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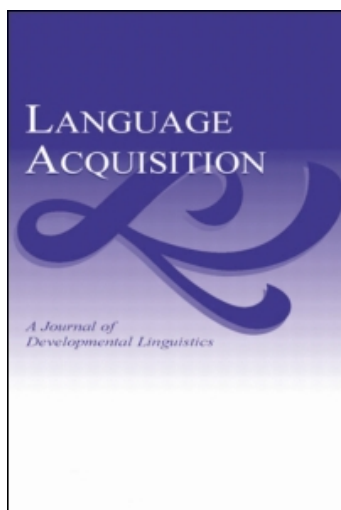
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BRIEF ARTICLE

Early Word Order Representations: Novel Arguments Against Old Contradictions

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One major controversy in the field of language development concerns the nature of children's early representations of word order. While studies using preferential looking methods suggest that children as early as 20 months represent word order as an abstract, grammatical property, experiments using the Weird Word Order (WWO) paradigm suggest that it is represented as a lexical property until age four. In order to shed light on these contradictions, two types of arguments are developed. First, it is argued that the observations taken to support the lexical hypothesis, based on the WWO paradigm, have been incorrectly interpreted. Second, an experiment is reported using the standard WWO paradigm with minimal changes in the design. Two groups of French children were contrasted (mean ages 2;11 and 3;11). Both groups were found to (i) reproduce WWO at a similar, low rate; (ii) correct WWO at a similar rate, even with pseudo-verbs; (iii) reuse the grammatical, SVO order significantly more often than WWO; and (iv) produce grammatical markers, indicating productive use, in grammatical sentences only. We conclude that empirical evidence converges to support the grammatical hypothesis.

1. INTRODUCTION

This article focuses on the controversy about the format by which young children represent one major property of the grammar of their language: word order. The debate about how word order

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is acquired opposes two theoretical positions. According to what we will call the *grammatical hypothesis*, word order is acquired via a mechanism of parameter setting during which the head direction parameter is fixed (e.g., Wexler 1998). In linguistic theory, the head direction parameter captures the order of the head and the complement that is constant across lexical choices in a given language (i.e., a language has Verb-Object or Object-Verb order; Chomsky 1981). In this view, the initial format of word order representation is abstract, i.e., grammatical in nature. In contrast, the *lexical hypothesis* assumes that word order is acquired via a general mechanism of gradual generalization on the basis of specific verb instances (e.g., Tomasello 2000). For example, the child knows that the noun phrase preceding the verb 'drink' is the agent and the one following it is the patient, but this knowledge is specific to that verb. Hence, in this view, the initial format in which the child represents word order is verb-specific, i.e., lexical in nature.

The aim of the article is to show that the contradictions between the two sets of empirical evidence taken to support these two hypotheses are only apparent. Two types of arguments are developed. First, it is argued that the observations put forth in support of the lexical hypothesis, based on the Weird Word Order experimental paradigm, have been incorrectly interpreted. Our critical review of these studies suggests that the data actually support the alternative, grammatical hypothesis. Second, novel empirical evidence is presented, which consists of the replication of a study using the Weird Word Order paradigm, with an additional, critical experimental condition. It is argued that the lexical hypothesis fails to account for the data, which rather find a natural explanation under the hypothesis that children, as young as they have been tested with this experimental paradigm, represent word order abstractly.

2. CRITICAL REVIEW OF THE LITERATURE

2.1. Contradictory Evidence

This section briefly reviews the two sets of contradictory evidence taken to support the two hypotheses. We concentrate on the specific set of evidence obtained in experiments involving pseudo-verbs or infrequent verbs. The use of such verbs is indeed critical to the debated issue since it allows us to examine how the child behaves with verbs for which she cannot use any lexicalized knowledge.

Evidence in favor of the grammatical hypothesis comes from experiments using the preferential looking procedure. In these experiments, children are presented with a pair of pictures or videos while they hear a sentence that matches only one of them. The other picture or video illustrates the alternative, ungrammatical interpretation of the sentence that the child is assumed to possibly generate. Initial evidence came from studies on the acquisition of verb meanings in phrasal contexts involving two noun phrases (NP; Naigles 1990). It has been argued that English-speaking children at 25 months interpret novel (pseudo-)verbs (V) in NP-V-NP sequences as transitive, with the post-verbal element being interpreted as the patient of the action. Children indeed showed significant preference for the picture illustrating the first NP performing some action on the second NP as compared to the distracter picture illustrating the two NPs performing the action reflexively. In contrast, when hearing NP-and-NP-V sentences the same children looked longer at the reflexive action, suggesting that verbs were interpreted

as intransitive. Even more compelling evidence comes from a study by Gertner, Fisher & Eisengart (2006), which found that at 21 months old, English children appear to interpret NP-V-NP sequences as Subject-Verb-Object sentences and not as Object-Verb-Subject. Upon the presentation of these sentences, children looked longer at the video illustrating a transitive action performed by the first NP on the second NP than at the video illustrating the same action performed by the second NP on the first NP.

