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Development of sentence interpretation strategies by typically developing and late-talking toddlers*

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ABSTRACT

Three studies, designed to examine use of word order and animacy for interpretation of sentences by 21 typically-developing two-year-old, 23 typically-developing two-and-one-half-year-old, 16 typically-developing three-year-old, 17 language-delayed two-and-one-half-year-old and 19 language-delayed three-year-old children were carried out. Results indicated that typically-developing two-year olds used neither cue consistently to interpret sentences. Typically-developing two-and-one-half-year olds, on the other hand used a coalition of word order and animacy cues and language-delayed two-and-one-half-year olds used neither cue. At three years of age both groups of children used word order exclusively to interpret sentences.

INTRODUCTION

As one of the most important cues to grammatical relations in English, use of word order for sentence interpretation has been the focus of a number of studies of language acquisition (Bever, 1970; Maratsos, 1974; Strohner & Nelson, 1974; Chapman & Miller, 1975; Chapman & Kohn, 1978; Lempert, 1978, 1983; Bridges, 1980; Bates, MacWhinney, Caselli, Devescovi, Natale & Venza, 1984; Golinkoff, Hirsh-Pasek, Cauley & Gordon, 1987; Hirsh-Pasek & Golinkoff, 1996). Many of these studies have attempted to determine

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whether semantic or word order strategies predominate during language development. Since these two strategies can lead, independently or convergently, to a correct interpretation for the great majority of noun-verb-noun (NVN) sentences in English, they are important sources of information for language-learners.

Animacy, word order, and real world plausibility

The earliest studies (Bever, 1970; Strohner & Nelson, 1974; Chapman & Miller, 1975) were carried out in the context of testing linguistic universals. In those studies, children's interpretations of fairly complex sentence forms, such as the passive, were compared to comprehension of simple declarative sentences in which the first noun was always the subject. The common conclusions were that semantic strategies predominated over word order in younger (two- to three-year-old) children, but word order ultimately predominated (by four to five years of age). However, Chapman & Kohn (1978) pointed out that all of the results interpreted as showing use of lexical semantic strategies could be due to an understanding of event probability rather than knowledge of formal lexical semantic rules. Results from their study, designed to control for the degree of event probability in their stimuli, showed that children did not use formal semantic strategies for interpreting sentences. Rather, their decisions were influenced by real world event probabilities when the stimulus items were familiar to them, and by word order (or were random) when the items did not have strong previously established relationships. However, their results were consistent with previous claims that children do not begin to use word order systematically for sentence interpretation until approximately four years of age.

Sentence interpretation and the Competition Model

Based on developmental studies of other languages (Sinclair & Bronkart, 1972; Hakuta, 1982) and cross-linguistic studies of adults (Bates, McNew, MacWhinney, Devescovi & Smith, 1982), Bates *et al.* (1984) argue that, in the absence of real world plausibility and/or event probability, the formal linguistic cues that children will use to interpret sentences are determined by which ones are consistently reliable for the language that they are learning. These ideas were proposed in the context of a functionalist account of grammatical comprehension called THE COMPETITION MODEL (Bates & MacWhinney, 1982, 1989). The major principle of the Competition Model is CUE VALIDITY, an objective, quantitative construct based on cue availability and reliability. Simply put, the higher the frequency (availability) of a particular cue, and the greater the likelihood that an available cue will lead to the correct interpretation of a sentence (reliability), the higher the validity of that cue. However, the degree to which a listener actually depends on a particular cue for understanding the sentences that they hear depends on the

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strength of the cue. CUE STRENGTH is a subjective construct in the model, referring to the actual probability or weight attached to a particular cue by a given person. Thus, although cue validity is an objective product of the structure of the language being learned, cue strength will vary from individual to individual, depending on their experience with the language. Cue validity and cue strength are not, however, sufficient to account for language learning. Some grammatical devices are harder to perceive, and others require more working memory. These kinds of cues will be more difficult to learn than cues that are highly perceivable and local (thus requiring little working memory). The principle of CUE COST is used in the Competition Model to account for the factors that make cues harder to use. In English, word order appears to be a highly valid and low-cost cue. Adults consistently choose the first noun as the subject of the sentence in canonical subject-verb object (SVO) or noun-verb-noun (NVN) sentences (e.g. The boy is pushing the car), and the second noun as subject in noncanonical VOS/VNN (e.g. Throw the ball, Jim) and OSV/NNV (e.g. Ice cream I like) sentences. Children as young as 2;6 of age rely on the first noun to determine the subject of the sentence in canonical sentences (Bates *et al.* 1982, 1984). However, children do not use the second noun strategy to interpret noncanonical sentences until they are seven to eight years of age (Von Berger, Wulfeck, Bates & Fink, 1996).

The most valid and least costly cues of a particular language will compete with less valid and more costly ones, eventually coming to dominate because they are more likely to lead to better understanding. However, cues can also combine, creating a coalition that is stronger than each cue individually. According to Bates & MacWhinney (1989) the process of acquiring a language is one in which coalitions of form-function mappings are learned, and the weights of these are adjusted over time with experience of the language, until an optimal fit between the language and the processing environment is reached. That is, language development is a process through which the value of cue strength (how much an individual relies on a given cue or coalition of cues) comes to converge on the actual quantitative level of cue validity. The idea of coalitions of cues helping sentence interpretation is similar to the Coalition Model proposed by Hirsh-Pasek & Golinkoff (1996). However, in that model, coalitions of linguistic and nonlinguistic cues help the child to learn the formal structure of grammar, and non-formal information is used less and less as the child acquires the grammar of the language. In the Competition Model, the coalitions are viewed as occurring within the formal structures of language (e.g. lexical sematics and word order may 'team up' to make a cue easier to learn).

