The role of frequency and distributional regularity in the acquisition of word order

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Studies of spontaneous speech (e.g. Pine, Lieven, & Rowland, 1998) have highlighted how children's use of grammatical markers, such as the use of word order to mark agent-patient relations, is often restricted to specific lexical items, rather than being generalized as much as one might expect. This has led to the suggestion that grammatical knowledge is generalised from lexically specific constructions. A major implication of this constructivist view is that grammatical development will be affected by the frequency of individual lexical (and larger syntactic) items and the probabilistic relations between these items. In particular a greater degree of distributional regularity may facilitate the acquisition of a given lexical item. Intuitively this appeals to the idea that the more a child hears something and the more it occurs in the same place (absolutely or relative to some other marker) the more likely it is that s/he will be able to use it.

The following two experiments set out to investigate these ideas. In the first experiment we tested the effect of verb frequency on the use of word order as a grammatical marker (this study is reported in detail in Matthews, Lieven, Theakston, & Tomasello, in press). In the second experiment we looked into the role of distributional regularity on the use of word order. More specifically we considered the role of case-marked pronouns, in structuring early grammatical knowledge by comparing English with French, a language where pronoun (clitic) and lexical objects do not share the same distribution relative to the verb.

The experiments employed the WWO methodology, developed by Nameera Akhtar (1999) to test English-speaking children's productive control of word order. In Akhtar's experiment children were taught novel verbs (and known nouns) in a novel, ungrammatical word order (e.g. Subject Object Verb, as in "Ernie the spoon dacking"). The idea was to test whether, the children would themselves talk about the actions with the non-canonical word orders when asked, "What's happening?" or whether they would prefer to use the novel verb in the canonical order of their language.

Akhtar found that children aged 4;4 preferred to use canonical SVO word order with the novel verbs. Whereas, children aged 2;8 and 3:6 were just as likely to adopt the SOV and VSO word orders with novel verbs as they were to switch to using them in SVO order. Importantly, however, the same children who had used the novel orders for the novel verb, nonetheless preferred to use SVO order when the known verb, *push*, was presented in a novel order in a control condition. This provides some assurance that the children weren't simply being compliant and suggests that for the words they knew well these young children had developed a preference for using SVO word order, which they didn't fully generalize to the novel verbs.

The logic of the first study was to combine this weird word order methodology with verb frequency manipulations to test the extent to which children's knowledge of word order depends on the frequency of the lexical items being ordered. Our hypothesis was that younger children should be more likely to adopt the experimenter's 'weird word order' with verbs they had rarely heard used otherwise than with more frequent verbs (for which their knowledge of the argument structure should override their tendency to conservatively copy the experimenter). In contrast older children should be able to generalize from their more considerable experience of the language and be able to apply their knowledge of SVO word order verb-generally.

Experiment 1

In experiment 1 we adapted Akhtar's (1999) methodology, using real English verbs and eliminating animacy cues. We presented three groups of English speaking children at two ages (2;9 and 3;9) with verbs of varying frequency, in a novel (SOV) order. One group of children heard highly frequent verbs, another moderately frequent verbs and another relatively infrequent verbs.

Participants

Ninety-six normally developing, monolingual English-speaking children participated in the study (50 boys, 46 girls). The 48 children in the younger age condition were of a mean age of 2;9 (range 2;3 to 3;2). The forty-eight older children were of a mean age 3;9 (range 3;3 to 4;3). A further 43 children were not included in the study due to experimenter error or because they failed to complete the testing session or to produce any multi-word utterances using any verb to describe the actions.

Materials and design

Twelve transitive verbs were used to form three, between subjects conditions on the basis of verb frequency according to counts performed on the child directed speech of the twelve mothers in the Manchester corpus (Theakston, Lieven, Pine, & Rowland 2001) available on the CHILDES database (MacWhinney, 2000). Table 1 shows the verbs used and their respective frequencies.

