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ABSTRACT

A study investigated the validity of a linking rule of object affectedness; the rule states that an argument is expressed as the direct object of a verb if its referent is specified as affected in a specific way in the semantic representation of the verb. Specifically, the study examined whether the principle determines which argument will be encoded as direct object and which as oblique object ("Dan stuffed the hamper with laundry," or "Dan stuffed laundry into the hamper"). Four experiments were conducted with a total of 216 children aged 3.4-9.4 and 72 adults. In each, the subjects were taught novel verbs for actions involving transfer of objects to a surface or container, and were tested on their willingness to encode the figure or ground as the direct object. Results indicate that relatively more figure-object sentences were produced with verbs for which the figure changed location in a particular manner, and more ground-object sentences with verbs in which the ground changes. In addition, it was possible to explain children's absolute preferences, or lack of preferences, for a particular syntax type. It is concluded that a causal relationship holds between verb meaning and verb syntax, as formulated in the linking rule. (MSE)

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OBJECT AFFECTEDNESS AND THE ACQUISITION OF NOVEL VERBS

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It is common these days to hear talk about the relevance of lexical meaning to other levels of representation in the grammar and/or lexicon. The question we address here is whether a particular principle governing the linking of semantic arguments to grammatical functions is relevant to how children actually acquire the argument structure of verbs.

By ARGUMENT STRUCTURE, we mean how a verb expresses its arguments in syntax. For example, let's consider some of the possible argument structures of 'locative' verbs -- verbs involving the transfer of a substance, object, or group of objects to a surface or container. To keep things straight, let's use the gestalt term FIGURE for the stuff that's transferred, and the term GROUND for the surface or container that it's transferred to. These aren't meant to be technical terms; they're just convenient labels. One argument structure can be called the FIGURE-OBJECT FORM because the direct object corresponds to a Figure, such as the water in *Betty poured water into the cup* or the paint in *Tom dripped paint onto the floor*. Another argument structure can be called the GROUND-OBJECT FORM because the direct object corresponds to a Ground, such as the glass in *Mike filled the glass with water* or the bed in *Lloyd covered the bed with a sheet*. Notice that some locative verbs, such as *load* and *stuff*, may appear in either form; *Dan stuffed the hamper with laundry*, *Dan stuffed laundry into the hamper*. These verbs we shall call ALTERNATORS.

Now the question we're interested in is whether a particular principle linking verb meaning and verb syntax determines which argument will be encoded as the direct object and which argument will be encoded as the oblique object. The principle we have in mind, which we shall call the LINKING RULE OF OBJECT AFFECTEDNESS, may be stated as follows:

> An argument is expressed as the direct object of a verb if its referent is specified as affected in a specific way in the semantic representation of the verb.

If we think of the typical locative event, it might be argued that both the Figure and the Ground are to some extent affected; after all, the Figure changes location and the Ground may change state -- for example, from being non-full to being full. The essential thing, however, is not what happens in the world, but rather *what the verb takes* to happen in the world. For example, *pouring* -- essentially -- tells you something about the way a liquid moves: in a cohesive stream. It wouldn't be *pouring* if one drop at a time changed location; that would be *dribbling* or *dripping*. Neither would it be *pouring* if an entire array of drops or particles changed location; that would be *splashing* or *showering*. On the other hand, *pouring* says nothing specific about a container or any other Ground. Certainly one may pour water into a glass, but it would still be *pouring* if the water missed the glass entirely. We can summarize these intuitions by saying that the meaning of *pour* specifies the way in which the Figure is affected, but does not specify the way in which the Ground is affected. According to the linking rule, then, we should expect to find that the direct object of *pour* encodes only the Figure. Indeed it does: one can say *Mary poured water into the glass*, but not **Mary poured the glass with water*.