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Word order versus formal lexical semantics

The kind of coalition described by Bates & MacWhinney (1989) is likely for word order and animacy cues in English, since both the first noun and animate nouns are consistently more likely to be the subject of the sentence than the second noun or inanimate nouns. If one excludes real world event probability from the experimental paradigm, forcing children to rely only on their formal linguistic knowledge, then some combination of animacy and word order would likely be used by children from the very earliest stages of grammatical development. In addition, given that word order is a more frequent and more reliable cue than animacy in English, word order could take precedence over animacy if the two are put into competition.

Bates *et al*. (1984) tested this idea in a cross-linguistic study of American and Italian children between two-and-one-half and five-and-one-half years of age. They hypothesized that there would be a significantly different reliance on word order and animacy cues by the two groups because of differences in the structure of the languages that the children were learning. As noted above, word order is a highly reliable cue in English. In Italian, on the other hand, the subject of the sentence can occur in any sentence position or (since it is a prodrop language) can be completely omitted. As a result, word order has low cue validity in Italian, and Italians must use some other cue or combination of cues to determine the subject of a sentence. Bates *et al*. used a factorial design so that word order (NVN, NNV and VNN) and lexical semantic cues (animate/inanimate [AI; e.g. The girl is pushing the shoe.], inanimate/animate [IA; e.g. The cup is hitting the bear.], and animate/animate [AA; e.g. The girl is kissing the bear.] nouns) were placed into converging and competitive positions in the stimulus sentences of an enactment task. In addition, sentences were constructed so that real world event probability was eliminated as a confounding variable, by counterbalancing assignment of actors and actions. Specifically, the test protocols were constructed by randomizing the assignment of animate nouns, inanimate nouns, and verbs to appropriate conditions. This assured that event probabilities resulting from particular lexical combinations (e.g. bears are inherently fiercer than girls) were homogenized across children and conditions. Results showed that English-speaking children as young as two-and-one-half years of age consistently used word order but not animacy to interpret canonical (NVN) sentences, choosing the first noun as the subject of the sentence regardless of whether it was animate or inanimate. Responses to noncanonical (NNV & VNN) sentences, sentence types with which children have much less experience (and for which the second noun is the appropriate choice), were random. Italian children, on the other hand, chose the animate noun as the subject of the sentence for nonreversible forms (i.e. AI and IA) regardless of whether it was the first or second noun, or whether

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the sentences were canonical or noncanonical. In addition, reliance on word order by English-speaking children (as determined by the percent of variance it accounted for in the subjects enactment decisions) increased from two-and-one-half through five years of age, with the largest increases occurring between two-and-one-half and four years of age. The same was true for animacy for the Italian-speaking children.

Later studies of English-speaking children (Golinkoff *et al.*, 1987; Hirsh-Pasek & Golinkoff, 1996) used a preferential looking paradigm to determine children's sensitivity to word order cues. The early use of word order was also reported in a study by Golinkoff *et al.* (1987) who demonstrated that 2;4 to 2;6 year old children used word order to interpret NVN sentences with two animate nouns. Hirsh-Pasek & Golinkoff (1996) showed the same results for even younger (1;4 to 1;6 year old) children. These studies demonstrate that, when put into a situation in which word order is the only formal cue available for interpreting sentences, very young children are able to do so. What children who are younger than two-and-one-half would do if animacy and word order are placed in competition has not yet been tested. This question provided the motivation for the first study described below.

To sum up, results of studies of sentence interpretation strategies used by typically developing children who are in the process of learning language suggest that, given the opportunity, children under four years of age will use real world event probability as the means of understanding sentences. However, when that opportunity is removed, children as young as two-and-one-half use word order instead of lexical semantics to interpret sentences, and even children as young as 1;4 to 1;6 years demonstrate some awareness of word order as a cue to semantic roles.

Word order, animacy, and real world probability in atypical children

The small literature describing language-impaired children is consistent with the research with typically developing children. Three studies of English-speaking children (van der Lely & Dewart, 1986; Precious & Conti-Ramsden, 1988; Adams, 1990) have shown that children with specific language impairment use the same kinds of strategies for comprehending sentences as typically developing children, although they are likely to be those forms used by younger typically-developing children. That is, given the opportunity to use real world event probability or semantic information, they will do so. Denied that opportunity, they may use word order. Interestingly, Adams' study focused on children with normal levels of language comprehension (as measured by standardized tests). It is remarkable, therefore, that her research found the same kinds of sentence comprehension delays reported in the other studies in which children with delays in both comprehension and production were used.

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In a more recent study, Evans & MacWhinney (1999) compared the sentence comprehension strategies of six- to eight-year-old language-impaired children with normal comprehension (E-SLI) to those with delays in both comprehension and production (ER-SLI) and to typically developing children of the same age. Like the studies of younger children described in the research reported in this manuscript, Evans & MacWhinney constructed sentences in which word order and animacy were placed in competition so that reliance on word order versus lexical semantic cues could be compared. They found that the E-SLI, like the typically-developing controls, consistently used a word order strategy to determine the subject of the sentence. The ER-SLI, on the other hand, used animacy cues and not word order. Analysis of individual patterns using maximum likelihood estimates indicated that use of word order cues was highly correlated with better receptive language skills. These studies, in conjunction with the research on typically developing children described above, provided the motivation for the second and third study described in this manuscript.

