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Direct object predictability: effects on young children's imitation of sentences*

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ABSTRACT

We hypothesize that the conceptual relation between a verb and its direct object can make a sentence easier ('the cat is eating some food') or harder ('the cat is eating a sock') to parse and understand. If children's limited performance systems contribute to the ungrammatical brevity of their speech, they should perform better on sentences that require fewer processing resources: children should imitate the constituents of sentences with highly predictable direct objects at a higher rate than those from sentences with less predictable objects. In Experiment 1, 24 two-year-olds performed an elicited imitation task and confirmed that prediction for all three major constituents (subject, verb, direct object). In Experiment 2, 23 two-year-olds performed both an elicited imitation task and a sticker placement task (in which they placed a sticker on the pictured subject of the sentence after hearing and

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imitating the sentence). Children imitated verbs more often from predictable than unpredictable sentences, but not subjects or objects. Children's inclusion of constituents is affected by the conceptual relations among those constituents as well as by task characteristics.

A hallmark of early child speech is the absence of elements that are present in adult speech. What influences children's inclusion or omission of constituents in a sentence? We hypothesize that any utterance, whether spontaneous or imitative, is a product of many factors operating simultaneously, including at a minimum the child's linguistic knowledge, the child's attentional and cognitive resources, the information value of each constituent in the child's message, the child's communicative goals, and the social setting of which the utterance is a part. To tease those factors apart, it is necessary to perform experiments which can independently vary different influences.

In this experiment we systematically vary the semantic–conceptual structure of predicates in an elicited imitation task. We hypothesize that some direct objects, because of their semantic–conceptual relation to the verb, will require fewer cognitive resources to process. As a result, those predictable direct objects will improve a child's ability to imitate the sentence, particularly the verb, but also the subject and object. Previous research has found that very young children are more likely to include the direct object than the subject in their spontaneous speech (English: Valian, 1991; Hyams & Wexler, 1993), as are older children in a story-telling task (Warlpiri: Bavin, 2000). Since young children produce direct objects more often than subjects even in languages where both are grammatically optional (Chinese: Wang, Lillo-Martin, Best & Levitt, 1992), it is clear that grammar alone does not determine children's preference for including objects in their utterances. The present experiment is the first to examine whether the semantic–conceptual relation between the direct object and the verb affects the likelihood that a child will include a constituent.

Direct objects vary in how much information they add to that carried by the verb. In (1), for example, the direct object adds nothing because part of the meaning of the verb *eat* is the fact that an ingestable is eaten. In (2), however, the direct object adds considerable information to

(1) The cat is eating some food.
(2) The cat is eating a sock.

that contained in the verb. It is possible for a cat to eat a sock, but the meaning of *sock* is not contained in the meaning of *eat*. Thus, the predicate in (2) has a more complex sense and is a less predictable constituent than the predicate in (1).

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We propose that a predicate with predictable content, such as that in (1), requires fewer processing resources than one with less predictable content, such as that in (2). In an elicited imitation task, more predictable predicates demand fewer processing resources in comprehension and memory, thus leaving more resources for imitating the sentence. A predictable direct object is similar to a semantically redundant one, in which a semantic marker for a verb inherently includes a sub-marker of a direct object with certain semantic properties (Katz, 1987). We use the term 'predictable' because many direct objects, although not formally redundant with their verbs, are nevertheless highly predictable from the verb's meaning and the child's environment. We argue that predictable verb–object configurations are easier to process than predicates with unpredictable direct objects. In (3), for example, the meaning of *ball* is not contained in the meaning of *kick*, but it is more predictable than *pillow* in (4).

(3) The bear is kicking the ball.
(4) The bear is kicking the pillow.

If very young children are indeed sensitive to the semantic–conceptual relation between a verb and its direct object, that sensitivity has implications both for spontaneous speech and for performance in elicited imitation tasks. Previous work has suggested that one reason children's early utterances are short is that children have limited cognitive resources to devote to the complex tasks of speaking and listening (Valian & Eisenberg, 1996; Valian, Hoeffner & Aubry, 1996; Kim, 1997; Valian & Aubry, 2005). Much of this work concentrates on sentential subjects, but the principle holds more generally: children may fail to include a constituent of a sentence because of limits on their performance.

We connect limits on children's performance to limits on adults' performance and, following Engle (2002), see both as a matter of attentional control. On this view, greater working memory capacity is the result of more ability to control attention and thus greater ability to handle multiple items in memory at one time. Children's working memory does increase with age (e.g. Adams & Gathercole, 1995; Luciana & Nelson, 1998), but our focus here is on directing attention when resources are very limited. We propose that variations in the relation between a direct object and a verb change how children will direct their attention when understanding a sentence: predictable direct objects will allow attention to be directed to other parts of the sentence and thus improve comprehension of the sentence as a whole.

Recent eye-tracking research with adults and older children shows that a verb's selectional information can direct visual attention to potential referents of direct objects even in advance of hearing the direct object (e.g. Altmann & Kamide, 1999; Kamide, Altmann & Haywood, 2003; Nation,

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Marshall & Altmann, 2003). In these studies, where participants' eye movements were monitored as they saw a display of objects and heard sentences, people heard sentences such as *the boy will eat the cake* or *the boy will move the cake*. Although the relation between *eat* and *cake* is looser than that between *eat* and *food* in our example (1), *cake* is a more predictable direct object for *eat* than for *move*. When the verb was *eat*, participants moved their eyes to the target object – the cake – even before they heard the direct object; but when the verb was *move*, they did not look at the cake until they heard that word. Thus, adults and older children actively use information from the internal meaning of a verb – such as that *eat* requires an ingestable. Verb-specific information can modulate visual attention in children as young as 5 years of age (Snedeker & Trueswell, 2004). If children even younger can use the semantics of verbs to shift their attention, the processing of sentences with predictable direct objects should be easier than sentences that do not contain predictable direct objects.

