

**Syntactic Bootstrapping from
Start to Finish with
Special Reference to
Down Syndrome**

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Discussions of the close relation between verbs and syntactic structures are not new to either linguistics or psychology. Linguists from very different traditions (e.g., Chafe, 1970; Chomsky, 1965; Fillmore, 1968) have relied on distinctions between verbs to illustrate and in some cases to motivate critical syntactic distinctions (for more recent work, see Grimshaw, 1990; Wierzbicka, 1988). Likewise, in psychology, models of language processing have exploited verb differences to demonstrate and explain differences in the retention and processing of syntax (e.g., Fodor, Garrett, & Bever, 1968; Wanner, 1974; more recently, Carlson & Tanenhaus, 1988; Shapiro, Zurif, & Grimshaw, 1987). Finally, in the field of language acquisition, the verb-syntax correspondence has been implicated in the acquisition of syntax (Bloom, 1970, 1981; Pinker, 1984, 1989; Tomasello, 1992). With few exceptions, this research involving verb-syntax relations has been uni-directional, focusing on what verbs and verb meanings reveal about syntax and syntactic acquisition (but see Bowerman, 1974, 1982; Jackendoff, 1983, 1990). Our work joins a recent reversal of this direction of focus (e.g., Gleitman, 1990; Gleitman & Gleitman, 1992); we study what syntax reveals about the acquisition and development of the verb lexicon.

BEYOND NAMES FOR THINGS

Young Children's Acquisition of Verbs

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certain semantic implications: Transitive frames canonically signal causative meanings (such as *push*), whereas intransitive frames implicate noncausative meanings (Bowerman, 1982; Fisher, Gleitman, & Gleitman, 1991; Jackendoff, 1983; Levin, 1985; Pinker, 1989). Thus, the syntactic bootstrapping hypothesis predicts that these correlations between syntax and verb meaning will be exploited early in the process of learning new verbs.

Empirical support for syntactic bootstrapping derives from several recent studies conducted by ourselves and our colleagues (Fisher et al., 1994; Naigles, 1990; Naigles & Kako, 1993), in which young children were taught novel verbs that were paired with videotaped scenes depicting multiple or ambiguous actions. In one such study (Naigles, 1990), the videos showed two characters (a duck and a rabbit) performing two simultaneous actions: The duck was forcing the rabbit to bend over (i.e., a causal action), and the duck and the rabbit were each moving their left arms in unison (i.e., a noncausal, synchronous action). Coincident with this scene, a novel verb was presented in either a transitive frame (e.g., "Look! The duck is gorp[ing] the bunny!") or an intransitive frame (e.g., "Look! The duck and the bunny are gorp[ing]!"). After several such presentations, the actions were separated, and the causal action was shown on one screen while the synchronous action was shown on the other screen. At this juncture the children were encouraged to "find gorp[ing]," and their looking patterns were recorded and analyzed using the preferential-looking paradigm developed by Hirsh-Pasek and Golinkoff (1991; Golinkoff, Hirsh-Pasek, Cauley, & Gordon, 1987). The results showed that young 2-year-olds ($M = 25$ months) modified their looking preferences based on the syntactic frame of presentation: When *gorp* had been presented in the transitive frame they looked longer at the causative action, but when *gorp* had been presented in the intransitive frame they watched the synchronous action.

This finding was replicated and extended by Naigles and Kako (1993) with the substitution of contact actions for causative actions and with the addition of a third audio condition in which the novel verb was presented with no syntactic frame (e.g., "Look! Gorp[ing]!"). The initial multiple-action scene depicted the duck and frog characters performing a synchronous action while the duck contacted the frog's head with a vertical sweeping motion. The two actions were again separated for the test trials, with the synchronous action shown on one screen and the contact action shown simultaneously on the other. There were three audio conditions for the novel verb: transitive, intransitive, and frameless. The looking preferences indicated that when the novel verb was presented in isolation or in an intransitive frame, the children chose the synchronous action as the referent of the novel verb. In contrast, in the transitive audio condition, a clear effect of syntax was obtained: The children looked significantly longer at the contact action. Thus, both studies demonstrate that young 2-year-old verb learners can

exploit the syntactic frame around a novel verb to narrow or constrain the referents of that novel verb. Hence, syntax appears to be an important and exploited source of information during early verb learning.

When Verb Acquisition Ends and How We Can Tell

Even with the addition of semantic biases and syntactic frames, the full complexity of most verb meanings cannot be captured in a single coincident presentation of verb and scene. Consider the causative verbs taught to 2-year-olds in the preferential-looking paradigm. After watching a duck making a rabbit bend over paired with the verb *gorp* in a transitive frame, the children deduced that *gorp* referred to the causing-to-bend-over action rather than the synchronous arm bends. Did the children think that *gorp* can also refer to noncausal bending-over actions? In English, verbs can be more or less flexible in their encodings of semantic components such as cause.¹ For example, *go* is quite restricted with respect to cause of motion: One can only go on one's own, noncausally. If one is causing another to go, then either the periphrastic construction must be used (e.g., "He made the truck go up the hill"), keeping the causal element external to the main verb (and thus implying indirect rather than direct causation, see Fodor, 1970), or an entirely different verb must be used (e.g., *take*, *push*). *Bring* and *take* are restrictive in the opposite fashion, as these verbs must include causal components (e.g., one can only bring by causing something to change its location). Finally, there is a set of verbs in English, including *move*, *sink*, *drop*, and *break*, which allow either a causal or a noncausal interpretation (e.g., The pirate sank the ship, The ship sank). Thus, verbs differ as to the components they encode and on the flexibility or rigidity of each componential distinction.

It therefore seems reasonable to assume that after a single presentation of, for example, "sink" or "go," children have not learned everything about the set of components of meaning that the verb encodes. They cannot know, for example, that *sink* can participate in either a causal or a noncausal interpretation until they hear the verb referring to both causal and noncausal events. They cannot immediately conclude that *go* allows only a noncausal interpretation, having heard it only in reference to a noncausal event, because *go* could be a verb in the *sink* class. Likewise, they cannot conclude that *take* allows only a causal interpretation after hearing it used to refer to a

¹Of course, this is not solely an issue for verb components that correlate with surface syntax (e.g., cause). For example, with regards to the manner component of verbs, *walk* is quite rigid as to its manner of motion (i.e., only walking will do), but *go* is quite flexible: One can go by skipping, stomping, sashaying, sidling, swimming, or skateboarding. Because our focus in this paper is on those aspects of verb meaning that are related to syntax, though, we do not further address these other components (see Fisher, Gleitman, & Gleitman, 1991, for further discussion).

causal event because a noncausal reference may be imminent. Eventually, however, English learners must arrive at each of these conclusions. The major question here, of course, is how children make these determinations, especially as they are unlikely to receive explicit negative instruction. In the section following, we discuss three hypotheses, namely, *conservatism* (Baker, 1979), *maturational* (Pinker, 1989), and *lexical knowledge* (Naigles, Fowler, & Helm, 1992). The purpose of the study following the discussion is to begin to distinguish among them.

Prior to addressing this question, another one must be answered: How can we determine when children have made these conclusions and so have arrived at the adult meaning of a verb? The most obvious route involves checking their spontaneous productions to see when they arrive at consistently correct usage (e.g., Brown, 1973); however, this route fails because incorrect verb usage is uncommon at any age. Children do not seem to need many presentations of a new verb in order to use it in production, and they appear to use it correctly from the start (Gropen et al., 1991; Maratsos, Gudeman, Gerard-Ngo, & DeHart, 1987). The major exceptions to this overwhelmingly correct verb usage are the spontaneous errors documented and analyzed by Bowerman (1974, 1977, 1982). These errors primarily involved using a familiar verb in an incorrect syntactic frame, such as

(3) Don't fall that on me.

(uttered to protest the impending dropping of something by a sibling). Because *fall* is an intransitive, noncausative verb, this use of it in a transitive frame indicating a causative meaning was both creative and incorrect. Evidently, the child had made an *overgeneralization*, extending the transitive-causative correlation to a verb that does not allow it. Interestingly, these errors did not occur until after at least three months of frequent and correct usage of the verb subsequently overgeneralized. This indicates that although the children had been using these verbs correctly, they had not yet arrived at a complete understanding of them, or they would not have made the errors. Correct usage, therefore, does not always imply complete knowledge. In fact, the children's knowledge may be incomplete on two levels: Not only do they violate semantic constraints (in that noncausative verbs are used to describe causal events), they also violate syntactic constraints (i.e., transitive frames are used with usually intransitive verbs).