Table 1 – *English Verbs used in each of the three between subjects conditions. Frequency counts from child directed speech are reported in parentheses.*

High frequency	Medium frequency	Low frequency
Push (596)	Shove (17)	Ram (5)
Pull (925)	Drag (12)	Tug (0)
Throw (722)	Flip (18)	Hurl (0)
Wipe (261)	Rub (112)	Dab (1)

Verbs were selected on the criteria that they should, as far as possible, i) be exclusively transitive[1] ii) be matched for semantic class across frequency conditions (using Levin's (1993) verb classes) iii) be able to take several animate subjects and objects iv) be one syllable long v) map to equally complex actions [2] vi) be equally nominalizable at all levels (e.g. One is just as likely to hear, "*Give it a wipe*" as "*Give it a rub*" and so on).

To ensure that each child saw precisely the same stimuli, videos of hand puppets acting out the verbs were made. Since the verbs had been semantically matched across verb frequency conditions it was generally possible to use precisely the same video clips for each verb frequency condition (i.e. the same video clips were used to model '*push*' '*shove*' and '*ram*'). The only exceptions to this were the clips used for '*flip*', '*rub*' and '*dab*', for which separate enactments better matching the verbs' semantics were made using the same puppets.

Each verb to be tested was enacted twelve times, each time by a different combination of hand puppets (a fox, a bear, a seal, a duck, an elephant and a giraffe). These enactments were compiled into a silent video that the experimenter and the child would take turns in describing. The enactments for each verb were compiled in pseudo-random order to ensure that any enactment to be described by the child would not i) contain the seal (as piloting

[1] One verb, flip, might be considered problematic in that is can also be used intransitively. This will be taken into account in the results section.

[2] That is the actions corresponding to the low frequency verbs shouldn't be considerably more complex than their higher frequency counterparts. This is a difficult issue as the meaning of lower frequency verbs is almost inevitably more restricted/ context specific.

demonstrated this animal was too difficult to name for some children), or ii) the same agent or patient as the previous clip (this was essential to ensure that the child could not describe any enactment by simply repeating what the experimenter had said for the previous clip).

The order of presentation of verbs was counterbalanced such that, for each frequency condition, each verb was presented first, second, third or fourth an equal number of times for the experiment as a whole. All the videos were of precisely the same duration (15 minutes).

Procedure

First, the experimenter introduced the child to the hand puppets and checked s/he knew what they were. The experimenter proceeded to use proper names for each puppet based on those used by the child (e.g. "This is Bear. He lives with Elephant"). The child then sat in front of the video screen with the experimenter and was asked if s/he could help say what the animals were doing in the video. The experimenter enacted each verb with the hand puppets before its first presentation saying, for example, "Do you know what dabbing is? Look. This is called dabbing! Can you say that?". The experimenter did not insist that the child repeat the verb s/he if preferred not to.

The experimenter then described the first enactment of the verb on the video. Each description by the experimenter entailed modelling the verb four times in SOV order, in either the present progressive or past tense. No auxiliaries were used for the present tense. For example, she would say: "Watch what X is going to do to Y! Look! XY dabbing! Oh, watch! XY dabbing. Oh, XY dabbed. Did you see what happened? XY dabbed!"

After three such enactments (i.e. twelve verb models), the experimenter *elicited* a response from the child by asking, for the next enactment, "*What's happening?"*. The video was paused if the child needed more time to answer and, if necessary, the experimenter would ask a second time, for example saying, "*What happened there?"*. The target action was replayed if the child was distracted and missed the video clip. If necessary the experimenter would occasionally model the beginning of the response (e.g. "*Bear…*") so the child simply had to respond with either the verb then the object or vice versa. If the child did not respond, the experimenter did not repeatedly question the child but simply moved on to the next clip. For the remainder of the enactments of any given verb, the experimenter and the child took turns in commenting on the video. To avoid boredom, only six (of a total of twelve) enactments of a verb were shown at a time. After all the verbs had been seen a first time the remaining six enactments per verb were presented.

To summarize, on each of the experimenter's turns a verb was modelled four times in SOV order. Each of the child's turns represents a potential response to the elicitation question. Each child thus heard 4 verbs with 28 SOV models per verb and could respond to 5 elicitations per verb.

Coding

A transcription of the child's utterances was made during the experiment either by the experimenter or by a second observer. A quarter of the trials were transcribed by both the experimenter and the observer. These transcripts were checked against audio-recordings of the experimental session. Sentences were classified as *matching* SOV order or *reverting* to SVO order. Single argument responses of the form SV or VO were also coded, as was the use of other constructions and verbs differing to those modelled by the experimenter. Any unintelligible or ambiguous utterances were discarded. All of the transcripts were coded by E and 20% were checked by an independent coder, yielding 100% agreement. The data were also subsequently coded for nominal versus pronominal argument type.