In the case of sentential subjects, there is evidence of performance effects in both spontaneous speech and elicited imitation. Crosslinguistically, all children increase their production of subjects as development proceeds, even if overt subjects are not required in their language, suggesting that a large percentage of young English-speakers' omission of subjects is due to performance limitations (Valian & Eisenberg, 1996; Elisha, 1997; Kim, 1997; Bavin, 2000). In elicited imitation two-year-olds with relatively low Mean Lengths of Utterance (MLUs) repeat subjects from short sentences more often than from long sentences, whereas children with higher MLUs show no effect of length, suggesting that low MLU children are particularly likely to be affected by performance limits (Valian *et al.*, 1996). In a 'double imitation' experiment, where a child hears and repeats a sentence twice, children repeated pronominal and expletive subjects – but not lexical subjects – more on the second opportunity, again suggesting performance limitations (Valian & Aubry, 2005).

The focus on subjects and on functional categories like verb inflections in past work has left unexplored the effects of performance limitations on verbs and on how the various constituents of a sentence fit together. We know little about children's inclusion of verbs, despite the central role that verbs play in a sentence's meaning and syntactic structure. Very early children's speech frequently contains no verbs at all, as numerous early transcripts show. Yet the factors that influence their presence or absence in a sentence has not been studied systematically.

Valian (1991) found that two-year-olds learning Standard American English (SAE) included verbs in 27% of their non-imitative non-imperative utterances when their MLU was below 2, but children above MLU 4 included verbs in 79% of their utterances. Not only did the use of verbs increase, but their distribution changed. For children below MLU 2, 45%

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of their verbs were obligatorily transitive, 35% were optionally transitive, and 20% were intransitive. For two-year-olds above MLU 4, 59% of their verbs were obligatorily transitive, 33% were optionally transitive, and 8% were intransitive. With increasing MLU, then, children use verbs more often and use a higher percentage of obligatorily transitive verbs, with a corresponding reduction in optionally transitive and intransitive verbs. We interpret this increase in verbs, particularly in obligatorily transitive verbs, as reflecting an increased ability to handle sentence complexity.

Lending support to that interpretation is the fact that children below MLU 2 are similar to those above MLU 4 in including obligatory objects more than 90% of the time. In contrast, however, children below MLU 2 include optional objects only 49% of the time, compared to 59% for children above MLU 4 (Valian, 1991). (Interestingly, the two-year-olds below MLU 2 used optional objects *less* often (49% of the time) than they used subjects (69% of the time).) With limited ability to direct their attention to multiple items at once and keep those items simultaneously active, children look as if they are economizing, directing their attention differentially across the constituents of a sentence.

In the present elicited imitation experiment we measure children's imitation of direct objects, verbs, and subjects, manipulating the conceptual status of the direct object so that it is either highly predictable or unpredictable but possible. We predict that fewer cognitive resources will be necessary in imitating sentences with predictable direct objects compared to those with unpredictable direct objects. That should lead to a predictability effect: superior direct object, verb, and subject imitation in predictable compared to unpredictable sentences. Since children are particularly likely to omit pronominal subjects in elicited imitation (Gerken, 1991; Valian *et al.*, 1996; Valian & Aubry, 2005), we used only lexical subjects.

EXPERIMENT 1

METHOD

Participants and settings

Participants were 24 white monolingual English-speaking children, with middle- to upper-middle-class parents, ranging in age from 25 to 32 months, with a mean of 28 months (*S.D.* = 2). The MLUs of the children's spontaneous speech (calculated following Brown's 1973 rules) ranged from 1·12 to 3·98, with a mean of 2·72 (*S.D.* = 0·8).

Children were divided into a low- and high-MLU group: the low-MLU group consisted of 10 children below MLU 2·6 with a mean MLU of 1·96 (*S.D.* = 0·5) and a mean age of 28 months (*S.D.* = 1·5); the high-MLU group consisted of 14 children above MLU 2·6 with a mean MLU of 3·26

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(*S.D.* = 0·44) and a mean age of 28 months (*S.D.* = 2·6). The MLU cutoff was chosen based on the clustering of MLU values.

The data from an additional 46 two-year-olds were excluded: 10 children because their performance was perfect or near perfect on all sentences; 36 children because they did not participate in the imitation game or did not provide usable data for the minimum number of sentences. Children at ceiling were excluded because the task could not reveal the extent to which such children might be sensitive to verb–direct object relations. In the same way that it would be inappropriate to include adults, it would be inappropriate to include children at ceiling.

Stimuli

Sixty-four sentences were constructed, varying in length from 6 to 8 morphemes. In all sentences the verbs were optionally transitive. There were 4 versions of 16 template sentences. The 4 versions manipulated the amount and type of post-verbal material (see Appendix 1). In 3 versions there was post-verbal material, consisting of (a) a highly predictable direct object, (b) a less predictable direct object, or (c) an adjunct. The subjects were lexical NPs, typically a determiner and noun. In the fourth version, there was no post-verbal material and the subject consisted of a determiner, one or two adjectives, and a noun ('the scary cat'). For a given template, each of the four versions had the same number of morphemes, plus or minus 1.

