

The Role of Syntactic Structure in Children's Sentence Comprehension: Evidence From the Dative

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Research has demonstrated that young children quickly acquire knowledge of how the structure of their language encodes meaning. However, this work focused on structurally simple transitives. The present studies investigate childrens' comprehension of the double object dative (e.g., I gave him the box) and the prepositional dative (e.g., I gave the box to him). In Study 1, 3- and 4-year-olds correctly preferred a transfer event reading of prepositional datives with novel verbs (e.g., I'm glorping the rabbit to the duck) but were unable to interpret double object datives (e.g., I'm glorping the duck the rabbit). In Studies 2 and 3, they were able to interpret both dative types when the nouns referring to the theme and recipient were canonically marked (Study 2: I'm glorping the rabbit to Duck) and, to a lesser extent, when they were distinctively but noncanonically marked (Study 3: I'm glorping rabbit to the Duck). Overall, the results suggest that English children have some verb-general knowledge of how dative syntax encodes meaning by 3 years of age, but successful comprehension may require the presence of additional surface cues.

INTRODUCTION

A unique yet universal quality of language is that meaning is represented not only in the use of abstract symbols (i.e., words) but also in the manner in which these symbols are combined (syntactic structure). The key to mastering a language is learning the way in which syntactic structure encodes meaning, and one of the most important aspects of this process is learning how the syntactic frame in which a verb occurs constrains its possible interpretations. Recent research has demonstrated that children may become sensitive to the implications that different syntactic structures have for verb meanings very early on. Soon after their second birthday, English children seem capable of inferring that novel verbs in transitive sentences (e.g., the duck is glorping the bunny) refer to causal actions in which one participant is acting upon another, not noncausal actions in which two participants are acting independently, side by side.

Studies using the intermodal preferential looking method (IPL) have shown that hearing a transitive sentence significantly increases infant looking times to causal actions (e.g., a duck forcing a rabbit into a bending position) compared to noncausal actions (e.g., a duck and rabbit flexing their own arms). The findings have been replicated with children of 25 months (Naigles, 1990), 27 months (Naigles & Kako, 1993), 29 months (Hirsh-Pasek, Golinkoff, & Naigles, 1996), and 30 months of age (Kidd, Bavin, & Rhodes, 2001).

Two separate conclusions have been drawn from these results. First, researchers have suggested that paying attention to the structure of the sentences in which a verb occurs is an integral part of the verb learning process (syntactic bootstrapping; Gleitman, 1990; Landau & Gleitman, 1985). Gleitman argues that there are many aspects of verb meaning that cannot be learned from situational observation alone: the perspective that verbs take on an event (e.g., fleeing vs. chasing), the level of specificity described by the verb (e.g., look vs. see), and the meaning of verbs that refer to nonobservable events (e.g., think, know). Syntactic bootstrapping provides the missing element; children acquire the links between particular syntactic frames and semantic structures early on and can then use their knowledge of the meaning associated with a syntactic structure as a source of information about the probable meaning of unknown verbs.

Second, if 2-year-olds are able to use syntactic structure to infer the meaning of novel verbs, the logical implication is that they already have an abstract representation of syntactic structure that supports generalizations across verbs. This conclusion runs counter to the strong predictions of early versions of the verb island hypothesis (Tomasello, 1992), which explicitly state that children lack such representations before the age of three. On this model, children's knowledge of syntactic structures, and the constraints on verb meaning that accompany them, emerge via a process of learning and abstraction from the language that children hear and use. Children initially learn individual verb-based linguistic constructions, which they can use to express particular meanings (e.g., hitter hit hittee, puller pull pullee) and then abstract across constructions that share form and meaning. The learning of these item-based patterns is predicted to be slow and gradual, with abstraction across patterns predicted not to occur until three years of age even for frequent structures such as the transitive (Dodson & Tomasello, 1998), a prediction that is clearly challenged by the evidence from the novel verb IPL studies (see Fisher, 2002a).

In sum, findings from research using the IPL paradigm have frequently been interpreted as indicative of children's ability to learn verbs via syntactic bootstrapping and thus of early, verb-general acquisition (though see Abbot-Smith, Lieven, & Tomasello, 2008; Ibbotson & Tomasello, 2009; Tomasello & Abbot-Smith, 2002). However, the most robust evidence for very early acquisition comes mainly from studies investigating children's ability with transitive verbs (though see Papafragou, Cassidy, & Gleitman, 2007). A number of studies with the English intransitive have yielded inconsistent results. Naigles (1990) found that 25-month-old children interpret novel verbs in intransitive frames (e.g., the duck and the bunny are gorp) as referring to noncausal synchronous actions (not causal actions) and Kidd et al. (2001) found a similar effect, though not until 30 months. However, Naigles and Kako (1993) failed to replicate the findings with 27 month olds, and Hirsh-Pasek et al. (1996) reported that it was difficult to find an effect even with real verbs. Naigles (1996) showed that although presenting novel verbs in both full transitives and omitted object structures (The duck is sebbing the frog, the duck is sebbing) moved some 2 year olds away from a baseline bias to interpret the verbs as referring to causal actions (toward interpreting them as contact actions), presenting the verbs in the intransitive only (the frog is sebbing) had little effect. The picture is complicated by the fact that it is not strictly ungrammatical to

interpret intransitive sentences as referring to causal events if the novel verb is taken to refer to a generic action (such as playing), meaning that data on the intransitive can only ever tell us when children acquire the preferred interpretation. Thus, if the robust evidence for early acquisition is restricted to transitives, with the accurate interpretation of other syntactic structures occurring much later in development, the implications of these findings for theories of both verb and syntax learning will be far less significant.