Studies with younger children suggest that word order could be acquired even earlier, independently of its interpretive consequences on sentence comprehension. Three-month-old babies were found to be able to discriminate between languages with different head direction on the basis of prosodic information (Christophe et al. 2003). A recent study based on artificial language processing suggests that at 8 months, babies already know statistical properties of the distribution of function words in the sentence, a property that is correlated with the head direction of their mother tongue (Gervain et al. 2008). Hence, word order appears to be first represented independently of lexical and semantic information, on the basis of prosodic and statistical correlates. These formal properties are then mapped onto interpretive properties of word order around age 20 months (or earlier), allowing the child to interpret thematic roles associated to syntactic positions in the sentence.

Nevertheless, these results appear to be contradicted by a number of other observations. First, Dittmar et al. (2008) failed to replicate the observation of Gertner, Fisher & Eisengart (2006) with 21-month-old German children. The authors found that in the absence of a training phase introducing the agent in the same syntactic position as in the test phase but in a sentence involving a frequent verb, no preference was found for the matching video. They concluded that the preferences observed by Gertner, Fisher & Eisengart (2006) were due to the learning, during the training phase, of the agent's fixed position in the sentence and not to abstract knowledge of word order. However, we recently reported preferences for the matching video in a setting similar to that of Gertner, Fisher & Eisengart's, with even younger French-speaking children aged 19 months, and this without any training (Franck, Millotte & Posada 2009; Franck et al. in press). It therefore seems that the critical factor underlying variability amongst those results is not the presence or absence of training.

The most compelling experimental evidence for the lexical hypothesis comes from experiments using the Weird Word Order paradigm (Akhtar & Tomasello 1997; Akhtar 1999; Abbot-Smith, Lieven & Tomasello 2001; Matthews et al. 2005, 2007). The procedure in WWO experiments typically goes as follows: the experimenter first presents the child with one or more input sentences illustrated by videos. These sentences may involve a weird word order like <<Bear elephant dabbing>> where the video illustrates a bear doing some special action to an elephant. This phase is followed by a phase of elicited production during which the child has to describe a new video depicting the same action with new characters. The variables typically manipulated in these experiments are: (i) age, contrasting 'young' children around 2;09 and 'older' children around 4;00; (ii) the lexicality of the verb or its frequency, contrasting verbs and pseudo-verbs (or infrequent verbs); and (iii) in some studies, grammaticality, contrasting input sentences with grammatical word order to sentences with ungrammatical, WWO.

Four major arguments from these studies are taken to support the lexical hypothesis. First, young children, in contrast to older children, tend to reuse, i.e., match WWO used by the experimenter. Second, young children, in contrast to older children, do not 'revert' from WWO to the grammatical order, that is, they do not correct the test sentences. Third, young children

are sensitive to lexicality: they tend to match WWO more with pseudo-verbs or infrequent verbs whereas they tend to correct more when they know the verbs. Fourth, young children are not sensitive to the grammaticality of the input sentences: they do not match correct orders more than incorrect orders. In the next section, we revisit the validity of each of these arguments in light of three major problems with respect to data analyses, data interpretation, and lack of power (see Franck & Lassotta 2011, for a more detailed critical review of those studies).

2.2. Critical Review of Studies Using the Weird Word Order Paradigm

2.2.1. Argument 1: Young Children Tend to Match WWO

Across studies, so-called ‘match’ responses, in which the child matches the input word order, are in fact extremely rare as they represent between 0.9% and 7.5% of young children’s responses. Besides the fact that these percentages are very low, all studies reported that older children also match WWO, at a similar rate to young children and sometimes even more often. Unfortunately, the similarity between the two age groups was sometimes hidden due to the huge amount of missing data representing between 46% and 99% of children’s expected responses across studies. Missing data involve cases where children failed to respond; these cases were massively found in WWO conditions, indicating that children refused to use ungrammatical orders (as already pointed out by Naigles 2002). More generally, the distribution of missing data in these studies was found to be modulated by the variables manipulated: Age, Lexicality, Grammaticality. Data Not Missing At Random (NMAR) are considered as nonignorable in statistics. However, some studies ignored these missing data by analyzing the proportion of Matches over the sum of Matches and Reversions (i.e., corrections). This transformation contributed to radically changing data distributions, as for example in the data reported by Matthews and colleagues (2005), illustrated in Figure 1. The left graph illustrates the distribution of the raw number of Matches and Reversions in the ungrammatical condition with low frequency verbs. As appears in the graph, the two groups of children produced the same number of Matches, although they differ with respect to Reversions. The right graph illustrates the proportions of Matches over Matches + Reversions (ignoring all other responses