Predictions were made concerning differences between sentences with highly predictable and less predictable direct objects. For brevity, these two sentence types will be referred to as predictable and unpredictable sentences. In the 16 predictable sentences, the direct object added little information to that already contained in the sentence, as in 'the cat is eating some food' or 'the dog chews a bone'. In the 16 unpredictable sentences, the meaning of the direct object added considerable new information to that already contained in the sentence, as in 'the cat is eating a sock' or 'the dog chews a crayon'. (A given child heard 4 predictable and 4 unpredictable sentences.)

The other two sentence types provided variety and were regarded as fillers. The 16 adjunct sentences contained a prepositional phrase following the verb rather than a direct object, as in 'the cat is eating at home' or 'the dog chews at lunch'. The remaining 16 sentences contained no direct object but added adjectives to the subjects of the sentences. Examples are 'the scary black cat is eating' and 'the dirty yellow dog chews'.

Verification of predictability. For the sentences in Experiment 1, a direct object's predictability sometimes appeared contingent on the subject plus the verb rather than the verb alone. In 'the cowboy is riding a horse'

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vs. 'the cowboy is riding a camel', for example, *cowboy* may be contributing to the predictability of the direct object. Twenty-five undergraduates, divided into two groups, judged how likely it was that a given direct object would follow a given sentence fragment. One group ($n=11$) saw as a lead-in both the subject and the verb; the other group ($n=14$) saw only the verb. Predictable direct objects received significantly higher likeliness ratings (5·48 on a scale from 1 to 7) than did unpredictable direct objects (3·0, $F(1, 23)=251{\cdot}61$, $p<0{\cdot}001$). There was no difference in overall likeliness ratings as a function of type of lead-in and no interaction. In the US, riding a horse is so much more likely than riding a camel that adding a cowboy as a subject does not contribute anything extra.

Counterbalancing. The 64 sentences were divided into four groups of 16 sentences, such that in each group there were 4 sentences of each of the 4 types. No child heard a subject, verb, or direct object more than once. The 4 groups of sentences constituted 4 versions of the experiment. We attempted to have an equal number of children per version but that proved impossible. The four versions were administered to 5, 5, 7, and 8 children.

Procedure

A session with a child lasted 45 minutes to an hour. All sessions were audiotaped. The experimenter introduced himself or herself to the child, brought out a Richard Scarry book (1991), and used the book to develop rapport with the child and gather spontaneous speech so that MLU could be calculated. After approximately 20 minutes of conversation, the experimenter introduced the task as a game in which the child was to say what the experimenter said. The 16 sentences were presented to the child in random order. If a child did not imitate a target sentence, the experimenter repeated it once. If both experimental and filler sentences are included in the tally, 18 of the 24 children heard a sentence twice; if the tally is restricted to experimental sentences, 14 of the 24 heard a sentence twice. Eleven less predictable and 9 more predictable sentences were presented twice.

Transcription

Each session was transcribed by one experimenter and completely checked by at least one other person. The transcriber and checker then reviewed the transcript together to reach consensus on a final version. Transcripts included at least 100 utterances of spontaneous speech which could be used to compute MLU (Brown, 1973) and the entire experimental portion of the session. For one child included in the study only 62 utterances of

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spontaneous speech were recorded. Because the speech samples were limited and because we could not control the processing complexities that would lead to greater or lesser inclusion of constituents, we could not compare the children's imitative and spontaneous speech.

Scoring

In order to have stable and representative data for each child, children were eliminated from analysis if they failed to supply a minimum of four scorable attempted imitations of the 8 target sentences – two predictable and two unpredictable sentences. Children who were at ceiling in their inclusion of all three sentence constituents were excluded since they could not provide meaningful data about the hypothesis.

Scorable imitations. The first utterance provided by the child in response to a target sentence was scored. If an imitation was completely unintelligible, that response was not scored on any measure but labelled as 'not attempted'. If an imitation contained some unintelligible sections, the intelligible sections were scored. The unintelligible sections were labelled as 'not attempted' and did not contribute to the denominator for that constituent.

SUBJECT INCLUSION RATE was the percentage of attempted imitations in which the child included the subject. To be credited with the subject, no constituent other than the subject was necessary. If the child substituted a different subject or pronoun for the target, however, the subject was scored as present only if a verb or object from the sentence was also imitated. That additional criterion ensured that the substitution was for the subject and not the object or adjunct. Overall, 10·6% of included subjects were substitutions. Examples of subject substitutions are: 'corn' for 'horn', 'mom' for 'mouse', 'it' for 'lady', 'boys' for 'girl'.

VERB INCLUSION RATE was the percentage of attempted imitations in which the child included the verb. To be credited with the verb, the child did not have to produce any constituent other than the verb. If the child substituted a different verb for the target, however, the verb was scored as present only if the subject or object from the sentence was also imitated. That criterion ensured that the substitution was for the verb in the target sentence. Overall, 6·1% of the included verbs were substitutions. Examples of verb substitutions are: 'eats' for 'chews', 'plays' for 'hammers'.

OBJECT INCLUSION RATE was the percentage of attempted imitations in which the child included the direct object. To be credited with the object, no target item other than the object was necessary. If the child substituted a different object or a pronoun for the target, however, the object was scored as present only if a subject or verb from the sentence was also imitated. That additional criterion ensured that the child was repeating the

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TABLE 1. *Experiment 1: Percentage inclusion of sentence constituents as a function of direct object type and child MLU*

MLU	Predictability	Subject	Verb	Object	Mean
Low MLU	Predictable	58 (40)	67 (39)	91 (15)	72
$n=10$	Unpredictable	48 (36)	51 (44)	84 (22)	61
High MLU	Predictable	76 (28)	88 (18)	96 (11)	87
$n=14$	Unpredictable	70 (23)	79 (22)	89 (27)	80
Mean		63	73	90	

Note: Standard deviations are in parentheses.

direct object rather than the subject. Overall, 2·6% of included objects were substitutions. Examples of object substitutions are: 'book' for 'letter', 'train' for 'drum', and 'hair' for 'head'.

