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# Developmental Shifts in the Construction of Verb Meanings

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This research focused on when and how the argument structure of verbs becomes fully established. To this end, 60 grade-schoolers were presented with 40 sentences to interpret; 16 of the sentences were ungrammatical in that the syntactic frame was inconsistent with the standard argument structure for the verb (e.g., \*the tiger goes the lion). Previous work (Naigles, Gleitman, & Gleitman, 1992) indicated that preschoolers faced with ungrammatical sentences will alter the usual meaning of the verbs to fit with the novel frames (so-called Frame Compliance, also referred to as Syntactic Bootstrapping), but adults faced with the same sentences alter the syntax in favor of the usual meaning of the verb (Verb Compliance). Here we sought to document the shift in progress, to determine whether such a change is a general developmental phenomenon, or whether it could be attributed to progress within the linguistic domain in syntax and/or in the verb lexicon. In our findings, grade-school children were still adept at deducing new verb meanings from new syntactic forms; however, this productivity declined in a steady fashion with age, with a corresponding increase in Verb Compliance. Furthermore, the pattern of the decline and increase suggested that some syntactic factors, but lexical factors in particular, exerted significant influence on when and how children shifted away from Frame Compliance.

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In recent years, the study of lexical acquisition has finally expanded its focus beyond nouns, to consider the particular questions and concerns of the acquisition of verb meaning (for reviews, see Gleitman, 1990; Tomasello & Merriman, in press). This research on verb learning has uncovered several phenomena of interest. First, children exploit syntactic information in learning novel verbs (i.e., Syntactic Bootstrapping, see Fisher, Hall, Rakowitz, & Gleitman, in press; Naigles, 1990). Second, and conversely, children will employ familiar verbs in novel syntactic frames in order to signify new verb meanings (Bowerman, 1974, 1977, 1982a, 1982b; Braine, Brody, Fisch, Weisberger, & Blum, 1990; Gropen, Pinker, Hollander, Goldberg, & Wilson, 1989; Maratsos, Gudeman, Gerard-Ngo, & DeHart, 1987). Third, whereas children will readily revise the meaning and argument structure of a verb encountered in a novel syntactic environment (e.g., *the zebra goes the lion*), adults are much less likely to do so (see also Bowerman, 1982b, 1987; Braine et al., 1990; Mazurkewich & White, 1984; Naigles et al., 1992; Pinker, 1989). In this article, we will investigate the timing and source of this shift in interpretation. In particular, we ask whether the shift reflects gains in strategic capabilities, in knowledge about argument structure generally, or in knowledge specifically related to the semantics of individual verbs.

### **The Interaction of Syntax and Semantics in Verb Acquisition**

Our point of departure is a theory of verb learning called Syntactic Bootstrapping (Gleitman, 1990; Gleitman & Gleitman, 1992; Gleitman, Gleitman, Landau, & Wanner, 1987; Landau & Gleitman, 1985). This theory predicts that children will exploit the correlations between syntax and verb meaning in learning new verbs, using this information to narrow down or "zoom in on" (cf. Fisher et al., in press) the particular action to which a verb refers. Consider, for example, a scene where a parent shoves a truck so that it skids across the floor. A child observing this scene, and hearing the (nonsense) verb "blicking" could not, on observation alone, know whether "blicking" refers to the mother's push or the truck's skid. However, if the verb is placed in a syntactic frame (e.g., "Mom is blicking the truck" or "the truck is blicking"), the child should be able to pick out the intended referent. According to the theory, young children are sensitive to the semantic implications of the syntactic frames: Transitive frames canonically signal causative meanings whereas intransitive frames implicate noncausative meanings (see Bowerman, 1982b; Fisher, Gleitman, & Gleitman, 1991; Jackendoff, 1983; Levin, 1985; and Pinker, 1989, for further discussion). Support for this theory derives from recent work by Naigles (1990) and Fisher et al. (in press). In these studies, toddlers and preschoolers were presented with novel verbs in one of two syntactic frames (e.g., transitive or intransitive); their conjectures as to the referent of the verb (e.g., the causative or noncausative action) varied systematically with the syntax of presentation.

Although the syntactic bootstrapping hypothesis was originally devised to

account for how young children interpret unfamiliar verbs on a first encounter, further research has suggested that syntax can also influence how children extend the meanings of *familiar* verbs in novel frames. This phenomenon was investigated by Naigles, Gleitman and Gleitman (1992), who presented children with sentences such as (a) \**the zebra goes the lion*, and (b) \**the zebra brings to Noah*. If syntactic bootstrapping *alone* were in force, children should interpret (a) as causative and (b) as noncausative and directional (as dictated by the prepositional phrase [PP]). And yet, such an interpretation would be in direct conflict with the argument structures specified in the lexical entries for those verbs. That is, *bring* requires a direct object (it is transitive), but *go* is prohibited from having one (it is intransitive). In terms of thematic roles (also specified by the argument structure), transitive *bring* requires an "agent" and "patient," and intransitive *go* an "actor" (see Grimshaw, 1990; Jackendoff, 1983, 1990; Levin, 1985; Talmy, 1988, for more discussion). By using sentences such as (a) and (b), Naigles et al. were able to determine whether children's interpretations were consistent with the syntactic frame, forcing a modification of the verb meaning (so-called "Frame Compliance"), or whether they adhered to the existing semantics of the verb, forcing a modification of the syntactic frame ("Verb Compliance"). In that study, the 2- to 4-year-old subjects were predominantly Frame Compliant in their interpretations, enacting transitive "go" as *cause-to-go* or *take*, and intransitive "bring" as *come*. In contrast, adults tended not to modify the verb to fit the frame; they more often "repaired" the syntactic frame in order to comply with the usual meaning of the verb (Verb Compliance). For example, their typical enactment of (b) had the zebra going *to* the lion.

Such results are reminiscent of Bowerman's (1974, 1982a, 1982b) analyses of her daughters' spontaneous overgeneralizations, which also occurred with greatest frequency during the preschool years and were rare in adulthood. For example, the children would sometimes say (c) "*don't fall that on me*," meaning *don't cause that to fall on me*. Apparently, they had generalized from verbs such as *break* and *move* that *fall* could also be placed in a transitive frame without phonological modification to convey a causative meaning. Both Maratsos et al. (1987) and Braine et al. (1990) have also succeeded in eliciting such overgeneralizations of the transitive-causative correlation, by encouraging children to use intransitive verbs such as "fall" to describe causative actions. Preschool children not only produce these overgeneralizations; they are also quite willing to judge such ungrammatical transitives as acceptable, according to Hochberg's (1986) "silliness" scale. In contrast, adults judge utterances like (a) to be ungrammatical (Fisher et al., 1991; Mazurkewich & White, 1984), and strongly resist pressures to overgeneralize in this fashion even when the situation is presented as causal (Braine et al., 1990).

These findings suggest that preschool-aged children will hypothesize or accept novel argument structures for familiar verbs even though the structures had not previously been attested in the input. In contrast, research with adults sug-

gests that they are, at least, much less creative: Novel argument structures are viewed as unacceptable, and so are avoided in production and repaired in comprehension. The purpose of this article is to explore the possible bases, mechanisms, and implications for this developmental shift from flexible to well-established verb meanings and argument structures. As factors leading to mature knowledge of the lexicon, we focussed on two sources of developmental change: (a) changes in general strategies for interpreting sentences, and (b) domain-specific knowledge of verbs and their argument structures.