One need not wait for these overgeneralizations to occur spontaneously in order to gauge the status of children's verb meanings. A related method involves examining how readily they accept sentences containing such overgeneralized verbs (e.g., "the tiger goes the lion"). If children are still learning about a verb, then its appearance in an incorrect frame may not be recognized as incorrect, and the verb may even be reinterpreted in accordance

with this (novel) presentation. Thus, transitive *go* may be interpreted as causative and nonrestrictive. By contrast, if the verb has been fully acquired, then the information encapsulated in the incorrect form will be rejected, and the utterance will have to be repaired, perhaps rephrasing it as "the tiger goes TO the lion." Clark and Garnica (1974) made a similar proposal in their study of the acquisition of the deictic specifications of *come* and *go* (i.e., *come* here versus *go* there). They found a surprisingly late differentiation of the two verbs in comprehension (only by 9 years), even though in spontaneous production children generally use the verbs correctly by the age of 3 or 4 (see also Gentner, 1978). They suggested that the point of full acquisition may best be revealed by testing children with inappropriate descriptions or forms, that is, ones that selectively do not match the adult representation.

A straightforward grammaticality judgment task may seem to be the easiest way to implement this suggestion; however, one would then be restricted to studying children no younger than 5 years of age. For example, Hochberg (1986) found that only two-fifths of the 3- and 4-year-olds in her original sample performed consistently enough when asked to make such judgments to be included in the final pool. Because Bowerman's (1974, 1977) data suggest that the work of establishing verb restrictions is going on in the preschool years, a task that is accessible to this age group is preferable. In the studies described in the following sections, we used a sentence enactment task that elicits systematic effects in adults and can be performed consistently by subjects as young as 2½ years of age (Bever, 1970).

An additional advantage of the enactment task is that it reveals how subjects interpret the different types of sentences. That is, the enactments may reveal whether the subjects considered the novel (ungrammatical) frames as information still relevant to the verb's meaning. For example, for the ungrammatical sentence "the tiger goes the lion," would subjects enact the tiger going TO the lion, thus showing they know that *go* must be noncausal? Or would they enact the tiger causing the lion to go by pushing it, thereby suggesting that *go* in that frame must be causal? In their enactments, the subjects can either follow the restrictions of the verb and repair the sentence (*Verb Compliance*) or follow the restrictions of the frame and adjust the meaning of the verb (*Frame Compliance*).

The Data Thus Far

In two studies, we asked children and adults to enact both grammatical and ungrammatical sentences, using a "Noah's Ark" and toy wooden animals as props (Naigles, Fowler, & Helm, 1992; Naigles, Gleitman, & Gleitman, 1993). The ungrammatical sentences were constructed by placing transitive verbs (*bring*, *take*, *push*, *put*) in intransitive frames (e.g., NV: "The zebra brings,"

NVPN: “*The lion puts in the ark”) and intransitive verbs (*come, go, fall, stay*) in transitive frames (e.g., NVN: “*The elephant comes the giraffe,” NVNPN: “*The camel stays the penguin next to the ramp”). These sentences were presented to 120 children between the ages of 2½ and 12 years and 20 undergraduates at the University of Pennsylvania.

The results (see Fig. 11.1) demonstrate that younger subjects, especially the 2-year-olds, were more Frame Compliant. They enacted the ungrammatical sentences in accordance with the demands of the frame, changing the meaning of the verb (i.e., they were doing syntactic bootstrapping). Older subjects, especially the adults, tended to be more Verb Compliant, following the restrictions of the verb and repair the sentence. Thus, as we conjectured, the 2-year-olds allowed the novel frames to influence their enactments of these familiar verbs, whereas the adults tended to reject the novel frames and enact the verbs according to their known restrictions. The children at the intermediate ages were en route from the 2-year-old state to the adult state.

Interestingly, the shift from Frame Compliance toward Verb Compliance was not an across-the-board phenomenon, nor did it happen all at once.

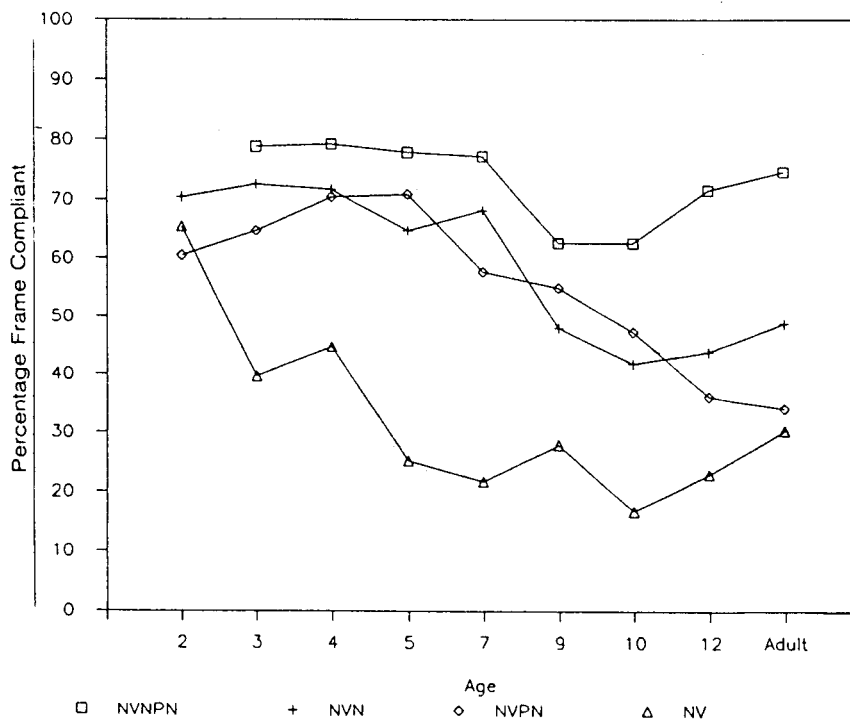


FIG. 11.1. Percentage of Frame Compliant enactments as a function of age group and syntactic frame. For normal-IQ subjects. From Naigles, Fowler, and Helm (1992). Adapted by permission.

Rather, the shift with age toward Verb Compliance varied as a function of syntactic frame (see Fig. 11.1). That is, the NV frame elicited both Verb Compliant and Frame Compliant responses from the 3- and 4-year-olds but elicited adult levels of Verb Compliant enactments from subjects aged 5 years and older. For this frame, the shift begins during the preschool years and is complete by age 5. By contrast, the NVPN frame showed a much more gradual shift toward Verb Compliance, reaching adult levels only by age 12. The NVN frame elicited adult levels of Verb Compliance between the ages of 9 and 10, whereas the NVNPN frame elicited mostly Frame Compliant enactments from subjects of all ages.

The shift toward Verb Compliance also differed as a function of individual verb. For both the NVN and NVNPN frames, the verbs *come* and *go* elicited Verb Compliance earlier and to a greater extent than did *fall* or *stay*. Similarly, *push* elicited Verb Compliance earlier than the other three transitive verbs in the NV frame, and *take* elicited Verb Compliance much later than the other three verbs in the NVPN frame. Our conjectures as to the bases of these frame and verb effects are discussed in detail in Naigles, Fowler, and Helm (1992) and Naigles et al. (1993). Two points are important here: The systematic effects of frame and verb suggest that the shift is not triggered by a general developmental change in how our subjects approached the task, and the fact that the shift follows a different course for different verbs suggests that verb knowledge itself is exerting an important effect.

How Verb Meanings Become Fully Established

Having suggested one method for determining when verb meanings become complete, we can return to the question asked previously. Given that one example of a verb in conjunction with its linguistic and extralinguistic contexts is not sufficient to reveal the entire meaning of that verb, how is this complete meaning finally established? This question has already been studied extensively from the opposite angle: Instead of posing the problem as one of how syntax aids in the acquisition of semantics, the issue has involved the influence of specific verbs on syntax and has been couched as the acquisition of argument structure. Baker (1979) was among the first to lay out the problem that the verbs that are allowed in particular syntactic frames appear to be arbitrarily selected; for example, why can something be dropped but not fallen? How might this difference be learned? Baker's solution involved rejecting the very notion of general form-meaning relations or rules. He suggested that the frames that a verb takes are learned by attending only to attested examples and resisting the formation of generalizations. If no generalizations are formed in early childhood, then none need be unlearned later on. Thus, children are expected to be conservative in allowing verbs to appear in unattested frames.

