The role of frequency in the acquisition of English word order

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Abstract

Akhtar [Akhtar, N. (1999). Acquiring basic word order: Evidence for data-driven learning of syntactic structure. Journal of Child Language, 26, 339–356] taught children novel verbs in ungrammatical word orders. Her results suggested that the acquisition of canonical word order is a gradual, data-driven process. The current study adapted this methodology, using English verbs of different frequencies, to test whether children’s use of word order as a grammatical marker depends upon the frequency of the lexical items being ordered. Ninety-six children in two age groups (2;9 and 3;9) heard either high frequency, medium frequency or low frequency verbs that were modeled in SOV order. Children aged 2;9 who heard low frequency verbs were significantly more likely to adopt the weird word order than those who heard higher frequency verbs. Children aged 3;9 preferred to use SVO order regardless of verb frequency. Furthermore, the younger children reverted to English word order using more arguments as verb frequency increased and used more pronouns than their older counterparts. This suggests that the ability to use English word order develops from lexically specific schemas formed around frequent, distributionally regular items (e.g. verbs, pronouns) into more abstract, productive schemas as experience of the language is accrued.

Keywords: Syntax; Language acquisition; Word order; Frequency

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The backbone of grammatical development is children’s marking of agent–patient relations, the ‘who did what to whom’ of a sentence. Across languages this is done mainly with either grammatical morphology (e.g. case markers) or, as in English, word order conventions. In studies of spontaneous speech, researchers have found that children’s use of grammatical markers of all kinds is often restricted to specific lexical items, rather than being generalized across the board, and becomes fully productive only gradually (e.g. Lieven, Pine, & Baldwin, 1997; Pine, Lieven, & Rowland 1998; Tomasello, 1992; Wilson, 2003).

Thus, Pine et al. (1998) found that the lexical items that served as the subjects and direct objects of transitive verbs for nascent English learners basically did not overlap, suggesting that word order was not being used contrastively by these children. Lack of productivity in spontaneous speech may result from many factors, however, and so researchers have turned to experiments to help sort out the explanatory alternatives.

A number of cross-linguistic studies of sentence comprehension have tested experimentally the degree to which children learning various languages depend on a range of grammatical cues to identify agent–patient relations in their language (e.g. Bates et al., 1984; Kail, 1989; Linder, 2003; Sinclair & Bronckart, 1972; Slobin & Bever, 1982). In terms of Bates and MacWhinney’s (1989) Competition Model, the general finding for word order has been that children move from ‘a loose system of positional patterns to a more organized parsing system’ (Bates et al., 1984). With regard to English and the use of word order cues in particular, Slobin and Bever (1982) found that the least linguistically mature children in their study (youngest child 2.0) did not demonstrate consistent comprehension of the canonical word order schema. Bates et al. (1984) observed an increasing tendency to rely on word order between the age of 2 1/2 and 5 1/2 that was liable, even for the eldest children, to be abandoned when pitted against animacy cues. This indicates that the use of word order to mark agent–patient relations in English is supported by, and works with, several formal and semantic cues or probabilistic constraints. Inducing and integrating these cues takes time and thus early usage is unlikely to be fully productive or consistent.

Such an initial lack of full productivity has also been demonstrated in experimental studies of language production (see Tomasello, 2000, 2003 for reviews). Thus, whilst children over the age of 3 or 4 can apply an SVO schema to novel verbs introduced in an alternative construction (Pinker, Lebeaux, & Frost, 1987) younger children are typically conservative in their use of novel verbs in unattested constructions (Tomasello, Akhtar, Dodson, & Rekau, 1997; Tomasello & Brooks, 1998).

Recently, an important new methodology has been introduced to investigate English-speaking children’s productive control of word order (Abbot-Smith, Lieven, & Tomasello, 2001; Akhtar, 1999). In these experiments children are introduced to novel verbs and known nouns in a novel (ungrammatical) word order (e.g. Subject Object Verb, as in “Ernie Bert dacking”) to test whether, and at what age, children would “correct” the adult and prefer to use the novel verb in the canonical order of their language. Thus, Akhtar (1999) introduced children of 2, 3 and 4 years of age to three novel actions and described them using three novel verbs (dacking, tamming and gopping). One verb was modeled in SVO order (e.g. Elmo dacking the car) another in SOV order (e.g. Elmo the car gopping) and another in VSO order (e.g. Tamming Elmo the car). The question was whether children would, for the SOV and VSO modeled verbs, themselves talk about the actions with the non-canonical word orders when asked, “What’s happening?” The results showed that the 4-year-olds
would not. Instead they preferred to use canonical SVO word order with all the verbs no matter how they had heard them used. The younger age groups, in contrast, were just as likely to adopt the SOV and VSO word orders for the verbs they had heard used that way as they were to switch to using them in SVO order.