### **Developmental Changes in Strategic Behavior**

Perhaps children are predominantly Frame Compliant because of their approach to the task. For example, a social-cognitive immaturity might lead children to succumb to discourse pressures, and enact transitive "go" causatively just because in that situation it was easier to conform (after all, transitive "go" IS interpretable) than to repair. Perhaps they hesitate to "correct" the unfamiliar adult who is delivering these sentences as if there was nothing amiss. This is akin to Braine et al.'s (1990) claim that the children in their study overgeneralized because the discourse requirements of the task demanded it. In that task children were shown enactments of, for example, X knocking Y down, and were told that this was "falling." When asked "what is X doing?" the children responded with ungrammatical transitives that "X is falling Y" approximately one-third of the time. Because such overgeneralizations were not spontaneous, but occurred primarily under this type of questioning, Braine et al. attributed the phenomenon to an acute sensitivity to discourse pressure. Although it might similarly be argued that the behavior observed in the enactment-of-ungrammatical-sentences paradigm also reflects age-related ad hoc strategies for dealing with bizarre situations, this explanation is inadequate to account for the diversity of paradigms in which the switch from overgeneral to correct uses of verbs has been observed.

### **Developmental Changes in Linguistic Knowledge**

A second possible explanation, and one entertained by Naigles et al. (1992), is that the difference in performance between preschoolers and adults reflects a corresponding difference in the stability and complexity of the *language*; specifically, the verb lexicon. Naigles et al. argued that the more the adults knew, both about a particular verb and about verbs in general, the less willing they were to accept new meaning components and argument structures. Presumably, then, the adults in that study were less likely to exploit the transitive-causative correlation because they had learned that causation is actually conveyed by a variety of means. For example, sometimes it is indicated by an unmarked verb (e.g., *I broke it*), whereas other times a phrase is required (e.g., *I made him run*). The hypothesis is that adult verb meanings had stabilized, such that the new information encapsulated in the novel frames was no longer considered valid for the meaning of these (unmarked) verbs. The Frame Compliant children, on the other

hand, were still in the process of acquiring the verbs. Therefore, when they received new input in the form of the new syntactic frames, they were still open to the possibility that these verbs *could* participate in new argument structures, and *could* include such new components of meaning as the presence or absence of causation. The hypothesis we will be concerned with in this article, then, is that Frame Compliance is not simply a strategy put forth to handle novel sentences, but also reflects the state of children's language, and in particular, their lexicon.

The studies to date are consonant with either a strategic interpretation of the developmental shift, in which children are prey to discourse pressures, or with a linguistic one, in which the stability of the verb argument structures determines performance. Both interpretations are consistent with what is known about the endpoints of the age continuum; however, they make different predictions concerning how this shift would play out during the intermediate (grade-school) years. The Strategic interpretation would predict that the changeover from Frame Compliance to Verb Compliance should be uniform across the sentences presented: Neither task demands nor discourse pressures should be differentially affected by the idiosyncrasies of particular verbs or syntactic frames. The Linguistic interpretation, on the other hand, would predict that the changeover to Verb Compliance could proceed in a non-uniform fashion. Knowledge of verbs and their argument structures could be accrued frame by frame, verb subclass by verb subclass, and even verb by verb. Grade schoolers' reactions to unattested argument structures have not been studied in great detail; however, Mazurkewich and White (1984) did find changes during the grade-school years concerning how willingly subjects accepted ungrammatical *dative* sentences. It seems reasonable to expect, then, that changes should also emerge in an investigation of ungrammatical transitive and intransitive sentences.

The study presented here was designed to more closely examine the age-related shift from Frame Compliance to Verb Compliance in interpreting unattested sentences. To this end, we presented ungrammatical sentences to groups of children ranging in age from 5 to 12 years, following the enactment procedure used by Naigles et al. Because we planned to make direct comparisons with the results from Naigles et al. (1992), the stimuli, procedure, and coding scheme were almost identical to those in that study. We investigated the effects of age and syntactic frame, as well as the effects of individual verbs.

## METHOD

### Subjects

The subjects were 60 middle-class children enrolled in elementary schools in Connecticut, Massachusetts, and the Philadelphia area. There were 12 children in each of five age groups: 5- and 6-year-olds (3 girls and 9 boys; range = 5 years, 0 months to 6 years, 9 months,  $M = 5$  years, 9 months), 7-year-olds

(4 girls and 8 boys; range = 7 years, 1 month to 7 years, 11 months,  $M = 7$  years, 7 months), 9-year-olds (5 girls and 7 boys; range = 9 years, 2 months to 9 years, 11 months,  $M = 9$  years 7 months), 10-year-olds (4 girls and 6 boys; range = 10 years, 0 months to 11 years, 0 months,  $M = 10$  years, 5 months), and 12-year-olds (6 girls and 6 boys; range = 12 years, 0 months to 12 years, 11 months,  $M = 12$  years, 6 months). All were native speakers of English.

### Stimuli and Design

The stimuli consisted of 42 sentences which the children were asked to enact using a toy Noah's Ark and a number of wooden animals and characters as props. Two were pretest sentences (*the monkey rides the tiger*, and *the giraffe hits the elephant*) designed to familiarize the subjects with the task, and 40 served as experimental sentences. The 40 experimental sentences were designed by fitting each of 10 motion verbs into four sentence frames. Four of the verbs were transitive (*bring*, *take*, *push*, and *put*), four of them were intransitive (*come*, *go*, *fall*, and *stay*) and two (*move* and *drop*) were verbs that could legitimately appear in both transitive and intransitive frames.

The sentences were of four different structures. Frames 1 and 2 (NVNPN and NVN, respectively) were transitive and hence canonically causative, whereas Frames 3 and 4 (NVPN and NV, respectively) were intransitive and so canonically noncausative. For the verbs *drop* and *move*, then, all of the sentences were grammatical. For the remaining verbs, placement in the frames yielded two grammatical sentences and two ungrammatical sentences. For example, *fall* is disallowed in Frames 1 (*\*The lion falls the monkey onto the elephant*) and 2 (*\*The lion falls the monkey*), and grammatical in Frame 3 (*The lion falls off the ramp*) and 4 (*The lion falls*). The design resulted in a total of 16 ungrammatical sentences and 24 grammatical ones. All subjects and direct objects designated animate characters, ensuring that a causal interpretation of the ungrammatical transitives could not be arrived at solely by a pragmatically-based strategy (e.g., that animate things are agents and inanimate things patients). Table 1 presents examples of both grammatical and ungrammatical test sentences for each frame. The sentences were presented in one of four semi-random orders, adjusted from true random orders such that there were (a) no more than two sentences in a row

**Table 1. Examples of Test Sentences**

Frame	Grammatical	Ungrammatical
(1) NVNPN	The tiger brings the bird next to the ark.	The elephant comes the giraffe towards the ark.
(2) NVN	The kangaroo moves the monkey	The tiger goes the lion.
(3) NVPN	The tiger goes to the ark.	The lion puts in the ark.
(4) NV	The elephant falls.	The tiger brings.

containing the same verb, (b) no more than two ungrammatical sentences in a row, and (c) no more than two sentences in the same frame in a row.

### Procedure

The children were tested individually in a single session lasting about 15 minutes. After naming the animals, the child was told to use them to act out forthcoming sentences. The animals were placed off the stage, within easy access of the children. The two pretest sentences were then presented for the child to enact, after which the test sentences commenced. Each sentence was spoken twice in succession by the experimenter. If there was a long pause with no action from the child, or if the child questioned the experimenter, the experimenter repeated the sentence once again and provided encouragement, saying "just do what you think." Feedback after enactments was always positive, regardless of what the child did. After each enactment, the animals were removed from the stage. All of the subjects' responses were recorded on videotape for later coding.