The studies described below were designed specifically to examine use of the formal linguistic cues of word order (syntax) and animacy (lexical semantics) for sentence interpretation by young children with typical and delayed language development. In Study 1 we looked at typically developing two-year-olds (who were 6 months younger than the youngest children examined by Bates *et al*.). In Study 2 we compared typically developing two-and-one-half-year olds to same-aged children who were delayed in expressive language development. In Study 3 we compared typically developing three-year-olds to same-aged children with delayed expressive language. Since both groups of children in Studies 2 and 3 were the same age as children studied by Bates *et al*., the design allowed us to partially replicate their study while also extending it to a sample of language delayed children.

STUDY 1

Given their young age and limited language skills, it is possible that two-year-olds have not yet had sufficient experience with English to have learned to trust word order for sentence interpretation. If coalition hypotheses are correct, it may be the case that children rely on a combination of word order and animacy, both of which are valid cues (albeit with different levels of reliability) for interpretation of sentence subject in English, at this very young age. Alternatively, they may not have learned enough to use either cue consistently.

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METHOD

Participants

Participants in Study 1 were 21 two-year-old typically-developing toddlers who were part of a large longitudinal study of language and cognition. All of the children scored within the normal range on the comprehension and expressive subtests of the Reynell Developmental Language Scales (Reynell, 1984; hereafter Reynell Scales) and the Bayley Scales of Infant Development (Bayley, 1969; hereafter Bayley Scales) when they were between 1;8 and 2;6.[1] In addition, a neurological screening and an extensive family and medical history filled out by the parents indicated normal development. The mean age for the children was 23·9 months (range 21·4 to 26·4). The task was administered to an additional 8 children who failed to complete the task. Age, language, and developmental or IQ scores for individual children are presented in the appendix.

Procedure

Using an enactment procedure adapted from Bates *et al.*(1984) and Bates, Bretherton & Snyder (1988), each participant was asked to act out 16 grammatical or ungrammatical sentences with two objects from a set of five (bear, girl, kitty, cup, shoe; see Table 1 for example sentences). Half of the

TABLE 1. *Examples of the sentences used in the enactment task*

Sentence	Construction	Word Order[a]	Animacy[b]
The girl is pushing the shoe.	Canonical	NVN	AI
The bear is hitting the girl.	Canonical	NVN	AA
The cup is kissing the bear.	Canonical	NVN	IA
Is kissing the bear the shoe.	Non-canonical	VNN	AI
Is pushing the girl the bear.	Non-canonical	VNN	AA
Is hitting the cup the girl.	Non-canonical	VNN	IA
The kitty the shoe is pushing.	Non-canonical	NNV	AI
The girl the bear is kissing.	Non-canonical	NNV	AA
The cup the bear is hitting.	Non-canonical	NNV	IA

[a] N, noun; V, verb. [b] AI, animate first noun, inanimate second noun; AA, both nouns are animate; IA, inanimate first noun, animate second noun.

sentences were in canonical (noun-verb-noun [NVN]) order and the other half were equally divided between two noncanonical word orders (verb-

[1] Reynell scores for two children and Bayley scores for one other child were not available.

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noun-noun [VNN] and noun-noun-verb [NNV]). In addition, within each word order type, animacy was varied systematically. In one quarter of the sentences an animate object was mentioned first and an inanimate object was mentioned second (AI). In another quarter an inanimate object was mentioned first and an animate object was mentioned second (IA). In the other half of the sentences, both nouns were animate (AA). The test trials were made up of eight contrasting pairs (e.g. 'The bear is pushing the girl' and 'The girl is pushing the bear') presented in one of four randomized orders. Test items were randomized with the constraint that contrasting pairs were never adjacent. The five nouns were presented in singular form and preceded by the definite article (e.g. 'the girl'). The transitive verbs 'kiss', 'hit', and 'push' were preceded by the auxiliary verb 'is' and in the present progressive morpheme '-ing' (e.g. 'is kissing').

Prior to the test, children were exposed to a warm-up and training. The purpose of the warm-up was to familiarize the child with the items used in the task and to be sure the child knew the name of each object. Each participant was seated across the table from an experimenter and five objects were introduced, one at a time. The experimenter said, 'look' and the child was given time to spontaneously label the object. If the child named the object (e.g. 'girl'), the experimenter confirmed the label (e.g. 'Yes, it's a girl'). If the child provided a label that was not the same as the test word (e.g. 'baby' 'for girl'), then the experimenter reinforced the child's attempt and provided the test word with stress (e.g. 'Yes, you're right, a baby girl. A GIRL'). If the child did not provide a label, the first attempt to elicit the label was the question 'What is that?' The second attempt to elicit the label was with repetition (e.g. 'It's a girl. What is that?'). After all five items were on the table in front of the child, the experimenter asked the child to give them back one at a time. The purpose of this task was to confirm the child's understanding of the test labels.