RESULTS

We hypothesized a predictability effect: sentences with predictable direct objects would be easier to imitate than those with unpredictable objects, as measured by the child's inclusion of the subject, the verb, and the object in her imitation. Confirming our hypothesis, children included all major constituents more often from predictable than unpredictable sentences.

Predictability. We conducted a (2) × (2) × (3) omnibus analysis of variance (ANOVA), with MLU group as a between-subjects variable and predictability and constituent as within-subjects variables. The proportion of successful imitations for each constituent was the dependent variable. As Table 1 and Figure 1 show, there was the expected overall effect of direct object predictability, with the constituents from sentences with predictable direct objects included more often than the constituents from sentences with unpredictable direct objects ($F(1, 22)=4{\cdot}89$, $p<0{\cdot}05$). There was also an overall effect of constituent, with later constituents included more often ($F(2, 44)=16{\cdot}42$, $p<0{\cdot}001$). Finally, there was an effect of the child's MLU, with low-MLU children including fewer constituents compared to high-MLU children ($F(1, 22)=4{\cdot}88$, $p<0{\cdot}05$). There were no interactions.

Order effects. As shown in Table 1 and Figure 1, children's inclusion of a constituent was related to its linear position, with the last constituent imitated best. The direct object was included in 90% of the imitations; the verb, the middle constituent, was included 73% of the time; the subject, the first constituent, was included 63% of the time. (As it happened, in this experiment, there were no children who repeated a subject 100% of the time who did not also repeat verbs 100% of the time; such 'perfect' children were not included in the analyses.)

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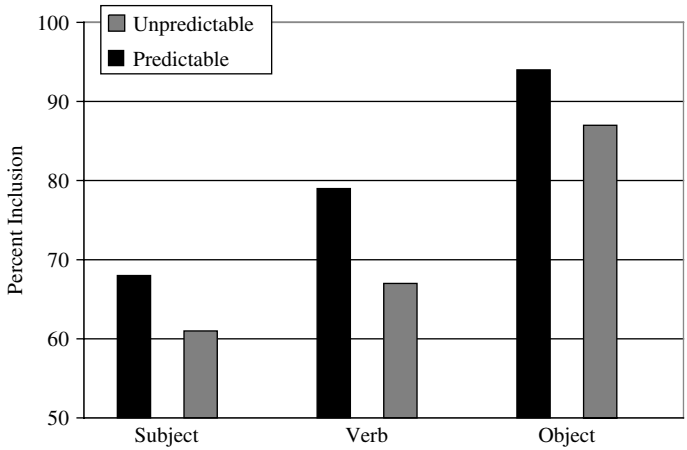


Fig. 1. Experiment 1, percent inclusion of constituents from sentences with predictable or unpredictable direct objects.

DISCUSSION

A subtle property of sentences – the predictability of the direct object – affected children's ability to imitate sentence constituents. Our omnibus analysis showed that the benefit of predictability operated across all three major constituents. In addition, there are linear order effects. We conjecture that they are a product of (a) recalling the most recent constituent best while (b) still treating the sentence as a sentence rather than an unordered string of words. Although there were no interactions, there is a suggestion that the predictability benefit was greatest for verbs: the benefit for subjects was 7 percentage points, for verbs, 12 percentage points, and for objects, 7 percentage points.

The data confirm our picture of the child as someone who is forced into cognitive economy because of limited resources. The child is unable to produce all parts of an utterance. Which parts of an utterance she does produce are affected by a number of factors, including, as the data from this experiment show, the ease with which the child can integrate the semantic–conceptual content of the direct object. Our picture is thus very similar, in this respect, to Brown's early characterization of children as telegraphic speakers (Brown & Bellugi, 1964; Brown & Fraser, 1963).

Experiment 1 highlights the interdependence of sentence constituents in elicited imitation. No previous experiments have systematically investigated imitation of the verb in a sentence along with the subject and direct object, and none have demonstrated two-year-olds' sensitivity to the relation between a sentence's verb and direct object. Our results show that children are sensitive at age 2 to the conceptual status of the direct object relative to

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the verb. They also show that the conceptual status of the direct object has consequences for how the child processes the sentence as a whole. Sentences with predictable direct objects are easier to process and imitate than are sentences with unpredictable direct objects.

EXPERIMENT 2

In Experiment 2 we modified the stimuli and procedures of Experiment 1. We had two aims. First, we wanted to provide a clearer test of the effects of the predictability of the direct object. Although adults in Experiment 1 rated the predictable direct object as a more likely continuation than the unpredictable direct object, and did so to the same degree whether they saw only the verb or the subject plus the verb, we cannot be certain that children interpreted the sentences in the same way as adults. We thus revised the sentences so that the subject could not bias the interpretation (see Appendix 2 for the new sentences), eliminating items like 'the dentist cleans my teeth/feet', 'the cowboy is riding a horse/camel', and 'the doctor helps the child/fish'.

Our second, more important, aim was to investigate the effects of focusing the child's attention on the subject – the constituent they had included least often in Experiment 1. We attempted to accomplish this indirectly, by having the child perform a forced-choice sticker placement task AFTER attempting to imitate each sentence. For example, after a child heard and imitated 'the frog is playing a game' or 'the spider is playing a game', we showed him or her two drawings, one of a frog and one of a spider; neither was playing a game. We gave the child a sticker and asked, 'Show me the animal that played a game'.

