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Technical Report No. 413

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ON LEXICAL CATEGORIES**

William Nagy

Dedre Gentner

University of Illinois at Urbana-Champaign

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Center for the Study of Reading

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Abstract

Children are prodigious word learners, able to gain substantial information about a word's meaning on the basis of even a single encounter with the word in context. Such rapid learning is possible only if there are constraints on the hypotheses that learners make about the meanings of words. Two experiments are reported which test the hypothesis that the notion "possible word meaning" plays a role in constraining the inferences that language users make about new words encountered in context. Results indicate that subjects applied implicit knowledge of constraints on possible word meanings in making and evaluating hypotheses about unfamiliar words encountered in context and suggest that implicit knowledge of both universal and language-specific constraints on possible word meanings may contribute to the remarkable speed with which children pick up new words.

SEMANTIC CONSTRAINTS ON LEXICAL CATEGORIES

Children are remarkably efficient word learners. The average child learns 2 or 3 thousand words per year between grades 3 and 12, and many children may learn at twice that rate (Nagy & Anderson, 1984; Nagy & Herman, 1987; Templin, 1957). Since it is implausible that more than a fraction of this word knowledge could come through formal vocabulary instruction or looking up words in a dictionary, it appears that children must learn substantial numbers of words incidentally, inferring meanings from written or oral context (Jenkins & Dixon, 1983).

How children learn word meanings from context is still poorly understood. Natural contexts are often uninformative (Shatz & Baldwin, 1986; Beck, McKeown, & McCaslin, 1983), so that gaining an adequate representation of a word's meaning should require a large number of exposures to the word in a variety of meaningful contexts (Deighton, 1959). Yet children demonstrate a surprising ability to gain quite substantial information about a word's meaning from even a single exposure to the word in a written or oral context (Carey, 1978; Dickinson, 1984; Heibeck & Markman, in press; Nagy, Anderson, & Herman, 1987; Nagy, Herman, & Anderson, 1985). This rapid initial learning (labelled 'fast mapping' by Carey, 1978) suggests that in word learning, as in reading and listening comprehension in general, the reader or listener plays an active role, bringing to bear both linguistic and world knowledge to generate hypotheses or models of meaning that go beyond the information present in the text.

This research investigates the role of linguistic knowledge, and specifically, of *semantic* knowledge, in extracting meanings from context. We approach this issue from two perspectives. On the theoretical level, this work arises from basic research we have pursued independently on how language refers to the world: issues such as how different form classes refer; how referential patterns differ cross-linguistically; and how children learn word meanings (Gentner, 1975, 1978, 1981a, 1981b, 1982) as well as how word reference is productively extended (Nagy, 1978). On a more practical level, this work bears on vocabulary acquisition and its relationship to reading (Nagy & Herman, 1987; Nagy, Herman, & Anderson, 1985). We hope that by understanding better the process by which readers learn new words from context, we can improve vocabulary instruction in schools.

Inferring Meanings from Context

Consider the hypotheses one might make about the meaning of the underlined nonce word in the following text:

There, a scant two hundred yards ahead of the stopped train, he found a washed-out bridge. The whole thing had toppled into a ravine. If it had not been for the mysterious flagman, the train would have ganted across the ravine into the opposite embankment, killing passengers and crew.

What knowledge does a reader bring to bear in this situation? Both knowledge of the world and knowledge of one's language help limit hypotheses about the new word's meaning.

World knowledge. First, it is clear that world knowledge plays a big role in determining what hypotheses the word learner entertains. For example, one would not expect ganted to mean something like looked. In this particular genre of text, trains don't look into embankments, and even if they did, that probably wouldn't have killed passengers and crew. Knowledge of the world permits one to construct a fairly definite scenario of the event depicted by the sentence containing the word gant, and this knowledge is obviously crucial in the process of making hypotheses about the meaning of the word. The problem is that world knowledge does not sufficiently constrain hypotheses about the meaning of a new word; in fact, it allows the word learner to make inferences that increase the

number of hypotheses to be considered. In Table 1 are some features of the scenario that a reader might construct from this text. (This list is certainly not exhaustive.)

[Insert Table 1 about here.]

The point is that even after the application of world knowledge, there is still too much information available; there are too many hypotheses about the word's meaning that are logically consistent with the input. If the learner had to consider all the hypotheses like "cessation of linear motion in the dark resulting in loss of human life," learning words from text would hardly be possible, let alone efficient.

Linguistic knowledge. General knowledge of the world can bring the learner to the point of having a fairly specific scenario, or situation model (Kintsch, 1986) associated with a piece of text containing an unknown word. The learner's task is then to discern which parts of this scenario are likely to be associated with the word's meaning. At this point, we believe linguistic knowledge comes into play: specifically, knowledge about how information is likely to be partitioned into word meanings. The work of semanticists such as Fillmore (1978), Jackendoff (1975, 1983), Langacker (1982, 1986), Miller and Johnson-Laird (1976), and Talmy (1972, 1975, 1978) suggests that there are systematic patterns of word meaning within a language. In Langacker's terms, to know what a word means, you have to know more than what situation or object it refers to; you have to know how it construes that object or situation. This is linguistic knowledge.