Actor construal

The transitive verbs used in the current experiment were designed to be semantically reversible i.e. they take both animate agents and patients. As a consequence, it was necessary to check that children intended their NNV matches to be SOV and not OSV or even S&SV intransitive sentences. All children (bar 4 due to experimenter error) who produced either a

SOV match or a conjoined subject intransitive were shown one video clip again at the end of the session and asked "*Who's doing the VERBing*". This acted as a simple measure of the intended subject of the sentence. With the exception of one child who responded to the question '*Who's doing the flipping?*' by naming the patient, all responses expressed a single subject, providing some reassurance that the first noun only was construed as the (single) agent. The results of this test are thus not discussed further.

Results

First we will consider only elicited responses that used a test verb along with two appropriate arguments. These responses either matched the SOV word order or reverted to SVO order.[3] Only the first full transitive utterance for any given elicitation is counted. As some individuals were more talkative than others, the results were analyzed in terms of mean proportions of responses. Figure 1 shows the proportion of SOV matches (as the converse of reversions to SVO order).

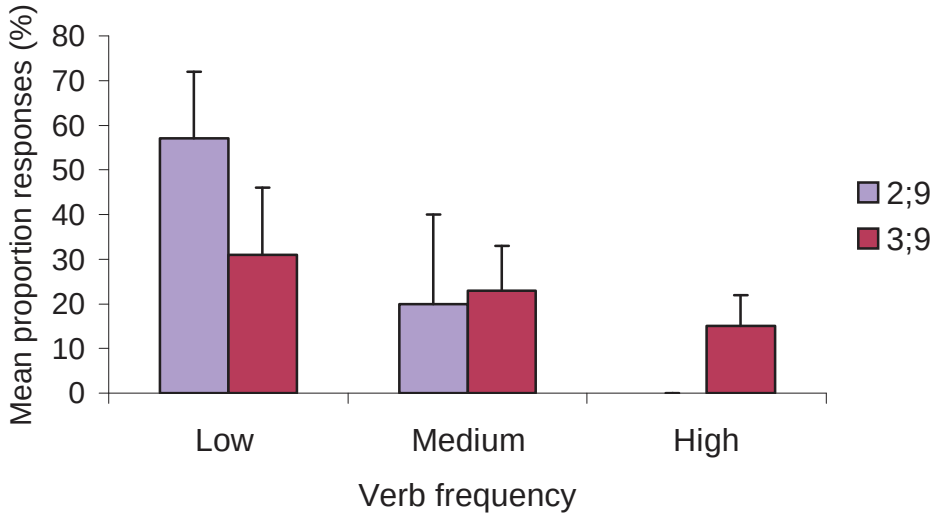

Figure 1. Mean proportion of responses that matched SOV word order as a function of age and verb frequency. Error bars show standard errors.

The two-year-olds were considerably more likely to match the SOV word order with lower frequency verbs than with higher frequency verbs. At 3;9, the children consistently preferred to use SVO order and also gave full transitive responses much more abundantly. Kruskal-Wallis tests[4] revealed that the proportion of two-year-old matches differed significantly according to verb frequency (χ^2 = 14, df = 2, $p \leq 0.001$) whereas no such difference was observed for the three-year-olds (χ^2 = 1.2, df = 2, p = 0.56)[5]. Post hoc Mann-Whitney U tests (using Hochberg corrected p's (Hochberg, 1988)) revealed a significant difference between the two-year-old high and low frequency verb conditions only (p = 0.003).

So far we have considered responses that used a test verb along with two appropriate arguments. However, eighteen children aged 2;9 and eight children aged 3;9 did not give any responses meeting this criterion. Nonetheless, half of these children (and many of the more productive children) often gave single argument responses of the form SV or VO, which could be argued to have demonstrated a preference for canonical English word order.

[3] Only correct SVO responses (that had the agent as subject and patient as object) were included in the results. However children did on occasion use NVN word order whilst switching the subject and object (e.g. said '*Fox pushed Bear*' when in fact Bear had pushed Fox). These responses were excluded.