Training trials designed to familiarize the child with the task demands and the actions to be enacted (kissing, hitting, pushing) followed the warm-up. They also provided examples of how the child carried out the action of each verb. Only children who were able and willing to produce the actions after the experimenter's presentations were included in the analysis. In the training trials, the experimenter acted out a sentence with each of the three test verbs and three objects that were different from those used in the warm-up and the test (a fork, a duck, and a boy doll). Each enactment model was accompanied by a sentence using one of the three verbs that described an activity to be carried out with the object (e.g. 'The fork is hitting the duck'). The experimenter repeated the action and the sentence two times, then she gave the child the objects and asked him or her to enact the sentence ('Now you make the fork hit the duck. Show me the fork is hitting the duck'). Three training sentences, each with a different verb and animate/inanimate noun

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relationship, were used in order to avoid biasing the child in favor of a particular animacy strategy. The three training sentences were 'The fork is hitting the duck' (inanimate N hit animate N), 'The dog is kissing the boy' (animate N kiss animate N), and 'The boy is pushing the fork' (animate N push inanimate N).

For the test, two objects from those labelled in the warm-up were placed on the table, but out of the child's reach, as the experimenter said a sentence. Then, the experimenter repeated the sentence and the objects were moved toward the child, keeping each one equidistant from the child and randomizing left or right side of presentation for each object across trials. For example, the experimenter put a cup and a toy cat on the table and said 'Is pushing the kitty the cup'. Then, while sliding the cat and the cup toward the child, the experimenter said, 'Show me ''Is pushing the kitty the cup'''. The experimenter did not enact the test sentence and no prompts were given.

Data reduction and analysis

Each participant's enactment of the sentences was videotaped and scored from the tape at a later date. Enactment of each sentence was scored according to which noun was chosen as the agent of the sentence. Following Bates *et al*. (1984), agent selection was based on the first item the child moved, picked up, or touched regardless of the action performed and/or the inclusion of a patient in the event sequence. A score of 1·0 was given if the child first moved, picked up, or touched the first noun mentioned. A score of 0 was given if the child first moved, picked up, or touched, the second noun mentioned. A score of 0·5 was given if the child moved, picked up, or touched both objects simultaneously or if s/he did not respond to the stimulus at all. On occasion, however, a child clearly indicated that they had changed their mind by putting down the first object before actually carrying out an activity and then using the second object in a clear agentive action. In such cases, the second object chosen was considered to be the agent chosen by the child. Scores closer to 1·0 indicated more frequent choice of the first noun (appropriate for NVN/SVO sentences), those closer to 0 indicated more frequent choice of the second noun (appropriate for NNV/OSV and VNN/VOS sentences), and those around 0·5 indicated no strong preference for either noun. Two research assistants independently scored sessions from 25% of the participants. Mean inter-rater agreement was 96% (range 92–100).

A (2) canonical vs. noncanonical word order × (3) AI by IA by AA repeated measure ANOVA, with percent first noun selection as the dependent variable, was conducted. This allowed us to determine if typically developing English-speaking two year olds used word order and/or animacy cues to enact sentences in which word order and animacy were the only cues available for sentence interpretation. Given findings by Bates *et al*. (1984)

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with slightly older children, and results from studies using the simpler looking preference paradigm (Hirsh-Pasek & Golinkoff, 1996), we predicted that there would be an effect for word order but not animacy. In addition, given that a second noun strategy for noncanonical sentences was shown to develop much later by Von Berger *et al*. (1996), we predicted that the word order effect would be found only for first noun choice in canonical (SVO/NVN) sentences.

RESULTS AND DISCUSSION

Contrary to the prediction, the ANOVA indicated no significant main effects for either word order or animacy, and no significant word order by animacy interaction. The mean level of responding to canonical (NVN) and non-canonical (NNV & VNN) sentences, collapsed across animacy conditions, was 0·57 and 0·56, respectively. Mean levels of response for animacy conditions (collapsed across word order conditions) were 0·62 when an animate noun preceded an inanimate noun (AI), 0·56 when an inanimate noun preceded an animate noun (IA), and 0·52 when both nouns were animate (AA). Thus, the two year old children with typical language development tested in this study did not use a word order strategy in preference to animacy as did the two and one half year old children described by Bates *et al*. (1984). Neither did they prefer an animacy strategy or use a coalition of word order and animacy. In fact, they appeared to perform randomly in deciding who was to do what to whom in this sentence enactment task. This contrasts with Hirsh-Pasek & Golinkoff (1996) in addition to the Bates *et al*. findings for slightly older children. Interestingly, the same pattern was found by Evans & MacWhinney for a seven-year-old child who had the greatest receptive language deficits among a group of seven children with expressive and receptive language delays and seven with only expressive language delays, suggesting that random responding may be related to level of language comprehension. Possible explanations for this will be discussed in the General Discussion that follows Study 3.

STUDY 2

In Study 2 we asked whether the results from Bates *et al*. (1984) for typically developing two-and-one-half year old children could be replicated. In addition, we also wanted to know whether two-and-one-half year old children with specific expressive language delay (late talkers) would use word order and/or animacy cues for sentence interpretation. Results from Bates *et al*. and Hirsh-Pasek & Golinkoff (1996) suggest that late talkers with normal levels of language comprehension would be just as likely to use the word order cue to interpret the sentences presented in the experimental task as typically developing children. However, given our results for typically

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developing two-year-olds (described above), and the more immature use of sentence interpretation strategies by language-impaired children reported by van der Lely & Dewart (1986) and by Adams (1990), late talkers may not use the available grammatical information as effectively as their same-aged peers.