The first use of linguistic knowledge in our example is rather elementary. Our scenario has some objects--the train, the bridge, the ravine, the people--and a cluster of events. Given some knowledge of English syntax and morphology, we can deduce that ganted is a verb. Given the knowledge that verbs are typically associated with events and relations, and nouns with objects, we can guess that ganted refers to some aspects of the cluster of events, rather than to one of the participants. The association of verbs with events and nouns with objects is certainly not without exception (Maratsos & Chalkley, 1981), but probably plays an important role in restricting children's initial hypotheses about word meanings (Brown, 1957; Gleitman & Wanner, 1982; Landau & Gleitman, 1985). The syntactic context in which ganted occurs, and especially the preposition into following it, suggests that it is a verb of motion. However, this still leaves a large number of possibilities for the meaning, for example, "motion above water," "motion of contained objects relative to container," or "motion of a group of long rigid objects."

We can restrict our hypotheses further by considering what aspects of events are typically incorporated into the meanings of English motion verbs. English motion verbs, for example, do not characteristically specify properties of the moving object. Thus, a meaning such as "motion of a group of long rigid objects," though compatible with the context, is not a likely candidate for an English verb meaning.

It should be noted that rejecting such a hypothesis about the meaning of gant is based on knowledge of English, and not on some general notion of plausibility. The degree to which object properties can be included in the meaning of a verb stem may be a parameter along which languages differ (Sapir, 1944; Talmy, 1975, 1978); as Talmy (1972) points out, in Atsugewi, meanings like "for a particulate substance to move or be located" are typical, rather than exceptional. Even two closely related languages may differ in this regard; for example, Plank (1980) has argued that German differs systematically from English in that German allows verbs to place more restrictions on properties of their arguments.

We can go one step further in restricting our hypotheses about the meaning of gant by invoking another piece of knowledge about English semantics. Although a few English motion verbs incorporate direction (e.g., *enter*, *leave*), the meaning pattern "motion plus manner" is far better represented in the English lexicon (e.g., *tumble*, *roll*, *slide*, *swoop*, *dash*, *slink*, *strut*, *saunter*, *gallop*,

hop, stroll, hurtle, skip, fly, zip, trudge). This pattern of meaning is developed in English to a greater extent than in some other languages (Talmy, 1972, 1975).

A good first guess about the meaning of *ganted* then, is that it is a verb of motion, with some additional specification as to the manner of motion, namely, the manner in which a train would move if it went over a washed-out bridge and into an embankment--swiftly and ballistically, perhaps uncontrollably, among other things. One can guess, then, that *gant* means something like "to move swiftly and uncontrollably."

Constraints on Word Meanings

The preceding discussion illustrates how a combination of world knowledge and linguistic knowledge may allow the learner to come up with a fairly specific hypothesis about the meaning of a new word encountered in context. The point we want to stress is that the information provided by the text and the reader's (or listener's) knowledge of the world do not constrain the range of hypotheses enough to allow rapid learning. There will always be indefinitely many hypotheses logically consistent with the data available (Quine, 1960). As Carey (1983) and Markman (in press) have argued persuasively, learning word meanings from context is possible only if there are severe constraints on the hypotheses that the learner makes. The nature of such constraints is still largely unexplored; but there have been a few specific proposals.

Keil (1979, 1981) and Sommers (1963) have postulated a particular type of conceptual constraint on word meanings: ontological constraints on natural kind terms. Keil (1983) has found that even young children have some ability to use knowledge of ontological categories in making hypotheses about the meanings of new words; for example, if a child is told that "Throstles can be fixed," the child can generally correctly answer a question such as "Can throstles bloom?" Keil's stronger claim, that ontological categories must form a strictly taxonomic hierarchy (the so-called M-constraint on ontological categories), has been disputed by Carey (1983). She suggests that natural kind concepts are constrained by children's emerging theories of the world, rather than by purely structural knowledge. But both accounts agree on some kind of conceptual constraints that would guide inferences about new words.