### Coding

Each action performed by the child in response to a sentence was first described using a detailed inventory of action descriptions (Naigles, 1988); the major focus of these descriptions was whether the verb was enacted as a causal or a noncausal action. For example, a correct enactment of "the tiger brings the bird" might be described as *Tiger carries bird on back across stage*. The written descriptions were then coded either for *correctness*, if the stimulus sentence was grammatical, or for *compliance*, if the stimulus sentence was ungrammatical. The details of the coding scheme will first be described for enactments of the grammatical sentences and then for the ungrammatical ones. For ease of explication, examples used here are those that appear in Table 1.

### *Grammatical Sentences.*

1. Frame 1 (NVNPV): "The tiger brings the bird next to the ramp." To count as correct, the enactment of this sentence had to be such that the tiger was made to appear as the bird's "bringer." This could be accomplished by making the tiger push, carry, or move behind the bird toward the ark; or by holding the tiger close to the bird while only the bird was actually moved to the ark. This last action was coded as causative because it shows that the subject has (correctly) analyzed the structure of the sentence as indicating that the patient, the direct object of the sentence, is the one that is supposed to move.
2. Frame 2 (NVN): "The kangaroo moves the monkey." The kangaroo had to be displayed as the agent of the monkey's movement, with any of the same actions listed for the preceding sentences considered to be appropriate.
3. Frame 3 (NVPN): "The tiger goes to the ark." The tiger must be made to move alone in the direction of the ark.

4. Frame 4 (NV): "The lion falls." The lion had to be displayed as moving alone in a downward direction. The child could knock it over on the stage, make it fall off the ramp, or off the ark itself.

*Ungrammatical Sentences.* The subjects' enactments of these sentences were classified into three categories: (a) *Frame Compliant*, in which the subject obeys the semantic implications of the syntactic frame rather than obeying the previously known semantic implications of the verb itself (e.g., causative for the ungrammatical transitive sentences), (b) *Verb Compliant*, in which the subject obeys the previously known semantic implications of the verb itself rather than those implied by the new frame in which the verb appears (e.g., causative for the ungrammatical intransitive sentences), and (c) *Other*, in which the enactment is "wrong" in some other way.

Some examples will clarify these three enactment categories as they were applied to the four types of frame. For the intransitive verbs in transitive frames (Frames 1 [NVNPN] and 2 [NVN]), enactments were coded as Frame Compliant when the child treated the first NP of the sentence as the agent (i.e., the cause) of the second NP's movement. For example, the enactment of "\*the elephant comes the giraffe" was scored as Frame Compliant if the child manipulated the elephant so as to make it push, carry, or move directly behind while touching the moving giraffe. The enactment was also scored as Frame Compliant if the child moved both animals together with the same hand, a response pattern often seen when the children enacted grammatical sentences such as "the tiger brings the bird."

The enactment was scored as Verb Compliant if the child manipulated the animals so that either the elephant or the giraffe moved alone, or so that they both moved independently of one another (i.e., in separate hands); that is, if the relevant action was as required by *come* in an intransitive frame. If the child repeated the sentence and "repaired" it; for example, by adding a preposition (e.g., "the elephant comes *to* the giraffe"), the trial was scored as Verb Compliant regardless of the enactment.

The enactment was coded as Other if it did not fit into either of the two preceding categories. The bulk of Other responses were enactments in which the child employed wrong movements (e.g., a vertical motion for *come* or no motion at all) or used the wrong animals. Occasional enactments suggested that the child misheard some part of the sentence, as when the lion was made to move behind the bird in a sentence containing *fall* (that is, "fall" might have been confused with "follow").

For the transitive verbs in intransitive frames (Frames 3 [NVPV] and 4 [NV]), enactments were coded as Frame Compliant when the first NP was cast as the performer of an action that was noncausative. For example, the enactment of "\*for the tiger brings to Noah" was coded as Frame Compliant if the child manipulated the tiger to make it move alone to Noah. The enactment was coded



as Verb Compliant if the child introduced a new animal as the object of the tiger's action, as when the tiger was made to push a penguin to Noah. Again, if the child verbally repaired the sentence (e.g., "the tiger brings . . . *the penguin* to Noah"), the response was automatically coded as Verb Compliant. As before, the enactment was coded as Other if neither of the two preceding categories was appropriate. These "Other" enactments mostly involved wrong movements or animals.

*The Reliability of the Coding.* The enactments for all the sentences were initially described and then coded by the experimenters. The entire set of enactments was described and coded a second time by Naigles; agreement between coders averaged 85%, and disagreements were resolved by discussion. To further determine the reliability of the coding procedure, one other individual described 13.3% of the videotaped enactments with the audio *turned off*. These samples were selected at random, and consisted of the entire set of enactments by two children from each of the 12-year-old, 9-year-old, 7-year-old, and 5-year-old age groups. The reliability coder had no knowledge of the sentence to which the child responded. She coded these enactments by describing what she saw, using the detailed inventory of action descriptions outlined in Naigles (1988). These codings were in agreement with Naigles' descriptions 89.4% of the time for the entire set of sentences, and 83% of the time for the subset of ungrammatical sentences. Calculation of Cohen's Kappa (Hays, 1981) for the ungrammatical sentences yielded a reliability score of .778 (Kappas close to 1.0 indicate high levels of agreement).

## RESULTS

Each subject enacted at least 90% of the grammatical sentences correctly. Consistent with our expectations, school-aged children readily understood the task, and were highly accurate when the verbs occurred in familiar structures. The schoolchildren also enacted the *ungrammatical* sentences in an interpretable fashion. Responses coded as "Other" (neither Frame Compliant nor Verb Compliant) were relatively rare, constituting between 4% and 10% of the responses for each age group ( $M = 5\%$  overall). Because these "Other" responses did not differ as a function of frame type or subject age, nor did they appear to follow any discernible pattern whatsoever, they were omitted from the statistical analyses that follow. All tabular presentations and analyses are based on the 95% of responses which were coded as either Frame Compliant or Verb Compliant.

Two questions were asked in the analyses of the data to follow. First, is there a developmental shift in the pattern of enactment away from Frame Compliance and towards Verb Compliance during the grade-school years, thereby supporting what we can only infer from Naigles et al.? Second, does the pattern of change support a general developmental shift, or does it vary systematically with the

syntactic frames? A further question concerns whether Verb Compliance is achieved on a verb-by-verb basis. Although the number of tokens for each verb was too small to yield firm conclusions, we were interested in whether all four verbs within a particular frame elicit Frame Compliance or Verb Compliance to the same degree.