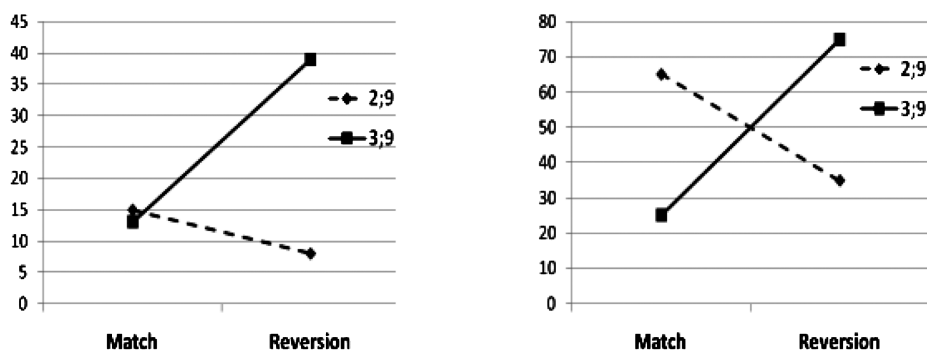


FIGURE 1 Distribution of Matches and Reversions in data from Matthews et al. (2005). The left graph plots raw data, whereas the right graph plots proportions used by the authors in their statistical analyses.

and nonresponses) on the basis of which statistical analyses were run in Matthews et al. (2005). This transformation radically modifies the data distribution, giving the incorrect impression that young children matched WWO orders more than older children.

What does it tell us? If older children, who are assumed to have grammatical representations, also match WWO, and this at a similar rate to young children, then Matches cannot be taken as evidence for the lack of grammatical representations. In addition to this empirical argument based on the data themselves, the interpretation of match responses in terms of grammatical knowledge (or lack of it) is prevented by the simple fact that children may match the WWO because they believe that this is what the experimenter expects, without having integrated the ungrammatical structure into their grammar.

2.2.2. Argument 2: Young Children Do Not Revert from WWO to the Grammatical Order

All these studies show that even though young children indeed revert from WWO less often than older children, they do not revert from WWO less than they match them. Moreover, when they revert from WWO, they always correct them. More critically, argument 2 contains a logical fallacy. Although the presence of corrections implies the presence of grammatical representations (the child cannot correct without having a grammar), the inverse is false: the lack of correction does not imply the lack of grammatical representations. Indeed, the child may fail to correct for many other reasons, one being that she thought that this is what the experimenter expected her to do!

What does it tell us? Although the presence of above-chance corrections of ungrammatical word orders would provide evidence in support of the presence of a grammar, failing to correct cannot be taken as evidence against it.

2.2.3. Argument 3: Young Children are Sensitive to Lexicality

All studies but one (Matthews et al. 2005) showed that, like younger children, older children are also sensitive to lexicality. And again, the role of lexicality in that study, which failed to report an effect, was hidden by the transformation into proportions. It is interesting to note that the difference observed in that study even goes in the opposite direction to that expected, with more Matches in the high frequency condition than in the low frequency condition.

What does it tell us? Since older children, who are assumed to have grammatical representations, are sensitive to lexicality, then sensitivity to lexicality cannot be taken as evidence for the lack of grammatical representations in younger children. This is an argument strictly based on the data from these studies, but there is a whole literature in adult psycholinguistics showing influences of lexical frequency in parsing and in grammatical encoding (e.g., Trueswell, Tanenhaus & Kello 1993; MacDonald, Pearlmutter & Seidenberg 1994; Garnsey et al. 1997).

2.2.4. Argument 4: Young Children are Not Sensitive to the Grammaticality of the Input Sentences

Only two studies manipulated grammaticality in input sentences (Akhtar 1999; Abbot-Smith, Lieven & Tomasello 2001). A closer look at the data shows that young children actually match the grammatical order four to five times more than ungrammatical orders: respectively, 4.5%

vs. 0.9% in the former study and 5.8% vs. 1.3% in the latter. Although the latter simply fails to address this difference (we do not know whether it is significant or not), the former study reported a nonsignificant difference. The problem here appears to be a lack of power due to the very small number of observations. Additional evidence for children's different processing of grammatical and ungrammatical orders comes from the systematic report across studies of a total lack of productivity in their ungrammatical sentences, contrasting with the massive presence of productivity markers (pronominalizations and verbal morphology) in their grammatical sentences (Akhtar 1999; Abbot-Smith, Lieven, & Tomasello 2001; Matthews et al. 2005, 2007).

What does it tell us? Although the lack of sensitivity to grammaticality would not provide evidence against the presence of grammatical representations (following the same reasoning as Argument 2), sensitivity to grammaticality would provide strong support for it since it seems hard to find any alternative explanation to this effect.

Given the high relevance of the grammaticality effect in the debate, we designed an experiment that contained a grammatical condition and that involved some modifications in the procedure aiming to reduce missing responses in order to increase statistical power.