Thus, whilst 4-year-olds confidently use their knowledge of English word order with the new verbs, younger children are torn between using this emerging knowledge and conservatively proceeding on the basis of what they have heard for that specific verb. That this illustrates the tendency to learn on an item-by-item basis was confirmed by a control condition, which presented a known verb, *push*, in a novel order. The same children who had used the novel orders for the novel verb, nonetheless preferred to use SVO order for the known verb presented in a novel order. So, for the words they knew well, these young children had learnt to use SVO word order. They just didn’t fully generalize this ability to the novel verbs. Similarly, using intransitive verbs (SV and VS order) Abbot-Smith et al. (2001) found that younger children (2;4) corrected a novel VS order to SV order significantly more with the familiar verb *jump* than with a novel verb, whereas older children (3;9) preferred to use SVO order regardless of the familiarity of the verb in question.

Familiar verbs, however, are not the only elements organizing young children’s syntactic knowledge. As Pine et al. (1998) argue, it is likely that any consistently employed high frequency item could anchor emerging grammatical schemas. Pronouns fit this bill perfectly: they are extremely common in child directed speech (Cameron-Faulkner, Lieven, & Tomasello, 2003) and, since they are case marked in English, they are distributionally much more regular than full NP’s. Akhtar (1999) found that children used pronouns approximately 50% of the time when correcting novel word orders to SVO whereas when they used a novel word order, they almost exclusively used full NP’s. This effect was just as clear in the younger children studied by Abbot-Smith et al. (2001), who scarcely used a pronoun when using a non-canonical word order (only 3 of the 76 utterances that matched VS order contained pronouns). More interestingly still, when these children *copied* canonical SV order in the control condition they used pronouns approximately 40% of the time (indicating a baseline pronoun usage rate). Yet when the same children *corrected* a novel VS order to SV the percentage of pronoun arguments used leapt to above 60%. The children seemed highly reliant on subject pronouns when correcting a novel order to an existing SV schema. (See also Childers & Tomasello, 2001; Dodson & Tomasello, 1998 for demonstrations of the importance of high frequency pronoun combinations in facilitating the transition from lexically-specific to lexically-general constructions.)

A major implication of these studies is that the frequency of individual lexical (and larger syntactic) items and the probabilistic relations between these items are key in language acquisition and language use, even at the grammatical level (see also Ellis, 2002). This idea has been paralleled in the field of linguistics by those working with a usage-based approach to language (Bybee & Hopper, 2001; Croft, 2001; Langacker, 1987, 1991). For example, since linguistic representations are manifestly affected by linguistic experience (i.e. subject to frequency effects), Bybee and Hopper (2001) argue that, ‘grammar is not fixed and absolute with a little variation sprinkled on top, but is variable and probabilistic to its very core.’

Such usage-based theories, applied to language acquisition, would predict that distributionally regular, high frequency items play a key role in forming grammatical schemas. A
potentially useful approach in the study of syntactic development is thus to manipulate the frequency of lexical items within a given structure and to measure the effect of frequency on children’s use of that construction. Verbs (being typically distributionally more regular than their NP arguments) make good lexical candidates for investigating children’s early grammatical knowledge.

Verb frequency manipulations have already been successfully used to measure children’s knowledge of the argument structure of transitive and intransitive verbs (Brooks, Tomasello, Lewis, & Dodson, 1999). Brooks et al. (1999) tested the entrenchment hypothesis prediction that the more frequent and the earlier acquired a verb is, the less likely children will be to violate its argument structure by over-generalizing. (That is, children should be less likely to say ‘I disappeared the rabbit’ than ‘I vanished the rabbit’ because disappear is more frequent and is thus more entrenched in the intransitive construction.) Brooks et al. found support for this hypothesis for children of 3, 4 and 8 years, all of whom were more likely to over-regularize infrequent, late acquired verbs than frequent, early acquired verbs. This study was recently followed up by Theakston (2004) who found that adults and children of 5 and 8 years were more likely to judge over-generalized sentences (e.g. I’m gonna disappear it) as more grammatical if they contained infrequent verbs than if they contained semantically matched frequent verbs.