Baker seems to have been unaware, though, of the spontaneous overgeneralizations observed by Bowerman and others (for a summary, see Pinker, 1989). These errors indicate that productive generalizations with argument structure are made during development (see also Gropen et al., 1991; Gropen, Pinker, Hollander, Goldberg, & Wilson, 1989), and so one is forced to consider how children recover from such errors to form stable (i.e., adultlike) argument structures). The just-described findings of Frame Compliance in younger children are reminiscent in many ways of these spontaneous overgeneralizations; they are in fact mirror images. Thus, the process of recovery from the overgeneralizations—of learning that these are errors and of forming argument structures—may be considered the same as the process of shifting from Frame Compliance to Verb Compliance. The question we are addressing, then, is how children determine that the rules or relations do not apply indiscriminately.

The most recent theory concerning the retreat from overgeneralizations, put forth by Pinker (1989; see also Bowerman, 1983), relies partly on the child's increasing lexical knowledge to constrain each verb's argument structure. In brief, Pinker holds that verbs become organized into semantic subclasses (*narrow range subclasses*) as their representations are refined and elaborated during acquisition. The semantics of the subclasses predict whether the verbs allow such syntactic-semantic alternations as the causative, which can alternate between transitive and intransitive frames or causative and noncausative meanings. For example, motion verbs that encode manner (e.g., *roll* and *bounce*) allow both causative and noncausative interpretations, whereas motion verbs that encode path (e.g., *take* and *bring*, *come* and *go*) allow either a causal interpretation (for the first two) or a noncausal one (for the latter two), but not both. The crucial point is that when the representation of a verb matches that of another verb that is known to alternate, the former verb is licensed to alternate as well. Pinker (1989) spent three chapters discussing the grammatically relevant ways in which this matching is to be specified. Thus, as the representations of verbs are accrued during acquisition, they fall naturally into either licensing or nonlicensing narrow range subclasses. When verbs such as *come* and *go* fall into their nonlicensing subclass, they are no longer overgeneralized because broader lexical rules such as the transitive-causative correlation only apply to the licensing subclasses. (This is a very brief synopsis; see Pinker, 1989, and Naigles, 1991, for details.)

According to Pinker, the shift from Frame Compliance to Verb Compliance may occur because the verb representations are elaborated to the extent that they have formed grammatically relevant narrow range subclasses. Verbs such as *come* and *go* no longer allow the causative interpretation (i.e., become Verb Compliant) because they do not fit the semantic specifications of subclasses that "causativize" (i.e., they do not encode manner of motion).

Notice that this account predicts that *fall* and *stay* will also eventually fall into nonlicensing subclasses (i.e., *fall* will be in the same subclass as *come* and *go* because the verbs only differ on the specified path of motion, which Pinker claimed is not grammatically relevant. These verbs will thus eventually disallow the causative interpretation. Our subjects, however, continued to allow *fall* and *stay* to be causativized well past the shifts for *come* and *go*. In fact, even our adults were predominantly Frame Compliant (68%) for "the lion falls the chicken" and "the penguin stays the bird." Within Pinker's narrow range subclasses, all verbs are supposed to behave similarly with regard to argument structure, yet our data show that at least one of the verbs in the *come* subclass exhibits quite a different degree of flexibility.

A second feature of Pinker's account concerns the mechanism involved in the achievement of stable argument structures. Because assignment to an alternating subclass depends upon positive evidence to that effect (e.g., that children hear "sink" being used in both transitive and intransitive frames), it should in principle always remain possible that the next utterance the child hears will contain a critically relevant datum. However, Pinker argued—and our data confirm—that children eventually become more definitive about the status of nonalternating verbs such as *go* and *bring*. Having not heard these verbs in the alternate syntax, they somehow come to expect that they will not. Pinker's explanation for this "closing off" of the argument structure is maturational in nature: At the time of puberty, those subclasses of verbs for which there has been no evidence of alternation become fixed as nonalternating subclasses, and the adult state is achieved. Beyond this point, no new information about these verbs is accepted. Our results are not entirely inconsistent with this hypothesis: The 12-year-olds in the study by Naigles, Fowler, and Helm (1992) were indeed indistinguishable from adults in this regard, and there was considerable growth until this point.

On the other hand, we have reason to be skeptical about this maturational account as telling the whole story. For example, why is it that the tendency to reject novel syntactic information begins as early as age 3, is complete for the NV frame by age 5, and varies as a function of syntactic frame and individual verb? Such findings are clearly not supportive of a strict maturational account, as they indicate that some verbs and frames achieve stability well before puberty. In fact, because of the verb-by-verb nature of the shift toward Verb Compliance, we put forth a hypothesis, which we dubbed *lexical knowledge*, which focuses even more specifically on the role of individual verb knowledge in the construction of verb representations (Naigles et al., 1993). In particular, we suggested that the observed developmental shift may be displaying the gradual accrual of verb knowledge over time, so that Verb Compliant behavior is a function of verb-specific experience. Thus, our proposal was that the actual closing off of verbs and their argument structures is governed by the accrual of lexical knowledge.

SYNTAX PROVIDES TWO WINDOWS ON VERB ACQUISITION

Our guiding principle in this chapter is that, by virtue of the correspondences between syntax and verb meaning, syntax and tasks requiring sensitivity to syntax can be exploited to tap into the process and products of verb acquisition. At the beginning of verb learning, a major concern is characterizing how the child maps the correct referent onto a new verb. We provide evidence that the syntactic frame in which the verb is presented can be exploited by the learner to aid in selecting among the plethora of meanings allowed by observation alone. As verb acquisition progresses, the concern becomes how we finally achieve fully elaborated and stable verb meanings. We argue here that how children resolve novel combinations of familiar verbs and syntactic frames provides insights into the stability and formation of their verb representations. Finally, to add to our growing body of evidence on normally developing children, in this chapter we present converging evidence from a special population also faced with sorting out verbs and their syntactic frames. We suggest that schoolchildren and adolescents with Down syndrome, in their interpretation of novel pairings of verbs and frames, are guided by many of the same principles apparent in the interpretations of preschoolers at a similar syntactic level.

How Verb Acquisition Begins

At the beginning of verb learning, the child's task is to select the right action, process, or state (i.e., the meaning) from those supported by the context and to attach it to the designated lexical item. That is, to learn what *skid* means, the child must map skidding actions present in the visual-spatial context onto the word *skid*. This mapping task is not as straightforward as it may seem, though. As discussed in detail by Quine (1960; see also Wittgenstein, 1953), Landau and Gleitman (1985), Gleitman (1990), and Naigles, Gleitman, and Gleitman (1992), among others, there is a multitude of possible meanings available in the real-world scene that can be attached to a new verb. For example, a child hearing "skidding" and observing his mother pushing a truck such that it moves across the floor in a skidding manner cannot know whether "skid" refers to the mother's pushing (the causal action), or the truck's skidding (the manner of action), or traversing the floor (the path of the action). In these circumstances, one might expect children to be cautious or error-prone in using new verbs; however, the evidence to date (Carey, 1978, 1982; Tomasello, 1992) indicates that few mistakes are made.

Researchers have therefore suggested that children are not completely openminded in their acquisition of verbs. They have proposed that children approach the verb-learning task with specific biases in mind. For example,

Gentner (1978), Gropen, Pinker, Hollander, and Goldberg (1991), and Golinkoff, Hirsh-Pasek, Mervis, Frawley, and Parillo (this volume) all provided evidence that 3- and 4-year-old children find the manner of a novel action more salient for the referent of a novel just-presented verb than the instrument or endstate of the action (see also Behrend, 1990, and Fisher, Hall, Rakowitz, & Gleitman, 1994). Such semantic biases provide a basis from which young verb learners select some elements of verb meaning from among the possibilities.

However, semantic biases are not sufficient to account for the beginnings of verb acquisition because not all verbs in a language are consonant with the biases. For example, if children have a bias to assume that a novel verb refers to the manner of an action in the real-world scene, how will they learn all the verbs that do not encode manner or encode manner plus other components? What if the articulated verb in the *pushing/skidding/traversing* scene were "push" or "cross" instead of "skid"? Operating with a manner bias alone would lead a verb learner to make numerous errors. This becomes even more of an issue from a cross-linguistic perspective. Although in English the manner of motion or action is usually encoded in the verb, in Spanish, French, and other Romance languages the verb encodes the path of the motion (Choi & Bowerman, 1991; Talmy, 1985). Hence, the English sentence

- (1) He is running down the stairs.

translates into French as

- (2) Il descend l'escalier courant.