3. EXPERIMENT

The experiment replicates the one reported by Matthews and colleagues (2007) on French-speaking children with two modifications. First, a condition with grammatical order was introduced in order to test the grammaticality effect. Second, the procedure was slightly changed. Input sentences, rather than being presented by the experimenter with whom the child interacts, were presented via a computer voice. Children were expected to be more prone to correct this unknown character than the experimenter. In addition, the child was asked to describe the scene to a zebra puppet wearing a scarf on its eyes. Establishing a communicative goal to the task was expected to act as an incentive for the child to speak properly. We hypothesized that these changes would encourage the child to respond more often and with correct sentences, if she has the grammatical knowledge necessary to do so.

3.1. Method

3.1.1. *Participants*

Twenty-four native French-speaking children between 2;04 and 4;04 living in the area of Geneva took part in the experiment. Children were divided into two age groups: 12 children in the young group with a mean age of 2;11 (age range: 2;04–3;03) and 12 children in the older group with a mean age of 3;11 (age range 3;04–4;04). Five additional children were excluded because they failed to complete the experiment.

3.1.2. *Materials*

The variables manipulated were: Age (Young vs. Older group), Lexicality of the verb (Verbs vs. Pseudo-verbs), Grammaticality of the input sentence (Grammatical, Subject-Verb-

Object order vs. Ungrammatical, Weird Word Order), and Nature of the ungrammaticality (NP-NP-V vs. V-NP-NP). Since the latter between-subject variable failed to show any effect, we collapsed the two conditions and refer to them as the ungrammatical or WWO condition. A total of 4 verbs (*pousser* 'to push,' *taper* 'to slap,' *laver* 'to wash,' *mordre* 'to bite') and 4 pseudo-verbs (*pouner*, *touser*, *nuver*, *daser*) were selected. Pseudo-verbs were selected such that they respected phonotactic constraints of the French language. The pseudo-verbs referred to specific actions that are not lexicalized in French, respectively: bumping with the head into someone's belly, catching someone with a strainer, pulling someone's tail, putting a crown on someone's head. Lexicality and Grammaticality were crossed such that two verbs and two pseudo-verbs were introduced in SVO sentences (*mordre*, *pousser*, *daser*, *nuver*), whereas the two other verbs and the two other pseudo-verbs were in WWO sentences (*taper*, *laver*, *touser*, *pouner*).

A total of 64 transitive sentences were created: 8 sentences involving each of the 8 verbs. Examples of sentences in the four experimental conditions are presented in Table 1. Sentences were recorded by a female native French speaker. In contrast to previous studies that failed to report any systematic control of prosody (the experimenter uttered sentences on-line), the natural contours of grammatical structures closest to the ungrammatical structures were systematically implemented in our prerecorded sentences. The contour of NP-and-NP-V sentences (e.g., *la vache et le cheval courent* 'the cow and the horse run') was used for ungrammatical NP-NP-V sentences, whereas the contour of PRO-V-NP-and-NP sentences (e.g., *ils lavent la vache et le cheval* 'they wash the cow and the horse') was used for ungrammatical V-NP-NP sentences.

Six hand puppets were used to illustrate the actions: a cow, a dog, a donkey, a lion, a sheep, and a horse. Animals were selected such that they were known by 2-year-olds according to the French version of the MacArthur Communicative Development Inventory (Kern 2003). Sixty-four videos were created illustrating the 64 experimental sentences. Following Matthews et al. (2007), videos corresponding to ungrammatical NP-NP-V sentences illustrated the first NP as the agent and the second NP as the patient such that it corresponded to the SOV interpretation of the sentence (available in an SOV language, e.g., Japanese). Videos corresponding to ungrammatical V-NP-NP sentences illustrated the first NP as the agent and the second NP as the patient such that it corresponded to the VSO interpretation of the sentence (available in a VSO language, e.g., Welsh).

Two experimental, between-participants lists were created—List 1 involving V-NP-NP as WWO and List 2 involving NP-NP-V as WWO—such that each child only heard one of the WWO. Lexicality and Grammaticality were manipulated within-participants (in contrast to

TABLE 1
Examples of Input Sentences in the Four Experimental Conditions

SVO		WWO	
Verb	Pseudo-Verb	Verb	Pseudo-Verb
La vache mord le chien. 'The cow bites the dog.'	Le lion dase le cheval. 'The lion dases the horse.'	La vache le cheval lave. 'The cow the horse washes.'	L'âne le cheval poune. 'The donkey the horse pounes.'

Matthews et al. 2007 who manipulated Lexicality between-participants), whereas Age and Nature of the ungrammaticality were between-participants variables. Each list contained 24 items. An item consisted of video-sentence pairs followed by a video eliciting the child's response. Following Matthews et al. (2007), in the first part of the experiment, items consisted of 3 video-sentence pairs after which the child was asked to describe the fourth video, whereas in the second part of the experiment only 1 video-sentence pair preceded the presentation of the video to be described by the child. Children produced 8 responses in the first part and 16 responses in the second part of the experiment. Each list contained 6 items in each condition (Grammatical, Verb; Grammatical, Pseudo-verb; Ungrammatical, Verb; Ungrammatical, Pseudo-verb). Each of the 4 verbs and 4 pseudo-verbs appeared in 3 items such that the child was expected to produce each of them 3 times with a total of 24 sentences. The complete sequence of items from List 1 is presented in the Appendix.

