Learning to Generalize Verbs to New Syntactic Environments[∗]

Nitya Sethuraman   Judith C. Goodman
Indiana University   University of Missouri

1. Conservatism in Verb Learning

Processes of generalization have been at the core of many debates in child language. That is, how do children get the grain-size of generalization correct? If such processes are broad, if children entertain the most abstract possible description of a language, then constraints are needed to reign in those generalizations. If such processes are highly conservative, then the theoretical problem is how children move from narrow construals to appropriately broad ones.

Recent research has suggested that children's verb learning in particular begins with too-narrow generalizations (e.g. MacWhinney 1982, Schlesinger 1982, Bowerman 1977, 1982, Bates and MacWhinney 1987). This conservatism has been most studied with respect to verb use (e.g., Akhtar & Tomasello 1997, Bowerman 1982, Braine 1976, Gropen et al. 1989, Lieven et al. 1997, MacWhinney 1982, Olguin & Tomasello 1993, Schlesinger 1982, Tomasello 1992, 2003, Tomasello & Brooks 1999). Researchers have found that when children first begin to produce word combinations, syntactic patterns that children use with one verb are not immediately used with other verbs. In addition, once children learn a verb in one syntactic pattern, they don't immediately use it in other patterns in which that verb can participate. For instance, a verb that is used with a direct object may not immediately be used with a prepositional phrase as well.

Tomasello (1992, 2003) hypothesizes that children first learn how to use verbs in multi-word utterances on a verb-by-verb basis. Children initially use verbs only in syntactic patterns in which they've heard them used previously; patterns and morphological markers learned for one verb do not immediately generalize to other verbs. He argues that they treat each verb as a separate "verb island". Below (Table 1) are examples of two verb islands in one child's speech:

TABLE 1: EXAMPLES OF VERB ISLANDS (DATA FROM TOMASELLO 1992: 340-341)

Age of first use	DRAW	CUT
17mo	*yaya* [child's initial pronunciation of 'draw']	*cut*
18mo	*yaya book* ['draw book']	
19mo		*cut-it toes*
20mo	*draw star on me*	*cut Weezer*
21mo		[no recorded uses]
22mo		[no recorded uses]
23mo		[no recorded uses]
24mo		*cut it with the knife*

This child uses *draw* (initially *yaya*) and *cut* as bare verbs at around 17 months of age. However, each verb develops further on its own timeline. At 18 months, she uses *draw* with a direct object. The child starts producing a form of *cut*, *cut-it*, with a direct object at 19 months; she uses *cut* by itself with a direct object at 20 months. At this time, she is using *draw* with a direct object and a preposition phrase. It's not until 24 months that she uses *cut* with a direct object and preposition phrase. Her use of each of these verbs at any given time is best predicted by her use of the same verb at an earlier age, not a different verb at the same age. Each verb is effectively an "island of organization in the sea of grammar" in her language at this stage (Tomasello 1992).

An important question raised by this proposal is how children move from individual item-specific verb usages to more general and abstract argument structure patterns (e.g., Bates & MacWhinney 1987, Bowerman 1982, Tomasello 2003). If children simply mirror their input, how do they learn to generalize verbs to new syntactic patterns? Obviously, this must occur at some point, because adults comprehend and produce utterances with novel combinations of verbs and syntactic patterns (e.g., *as a soup that eats like a meal* and *cry me a river*).

The main question that we address here is how do children learn to generalize verbs to new syntactic patterns? For example, what aspects of the input provide children with the best information for learning to generalize? To address these issues, we examine which verbs are first generalized to new syntactic patterns as well as the factors that influence children to extend these verbs. We argue that a number of different factors play a role in verb generalization, and no one of these factors alone fully explains when or why a child extends a particular verb to new syntactic patterns. We examine five factors in this paper, discussing the importance of each factor in explaining verb generalization and the inability of each factor alone to determine when a verb will be extended to new syntactic patterns.