[4] Non-parametric statistics were used as no children at 2;9 matched the weird word order in the high frequency condition.

[5] Similar results were found when a single factor ANOVA was performed on the 3 year olds' data (df = 2, F = 0.537, p = 0.589).

These responses are also interesting in that they may indicate that children first develop SVO word order in terms of its SV and VO components as Bates et al. (1984) have suggested. Figure 2 shows the proportion of SOV matches, partial, SV or VO single argument reversions and full SVO reversions as a function of verb frequency for children aged 2;9. Figure 3 presents the same results for the children aged 3;9.

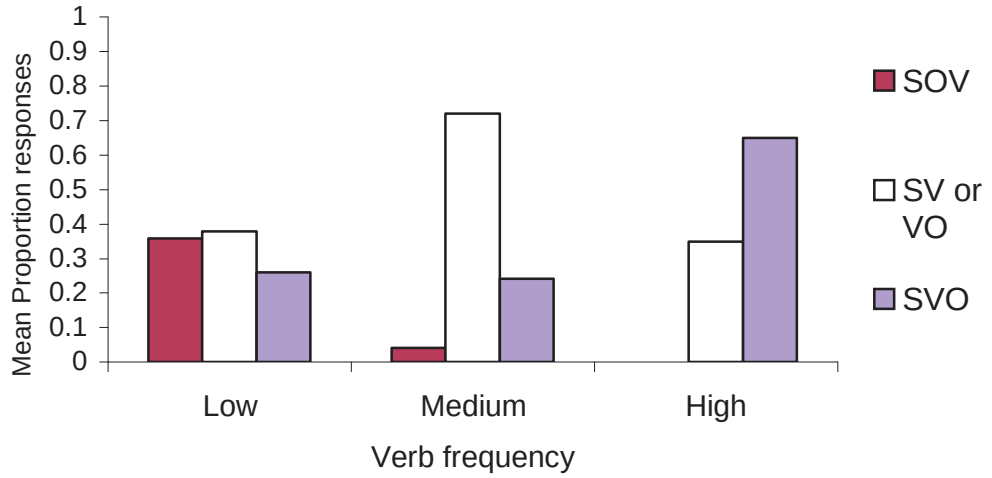

Figure 2. Mean proportion of responses that matched SOV order, reverted to SV or VO order and reverted to SVO order as a function of verb frequency. Age 2;9.

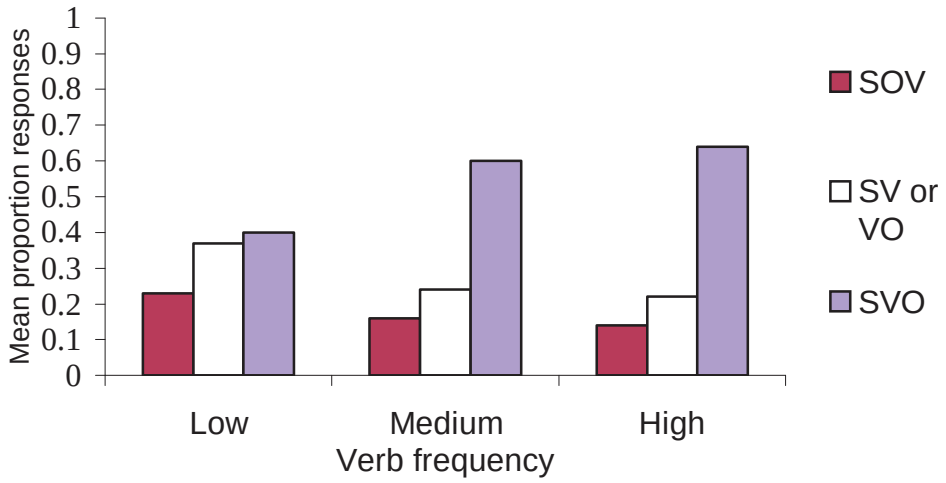

Figure 3. Mean proportion of responses that matched SOV order, reverted to SV or VO order and reverted to SVO order as a function of verb frequency. Age 3;9.