3.1.3. Procedure

Children were tested in the quiet room of two kindergartens in Geneva. Videos and sentences were presented via a portable computer. The child was first presented with the real puppets and asked to name them; if she used another word to describe an animal, the experimenter gave her the target word. The child was then told that she would see these characters in little films, which would sometimes be described by a woman in the computer, and which she would sometimes be asked to describe herself. Importantly, the child was told that she should give a description as correct as possible so that the Zebra, whose eyes were hidden, could imagine what happened in the film.

The experimental session always started with 4 grammatical input sentences, followed by 4 ungrammatical sentences, and then again a block of 4 grammatical and 4 ungrammatical sentences. Within these blocks of four sentences, the first two contained verbs and the latter two contained pseudo-verbs. Following Matthews et al. (2007), for the first 8 items the child was presented with 3 videos described by 3 versions of the input sentence (same verb, same structure, different puppets). The child was then asked to describe the fourth video, which illustrated the same action performed by different characters. At the end of the first part of the experiment, a pause was proposed to the child during which the experimenter read her a little story book. The 16 following items were then presented. They consisted of a single video described by a single input sentence, which was then immediately followed by a new video depicting the same action with different characters, which the child was asked to describe. The whole session lasted about 20 minutes.

3.1.4. Scoring and Data Analysis

All productions were coded by two independent coders and additionally checked by a third coder. Children's responses were scored following Matthews et al. (2007). *Matches* were coded when the child used the same structure and the same verb as the input sentence. *Reversions* were coded when the child produced a sentence with the same verb as the input sentence but reverted from the ungrammatical structure to canonical word order. This category includes sentences with a single argument in its correct position (SV or VO) and sentences with two arguments (SVO). *Other sentences* were coded when children produced a sentence with grammatical word order but with a verb different from the input verb. Sentences matching the SVO input

order but with a missing argument were also coded in this category. *Nonresponses* were coded when the child failed to produce a verb or did not say anything. Two types of grammatical productivity markers were also analyzed: pronominalizations (when children pronominalized the subject and/or the object of the input sentence) and verbal morphemes (when children produced auxiliaries, past participles or infinitive forms different from the verb presented in the input sentence). Given the non-normal and skewed distribution of the data, proportions were transformed into arcsine. Parametric tests were then conducted on these transformations involving analyses of variance (ANOVAs) with participants ($F1$) and items ($F2$) as random factors, as well as pairwise contrasts (student t).

3.2. Results

The distribution of Matches, Reversions, Other sentences, and Nonresponses is reported in Table 2.

Analyses of variance of Match responses revealed no effect of Age and no interaction between Age and the two other variables (F s < 1). Lexicality influenced the occurrence of Matches with more Matches in the verb than in the pseudo-verb condition ($F1(1, 22) = 65.9$, $p < .001$; $F2(1, 6) = 11$, $p < .05$). A significant effect of Grammaticality was found with more Matches of SVO than WWO sentences ($F1(1, 22) = 58.1$, $p < .001$; $F2(1, 6) = 41.3$, $p < .001$). An interaction between Grammaticality and Lexicality was also found significant ($F1(1, 22) = 58.8$, $p < .001$; $F2(1, 6) = 12.9$, $p < .05$). The interaction reflected a stronger effect of Grammaticality in the verb condition than in the pseudo-verb condition (respectively $F1(1, 22) = 69.8$, $p < .001$; $F2(1, 6) = 50.2$, $p < .001$ and $F1(1, 22) = 12.0$, $p < .01$; $F2(1, 6) = 4.0$, $p = .09$).

TABLE 2
Distribution of Matches, Reversions, Other Sentences, and
Nonresponses as a Function of Age, Lexicality, and Grammaticality
(Percentages in Parentheses)

	SVO		WWO	
	Verb	Pseudo-Verb	Verb	Pseudo-Verb
<i>Matches</i>				
2;11	42 (58.3)	13 (18.1)	3 (4.2)	3 (4.2)
3;11	49 (68.1)	14 (19.4)	9 (12.5)	9 (12.5)
<i>Reversions</i>				
2;11	n.a.	n.a.	38 (52.7)	7 (9.7)
3;11	n.a.	n.a.	45 (62.5)	5 (6.9)
<i>Other sentences</i>				
2;11	21 (29.2)	33 (45.8)	8 (11.1)	38 (52.8)
3;11	16 (22.2)	48 (66.7)	12 (16.7)	38 (52.8)
<i>Nonresponses</i>				
2;11	9 (12.5)	26 (36.1)	23 (31.9)	24 (33.3)
3;11	7 (9.7)	10 (13.8)	6 (8.3)	20 (27.7)

Note. Reversions could only occur in WWO.