METHOD

Participants

Participants in Study 2 were 40 two-and-one-half-year-old toddlers who were part of the same large longitudinal study of language and cognition as those who participated in Study 1. All 40 children passed a neurological screening and had normal medical and family histories. Seventeen of the children had been identified as delayed in language development when they were between 1;8 and 2;4 years old using the MacArthur Communicative Development Inventory: Words and Sentences (CDI; Fenson, Dale, Reznick, Thal, Bates, Hartung, Pethick & Reilly, 1993). The criterion for language delay was a score at or below the tenth percentile for the child's age on the CDI. This expressive language delay was confirmed using the Reynell Scales when the children were between 1;8 and 2;6. All late-talking toddlers (LT) scored within the normal range on the Bayley Scales (also obtained when they were between 1;8 and 2;6).[2] An additional four late talkers did not complete testing and were dropped from the study. Twenty-three typically developing children served as controls. All of these children scored within the normal range on the Reynell Scales (obtained between 1;8 and 2;7) and the Bayley Scales (obtained between 1;4 and 2;7).[3] The mean age for the late talkers was 30·7 months (range 29·1 to 32·1). This was not significantly different from that of the control group (mean 31·0, range 29·4 to 32·9). Because these children were part of a large longitudinal project in which some children were followed longitudinally and others were tested only once, thirteen of the controls also participated in Study 1. A t-test determined that there was no significant difference in the scores of the children who had participated in Study 1 and those who had not. One typically developing child did not complete the experiment and was dropped from the study. Age, language, and developmental scores for individual children are presented in the appendix.

[2] Bayley scores were not available for two late talkers and one child failed to complete the Bayley Psychomotor Index, but did complete the Mental Development Index. Another late talker was tested using the Wechsler Preschool and Primary Sale of Intelligence–Revised (Wechsler, 1989) when he was 3;7 instead of the Bayley. One additional child did not complete the expressive subtest of Reynell.

[3] One typically developing children did not receive the Bayley Scales.

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Procedure

The procedure, data reduction, predictions, and analysis of the data for Study 2 were identical to that for Study 1. Inter-rater agreement on 25% of the samples was 95% (range 91–100).

RESULTS AND DISCUSSION

A (2) group × (2) word order × (3) animacy mixed ANOVA showed a significant main effect for group ($F(1,228) = 9{\cdot}66$, $p < 0{\cdot}002$), word order ($F(1,228) = 10{\cdot}33$, $p < 0{\cdot}001$), and animacy ($F(2,228) = 4{\cdot}61$, $p < 0{\cdot}01$). None of the interactions were significant.

These results (shown in Figure 1) are clearest when percent of first noun choice is depicted separately for each group and each word order and animacy condition. First, it is clear that, collapsing across conditions, typically developing children chose the first noun more frequently (0·66) than the late talkers (0·53), and late talkers appear to be choosing randomly. Similarly, combining across groups, children chose the first noun more often in canonical sentences (0·67) than in noncanonical ones (0·53). This is consistent with the results described by Bates *et al*. (1984). The percent of variance accounted for by the main effect (sum of squares effect/sum of squares total from the ANOVA) for word order is 3·9%, which is similar to the 3·5% reported for English-speaking two-and-one-half year olds described by Bates *et al*. These results, indicating consistent use of a first noun strategy by typically developing two and one half-year-old children, are a replication of those reported by Bates *et al*. Unlike Bates *et al*., the main effect for animacy was significant in this study. Tukey tests ($p < 0{\cdot}05$) indicated that children chose the first noun significantly more often in the AI condition (0·67) than in the IA condition (0·53). There were no significant differences between the AA condition (0·60) and either of the other two animacy conditions. These results are consistent with recent results from a sentence identification task in which children identified the subjects of sentences in which they could exploit both syntactic and semantic information (the first noun was animate and the second inanimate) than when only syntax (two animate nouns) could be used (Childers, 1998), and with findings reported by Evans & MacWhinney for seven-year-old children with expressive and receptive specific language impairment. The amount of variance accounted for by animacy was 3·5%, equivalent to that accounted for by word order in both this study and Bates *et al*., but considerably less than that accounted for by animacy for the Italian-speaking two-and-one-half year olds (17·5%) in Bates *et al*.

We explored the potential effects of the combination of word order and animacy for sentence interpretation by comparing the performance of each

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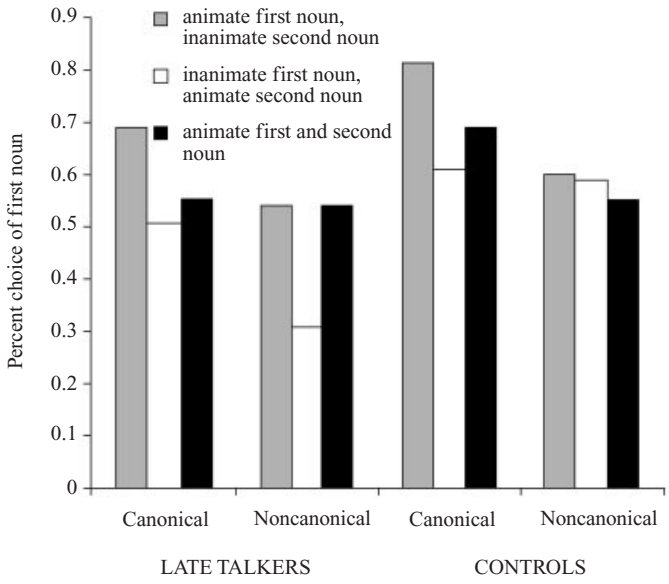