At 2;9 the children who heard low frequency verbs were likely to give any response. The children who heard medium frequency verbs strongly tended to give SV responses whereas the children in the high frequency condition gave many more full canonical SVO responses. It would appear that the younger children's tendency to follow a novel word order is replaced by partial corrections to English word order and then full transitive corrections as verb frequency increases. At 3;9 full corrections are still less likely to occur in the low frequency condition, but this effect is clearly diminishing with age and the children are generally much less dependent on SV responses.

To summarise the first experiment, it would appear that children's ability to use word order as a productive grammatical device at 2;9 depends to some extent upon the frequency of

the lexical items employed. Nonetheless some of these younger children did use canonical word order with low frequency verbs. The question thus arises as to how they managed this with verbs that were presumably quite unfamiliar to them. One potential, explanatory proposal here is that any consistently employed, high frequency item could anchor emerging grammatical schemas (Pine et al.1998). In particular, case-marked pronouns, which are both highly frequent and highly regular with regard to distribution, might help to structure early grammar and provide a way into word order. Put simply, pronouns could form lexically specific constructions (such as 'He VERBed it' and 'He's VERBing him') that would feed emerging abstract SVO constructions.

If this is so, then the question arises as to how constructions might develop in languages that do not demonstrate such consistent distributional regularities. For example, French is like English in that it does not permit subject ellipsis and its canonical word order is SVO[6]. However French object pronouns (clitic objects), behave differently to lexical objects in that they come before the verb. As sentences 1 and 2 demonstrate.

1. Il pousse **Marie** - *He pushes **Marie***
2. Il **la** pousse - *He pushes **her***

So, French children could build a *set* of constructions such as SV, sV, SsV, sVO, soV and so on from lexically specific exemplars and gradually link these where it is possible to do so. However, at their most abstract, there will have to be two, separate constructions with regards to object order relative to the verb: s/S V(O) and s/S oV (small letters represent clitics). We wondered whether this complication would slow the development of a construction network and affect French children's preferences in using canonical word order.

Experiment 2

In experiment 2, we set out to test the effect of verb frequency on French children's use of word order and to investigate how the contrasting distribution of French lexical and clitic objects might affect children's construction use. To do this we replicated experiment 1 in French, keeping the method as similar to that of the English weird word order study as possible

Participants

One hundred and twelve normally developing, French-speaking children participated in the study (58 boys, 54 girls). The fifty-six children in the younger age condition were of a mean age of 2 years and 10 months (range 2;3 to 3;2). The fifty-six older children had a mean age of 3;9 (range 3;3 to 4;3). A further 28 children were not included in the study due to experimenter error or because they failed to complete the testing session or to produce any multi-word utterances using any verb to describe the actions. All the children were tested in a quiet room in their primary school or day care centre in Lyon, France.

Materials and design

The design was the same as for the English study except that there are only two verb frequency conditions: *high* and *low* and there are two weird word orders: *SOV* and *VSO*. This yields eight (2 ages x 2 verb frequencies x 2 word orders) between-subjects conditions.

The high and low frequency French verbs (see table 2) were identified using frequency counts from the Lexique and Brulex online lexical databases (Content, Mousty, & Radeau, 1990; New, Pallier, Ferrand, & Matos, 2001). The high frequency verbs were then identified in the French corpora available on CHILDES (MacWhinney, 2000) to check two and three-year-old children were likely to be familiar with them. The verbs *pousser* and *tirer*

[6] Or rather, as Lambrecht (1987) has shown, [clitic+verb (X)]. I adopt Lambrecht's (1994) Principle of the Separation of Reference and Role and consider only the arguments of the verb when discussing word order as a marker of agent-patient relations. Dislocated subjects and objects are not considered here.

were found to be more frequent than *frapper* and *embrasser* but the latter two verbs are still high frequency in CDS relative to their low frequency matches, which are never encountered.

Table 2 – *French verbs used in the two between subjects frequency conditions*

High Frequency	Low Frequency
Pousser	Percuter
Tirer	Haler
Frapper	Tapoter
Embrasser	Enlacer

Procedure

The procedure was identical to that of the English experiment except that the verbs were only modelled in the present tense to avoid having to drop auxiliaries. Also, E never prompted the children to answer by naming the subject. The children were tested by a native French speaker. The first author was present to transcribe the sessions.