Literally, *He is-going-down the stairs runningly*. Therefore, a manner bias may be detrimental to a young Romance verb learner; children at least seem to have to learn their language-specific biases in verb encoding (Choi & Bowerman, 1991; Gentner, 1982; Naigles, 1991; Naigles, Eisenberg, & Kako, 1992).

In sum, children need more than the real-world scene and their semantic biases to begin to learn many novel verbs. In several recent papers, Gleitman (1990; Gleitman & Gleitman, 1992; Landau & Gleitman, 1985) proposed the *syntactic bootstrapping* process: Children use the syntactic frames in which verbs are placed to help determine the meaning of novel verbs. Recall our *push/skid/traverse* scene. If the verb is placed in an intransitive syntactic frame (e.g., "The truck is X-ing"), then the intended action is probably *skidding*, given the manner bias in English. If, however, the verb is placed in a transitive frame (e.g., "Mom is X-ing the truck"), then *skidding* becomes a less-favored option, and *pushing* becomes more plausible as the intended referent. The syntactic frames are informative precisely because they have

Our purpose in the study presented next was twofold. First, to further refine the concept of lexical knowledge, we consider a new population whose syntactic and lexical skills are divergent. Second, we consider a maturational account in a somewhat different light: Regardless of when verbs and argument structures *begin* to achieve stability, is puberty the point at which the verb acquisition process necessarily *ends*?

THE END OF VERB ACQUISITION IN SUBJECTS WITH DOWN SYNDROME

To address the issues presented previously, we turned to a different population of verb learners, namely, schoolchildren and adolescents with Down syndrome (DS). Our subjects were individuals whose language learning was often far from complete but who either had attained puberty or were prepubescent. How flexible would they be in interpreting familiar verbs in novel syntactic frames? This is not the first time researchers have turned to individuals with DS to investigate critical-period questions. Indeed, the evident lack of growth in sentence structure among individuals with DS beyond puberty (Lenneberg, Nichols, & Rosenberger, 1964) was cited as one of the key pieces of evidence in the most comprehensive and influential critical-period hypothesis ever put forth (Lenneberg, 1967). What is particularly exciting in the study presented here is that we have the opportunity to investigate not what these individuals have acquired but how they respond to new input.

When we ask whether students with DS respond in accordance with chronological age (CA) or language level, a particularly intriguing question concerns how their language state is defined. It is a well documented fact about individuals with DS that their language skills split in an interesting fashion—generally portrayed as distinguishing between lexical and syntactic knowledge or vocabulary and grammar (for reviews, see Fowler, 1988; Miller, 1988). Specifically, receptive vocabulary growth, although well behind CA, proceeds well in advance of syntactic knowledge (e.g., MLU, auxiliary use). For example, in a study of adolescents with DS, Fowler (1990) reported that children with vocabulary ages of 6 years had “syntactic ages” closer to 3 years (see also Evans, 1977; Hartley, 1982). This dichotomy creates considerable interest for our inquiry into verb acquisition, an area that clearly straddles the boundary between lexical and syntactic development. Do schoolchildren with DS respond to novel sentences in accordance with general lexical knowledge as assessed by their vocabulary or mental age, or more in accordance with their level of syntactic development? Given the oft-cited discrepancy between vocabulary and syntactic development, it should in principle be possible that students acquire vocabulary well in advance of their syntactic development, yielding verb compliance out of keeping with that found among peers defined on a syntactic basis.

Thus, our goal in the study was to determine those factors that bear on verb interpretation in individuals for whom the usual course of maturational, lexical, and syntactic development has become dissociated (see also Gopnik, 1992). To this end, we gave the Noah's Ark task to both pre- and postpubescent schoolchildren with DS and assessed syntactic and lexical skill independently via standardized measures. Our design allowed us to explore two different hypotheses. First, if Pinker and Lenneberg were correct regarding maturational factors, then adolescents with DS will be no more Verb Compliant than their prepubescent counterparts. On the other hand, if our lexical knowledge hypothesis is correct, then adolescents with DS who have accrued more linguistic knowledge will be more Verb Compliant than prepubescents with DS. Second, if the subjects with DS are as Verb or Frame Compliant as their normal-IQ mental-agemates, then we can assume that the Noah's Ark task (and perhaps verb acquisition more generally) is primarily tapping into lexical knowledge. If they perform more in keeping with their syntactic agemates, then we have additional evidence that the acquisition of verbs has a strong syntactic component.

Method

Subjects. The subjects were 24 middle-class children with Down syndrome from elementary and secondary schools in Connecticut and Pennsylvania; all were enrolled in outstanding programs for children with special needs, and all were native speakers of English. Twelve of the children were gradeschoolers between the ages of 9;0 and 11;8 (MA = 10.12 years), and 12 were adolescents between the ages of 12;0 and 17;11 (MA = 14.90 years). All but one of the subjects had full trisomy 21; the youngest child had a mosaic form of trisomy 21. The mental ages of the grade school children ranged from 4;2 to 7;8, with a mean of 5;4. These were derived from recent school-administered omnibus IQ tests, including the Stanford-Binet and the WISC-R. A *language age* measure for these children was based on mean length of utterance (MLU), calculated on the basis of their spontaneous comments during the experimental sessions. Their MLUs ranged from 1.0 to 3.21, with a mean of 2.08, making their mean language age around 2;3 (Miller, 1980) and confirming prior studies finding MLU to lag well behind mental age (Fowler, 1990; Miller, 1987). Mental ages for the adolescents were estimated on the basis of the PPVT-R test (Dunn & Dunn, 1981), which correlates highly with the Stanford-Binet and WISC-R. The resulting mental ages ranged from 4;6 to 10;8, with a mean of 6;6. Language age in these subjects was based on the Test of Auditory Comprehension of Language-Revised (TACL-R; Carrow-Woolfolk, 1985); subjects' performance placed them at the 5;7 age-equivalent level on both the grammatical markers and elaborated sentences subsections (range 3;5 to 9;9). It seems from these

scores that the adolescents did not show the typical split between language age and mental age. We suspect that this is entirely an artifact of the language measure used. The TACL-R assesses comprehension rather than production, and a high level of performance can be obtained with well-developed lexical skills. In short, it captures some of the same skills as the PPVT-R; a production measure would presumably be much lower (Miller, 1987).

To be included in this study, all subjects had to meet our criterion of enacting the grammatical control sentences correctly at least 75% of the time; six additional children with DS were tested but failed to reach this criterion.

Stimuli and Design. The stimuli and design were exactly the same as those reported in Naigles et al. (1993); the reader is directed to that paper for details. Briefly, 40 experimental sentences were designed by fitting each of 10 motion verbs into four sentence frames (NVNPN, NVN, NVPN, NV): Four of the verbs were transitive (*bring, take, push, put*), four were intransitive (*come, go, fall, stay*), and two (*move, drop*) could legitimately appear in both transitive and intransitive frames. Of the 40 sentences, 16 were ungrammatical and 24 were grammatical.

Procedure. The subjects were tested individually in a room provided by the school. Each subject was asked to name the characters and practice was provided in the case of any confusion. In general, however, subjects did know the names. When working with the normal-IQ children in Naigles, Fowler, and Helm (1992) and Naigles et al. (1993), all animals were placed within easy access of the children, and the children then chose the animals needed to enact each sentence in turn. However, pilot testing revealed that the selection of animals distracted the children with DS; they often forgot the test sentence in the process. These children were therefore only given access to the named characters plus deliberate foils. For the adolescents, three or four characters were set up by the experimenter within easy reach of the subjects, who were then directed to choose the one(s) they needed to enact each sentence. For the grade schoolers, the named characters were placed on the stage, and the children were told to use these to enact each sentence. For 6 of the gradeschoolers, an extra animal (usually a bird) was placed right next to the stage for each sentence in which a direct object was missing (e.g., "the tiger takes," "the elephant pushes toward the ark"); no particular instructions were given about this extra animal. For both groups, after each enactment, the animals were removed from the stage.