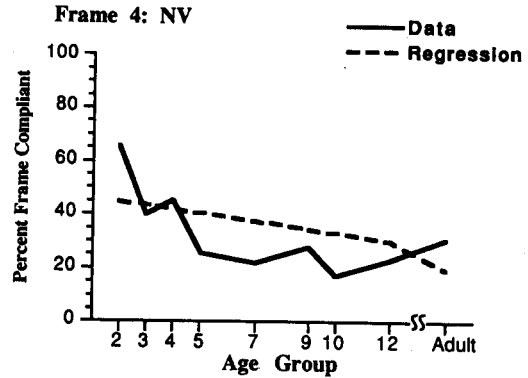
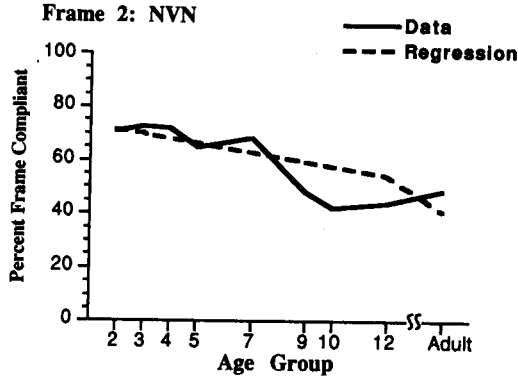
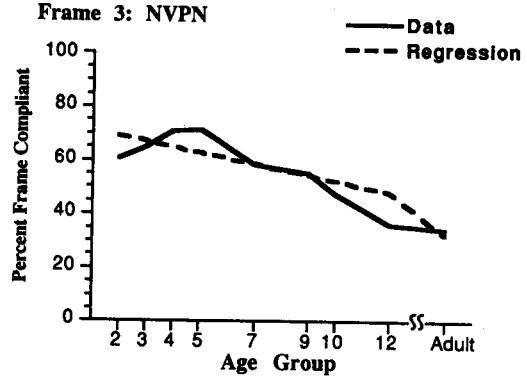
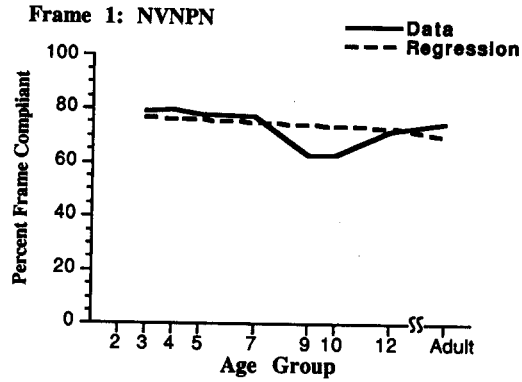
### The Big Picture: Developmental Changes from Preschool to Adult

In order to view the pattern of shift across a broad age range, we first present the grade-school data embedded within the context of the preschool and adult data collected by Naigles et al. (1992). The Naigles et al. study was identical to this one with only minor exceptions: There were 20 (rather than 12) subjects in each age group, the preschoolers received the 40 sentences in two sessions instead of one, and the 2-year-olds did not receive any verbs in Frame 1 (For further details, refer to Naigles et al., 1992; and Naigles, 1988).

The bold lines in Figure 1 present the change in percent Frame Compliant enactments for each frame, across the age range from 2 years to adult.<sup>1</sup> The most obvious effect is an overall decline in percent Frame Compliant enactments with increasing age. It appears that the preschoolers are more Frame Compliant than the young grade-schoolers, and that the young grade-schoolers are (sometimes) more Frame Compliant than the 12-year-olds and adults. A one-way analysis of variance (ANOVA) comparing 4-year-olds with 5- and 7-year-olds across all four frames approached significance  $F(1, 42) = 2.96, p = .089$ , whereas the 12-year-olds' enactments were Frame Compliant as often as the adults were,  $F(1, 30) < 1, n.s.$  The grade-schoolers, then, instantiate the hypothesized transition between the preschoolers and the adults, providing us, for this limited set of verbs and frames, with a fairly complete picture of the change away from Frame Compliance and towards Verb Compliance.

To look at the data across the entire age range, integrating all of the data points, we turned to a regression analysis. Regression lines (represented by the dashed lines in Figure 1) were fitted to each curve, using the least squares estimate (Kleinbaum & Kupper, 1978) to regress age in months on percent Frame Compliant. First, to see if age significantly affects performance, the slopes of the regression lines were analyzed to see if they differed significantly from zero. There was a significant effect of age for Frames 2 (NVN), 3 (NVPN), and 4 (NV); the values were  $M = -1.75, t(138) = 4.05, p = .000083$ ;  $M = -2.09, t(138) = 4.34, p = .000027$ ; and  $M = -1.45, t(137) = 2.60, p = .0102$ , respectively. For Frame 1 (NVNPN), the slope indicates a nonsignificant effect of age ( $M = -0.39$ ); as can be seen in Figure 1, the percent Frame Compliance for

<sup>1</sup> The ages of the adults were not ascertained at the time of the experiment; for the purposes of the regression analyses performed below, their mean age was set at 19.5 years. Given that these adult subjects were drawn from introductory psychology classes at the University of Pennsylvania, 19.5 years seems to be a reasonable estimate.



**Figure 1. Percent Frame Compliant Enactments as a Function of Age and Frame.**

Frame 1 remains at a high level from the youngest age group to the oldest. These regression analyses suggest performance is not uniform across frames; further analyses explored the frame effect directly.

To compare the slopes of the regression lines as a function of frame, pairwise *t* tests were performed. Each frame differed significantly from the others, NVN versus NVPN,  $t(276) = 3.02, p < .01$ ; NVN versus NV,  $t(275) = 2.52, p < .025$ , and NVPN versus NV,  $t(275) = 5.55, p < .005$ , NVNPN versus all others,  $t(275) \geq 2.5, p < .05$ . In short, children reach adult-like performance on this task at different ages for different frames. Developmental changes are evident until age 12 for Frame 3 (NVPN), and until age 10 for Frame 2 (NVN). In contrast, the shift to Verb Compliance for Frame 4 (NV) is completed as early as age 5. Further exploration of the frame effects made use of two-way ANOVAs (Age  $\times$  Frame, excluding the 2-year-olds), to contrast transitive (Frames 1 and 2) versus intransitive (Frames 3 and 4) frames, and elaborated (Frames 1 and 3) versus unelaborated (Frames 2 and 4) frames. Transitive frames elicited more Frame Compliant enactments than intransitive frames [ $F(1, 112) = 33.25, p < .01$ ], and that the elaborated frames elicited more Frame Compliant enactments than the unelaborated frames [ $F(1, 112) = 106.24, p < .001$ ]. There was no interaction with age.

These analyses cast doubt on the proposition that the shift to adult-like patterns of interpretation occurs as an across-the-board phenomenon, mediated solely by social-cognitive or discourse factors. Rather, the shift towards adult-like Verb Compliance is affected by the particular syntactic frame in which the verbs are placed. We now turn to an in-depth analysis of the grade-school data, in order to see the shift patterns in greater detail.

### Developmental Shifts in Frame Compliance Over Grade-School

As is evident in Table 2, Frame Compliance decreased overall during the grade school years, yielding a significant main effect of age [ $F(4, 55) = 3.518, p < .02$ ]. Table 2 also shows that the degree of Frame Compliance varied significantly as a function of frame [ $F(3, 165) = 20.04, p < .0001$ ]: NVNPN (Frame 1) elicited the most Frame Compliance, NV (Frame 4) elicited the least, and NVN and NVPN (Frames 2 and 3) lay in between. Again, the interaction of age and

**Table 2. Mean Percent Frame Compliant Enactments**

	Age Group (Yrs.)				
	5	7	9	10	12
Across Frames	59.55	56.08	48.27	42.02	43.58
Frame 1: NVNPN	77.78	77.08	62.50	62.50	71.53
Frame 2: NVN	64.58	68.06	47.92	41.67	43.75
Frame 3: NVPN	70.83	57.64	54.86	47.22	36.11
Frame 4: NV	25.00	21.53	27.78	16.67	22.92

frame was not significant, indicating that the same pattern of Compliance holds for each group. In sum, during the grade-school years Frame Compliance diminishes overall, with the frame itself significantly affecting how readily the child will alter a verb's argument structure in the face of new syntactic information. The age-related decrease in Frame Compliance was most evident for Frames 2 and 3, only reaching significance for Frame 2 [ $F(4, 55) = 3.304, p < .02$ ] in separate, one-way ANOVAs. The lack of an age effect for Frame 3 is surprising, given the divergence between the 12-year-olds' performance (36.11% Frame Compliance) and the 5-year-olds' performance (70.83% Frame Compliance). A post hoc  $t$  test comparing these two age groups did reach significance [ $t(22) = 5.277, p < .03$ ], and it is likely that the larger analysis did not because of a lack of power.