The verb *fill*, on the other hand, only tells you something about the change of state that a container undergoes; namely, from unfilled to full. It says nothing specific about the substance. Again, you can certainly fill a glass by pouring water into it, but it would still be *filling* if the water dripped into the glass from a faucet. So, the meaning of *fill* specifies the way in which the Ground is affected, but does not specify the way in which the Figure is affected. According to the linking rule, therefore, the direct object of *fill* should encode only the Ground. Sure enough, one can say *John filled the glass with water*, but not **John filled water into the glass.*

Finally, the meaning of the verb *stuff* jointly constrains the particular change of location that the Figure undergoes and the particular change of state that the Ground undergoes. In *stuffing the hamper with clothes*, for instance, the clothing must be forced into the hamper -- perhaps compressing the clothing -- BECAUSE the hamper is being filled to a point where its remaining capacity is too small. According to the linking rule, the direct object of *stuff* should be able to encode either the Figure or the Ground. And this is what we find: *stuff* is an alternator.

The Object Affectedness Rule, as it turns out, may be quite general, applying not only to locative verbs in English but to other argument structures involving a direct object, and in many languages. In fact, there is a considerable amount of evidence for the following universal tendency: affected entities tend to be encoded as direct objects across the languages of the world. Some evidence for this claim comes from the finding that verbs that take an affected entity and an agent as arguments are invariably transitive, with the affected entity encoded as the direct object. Examples from English include causative verbs of change of position in some manner, such as *slide*, or verbs of ingestion, such as *eat*. In contrast, verbs that fall outside this broad semantic class show more variation within and across languages. For example, verbs of emotion may take either the stimulus (e.g., *fear*) or the experiencer (e.g., *scare*) as direct object, and verbs of surface contact (e.g., *hit*) may have their non-agentive argument expressed as the object of a preposition. For discussion, see Levin (1985), Hopper & Thompson (1980), and Talmy (1985).

The evidence for a Universal Tendency of Object Affectedness is quite compelling. The question that we'd like to raise, however, is what EXPLAINS this universal tendency. In four experiments we tested the hypothesis that a CAUSAL relation holds between verb meaning and verb syntax, as formulated in the linking rule of Object Affectedness, and that children as well as adults can use the linking rule to assign syntactic privileges to verbs. Altogether, 216 children (3;4-9;4) and 72 adults were tested. In each experiment, the sample of children was equally divided into three age groups, roughly centered on the ages of 4;0, 5;6, and 7;6. The logic of each of the experiments is the same: children and adults were taught novel or made-up verbs for actions involving the transfer of an object or objects to a surface or container. Subjects were then tested on their willingness to encode the Figure or the Ground as the direct object of the verb. In these experiments, the verbs were always taught with a neutral syntax -- the experimenter would say, for example, *this is mooping* while teaching the verb. The meanings of the verbs, however, were varied according to whether the Figure or Ground is affected in a particular and salient way (but the same Figures and Grounds were always used for both verb meanings in each experiment). In each experiment, it is predicted that children and adults should produce relatively more Figure-object sentences for verbs in which the Figure changes location in a

particular manner, and relatively more Ground-object sentences for verbs in which the Ground changes state in a particular way.

In the first experiment, each subject was taught and tested on two verbs, one at a time. In the manner condition, the experimenter would move a packet of marbles over to a piece of plastic with a zig-zagging manner, while saying (e.g.) *this is mooping*. In the endstate condition, the experimenter would again move a packet of marbles over to a piece of plastic, but this time with a non-descript manner, and with the end result that the piece of plastic would sag down: (e.g.) *this is keating*. Each verb was taught with several pairs of materials, and in addition children were asked to act out the meanings as a check on their comprehension. After a particular verb was taught, we tested the subject's ability to produce sentences with that verb, especially their willingness to encode either the marbles or the plastic as the direct object. Because subjects might have a general preference for one type of syntactic form or the other, masking any potential effect of verb meaning, we elicited sentences in two discourse contexts. In one context each subject was shown the action and then asked, 'what did I do to the MARBLES?' Notice that a natural response to this question is a Figure-object sentence, such as 'You keated the MARBLES onto the plastic'. In a second context, for the same verb meaning, each subject was asked, 'what did I do to the PLASTIC?' A natural response in this context would be a Ground-object sentence, such as 'You keated the PLASTIC with marbles'.