Verbal memory limitations of the subjects with DS also led us to modify presentation of the test sentences. The normal-IQ children generally needed to hear just one presentation to produce an enactment; however, the subjects with DS required multiple repetitions, lengthening considerably the necessary time to administer the test. Whereas the entire procedure was administered in

one session for the normal-IQ children over age 5, 2 of the grade-school children with DS needed two sessions and one needed three sessions to complete the entire task. For both groups, feedback was always positive, regardless of accuracy. The subjects' responses were recorded on videotape for later coding.

Coding. The coding scheme employed is fully described in Naigles (1988), Naigles, Fowler, and Helm (1992), and Naigles et al. (1993). Each enactment of a sentence was first described using a detailed inventory of action descriptions, such as "tiger pushes lion over to ark." The major focus of these descriptions was whether the verb was enacted as a causal or a noncausal action; in this example the action was causal. If the stimulus sentence was grammatical, the description was then coded for *correctness*; if the stimulus sentence was ungrammatical, it was coded for *compliance*. For example, the ungrammatical transitive sentences (e.g., "the tiger goes the lion") were coded as Frame Compliant if the enactment was causal (e.g., the tiger makes the lion go) and Verb Compliant if the enactment was noncausal (e.g., the tiger and lion go separately). The ungrammatical intransitive sentences (e.g., "the tiger brings to Noah") were coded as Frame Compliant if the enactment was noncausal (e.g., the tiger moves alone to Noah) and Verb Compliant if the enactment was causal (e.g., the tiger brings the bird to Noah).

An enactment was coded as *other* if it did not fit into either of the two preceding categories. For example, the child employed wrong movements (e.g., a vertical motion for *come* or no motion at all) or reversed the thematic roles of the sentence, such as making the bird knock the lion over in response to "the lion falls the bird." Although the latter enactment is causal and so partially fits the Frame Compliant criteria for the ungrammatical transitives, the subject of this sentence is cast as the experiencer of the action rather than its agent, thus partially fitting the Verb Compliant criteria. Finally, 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* (i.e., "fall" may have been confused with *follow*).²

²After coding the enactments according to the specifications just detailed, we made a small number of modifications to take into account the children's enactments of the grammatical sentences. The grammatical and ungrammatical sentences were paired according to their causal and noncausal counterparts for each frame. Thus, ungrammatical *come, go, stay, and fall* were paired with grammatical *bring, take, put, and drop*, respectively (e.g., "the elephant comes the giraffe" was compared with "the tiger brings the bird"). Likewise, ungrammatical *bring, take, push, and put* were paired with grammatical *come, go, move, and stay*, respectively (e.g., "the lion puts" was compared with "the kangaroo stays"). The pairs of sentences were then compared, with the grammatical enactment providing the basis for our interpretation of the ungrammatical enactment. For example, if a child's enactment of "the tiger brings the bird" (a grammatical sentence) involved the tiger and bird moving side by side in two hands without

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 LGN; agreement among coders averaged 85%, and disagreements were resolved by discussion. This is the same level of reliability as was obtained when coding the normal-IQ toddlers and preschoolers (Naigles et al., 1993) and gradeschoolers (Naigles, Fowler, & Helm, 1992).

Results and Discussion

Each subject enacted at least 75% of the grammatical sentences correctly, and the mean percentage correct for both the gradeschoolers and adolescents was 88%. Consistent with our expectations and with the performance of their normal-IQ peers, the children with DS readily understood the task and were quite accurate when the verbs occurred in familiar structures. The children also enacted the ungrammatical sentences in an interpretable fashion: Responses coded as other (neither Frame Compliant nor Verb Compliant) were relatively uncommon, constituting 10.8% of the responses for both age groups. This level of other responses is higher than that of the normal-IQ gradeschoolers but the same as that of the normal-IQ preschoolers (see Naigles et al., 1993). Because these other responses did not differ as a function of frame type or subject age and did not appear to follow any discernible pattern, they were omitted from the statistical analyses that follow. All tabular presentations and analyses are based on the 89.2% of responses that were coded as either Frame Compliant or Verb Compliant.

Two questions were addressed by the analyses below. First, how Frame Compliant were the subjects with DS? Did they tend to follow the frame and change the verb, as the normal-IQ preschoolers did, or did they follow the verb and repair the frame, as the gradeschoolers and adults from the normal-IQ population had? Second, was there a shift with age among the

touching (coded as incorrect because it was noncausal), and if the same child's enactment of "the elephant comes the giraffe" involved the same noncausal action (initially coded as Verb Compliant because it was noncausal), then the latter enactment was recoded as Frame Compliant because of its close similarity to the enactment of the grammatical sentence. Likewise, if a child's enactment of "the kangaroo stays" involved simply putting the kangaroo on the stage, motionless, and if the same child's enactment of "the lion puts" involved putting the lion motionless on the stage and also putting the bird motionless on the stage (initially coded as Frame Compliant because it was noncausal), then this latter enactment was recoded as Verb Compliant because of its dissimilarity to the enactment of the grammatical sentence (i.e., a second animal was introduced for the ungrammatical sentence but not the grammatical one). Only pairs of sentences within the same frame were compared; thus, if the child who enacted *come* and *bring* in the NVN frame as described previously also enacted *come* noncausally in the NVNPN frame but did not enact *bring* noncausally in the NVNPN frame, then the Verb Compliant coding of *come* in the NVNPN frame was maintained. A total of 23 enactments (out of 384: 6%) were changed in this fashion; 5 were changed from Frame Compliant to Verb Compliant, and 18 were changed from Verb Compliant to Frame Compliant.

subjects with DS, away from Frame Compliance and toward Verb Compliance? If so, was it uniform or does it vary as a function of frame and verb? A final analysis assessed whether implicit and explicit recognition of ungrammaticality were precipitating factors in the shift towards Verb Compliance and, by extension, toward stable argument structures.

How Frame Compliant Are Subjects With DS? Table 11.1 shows the percentage of Frame Compliant enactments for each DS age group. Both age groups were quite Frame Compliant: The gradeschool children performed Frame Compliantly almost 75% of the time and the adolescents almost 67% of the time. This finding, together with the small percentage of other responses reported previously, indicates that the children with DS systematically exploited the aforementioned correlations between verb meaning and surface syntax (i.e., transitive-causative) and so made systematic predictions about verb meaning based on syntax. With the obvious caveat that these verbs were familiar rather than novel, it seems clear that children with DS can bootstrap syntactically.

The subjects with DS seemed even more Frame Compliant than many of the normal-IQ subjects studied by Naigles, Fowler, and Helm (1992) and Naigles et al. (1993). In the ANOVAs (Group \times Frame) that follow, the percentage of Frame Compliance demonstrated by subjects with DS was compared with that generated by their chronological age mates (CA-mates), their mental age mates (MA-mates), and the normal-IQ 2- and 3-year-olds who were closest to their syntactic age mates. Across all four frames, the gradeschoolers with DS performed significantly more Frame Compliantly than the normal-IQ 10-year-olds ($F(1, 23) = 19.54, p < .001$) and the normal-IQ 5-year-olds ($F(1, 22) = 6.34, p < .02$). There was a nonsignificant trend toward greater Frame Compliance in the DS gradeschoolers than the normal-IQ 3-year-olds ($F(1, 30) = 2.81, p = .10$), and there was no difference between the DS gradeschoolers and the normal-IQ 2-year-olds for the NVN and NVPN frames ($F(1, 30) < 1, ns$) or for the NV frame ($F(1, 29) < 1, ns$). Thus, the gradeschool children with DS were more Frame Compliant than either their CA- or MA-mates; the normal-IQ group they most resembled was the 2-year-old group.

As with the younger group, the adolescents with DS performed significantly more Frame Compliantly across all four frames than did the normal-IQ 12-year-olds ($F(1, 22) = 6.40, p < .02$) or the normal-IQ 9-year-olds ($F(1, 22) = 4.996, p < .05$). They performed like the normal-IQ 7-year-olds for all frames except NV; they were somewhat more Frame Compliant for this frame ($F(1, 22) = 3.25, p < .09$). Their performance was not different from that of the normal-IQ 3-year-olds on any frame ($F(1, 30) < 1, ns$), nor was it different from that of the normal-IQ 2-year-olds on frames NVN and NVPN ($F(1, 30) < 1, ns$). They were, however, significantly less Frame Compliant

TABLE 11.1
Mean Percentage Frame Compliant Enactments

		Down Syndrome Subjects									
		Grade School					Adolescent				
		Age									
Across Frames		73.38									62.50
Frame 1: NV/NPN		78.47									63.19
Frame 2: NVN		71.97									67.36
Frame 3: NVPN		68.06									75.69
Frame 4: NV		75.00									43.75
Chronological Age	10.12 years										14.90 years
Mental Age	5.33										6.65
Syntactic Age	2.29 (MLU)										5.66 (TACLR)
		Normal IQ Subjects									
		Age									
Across Frames		64.96									43.58
Frame 1: NV/NPN		69.10									71.53
Frame 2: NVN		60.40									43.75
Frame 3: NVPN		65.37									36.11
Frame 4: NV											22.92
											Adult
											47.60
											75.85
											50.00
											34.15
											30.40

than the 2-year-olds for the NV frame ($F(1, 29) = 3.74, p < .06$). In sum, the adolescents with DS were much more Frame Compliant than their CA-mates and somewhat more Frame Compliant than their MA-mates (i.e., for the NV frame). These subjects most resembled the preschool-aged normal-IQ group.