In these analyses, Frame Compliance for each age group was collapsed across subjects. Stronger support for a systematic shift towards Verb Compliance would derive from evidence that the number of subjects who consistently applied a Frame Compliant approach decreased with age. To gather such evidence, we performed an exploratory analysis in which individual subjects were categorized as either Frame Compliant, Verb Compliant, or Ambivalent. One fact was immediately evident: Children did not appear to perform consistently Frame or Verb Compliantly across all frames. Of the 16 ungrammatical sentences, few children at any age performed more than 12 consistently in a Frame Compliant or Verb Compliant manner. This finding is in keeping with the frame effects obtained earlier; in particular, the high degree of Frame Compliance with Frame 1 may have obscured significant Verb Compliance with the other frames. Although the small number of sentences per frame precluded strong statistical conclusions, we next looked at individual performances frame by frame to derive some overall trends.

To this end, four scores were generated for each subject. These indicated the number of Frame Compliant enactments performed with each frame (maximum score = 4 for each frame). We categorized as Frame Compliant those subjects whose score was 4 out of 4, 3 out of 3, 2 out of 2 (if one or two were coded as Other), or 3 out of 4. We categorized as Verb Compliant those whose score was 0 out of 4, 0 out of 3, 0 out of 2 (one or two "Other"s), or 1 out of 4, and we categorized as Ambivalent those whose score was 1 out of 3 (one "Other"), 1 out of 2 (two "Other"s), 2 out of 3 (one "Other"), or 2 out of 4. The statistically significant criterion (only 100% Frame Compliant or Verb Compliant to be categorized as such) was rejected as too conservative, because (a) it does not allow for any variability in the child, and (b) it makes the *a priori* assumption that there should be no verb differences in eliciting Frame Compliance.

Figure 2 presents the results from this categorization for all four frames. The top left panel shows that for Frame 1 (NVNPN), the majority of subjects are Frame Compliant in all five age groups. Assuming that the probability of falling into any one of the three categories is one-third, the probability of the Frame 1

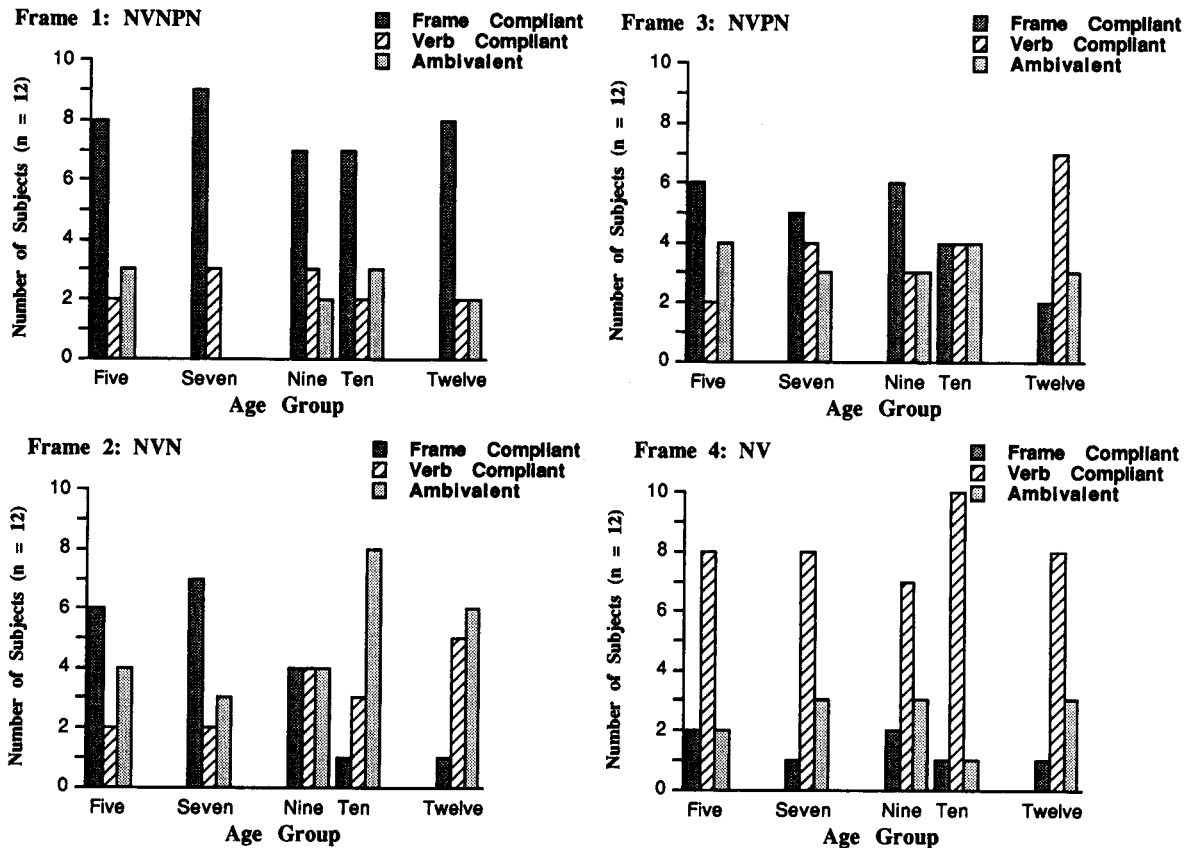


Figure 2. Number of Subjects who meet Criteria for Modes of Enactment as a Function of Age and Frame.

pattern occurring by chance is .000004 when collapsing across the five age groups. A chi-square analysis comparing the age groups revealed no significant effect of age, supporting earlier ANOVAs based on grouped data and including the preschoolers and adults. The bottom right panel also shows no change across age for Frame 4 (NV); for this frame, though, the majority of subjects were *Verb Compliant*. The probability of this pattern occurring by chance is very small,  $p < .000001$  when collapsing across the five age groups, and the chi-square again reveals no significant age effect. This corroborates the "big picture" analysis, which showed that the shift towards *Verb Compliance* for this frame occurred mainly during the preschool years.

Different patterns of *Compliance* and *Ambivalence* across age groups can be seen in Frames 2 (NVN) and 3 (NVPN), which are displayed in the top right and bottom left panels, respectively. For both frames, there is obviously no overall enactment preference across the age groups, and the probability of such distributions occurring by chance is fairly large:  $p = .364$  for Frame 2, and  $p = .644$  for Frame 3. The absence of a significant overall preference can be attributed, though, to a *change* in preferential enactment types across age. Indeed, the chi-square comparison of age groups approaches significance for Frame 2 [ $X^2(8) = 13.43$ ,  $p < .10$ ], although not for Frame 3.<sup>2</sup>

The distribution of subject preferences for Frames 2 and 3 suggests an age-related change from *Frame Compliance* towards *Verb Compliance*. Although statistical analyses comparing individual age groups' data lack sufficient power to be valid, the trends seem fairly clear. For Frame 3 (NVPN), *Frame Compliance* is the modal category for the 5-year-olds, with very few children displaying consistent *Verb Compliance*. *Frame Compliance* remains dominant through age 9, but *Verb Compliance* is increasing until, at age 10, there is no modal response. It is only in the 12-year-old age group that *Verb Compliance* has become the category of the majority (58.3% of the subjects). A similar pattern can be seen for Frame 2 (NVN); there *Frame Compliance* decreases from describing 50% of the subjects in the 5-year-old group to only 8.3% of the subjects in the 10- and 12-year-old groups. Correspondingly, *Verb Compliance* increases from characterizing only 16.6% of the subjects in the 5-year-old group to 41.6% of the subjects in the 12-year-old group. As with Frame 3, there is a point in development where no single pattern is evident. What distinguishes the NVN frame (Frame 2) is the high number of 10- and 12-year-old subjects who are *Ambivalent* in their treatment of the ungrammatical sentences. Although they have clearly moved away from the *Frame Compliant* approach of the preschoolers, they seem to vacillate between following the verb and following the frame.