We turn now to proposals concerning *semantic* (as opposed to conceptual) constraints on word meanings. A number of linguists have suggested or assumed formal constraints on word meanings. Katz and Fodor's (1963) distinction between semantic markers and distinguishers, for example, constitutes an attempt (although not necessarily a successful one) to impose constraints on the notion "possible word meaning." Benwick, Le Fay, and Knight (1976, written in 1968) suggested the constraint that lexical items can represent only constituents of well-formed semantic structures. As an example of an impossible word meaning, they offered "every broken;" that is, there could not be a word *zarf* such that the sentence *the doctor put a splint on zarf arm* meant "The doctor put a splint on every broken arm." This constraint was taken as axiomatic in Generative Semantics argumentation (e.g., McCawley, 1968). Since lexical items could replace derived constituents, syntactic constraints on transformations would also play a role in defining the notion "possible word" (e.g., Lakoff, 1970). However, to our knowledge, the discussion of such constraints on word meanings in the Generative Semantics tradition never led to any experimental work on the acquisition of word meanings from context.

Early Language Acquisition

The research bearing most directly on constraints on possible word meanings has been in the area of early language acquisition. One of the first and most basic semantic constraints to be investigated was the *one-to-one mapping hypothesis*. There are several variations of this hypothesis--the one-to-one mapping principle (Slobin, 1973), the contrast principle (Clark, 1983), the mutual exclusivity hypothesis (Markman, in press), and the one-to-one mapping hypothesis (Pinker, 1984). Although

these proposals differ in detail, all postulate an expectation on the part of the language learner that there will be a one-to-one mapping between words and meanings, or more broadly, between linguistic elements and conceptual elements.

Another basic constraint on meanings that appears to apply early in language acquisition is what could be called the *taxonomic constraint*. Markman and Hutchinson (1984) asked children 2 to 5 years old to choose which of two pictures went with a third target picture under either neutral or linguistic instructions. The choice was always between a thematic and taxonomic associate. For example, children were given a target picture of a cow, and asked to decide whether it went with *milk* (a thematic associate) or with a *pig* (a taxonomic associate). In this neutral or nonlinguistic condition, children were equally likely to choose the thematic or the taxonomic associate. However, in the linguistic version of the sorting task, children were told, for example, "See this fep? Put it with another fep." In this case, children sorted predominantly on a taxonomic basis, putting the cow with the pig, rather than with the milk (see also Hutchinson, 1985).

In the neutral condition, then, children find thematic relations at least as salient as taxonomic relations; but when the task requires thinking in terms of the meaning of a word, children focus on taxonomic relationships. This is presumably helpful in word learning, because English noun categories tend to be organized taxonomically. There may be a strong association between *cow* and *milk*, but English doesn't have words with a meaning like "cow and milk" or "cow or milk." Thus, even very young children understand some of the principles that constrain word meanings over and above any constraints on conceptual organization.

Further evidence that children learn constraints on word meanings comes from the work of Bowerman (1981, 1982a, 1982b) on children's late semantic errors. These errors occur relatively late in language acquisition, after the child has used the terms correctly for a long period, and seem to arise, paradoxically, from the child's increasing understanding of the dominant underlying semantic patterns of the language. A typical instance concerns the expression of causality. At around 3 to 7 years old, children begin to say things like "Who highered the swing?" (Boy, 5;11); "Don't dead him" (as M. picks up a spider) (Eva, 4;10); or "I'll jump that down" (Rachel, 4;9); meaning "cause that to go down by jumping on it;" R. is about to jump on a bathmat placed on top of the water in a tub (Bowerman, 1982b, pp. 14-18). These late errors seem to show the child's increasing sense of the semantic structure of the language. The child seems to have grasped that, in English, the verb for causing a particular change of state is often the same word as the verb for the change of state, or even the word for the state itself. For example, the same word ("open") is used in "Open the door" (i.e., cause the door to become open), "The door opens" (the door changes to a state of being open), and "The door is open." According to Bowerman, such regularities may go unappreciated at the earliest stages of semantic acquisition; but as the child acquires expertise in English, this implicitly grasped semantic regularity leads the child to attempt generating utterances based on this pattern.

For our purposes, Bowerman's research is important in showing that children have knowledge of patterns of permissible word meanings and also of morphological regularities among sets of word meanings. (See also Clark, 1982; and Clark & Hecht, 1982, for other instances of children creating new words according to regularities they have discovered.) Such errors are clearly self-generated, not learned by imitation; and although the particular utterances are erroneous, they show that the child is beginning to grasp a semantic pattern that plays a role in an adult's competence in English. Such errors are therefore further evidence of naturally developing knowledge of what constitute allowable word meanings in one's language.

Despite the promising results found with children, there has been little research on the use of linguistic constraints in adult word learning. In this research, we investigated such constraints. The first study was designed to explore a wide variety of possible constraints. As in the research of Markman and her colleagues, we compared the hypotheses people make when the meaning of an unfamiliar word is at issue with those made in a nonlinguistic situation. However, this experiment

differs from the prior research first, in that the subjects were adults; second, in that we tested a number of different possible constraints; and third, in the experimental task. The task was modeled roughly after the pioneering studies of Werner and Kaplan (1952) and was designed to resemble the process of learning word meanings incidentally from context, rather than by directly labeling objects.