The aim of the present work was to extend previous work on children's knowledge of the argument structure constraints imposed by syntax to two new syntactic structures: the prepositional dative with *to* (the boy gave the book to the girl) and the double object dative (the boy gave the girl the book). There is a strong correlation between these two English dative frames (which contain the three syntactic roles — subject, direct object, and indirect object) and transfer of possession events (with three semantic arguments — donor, theme, and recipient).¹ Adults are aware of this and attribute different meanings to novel verbs depending on the sentence frames in which they are used. For example, an adult faced with a prepositional dative such as *teddy's blinking the duck to the rabbit* will infer that *blinking* refers to an event depicting the transfer of possession of an object from a donor to a recipient, rather than, say, a simple causal action in which the teddy causes the duck and the rabbit to move or to change location. The present work will assess at what age children can use the structure of datives to make these adult-like inferences about the meaning of a novel verb. It is important to note that, unlike some recent studies (e.g., see Gertner, Fisher, & Eisengart, 2006), the studies here do not test whether children, given a particular type of referent action, can assign semantic roles to the correct participants (e.g., whether children can distinguish between two causal actions by assigning agent and patient roles to the correct participants). The present work will, instead, assess children's ability to use the syntactic structure to identify the correct type of referent action (the basic requirement for syntactic bootstrapping; Naigles, 1990).

Studies on the dative provide an ideal extension of the previous literature for a number of reasons. First, they provide us with evidence about the acquisition of a less frequent and more complex structure than the transitive. Datives occur far less often than transitives but they occur often enough to provide children with the opportunity to acquire them within the preschool years, unlike very low frequency structures like passives (transitives comprise about 10%, datives 1%; Cameron-Faulkner, Lieven, & Tomasello, 2003; Cameron-Faulkner, personal communication). Datives also tend to occur with a smaller set of verbs, which clearly restricts the opportunity for generalization across verbs that is critical for learning syntactic structure in accounts such as the verb island hypothesis (Tomasello, 1992).

Second, differences in the configuration and the input frequency of the two datives allow for an investigation of the role of frequency of occurrence and surface structural cues in children's sentence interpretation strategies. Double object datives are more frequent than prepositional datives (Campbell & Tomasello, 2001; Snyder & Stromswold, 1997). A search of the input of four mothers of 3-year-old children found that, on average, 76% of datives were double object datives (see Theakston & Rowland, 2009, for details of the mothers and children), so if the input frequency of the structure drives acquisition, we would expect the double object dative to be

¹There are probably subtle differences between the meanings of double object and prepositional datives (Pinker, 1989). However, the present study uses transfer of possession actions which are prototypically ditransitive and occur freely in both forms.

acquired first. However, the word order of the prepositional dative follows the most frequent pattern in the language because, as in most sentences with more than one argument role, the first postverbal noun is the patient/theme. The double object dative has a reversed order that is not found in any other English construction (the theme role does not occur straight after the verb but is placed after the recipient role). Thus, if the frequency of semantic role orderings in the language as a whole is more important than the frequency of individual constructions, we would expect prepositional datives to be acquired first.

In addition, unlike the double object dative, the prepositional dative contains a reliable lexical cue to the fact that it encodes a transfer event, that is, the presence of the preposition *to*, which always precedes the recipient role and indicates that it should be interpreted not as a patient but as the recipient or location. Some previous work has shown that the rapid and accurate acquisition of the link between a structure and its meaning is facilitated when the structure contains a local cue that is frequent, reliable (regularly associated with the presence of a particular meaning) and/or salient (perceivable in the speech stream, see Bates & MacWhinney, 1987, for a fuller description of reliability, frequency and perceivability). For example, learners of languages that mark semantic roles using a reliable, salient local cue such as a direct object inflection (e.g., Turkish and Serbo-Croatian) seem to learn the links between surface syntactic structure and semantic roles earlier than learners of languages that mark them with distributed cues such as subject-verb agreement and word order (English and Italian; Slobin & Bever, 1982) (for other work on the role of local cues see Dittmar, Abbot-Smith, Lieven, & Tomasello, 2008; Lindner, 2003). More importantly, Fisher (1996) found that 3- and 4-year-old children interpreted the syntactic subject in *to* datives (e.g., *she's blicking it to her*) as referring to the more causal or agentive participant in a transfer event more often than in sentences using the preposition *from* (e.g., *she's blicking it from her*), even though the only lexical cue to the identity of the agent was the identity of the preposition (see also Fisher, Hall, Rakowitz, & Gleitman, 1994, for a similar finding). On this account, we might expect that the presence of the preposition would allow faster acquisition of the meaning associated with the prepositional dative.

Third, the existing data regarding young children's ability with dative structures are ambiguous, particularly with regard to the double object dative. Studies of spontaneous speech suggest that children start to produce both datives soon after age two, reporting that children acquire double object datives earlier than, or in tandem with, prepositional datives, and use them appropriately to express transfer events (Campbell & Tomasello, 2001; Gropen, Pinker, Hollander, Goldberg, & Wilson, 1989; Snyder & Stromswold, 1997). However, as Campbell & Tomasello point out, these studies provide evidence only for verb-specific knowledge of how to use particular verbs such as *give* and *send*, not verb-general knowledge of how the structure encodes meaning.

Two studies have investigated dative knowledge in 3- and 4-year-olds using an experimental priming methodology. Shimpi, Gamez, Huttenlocher, and Vasilyeva (2007) elicited datives in a production task, and Thothathiri and Snedeker (2008) used eye tracking to measure dative knowledge in a comprehension paradigm. Both reported structural priming of the theme and recipient roles in both 3- and 4-year-old children (e.g., in Thothathiri & Snedeker's study, *give the bird the bone primed show the horse the book*) and are the first to report robust evidence of verb-general knowledge of the double object dative structure in children as young as three years. However, although the results provide clear evidence of structural priming, the stimuli contained animacy cues that, although not solely responsible for the priming effect, could certainly

have boosted it. In addition and more importantly, these studies simply show that children are able to assign semantic roles to familiar verbs – verbs they have previously heard in dative sentences perhaps thousands of times and for which they already know the argument structure privileges (i.e., the children may already know that these verbs refer to transfer actions and can or must appear in dative sentences with theme and recipient semantic roles). These studies do not tell us at what age children, like adults, can use the dative structure to assign a particular meaning to a novel verb, which is the crucial test of syntactic bootstrapping theory and an important test of whether children have sophisticated knowledge of the syntactic structure.