Fig. 1. Percent choice of first noun by 2;6-year-old late talkers and controls in the different word order conditions.

group to chance levels of responding in each animacy condition for the canonical sentences. Chance was set at 0·5 since there was a two-way choice, and t-tests (with the Bonferroni correction) were carried out. Results showed that typically developing children chose the first noun significantly more frequently than expected by chance, but only in the AI ($t(22) = 4{\cdot}70$, $p < 0{\cdot}001$) and the AA ($t(22) = 6{\cdot}39$, $p < 0{\cdot}001$) conditions, i.e. when an animate noun was in the first position. None of the t-tests for late talkers reached significance at an alpha level of 0·05. Thus, although the patterns of development were the same for the children with delayed and typically developing language, only the typically developing children consistently responded above chance and then only in the canonical sentences in which an animate noun was the first noun. Late-talking toddlers, despite language comprehension scores that were within the normal range on the Reynell scales, and patterns of first noun choice that were similar to those of typically developing children, did not use a first noun strategy more frequently than expected by chance in any condition. This result is concordant with those reported by Adams (1990) for children with specific expressive language impairment.

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STUDY 3

In Study 3 we attempted to replicate the findings of Bates *et al*. (1984) for typically-developing three-year-olds and we compared the typically-developing children to language delayed three-year-olds. Again our prediction was that both groups of children would use word order and neither would use animacy.

METHOD

Participants

Participants in Study 3 were 35 three-year-old toddlers who also participated in the same large longitudinal study of language and cognition as the children in Studies 1 and 2. All children passed a neurological screening, and had normal medical and family histories. Sixteen of the children had been identified as late talkers using the same criteria used in Study 2. The other 19 children were typically-developing and served as controls. Normal development for these children was also confirmed using the same methods as in Study 2. The mean age for the late talkers was 36·4 months (range 35·8 to 37·5). This was not significantly different from that of the control group (mean 36·6, range 36·1 to 37·3). Eleven late talkers and 14 controls also served as subjects in Study. A t-test determined that there was no significant difference between the scores of the children who had participated in Study 2 and those who had not. Age, language, and developmental or IQ scores for individual children are presented in the appendix.

Procedure

The procedure, data reduction, predictions, and analysis of the data for Study 3 were identical to those for Studies 1 and 2. Mean inter-rater agreement on 25% of the samples was 98% (range 97–100).

RESULTS AND DISCUSSION

The (2) group × (2) word order × (3) animacy ANOVA, with percent first noun selection as the dependent variable showed a significant main effect for word order ($F(1, 199) = 46{\cdot}90$, $p < 0{\cdot}001$). None of the other main effects or interactions were significant. As can be seen in Figure 2, the first noun choice effect is clearly from the canonical sentence structure.

Responses to noncanonical sentences appear to be random. The main effect for word order accounted for a much larger proportion of the variance at three years of age (24%) than at two-and-one-half, and this, too is comparable to results by Bates *et al*. (1984) who reported that word order accounted for 17·3% of the variance in the 3-year-old children whom they tested.

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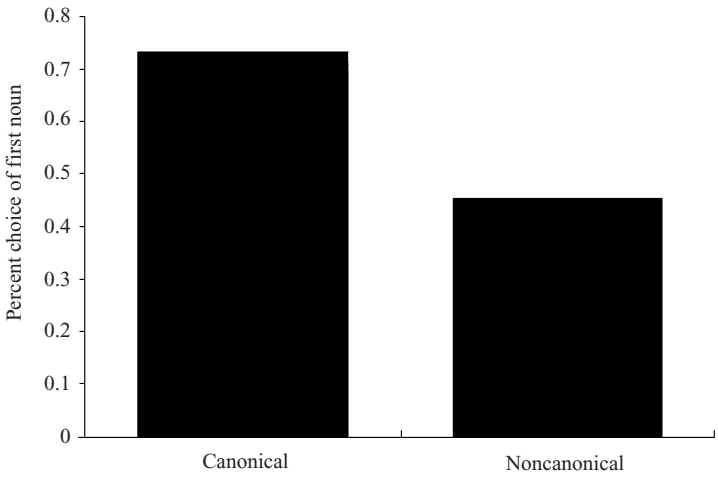


Fig. 2. Percent choice of first noun by 3-year-old children in the different word order conditions.

T-tests (with chance set at 0·5) were conducted to determine if subjects chose the first noun significantly more often than expected by chance. Given that the effect for animacy did not even approach significance, and that there were no significant interactions, the tests were carried out on results collapsed across the animacy conditions. Results indicated that, in canonical sentence structure, both typically-developing and late-talking three year olds chose the first noun more frequently than expected by chance ($t(56) = 5{\cdot}91$, $p < 0{\cdot}001$ and $t(47) = 5{\cdot}86$, $p < 0{\cdot}001$, respectively). Neither group responded at levels higher than expected by chance in the noncanonical sentence condition. These results are compatible with those reported by Bates *et al*. (1984) for typically developing three-year-old English-speaking children. In addition, they show that the children with late onset of expressive language skills but typically developing language comprehension used the same strategies with the same level of ability as typically developing children at three years of age.