Experiment 1

The constraints. Several classes of constraints were investigated, some purely semantic and others partly semantic and partly morphological. Some of these constraints seem likely to reflect universal tendencies, while others appear to be language-specific restrictions.

[Insert Table 2 about here.]

Table 2 gives examples of constraints examined in this experiment. The first constraint listed is the *taxonomic* constraint on nouns. It states that nouns tend to refer to classes, not to thematic collections. Markman and Hutchinson's (1984) research indicates that young children observe this constraint, and indeed it seems likely to be a language-universal constraint. The second constraint, the *durative* constraint on nouns, again seems likely to reflect a universal tendency, but it admits some exceptions, especially in the case of nouns morphologically derived from verbs (e.g., *explosion*, *recipient*). We next turn to two constraints that seem less likely to be universal. The next constraint is the *no specification of time of day* constraint on verbs. It states that although verbs in English are inflected for tense, they do not incorporate in their meanings any specification of the time (in terms of a clock or calendar) at which an activity is performed. Hence, we would predict that one is much less likely to find, or coin, a new verb meaning "to wake up early in the morning" than one meaning "to wake up quickly." (Note that verbs like "to winter" or "to summer," which do incorporate time, do so without specifying any other activity. Thus, "to winter" can mean "to spend the winter," but not something like "to engage in winter sports.")

The last constraint in Table 2, the *no cessation of X* constraint on verbs, states that there are no English verbs meaning to stop doing a particular action. Thus, although there are general negative verbs like *stop*, *cease*, *halt*, and *desist*, they mean simply to stop doing whatever one is doing. We do not find verbs meaning "to stop writing" or "to stop running."

A discussion of all 15 of the constraints tested in this experiment is given in Appendix A.

The basic plan was to present subjects with a context sentence containing either a blank or an unfamiliar word, e.g., "Jack _____ into the canyons" or "Jack *strounded* into the canyons." With the sentence, subjects were given a set of possible concepts (e.g., "went northward" or "disappeared quickly") and were asked either to rate how well they fit into the blank in the context sentence (the *cloze* condition) or to rate their plausibility as meanings of the unfamiliar word (the *definition* condition). The definition and cloze conditions are analogous to Markman and Hutchinson's (1984) "novel word" and "no word" conditions. In both cases, the subjects are evaluating hypotheses about what can occur in a given context; but only in the definition condition are the hypotheses construed as hypotheses about the possible meanings of an unfamiliar word.

We also manipulated the degree of fit between the context sentences and the concepts to be rated. In both the definition and cloze task, we expected subjects' ratings to be influenced by contextual plausibility. However, in the definition condition only, we expected an additional factor to influence the subjects' ratings, namely, whether the phrases satisfy constraints on possible word meanings.

Method

Subjects

The subjects were 68 undergraduate students at a large midwestern university, who volunteered to participate in the experiment. Subjects were divided randomly into two groups, the *cloze* group and the *definition* group.

Materials

The experimental booklets contained 20 items, all in either the cloze or the definition condition, as shown in Table 3, along with instructions appropriate for that condition. In the cloze condition, the sentence contained a blank, followed by four phrases. In the definition condition, the item consisted of the same sentence, with a nonce word in place of the blank, and the same four phrases. Note that the content of the two conditions is identical; the difference is in the nature of the task.

For each item, the four phrases differed orthogonally on two dimensions: how well they fit the context ("contextually appropriate/inappropriate"), and whether they are possible meanings in English ("lexically appropriate/inappropriate"). For example, in the item given in Table 3, both "laugh nervously" and "stop sewing" fit the context, but only "laugh nervously" represents a possible word meaning in English. The contextually inappropriate phrases are "spend time on the beach" and "arrive exactly on the hour." Of these two phrases, "arrive exactly on the hour" is less likely to constitute a possible word meaning in English than "spend time on the beach."

[Insert Table 3 about here.]

Procedure

Each subject received a booklet of 20 items, all either in the cloze or in the definition condition. Each item consisted of a sentence followed by four phrases, as described above. In both conditions, subjects were to rate each phrase independently. In the cloze condition, subjects were instructed to rate each phrase as to how well it fit into the blank, on a scale of 1 to 5, from "utterly implausible, unnatural" to "perfectly natural, totally plausible." In the definition condition, the same phrases were rated on a similar plausibility scale, but in this case subjects rated how plausible the phrases were as possible meanings for the underlined nonce word. A single random order of items was used in all booklets. Subjects were self-paced.

Design and Analysis

A 2 x 2 x 2 mixed factorial design was used, with task condition (cloze or definition) as a between-subject factor, and lexical appropriateness and contextual appropriateness as within-subject factors. We expected an effect of contextual appropriateness in both tasks. But more importantly, we predicted that lexically inappropriate phrases would be rated lower in the definition condition than in the cloze condition. Thus, we expected a significant interaction between task and lexical appropriateness. Such an interaction would indicate that there are constraints on what sorts of information people can package into word-meanings--constraints that are distinct from the concept of "plausibility in context."