Conwell and Demuth (2007) elicited datives with novel verbs from 3-year-old children in order to investigate whether the children could extend their knowledge of the dative beyond familiar verbs.² The children demonstrated productive use of the prepositional dative; they were able to produce novel verbs in prepositional datives 52% of the time, even though they had only heard them in the double object dative. They also concluded that the children were able to produce novel verbs in double object datives, but this finding merits closer investigation. Shifts from the prepositional dative (modelled) form to the double object form never occurred in experiment 1 and occurred only 8% of the time in experiment 2 — only 7 of the 15 children produced a double object dative, and most of these 7 produced only one double object dative. Thus, although the children were producing double object datives at levels significantly above zero, it is not clear why rates of production were so low. For example, the seven children who produced one (or occasionally more) double object datives might have been “learning on task” that the form could be used in this experiment. During the task, the children heard the experimenter use both forms interchangeably within a short space of time (albeit with different verbs) to describe similar types of transfer actions, and there is evidence that focused exposure to a structure can promote rapid learning (Brooks & Tomasello, 1999; Vasilyeva, Huttenlocher, & Waterfall, 2006).

Thus, a more conservative interpretation of Conwell and Demuth’s (2007) data is that 3-year-old children have productive verb-general knowledge of the prepositional dative but that their knowledge of the double object dative is less sophisticated (and may or may not be productive). However, as Conwell and Demuth acknowledge, there were some problems with the actions used in the study, which made them less compatible with the meaning associated with the double object dative. In addition, elicited production studies may involve heavy task demands that depress performance (see Fisher, 2002a), so it is possible that Conwell and Demuth’s study underestimated young children’s competence with the double object dative.

The present paper reports two studies using a simple pointing paradigm to investigate 3- and 4-year-old children’s knowledge of how English double object and prepositional dative structures encode meaning. The studies will focus on whether children can use the structure of the sentence to interpret novel verbs (analogous to the work on the transitive and intransitive by Hirsh-Pasek et al., 1996; Kidd et al., 2001; Naigles, 1990; Naigles & Kako, 1993) and will inform two separate debates: a) the role of syntactic bootstrapping in the acquisition of the meaning of ditransitive dative verbs and b) whether young children possess verb-general knowledge of the constraints on meaning imposed by the dative syntactic structure.

We employed a forced-choice paradigm in which the children were required to choose between two scenes. One showed a donor transferring an object to a recipient (e.g., a rabbit bouncing a duck to a frog); selection of this scene indicated an accurate interpretation of the

²Gropen et al. (1989) also report an elicitation study with novel verbs but with much older children (6–8 years old).

sentence as referring to a transfer action. The other scene showed an agent acting on two patients (e.g., a rabbit rolling a frog and a duck across the screen); selection of this scene indicated that the sentence had been misinterpreted as if it was a simple transitive; requiring only agent and patient semantic roles. The studies also tested for differences in the age of acquisition of the double object and prepositional dative.

STUDY 1: METHOD

Participants

The original sample consisted of 49 3-year-old and 59 4-year-old children. One 3-year-old and one 4-year-old were excluded for failing to complete all test trials or for a side bias (pointing to the same side of the screen for all practice and test trials). The final sample consisted of 48 3-year-old (31 boys, 17 girls; mean age = 3 years 5 months; range = 2;10 to 3;11) and 58 4-year-old children (33 boys, 25 girls; mean age = 4 years 6 months; range = 4;0 to 5;0). All were native speakers of British English who had no recorded language difficulties. The children were randomly assigned to a baseline, double object, or prepositional dative condition and one of eight counterbalance conditions.

Design

The task was a forced-choice comprehension task based on pointing, similar to the method used by Fisher (2002b). The study employed a between-subjects design with two independent variables: age, with two factors (3-year-olds/4-year-olds) and sentence type, with three factors (baseline/prepositional dative/double object dative). The dependent variable was the number of correct points to the screen matching the spoken sentence (maximum score per child = 4).

Materials

Visual Stimuli

Four transfer event animations (targets) were created in Anime Studio Pro. The animations depicted prototypical transfer actions — the transfer of an object from a donor to a recipient. Donor, object, and recipient were all cartoon animals (e.g., a rabbit, a frog and a duck), and the donor in each event was the rabbit character, which enabled us to present the test sentence in the format *I'm verbing the NOUN the NOUN* (see audio materials below). The object animal was always portrayed as smaller than the donor and recipient animals, and it never expressed any self-generated movement in order to ensure that it was unambiguously capable of being possessed by the recipient. Four simple causal event animations (foils) were created and paired with the target actions. These contained the same characters as the transfer events but with the character that played the recipient in the transfer event now playing a patient role (e.g., a rabbit catapulting a duck and a frog). This configuration of participants ensured that the children could not use the position of the nouns with respect to the verb to parse the scenes; both target and

TABLE 1
Target and Foil Verb-action Pairs for Test Items

<i>Novel Verb</i>	<i>Target Action</i>	<i>Foil Action</i>
BILK	The rabbit sends the frog across the screen on a trolley to the teddy	The rabbit carries the frog and teddy across the screen
GLORP	The rabbit catapults the frog to the duck	The rabbit sends the duck and the frog across the screen along a conveyer belt
MEEP	The rabbit bounces the duck to the frog	The rabbit rolls the frog and the duck across the screen
JEMM	The rabbit throws the teddy to the frog	The rabbit pushes the frog and teddy across the screen along the floor

foil events would be described by utterances containing one preverbal noun and two postverbal nouns (Table 1 details the target/foil action pairs for each verb). Practice trials were also created (see procedure section for details).

Four QuickTime movies were created in which a transfer event animation was presented on one side of the screen and a foil event (with the character that played the recipient in the transfer action now playing a patient role) on the other. The movies were created such that each target action was paired with one foil action and one novel verb (e.g., the catapult action was paired with the conveyer belt action and the novel verb *glorp*, see Table 1; a previous pilot study with 27 4–5-year-olds found no effect of different target-foil pairings). Twelve counterbalance groups were created, four accompanied by the baseline audio, four accompanied by the prepositional dative audio and four accompanied by the double object dative audio. We counterbalanced for target animation side (left/right), direction of action motion (left to right/right to left) and order of presentation. The total running time of each movie was 12 seconds. The movies were presented on a laptop computer.