The logic of the current study was to combine the verb frequency manipulations from entrenchment studies with Akhtar’s (1999) ‘weird word order’ methodology to provide a clear indication of the extent to which children’s knowledge of word order at various ages is item-based or generalisable across lexical items. 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.

Adapting 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. We anticipated that the number of occasions on which the younger children matched the SOV word order would be roughly inversely proportional to the frequency of the verbs they heard and that this effect of verb frequency would gradually diminish with age.

1. Method

1.1. 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 2.3–3.2). The 48 older children were of a mean age 3;9 (range 3.3–4.3). 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.

1.2. Materials and design

Twelve transitive verbs were used to form three, between subjects conditions on the basis of verb frequency. Four high frequency, four medium frequency and four low frequency verbs were identified using verb frequency counts performed on the child directed speech of the 12 mothers in the Manchester corpus (Theakston, Lieven, Pine, & Rowland, 2001) available on the CHILDES database (MacWhinney, 2000). This corpus was used as it was considered to give a representative sample of speech heard by British English-speaking children between the ages of 2 and 3 years of age. Table 1 shows the verbs used and their respective frequencies.

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 12 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 demonstrated this animal was too difficult to name for some children), or (ii) the same agent

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¹ One verb, flip, might be considered problematic in that is can also be used intransitively. This will be taken into account in Section 2.

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.
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 min).

1.3. 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 modeling 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. 12 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 6 (of a total of 12) 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 modeled 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.

1.4. 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
Table 2
Frequency of responses that matched SOV order and reverted to SVO order as a function of age and verb frequency

<table>
<thead>
<tr>
<th>Age</th>
<th>Response</th>
<th>Low</th>
<th>Medium</th>
<th>High</th>
</tr>
</thead>
<tbody>
<tr>
<td>2;9</td>
<td>Match</td>
<td>15</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Revert</td>
<td>8</td>
<td>9</td>
<td>72</td>
</tr>
<tr>
<td>3;9</td>
<td>Match</td>
<td>13</td>
<td>26</td>
<td>32</td>
</tr>
<tr>
<td></td>
<td>Revert</td>
<td>39</td>
<td>73</td>
<td>138</td>
</tr>
</tbody>
</table>

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 modeled 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.

1.5. 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.

2. Results

Initially only elicited responses that used a test verb along with two appropriate arguments were analyzed. These responses either matched the SOV word order or reverted to SVO order. Only the first full transitive utterance for any given elicitation is counted. Analysis of the frequency of responses reveals that overall the 3-year-olds were far more productive than their 2-year-old counterparts (see Table 2). As some individuals were also more talkative than others, the results were analyzed in terms of mean proportions of responses (see Fig. 1). All transitive responses that mismatched SOV word order were reversions to SVO word order. The converse of the proportion of SOV matches therefore represents the proportion of SVO reversions.

Since all 2 years olds in the high frequency verb condition exclusively reverted to SVO word order, the proportion of matches was analyzed using non-parametric statistics. Two Kruskal–Wallis tests were performed, one for each age group, with the independent variable

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3 Eighteen children (Low 6, Medium 11, High 1) aged 2;9 and eight children (Low 6, Medium 2) aged 3;9 did not give any responses meeting this criterion.

4 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.
verb frequency (high, medium, low). The proportion of 2-year-old matches differed significantly according to verb frequency ($\chi^2 = 14$, d.f. = 2, $p \leq 0.001$) whereas no such difference was observed for the 3-year-olds ($\chi^2 = 1.2$, d.f. = 2, $p = 0.56$). Post hoc Mann–Whitney $U$ tests (using Hochberg corrected $p$’s (Hochberg, 1988)) revealed a significant difference between the 2-year-old high and low frequency verb conditions only ($p = 0.003$). Since the SVO reversions are a mirror-image of the matches similar results obtained for this response type.

The 2 years olds were considerably more likely to match the SOV word order with lower frequency verbs than with higher frequency verbs. Indeed, the 10 children (out of 16) who responded with full transitives in the low frequency condition were just as likely to match SOV order as to correct to SVO order ($t(9) = 0.465$, $p = 0.653$). In contrast children of the same age who heard higher frequency verbs not only consistently reverted to SVO order but also gave full transitive responses much more abundantly.