Coding

The transcripts were transcribed, checked and coded as for the English experiment (this included coding of dislocation constructions). A third investigator, who is a native French speaker and blind to the hypothesis of the experiment, checked and coded 20% of the transcripts. Reliability was very good (Cohen's Kappa = 0.973).

Results

Figure 4 shows the proportion of SOV matches, partial, SV or VO single argument reversions and full reversions to canonical French order as a function of verb frequency for children aged 2;10. Figure 5 presents the same results for the children aged 3;9. Error bars represent standard errors.

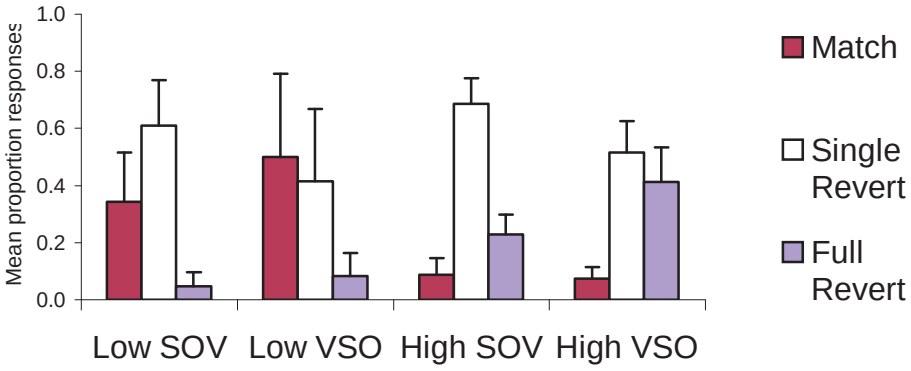

Figure 4. Mean proportion of responses that matched SOV order, reverted to SV or VO order and reverted to SVO order as a function of verb frequency for Age 2;10.

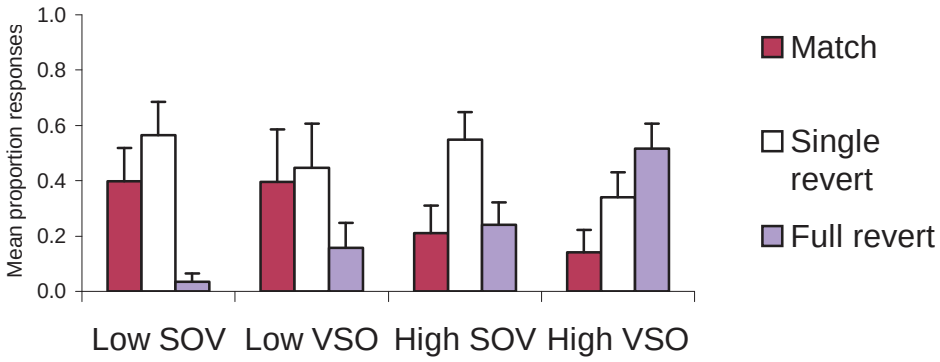

Figure 5. Mean proportion of responses that matched SOV order, reverted to SV or VO order and reverted to SVO order as a function of verb frequency for Age 3;9.

The proportions of matches, single argument reversions and full reversions were analysed with three, separate 2 (age) x 2 (frequency) x 2 (order) ANOVAs. None of the tests revealed any significant interactions or age effects. The ANOVA on matches revealed a main effect of verb frequency ($df = 1$, $F = 11.5$, $p = 0.001$). The ANOVA on single argument reversions revealed a borderline effect of modelled word order ($df = 1$, $F = 3.7$, $p = 0.058$) only. This indicates a higher use of single argument responses in the SOV condition than in the VSO condition. Almost all of these single argument reversions were of the form SV (there were 267 SV responses and 3 VO responses in total). This might suggest a tendency to interpret verb final sentences as approximating to an existing SV schema, encoding the subject only. The ANOVA on SVO reversions revealed a significant effect of verb frequency ($df = 1$, $F = 14.8$, $p < 0.001$) and a significant effect of modelled word order ($df = 1$, $F = 5$, $p = 0.028$). As verb frequency increases children are much better equipped to give full, two-argument responses. These responses are also more predominant in the VSO condition than the SVO condition.