We expected the sticker task to increase the child's interest and enjoyment in the task as a whole and thus to reduce attrition. We also expected the task to make it more likely that the child would process the sentences for understanding and thus perform better overall in including sentence constituents. Finally, we thought it possible that the sticker task would particularly help direct attention to the subjects of sentences and thus increase children's inclusion of subjects in their imitations. Since the sticker task occurred after each attempted imitation, it could not directly influence the child's inclusion of a subject for that sentence. But it could lead to increased generalized attention to subjects.

METHOD

Participants and settings

Participants were 23 white monolingual English-speaking children, with middle- to upper-middle-class parents, ranging in age from 21 to 35 months,

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with a mean of 27 months (*S.D.* = 4). The MLUs of the children's spontaneous speech (calculated following Brown's 1973 rules) ranged from 1·14 to 3·88, with a mean of 2·41 (*S.D.* = 0·78).

As in Experiment 1, children were divided into a low- and high-MLU group: the low-MLU group consisted of 14 children below MLU 2·6 with a mean MLU of 1·89 (*S.D.* = 0·41) and mean age of 26 months (*S.D.* = 3·6); the high-MLU group consisted of 9 children above MLU 2·6 with a mean MLU of 3·22 (*S.D.* = 0·42) and a mean age of 29 months (*S.D.* = 4·3). The ages and MLUs of the children in Experiment 2 were almost identical to the ages and MLUs of the children in Experiment 1; the children of Experiment 2 were very slightly younger (27 months compared to 28 months) and had very slightly lower MLUs (2·41 compared to 2·72).

The data from an additional 16 two-year-olds were excluded, primarily because they did not participate in the imitation game or did not provide usable data of at least 4 sentences for each of the two major types of sentences. Note that the attrition rate was much lower in Experiment 2 than in Experiment 1. The addition of the sticker task made the event as a whole more enjoyable for the child.

Stimuli

Sixty-four sentences were constructed, varying in length from 6 to 8 morphemes. In all sentences the verbs were optionally transitive. There were 4 versions of 16 template sentences. The 4 versions manipulated the subject and the direct object (see Appendix 2). The subjects were lexical NPs, consisting of the definite determiner *the* and a singular count noun. Subject pairs were constructed for each verb so that each member of the pair was roughly the same size when drawn on an 8·5 in. × 11 in. piece of paper. The two subjects were also in roughly the same ontological category (e.g. fireman and farmer). Direct object pairs were constructed for each verb so that one member of the pair was highly predictable for that verb and the other member less predictable. Across children, each subject for a given verb occurred with each object. For a given template, each of the four versions had the same number of morphemes, plus or minus 1.

We created a binder with 32 drawings. When the binder was opened like a book, vertically, a drawing was visible on each side. One member of the pair was the subject the child had heard for the preceding sentence; the other member of the pair was the subject another child heard for that sentence. The correct drawing was equally often on the left and right.

Verification of predictability. In order to confirm that unpredictable direct objects provided more information than predictable objects, 60 undergraduate participants estimated how likely a particular direct object was, given either the verb alone as a lead-in ($n = 20$), or subject 1 and the verb as

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a lead-in ($n=20$), or subject 2 and the verb as a lead-in ($n=20$). The two groups that received a subject and a verb as a lead-in were combined for the analysis of variance. Predictable direct objects were rated as significantly more likely than unpredictable direct objects (5·18 vs. 2·97, $F(1, 58)=268·5$, $p<0.001$). Because many of the subjects were, from an adult point of view, unlikely agents (e.g. a cat or a dog opening a door or a bottle), the likelihood ratings were *lower* when undergraduates saw both the subject and the verb (3·73) than when they only saw the verb (4·76, $F(1, 58)=37·58$, $p<0·001$). There was also an interaction ($F(1, 58)=12·58$, $p=0·001$). The less predictable direct objects varied little whether the participants received only the verb (3·32) or the subject plus the verb (2·8), but the predictable direct objects differed depending on whether participants received only the verb (6·2) or the subject plus the verb (4·66). If anything, then, the effect of the subject and verb as a lead-in leads to reduction of the predictability effect for these sentences for adult judges.

Counterbalancing. The 64 sentences were divided into four groups of 16 sentences, such that in each group there were 8 sentences with predictable direct objects and 8 sentences with unpredictable direct objects. Each type of direct object occurred, across children, with each of the two subjects paired with a given verb. No child heard a subject, verb, or direct object more than once. The 4 groups of sentences constituted 4 versions of the experiment. The four versions were administered to 6, 5, 6, and 6 children.

Procedure

A session with a child lasted 45 minutes to an hour. The sessions were audiotaped. The procedure was identical to that for Experiment 1, with the addition of a sticker placement task after the child attempted to imitate each sentence. Thirteen of the 23 children heard a sentence twice; 11 less predictable and 10 more predictable sentences were presented twice. After each sentence, we opened the book of drawings and showed the child the two possible pictures for that sentence. We gave the child a sticker and asked, for example, 'Show me the animal that played a game'. Children did not see the pictures until after they had heard the sentence and attempted to imitate it.

Transcription

Each session was transcribed by one experimenter and completely checked by at least one other person. The transcriber and checker then reviewed the transcript together to reach consensus on a final version. Transcripts typically included at least 100 utterances of spontaneous speech which could be used to compute MLU (Brown, 1973) and the entire experimental

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portion of the session. Four transcripts included only 83, 91, 93, or 94 utterances that were used to calculate MLU. Again, limited spontaneous data precluded a comparison between elicited imitations and spontaneous speech.