2. Method

We conducted a corpus study examining what verbs children first use in more than one syntactic pattern. Data samples were collected from the Goodman Longitudinal Study (Bates & Goodman 1997), which includes 28 children from 12 to 30 months of age. The monthly sessions were one hour long and consisted of a 10-minute free play session followed by a variety of tasks designed to assess language and social development, recorded on audio and videotape. Sessions were transcribed using CHAT conventions (MacWhinney 2000) for the 22 children who had missed no more than one session at the ages of 18, 20, 22, 24, 26, 28, and 30 months.

The number of utterances produced by the children is shown in Table 2. For our analysis, we were only interested in complete utterances which contained a lexical verb of English and which followed English word order (these utterances are listed under "Counted"). Utterances without a verb ("No Verb") were discounted. Auxiliary verbs were not counted in the analysis ("Auxiliary Verb"), either when used as the main verb (e.g., *I am happy*) or in utterances that contained both an auxiliary verb and a lexical verb (e.g., *drive* would be counted in *I can drive there*, but *can* would not). The following types of utterances ("Thrown Out") were not part of the analysis: incomplete, imitation, self-repetition, routines, unintelligible, ambiguous, involving "made up" verbs, idiomatic or set phrases, and unclassifiable utterances. Utterances that are ambiguous in meaning or part of speech (e.g., a single word used which could be interpreted as a noun or a verb such as *swing* and which could not be disambiguated from context) were discounted, as well. Set phrases such as *thank you, you're welcome, wait a minute, I don't know*, etc. were also discounted as being idiomatic phrases children often learn unanalyzed.

TABLE 2: UTTERANCES THAT WERE INCLUDED AND DISCOUNTED IN THE ANALYSIS

Age (mo)	Counted	No Verb	Auxiliary Verb	Thrown Out
18	100	2256	65	4201
20	196	2866	84	4330
22	577	3318	305	5071
24	989	3771	640	5135
26	1142	3370	780	4523
28	1702	3279	1182	4458
30	2404	3698	2109	5587
Total	**7110**	**22558**	**5165**	**33305**

We examined a total of 7110 utterances in the Goodman Corpus. We coded the children's utterances syntactically for post-verbal NPs, locatives (*here, home, on the chair*), non-locative PPs (*with your brother*), ADJs (*look pretty*), ADVs (*get ready*), VPs (*make him do it*), and Ss (*I thought you did it*). We examined the codings to determine what syntactic patterns were used with what verbs to determine which verbs were first used in more than one syntactic pattern.

3. First verbs children use in multiple syntactic patterns

In Figure 1 we give the number of children who use verbs in more than one syntactic pattern. Early on (18-20 months), only a small proportion of children use any given verb in multiple syntactic patterns. We see a big "jump" in use of verbs in multiple syntactic patterns between 22 and 24 months. By 26 months, nearly all children use verbs in multiple syntactic patterns.

FIGURE 1: NUMBER OF CHILDREN USING VERBS IN MULTIPLE PATTERNS, 18-30 MONTHS OF AGE (DATA FROM BATES & GOODMAN 1997)
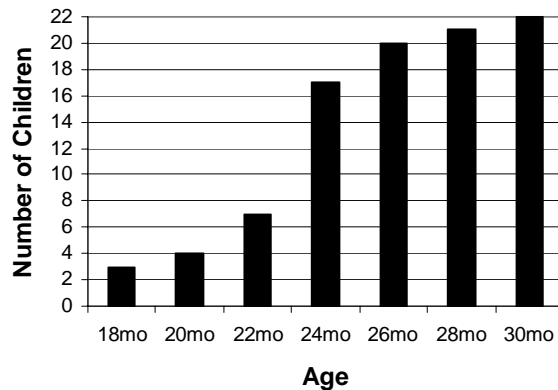
The first question of the study asks what verbs are first used by children in more than one syntactic pattern.