Audio Stimuli

Audio tracks were recorded by a native British English speaker. Three sets of audio files were prepared; a baseline neutral audio condition in which the sentence was a simple intransitive, to establish whether the children had any scene preferences in the absence of a dative sentence (e.g., *look I'm bilking*), a PD condition in which the sentence was a prepositional dative (e.g., *I'm bilking the frog to the teddy*), and a DOD condition, with a double object dative (e.g., *I'm bilking the teddy the frog*). The audio tracks were edited in Audacity, and then imported into the QuickTime movie files, which contained the cartoons. A toy rabbit (named Flopsy), with a hidden speaker inside, was attached to the laptop computer. The audio stimuli thus seemed to emanate from the toy rabbit, which enabled us to present the test sentence in the format *I'm verbing the NOUN the NOUN*, shortening the length of the sentence and improving the chances that the children would parse it successfully. The children heard three sentences for each verb. The following examples demonstrate the prepositional dative audio with *glorp*: 1) *Look, I'm gonna glorp the frog to the duck* (accompanied by a blank screen), 2) *Look, I'm glorping the frog to the duck*, and 3) *point to where I'm glorping the frog to the duck* (both accompanied by the visual scene).

Procedure

Each child was assigned to the baseline, PD, or DOD condition. Testing took place in a quiet room within the children's nursery or school. The order of trials was: Character Identification > Practice Trials (4) > Test Trials (4) and Distracter Items (2).

Character Identification

The child was shown a still picture of the four characters (duck, teddy, frog, rabbit) and asked to identify each one in turn (e.g., point to the duck). All children correctly identified all characters.

Practice Trials

The practice trial sentences were all intransitive or truncated passive sentences because using transitives might have primed a direct object reading of the second noun phrase. The first practice trial depicted real verb actions and the last three depicted novel verb actions (see Table 2 for actions and details of audio stimuli).

Test Trials

There were four test trials, one for each novel verb (see Table 2). The procedure was identical to that used for the practice trials above. Two distracter items were interspersed among the test trials in order to ensure that the child did not develop the strategy of always pointing to the same action type regardless of the sentence (see Table 2). No child needed more than two repetitions of the movie before they pointed. If the child pointed before he or she had heard the whole of the stimulus sentence, the child was reminded to listen first and then point to the picture that Flopsy was talking about. The movie was then repeated and all children responded appropriately. Some children pointed to one screen first and then the other — the child's first point was coded unless they clearly indicated that their first point was an error. A small number of children made ambiguous points to the middle of the computer screen or to both screens simultaneously; the children were reminded that they had to point to one picture only, the movies were repeated and all the children then pointed clearly at one of the pictures. The responses of 22 of the children were coded by two researchers, both of whom were present during the testing session. Reliability was 99%, with only one disagreement out of 88 responses.

RESULTS

Counterbalance analyses revealed no effect of target verb or order of presentation, but there was a main effect of target side — the children, on the whole, preferred to point to the right hand picture ($F(1,100) = 6.05, p = .02, \eta_p^2 = 0.06$). There was no interaction with either dative type or age, indicating that the side bias affected both age groups and both dative conditions equally but, as a precaution, target side was entered into all subsequent ANOVAs.

TABLE 2
 Example Procedure for Prepositional Dative Condition, Counterbalance Group 1

Trial	Visual Stimulus (Items Depicted in Grayscale but were Presented in Color)	Audio Stimulus
Character identification		Where's the/can you point to the . . . duck/teddy/frog/rabbit.
Practice 1		Look, the teddy is gonna feed. The teddy is feeding. Point to where the teddy is feeding.
Practice 2		Look, the teddy is gonna be klimped. The teddy is being klimped. Point to where the teddy is being klimped.
Practice 3		Look. I'm the rabbit. I'm gonna be blicked. I'm being blicked. Point to where I'm being blicked.
Practice 4		Look, the duck is gonna be mooped. The duck is being mooped. Point to where the duck is being mooped
Test item 1		Look, I'm gonna meep the duck to the frog. I'm meeping the duck to the frog. Point to where I'm meeping the duck to the frog.
Distracter item 1		Look, the duck is gonna kradd. The duck is kradding. Point to where the duck is kradding

(Continued)

TABLE 2
(Continued)

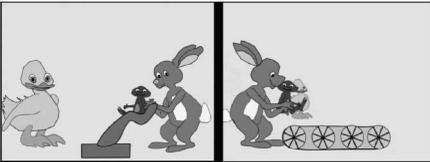
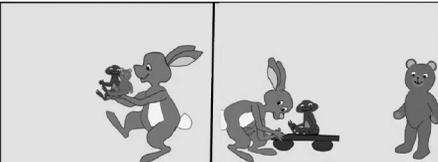
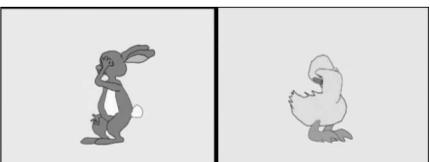
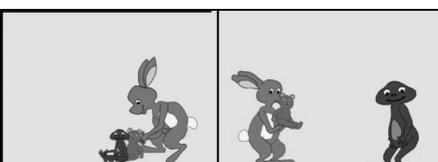
Trial	Visual Stimulus (Items Depicted in Grayscale but were Presented in Color)	Audio Stimulus
Test item 2		Look, I'm gonna glorp the frog to the duck. I'm glorping the frog to the duck. Point to where I'm glorping the frog to the duck.
Test item 3		Look, I'm gonna bilk the frog to the teddy. I'm bilking the frog to the teddy. Point to where I'm bilking the frog to the teddy.
Distracter item 2		I'm the rabbit. I'm gonna wug. I'm wugging. Point to where I'm wugging
Test item 4		Look, I'm gonna jemm the teddy to the frog. I'm jemming the teddy to the frog. Point to where I'm jemming the teddy to the frog.

Table 3 shows the mean number of correct points per child to the target action by age group and sentence type (baseline/prepositional dative/double object dative). Since only children who had completed all four test trials were included, the total possible number of correct points to target was four, with chance performance indicated by a score of two (50%). Assumption testing showed that the data were normally distributed so we ran a three-way mixed design ANOVA, with target side (left/right), age group (3 years/4 years) and dative type (baseline/PD/DOD) as the independent variables, and number of points to the target scene (the transfer action) as the dependent variable. This revealed a significant effect for dative type, $F(2,100) = 13.15$ $p < .001$, $\eta_p^2 = 0.21$, and target side (reported above) but no other main effect or interactions. Post-hoc tests indicated that the children were significantly better at interpreting the prepositional datives than either the double object datives or the baseline sentences (both $ps < .001$), but that there was no significant difference between double object dative and baseline conditions ($p = .38$).

