical predictor, and age in months as a continuous variable, plus the interaction between age and group. The results of this analysis are given in Table 4. The results indicated a significant effect of age in months on the production of target responses, but no effect of language group, nor interaction between the two main effects.

Table 4. Generalized linear model testing the interaction of age in months and group in the production of target responses in recursive condition (Formula: Target~Age in months*Group + (1|Participant)).

		Estimate	Std. Error	*p*
(Intercept)		-10.726	3.055	<0.001 ***
Age in Months		0.113	0.041	0.006 **
Language Group		3.206	3.331	0.336
Age in Months*Language Group		-0.0341	0.046	0.456
AIC	BIC	logLik	deviance	df.resid
390.6	1001.5	-190.3	380.6	623

The last step in our analysis was to examine the response patterns of individual participants. In the recursive condition distribution of response types was similar for bilinguals and monolinguals, with the exception of the frequency of incomplete responses (Table 3). Bilinguals produced significantly more incomplete responses than their monolingual counterparts. A chi-square test on the frequencies of response types across groups identified an association between group (bilingual vs. monolingual) and response type (incomplete, alternative, sequential, non-embedded, target) (χ^2 (4, 728) = 19.03, $p< 0.001$). This result can be attributed to the difference in frequency of incomplete responses between the two groups, given that the highest residual score in the analysis corresponded to incomplete responses given by the bilingual group (i.e., >2 SDs).

Table 3. Frequency of responses per group to the recursive condition, classified according to the semantic coding. Percentages are indicated in parentheses.

	Incomplete	Alternative	Sequential	Non-embedded	Target
Bilingual (n=35)	143(69%)	21(10%)	13(6%)	15(7%)	16(8%)
Monolingual (n=71)	212(50%)	70(17%)	44(10%)	44(10%)	50(12%)

In the sequential (double non-embedded) condition bilinguals differed from monolinguals in their production of incomplete, sequential and target responses, but produced comparable numbers of non-embedded and alternative responses. Again, a chi-square test was performed and a relationship was found between speaker group (bilingual vs. monolingual) and response type (incomplete, alternative, sequential, non-embedded, target) (χ^2 (4, 628) = 35.18, p<.001). The inspection of the residual data within this analysis suggest that the result depended on the difference in frequency of incomplete, sequential and target responses between the two groups. The standard residuals for each of these response types in the bilingual group was significant for incomplete (>2SDs), and for sequential and target responses (< -2 SDs).

Table 4: Frequency of responses per group to the non-recursive condition, classified according to the semantic coding. Percentages are indicated in parentheses.

	Incomplete	Alternative	Sequential	Non-embedded	Target
Bilingual (n=35)	142(69%)	18(9%)	13(6%)	6(3%)	26(13%)
Monolingual (n=71)	204(48%)	24(6%)	62(15%)	15(4%)	118(28%)

The differences between groups in the distribution of responses can be summarized as such: bilinguals generally produce more incomplete responses than monolinguals, and less sequential and target responses than expected, but this is only significant in the non-recursive condition.

5. Discussion

Recall that our first question was whether one can observe a general delay in bilingual children's acquisition of embedded PP modifiers. Our second question was whether recursive modification was specifically delayed. Our data suggests a general delay with the acquisition of embedding, but no specific cost of recursive embedding. Let us consider our main results:

a) When children were analyzed individually, more bilinguals than monolinguals were still at the single DP level, at a much higher ratio: 7/35 vs 2/71. Those children were not yet providing evidence of use of DP internal embedded modifiers.

b) When children were analyzed as a group, and the two conditions were taken into consideration, we observed a general advantage for monolinguals, and a general difference between conditions, with the recursive condition being more difficult than the non-recursive condition, for both groups. While the advantage was much greater for the non-recursive condition, the statistical interaction did not prove to be significant.

c) However, when age was entered into evaluation of the recursive condition, it was clear that age, rather than bilingual status, was the principal determinant of whether a child was able to produce recursive responses.

d) In terms of error types, bilinguals showed a trend for structurally simpler (incomplete and sequential responses) when they failed to provide a target.