Results and Discussion

Figure 1 shows subjects' mean plausibility ratings. A mixed-measure analyses of variance across subjects was performed for the 2 x 2 x 2 design of Task x Contextual Appropriateness x Lexical Appropriateness. We begin by describing the main effects. (Although the main effects are not of primary interest, they serve as a test of whether the materials worked as planned.) The main effect of

Task (cloze vs. definition) was not significant, $F(1,66) = 1.47, p > .2$. Overall, items were not rated higher in one condition than in the other. The effect of Contextual Appropriateness was highly significant, $F(1,66) = 970.9, p < .001$; items which were intended to fit the context well were rated consistently higher than items which did not fit the context. The main effect of Lexical Appropriateness was not significant, $F(1,66) < 1, p > .5$. That is, overall, the lexically inappropriate phrases were not rated as being more or less plausible than the lexically appropriate phrases.

[Insert Figure 1 about here.]

The predicted interaction of Lexical Appropriateness with Task was highly significant, $F(1,66) = 17.4, p < .001$. Lexically inappropriate phrases--phrases that should not constitute possible word meanings in English--were rated considerably lower in the definition condition than in the cloze condition.

There was also a three-way interaction, reflecting the fact that the interaction of Condition and Lexical Appropriateness was found only for those items that fit the context. As expected, items that were contextually inappropriate showed a floor effect; all such items received low ratings, regardless of task or lexical appropriateness.

In addition to the subjects analysis, an items analysis was performed. The main effects were the same, with the exception that the effect of Task was significant in the item analysis, $F(1,19) = 7.5, p = .013$. The key interaction of Lexical Appropriateness \times Task remained significant, $F(1,19) = 12.6, p = .002$. Hence, these results appear to be generalizable both to the universe of subjects and the universe of items (quasi min $F(1,49) = 7.3, p < .01$).

However, one aspect of the data is problematic. As Figure 1 shows, the ratings for lexically inappropriate phrases are higher than those for lexically appropriate phrases in the cloze task. Our hypothesis would suggest that these ratings should be equal in the cloze task, whereas lexically appropriate phrases should be rated higher than lexically inappropriate phrases in the definition condition. We believe that the explanation for this apparent anomaly lies in our method of stimulus construction. In order to avoid biasing the materials in favor of our hypothesis, we took great pains to make the lexically inappropriate phrases fit the context well. This effort appears to have been extremely successful, so that in the cloze task, among the two contextually appropriate choices, the lexically inappropriate phrase is subjectively superior. The crucial result in this experiment, however, does not have to do with the absolute level of the ratings, but with the *difference* between the two tasks. Only one category of phrases--the contextually appropriate but lexically inappropriate items--shows a difference in ratings between the two conditions. This indicates that subjects evidenced sensitivity to constraints on possible word meanings when evaluating different hypotheses about the possible meaning of an unfamiliar word. These results provide clear evidence of a distinction between conceptual-contextual plausibility and lexical plausibility.

The items in this experiment were intended to include both universal and language-specific constraints on possible word meanings. All of the six items that represented what are likely to be universal constraints on the form of word meanings, or at least universal tendencies, showed the predicted pattern of results. Of the 14 items that represent what we judged to be language specific constraints--restrictions on what is a possible word in English, which may not apply in other languages--all but three items behaved consistently with our predictions. Thus, it appears that not only do people approach language learning with general expectations about possible word meanings--e.g., that nouns are likely to represent taxonomically rather than thematically organized categories--but that language learners acquire implicit knowledge of the semantic patterns of their language, and use this knowledge when formulating hypotheses about the meanings of new words.

The results of Experiment 1 indicate that speakers possess and use knowledge about constraints on possible word meanings in their language. Furthermore, there appear to be a number of different constraints, of varying degrees of specificity. However, the methods used in Experiment 1 had the

disadvantage of requiring subjects to make explicit judgments of plausibility. For our second experiment, we developed a method that more closely resembled natural learning from context. In addition, we focused on a smaller number of constraints specific to the possible meanings of nouns and verbs. We first discuss the constraints tested, and then turn to the methodology.