GENERAL DISCUSSION

Taken together, the results from these studies add to the body of literature that demonstrates understanding of word order in very young children that becomes increasingly stronger as they get older, providing support for processing models of language learning like the Competition Model (Bates & MacWhinney, 1989) or the Coalition Model (Hirsh-Pasek & Golinkoff, 1996). They are also consistent with claims that children with early expressive language delay are not at significant risk for atypical language

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development (Paul, 1996, Rescorla, 1993, 1999, Thal, 1999). Each of these points will be discussed in more depth next.

Development of word order comprehension

The studies described above showed a clear development of word order comprehension from two to three years of age. At two, typically developing children demonstrated no ability to use word order or animacy in this task, suggesting that they lacked sufficient experience with English to exploit the use of either of these cues to understand sentences like those used in these experiments. This is in clear contrast to results reported by Hirsh-Pasek & Golinkoff (1996) who reported sensitivity to word order as early as 1;4 years of age. One likely explanation of this difference is the kinds of demands made by the experimental tasks. First, the Hirsh-Pasek & Golinkoff experiment used a much simpler task than enactment. In that task participants were only required to look at a picture on a monitor while our children had to act out the sentences. In addition, the children in the Hirsh-Pasek and Golinkoff studies were required to respond to a much smaller set of sentences. They argue that the looking preference procedure is preferable to enactment because it is less likely to underestimate children's linguistic knowledge by including the confounding variable of competing action biases. That is, children are likely to respond based on real world rather than linguistic knowledge in an enactment task and that looking preference procedures avoid such a bias. The enactment task used in this study was carefully constructed to avoid the confound of real world response bias, so that is not a likely explanation for the differences we found. The sentence enactment task does place greater cognitive demands on the child in that they have to remember what was said, identify the appropriate objects, and then perform the activity. Thus, enactment requires more than passive recognition of a difference between two utterances and requires that the child use his or her understanding to act on the environment. Does the looking preference task test 'real' comprehension sensitivity and the enactment task test something more? Perhaps. However the looking preference task has a significant weakness that was not found in the enactment task used in this study. Hirsh-Pasek & Golinkoff report subject loss rates of 50% to 78% in their looking preference studies, whereas we had little to no subject loss. Thus, although looking preference may be a more sensitive measure of comprehension, it appears to be applicable to somewhere between half and one quarter of normally-developing 1;4 to 1;6 year olds. We believe, like Hirsh-Pasek & Golinkoff, that these differences are best explained in terms of the stability of the knowledge being tested. It is likely that, at these early stages, comprehension of word order is what Hirsh-Pasek & Golinkoff would call fragile knowledge. That is, it requires support from a number of additional cues in order to be used successfully to derive meaning. The design of our

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experiment specifically varied cue cooperation and competition, and this could have increased the processing load sufficiently to disrupt a fragile knowledge base. This is useful information in that, even if some basic comprehension is present at two years of age, it may be too fragile to stand up to the rigours of real world use without substantial environmental support.

By two-and-one-half years of age, typically developing children did use word order as a cue to sentence interpretation, but in conjunction with animacy. That is, they chose the first noun at levels above chance only in canonical sentences in which the first noun was animate. This is a non-replication of the word order cue only findings reported by Bates *et al*. (1984). That is, Bates *et al*. reported no significant effect of animacy in the 2;6 year old English-speaking children that they studied. The result is consistent with the general claims of both the Competition Model (Bates & MacWhinney, 1989) and the Coalition Model (Hirsh-Pasek & Golinkoff (1996), and with results for seven year old language-impaired children with deficits in both receptive and expressive language (Evans & MacWhinney, 1999). Again, differences in methodology might account for the nonreplication. Bates *et al*. presented subjects with 54 different sentences, and they included variations in stress as well as word order and animacy, creating more and different coalitions and competitions between cues than in the studies reported here. We used only 16 different sentences and varied only animacy and word order. Given the different task demands in the Bates *et al*. study, it is possible that the youngest children in that study used only word order, the cue with highest validity for English. This is consistent with the studies in which children with specific language impairment were more likely to rely on word order for more difficult grammatical constructions and when semantic/event probability cues were not available (van der Lely & Dewart, 1986; Adams, 1990). Our results are more consistent with those of Evans & MacWhinney, and also with the notion that children with fragile levels of knowledge are more likely to use coalitions of cues when they are available than those with somewhat more resilient knowledge.

At three, both late talkers and typically developing children relied exclusively on word order to interpret the sentences, and the amount of variability accounted for by the word order effect had increased from 3·5% to 24%. These results are also consistent with Competition Model and Coalition Model explanations of language development, and demonstrate an earlier ability to use word order as a comprehension cue than was demonstrated by the earlier studies in which real world event probability was an available cue. In addition, they are consistent with the Competition Model argument that language development involves adjusting the strength of the form-function mappings toward an optimal fit with the cue validity for that particular form (Bates & MacWhinney, 1989) through experience with the

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language. This is theoretically interesting in that it supports functionalist and emergentist perspectives on language development (MacWhinney, 1998). It is developmentally interesting in that it suggests that children under three years of age are likely to need a combination of supportive cues in order to make useful communicative decisions about the meaning of utterances whereas by three they will be able to rely exclusively on the most important structural cue of the language that they speak. This has implications for the kinds of early input that are likely to help language development and for the kinds of input that will be most helpful for children with delays or disorders of language development.