Age failed to have any effect on the distribution of Reversions and failed to interact with the other variables ($F_s < 1$). Lexicality significantly influenced Reversions, which were more frequent with verbs than with pseudo-verbs ($F1(1, 22) = 61.6, p < .001$; $F2(1, 6) = 44.1, p < .001$). Children from the two groups never modified the ungrammatical word order into another ungrammatical word order, and they never modified the correct word order in the SVO condition.

Other sentences were not influenced by Age either ($F1 < 1$). However, children produced more Other sentences in the pseudo-verb than in the verb condition ($F1(1, 22) = 39.7, p < .001$; $F2(1, 6) = 26, p < .01$). Other sentences tended to be influenced by Grammaticality with more of them in the SVO than in the WWO condition, although this tendency was only significant in the analysis by subjects ($F1(1, 22) = 5.2, p < .05$; $F2(1, 6) = 1.2, p = 0.3$). Interactions were not significant ($F_s < 1$).

A total of 125 Nonresponses were observed representing 21.7% of expected responses. There was no main effect of Age on Nonresponses ($F_s < 1$). More Nonresponses were observed in the pseudo-verb condition than in the verb condition ($F1(1, 22) = 20.5, p < .001$; $F2(1, 6) = 23.9, p < .01$). Although more Nonresponses were observed in the ungrammatical condition than in the grammatical condition, Grammaticality was only found significant in the analysis with participants as random factor ($F1(1, 22) = 4.1, p = .05$; $F2(1, 6) = 1.5, p = 0.27$). Grammaticality interacted with Lexicality ($F1(1, 22) = 20.5, p < .001$; $F2(1, 6) = 23.9, p < .01$). However, the finding of a significant triple interaction involving Age, Lexicality, and Grammaticality ($F1(1, 22) = 8.4, p < .01$) showed that the interaction between Grammaticality and Lexicality was significant in the younger group, with an effect of grammaticality in the Verb condition only ($F1(1, 11) = 5.6, p < .05$), while this interaction was not significant in the older group ($F1(1, 11) = 2.8, p = 0.1$).

A high rate of pronouns and verbal morphemes was produced by both age groups (see Figure 2). Note that over the 347 pronouns used, only 14 were object pronouns, the others being subject pronouns. Examples of children's productions are given in (1).

- (1) a. La vache, **elle a** dasé le chien.
'The cow, it has dased the dog.'
- b. L'âne **a** tousé le cheval.
'The donkey has toused the horse.'
- c. Le mouton, **il est en train de** touser le lion.
'The sheep, it is busy tousing the lion.'

Analyses of verbal morphemes showed an effect of Age with more productivity for the older group ($F1(1, 22) = 4.4, p < .05$). Lexicality significantly interacted with Age ($F1(1, 22) = 5.4, p < .05$), revealing an effect of Lexicality in the older group only, with more verbal morphemes in the pseudo-verb than in the verb condition ($t(11) = 2.7, p < .05$; $t(11) < 1$ for the younger group). Pronominalizations were not different across the two age groups ($F1 < 1$). Lexicality showed a significant effect with more pronominalizations in sentences containing verbs than in sentences containing pseudo-verbs in the $F2$ analysis ($F2(1, 6) = 14.2, p < .01$) but not in the $F1$ analysis ($F1(1, 22) = 2.5, p = 0.12$). The role of Grammaticality was

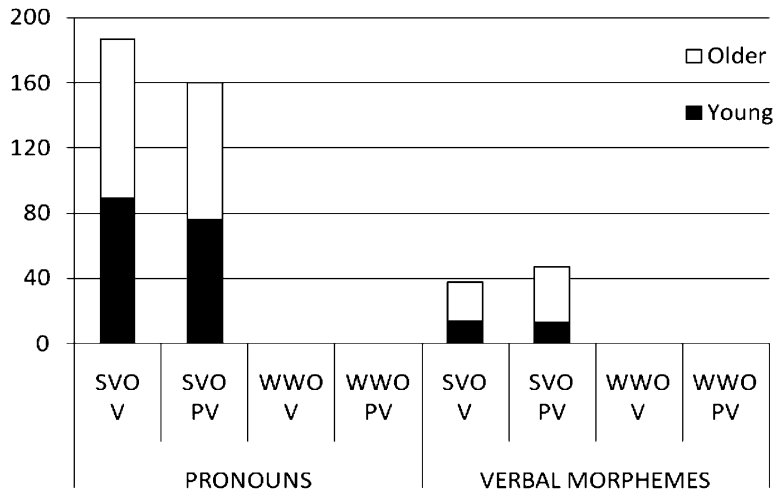


FIGURE 2 Total numbers of pronominalizations and verbal morphemes as a function of Age, Grammaticality, and Lexicality. Grammaticality refers here to the sentences produced by the child and not to input sentences. V = Verb; PV = Pseudo-Verb.

examined with respect to the grammaticality of children's actual sentences (rather than to the grammaticality of the input as for the other measures). Children produced no verbal morphemes and no pronouns in their ungrammatical sentences, whereas they produced them at a rate significantly different from zero in their grammatical sentences (respectively $t(23) = 4.6$, $p < .001$ and $t(23) = 14.9$, $p < .001$).