There is prior evidence for lexical constraints that are specific to particular parts of speech. For example, Roger Brown (1957), considering the problem of multiple hypotheses facing the word learner, used the example of an adult saying "water" while looking at a glass of water in the presence of a child. The child is faced with the problem of determining whether the adult is referring to the glass container, the transparency of the glass, the height of the liquid in the glass, and so on. Brown suggested that grammatical information such as part of speech and the count-mass distinction marked by articles would enable the child to limit the range of hypotheses to be considered. Such grammatical information is helpful, of course, only if the child knows that nouns typically refer to objects, that fluids are likely to be named by mass nouns, and so on. Brown conducted an experiment which showed that preschoolers 3 to 5 years of age used the distinctions between verbs, mass nouns, and count nouns when making judgments about what aspects of a picture were associated with the meaning of a novel word uttered in a syntactic context. Other experiments (e.g., Katz, Baker, & MacNamara, 1974) suggest that preschool children can infer from the type of determiner (e.g., "This is a zav" vs. "This is zav") whether a novel word is a proper or a count noun, and adjust their hypotheses about its meaning accordingly.

Such findings establish a connection between part of speech and the basic meaning of a new word--whether it refers to an action, an object, a substance, or a particular individual. However, we wish to go beyond this level to pursue more specific constraints on the meanings of nouns and verbs. English verbs of motion frequently incorporate information about the manner in which an action is performed, but rarely incorporate information about the properties of the object upon which the action is performed (Talmy, 1972). (Note that English denominal verbs such as *paint* or *hammer* incorporate an instrument, rather than an object, cf. Clark & Clark, 1979.) For example, English does not have many, if any, meanings like "to carry something long and rigid," or "to find something small."¹ This restriction on verb meanings is not universal among languages. There are languages, for example, which have different verb stems for the meanings "to carry a long rigid object" and "to carry a small round object" (Friedrich, 1970). In fact, Plank (1980) argues that German systematically differs from English in its tendency to allow verbs to specify object properties: for example, *schliessen* (to shoot a game animal or bird) versus *erschliessen* (to shoot a human or a non-game animal, particularly one to which one is attached).

Conversely, English nouns that are object names do not typically incorporate information about actions that have been performed on them. There are nouns such as *victim*, *recipient*, or *nominee* with meanings of the form "person who has been Xed" for some verb X; but one does not expect to find, at least in English, monomorphemic terms with meanings like "fish caught by nets (as opposed to hooks)" or "a long stick being waved in large circles."

Experiment 2 utilized a task intended to resemble natural word learning during reading. The design is essentially this: A nonce word appears twice in a story. The first instance occurs in a context that allows rich inferences about both the manner in which an action is performed, and about the object upon which it was performed. The second instance of the nonce word occurs in a context vague with respect to both types of information. We ask the subjects to make inferences about the event described in the second context. We can use these inferences to deduce the meaning that the subject had stored for the nonce word. This method has the advantage that subjects do not have to introspect about possible meanings; they merely have to use a newly learned word in comprehending the passage--a situation that often occurs in natural word learning. A key manipulation is whether nonce word is a noun or a verb. Our prediction is that as we vary part of speech, different types of information supplied by the first context should be incorporated into the meaning of the nonce word.

This will, in turn, lead subjects to make different inferences when they read the second occurrence of that word.

This experiment might be likened to dipping a magnet into a mixture of iron filings and sand: One expects the iron filings to stick and the sand to fall off. In this study, the picture is slightly more complex, in that we have two kinds of magnets. When the target word is a noun, we expect certain pieces of the scenario to stick to it, namely, properties of the objects referred to. When the target word is a verb, we expect a different set of pieces to stick to it, namely, information about the manner in which the action was performed. By examining the subjects' inferences in the second, underspecified context, we can see whether this differential selection hypothesis is correct.

Experiment 2

Method

Subjects

Subjects were 56 undergraduates at a large midwestern university, who were paid for participation in the experiment.

Materials

There were four experimental passages, as well as one practice passage, each containing two instances of a target nonce word. The first instance of the target word was in a rich context. That is, the preceding and surrounding context were designed to give the reader a clear picture of the events described by the sentence--both the nature of the object which was being acted upon, and the manner in which the action was performed. Crucial sections from a sample passage are shown in Table 4. (The entire passage is given in Appendix B.) In the noun version of the text, for example, it is clear from Context 1 that the noun *saptyn* refers to a small animal, probably the edible, rodent-like animal already referred to. The context also makes the nature of the actions clear; in this case, capturing the animal involves shooting seeds through a peashooter.

[Insert Table 4 about here.]

The second instance of the target word is in a context which is intended to be vague about both the manner of the action and the object. In the text in Table 4 (noun version), for example, when *saptyn* occurs in Context 2, there is no way to tell from the context either what kind of animal was involved, or the exact manner of capture that was intended; any such information must be supplied by the target word itself.

There were two versions of each experimental passage, a noun version and a verb version, as illustrated in Table 4. In the noun version, the position of the verb in the verb version is taken by a more generic verb (in this example, *ensnare*) which does not provide crucial information about the manner in which the action was performed. Conversely, in the verb version, the position of the noun in the noun version is taken by a more general noun (in this case, *animal*), which does not provide crucial information about the nature of the object.