Scoring

Children were eliminated from analysis if they failed to supply a minimum of 8 scorable attempted imitations of the 16 target sentences, four predictable and four unpredictable. In addition, children's subject imitation rate was required to be less than 100%. That requirement eliminated children who were perfect or near perfect.

Imitation scoring. The same scoring procedures used in Experiment 1 were used in Experiment 2. The substitution rate for subjects was 10·6%, for verbs, 10·3%, and for objects, 3·4%.

Sticker scoring. Children enjoyed the sticker placement aspect of the task and thus usually placed a sticker on one of the drawings even if they had not repeated the sentence. The child's sticker was left on the page and the correct stickers were tallied afterwards. Sticker scores were analysed only for the 23 children who provided sufficient data on the imitation task.

RESULTS

As in Experiment 1, we hypothesized that sentences with predictable direct objects would be easier to imitate than unpredictable sentences. But since, in Experiment 2, we made two task changes (having subjects that were completely unrelated to the verbs and direct objects; adding a forced-choice sticker task after each attempted imitation to focus children's attention on the subject), we did not know how these changes would modify the predictability benefit. In Experiment 2, children included verbs, but not subjects or objects, more often from predictable than unpredictable sentences.

Predictability. As in Experiment 1, we conducted a $(2) \times (2) \times (3)$ omnibus analysis of variance (ANOVA), with MLU group as a between-subjects variable and predictability and constituent as within-subjects variables, and proportion of imitations as the dependent variable. As Table 2 shows, there was no overall effect of direct object predictability, although there was a trend for constituents from sentences with predictable direct objects to be included more often than constituents from sentences with unpredictable direct objects ($F(1, 21) = 1{\cdot}91$, $p < 0{\cdot}09$). There was also an overall effect of constituent, with later constituents included more often ($F(2, 42) = 4{\cdot}77$, $p < 0{\cdot}05$). Finally, there was a main effect of the child's MLU, with low-MLU children including fewer constituents compared

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TABLE 2. *Experiment 2: Percentage inclusion of sentence constituents as a function of direct object type and child MLU*

MLU	Predictability	Subject	Verb	Object	Mean
Low MLU	Predictable	65 (41)	79 (28)	94 (9)	79
$n=14$	Unpredictable	67 (38)	68 (35)	95 (10)	77
High MLU	Predictable	92 (7)	94 (13)	100 (0)	96
$n=9$	Unpredictable	93 (9)	87 (17)	100 (0)	93
Mean		76	80	96	

Note: Standard deviations are in parentheses.

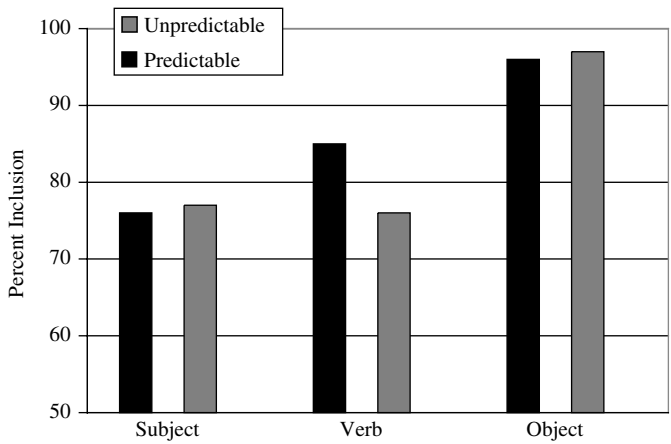


Fig. 2. Experiment 2, percent inclusion of constituents from sentences with predictable or unpredictable direct objects.

to high-MLU children ($F(1,21)=5{\cdot}7$, $p<0{\cdot}05$). There was only one interaction, that between constituent and predictability ($F(2,42)=3{\cdot}49$, $p<0{\cdot}05$).

Since there was manifestly no difference in inclusion rates for subjects or direct objects in predictable and unpredictable sentences, we conducted a separate (2) × (2) analysis only on verbs, including MLU as a factor. There was a main effect of predictability, with verbs from predictable sentences included more often (85%) than verbs from unpredictable sentences (76%, $F(1,21)=5{\cdot}29$, $p<0{\cdot}04$). There was no main effect of MLU group and no interaction between predictability and MLU.

Order effects. As in Experiment 1, children's inclusion of a constituent was related to its linear position, with the last constituent imitated best. As shown in Table 2 and Figure 2, the direct object was included in 96%

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of the imitations; the verb, the middle constituent, was included 80% of the time; the subject, the first constituent, was included 76% of the time. The rates of inclusion of all constituents were higher in Experiment 2 than Experiment 1. Since the ages and MLUs of children in the two experiments were so similar, the most likely reason for the improvement is that the sticker task increased children's attention to the task.

Sticker placement. We scored sticker placement for the 23 children whose elicited imitation data were analysed; we scored placement for all sentences, whether the child had attempted to imitate the sentence or not. Children correctly placed 70% of the stickers. We conducted an ANOVA to determine whether low- and high-MLU two-year-olds differed in their success rate and whether children were more successful in placing stickers on subjects from predictable sentences. There were no main effects and no interaction, despite seeming numerical differences. The low-MLU group averaged 67% correct placement and the high-MLU group 76% correct placement. Both predictable and unpredictable sentences averaged 70% correct sticker placement. The low-MLU children tended to perform *worse* with predictable direct objects than unpredictable ones (65% compared to 70%), while the reverse was the case for the high-MLU children (80% compared to 72%).