The overall analysis shows that bilinguals differed significantly from monolinguals in their overall ability to produce targets, since groups means were slightly depressed compared to monolinguals. It is important to recall that the difference was quite small in the in the recursive condition (8% vs. 12%); and much more substantial in the non-recursive condition (12% vs.

28%). When performance in the recursive condition was further analyzed taking the effects of age in consideration, the statistical analyses demonstrate that group differences were driven by the non-recursive condition. Bilingual status seemed not to make a difference in the production of recursive targets; both groups significantly improve with age. For monolinguals, few children under the age of five produce recursive modification at all, for the smaller sample of bilinguals, only one child did. For both groups, it was only after the age of six that we observed a clear increase in productivity.

The individual analyses further assist us in interpreting these results, as they pinpoint the locus of the delay at the onset of emergence of first level of embedding. Past that step, we see no further differences between groups in the distribution of children according to whether they managed to produce first or second level embedding. We also note that there was no evidence of a different pattern of errors. The distribution of response types was generally similar across groups, except for two minor differences. In the recursive modification condition, bilinguals gave relatively more incomplete responses than monolinguals. In the sequential modification condition, they produce relatively more sequential and incomplete responses, and less targets. These significant but quantitatively small asymmetries do not lead us to believe that bilinguals' performance is fundamentally different from monolinguals. If bilingual children experienced specific difficulty with recursion, we would expect bilinguals to produce more non-embedded (referentially complete, but non-recursively embedded responses) than monolinguals in the recursive condition; this was not the case.

As the differences between bilingual and monolinguals in the recursive condition are not statistically significant, once the effects of age are taken into account, our results do not support the Complexity Hypothesis, where general bilingual delays associated with structural complexity are expected. Under such a view, we would have expected for bilingual children to produce significantly less recursive DPs than monolingual children, and to be further delayed in their production of recursive DPs than non-recursive DPs. In fact, the opposite pattern emerges; where the monolingual advantage is stronger in the non-recursive condition. This suggests that the differences between bilingual and monolinguals seem concentrated on the point in which children are transitioning into the first level of embedding, not between first level embedding and recursive embedding.

To sum up: we do find differences between bilinguals and monolinguals, so that the null hypothesis can be rejected. The delay seems to pertain more to the onset of embedding; there is no evidence that recursive embedding is specifically delayed for bilingual children. Thus, the Complexity Hypothesis is not supported. Our results seem most compatible with lexically-dependent vulnerability hypothesis, which predicted delay at the first level of embedding.

The study of domain vulnerability is fundamental to our understanding of what components are sensitive to reduction in language exposure, and which can be learned under noisier and sparser conditions. Our results suggest that simultaneous bilingual children have a small lag in the onset of use of Level 1 DP modification, but no such lag is apparent in the subsequent developmental step, the onset of use of Level 2 modification. In other words, a few bilingual children lag in the acquisition of the embedding rule; but after that, the rest of the group seems not to be further delayed with acquisition of rule iteration. Recall that the first step involves acquisition of the relational terms required to generate PP modifiers and relative clauses, such as prepositions and complementizers. The second level of embedding does not add additional lexical requirements. Therefore, our results bear on ongoing proposals about the differences between lexically-sensitive measures of grammar, and purely formal/computational aspects of grammatical development. As such, this evidence favors the third hypothesis, which stated that bilingual delays were to appear at the first level of embedding, but not necessarily at the second level.

We conclude that our findings are compatible not with approaches that predict general delay for bilinguals, but rather with those that predict delay of only those properties of grammar that would be slowed down by virtue of being heavily dependent on lexical learning. Under this perspective, delay is a natural consequence of the fact that bilingual single-language vocabularies are on the average smaller than monolinguals. Complexity itself does not add to the vulnerability of bilingual grammars, once the lexical requirements are met. Despite being a complex, difficult-to-acquire domain of grammar, recursion appears to be a relatively invulnerable domain in bilingual development, what Goldin-Meadow has labelled a "resilient" property of language (Goldin-Meadow, 1982).

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