This effect of verb frequency is considerably reduced in children a year older. Although more productive in higher frequency conditions, the 3-year-olds generally always preferred to revert to SVO order no matter which verbs they were using. Furthermore, they were no more likely to produce SOV matches in the low frequency condition than the high frequency condition. However, Mann–Whitney $U$ tests (again using Hochberg corrected $p$’s) comparing the proportion of matches per age group for each condition revealed no significant difference between the 2-year-olds and the 3-year-olds for the high condition ($p = 0.126$), medium condition ($p = 0.653$) or low condition ($p = 0.244$). This indicates that whilst the effect of verb frequency on the proportion of SOV matches was only statistically significant for the 2-year-olds, the 3-year-olds manifested the same trend only to a lesser extent. This is consistent with our hypothesis that the effect of verb frequency should decrease steadily with age.

One discrepancy in the results is the greater proportion of SOV matches for 3-year-olds than 2-year-olds in the high frequency verb condition. However, in terms of raw frequency

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5 Similar results were found when a single factor ANOVA was performed on the 3-year-olds’ data (d.f. = 2, $F = 0.537$, $p = 0.589$).
the older children reverted to SVO word order almost twice as often as their younger counterparts indicating they were more confident in their use of SVO order. The high rate of matching for low frequency verbs reported here complements Akhtar’s (1999) results for nonce verbs which children matched at a rate of approximately 60% at 2;8 years and 55% at 3;6 years in the SOV word order condition. Similar mean proportions of SOV matches in the current low frequency verb condition were observed for the younger children (57% matching at 2;9), which suggests that the younger children in the current study were unfamiliar with the low frequency verbs and acted conservatively, just as if they were a novel verb. At 3 years the children in the current study were less likely than those in Akhtar’s (1999) study to match SOV word order (only 31% of responses matched SOV order at 3;9), presumably because the children were slightly older and would also be increasingly likely to be familiar with some of the low frequency verbs.

Occasionally children either spontaneously imitated the experimenter’s SOV model or commented on the actions the experimenter was describing with SVO order (i.e. corrected the model to SVO order). Since any spontaneous matches would simply amount to mimicking the experimenter, spontaneous responses were not included in the main analysis but are shown in Table 3. In line with the elicited data, the number of spontaneous matches tended to decrease as verb frequency increases whereas the reverse was true of spontaneous reversions.

2.1. Order effects

To check whether there was an increasing tendency to match word order as the experiment progressed, it was necessary to compare responses made at the beginning of the experiment with those made at the end. The numbers of children matching SOV order, reverting to SVO order and not responding in the first and second halves of the experiment was compared. Chi-square tests for each age and verb frequency condition revealed no significant differences in the pattern of elicited responses in the first and second half of the experiment.

Since it is essential to check whether the children in the low frequency, 2;9 age condition (who predominantly matched) only began to be able to use the test verb at the end of the experiment, by which time they had been overwhelmed with SOV exemplars, a further test for order effects was run. The proportions of matches provided by each child (in the low frequency, 2;9 condition) in the first and second halves of the experiment were compared with a Wilcoxon signed-ranks test. The children were not significantly more likely to match the SOV models in the second half of the experiment ($T = 9, p = 0.389$).

<table>
<thead>
<tr>
<th>Age</th>
<th>Response</th>
<th>Low</th>
<th>Medium</th>
<th>High</th>
</tr>
</thead>
<tbody>
<tr>
<td>2;9</td>
<td>Match</td>
<td>20</td>
<td>8</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td>Revert</td>
<td>0</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>3;9</td>
<td>Match</td>
<td>18</td>
<td>20</td>
<td>9</td>
</tr>
<tr>
<td></td>
<td>Revert</td>
<td>6</td>
<td>5</td>
<td>9</td>
</tr>
</tbody>
</table>
Table 4
Mean proportion of responses that matched SOV order, reverted to SV or VO order and reverted to SVO order as a function of age and verb frequency