Development of word order understanding in language delayed children

In this study, the late talkers showed the same pattern of cue use as typically developing children, but they were delayed by approximately six months. This may reflect an early language delay that is simply normal variation, or one that may be manifested as language impairment at a later age. In either case, it is consistent with an older literature suggesting that delayed language development reflects more slowly developing normal processes rather than a deviant developmental pattern (Leonard, 1987), and more recent research suggesting that late-talking toddlers with normal levels of receptive language lag behind typically-developing peers but move into the normal range beginning around 3 years of age (Paul, 1996; Rescorla, 1993, Thal & Katich, 1996, Thal, 1999). In addition, our results demonstrated a delay in comprehension in children who had normal comprehension scores on standardized tests of language. This is, perhaps, the more intriguing result. It is concordant with Adams' (1990) and Bishop's (1979) observations in older children with specific expressive language impairment, and deserves further investigation. One potential explanation is the difference between a procedure such as the one used here and those used in typical standardized tests. The procedure used here was specifically designed to eliminate confounds with real world knowledge and to place specific linguistic cues into competition with one another to see which ones children were willing to rely on when the situation required a choice. Tests, such as the Reynell (which we used with our participants) do not put specific linguistic forms into competition with each other, and do not eliminate real world plausibility. For example, in one of the comprehension tasks, young children are given some animals and a fence, and they are asked to put various animals inside of, outside of, or next to the fence. Other questions concern manipulating objects such as buttons that are of different sizes. These kinds of test procedures incorporate real world plausibility, and allow children to use a variety of linguistic and nonlinguistic cues to determine the correct response. Superior performance on such tests would be predicted by both the Competition Model (Bates & MacWhinney, 1989) and the Coalition Model (Hirsh-Pasek & Golinkoff,

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1996), since there are a large variety (or coalitions) of cues available to the children to support even fragile linguistic knowledge.

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APPENDIX

AGE, LANGUAGE AND DEVELOPMENTAL LEVEL SCORES OF ALL PARTICIPANTS

Subject	Reynell C[a]	Reynell E[b]	Age at test[c]	MDI[d]	PDI[e]	Age at test[c]
Late talkers						
2001[i]	137	63	25	101	131	25
2009[m]	104	75	37	84	91	30
2011[i]	107	Below norms	24	96	114	24
2015[i]	108	80	30	112	97	30
2024[l]	100	Below norms	21	85	85	20
2025[m]	94	75	21	113	136	21
2028[m]	127	72	22	136	114	24
2030	104	Below norms	29	104	114	23
2039[i]	101	Below norms	27	74[f]	115[g]	43
2044[m]	84	Below norms	25	114	131	26
2046[i]	89	Missing	26	133	116	26
2050[i]	110	Below norms	20	147	143	26
2053[l]	93	Below norms	26	118	91	20
2060[l]	114	Below norms	25	Missing	Missing	Missing
2066[i]	104	Below norms	27	89	Missing	29
2070[i]	111	72	23	110	95	27

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2071[i]	97	78	22	118	126	26
2072[i]	86	72	22	102	131	24
2073[l]	67	68	22	Missing	Missing	Missing
2075[l]	111	78	22	111	104	26
2080[l]	87	Below norms	25	106	92	29
2081[i]	86	Below norms	23	85	95	27
Controls						
8009[h]	96	93	23	112	104	23
8016[m]	96	95	34	91[f]	97[g]	38
8024[h]	123	96	42	131	120	22
8028[m]	103	104	21	120	113	20
8029[i]	118	130	27	110	130	26
8031[i]	137	137	26	133	108	30
8039[l]	120	106	27	121	126	22
8047[h]	106	111	30	113	100	18
8054[j]	116	102	30	96	86	11
8063[l]	98	88	42	114	102	16
8071[h]	107	107	25	114	140	26
8074[h]	125	110	25	133	129	31
8080[k]	Missing	Missing	Missing	122	102	16
8081[j]	91	86	42	112	93	24
8082[h]	103	120	20	122	100	21
8083[m]	110	109	26	133	123	30
8084[h]	125	137	25	Missing	Missing	Missing
8116[k]	111	111	28	134	125	27
8118[k]	Missing	Missing	Missing	135	119	18
8121[j]	94	108	27	124	85	30
8126[j]	128	123	27	133	108	27
8127[i]	130	133	29	124	129	29
8149[k]	129	99	39	124	104	22
8150[h]	117	110	26	145	131	25
8156[k]	99	122	26	125	131	25
8158[h]	125	107	32	117	97	29
8160[h]	116	91	20	112	83	28
8165[k]	92	89	24	93	137	27
8187[l]	100	91	23	123	106	17
8188[m]	112	123	40	122[f]	122[g]	40
8190[i]	104	107	31	109	91	30
8192[k]	97	104	25	120	117	23
8193[l]	97	119	25	95	125	27
8195[m]	95	100	31	98	102	24
8210[j]	137	129	23	123	106	29
8212[k]	87	104	24	121	112	22

[a] Reynell Receptive Language Score; [b] Reynell Expressive Language Score; [c] Age in months; [d] Bayley Mental Development Index; [e] Bayley Psychomotor Index; [f] WPPSI Verbal IQ; [g] WPPSI Motor IQ; [h] Participated in Studies 1, 2 and 3; [i] Participated in Studies 2 and 3; [j] Participated in Studies 1 and 2; [k] Participated in Study 1 only; [l] Participated in Study 2 only; [m] Participated in Study 3 only.

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