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<sup>2</sup> Similar to the result with the percentages analysis, a chi-square comparing just the 5- and 12-year olds' distributions for Frame 3 does approach significance [ $X^2(2) = 4.9$ ,  $p < .10$ ].

### Verb Effects on Frame Compliance

The analyses thus far suggest that the tendency to enact ungrammatical sentences in a Frame Compliant fashion is affected by both age and syntactic frame. However, age and frame effects do not explain what appears to be considerable ambivalence within a frame as a given age, especially within Frame 2. Does this Ambivalence reflect random performance, or are these subjects behaving systematically with regard to yet a third factor? In this analysis we consider the role that individual *verbs* may exert on enacting ungrammatical sentences Frame Compliantly or Verb Compliantly. Because the database is too small to allow consideration of Age  $\times$  Frame  $\times$  Verb effects, we looked for patterns of verb differences collapsing across the five grade-school age groups.

As can be seen in Table 3, different verbs do seem to elicit different degrees of Frame Compliance. For Frame 1, pairwise Cochran's tests (Hays, 1981) showed

**Table 3. Number of Grade-Schoolers Performing in a Frame Compliant Fashion Presented as a Function of Verb and Frame**

Frame	Fall	Stay	Come	Go
Frame 1 (NVNPN)	53 <sup>c</sup>	43 <sup>b</sup>	34 <sup>a</sup>	30 <sup>a</sup>
Frame 2 (NVN)	39 <sup>b</sup>	35 <sup>b</sup>	17 <sup>a</sup>	24 <sup>a</sup>
	Take	Bring	Put	Push
Frame 3 (NVPN)	46 <sup>b</sup>	28 <sup>a</sup>	27 <sup>a</sup>	19 <sup>a</sup>
Frame 4 (NV)	16 <sup>a</sup>	14 <sup>a</sup>	19 <sup>a</sup>	5 <sup>b</sup>

#### *Q* Scores (df = 2) for Individual Comparisons

	Frame 1	Frame 2
Fall versus Stay	6.25*	0.57 n.s.
Fall versus Come	14.4*	17.29*
Fall versus Go	18.2*	6.43*
Stay versus Come	3.9*	13.5*
Stay versus Go	8.1*	4.48*
Come versus Go	0.89 n.s.	2.58 n.s.
	Frame 3	Frame 4
Take versus Bring	16.2**	0.33 n.s.
Take versus Put	15.7**	0.82 n.s.
Take versus Push	23.5**	8.1*
Bring versus Put	0.07 n.s.	1.92 n.s.
Bring versus Push	3.52 n.s.	6.23*
Put versus Push	3.2 n.s.	10.9*

*Note.* Numbers that are significantly different are indicated by different superscripts.

\* $p < .05$ . \*\* $p < .01$ . n.s. =  $p > .05$ .



that *come* and *go* each differed significantly from *fall* and *stay*. *Stay* and *fall* also differed significantly from each other, but *come* and *go* did not. A similar pattern emerges for Frame 2: *come* and *go* elicited significantly fewer Frame Compliant enactments than *stay* and *fall*; however, in this latter frame, neither *come* and *go* nor *fall* and *stay* differed significantly from each other.

Verb differences were also evident for Frames 3 and 4, the intransitive frames. In Frame 3, *take* elicited significantly more Frame Compliant enactments than either *bring*, *push*, or *put*. These latter three verbs did not differ significantly from each other. In Frame 4, it is *push* that elicited the different number of Frame Compliant enactments; however, *push* yields significantly *less* Frame Compliance than either *bring*, *take*, or *put*. Again, the other three verbs do not differ from each other in number of Frame Compliant enactments.

In sum, the "big picture" age range analyses highlighted a general decrease in Frame Compliant enactments with age, and pointed to general frame differences. The grade-school analyses documented the role of syntactic frame in more detail, focusing on the pattern of shifting away from Frame Compliance in more detail; these analyses also motivated our search for verb differences. The verb analysis revealed that some verbs elicit more Verb Compliance than others, providing a systematic explanation for the apparent Ambivalence in older children, especially in enacting NVN sentences.

## GENERAL DISCUSSION

In this study we asked the question, when and how do children change from being Frame Compliers—that is, exploiting new syntactic information to augment meanings for known verbs, to becoming Verb Compliers—that is, repairing the novel syntactic information to fit the usual meaning of the verbs? Previous work (Naigles et al., 1992) had found that preschoolers faced with such ungrammatical sentences alter the usual meaning of the verbs to fit with the novel frames, whereas adults faced with the same sentences tend to alter the syntax in favor of the usual meaning of the verb. Here, we presented the same ungrammatical sentences to grade schoolers, to see how this shift away from Frame Compliance and towards Verb Compliance proceeds. We considered that the timing and uniformity of the shift across age, frame and verb would be informative as to whether the shift was mediated solely by such task-related forces as developing strategies or discourse sensitivity, or could be attributed more specifically to the growth and acquisition of the verb lexicon and argument structures.

First, given that subjects of all ages performed in an interpretable fashion, it appears that we can view this task of enacting ungrammatical sentences as a useful one for studying developmental change. Second, as predicted, the grade-schoolers were in general less Frame Compliant than the preschoolers, but more

Frame Compliant than the adults. Thus, their data connected neatly with, and fit right in between, those previously collected by Naigles et al. (1992).

We were particularly interested in the uniformity of this shift towards Verb Compliance—and the shift was anything but uniform. Rather, the overall decline in Frame Compliance was systematically affected by the particular frame in which a verb was presented. At one extreme, for Frame 4 (NV), the shift to Verb Compliance was virtually complete by 5 years of age. At the other extreme, even 12-year-olds and adults continued to operate in a Frame Compliant manner for Frame 1 (NVNPN). For the two other frames, the shift to adult-like performance stabilized only at 10 (Frame 2; NVN) and 12 (Frame 3; NVPN) years of age. Thus, the intransitive frames (Frames 3 and 4) shifted earlier than the transitive frames (Frames 1 and 2), and the unelaborated (PP-less) frames (Frames 2 and 4) shifted earlier than the elaborated frames (Frames 1 and 3). Moreover, the verbs themselves affected the degree of Verb Compliant performance. In Frame 2, for example, (e.g., “the elephant comes/falls the giraffe”), “come” and “go” elicited significantly more Verb Compliant enactments than “stay” and “fall.”

The effects of syntactic frame and individual verb tell against the Strategic explanation of the shift in performance, which should lead to a *uniform* shift across frames and verbs. Why, for example, should a child systematically resist experimenter and discourse pressure when enacting “the tiger brings,” but not when enacting “the tiger goes the lion?” Although this by no means proves that strategies do not play some role, the effects observed led us to a closer exploration of the extent to which our effects can be attributed to the accrual of linguistic, particularly verb-specific, knowledge. We begin with the frame effects.

### Linguistic Explanations for the Frame-Dependent Shifts

We first ask why intransitive frames elicit Verb Compliance well before transitive frames. For the unelaborated forms, the difference is between 5 (NV) and 9 or 10 (NVN) years of age; an analogous disparity occurred between the intransitive and transitive frames containing PPs, albeit at a later point in development. This same asymmetry has been observed both in the spontaneous production of and judgments about lexical overgeneralizations (Bowerman, 1974, 1982a, 1982b; Hochberg, 1986). In Bowerman’s data, novel causatives such as “don’t fall that on me” were produced earlier and more frequently than novel noncausatives such as “Bert knocked down” (meaning *Bert fell down*). Likewise, Hochberg found that preschoolers were more accepting of the ungrammatical transitive “I’m gonna come food to the party” than the ungrammatical intransitive “My clothes are putting on.” Although this asymmetry is not universally acknowledged (cf. Braine et al., 1990; Lord, 1979), the fact that it has emerged in three different paradigms bears consideration.