<table>
<thead>
<tr>
<th>Age</th>
<th>Verb frequency</th>
<th>SOV</th>
<th>SV or VO</th>
<th>SVO</th>
<th>Total reversion</th>
</tr>
</thead>
<tbody>
<tr>
<td>2;9</td>
<td>Low</td>
<td>0.36</td>
<td>0.38</td>
<td>0.26</td>
<td>0.64</td>
</tr>
<tr>
<td></td>
<td>Medium</td>
<td>0.04</td>
<td>0.72</td>
<td>0.24</td>
<td>0.96</td>
</tr>
<tr>
<td></td>
<td>High</td>
<td>0.0</td>
<td>0.35</td>
<td>0.65</td>
<td>1.0</td>
</tr>
<tr>
<td>3;9</td>
<td>Low</td>
<td>0.23</td>
<td>0.37</td>
<td>0.40</td>
<td>0.77</td>
</tr>
<tr>
<td></td>
<td>Medium</td>
<td>0.16</td>
<td>0.24</td>
<td>0.60</td>
<td>0.84</td>
</tr>
<tr>
<td></td>
<td>High</td>
<td>0.14</td>
<td>0.22</td>
<td>0.64</td>
<td>0.86</td>
</tr>
</tbody>
</table>

2.2. Single argument reversions

Some 26 of the 96 children in the current study failed to use the test verb in a transitive utterance with two appropriate arguments. Half of these children did, however, give single argument responses of the form SV or VO and so could be argued to have demonstrated a preference for canonical English word order.6 This is consistent with Bates et al.’s (1984) conjecture that children first develop SVO word order in terms of its component SV and VO components. The following analysis includes these responses for all the children. Table 4 shows the proportion of SOV matches, SV or VO single argument reversions and full SVO reversions. The final column sums all types of reversion to give the total proportion of responses indicating some preference for English word order for the test verb as the converse of the proportion of responses that matched SOV order.

Importantly even when we include single argument responses, the effect of verb frequency on the younger children’s likelihood to match or correct a novel word order still holds. Repeating the original Kruskal–Wallis tests with this new, less conservative measure for reversions revealed that the proportion of 2-year-old SOV matches still differed significantly according to verb frequency ($\chi^2 = 17.585$, d.f. = 2, $p < 0.001$) whereas no such difference was observed for the 3-year-olds ($\chi^2 = 0.407$, d.f. = 2, $p = 0.816$). Post hoc Mann–Whitney $U$ tests (using Hochberg corrected $p$’s) revealed a significant difference between the 2-year-old high and low frequency verb conditions ($p = 0.015$), and the 2-year-old medium and low frequency verb conditions ($p = 0.036$) only. Thus, in the 2;9 age group children who heard low frequency verbs were significantly more likely to match the weird word order than those who heard higher frequency verbs.

Two further Kruskal–Wallis tests revealed that the proportion of 2-year-old single argument (SV or VO) and dual argument (SVO) reversions also differed significantly according to verb frequency ($\chi^2 = 6.98$, d.f. = 2, $p < 0.03$; $\chi^2 = 10.126$, d.f. = 2, $p < 0.006$). Post hoc Mann–Whitney $U$ tests (again using corrected $p$ values) revealed that children in the medium frequency verb condition were significantly more likely to respond with single argument reversions (of the form SV or VO) than their counterparts in the high frequency condition ($p = 0.045$).7 Furthermore, children in the high frequency verb condition were significantly

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6 Eight children (Low 5, Medium 3) aged 2;9 and five children (Low 4, Medium 1) aged 3;9 did not give any responses meeting this criterion. Little can be said about their knowledge of word order for the verbs tested.

7 There was also a borderline difference between the low and medium frequency conditions ($p=0.082$).
more likely to respond with a full English transitive (SVO) than those in the low frequency ($p = 0.018$) and medium frequency ($p = 0.018$) conditions. For children a year older, equivalent Kruskal–Wallis tests showed no significant effect of verb frequency for any response type.

The most interesting aspect of these results is the extent to which children in the medium frequency condition do in fact demonstrate canonical use of English word order, albeit with only one argument. It would appear that, in the case of the younger children, the tendency to follow a novel word order, is replaced by partial correction to English word order and then full transitive corrections as verb frequency increases. This difference persists to some extent for the older children – reversions are less likely to occur and to be fully SVO in the low frequency condition – but is clearly diminishing with age.

2.3. Pronoun use

Previous studies (Abbot-Smith et al., 2001; Akhtar, 1999) have demonstrated that although children commonly use pronouns when correcting to canonical word order, they are reluctant to do so when matching a novel word order. This trend is confirmed here with a stark difference in pronoun use between SOV matches and SVO reversions: in both age groups not a single child used a pronominal argument when matching SOV word order. The children appear to have a good idea of the distributional probabilities of case marked pronouns. They thus employ them freely in SVO order but not in a novel word order that they may nonetheless adopt productively with full NPs.