For each passage, four questions were constructed, two about the first context, and two about the second context. For each context, one question was about the manner in which the action was performed, and the other about the properties of the object. Table 5 gives examples of the questions used for the passages in Table 4.

[Insert Table 5 about here.]

Our primary interest is in subjects' answers to the questions concerning the second context. At issue is whether subjects are likely to carry over information about the *manner* of the young hunter's action (i.e., whether or not he had attempted to use a peashooter), information about the kind of objects acted upon (i.e., whether the animal was a small, edible rodent, or some other kind of animal), or both. The context of the second occurrence of the target word provides no conclusive information about either. Moreover, the noun and verb versions differ only in the part of speech of the target word, and not in the information provided by the context. Our prediction was that subjects would assign different meanings to the target word on the basis of the first context. That is, they would retain different contextual features from the first occurrence of the word, depending on whether it appeared as a noun or a verb. Thus, subjects would respond differently to questions concerning Context 2; those reading the noun version would associate object properties with the target word, whereas those reading the verb version would associate with the target word information about the manner in which the action was performed.

We also asked similar questions about the first context, simply as a test of whether the subjects had understood the materials. For questions regarding the first context, we expected subjects to give correct answers.

Thus, overall, there were four types of questions, first versus second context, and object versus action properties. Each subject saw two questions for each story—one about the first context, and one about the second. One of these concerned the properties of the object, and the other the manner in which the action was performed. There were four experimental passages and one warm-up passage. conditions were counterbalanced so that all questions occurred equally often across subjects.

Procedure

Subjects were given a booklet containing instructions, one practice passage, and the four experimental passages. In the instructions, subjects were told that the experiment concerned how people make inferences during normal reading, and that they should therefore approach this task in the way they would approach an everyday reading situation. They were also told that the texts contained one or two words they might not have seen before, that they could proceed at their own pace, and that they were allowed to look back at the text while answering questions about it.

Design

A 2 x 2 x 2 design was used, with context order (first or second), part of speech (noun or verb passage version) and question target (manner of action or object properties) as within-subject factors.

Results

Figure 2 shows the mean proportion of subjects giving target answers to the question, that is, answers reflecting the information conveyed by the first context. As can be seen in the figure, the results were as predicted. When subjects read the nonce word as a noun, they stored with it properties of the objects in the context. When they read it as a verb, they stored with it properties of the action, notably the manner of action. Each of the four individual stories showed the same pattern, with the only difference being the absolute size of the percentages.

[Insert Figure 2 about here.]

Separate Chi square tests were performed for the first and second questions. As expected, for the first question there was no effect of form class. For the second question, there was a strong effect of form class, $X = 31.25, p < .01$.

General Discussion

Constraints on the content of possible word meanings are so seldom brought to conscious attention that it is easy to underestimate their importance in vocabulary acquisition. However, the speed of the 'fast mapping' process (Carey, 1978; Heibeck & Markman, in press)--the fact that people can construct a substantial, if incomplete, representation of the meaning of a new word on the basis of even a single encounter--indicates that language learners must have rich knowledge about what types of information are typically packaged into word meanings, and what types of information are not. The results of our two experiments have confirmed that people possess implicit knowledge of constraints on possible word meanings, and that they apply this knowledge in tasks which represent important aspects of natural word-learning situations.

There are a number of speculations that arise from this view. For example, the contrast between universal and language-specific constraints may be important in semantic development. Some of the constraints tested appear to represent universal tendencies which, even if they allow exceptions, may serve as powerful heuristics for facilitating initial hypotheses about the meanings of new words. Some of these, such as the taxonomic constraints, may be operative even in very early stages of language acquisition. Constraints that are language-specific, on the other hand, are necessarily acquired only as the individual comes to know enough words to draw generalizations about patterns of word meaning in that language. Knowledge of such constraints should, in turn, facilitate further word learning. Differential knowledge of patterns of word meaning in a language may therefore be a factor distinguishing proficient from less proficient word learners.

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Author Notes

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Footnote

¹There are some verbs such as *lug*, which might be paraphrased "to carry something heavy." However, it could be argued that it is still the manner in which the action is performed, and not the property of the object, that is essential to the meaning of *lug*. No matter how heavy the object, if someone is strong enough to carry it with ease, he or she would not be said to be lugging it.