3.3. Discussion

Our results replicate and extend those obtained by Matthews and colleagues (2007) on a similar population of French-speaking children. Minor changes were introduced in the experimental procedure in order to reduce missing responses and to allow a direct comparison between children's performance with grammatical and ungrammatical orders. In line with our expectations, missing responses were considerably reduced as they went down to an average of 22%, with a maximum of 36% in the SVO condition with pseudo-verbs for the young group (against a range of 46%–99% in previous studies). Moreover, and critically, children were found to behave radically differently with SVO and WWO.

Results can be summarized as follows. First, no effect of age was found in the two critical measures taken, i.e., Match responses and Reversions: children aged 2;11 performed identically to children aged 3;11, replicating the previous observations of Matthews et al. (2007). This shows that, in spite of the obvious differences in the lexicons of these two groups of children, their performance with respect to grammar is the same. More generally, the fact that young children behave like older children, who are assumed to have grammatical representations, may be interpreted in two different ways. According to the first hypothesis, the lack of an effect of Age on Matches may be interpreted as evidence that young children also represent word

order abstractly. As will become clear, this hypothesis receives support from other aspects of our data. An alternative hypothesis could be that Match responses do not reflect grammatical knowledge, in which case one has to conclude that the WWO paradigm is inadequate to test grammatical representations. This latter hypothesis is plausible given that the task clearly involves abilities that have nothing to do with grammar, such as the ability to infer what the experimenter expects. Socio-pragmatic factors were indeed recently found to play a critical role in children's performance with novel word orders. Chang and colleagues (2009) found that 4;06-year-old Japanese children matched WWO more often when speaking to a robot (assumed to speak a WWO language) than when speaking to the experimenter (Chang, Kobayashi & Amano 2009). Interestingly, children aged 4;06 were shown to produce more WWO matches than children aged 3 when speaking to the robot with both new and familiar verbs. Along these lines, we ran a pilot study with our materials on five 9- to 11-year-old children and found that all of them either asked whether they were supposed to produce the same weird sentences, or directly reused the WWO. When asked whether their sentences were correct or not, children claimed that they did so because this was what the experimenter asked them to do!

Second, children were sensitive to Lexicality: they produced more Matches, reverted from ungrammatical word orders more often, produced more pronouns, and more generally answered more often when the input sentence contained a verb than when it contained a pseudo-verb. As mentioned in Section 2.2., the finding that older children, who represent word order abstractly, are sensitive to Lexicality like younger children demonstrates that this effect cannot be taken as evidence for the lack of a grammar. Moreover, frequency effects are reported across the board in the adult psycholinguistic literature, at every level of language processing, including syntactic processing. Hence, lexical frequency effects do not appear to stand against grammatical representations, but rather coexist with grammatical processes.

Third, our experiment included a grammatical condition that was absent in the study by Matthews et al. (2007). This allowed us to observe that Grammaticality affects performance similarly in both age groups. Both older and younger children were found to match the grammatical word order significantly more often than ungrammatical word orders, even when sentences contained pseudo-verbs for which children cannot have developed any stored lexicalized representation of word order. Grammaticality also significantly affected children's productivity measured by verbal morphology and noun phrase pronominalizations. In line with data reported by Matthews and colleagues (2007), both groups of children showed the hallmarks of productivity in their grammatical sentences with subject and (more rarely) object pronominalizations, verbal morphology (auxiliaries, past participles, infinitive forms, see examples in (1)), as well as occasional dislocation and clefting phenomena (e.g., *C'est le lion qui dase le mouton* 'it's the lion that dases the sheep'). In contrast, children failed to produce any verbal inflections or pronouns in their ungrammatical sentences, which were systematically produced with full NPs and verbs in the present tense, exactly as they appeared in the input. The finding that children's ungrammatical sentences failed to show the productivity markers massively observed in their grammatical sentences suggests that when they matched WWO, they did so following some rigid repetition process that did not involve the grammatical machinery. Finally, grammaticality also influenced children's tendency to modify the input word order: although children occasionally modified WWO input sentences, as manifested in Reversions, they never modified the SVO input order.

As argued in Section 2.2, sensitivity to grammaticality is critical in the debate on the nature of early word order representations. Indeed, it seems hard to account for why children are sensitive to grammaticality without assuming that they have grammatical representations. Hence, the logical link between theory (the grammatical hypothesis) and data (the grammaticality effect) is particularly strong here since data logically imply theory, i.e., the grammatical hypothesis appears as a necessary condition for grammaticality effects to arise.