In principle, the frequencies of Figure-object and Ground-object responses are independent because children could fail to provide an unambiguous sentence of either type; in practice, however, ambiguous responses were rare (i.e., 8 out of 2048 elicitation trials (0.4%) in these four experiments). For this reason, and in order to indicate in one index a preference for one type of direct object or the other, we have analyzed the results for Experiment 1, and the other experiments, in terms of DIFFERENCE SCORES: the proportion of trials in which a Figure-object form was produced minus the proportion of trials in which a Ground-object form was produced. Difference scores therefore range from +1.0, a strong preference for the Figure or 'marbles' as direct object, to -1.0, a strong preference for the Ground or 'plastic' as direct object.

Experiment 1: Mean Difference Score for Novel Verbs as a Function of Meaning and Age Group

	AGE GROUP			
	3;4-4;5 (N=16)	4;7-5;11 (N=16)	6;5-8;6 (N=16)	Adult (N=16)
Manner Meaning	+1.00	+1.00	+0.88	+0.62
Endstate Meaning	+0.56	+0.38	+0.06	-0.38

Note: Data are only from the first verb taught to each subject, and comparisons are between subjects; similar results obtain within subject. See Gropen (1989) for a full discussion.

The results of Experiment 1 indicate a highly significant effect of verb meaning -- at $p < .001$ -- confirming our prediction: subjects produced relatively more Figure-object sentences (and relatively fewer Ground-object sentences) for the novel manner verb than for the novel endstate verb. Notice the difference in sign between the meaning conditions

for the adults: they produced absolutely more Figure-object forms for the manner verb, and absolutely more Ground-object forms for the endstate verb. The difference between these means is significant at $p < .02$. Although we don't see this absolute difference in sign for any of the child groups, the difference in means is significant for each child group, marginally so for the youngest and mid-aged children because of a ceiling effect.

The results show that children and adults can use affectedness as the basis for attributing at least SOME syntactic difference in the predicted direction between the verbs. However, we wanted to demonstrate that the observed syntactic difference corresponds to the discrete syntactic judgments that adults ultimately make about English non-alternating verbs like *pour* and *fill*. It would have been nicer, therefore, had we been able to show that the children had an absolute preference to express the manner verb more often in the Figure-object form, and the endstate verb more often in the Ground-object form. Part of the problem, we guessed, had to do with the complexity of the so-called endstate verb, in which the experimenter placed a packet onto a surface, causing the surface to sag. In fact, a post-hoc analysis of children's spontaneous utterances revealed that this action was subject to various interpretations, involving the affectedness of either the Figure or the Ground.

Therefore, in our second experiment we attempted to teach children and adults a purer endstate verb: the Ground changes color, not configuration, and furthermore the proximal cause of the change is chemical, not the motion of an impinging Figure. This should make subjects less likely to focus on the motion of the Figure. In designing this verb we took advantage of the fact that the juice from a red cabbage is a natural indicator; that is, the color of unadulterated cabbage juice is purple; if you add lemon juice to it, it turns pink; if you add a baking-soda solution to it, it turns green; if you add water to it, it stays purple. So, before the experimental sessions we soaked pieces of felt or absorbent paper in cabbage juice, and cotton balls or little sponges in water, lemon juice, or baking-soda solution. In the endstate condition, the experimenter moved a cotton ball over to a piece of felt with a nondescript manner, and the felt changed color from purple to either pink or green. *This is mooping*. In the manner condition, the experimenter would move a cotton ball over to a piece of felt with a zig-zagging or hopping manner, while saying (e.g.) *this is keating*. But this time there would be no color change because the cotton ball was damp only with water.

Before presenting the results, we must report that our plan to design a pure endstate verb apparently worked; the spontaneous utterances of the children showed that they understood the essential nature of a specific color change to the meaning of the endstate verb. Here are the results:

Experiment 2: Mean Difference Score for Novel Verbs as a Function of Meaning and Age Group

	AGE GROUP			
	3;5-4;5 (N=16)	4;7-5;8 (N=16)	6;7-8;5 (N=16)	Adult (N=16)
Manner Meaning	+0.38	+0.62	+0.88	+0.62
Endstate Meaning	-0.88	-1.00	-1.00	-1.00

Note: Data are only from the first verb taught to each subject, and comparisons are between subjects; similar results obtain within subject. See Gropen (1989) for a full discussion.