FIGURE 2: FIRST VERBS USED IN MULTIPLE SYNTACTIC PATTERNS BY THE 22 CHILDREN (DATA FROM BATES & GOODMAN 1997)
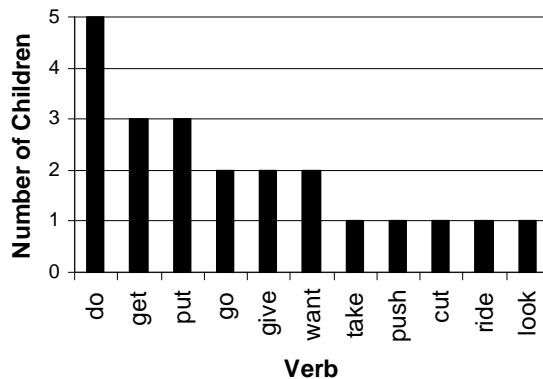

Figure 2 shows the verbs that children used first in multiple syntactic patterns. For five children, *do* was the first verb that they used in more than one syntactic pattern. Likewise, for three children, it was *get* and *put*. *Go, give,* and *want* are first extended by 2 children. Finally, *take, push, cut, ride*, and *look* were each extended by one child.

Children consistently extend particular verbs first to multiple syntactic patterns. But we do not know yet why they generalize some verbs to new syntactic patterns before others. Some

possible explanations may lie in characteristics of the input. Others may rest on semantic characteristics of the verbs themselves. In the next section, we examine five potential factors that lead children to generalize verbs to new syntactic environments.

4. What factors influence children to use verbs in multiple patterns?

Highly-frequent verbs like *do, get, put* and *go* are the first verbs children extend. But, this raises a deeper question: why are these verbs the first to be extended?

We examine 5 possible explanations:

1. Frequency (Theakson et al. 2004): Children first extend the verbs they hear and use most frequently to new syntactic environments.

2. Syntactic consistency (Goldberg et al. 2004): Children first extend the verbs they hear used predominantly in one particular syntactic environment.

3. Syntactic diversity (Naigles & Hoff-Ginsberg 1998): Children first extend the verbs they hear used in many different syntactic environments.

4. Pronouns (Childers & Tomasello 2001, Dodson & Tomasello 1998): Children first extend to new syntactic environments the verbs they hear used more frequently with pronouns than with lexical nouns.

5. Lightness (e.g., Clark 1978): Children first extend verbs that have highly general meanings that are easily applicable to many situations. In other words, there may be something about the general meanings of light verbs that help children learn to use them in diverse ways very early.

Although none of these ideas was initially designed to directly address why certain verbs are extended to new syntactic environments before others, they may be relevant in explaining syntactic generalization. It is unlikely, however, that any one factor alone can explain what verbs children will first use in multiple syntactic patterns. Rather, we argue that this is a very complex problem with much redundancy. As we discuss each of these factors in turn, we first show evidence that each factor may be important for children in extending verbs to new syntactic patterns, and then provide evidence that none of these factors alone can explain the phenomenon.

4.1 Frequency
Factor 1: Children first extend the verbs they hear and use most frequently to new syntactic environments
      Frequency of use may be the best predictor of which verbs children learn to generalize first to new syntactic environments. Children initially use inflections with highly frequent words (Fortescue & Olsen 1992, MacWhinney 1985). Children later learn to use inflections with more infrequent words. In addition, verbs most frequently used by parents are the verbs first used by children (Goodman, Dale, and Li 2002, Naigles & Hoff-Ginsberg 1998). We found evidence to support the idea that frequency is an important factor in generalization: *want, do, put, get,* and *go* were the most frequent verbs used by the children as well as the verbs most frequently used by the children in multiple syntactic environments.
      The reason that frequency can't be the sole explanation is that there are many exceptions. *Sit* and *have* were among the most frequent verbs used by the children, but were not used in multiple syntactic patterns by any. *Ride* and *cut* were not among top 20 most frequently used

verbs, but were extended to multiple contexts by two children. Lastly, the 19th most frequent verbs were *give* and *like,* however *give* was extended by two children and *like* was not extended by any children.