Although there were no significant effects of age, it is important for establishing the developmental pattern to investigate whether the significant effect of dative type holds for both 3- and 4-year-olds separately. Two two-way ANOVAs were conducted to test if the significant effect of

TABLE 3
 Study 1: Mean Number of Correct Points to the Target (SD) by Age Group and Dative Type
 (Maximum Score = 4)

<i>Age Group</i>	<i>Prepositional Dative</i>	<i>Double Object Dative</i>	<i>Baseline Condition</i>
3-year-olds	2.81 (0.98)	1.94 (1.18)	1.94 (0.85)
4-year-olds	2.90 (0.97)	1.47 (1.17)	1.89 (0.80)
Overall mean	2.86 (0.96)	1.69 (1.18)	1.91 (0.81)

dative type held at both ages (IV1 = dative type; IV2 = target side, DV = number of points to target scene). The pattern of results was the same for both ages — there were significant differences between the prepositional dative condition and both the double object dative and the baseline condition, indicating that both 3- and 4-year-olds were able to interpret prepositional datives (3-year-olds: $F(2,45) = 3.97, p = .03, \eta_p^2 = 0.15$; 4-year-olds, $F(2,55) = 10.66, p < .001, \eta_p^2 = 0.28$; post hoc tests, all $ps < 0.03$). Both age groups, however, were just as likely to choose the correct transfer action after hearing the neutral baseline audio as they were after hearing a double object dative (both $ps > .05$), indicating that they were unable to interpret double object datives successfully.

DISCUSSION

To summarize, both 3- and 4-year-old children correctly interpreted prepositional datives as transfer actions. However, neither age group was able to interpret double object datives at above baseline levels. These data seem to suggest that prepositional datives are acquired first and do not support the notion that the order of acquisition of sentence structures can be predicted directly off their frequency in the child's input, which would predict that the more frequent double object dative be acquired first. Instead, children seem to acquire the prepositional dative first, either because its acquisition is aided by the fact that its word order follows the most frequent pattern in the language (see Abbot-Smith & Behrens, 2006), or by the presence of the preposition to, which indicates the presence of a recipient or location role, or by a sensitivity to both cues.

However, the fact that there were no developmental effects at all — the 4-year-olds were no better than the 3-year-olds at interpreting double object datives — is problematic, perhaps indicating that the children's problems may have been due to processing difficulties rather than lack of knowledge of the syntactic structure. In particular, it is likely that the children's performance was affected by the fact that the double object datives used in the study required the children to parse a sequence of two definite determiner noun phrases (NPs; e.g., . . . blinking the teddy the frog). Bever (1974) has noted that complex sentences are difficult to understand when they contain sequences of noun phrases with the same surface lexical form (i.e., unmarked noun phrases), becoming comprehensible when the NPs are "of a different surface lexical type" (1974, pp. 188–189). In adults, this applies to a number of complex sentence structures such as double embedded sentences (Gibson, 1998), cleft sentences (Warren & Gibson, 2005), and object extracted relative clauses (Gordon, Hendrick, & Johnson, 2001) and has been reported to cause problems in experiments eliciting double object datives with older children

(see Gropen et al., 1989, who had to include a lengthy priming/teaching session in order to elicit double object datives from 6- and 7-year-old children).

The problem is exacerbated in the case of the double object dative by the fact that the correct interpretation requires the listener to assign the recipient role to the first postverbal noun, when across the entire language, postverbal NPs are most likely to be assigned the theme/patient role (e.g., in transitives). Adults are sensitive to this fact, a bias that can cause “garden path” effects when reading complex sentences that run counter to the most common order of semantic and syntactic roles. For example, adult participants reading sentences such as the student read the book was stolen, often initially interpret the noun phrase the book as the object of the verb read, which results in processing difficulties and even a conscious feeling of being garden-pathed on reading was (Frazier & Rayner, 1982; Juliano & Tanenhaus, 1994). In addition, children have more trouble than adults revising their initial interpretation of sentences, which leads them to errors in interpretation as a result, a phenomenon which has been termed the “kindergarten path” effect (Trueswell, Sekerina, Hill, & Logrip, 1999). If the children in the present study are sensitive to the usual ordering of semantic roles in their language, this could explain why they are unable to interpret double object datives; they assign the theme role to the first postverbal noun and find it difficult to recover from this initial misparse.

In addition, the postverbal nouns presented in Study 1 were all presented as determiner noun phrases (the teddy, the duck). However, in the language as a whole, the recipients in double object datives are usually animate entities that are capable of receiving the object and are thus usually referred to using a pronoun or proper noun. A search of all double object datives in the child directed speech of four mothers (see Theakston & Rowland, 2009, for details of the data) found that 94% of DODs in the input occurred with a pronoun or proper noun recipient and 76% of these marked the theme with a common noun (e.g., the dog), which means that overall 70% of DODs had very distinctive marking of the postverbal nouns. Thus, it is possible that the children’s failure to interpret double object datives in Study 1 is due simply to a difficulty interpreting sentences with a sequence of unmarked noun phrases, exaggerated by a bias to interpret the first postverbal noun as the theme in the absence of the distinctive noun marking that usually accompanies double object datives.

The aim of Study 2 was to assess whether the children’s difficulties at interpreting double object datives in Study 1 resulted from processing difficulties inherent in interpreting sentences with unmarked postverbal noun phrases. If this were the case, marking the postverbal nouns distinctively and canonically would be predicted to improve their performance. Study 2 tested children’s ability to interpret double object and prepositional datives in which the postverbal nouns were marked distinctively and canonically; the theme with a determiner + noun phrase (the teddy) and the recipient with a proper noun (e.g., Frog).

STUDY 2: METHOD

Participants

The original sample consisted of 41 3-year-old and 34 4-year-old children. Nine 3-year-olds and three 4-year-olds were excluded due to failing to complete the task or for a side bias. The final sample comprised 32 3-year-old (17 boys, 15 girls; mean age 3 year 5 months; range = 2;11 to

3;11) and 31 4-year-old children (17 boys, 14 girls; mean age = 4 years 6 months; range = 4;0 – 4;11). All were native speakers of British English who had no recorded language difficulties. The data from the baseline condition in Study 1 (16 3-year-olds, 19 4-year-olds) were included as a control condition.