Bowerman (1982a, 1982b) has pondered this asymmetry in great detail. To explain the lexical innovations in her data, she suggests that children have hypothesized a word-formation rule in which a causal element is added on to an

intransitive base to yield a transitive causal form (see also Aronoff, 1976). Thus, just as the verb *break* in *the window broke* can be causativized into *I broke the window*, why shouldn't the verb *go* in *the lion goes* be causativized to yield in production (cf. Bowerman's data) or comprehension (our task) the causal *the tiger goes the lion*? Bowerman goes on to suggest that the ungrammatical non-causative innovations (e.g., *Bert knocked down*) are created by reversing the same set of steps, which is a more complicated procedure. The child must assume that the word-formation rule has already operated once to create a transitive form, and that this rule must now be undone to yield the "base" intransitive form. Bowerman's claim is that because this process of *undoing* the effects of a word-formation rule is more complicated, it is less also exploited, resulting in relatively few spontaneous novel intransitives. This explanation can also account for our observed transitive/intransitive asymmetry: The intransitive/noncausative correlation is less favored and so less likely to apply.

Bowerman's proposal does not, however, account for the effects of including a PP in a sentence frame. Why should children shift to Verb Compliance so much more readily with *the tiger brings* than with *the tiger brings to Noah*?<sup>3</sup> Recent theories of argument structure and verb semantics (e.g., Grimshaw, 1990; Jackendoff, 1990; Talmy, 1988) can provide some clues. In these accounts, the argument structures of transitive and intransitive verbs assign thematic roles of the NP arguments on two separate tiers. On Jackendoff's analysis, for example, there is an action tier, that deals with agent-patient relations, and a thematic tier, that deals with motion and location. To see how this analysis applies to our NVPN sentences, consider the sentence *the giraffe takes (the chicken) next to the tiger*. In the action tier, *the giraffe* is designated as the actor, *the tiger* as the beneficiary, and *the chicken* (if inserted) the patient. The addition of the thematic tier accounts for the intuition that *the giraffe* also serves as the source of the action, *the tiger* as the location, and crucially, *the chicken* as EITHER the goal or the theme. That is, if an NP such as *the chicken* is inserted to make the sentence grammatical, then there are two resulting interpretations. Either the giraffe takes the chicken WHICH IS LOCATED next to the tiger (the LOCATIVE interpretation), or the giraffe takes the chicken TO THE PLACE next to the tiger (the DIRECTIONAL interpretation).<sup>4</sup> Therefore, it seems that the child needs not

<sup>3</sup> Frame 3 also presents problems for less linguistically-based explanations for the frame differences. For example, it might be noted that the degree of Verb Compliance varies by length of frame, with the longest frame, NVNPN eliciting the least Verb Compliance and the shortest frame, NV, eliciting the most. It would follow that the two two-argument frames, NVN and NVPN, should shift towards Verb Compliance at the same rate. However, recall that the slopes of the regression lines fitted to each frame in Figure 2 were all significantly different, thus indicating that each frame exhibits a different rate of change towards Verb Compliance. Sheer length of frame cannot account for this.

<sup>4</sup> We thank Janet Randall, Doug Saddy, and Jurgen Weissborn for the discussions which led to this crucial insight.

only to learn that *take* must have a direct object and that this direct object must be a patient in the action tier, but *also* that, depending on the type of PP, the direct object can vary in its thematic tier role assignment.

Our proposal is that this additional information concerning how verbs interact with various prepositions may explain the delay in enacting Frame 3 sentences Verb Compliantly. For example, both "bring" and "take" are ambiguous between DIRECTIONAL and LOCATIVE interpretations with prepositions such as "next to" (as well as "near," "behind," "under," etc.), but straightforwardly take the DIRECTIONAL interpretation with prepositions such as "to" and "towards." We conjecture that discovering these peculiarities of verb and preposition, and integrating them into lexical representation, takes time and is not fully accomplished until late grade-school. Until these are worked out, the child is more likely to choose the simpler approach of enacting such sentences Frame Compliantly; that is, by *not* inserting a direct object.

In sum, we suggest that the addition of a PP affects the thematic role assignment of an introduced direct object, and thus makes an additional test of the child's lexico-semantic knowledge. We can extend this explanation to help account for the pervasive Frame Compliance obtained for Frame 1 (NVNPN). Perhaps this frame is subject to the combined effects of the transitive/intransitive asymmetry and the addition of the PP. Because the word-formation rule tends to allow novel causatives, and the PP introduces more complexity if the sentence is *not* interpreted causatively, the Frame Compliant enactment remains the preferred one in adulthood.

The most relevant finding regarding all of the frame effects is simply that they exist, and so cast doubt on task-related or discourse-related explanations for the shift towards Verb Compliance. The particular frame effect involving the transitive/intransitive asymmetry seems best explained by a causative word-formation rule that operates preferentially in one direction. The second frame effect, involving the presence of PPs, was explained more directly within a framework of lexical acquisition, involving the interaction of the acquisition of the semantics of verbs and their prepositions. In the next section, we continue this line of explanation, as we consider the significant verb effects within a brief discussion of the *mechanisms* of the shift towards Verb Compliance.

### **How the Shift Towards Verb Compliance Occurs**

In this discussion, we focus on the two verb effects which were the most pervasive and hence the most compelling: (a) "come" and "go" elicited more Verb Compliance than "fall" and "stay" in both Frames 1 and 2; and (b) "push" elicited more Verb Compliance than either "bring," "take," or "put," in Frame 3. We suggest that these verb differences, insofar as they can be shown to be principled, indicate that this task is tapping aspects of verb acquisition, potentially providing insights into the mechanisms involved.

The question of how children shift away from predominant Frame Com-

pliance to greater Verb Compliance is the same question as how children recover from their earlier overgeneralization errors. The issue in both cases appears to us to concern a change in flexibility of verb use with age. In their early years, children exploit general form-meaning relations (e.g., transitive-causative) in language learning. In their later years, children can still use the form-meaning relations to learn about new verbs, but cease to allow them to extend either the frames or the meanings a particular familiar verb can take. The question we are addressing, then, is how a particular verb becomes sufficiently familiar or stable to disallow an attested extension of these relations. This question has stimulated much research, a comprehensive review of which is beyond the scope of this article. We will only mention the two theories which are most relevant to our own results.

**Maturation.** One possible explanation for the shift towards Verb Compliance involves maturation of the semantic structures for individual verbs. To account for the observation that overgeneralizations become increasingly uncommon after puberty, Pinker (1989) argues that verbs that have not appeared in particular argument structures (i.e., *come* in transitive frames) achieve this fixed status at puberty. After this time, any new information concerning argument structure is rejected. Our data indicate, though, that the point of rejection of new information differs according to the syntactic frame that is introduced, as well as according to the particular verb (see Figure 1 and Table 3). Moreover, this point varies from the age of 5 for Frame 4 (NV) to adult for Frame 1 (NVNPN), which is quite a wide age range. Thus, the particular maturational argument put forth by Pinker (1989) is not supported by our data.