4.2 Syntactic Consistency
Factor 2: Children first extend the verbs they hear used predominantly in one particular syntactic environment

       Goldberg et al. (2004) have shown that consistency of verb use helps with learning syntactic patterns. Certain verbs are used by parents most frequently in specific syntactic patterns. This consistency of use plays a role in children learning to associate the meaning of certain verbs with specific syntactic patterns. They examined data from the Bates Corpus which is available on CHILDES (Bates et al. 1988, MacWhinney 2000). This longitudinal corpus consists of 28 children, at ages 20- and 28-months-old, observed longitudinally in the home for 15 minutes. Mother/child interaction consisted of free play, snack time, and story time. Goldberg et al. examined speech from the 28 children and 15 mothers at both ages. They were interested in whether there was a most frequent verb in children's and mothers' uses of the (SUBJECT) VERB LOCATION and (SUBJECT) VERB OBJECT LOCATION patterns.

TABLE 3: MOST FREQUENT VERBS USED IN TWO PATTERNS BY 20MO- AND 28MO-OLD CHILDREN AND THEIR MOTHERS (DATA FROM GOLDBERG ET AL. 2004, SETHURAMAN 2002)

Group	Age	Subject Verb Location	Subject Verb Object Location
Mothers	20mo	133 uses, 15 verbs ***go* 67%,** *come* 12%	148 uses, 18 verbs ***put* 61%,** *take* 10%, *turn* 10%
	28mo	353 uses, 39 verbs ***go* 39%,** *come* 15%	250 uses, 43 verbs ***put* 40%,** *take* 7%
Children	20mo	6 uses, 2 verbs *go* 83%	1 use, 1 verb *throw* 100%
	28mo	224 uses, 25 verbs ***go* 54%,** *get* 6%	51 uses, 12 verbs ***put* 31%,** *get* 16%

       Goldberg et al. found that mothers talking to their children at both 20 and 28 months of age (see Table 3) used *go* most frequently in SUBJECT VERB LOCATION and *put* most frequently in SUBJECT VERB OBJECT LOCATION. In fact, in mothers' speech to the younger children, *go* and *put* make up a larger proportion of usage in SUBJECT VERB OBJECT LOCATION than in mothers' speech to the older children. This provides the younger children with more focused and consistent input and might help the younger children who are just beginning to use these syntactic patterns. However, the older children are using both of these patterns productively with a number of different verb types, and mothers addressing them use a wider range of verbs.

       The use of verbs in specific syntactic patterns may help children learn to associate the meaning of the verb with the syntactic pattern in which it is used most frequently. Although it is counterintuitive, consistently hearing verbs used in the same syntactic patterns may help children learn to generalize those same verbs to new syntactic environments, by providing young learners with a starting base from which to learn to use the verb. When infrequent syntactic patterns are then used with this verb, they may "pop out" in contrast.

       Examining the data "in reverse", we find that *go* and *put* are also used in very few syntactic patterns (Table 4). *Go* predominantly occurs in (SUBJECT) VERB LOCATION, as well as a few other patterns, and *put* predominantly occurs in (SUBJECT) VERB OBJECT LOCATION, as well as a few other patterns in both the children's and mothers' speech. This type of input provides children with very consistent input syntactically.

Group	Age	Uses of "GO"	Uses of "PUT"
Mothers	**20mo**	111 uses, 4 patterns **82% VL**; 8% V	92 uses, 3 patterns **96% VOL**
	28mo	182 uses, 6 patterns **76% VL**; 13% V	114 uses, 4 patterns **94% VOL**; 5% VO, 5% VL
Children	**20mo**	8 uses, 2 patterns **50% VL**; 50% V	0 uses
	28mo	142 uses, 3 patterns **75% VL**; 20% V	21 uses, 2 patterns **76% VOL**; 24% VL

We further examined the distributional frequencies of syntactic patterns in which particular verbs are used in parent input by comparing two corpora. If we find relationships across corpora, then the findings are not due to specific mother-child relationships, but are more general to English. We roughly matched for frequency two verbs that were extended with two verbs that were not extended. We find that the verbs that are extended by children in the Goodman corpus, such as *give* and *put*, tend to be used overwhelmingly consistently in one particular pattern in the mothers' speech in Bates. *Like* and *eat*, which are not extended by children in the Goodman corpus, are used predominantly in one pattern by mothers in Bates', but not to the overwhelming extent that *give* and *put* are (Table 5).