Table 5 shows the proportion of subjects and objects of SVO responses that were pronominal for each age and frequency condition. Excluding the low frequency condition for the 2;9 age group (for which there were few reversions), the younger children tend to use more pronominal arguments than their older counterparts. The older children tended to prefer using full NPs except for the infrequent verbs, suggesting perhaps a tendency to rely on pronouns to frame unfamiliar transitives.

2.4. Agent/patient construal

It was necessary to check that children who gave NNV matches intended them to be SOV and not OSV and to check whether children who gave N&NV intransitive responses had in

<table>
<thead>
<tr>
<th>Table 5</th>
<th>Mean proportion of pronominal arguments used in SVO responses as a function of age and verb frequency</th>
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<tbody>
<tr>
<td></td>
<td>2;9</td>
</tr>
<tr>
<td></td>
<td>Subjects</td>
</tr>
<tr>
<td>Low</td>
<td>0.13</td>
</tr>
<tr>
<td>Medium</td>
<td>0.56</td>
</tr>
<tr>
<td>High</td>
<td>0.40</td>
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</tbody>
</table>
fact conceived the action as having two agents. In order to test for the intended agent(s), one video clip was shown again and the child was asked “Who’s doing the VERBing”. All responses expressed a single subject, providing some reassurance that the first noun only was construed as the (single) agent with the exception of one child who responded to the question ‘Who’s doing the flipping?’ by naming the patient. However, as it is acceptable to interpret flipping intransitively, this child was tested with the remaining verbs, shoving, rubbing and dragging and each time chose a (correct) single agent.

3. Discussion

The current study aimed to assess the extent to which English-speaking children’s use of word order depends on the frequency of the specific lexical items being ordered. By modifying Akhtar’s (1999) paradigm, using real English verbs of different frequencies, we tested whether children would be more willing to use a novel word order with a range of verbs they were relatively unfamiliar with and more eager to revert to canonical English SVO order for the verbs they knew better. The general trends were very clear.

Children of 2;9 were far more likely to use low frequency verbs in the non-canonical SOV order than high frequency verbs: 47% of transitive responses matched SOV order in the low frequency condition in comparison with 0% in the high frequency condition.

Furthermore, when a less conservative measure of preference for English word order was used (including SV and VO utterances as reversions) the results suggested that the younger children overcame their tendency to match the SOV order by reverting to increasingly more grammatically complex alternatives as verb frequency increased. Thus, with low frequency verbs children both matched and reverted with one or two arguments, whereas with medium frequency verbs they overwhelmingly preferred to revert to canonical order but using only one argument (generally the subject) and with high frequency verbs they reverted to canonical order and mostly provided both subject and object arguments. The major finding is thus that the younger children manifested knowledge of word order to varying degrees according to the frequency of the verbs used. We would therefore argue that the acquisition of word order, and of the transitive construction, is not a binary affair but is rather an instance of gradually strengthening, graded representations (Munakata, 2001; Munakata & McClelland, 2003, see also Demuth, Machobane, & Moloi, 2003). The more these representations are strengthened with experience (of specific lexical items and of the construction as a whole) the more they can support linguistic productivity. Equally, different testing methods and test items will tap into more or less robust generalizations.

Children at 3;9 demonstrated none of the above frequency effects. Although in terms of frequency of responses, they used SVO order far more productively for higher frequency
verbs, these older children were always more likely to revert to SVO word order no matter what verb they used. A possible objection to the current analysis is that the 3-year-olds matched the weird word order more often than their younger counterparts in frequency terms and even in terms of proportion for the high frequency verb condition, for which they presumably had a good idea of word order. However, the older children matched SOV word order indiscriminately with respect to verb frequency. Thus, although we would not have predicted this proportion of matching in the high frequency verb condition at 3:9, it is plausible that these older children were confident in their use of SVO word order and what we are seeing is rather a general tendency to copy the experimenters word order at a rate of just below 20% of the time. Any such general tendency to copy the experimenters word order would not explain the considerable effect of frequency on the 2-year-olds’ matches and reversions. To the extent to which all children were exposed to equally abnormal linguistic environments we can safely assume that any such differences across conditions are of theoretical interest (see also Bates et al., 1984; Slobin & Bever, 1982 for further comments).