As should be fairly clear, we again found a very large effect of verb meaning -- in fact, it's a larger effect of verb meaning than we found in the previous experiment. The effect is highly significant not only for the adults, but for each of the child groups as well. Furthermore, this larger effect is entirely due to a shift in the difference scores for the endstate verb; the endstate score for the youngest children is significantly lower than zero according to a two-tailed *t*-test, and the rest of the endstate scores are at floor. In contrast, the manner scores are significantly greater than zero for every group except the youngest children. In sum, the results of this experiment, and the last, support our hypothesis that children and adults can assign a difference in the syntax of novel verbs on the basis of whether the Figure or the Ground is affected according to their meanings. Moreover, the difference in absolute preference that we found here corresponds to the discrete syntactic judgments that adults ultimately make about non-alternating verbs like *pour* and *fill*.

In our third and fourth experiments, we decided to test a more subtle variety of Affectedness which applies not to non-alternating verbs such as *pour* and *fill*, but to alternating verbs such as *stuff* and *load*. This variety of Affectedness has been called the "holism" effect because the Ground-object form of the verb carries the necessary implication that the Ground is totally or holistically affected. For example, the sentence *John loaded the cart with apples* implies that the cart ends up full of apples. On the other hand, the Figure-object sentence *John loaded apples into the cart* carries no such implication; John may have put a few apples into the cart, leaving most of the cart empty. The holism effect has been found not only for the English locative alternation, but also for the locative and other direct-object alternations in a variety of languages (see Green, 1974; Moravscik, 1978; Hopper & Thompson, 1980; Foley & Van Valin, 1985; Levin, 1985; Rappaport & Levin, 1988; Gropen, 1989; Pinker, 1989).

In Experiment 3, we wanted to test the ability of subjects to attribute syntactic differences to verbs which vary only in whether or not the Ground is holistically affected. Children and adults were randomly assigned to one of two between-subjects groups. In the partitive condition, for example, one peg would be placed into a hole on a board; *this is keating*. In the holistic condition, the same action would be repeated until all the holes on the board were plugged with pegs. We predicted that if children and adults were sensitive to this variety of Affectedness they should avoid uttering Ground-object forms in the partitive condition, because in that condition the Ground is not holistically affected.
The results bear out this prediction:

Experiment 3: Mean Difference Score for Novel Verbs as a Function of Meaning and Age Group

	AGE GROUP			
	3;5-4;10 (N=16)	5;0-6;11 (N=16)	7;0-9;4 (N=16)	Adult (N=16)
Partitive Meaning	+0.72	+0.75	+0.47	+0.56
Holistic Meaning	+0.28	-0.09	+0.38	+0.41

According to two-tailed *t*-tests, the difference scores for subjects in the partitive condition were significantly greater than zero for every age group except the oldest chil ren. In other words, subjects in the partitive condition selectively avoided uttering the Ground-object sentence, presumably for the same reason that they would avoid saying *John loaded the cart with apples* in the situation where most of the cart remained empty. In contrast, the difference scores for subjects in the holistic condition were not significantly different from zero for any of the age groups. Furthermore, we found a significant effect of verb meaning for the combined subjects and for the combined child groups; children and adults produced relatively more Figure-object sentences in the partitive-verb condition and relatively more Ground-object sentences in the holistic-verb condition. The direction and size of the effect are exactly as we would expect with verb meanings of this sort.

In Experiments 1, 2, and 3, the challenge was to manipulate verb meaning as an independent variable, but one of the first things we learned was that we couldn't completely control how a subject was going to interpret a novel verb. In Experiment 4 we decided to take a slightly different tack, with the hope of showing that the same event could be construed in different ways, leading to differences in syntax. Our method was essentially to present every subject with the same AMBIGUOUS action, find out how they construed the action, and then find out how they would express in syntax a novel verb for that action. In particular, the ambiguous action that we presented to subjects was a version of the holistic verb that we used in Experiment 3. For example, the experimenter repeatedly placed little strips of felt onto a board, one at a time, until the surface of the board was completely covered. Notice that this action can be interpreted in two ways: either as a way of affecting objects by PUTTING them onto a surface or as a way of affecting a surface by COVERING it with objects. So, before we had subjects learn a novel verb for the action, such as *keat*, and produce sentences with it, we simply asked them to use either the verb *put* or the verb *cover* to describe the new action. The prediction is that subjects who chose *put* would produce relatively more Figure-object sentences with the novel verb, and that subjects who chose *cover* would produce relatively more Ground-object forms with the novel verb. Here are the results:

Experiment 4: Mean Difference Score for the Novel Verb as a Function of Choice of *Put/Cover* and Age Group

	AGE GROUP			
	3;7-4;10 (N=13)	5;0-6;10 (N=12)	7;2-9;1 (N=8)	Adult (N=15)
Subjects Choosing *Put*	+0.06	-0.31	-0.19	+0.08
Subjects Choosing *Cover*	-0.79	-0.97	-0.62	-0.79

As predicted, we found that subjects who chose *cover* have a lower mean difference score than those who chose *put*, highly significant at $p < .001$. For each age group, the difference score is always lower for those subjects choosing *cover*, significantly so for every group except the small sample of oldest children. In addition, the difference score for each of these groups choosing *cover* is significantly less than zero. These findings show that subjects who interpreted the novel action as a way of affecting a surface by covering it, rather than as a way of affecting objects by putting them onto a surface, produced relativ

more Ground-object sentences with a novel verb for that action. Such subjects also had an absolute preference for the Ground-object form with the novel verb.

In summary, we were able to predict the syntactic privileges that subjects would assign to novel verbs in each of four separate experiments: we found that relatively more Figure-object sentences were produced with verbs for which the Figure was affected, and relatively more Ground-object sentences were produced with verbs for which the Ground was affected. In addition, we were able in most cases to explain children's absolute preferences, or lack thereof, for one type of syntax or the other. On the basis of these results we suggest that a causal relation holds between verb meaning and verb syntax, as formulated in the linking rule of Object Affectedness, and that something like this rule MUST be used under some circumstances.

The question, of course, is what those circumstances are: have we tapped into something that has some generality and importance in the language acquisition process? We think we have: children may actually use linking rules in learning which verbs permit alternations between argument structures. Some evidence for this claim comes from the correlation of syntactic and semantic ERRORS in children's speech. For example, Bowerman (1982) found that children between the ages of four and seven often overuse the Figure-object form, producing sentences such as **Can I fill some salt into the bear?* [referring to a bear-shaped salt shaker]. Errors of the other type, involving incorrect Ground-object forms (e.g., **I poured you with water*), also occur, but are much rarer. In Gropen, Pinker, Hollander, & Goldberg (in press) we suggested an explanation for these errors: if children are prone to systematic mistakes in verb meaning, such as the mis-specification of which entity is affected, the affectedness linking rule, even when applied correctly, would yield syntactic errors. We also noted that there was independent evidence that children are prone to making systematic errors in verb meaning, having more difficulty acquiring meaning components relevant to changes of state than components relevant to changes of location (Gentner, 1978). Thus on this account if a child erroneously thought that a Ground-object verb such as *fill* specified a particular manner of motion of the content argument (e.g., pouring), he or she could derive a Figure-object form from it and would produce errors like *fill the water*. In fact, in two experiments we showed that children between the ages of 2;6 and 8;9 not only have a tendency to make more *fill the water* than *pour the glass* errors in their speech, but that they are also more likely to misrepresent the meaning of *fill* than the meaning of *pour* in comprehension. Unlike adults, they often interpreted *fill* as implying that something be poured, even if the container ended up not full. Furthermore, there was even a weak tendency for the individual children who misinterpreted verbs like *fill* to be more likely to make syntactic errors with such verbs, errors in which the content was used as the direct object.

An important question which remains is precisely how, in the normal course of language acquisition, children learn which verbs specify which entities as affected, and in particular which verbs may specify either entity as affected. We suggest that children learn to restrict productive extension of the locative alternation within particular narrow, semantically cohesive subclasses of verbs (see Levin, 1985). For example, verbs involving forced directed motion of a substance alternate (*splash the water/splash the wall*; also *inject*, *splatter*, *spray*), but verbs involving gravity as the impetus for the motion of a substance do not (*pour the water/*pour the glass*; also *spill*, *ladle*, *drip*). This is a topic taken up in detail in Pinker (1989) and in Gropen (1989).

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