TABLE 5: MOTHERS' USES OF FOUR VERBS IN VARIOUS SYNTACTIC PATTERNS TO 28-MONTH-OLDS

Extended	Not Extended
GIVE 27 uses, 3 patterns **86% V-NP-NP** 7% V-NP-PP	LIKE 53 uses, 4 patterns **62% V-NP** 23% V-VP
PUT 114 uses, 4 patterns **94% Verb-Obj-Loc**	EAT 119 uses, 7 patterns **60% V-NP** 25% V

As discussed previously, this account does not solely explain what verbs children will generalize. One problem is that it's not clear how consistent the use has to be in order to be called "consistent" and there appear to be exceptions to every rule. We again roughly matched another two pairs of verbs for frequency: *look* vs. *eat* and *get* vs. *have* (Table 6). In this case, the verbs that were extended (*look* and *get*) were not used overwhelmingly consistently in one particular syntactic pattern. On the other hand, the verbs that were not extended (*eat* and *have*) were used much more consistently in one particular syntactic pattern (though still less frequently than *give* and *put*).

TABLE 6: MOTHERS' USES OF FOUR VERBS IN VARIOUS SYNTACTIC PATTERNS TO 28-MONTH-OLDS

Extended	Not Extended
LOOK 74 uses, 7 patterns **31% V** **31% V-PP**	EAT 67 uses, 6 patterns **69% V-NP** 11% V
GET 103 uses, 10 patterns **50% V-NP** 13% V-NP-PP	HAVE 84 uses, 6 patterns **70% V-NP** 17% V-NP-PP

4.3 Syntactic diversity
Factor 3: Children first extend the verbs they hear used in many different syntactic environments
Syntactic diversity has also been proposed as a factor underlying verb generalization. Naigles and Hoff-Ginsberg (1995, 1998) show that syntactic diversity of maternal syntactic patterns is an important cue for children learning new verbs. They find that the verbs mothers use in a large number of syntactic patterns correlate significantly with the verbs children use in a large number of syntactic patterns. Naigles & Hoff-Ginsberg (1998) found that the verbs used in the greatest number of syntactic patterns by mothers were *go, come, put, push, sit, take, see, look*, and *want*. Most of these verbs were the first verbs extended by the children in the Goodman corpus.

In our data, syntactic diversity alone does not provide an explanation for all the verbs we found extended in the Goodman corpus. Some verbs that were used in many syntactic patterns by the children we examined were not extended early (e.g., *sit, see*) and some verbs that were extended by children were not used in many patterns by mothers (e.g., *ride, cut*).

4.4 Pronouns
Factor 4: Children first extend the verbs they hear used more frequently with pronouns than with lexical nouns
Pronouns may provide children learning English with important information about constructions. Because there are a limited number of them and they occur with high frequency in parental input in English, they are easy markers for children to attend to. Pronouns provide children with morphological information (e.g., *I* vs. *me, he* vs. *him*). In addition, pronouns may provide children with syntactic information about the form of a construction. Dodson and Tomasello (1998) and Childers and Tomasello (2001) suggest that the transitive schema is structured around a "pronoun frame" (e.g., *He ___ it, I ___ it, you ___ him*), giving children a highly focused type of input that cues them onto the transitive. In other words, pronouns may provide English-learning children with cues that help them identify transitive utterances.

We suggest that hearing verbs used frequently with pronouns may help children learn to generalize those verbs to new syntactic environments. As discussed above, pronouns provide children with morphological information and have been suggested to provide syntactic information about the transitive. Pronouns may provide syntactic information about other syntactic patterns, as well, and this information may very well be important for helping children learn to generalize verbs to new syntactic environments.

The idea that pronouns may be important for children learning to extend verbs holds for some verbs but not others. In our data, we find that *do*, *get*, *put*, *want, take* are the verbs that are most frequently extended first. Laakso & Smith (2004) find that these verbs are used much more frequently with pronouns than with nouns. In addition, in our data, we find that *have* is not extended early by children. Laakso & Smith find that *have* is used more with nouns than with

pronouns.