**Uniqueness.** A second proposal for the abatement of overgeneralizations has been variously called Uniqueness, Contrast, Pre-emption, and Mutual Exclusivity (Bowerman, 1982b, 1987; Clark, 1987, 1991; Markman, 1987, 1989; Pinker, 1989). The basic principle is that children (and indeed, adults) will not allow more than one lexical entry to occupy a semantic niche. When two words are determined to be equivalent in meaning, one of the two is pre-empted and removed from the lexicon. In the domain of verb meaning and argument structure under consideration here, Uniqueness would apply once the child realizes that, for example, causative *come* is basically equivalent to *bring*: Because transitive "bring" is attested in the input, causative *come* will be the entry pre-empted. Preliminary evidence for the role of Uniqueness in recovering from overgeneralizations comes from Bowerman's data (1982b): During the period in which overgeneralized "come" was frequent, "bring" was practically nonexistent. As "bring" eventually became more frequent, causative "come" declined.

This theory could explain why some of the verbs in our stimulus set elicited Verb Compliance: Intransitive "bring" and "take" were pre-empted by the attested noncausative meanings of *come* and *go*, and transitive *bring* and *take*

themselves pre-empted causative "come" and "go." Likewise, *drop* and *keep* should function as pre-emptors for transitive "fall" and "stay," respectively. But then why should children reject transitive "come" and "go" earlier and more consistently than transitive "fall" and "stay?" Close scrutiny suggests that the answer may lie in the verbs doing the pre-empting. It turns out that *drop* and *keep* are not nearly as equivalent to causative "fall" and "stay" as *bring* and *take* are to causative "come" and "go." In fact, causative "stay" may fill a semantic niche on its own. In Roget's Thesaurus (1980), four of the eleven entries for the verb *stay* involve causation: One can "stay" a dog, "stay a hand," and "stay an execution." These are meanings for which there are no pre-empting verbs in English.<sup>5</sup>

Can Uniqueness also explain the other major verb effect in our data; that is, why intransitive "push" elicits Verb Compliance earlier than intransitive "bring," "take," and "put?" Curiously, noncausative "push" does not appear to have a suppletive lexical form in English. If there is no suppletive or overlapping form, then the principle of Uniqueness cannot account for why intransitive "push" is enacted causatively (Verb Compliantly) at all, let alone why it is enacted causatively so much earlier than the other three verbs. Thus, whereas the principle of Uniqueness provides a clear explanation for why overgeneralizations all but cease in spontaneous production, and can account for the pattern of the shift towards Verb Compliance by over half of the verbs in our stimulus set, it does not give a clear account for at least one of our effects. Therefore, we now turn to a second proposal which might work in tandem with Uniqueness.

**Input.** Prior accounts of the retreat from overgeneralizations have not seriously considered the possible role of input. In part, this is surely due to the fact that just describing the input is a formidable task. In recent years, though, corpora of parental input have been established; we turned to one of these to see if a plausible explanation for "push" could be obtained. We consulted a corpus of mothers' speech to their 1- and 2-year-old children in such different contexts as feeding, bathing, storybook reading, and toy play (see Hoff-Ginsberg, 1991 for details).<sup>6</sup> Approximately 400 utterances by each of 20 mothers were analyzed, and those containing the relevant verbs extracted.

Our scrutiny of the Hoff-Ginsberg corpus regarding the verbs "push," "take,"

<sup>5</sup> The lack of pre-emption with "fall" is more difficult to explain. Like "keep," "drop" does not completely match causative "fall": one can *make something fall* without necessarily *dropping* it—knocking it over will also do the trick. We compared the proportion of DROP versus KNOCK OVER enactments for different age groups, and noticed a decline in DROP enactments with age (69% by the 2-year olds, 50% by the 5-year olds, 40% by the 12-year olds, and only 23% by the adults). This suggests that with age, children become sensitive to this distinction. However, we have no explanation for why the lexical entry *knock over* (not to mention *fell*) does not eventually supplete this other interpretation of causative *fall*.

<sup>6</sup> We are grateful to Erika Hoff-Ginsberg for making this database available to us, and to Lori Singer for extracting the utterances containing the relevant verbs.

and "put" yielded the finding that "put" was the most frequent verb; the mothers used it in 285 utterances, compared with 64 utterances for "push" and 60 utterances for "take" ("bring" was even less frequent). Of the utterances containing "push," one-third (21) did not include a direct object; for example, a mother might say "push harder," or simply "push" (apparently, the contexts indicated the intended pushee). In contrast, "take" and "put" almost never occurred in utterances lacking an explicit object ("take" = 5%, "put" = 3%). Perhaps some kind of "agency bias" (cf. Fisher et al., in press; Gleitman and Gleitman, 1992) overrules the syntax in this case, so that children learn that "push" always involves a patient, even when that patient is not specified linguistically. (This is not at odds with the adult world: think of all the doors, windows, and handles which are labelled, simply, "PUSH."<sup>7</sup>) Perhaps the Frame Compliant enactment of intransitive "push" is the same as the Verb Compliant one; it may be that both transitive and intransitive forms of "push" in English are causative. Like transitive "stay," intransitive "push" seems not to be ungrammatical after all; however, unlike "stay," "push" apparently carries the same meaning whether it is used transitively or intransitively.

We end this section with a second look at the basis for the transitive/intransitive asymmetry in the shift towards Verb Compliance, in terms of Uniqueness and the input provided. The question is, why might *come* and *go* be acquired earlier than *bring* and *take*, so that the former verbs end up pre-empting the latter ones, instead of the other way around (see Clark & Garnica, 1974; Gentner, 1978 for supporting data regarding comprehension of these verbs)? In our analysis of the Hoff-Ginsberg corpus, we noticed that *come* and *go* appear much more frequently (133 uses and 340 uses, respectively) than *take* and *bring* (60 uses and less than 10 uses, respectively). This differential in the input might provide some of the basis for the asymmetry: One might easily conjecture that the more a verb was heard, the more likely it would be to supplete semantically identical lexical innovations. Thus, it is possible that information about the individual verb may provide an account of the transitive/intransitive asymmetry over and above, or even in place of, the syntactic frame account presented here. The verb effects may also explain why Braine et al. (1990) did not observe such a systematic asymmetry. With only two transitive and two intransitive verbs in their stimulus set, an asymmetry could have been easily missed.

## CONCLUSIONS

This study has demonstrated that a shift away from the use of new syntactic information to augment meanings for known verbs (i.e., Frame Compliance) begins in late preschool, and continues throughout the grade-school years. This shift is paired with a corresponding one in which children tend increasingly to

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<sup>7</sup> We thank Bill Kessen for pointing out the relevance of this fact to the current work.

repair the novel syntactic information to fit the usual meaning of the verbs (i.e., Verb Compliance). We have documented such a shift for both transitive and intransitive argument structures, and for a set of common English motion verbs.

Our findings suggest that the timing of the shift towards Verb Compliance is affected by the particular syntactic frames in which the familiar verbs are placed. The frame effects appear to be due both to differential complexities of the transitive and intransitive sentence structures, as well as to the interaction of the semantics of the particular verbs, the prepositions, and the argument structures. Over and above these frame effects, we obtained evidence that each verb shifts from eliciting Frame Compliance to eliciting Verb Compliance on its own individual schedule. On the strength of these results, we hypothesize that verb acquisition as regards argument structure is constrained by the Uniqueness principle, and affected by the frequency and diversity of presentations in the input. In order to investigate this hypothesis more fully, of course, more verbs and frames need to be manipulated. Moreover, detailed analyses of the use of verbs to children, akin to those we did with Hoff-Ginsberg's (1991) database but more systematic, must be performed. Finally, studies that manipulate the input of novel verbs over a period of years, and periodically test for shifts in acceptance of new information would be critical. Perhaps these might be future directions for studies of the construction of verb meaning.

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