Fourth, both groups of children occasionally reverted from the ungrammatical word orders of the input sentences. Although Reversions were rather rare with pseudo-verbs in the young group (9.7%), they were critically not rarer than in the older group (6.9%), and not rarer than Matches (4.2%). Moreover, children never reverted from a weird word order to another ungrammatical word order: when they modified the input order, this was always to correct it.

We argued in Section 2.2 that in contrast to the claim of WWO studies, the absence of correction of WWO sentences cannot be taken as evidence for the lack of grammatical representations, since the child may fail to correct for many other reasons. However, the presence of corrections, critically in sentences involving pseudo-verbs, strongly suggests that the child has abstract representations. Indeed, it seems hard to explain how the child may correct an ungrammatical order without knowing what the grammatical order is. Again here, the data logically imply the grammatical hypothesis, such that the presence of a mental grammar appears as a necessary condition to account for children's corrections.

4. CONCLUSION

Two lines of argumentation were developed to shed light on the ongoing debate on the format of early word order representations. First, we argued that the data reported in Weird Word Order studies, presented as key evidence for the lexical hypothesis, have been incorrectly interpreted. Major issues concern data analyses, logical fallacies, the misinterpretation of the functional significance of lexical frequency effects, and the lack of attention to the critical variable of grammaticality.

Second, we designed an experiment similar to the one conducted on the same population by Matthews and colleagues (2007), with two modifications: a condition of grammatical word order was introduced in order to test grammaticality effects and the procedure was adjusted in order to encourage the child to speak properly. Results bring strong evidence in support of the grammatical hypothesis: (i) Children aged 2;11 behave like children aged 3;11 on all critical dependent measures; (ii) They rarely matched ungrammatical word orders, although they matched the grammatical order; (iii) When they matched ungrammatical orders, they did so in a totally nonproductive way, i.e., they did not use their grammatical machinery; (iv) They modified ungrammatical word orders only, never the grammatical order; and (v) When they modified ungrammatical orders, this was always to correct them.

In sum, empirical evidence converges toward the hypothesis that children, as early as they have been tested (2;11 in language production, 1;07 in language comprehension), have an abstract grammatical representation of the word order of their language.

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APPENDIX Experimental List 1

Part 1			Part 2		
Grammaticality	Lexicality	Sentence	Grammaticality	Lexicality	Sentence
SVO	V1	le cheval tape la vache	SVO	V1	le chien tape l'âne
SVO	V1	l'âne tape le chien	SVO	V1	RESPONSE9
SVO	V1	le lion tape le mouton	SVO	V1	le cheval tape le lion
SVO	V1	RESPONSE1	SVO	V1	RESPONSE10
SVO	V2	la vache lave le cheval	SVO	V2	l'âne lave le chien
SVO	V2	le chien lave l'âne	SVO	V2	RESPONSE11
SVO	V2	le mouton lave le lion	SVO	V2	le lion lave le cheval
SVO	V2	RESPONSE2	SVO	V2	RESPONSE12
SVO	PV1	le cheval touse le lion	SVO	PV1	le lion touse le chien
SVO	PV1	le chien touse le mouton	SVO	PV1	RESPONSE13
SVO	PV1	l'âne touse la vache	SVO	PV1	le mouton touse le cheval
SVO	PV1	RESPONSE3	SVO	PV1	RESPONSE14
SVO	PV2	l'âne pousse le cheval	SVO	PV2	le cheval pousse la vache
SVO	PV2	la vache pousse le chien	SVO	PV2	RESPONSE15
SVO	PV2	le mouton pousse le lion	SVO	PV2	le chien pousse l'âne
SVO	PV2	RESPONSE4	SVO	PV2	RESPONSE16
NNV	V3	la vache le chien mord	NNV	V3	la vache le lion mord
NNV	V3	le lion le cheval mord	NNV	V3	RESPONSE17
NNV	V3	l'âne le mouton mord	NNV	V3	le cheval la vache mord
NNV	V3	RESPONSE5	NNV	V3	RESPONSE18
NNV	V4	le chien la vache pousse	NNV	V4	le lion la vache pousse
NNV	V4	le cheval le lion pousse	NNV	V4	RESPONSE19
NNV	V4	le mouton l'âne pousse	NNV	V4	la vache le cheval pousse
NNV	V4	RESPONSE6	NNV	V4	RESPONSE20
NNV	PV3	le lion le cheval dase	NNV	PV3	le chien le lion dase
NNV	PV3	le mouton le chien dase	NNV	PV3	RESPONSE21
NNV	PV3	la vache l'âne dase	NNV	PV3	le cheval le mouton dase
NNV	PV3	RESPONSE7	NNV	PV3	RESPONSE22
NNV	PV4	le cheval l'âne nuve	NNV	PV4	la vache le cheval nuve
NNV	PV4	le chien la vache nuve	NNV	PV4	RESPONSE23
NNV	PV4	le lion le mouton nuve	NNV	PV4	l'âne le chien nuve
NNV	PV4	RESPONSE8	NNV	PV4	RESPONSE24