Design

The study employed a 2×3 between-subjects design: The independent variables were Age (3 year olds/4 year olds) and Sentence type (PD/DOD/baseline). The dependent variable was the number of correct points to the screen matching the spoken sentence (total possible score per child = 4).

Materials and Procedure

These were identical to those for Study 1 except that the recipient role was marked with a proper noun and the theme role with a determiner noun phrase. The children in the PD condition heard I'm verbing the NOUN to (PROPER) NOUN (e.g., I'm blicking the frog to Teddy). The children in the DOD condition heard I'm verbing NOUN the NOUN (e.g., I'm blicking Teddy the frog).

RESULTS

Table 4 shows the mean number of correct points per child to the target action by age group and sentence type. Counterbalance tests showed no effect of target side, target verb or order of presentation. A two-way between-subjects ANOVA, with age group and dative type as the independent variables and the number of points to the target scene (the transfer action) as the dependent variable, revealed a significant effect for dative type, $F(2,92) = 13.75$, $p < .001$, $\eta_p^2 = 0.23$, but no main effect of age and no interactions. Post-hoc tests indicated that the children were significantly better at interpreting the prepositional datives than the baseline sentences ($p < .001$), as in Study 1. However, unlike in Study 1, the children were also significantly better at interpreting the double object datives than the baseline sentences ($p < .001$). There was no difference between prepositional and double object datives ($p = .43$). Two one-way ANOVAs confirmed that the effects of dative type held for 3-year-olds ($F(2,45) = 3.85$, $p = .03$, $\eta_p^2 = 0.15$, PD \times baseline $p = .02$,

TABLE 4
Study 2: Mean Number of Correct Points to the Target (SD) by Age Group and Dative Type (Maximum Score = 4)

<i>Age Group</i>	<i>Prepositional Dative</i>	<i>Double Object Dative</i>	<i>Baseline Condition</i>
3-year-olds	2.76 (1.09)	2.80 (1.01)	1.94 (0.85)
4-year-olds	3.29 (0.73)	2.88 (0.99)	1.89 (0.80)
Overall mean	3.00 (0.97)	2.84 (0.98)	1.91 (0.81)

DOD \times baseline $p = .02$; PD \times DOD $p = .92$) and 4-year-olds separately ($F(2,47) = 11.68$, $p < .001$, $\eta_p^2 = 0.34$; PD \times baseline $p < .001$, DOD \times baseline $p = .001$, PD \times DOD $p = .20$).

DISCUSSION

Study 2 replicated the finding from Study 1 that both 3- and 4-year-olds were able to interpret prepositional datives with novel verbs at above baseline levels. However, unlike Study 1, the children were equally successful at interpreting double object datives. The results indicate that, by the age of three, children are able to interpret both prepositional and double object datives with novel verbs, correctly choosing the transfer action as the target referent. The problems in interpreting double object datives in Study 1 could thus be attributed to processing difficulties, caused by the fact that they had both theme and recipient roles presented as definite determiner noun phrases (e.g., . . . **blinking the teddy the frog**).

However, Study 2 does not allow us to distinguish between two explanations for the improvement in ability with double object datives. One possibility is that, like adults, children have problems parsing sequences of unmarked nouns in the absence of other information to guide semantic role assignment (e.g., presence of a preposition), and that simply providing distinctive noun marking reduces processing load and aids successful parsing. The reason why unmarked nouns cause problems is unknown, but one explanation (Gordon et al., 2001) is that similarity in the memory representations for identically marked NPs causes interference in the retrieval of ordering information from memory. Since the semantic roles of theme and recipient are assigned based on the order in which they appear in the sentence, any problems retrieving ordering information will disrupt their interpretation. Another possibility is that referents such as pronouns and proper nouns are more accessible (according to the Givenness Hierarchy of nominal reference; Ariel, 1990; Gundel, Hedberg, & Zacharski, 1993) and require fewer resources for referential processing, leaving more resources available for interpreting syntactic structure (Gibson, 1998; Warren & Gibson, 2005). Either way, the use of a proper noun to mark either of the semantic roles would be expected to reduce processing load and improve performance.

Alternatively, it could be that success in Study 2 is attributable to children's sensitivity to the usual semantic role marking of their language. On this view, the children's difficulties in Study 1 were caused by a tendency to interpret the first postverbal NPs as a theme/patient role and difficulty recovering from this initial misparse (Trueswell et al., 1999). In Study 2, the provision of the distinctive noun marking that usually accompanies double object datives (i.e., canonical marking), verb-NOUN-the NOUN, and in particular, the proper noun marking on the first postverbal noun, provided a cue that the first postverbal noun may not be a theme/patient, thus blocking the misinterpretation of the sentence and allowing the child to parse the whole sentence correctly.

The aim of Study 3 was to distinguish between these two possibilities. If the children's difficulty with double object datives in Study 1 was due to difficulties processing unmarked noun phrases, then we should be able to reverse the marking — marking the recipient with a determiner noun phrase and the theme with a proper noun (noncanonical marking) — with little effect. However, if the effect stems from the fact that the double object datives in Study 2 are canonically marked, we would expect that reversing the noun marking would disrupt children's ability to interpret the sentences correctly. If canonical marking is important, we might also

expect reversed marking in prepositional datives (e.g., I'm glorping Frog to the duck) to disrupt successful interpretation, leading the children to try to analyze the first postverbal noun (marked as a proper noun) as a recipient.

STUDY 3: METHOD

Participants

The original sample comprised 41 3-year-old and 42 4-year-old children. One 3-year-old was excluded due to a side bias. The final sample comprised 40 3-year-old (17 boys, 23 girls; mean age 3 year 6 months; range = 3;1 to 3;11) and 42 4-year-old children (23 boys, 19 girls; mean age = 4 years 4 months; range = 4;0 – 5;0). All were native speakers of British English who had no recorded language difficulties. The data from the baseline condition in Study 1 (16 3-year-olds, 19 4-year-olds) were included as a control condition.

Design

The study employed a 2×3 between-subjects design: The independent variables were Age (3-year-olds/4-year-olds) and Sentence type (PD/DOD/baseline). The dependent variable was the number of correct points to the screen matching the spoken sentence (total possible score per child = 4).