DISCUSSION

Experiment 2, like Experiment 1, showed a predictability benefit, but in Experiment 2 the benefit was localized to verbs: children included verbs from predictable sentences more of the time than they included verbs from unpredictable sentences, a benefit of 9 percentage points. Another difference between the two experiments was that children included constituents overall more often in Experiment 2 than Experiment 1: their inclusion of subjects was 13 percentage points higher, verbs were 7 percentage points higher, and direct objects were 6 percentage points higher. There was also a lower attrition rate. As in Experiment 1, children showed a linear order effect: they included direct objects most often, followed by verbs, followed by subjects, though the effect seemed attenuated by the sticker task.

With respect to the predictability benefits, all benefits were numerically smaller in Experiment 2 than Experiment 1. The already small benefits for subjects and objects in Experiment 1 (7 percentage points for each) were eliminated entirely in Experiment 2 and the benefit for verbs was reduced from 12 percentage points to 9.

The increase in the overall percentage of constituents that children included, the lower attrition rate, and the reduced benefits of predictability all seem attributable to the addition of the sticker placement task. There is no reason for the reduction in the contribution that the subject of the

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sentence made to overall predictability to have improved performance; if anything, the reverse should have been the case. Children loved placing the sticker on one of the two drawings after they had imitated the sentence. The overall rate of 70% correct sticker placement suggests that the children processed enough of the target sentence to remember the identity of the subject noun, but the rate was far from perfect. From some of their spontaneous remarks, it was clear that the two-year-olds sometimes placed a sticker on a drawing that they liked, whether or not that drawing depicted the subject of the sentence.

The sticker task greatly increased the children's interest in the session. Since children were more engaged in the task, they were also more willing to continue through the entire session, even though the sticker task increased the length of the session somewhat. The task also seems to have succeeded in focusing children's attention on the subjects of sentences. Although all constituents were included more often in Experiment 2, the subject benefited considerably more than the verb (the direct object was already close to ceiling). This is presumably because the drawings illustrated subjects and the questions in the sticker placement task asked the child to identify subjects. In sum, the sticker task seems to have mobilized extra resources by increasing how much overall attention children paid to the sentences to be imitated, leading to overall improvement in performance and a major reduction of predictability benefits.

GENERAL DISCUSSION

A subtle property of sentences – the predictability of the direct object – affected children's ability to imitate sentence constituents. In Experiment 1, all constituents were repeated more often from predictable compared to unpredictable sentences; in Experiment 2, only verbs benefited from predictability. The predictability benefits occurred in addition to order effects. In both experiments, the last-encountered constituent, the direct object, was included most often, followed by the verb, and then by the subject. But the children were not treating the sentence merely as an unstructured list of unrelated words with the most recent best recalled. Were that the case, no predictability effects would have been found.

The predictability benefit appears due to the knowledge of syntactic, semantic, and conceptual structures which two-year-olds bring to bear even in an elicited imitation task. Although elicited imitation is only partially understood as a task (Smith & van Kleeck, 1986; Lust, Flynn & Foley, 1996), our data confirm earlier suggestions that children process the meanings and implications of the sentences they imitate and do not merely parrot isolated words (Potter & Lombardi, 1990; Lust *et al.*, 1996). When a child tries to parse and understand a sentence with a predictable direct

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object, it is easier for her to remember and repeat the constituents of the sentence than when she hears a sentence with an unpredictable direct object.

But the differences between the results of Experiments 1 and 2 show that, by increasing the interest of the task and by focusing a child's attention on the subject of a sentence, the benefits of predictability will be reduced. We conjecture that the sticker task marshals more of the child's resources than is generally the case with elicited imitation and thus reduces the predictability benefits. If a sticker task were devised that would query the verb, we hypothesize that the predictability benefit for verbs would be reduced even further.

Elicited imitation is, of course, not a 'natural' task. Although a certain amount of imitation occurs naturally (in our examination of other children's spontaneous speech, about 5% to 10% of their utterances are imitations of the immediately-preceding adult utterance), it occurs in a much different context. The fact that about half of the children we see either do not meet our criterion for adequate data or do not imitate any sentences requires that we extend our conclusions to natural speech with caution. Nevertheless, the children do appear to try to parse and understand the sentences they hear.

Further, despite the differences between spontaneous speech and elicited imitation, right-to-left effects can operate in addition to left-to-right effects even in spontaneous production, if for different reasons. In spontaneous production, speakers – adult and child alike – typically have a conceptual sketch of the entire sentence they are about to utter. The complexity and informativeness of the components of the sketch will affect word order, pronominalization, and omission, yielding some right-to-left effects. For example, adult speakers of right-branching languages like English commonly place more informative and 'newer' material in direct object position rather than in subject position (Clark & Haviland, 1977; MacWhinney & Bates, 1978). In turn, speakers then either pronominalize the subject or, in null subject languages, omit it altogether (MacWhinney & Bates, 1978). That can only occur if speakers have a conception – however sketchy – of the utterance as a whole.

As we noted above, very young children spontaneously produce obligatory objects at a much greater rate than they produce subjects (Valian, 1991; Hyams & Wexler, 1993), an asymmetry that would be expected if objects are more informative than subjects and if there are right-to-left effects. In addition, longer VPs – which are likely to contain more information – are associated with subject absence (Bloom, 1970; Bloom, 1990). Conversely, VP length is shortest when children use a full lexical NP subject, longer with a pronominal subject, and longest with no subject (Bloom, 1990; Valian, 1991, for children below MLU 3). For young

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speakers, then, informativeness stimulates intra-sentence trade-offs in spontaneous speech.