These analyses suggest that there is an age effect within the DS population; that is, the adolescents with DS were less Frame Compliant than the gradeschoolers with DS and so may be beginning to shift toward Verb Compliance. An ANOVA was performed (Age \times Frame) comparing the two DS groups, and although it yielded no main effect of age ($F(1, 22) = 2.26, p > .10$), the interaction of age and frame approached significance ($F(3, 66) = 2.25, p < .09$). Post hoc Tukey tests revealed that the adolescents were significantly less Frame Compliant than the gradeschoolers for the NV frame only ($p < .01$). Thus, whereas the gradeschool children with DS performed at approximately the same level of Frame Compliance with all four frames, the adolescents with DS performed less Frame Compliantly with the NV frame than with the other three frames ($F(3, 33) = 3.08, p < .05$). This effect is shown graphically in Fig. 11.2. Thus, it appears that the adolescents with DS had begun to shift toward Verb Compliance with the NV frame.³

Our final analysis of Frame and Verb Compliance investigated possible verb effects across age groups. Table 11.2 shows the percentage of Frame Compliant enactments elicited for each verb in its two frames. Our first comparison was motivated by a result from Naigles et al. (1993), who found that normal-IQ gradeschool subjects enacted sentences with *come* and *go* less Frame Compliantly than sentences with *fall* and *stay*, with *come* and *fall* the most and least Frame Compliant, respectively. Although the number of DS subjects was much smaller (24 DS subjects versus 60 normal-IQ subjects in Naigles et al., 1993), these subjects followed a similar pattern: Across both

³At this point, a methodological issue must be addressed. Recall from the procedure section that all the adolescents with DS were presented with extra animals for each sentence enactment, whereas only half of the DS gradeschoolers had access to extra animals. That is, upon hearing "the tiger brings," an adolescent always had access not only to the tiger but also to at least one other animal, which he or she could exploit as the patient of the tiger's bringing. Half of the gradeschoolers with DS, on the other hand, were only presented with the tiger; perhaps they did not pick up another animal (and so perform Verb Compliantly) because they believed they were restricted to the animals accessible. Might this procedural difference be the reason that the gradeschoolers with DS performed more Frame Compliantly with the NV frame? There are two reasons why this explanation cannot entirely account for the age difference. First, the gradeschoolers who were not presented with an extra animal sometimes performed Verb Compliantly with the NV sentences; they were Verb Compliant 16.7% of the time and exploited other props such as the ark and the ramp as the patients of the action. Second, the gradeschoolers who received the extra animal did not always make use of it. In fact, they performed Verb Compliantly only 33.3% of the time, which is much less than the 57% Verb Compliance of the adolescents. In sum, although the addition of an extra animal probably helped the subjects with DS to perform Verb Compliantly once they realized a sentence warranted it, it is unlikely that the presence of the extra animal instigated the Verb Compliant enactments.

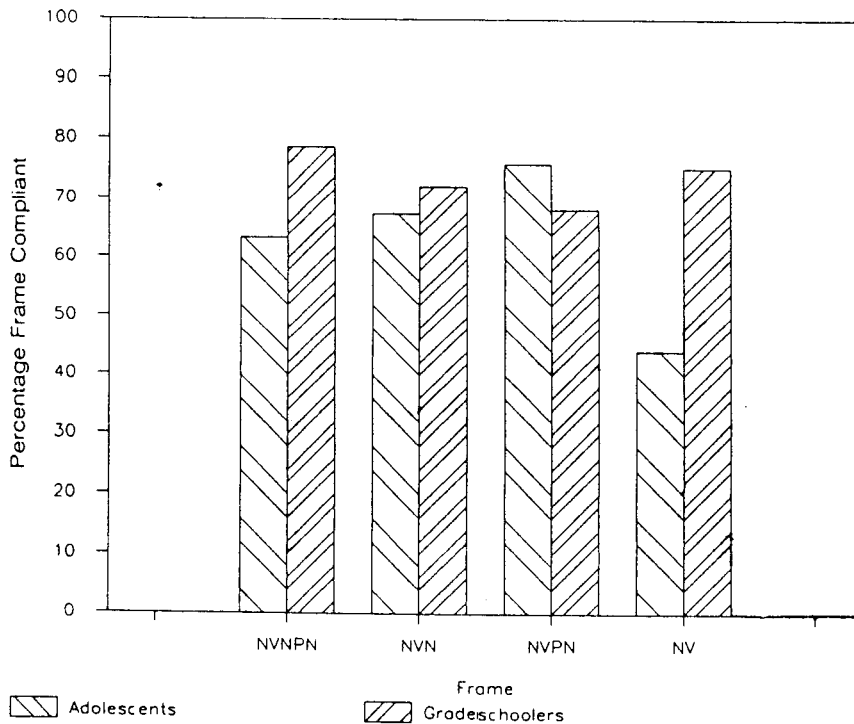


FIG. 11.2. Percentage of Frame Compliant enactments as a function of frame for the subjects with Down syndrome.

frames, *come* elicited Frame Compliant enactments around 50% of the time, whereas *fall* elicited Frame Compliant enactments around 80% of the time (by items, $\chi^2 = 9.5, p < .05$), with *go* and *stay* falling in between. For these data, then, the verb effects gain in generality. Naigles et al. (1993) also found that for the NVPN frame, *take* elicited the most Frame Compliance; however, with the DS subjects, *put* elicited significantly more Frame Compliance than

TABLE 11.2
Percentage Frame Compliance by Verb and Frame

	<i>Come</i>	<i>Go</i>	<i>Fall</i>	<i>Stay</i>
NVNPN	0.52	0.73	0.87	0.67
NVN	0.53	0.62	0.85	0.70
	<i>Bring</i>	<i>Take</i>	<i>Push</i>	<i>Put</i>
NVPN	0.67	0.58	0.58	0.96
NV	0.71	0.48	0.50	0.71

the other three verbs (by subjects, Cochran's $\chi^2 > 7.0, p < .05$ for each verb). Within the NV frame, Naigles et al. found that *push* elicited the *least* Frame Compliance; *take* had that distinction with the DS subjects, although *push* came very close (*take* differs significantly only from *put* [Cochran's $\chi^2 = 6.0, p < .05$]). Thus, some but not all of the verb effects found on Naigles et al. (1993) were revealed by the subjects with DS. What is more interesting is that verb effects were again present. Together with the significant frame effect, the verb effects indicate that the children's Frame Compliance has a linguistic aspect to it; it is not simply a function of slavishly obeying the experimenter.

To summarize, the gradeschool children with DS enacted the ungrammatical sentences predominantly Frame Compliantly. Despite their chronological age of 10 and their mental age (calculated mostly from vocabulary tests) of 5, their enactments of these sentences were most akin to those of normal-IQ 2-year-olds. They accepted the novel frames for the familiar verbs and reinterpreted the verbs' meanings almost 75% of the time. By contrast, the adolescents with DS appear to have begun to shift away from Frame Compliance and toward Verb Compliance with at least one of the four frames. They were more Frame Compliant than their CA-mates and slightly more Frame Compliant than their MA-mates. Like the preschoolers they most closely resemble, they seem to have begun to reject novel frames for some transitive verbs and seem to be beginning to build an argument structure for these verbs.