To summarise, just as in English, the French children were much more likely to match the weird word order with low frequency verbs. This effect is maintained for the French children at 3;9. However, this is probably due to the extreme low frequency of the French verbs and so no age-related, cross-linguistic comparisons can be drawn here. Interestingly, it would appear that the different modelled word orders might have differentially primed the constructions available to the children. If the children heard a verb final, SOV weird order they tended to give verb final SV responses. If the children heard the verb initial VSO weird word order they were more likely to fully revert to canonical order using a clitic subject.[7]

Cross-linguistically, the most interesting differences arise when we compare object use in the two studies. French children used far fewer object pronouns than their English counterparts. In fact, French children scarcely used object pronouns (only 3;9 year-olds in the high frequency VSO condition used this form) whilst for the English children a quarter of objects were pronominal on average. This delay in the emergence of French object clitics is well documented in the literature (e.g. Van der Velde, Jakubowicz, & Rigaut, 2002) and might even be explained in terms of non-structural/distributional factors such as lack of phonological salience. Perhaps more interesting, then, is that French children used far fewer lexical objects than their English counterparts too. This was the case even when we compared strictly like for like conditions. Figure 6 shows how French and English children used objects when correcting to canonical word order (with one or two arguments). It compares only the verb *pull* in English with *tirer* in French (including only the SOV modelled condition) and indicates whether the children expressed the object lexically, pronominally or not at all.

[7] This would perhaps bring some psycholinguistic light to the proposition that clitics are verbal prefixes and thus the canonical sentences in French is in fact a verb initial structure: [clitic+verb (X)] (Lambrecht 1987).

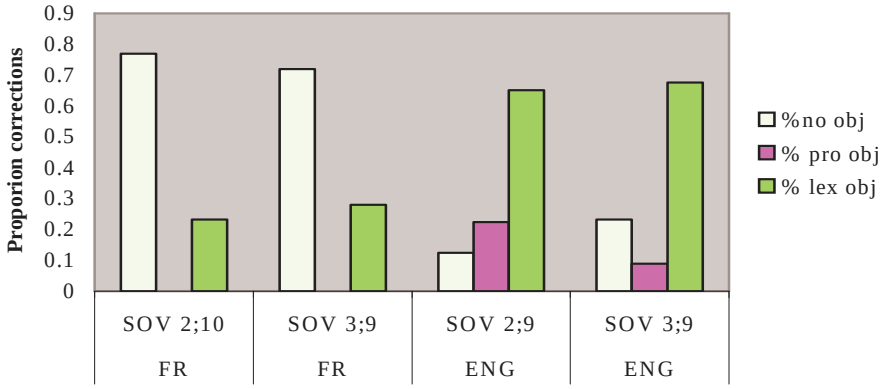

Figure 6. Mean proportion of canonically ordered responses that expressed no object, a pronominal object or a lexical object as a function of age and language.

Object use differs strikingly in the two languages. French children generally did not express the object at all when they corrected the weird word order. The English children generally did so with a lexical object and occasionally with a pronoun.

A tentative explanation of these results is that the inconsistent distribution of objects in French may hinder their acquisition. In English, functionally based distributional analysis (Tomasello, 2003) would allow children to form a single object slot after the verb whereas in French the two object types would have to 'make their own way' in a developing construction network. More generally, if a construction - or elements of constructions- do not fit well with other related constructions in a network, then acquisition of that form-meaning pair may be delayed. Clitic objects may be particularly adversely affected in this way. On this account post-verbal lexical objects, given their overwhelming frequency (in transitives, imperatives etc.), may pre-empt clitic objects until such time as children have acquired sufficient discourse skills at the supra-sentence level to master the use of pronouns in obligatory contexts.

Conclusions

The current weird word order experiments indicate that young children will learn new, weird constructions. However, experience of their language will also have provided alternative, conventional forms (both at the lexically specific and the more abstract constructional level). The more entrenched these alternatives are the more likely they are to be preferred to the new construction. So, children are better able to revert to canonical word order when using lexical items they know well and when they have drawn upon the similarities between structures (e.g. transitives) in various guises, to form more abstract constructions. Frequency and distributional regularity appear to aid this process considerably.

Acknowledgments

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