Pronouns are much more frequent subjects than are full lexical noun phrases for both adults and children in English (Valian, 1991), a phenomenon due to the combined effect of an on-going conversation (where pronouns substitute for already-established topics) and the relative lack of information carried by a pronominal subject compared to that carried by a lexical direct object. Given a focus on the direct object, young children (and adults in some circumstances) will often omit the subject altogether, even if the context does not completely specify the identity of the subject. We suggest that a relatively unpredictable object, even when a speaker knows that she is going to produce it and does produce it, draws attentional resources from other parts of the sentence, and leads to failure to lexicalize some other constituents.

We see the child's utterances as the result of several different forces acting simultaneously (Valian & Eisenberg, 1996). The child, like the adult, has a message to convey, a grammar she can use to give syntactic form to the message, and a limited set of resources. Resource allocation operates at the joint behest of message characteristics, grammar characteristics, and task characteristics. Children are, as Brown implicitly suggested, cognitive misers (Brown & Fraser, 1963; Brown & Bellugi, 1964). Depending on the message, the child's current grammar, and the discourse context, different parts of the message will be privileged.

This general picture of how processing resources and their allocation may affect the utterances that young children produce is consistent with research on adult sentence processing. Those studies show that the processor is incremental and sensitive to a variety of sources of information including message characteristics, grammar characteristics, real world knowledge and task characteristics (e.g. MacDonald, Pearlmutter & Seidenberg, 1994; Trueswell & Tanenhaus, 1994; Tanenhaus, Spivey-Knowlton, Eberhard & Sedivy, 1995; Kamide *et al.*, 2003). We suggest that there is a fundamental similarity in processing between children and adults, but that the limitations of the adult processor are less obvious during spontaneous speech than those of the child's because there are few 'super'-adults whose extended resources would make the average adult look limited.

From that perspective, the fact that the effects of predictability were equally strong in high- as low-MLU children is not surprising. We had expected more benefit from predictability for low-MLU children, on the grounds that they *needed* more help. But our data suggest both that low- and high-MLU children understand the semantic relation between the verb and direct object and that they benefit from it when it is predictable. Anyone will benefit from predictability when resources are limited; anyone will benefit from predictability in directing their attention.

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CONCLUSION

The structure, complexity, completeness, and length of any utterance depend on an individual's current cognitive resources, knowledge of different aspects of grammar, features of the current conversational context, and much else besides. All the factors, sentence-internal and sentence-external, interact. In the present set of experiments, we focused on the interplay between children's limited cognitive resources and the semantic relation between the verb of a sentence and the verb's direct object. As we hypothesized, sentences where the direct object was highly predictable from the meaning of the verb were easier for children to understand and imitate. In Experiment 1 there was a general predictability benefit: children included all constituents more often when the direct object was highly predictable. In Experiment 2, which employed a sticker task that increased children's attention to the target sentences and especially the subjects of sentences, the predictability benefit was localized to verbs. To understand when and why children will fail to include a constituent in their speech, we need to examine systematically the factors that control children's output. Our experiments suggest that two-year-olds know what major constituents are required for sentencehood and that their failure to include constituents lies outside the domain of syntax.

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APPENDIX 1

TARGET SENTENCES FOR EXPERIMENT 1

Practice sentences
The cow drinks the milk
Pigs dig in the mud
Firetrucks are red

Experimental sentences	*Example*
Highly Predictable Direct Object	The cat is eating some food
Less Predictable Direct Object	The cat is eating a sock

Filler sentences	*Example*
Adjunct	The cat is eating at home
Complex Subject	The scary black cat is eating

	Experimental sentences		*Filler sentences*	
	Predictable	Unpredictable	Adjunct	Complex
The cat is eating	some food	a sock	at home	scary black
The frog splashes	the water	the ketchup	at camp	fat green
The teacher is sweeping	the dirt	the cereal	at breakfast	nice smart
The girls clap	their hands	their toes	in school	very happy
The dentist cleans	my teeth	my feet	at work	funny little
The monkey draws	a picture	a clock	in class	silly brown
The clown is driving	a car	a boat	at night	big ugly
The boys are playing	a game	peek-a-boo	at daycare	many noisy
The lady sings	a song	a fairytale	at church	pretty young
The doctor helps	the child	the fish	on t.v.	quick new
Piggy is reading	a book	a letter	in bed	the pink
The dog chews	a bone	a crayon	at lunch	dirty yellow
The man is flying	the airplane	the balloon	up high	large old
The bear is kicking	the ball	the pillow	in grass	soft white
Bunny is cooking	the dinner	the cheese	all day	the cute
The cowboy is riding	a horse	a camel	on top	tall clean

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APPENDIX 2

TARGET SENTENCES FOR EXPERIMENT 2

Practice sentences
The cow drinks the milk
Pigs dig in the mud
Firetrucks are red

Experimental sentences	*Example*
Highly Predictable Direct Object	The mouse/bunny eats some food
Less Predictable Direct Object	The mouse/bunny eats a bug

Two different subjects were used for each type of direct object
The frog/spider is playing a game/drum.
The fireman/farmer hammers the nail/floor.
The lady/man is sweeping the dirt/bread.
The cat/dog opens the door/bottle.
The duck/bird splashes the water/juice.
The boy/girl is drawing a picture/square.
The cow/pig is brushing her teeth/head.
The dog/cat catches a ball/apple.
The fish/turtle is blowing a bubble/horn.
The mouse/bunny eats some food/a bug.
The horse/elephant sings a song/story.
The clown/skater is driving a car/boat.
The man/lady cuts the paper/shirt.
The cowboy/policeman is cooking our dinner/crackers.
The bear/lion claps his hands/feet.
The girl/boy is reading a book/letter.

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