What Precipitates the Shift? A Measure of Grammaticality. An additional advantage inherent in studying children with DS is that because of their extremely slow but normal development, milestones that pass swiftly in normal-IQ children can be studied in greater detail in children with DS. For example, in the normal-IQ population, 2-year-olds are Frame Compliant with all frames, whereas 3-year-olds are significantly less Frame Compliant with the NV frame—the beginning of the shift is swift. Within the DS population, though, the commencement of the shift is drawn out over a number of years. The issue at hand involves the precipitation of the developmental shift toward Verb Compliance. The most straightforward hypothesis concerning the start of the shift toward Verb Compliance (and by extension toward stable verb meanings and argument structures) involves the attribution of ungrammaticality to the novel sentences. That is, perhaps the realization that a sentence is ungrammatical is what precipitates the formation of stable argument structures for specific verbs. Alternatively, though, such a realization may be a result of the stable structures, not an instigating factor. Our data speak to this.

None of the Noah's Ark studies specifically tested for grammaticality judgments; however, the subjects sometimes commented on the sentences, and

many of the comments were quite revealing of difficulty with the sentences (e.g., "I don't know what *come* means" from a 4-year-old and "The tiger brings what to Noah?" from an adult). The comments, then, can be regarded as fairly explicit indications of whether the subjects viewed the sentences as grammatical or not. However, not every subject chose to comment on every sentence; in fact, some hardly spoke at all. Therefore, the more pervasive measure of latency to enact the sentences was used as an implicit measure of grammaticality. That is, if the sentence is regarded as ungrammatical, it may take longer to begin the enactment.

The spontaneous comments of all of the adults, 4-, 3-, and 2-year-olds who participated in the Naigles et al. (1993) study, as well as comments from the subjects with DS in the study described here were transcribed and categorized as relevant or irrelevant to grammaticality. Comments considered to be relevant to grammaticality were those that indicated some kind of uncertainty on the part of the subject: requests for repetition (e.g., "What?" "Say that again?"), requests for information (e.g., "Where?" "Brings what?"), comments on the characters (e.g., "Noah?" "Where's the ramp?"), declarative repetitions (e.g., "The elephant comes the giraffe"), interrogative repetitions (e.g., "Comes the giraffe?"), and explicit statements of confusion (e.g., "I don't know what that means," "Help"). Comments considered irrelevant to grammaticality included noises made while enacting the sentences (e.g., "vroom") and questions and declaratives off the subject (e.g., "what's your name?" "I like the tiger"). The latency to enact the sentences was also recorded for all the adults, 15 randomly selected 3- and 4-year-olds, 7 randomly selected 2-year-olds, and all the subjects with DS. Latency was recorded in seconds with a handheld stopwatch, starting at the end of the experimenter's first articulation of the test sentence and ending at the beginning of the subject's first attempt at enacting the sentence.

The results are presented in Tables 11.3 and 11.4. Consistent with our hypothesis, the normal-IQ adults and preschoolers took longer to enact the ungrammatical sentences than the grammatical sentences (by items, $\chi(32) = 62.14$, $p < .001$ and $\chi(32) = 30.05$, $p < .001$, respectively). Both groups also produced more comments about the ungrammatical sentences than about the grammatical sentences (by items, $\chi(6) = 7.6$, $p < .05$; $\chi(6) = 6.94$, $p < .05$; and $\chi(6) = 34.08$, $p < .005$; for the adults, 4-year-olds, and 3-year-olds, respectively). In contrast, the normal-IQ 2-year-olds did not distinguish the two types of sentence either in their comments or in their latency of enactment. It seems then, among normal-IQ individuals, that the only age group to perform predominantly Frame Compliantly with all frames was the same age group that demonstrated neither implicit nor explicit recognition of the ungrammaticality of the sentences. The next oldest group, the 3-year-olds, had both begun to shift toward Verb Compliance with one frame (NV) and demonstrated both implicit and explicit recognition of the ungrammaticality

TABLE 11.3
Latency to Enact Sentences

Age Group	Grammatical	Ungrammatical
Adult	4.573	7.473**
Preschool	8.949	12.514**
Two	8.322	7.676
DS-gradeschool	6.144	7.419*
DS-adolescent	8.889	10.276*

* $p < .05$. ** $p < .01$.

of the sentences. Here, then, is a case in which the subjects with DS, with their slower development, may shed light on the type of recognition that is more indicative of the beginnings of the formation of argument structure.

The mean latencies of enactment and percentage of comments produced by the DS subjects are also presented in Tables 11.3 and 11.4. As Table 11.3 shows, both the gradeschool and adolescent subjects with DS took longer to enact the ungrammatical sentences than the grammatical ones (by items, $\chi(32) = 6.55$, $p < .02$ and $\chi(32) = 3.84$, $p < .06$, for the gradeschoolers and adolescents, respectively). Thus, both age groups demonstrated implicit recognition of the ungrammaticalities. Although both age groups also produced a higher percentage of comments on the ungrammatical sentences than on the grammatical ones (see Table 11.4), this was not significant for either age group. That is, neither age group with DS exhibited explicit recognition of the grammatical/ungrammatical distinction. It appears, on this initial analysis, that neither of these measures distinguishes the gradeschool children with DS from the adolescents with DS.

Interestingly, the subjects with DS were much more talkative overall than either the normal-IQ adults or the preschoolers; the normal-IQ subjects tended to enact the sentences in silence, with just a few comments interspersed. The children with DS, on the other hand, tended to repeat almost every test sentence, sometimes asked for repetitions of every sentence, and

TABLE 11.4
Percentage of Sentences With Comments

Age Group	Grammatical	Ungrammatical
Adult	2.7	10.6*
Four	22.9	36.9*
Three	13.1	25.9**
Two	7.5	8.6 ns
DS-gradeschool	21.5	26.6 ns
DS-adolescent	45.5	52.6 ns

* $p < .05$. ** $p < .01$.

very often queried the experimenter about the animals. Thus, perhaps only the outright statements of confusion are truly indicative of grammatical uncertainty in this population. If only these statements are considered, we see a split between the adolescents and gradeschool children: Of the 12 statements of confusion expressed by the adolescents, 10 co-occurred with ungrammatical sentences. Only one statement of confusion was produced by any gradeschooler; the fact that this also co-occurred with an ungrammatical sentence is difficult to assess, given the small numbers.⁴ Thus, although the gradeschoolers with DS talked about half as much as the adolescents, they produced disproportionately fewer statements of confusion in response to the ungrammatical sentences. This suggests that the gradeschoolers' explicit recognition of the ungrammaticality of these verbs in unattested frames is less well developed than that of the adolescents.

General Discussion

In the experiment presented, we explored the extent to which maturational, lexical, or syntactic factors affected how schoolchildren and adolescents with Down syndrome interpreted familiar verbs in novel syntactic frames. Prior work with normal-IQ individuals (Naigles, Fowler, & Helm, 1992; Naigles et al., 1993) suggested that when children are very young, the argument structure for any given verb is sufficiently flexible that it can accommodate to a novel syntactic frame; the frame therefore tends to determine the interpretation. By adulthood, the argument structure of the verb has apparently stabilized enough to override most contradictory information provided by the syntactic frame. In short, in the normal-IQ case, we know that performance shifts from predominantly Frame Compliant to more Verb Compliant as children grow simultaneously older, smarter, and linguistically more sophisticated. But which of these three factors bears on their construal of the task and the verbs placed before them? We suggest that by studying schoolchildren and adolescents with DS—individuals for whom maturational, cognitive, and linguistic development are not as tightly linked as in the normal case—we may identify the important catalyst(s) for change.

Before discussing our results, we stress that basic knowledge of all 10 verbs and four frames was well within the competence of all children who participated in the study; children who failed to meet these criteria were excluded from the study. Thus, Frame and/or Verb Compliance cannot be

⁴Outright statements of confusion were also more evident in response to ungrammatical sentences than to grammatical ones for the normal-IQ adults, 4-year-olds, and 3-year-olds (1, 7, and 6 statements with grammatical sentences; 5, 14, and 12 statements with ungrammatical sentences, for the adults, 4-year-olds, and 3-year-olds, respectively). The 2-year-olds, by contrast, produced only two statements of confusion, one co-occurring with a grammatical sentence and one with an ungrammatical sentence.

attributed to a lack of any familiarity with the verbs nor to an insensitivity to the frame presented. Our major findings were that the gradeschoolers with DS performed Frame Compliantly with every syntactic frame and that the adolescents with DS had begun to shift toward Verb Compliance with the NV frame. Within this population, then, we observed both an age effect and a frame effect. In the following section, we discuss what these effects reveal about language in the DS population and what they reveal about the acquisition of verbs and argument structure more generally.