Materials and Procedure

These were identical to those for Studies 1 and 2 except that the recipient role was marked with a determiner noun phrase and the theme role with a proper noun. The children in the PD condition heard I'm verbing NOUN to the NOUN (e.g., I'm blicking Frog to the teddy). The children in the DOD condition heard I'm verbing the NOUN NOUN (e.g., I'm blicking the teddy Frog).

RESULTS AND DISCUSSION

Table 5 shows the mean number of correct points per child to the target action by age group and sentence type. Counterbalance tests showed no effect of target side, target verb or order of presentation. A two-way between subjects ANOVA, with Age group and Sentence type as the independent variables and number of points to the target scene (the transfer action) as the dependent variable, revealed a significant effect of dative type, $F(2,111) = 7.41$, $p = .001$, $\eta_p^2 = 0.12$, but no main effect of age and no interactions. Post-hoc tests indicated that the children were significantly better at interpreting both prepositional datives ($p = .001$) and double object datives ($p = .05$) than the baseline sentences. Prepositional datives were interpreted successfully marginally more often than double object datives, although this difference just failed to reach significance ($p = .06$).

TABLE 5
 Study 3: Mean Number of Correct Points to the Target (SD) by Age Group and Dative Type
 (Maximum Score = 4)

<i>Age Group</i>	<i>Prepositional Dative</i>	<i>Double Object Dative</i>	<i>Baseline Condition</i>
3-year-olds	2.81 (0.73)	2.39 (0.85)	1.94 (0.85)
4-year-olds	2.75 (1.33)	2.36 (1.14)	1.89 (0.80)
Overall mean	2.79 (1.05)	2.38 (1.00)	1.91 (0.81)

One-way ANOVAs run on each age group indicated that, for the 3-year-olds, there was a significant effect of dative type ($F(2, 53) = 5.55, p = .006, \eta_p^2 = .17$) because the children were significantly better at the prepositional dative than the baseline condition ($p = .002$). For the 4-year-olds, there was a marginally significant difference between sentence types ($F(2,58) = 2.85, p = .07$), and post-hoc tests showed a significant difference between prepositional datives and the baseline condition ($p = .02$). However, neither age group was able to interpret double object datives at above baseline levels (both $ps > .1$).

The final analysis compared performance across the three studies. A three-way mixed design ANOVA with three IVs: study (1: common noun recipient and theme, e.g., glorping the teddy the duck; 2: proper noun recipient, common noun theme, e.g., glorping Teddy the duck; 3: common noun recipient, proper noun theme, e.g., glorping the teddy Duck), target side (left/right)³ and sentence type (PD/DOD) was run. There was a main effect of dative type ($F(1,203) = 18.20, p < .001, \eta_p^2 = 0.08$) and of study ($F(2,203) = 5.53, p = .005, \eta_p^2 = 0.05$) and an interaction between study and dative type ($F(2,203) = 3.52, p = .03, \eta_p^2 = 0.03$). There were no other significant effects. Analysis of the interaction revealed that there were no significant differences in performance for prepositional datives across studies (all $ps > .1$). There was, however, a main effect of study for double object datives ($F(2,98) = 8.04, p = .001, \eta_p^2 = 0.14$), with performance in Studies 2 (canonical marking) and 3 (noncanonical marking) significantly better than performance in Study 1 (no marking; all $ps < .01$), but no difference between Studies 2 and 3 ($p = .16$).

In summary, the provision of distinctive but noncanonical marking in Study 3 had a significant positive effect on children's ability to interpret double object datives, both in comparison to a baseline measure and in comparison to the children's performance in Study 1. These data suggest that the children's difficulty with double object datives in Study 1 (unmarked NPs; e.g., . . . blinking the teddy the frog) should be attributed to the fact that they, like adults, find unmarked noun phrases hard to parse in complex sentences, not to a sensitivity to the usual semantic role marking of their language. However, it is worth noting that the effect of noncanonical marking was less marked (though not significantly so) than the provision of canonical marking on double object dative performance; the children in Study 3 performed above baseline levels only when the data from the two age groups was analyzed together, and double object datives were successfully interpreted marginally less often than prepositional datives ($p = .06$).

³Target side was included because there was a significant effect in Study 1.

GENERAL DISCUSSION

The present paper reports the results of a forced-choice comprehension task investigating the ability of 3- and 4-year-olds to interpret datives in English. The children were successful at interpreting prepositional datives in all three studies, no matter how the postverbal noun phrases were marked, indicating a robust understanding of the meaning conferred by the structure. However, the children were only successful (i.e., at above baseline levels) at interpreting double object datives when the postverbal noun phrases were distinctively marked, with performance best when the noun phrases were canonically marked (recipient marked with a proper noun and theme with a common noun, for example, *I'm glorping Teddy the frog*).

Our results do not support the notion that the order of acquisition of sentence structures can be predicted directly off the frequency with which the structures occurs in the child's input. Although our data do not directly address the issue of order of acquisition (since the youngest children we tested were able to interpret both structures in Study 2, suggesting that both had been acquired at an earlier stage), there was no evidence that the children found the more frequent double object dative structure easier to interpret than the less frequent prepositional dative at either age, which is what we might expect if the double object dative was acquired first. In fact, when differences between the two forms occurred, the results favored the prepositional dative. In both Studies 1 and 3 the prepositional datives were interpreted correctly at higher rates than the double object datives (though the differences were significant only in Study 1), and prepositional datives were more robust to changes in the surface forms of the noun phrases, despite the fact that double object datives are twice as frequent in English children's input (Campbell & Tomasello, 2001; Snyder & Stromswold, 1997).

Instead, explaining the pattern of data requires that we posit that the children's language processing abilities were influenced by at least two, and possibly three, other factors. First, the children's difficulties interpreting double object datives in Study 1 (unmarked NPs; e.g., . . . **bllicking the teddy the frog**) suggests that they, like adults, find unmarked noun phrases hard to parse in complex sentences. This may be because the similarity in the memory representations of identically marked noun phrases causes interference in the retrieval of ordering information (see Gordon et al., 2001) or because the provision of more accessible references reduces processing load (Gibson, 1998; Warren & Gibson, 2005). This parsing difficulty affects adults' interpretation of a number of complex sentence structures (Gibson, 1998; Gordon et al., 2001; Gordon, Hendrick, & Levine, 2002; Warren & Gibson, 2005) and has been reported to cause problems in experiments eliciting double object datives with older children (Gropen et al., 1989).