However, as before, there are exceptions. In our data, *like, make,* and *say* are used more frequently with pronouns than nouns but are not extended first by any children in the Goodman corpus. There is also, as in other factors, a confound with frequency: highly frequent verbs occur with everything.

4.5 "Semantic lightness"
Factor 5: Children first extend verbs that have highly general meanings that are easily applicable to many situations. In other words, there may be something about the general meanings of light verbs that helps children learn to use them in diverse ways very early

The factors discussed so far bear on properties of the input. Semantic properties of the verbs themselves may also be important. Many researchers have noted that there is a class of verbs, called "light" verbs, which appear to have special features. Light verbs have general meanings applicable to many situations (Clark 1978, 1990, 1996), are highly frequent in both adult and child speech (Clark 1978, Theakson et al. 2004), are learned early by children cross-linguistically (Clark 1978), and are often involved in grammaticization cross-linguistically (Ninio 1999). Examples of light verbs are *do, go, give, put,* and *make*.

Researchers have found that light verbs also tend to generalize to new syntactic patterns earlier than other verbs. Bloom et al. (1980) find that light verbs, what they call "pro-verbs", such as *go, do, make,* and *get*, are the first verbs that are used with more than one inflectional marker. Other verbs that also occurred with more than one inflection are *eat, sit, ride*, and *fix*, but unlike the light verbs, each of these occurred predominantly with one particular inflection. In addition, Bloom et al. found that light verbs are also the verbs most commonly used with other forms, such as *wh*-questions, and that as the children learned to use light verbs in those forms, they were able to include other verbs. We looked at the semantic lightness of the verbs that were first extended by the children in the Goodman corpus: 82% of the verbs children first extended were light verbs.

Previous research suggests that light verbs may be good candidates for what verbs are extended early to new syntactic environments by children, but lightness alone is unlikely to explain which verbs are generalized first. Theakson et al. (2004) point out two issues: there is no agreement between researchers on what set of verbs are light, and there is a confound with frequency because verbs that are listed as light are also the most frequent verbs used by both children and adults. Theakson et al. find that when the effects of semantic generality are removed, frequency appears to account for what verbs are learned first and used most frequently, what verbs are used in syntactically diverse patterns, and what verbs are used in particular syntactic patterns. Lastly, in the Goodman corpus, some children first extended so-called "heavy" verbs to multiple patterns (*cut, ride*).

5. Discussion and conclusion

Across twenty-two children, the same set of verbs are extended first: *do, go, get, put, want, take* are extended first by 82% of children examined. We explored five possibilities that may be important factors for why some verbs are extended early and why other verbs are not. These factors are frequency, syntactic consistency, syntactic diversity, use with pronouns, and "semantic lightness".

The question of how children learn to generalize is important. There are many possible explanations for how children learn to generalize, but everything appears to be linked to frequency:

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        Pronouns                    Semantic Lightness
                 \            /
                  FREQUENCY
                 /            \
        Syntactic Diversity          Syntactic Consistency
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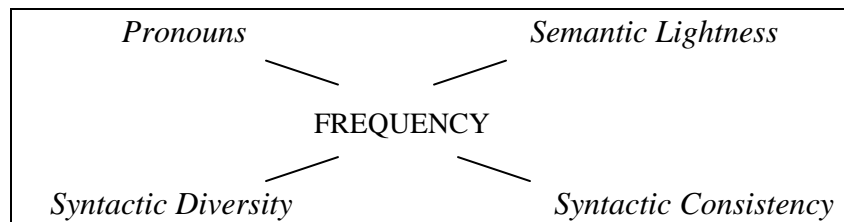
One reason that any one of these different factors alone seems inadequate in explaining syntactic generalization is that they are all confounded to one degree or another with frequency. However, we think that understanding verb generalization requires a multi-factor explanation. The factors may not be entirely orthogonal, but we do believe that they can be teased apart to some degree.

In studying language acquisition, it is important to study the processes of generalization. Understanding what aspects of the input allow children to generalize informs us about the role of input, redundancy in the input, and the learning mechanisms children use.

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