Language in the DS Population. The results from the Noah's Ark task indicate that schoolchildren with DS perform much like normal-IQ 2-year-olds with regard to their degree of Frame Compliance. This is consistent with their language age and well behind expectations based on general cognitive growth. The adolescents with DS also performed well behind mental age; their degree of Frame Compliance was closest to that of the normal-IQ preschoolers. Insofar as our Noah's Ark task is construed to be syntactic in nature, these results corroborate evidence using other methodologies and looking at other aspects of syntax (e.g., Fowler, 1990). That is, the syntactic knowledge of individuals with DS is disproportionately delayed relative to their mental age.

Our second finding, that the adolescents with DS appear to have begun to shift toward Verb Compliance with the NV frame, suggests that language acquisition continues during the gradeschool years and perhaps into adolescence. As in other studies, what appears to be a plateau is followed by an upswing in language growth at a surprisingly late point in development. Although these results are suggestive, they may ultimately challenge the prevailing view of a shutdown of language acquisition in adolescence (see also Fowler, 1988; Meyers, 1988; Miller, 1988). The significance of this finding for the role of maturation specifically in the acquisition of verbs and their argument structures is discussed in more detail in the sections following.

The Acquisition of Verbs and Argument Structure. The adolescents with DS were considerably more Frame Compliant than most of the normal-IQ comparison groups. Nonetheless, they were identical to the comparison groups with respect to the developmental sequence. That is, the first frame to elicit substantial amounts of Verb Compliance in both normal-IQ and DS individuals was the NV frame. This finding reinforces the contention of Naigles, Fowler, and Helm (1992) that the pattern of frames shifting toward Verb Compliance, at least for the four frames tested, is a principled one based more on differential linguistic complexity than on particular strategies for handling unattested sentences. Children with DS are often relatively adept at using nonlinguistic or pragmatic strategies to handle difficult linguistic (especially syntactic) tasks (Beeghley, Weiss-Perry, & Cicchetti, 1990;

Price-Williams & Sabsay, 1979); however, if those factors alone had led to the shift in the responses to our "Noah's Ark" task, we would not have obtained the significant frame effect from the adolescent group. It seems clear that this task is tapping developing lexical and syntactic knowledge in both normal-IQ and DS subjects.

The subjects with DS also bear on our conceptualization of verb acquisition by highlighting the problematic nature of the lexicon/syntax split. Recall that the DS subjects' performance most closely resembled that of their syntactic age-mates, thus suggesting that the task was tapping syntactic knowledge. On the other hand, even within this generally Frame Compliant group, some verbs—usually the same ones as had been observed in the normal-IQ groups—were enacted Verb Compliantly both earlier and more consistently than others. This finding implicates a significant lexical component in the task. We believe that these findings are not contradictory; rather, they are the inevitable result of dealing with verbs. Verbs, by their very nature, incorporate general conceptual knowledge (e.g., certain verbs encode movement), language-specific semantic knowledge (e.g., certain verbs encode the manner of movement), and specific syntactic knowledge (e.g., certain verbs involve particular argument structures). In sum, verbs are difficult to categorize as lexical or syntactic *because* they have multiple components.

The Noah's Ark task, which involves (depending on one's perspective) verbs in ungrammatical sentence frames or sentences containing the wrong verbs, investigates several of these components simultaneously. In fact, we suggest that, for the youngest normal-IQ group and the schoolchildren with DS, the task is predominantly syntactic. These subject groups, like 2-year-olds encountering novel verbs in a preferential-looking paradigm (Naigles, 1990; Naigles & Kako, 1993), relied wholly on the syntactic frame to interpret verb meaning. In contrast, for older normal-IQ children and for adolescents with DS, the task was lexical. These groups disallowed ungrammatical argument structures on a verb-by-verb basis. The questions produced by the subjects supported this lexical focus, singling out the verb as the source of concern in their enactments (e.g., "I don't know what *comes* means" and "Brings? Brings what?"). Thus, whether the task is viewed as predominantly syntactic or predominantly lexical may well depend on the level of linguistic knowledge of the individual subject.

Finally, the data suggest that the shift toward Verb Compliance does not seem to be maturationally bound, either at the beginning or at the end of development. Previous work has demonstrated that the shifts toward Verb Compliance begin anywhere between the ages of 2 and 7 in the normal-IQ population (Naigles, Fowler, & Helm, 1992; Naigles et al., 1993; see also Fig. 11.1). The study presented here expands this range, showing that subjects with DS begin to shift toward Verb Compliance at or beyond the onset

of puberty. It therefore does not seem to be the case that, whatever the degree of Frame Compliance achieved by children before puberty, no further development can occur in adolescence. Rather, there is evidence of modest but significant syntactic and lexical growth during the teenage years. This continued growth, combined with the findings from the normal-IQ population, suggests that what one knows about the language itself may play a much larger role than maturational factors in reducing flexibility.

This is not to say that maturation plays no role in language acquisition. In fact, research on both first and second language acquisition (Curtiss, 1979; Gleitman, 1981; Johnson & Newport, 1989; Newport, 1990) has provided important evidence that the ability to learn particular aspects of a language declines over age. Interestingly, much of this evidence for maturational constraints has involved linguistic structures rather distinct from verb argument structure, including auxiliary verbs, inflections, classifiers, determiners, and pronouns. Our data suggest only that it is unlikely that verb argument structures become rigid at some maturationally determined date. Thus, verb argument structures, at the very nexus of syntax and semantics, may not be nearly as dependent on maturational factors as the closed-class items.

So how are verbs and their argument structures acquired? At the beginning of verb learning, general rules that link verb meaning and syntax are exploited, allowing syntax to constrain the meanings of novel verbs. This general rule usage, known as syntactic bootstrapping, remains in effect for novel verb learning in adulthood; however, new syntactic information no longer affects the construals of familiar verbs in an indiscriminate fashion. Rather, for both normal-IQ subjects and those with DS, prohibition of novel syntax takes hold frame by frame and verb by verb. In accord with our lexical knowledge hypothesis, we proposed that specific lexical and syntactic information concerning each individual verb must be accrued in order to establish stable verb representations. This accrual may be aided by principles such as *uniqueness* (e.g., Clark, 1987; Wexler & Culicover, 1980) and by attention to the frequency and diversity of verb presentations in the input. For example, the principle of uniqueness can account for the shift toward Verb Compliance for transitive *come* and *go*, in that the attested transitive and causative verbs *bring* and *take* preempt the other, virtually synonymous entries. Likewise, the attested intransitive verbs *come* and *go* may preempt intransitive *bring* and *take*. To explain the sequence of these preemptions in development, we appealed to demonstrated differences in the use of these verbs to young children, in that *come* and *go* are used much more frequently than *bring* and *take*. We conjectured that verbs that are more commonly encountered allow the child to activate preemption much earlier.

In the case of children with DS, it may be the very lack of accrual of information about verbs and their cues that slows them down. For example, it appears that both phonological memory and phonological codes for in-

dividual words are often deficient compared to other children matched on receptive vocabulary age (Fowler, Doherty, & Boynton, 1992). These factors were found to slow further lexical development in other populations (Gathercole & Baddeley, 1989). This poorly detailed database, compounded by the demonstrably impoverished syntax of children with DS, may certainly hamper the successful exploitation of the principle of uniqueness as well as of the information in the input.

CONCLUSIONS

In this chapter we discussed the complex intertwining of syntax and semantics in the development of verb meanings. Our aim was to show how reversing the usual approach and focusing on how syntactic knowledge and syntactic tasks shed light on verb meaning can be revealing with respect to the acquisition of verbs. Prior research has shown that familiar syntactic frames can be used by very young children as information about the meaning of a novel verb (i.e., syntactic bootstrapping). Furthermore, children's interpretations of familiar verbs in novel syntactic frames in the Noah's Ark task can reveal how their verb meanings and argument structures are finally established. We presented a new study employing the same task with a new population, namely, children with DS and obtained the same interdependence of verb syntax and verb semantics. On the one hand, children with DS perform most like their normal-IQ syntactic peers, not like chronological or vocabulary peers, yet their eventual shift toward Verb Compliance seems to be dependent on features of individual verbs. Determining the meaning of a verb is partly dependent on the syntactic frames in which it appears, and establishing those syntactic frames in which it can appear is partly a function of the meaning thus far constructed. We therefore suggest that where the child is in the process of verb learning—that is, whether syntax is allowed to be informative about verb meanings—is dependent not on intelligence or maturational status but on the child's level of linguistic sophistication.

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