With this in mind, we might ask what, precisely, matching SOV order and reverting to SVO order amount to. In terms of the usage-based model proposed here, we might explain the younger children’s willingness to adopt a novel word order as being afforded by a developing, unstable system which will err between learning new symbolic patterns in an item-based manner and employing newly emerging canonical structures. More specifically, young children will happily learn new constructions consisting of (full) noun phrase variables and an unfamiliar, lexically specific item (in this case a verb). However, their experience of English 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. Thus, children will tend 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 construct more abstract grammatical schemas.

The frequency effect demonstrated in this study (as a function both of verb frequency and age) provides strong support for this usage-based account. In contrast, it would be difficult to explain if we assumed that linguistic experience does not permit generalization of grammatical knowledge but rather triggers a set of innately predefined syntactic options. Theories that propose a universal, innate component to word order acquisition, such as a head direction parameter (e.g. Christophe, Nespor, Guasti, & van Ooyen, 2003; Mazuka, 1996; Penner & Weissenborn, 1996; Radford, 1990), should predict a more sudden onset in the ability to use word order fully productively with all lexical items that have been successfully categorized. Supplementing such accounts with a significant lexical learning component could potentially explain the present frequency effect but would appear to render redundant the very innate constructs on which they are based (Mazuka, 1996). Alternatively, the current results could be dismissed as testing children’s ability to engage in a quasi-linguistic mimicking task, which tells us nothing about real language acquisition. However, the current results do not only show whether children will adopt a weird word order, but also when they prefer to use canonical order, what proportion of the time and with how many arguments. To the extent that even the number of arguments used in corrections to
canonical word order differed according to verb frequency we can be confident that the results are relevant to real language use.

Clearly though, brute frequency of exposure is not working alone. The analysis of pronoun use suggests that the degree of distributional regularity of lexical items also plays a major role in entrenching canonical sentence schemas. Notably none of the children used pronominal arguments with the weird word order. It appears that high frequency, distributionally regular items, such as pronouns (and familiar verbs), become entrenched particularly rapidly and were thus especially resistant to being employed in novel orders. Such lexical items are likely to provide valuable anchors for newly emerging conventional forms.

Further explanation of the role of frequency and distributional probability in language acquisition will require that we consider other lexical items and structures (at all levels of schematicity) that support grammatical productivity. Recent research has suggested that the development of a given grammatical construction (e.g. Subject–Transitive Verb–Object) may depend not only on experience of that particular construction but also on knowledge of other constructions to the extent that they share formal or semantic similarities with the construction being learned. If this Construction Conspiracy Hypothesis (Morris, Cottrell, & Elman, 2000) is correct, it becomes essential to identify the extent to which related constructions, and indeed different forms of the same construction, are represented similarly, as it is only by virtue of drawing on similarities across individual instances that frequency of exposure can strengthen representations and generalizations will be drawn. Computational models, particularly those of a connectionist ilk, will no doubt prove invaluable in demonstrating how linguistic representations may be organized such that these similarities become tangible (e.g. the similarity of two representations can be measured as the distance between two vectors).

Indeed, recent models of sentence processing and syntactic development (Allen, 1997; Chang, 2002; Morris et al., 2000; see also Elman et al., 1996; Seidenberg & Macdonald, 1999 for reviews) have demonstrated how syntactic structure can emerge from the integration of multiple sources of probabilistic sequential information. Importantly, these models demonstrate how apparently entirely abstract (and on some accounts innate) structure can emerge from several types of generalization working together to yield super-ordinate levels of abstraction. They also provide insight into the potential non-linear effects of frequency on behavioral outcome, explaining critical mass phenomena and the like. That said, a major question remains as to whether we can take a ‘radical’ connectionist approach, assuming that there is nothing more to syntax than the structure that emerges from mapping countless input sequences to semantic representations, or whether we need to appeal to more sophisticated, albeit domain general, architectures to capture the symbolic nature of grammatical relations (Chang, 2002; Jackendoff, 2002).

Finally, future research would benefit from considering additional factors affecting grammatical development such as complexity of form (Gathercole, Sebastian, & Soto, 1999), iconicity (Cho et al., 2002; Slobin, 2001), salience, relevance, form-function transparency (Slobin, 2001) and cue locality (Kail, 1989; Slobin, 1982). The aim of the current study was not, therefore, to argue that the frequency of exposure to linguistic material is the ‘be all and end all’ of language acquisition but rather that it plays a central role in structuring language and can shed much light on its developmental trajectory.
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