Second, we suggest that the children were sensitive to the presence and position of the preposition *to* in prepositional datives — a salient meaningful marker indicating that the subsequent noun should be interpreted as the recipient or goal. The presence of this cue contributed to the children's success at interpreting prepositional datives in all three studies, no matter how the postverbal noun phrases were marked, indicating a robust understanding of the meaning of sentences with *to* (NB: the children's ability to interpret the prepositional dative cannot be attributed, instead, to a bias to interpret the first postverbal noun as the theme because both the target and foil scenes were potential targets of sentences in which the first postverbal noun was interpreted as a theme).

Third, the fact that the children's performance with double object datives was marginally better in Study 2 (canonical marking) than Study 3 (noncanonical marking) could indicate that 3-

and 4-year-old children are already sensitive to the way in which different semantic roles tend to be marked in their language, and use these biases in their sentence interpretation strategies. Like adults, the children may be sensitive both to the fact that postverbal NPs are commonly patients or themes across the entire language and that most double object datives occur with a proper noun or pronoun recipient and a common noun theme. The former adds to their problems interpreting double object datives in Study 1 (the “kindergarten path” effect; Trueswell et al., 1999) and the latter protects them from this misanalysis (in Study 2), allowing them to delay a parsing decision until the completion of the sentence. However, we propose this only as a possible influence on processing since the children’s performance in Study 2 was only marginally, not significantly, better than their performance in Study 3. Further work is required to explore this possibility.

The results of the present study have implications for both verb learning and syntax acquisition literatures. First, in terms of verb learning, it is clear that the children in this study were capable of using both structures to infer something about the intended referent action. In all three studies for the prepositional dative and in Studies 2 and 3 for the double object dative, the children demonstrated a clear preference for the transfer actions, implicitly rejecting an interpretation in which the verb referred to a simple causal action. This is consistent with the syntactic bootstrapping hypothesis (Gleitman, 1990) which posits that systematicity in the relationship between a syntactic surface structure (including the presence of lexical items such as prepositions) and a verb’s meaning can be an important source of information about that verb to the learner, information that may not easily be gained solely from an observation of the event accompanying the verb.

Second, in terms of theories of syntax acquisition the results suggest that children can not only construct verb-general representations of the dative but can use these to discriminate between different types of referent action. The results count against those abstraction via learning accounts that predict delayed acquisition of the dative, requiring significant exposure to a structure before generalisation across verbs can take place (e.g., the strongest version of the verb-island hypothesis; Tomasello, 1992). Although the children were only able to interpret double object datives in the presence of distinctive noun-marking, the fact that they were successful suggests they have some form of verb-general representation by the age of three. Thus, our data is certainly compatible with the idea that young children already represent utterances in terms of some sort of broad syntactic and/or semantic categories; an abstract representation of sentences that supports generalisations across verbs. In addition, the fact that the children may have some sensitivity to surface structural features of the language such as canonical noun phrase marking indicates that they may be generalizing from past experience with the language and already possess expectations about how the language behaves. In other words, even 3-year-old children may have built up a store of information about what semantic role is most likely to be assigned to a noun, given both its position in the sentence and its surface form.

However, there is a substantial difference between concluding that 3- and 4-year old children have verb-general sensitivities to the regularities of their language and concluding that children’s syntactic knowledge is adult like. The latter would be an overinterpretation of data that simply show that, by three years of age, children are able to use at least some of the information present in the surface structure of dative sentences to parse novel verbs. In other words, although the process of acquiring the syntactic and semantic constraints of the English dative may begin early, this does not mean it is complete by three years of age. One promising model of the process of acquisition, in terms of its ability to explain both our results and that of previous studies, is the

dual route connectionist model described by Chang, Dell, and Bock (2006), which incorporates both a learning component and built-in innate architectural constraints: a meaning system (for encoding concepts and semantic roles) and a sequencing system (a simple recurrent network that learned to predict the next word in a sentence). The model's architectural configuration is crucial to its ability to create abstract syntactic representations (it only works if the two systems are kept separate, not if the lexical semantic representations of the meaning system are made available to the sequencing system). However, the model builds up syntactic representations in a learning phase during which it is exposed to sentences with real verbs. In other words, the model gradually develops abstract syntactic representations out of increasing experience with specific sentence-message pairs, incorporating more and more knowledge of the meaning constraints of syntactic structure with increasing experience.

Finally, our results are consistent with studies that show that children's ability to demonstrate knowledge may depend not only on task demands (e.g., Fisher, 2002a; Shimpi et al., 2007) but also on the presence or absence of a whole range of syntactic, semantic, lexical, pragmatic and contextual cues to meaning. For example, Tyler (1983) found that 5-year-olds tend to rely more than adults and older children on pragmatic plausibility in the assignment of pronominal co-reference. Similarly, Kidd, Brandt, Lieven, and Tomasello (2007) showed that children's ability to produce subject relative clauses depends on whether the target sentences reflects the distributional and discourse properties of the input, and Chan et al. (2009) reported that English, German, and Cantonese-speaking children's interpretation of transitives was superior when agent and patient roles were redundantly cued by both animacy and word order cues. Together with ours, these findings demonstrate the difficulty of establishing at what age a child can be said to have acquired knowledge of a particular syntactic structure. On the one hand, we may not want to conclude that a child has acquired a structure when s/he is only able to demonstrate this knowledge in the presence of a number of correlated cues to meaning (e.g., the presence of canonical marking or animacy cues). On the other hand, we know that adults' ability to demonstrate knowledge is also affected by these factors, and that the absence of such cues can sometimes disrupt parsing to a significant degree, but we would not want to conclude that adults had not acquired the relevant syntactic knowledge. Given this difficulty, arguments for or against a theory of acquisition based solely on evidence that children of a certain age do or do not show verb-general knowledge of a structure in a particular study are problematic. There is, instead, a need for researchers to take account of how the child's developing parsing strategies will affect his/her performance in experiments, as well as starting to map out the role they play in both the interpretation and the acquisition of syntactic structures.

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