Table 1**Some Aspects of the "Train Crossing the Washed Out Bridge" Scenario**

motion

with relatively low friction

unregulated

forward

swift

against air resistance

above water

across ravine

parallel to long axis of figure moving

ballistic trajectory

through the air

non-volitional motion of animate beings

motion of contained objects relative to container

great momentum

reduction in velocity

of an artifact

of a vehicle

wheeled vehicle

departure from planned route

disengagement of propelling mechanism

event outside of populated area

in the dark

without warning

Table 1 (continued)

not intentional

undesirable consequences

disruption of schedule

environmental damage

property of value in excess of \$2000

impact

contact between unlike substances

increase in entropy

non-reversible change of state

abrupt change of shape

generation of heat

noise

fear

surprise

pain

injury

loss of life

large objects

multiple objects

long objects

rigid objects

sausage-like string of objects

metal

Table 2**Examples of Constraints Tested in Experiment 1**

Nouns

1. Taxonomic constraint: Nouns tend to reflect taxonomic rather than thematic relationships:

needles and pins

*needles and thread

2. Durative constraint: Nouns are usually differentiated in terms of long-term properties rather than short term properties:

red bird

*flying bird (i.e., bird on the wing)

Verbs

3. Time of day constraint: English verbs do not include reference to specific times of day:

to wake up quickly

*to wake up early

4. Cessation constraint: English verbs do not generally have meanings of the form "to stop Xing" for any *specific* meaning X:

to laugh nervously

*to stop sewing

Note: Phrases marked with an asterisk are meanings that are *not* likely to be expressed by a single word in English.

Table 3**Sample Item from Experiment 1 in the Two Experimental Conditions**

Cloze Condition

Martha would _____ whenever she heard footsteps on the sidewalk in front of her house.

- a. spend time on the beach _____
- b. laugh nervously _____
- c. refuse to agree _____
- d. stop sewing _____

Definition Condition

Martha would werpet whenever she heard footsteps on the sidewalk in front of her house.

- werpet:
- a. spend time on the beach _____
 - b. laugh nervously _____
 - c. refuse to agree _____
 - d. stop sewing _____

-
- Key:**
- a) spend time on the beach - contextually inappropriate,
lexically appropriate
 - b) laugh nervously - contextually appropriate, lexically
appropriate
 - c) refuse to agree - contextually inappropriate, lexically
inappropriate
 - d) stop sewing - contextually appropriate, lexically inappropriate
-

Table 4**Key Sections from the Story "The Darsts of Zurdine"**Noun Version

... Their way of life depends heavily on the use of the seeds of the Yrang plant, which begin to sprout between one and two seconds after they have been exposed to any moisture, and grow at speeds of up to 15 feet a second. ... Our goal that day was to bring in a particular species of smaller rodent-like animals which are prized as a special delicacy by the Darsts. ... Finally, after several hours, we caught sight of a small animal moving to our right. While the rest of the party stood motionless, the head of the hunting party pulled out a hollow reedlike peashooter, and moistened some Yrang seeds with saliva. She slipped them into the peashooter and with accuracy that amazed me, she ensnared the unsuspecting saptyn ...

... One of the younger Darsts, who move even more slowly than their languid elders, was somewhat behind the group, and not even making much effort to stay close. Without warning, the young Darst found himself face to face with a saptyn. The youngster tried to ensnare it, but in his inexperience he dropped several moistened seeds. By the time I got to him, a vine was wrapped chokingly tight around his neck ...

Table 4 (continued)Verb Version

... Their way of life depends heavily on the use of the seeds of the Yrang plant, which begin to sprout between one and two seconds after they have been exposed to any moisture, and grow at speeds of up to 15 feet a second ... Darsts. Our goal that day was to bring in a particular species of smaller rodent-like animals which are prized as a special delicacy by the Darsts. ... Finally, after several hours, we caught sight of a small animal moving to our right. While the rest of the party stood motionless, the head of the hunting party pulled out a hollow reedlike peashooter, and moistened some Yrang seeds with saliva. She slipped them into the peashooter and with accuracy that amazed me, she saptvned the unsuspecting animal ...

... One of the younger Darsts, who move even more slowly than their languid elders, was somewhat behind the group, and not even making much effort to stay close. Without warning, the young Darst found himself face to face with an animal. The youngster tried to saptvn it, but in his inexperience he dropped several moistened seeds. By the time I got to him, a vine was wrapped chokingly tight around his neck.

Note: Target words are underlined here for clarity; they were not underlined in the text given to subjects.

Table 5**Questions for the Sample Passage from Experiment 2**

Questions concerning the first context containing the target word:

1a. How did the head of the hunting party ensnare the animal?

(Circle a letter)

- a) by throwing a net over it
- b) by shooting moistened Yrang seeds around it with a peashooter
- c) by throwing moistened Yrang seeds around it
- d) cannot be determined from the text

1b. What sort of animal did the head of the hunting party catch?

(Circle a letter)

- a) a large predator
 - b) a small rodent-like, edible animal
 - c) a poisonous razor-spined herbivore
 - d) cannot be determined from the text
-

Table 5 (continued)

Questions concerning the second context containing the target word:

2a. What sort of animal did the young Darst try to catch?

(Circle a letter)

- a) a large predator
- b) a small rodent-like, edible animal
- c) a poisonous razor-spined herbivore
- d) cannot be determined from the text

2a. How did the young Darst try to ensnare the animal?

(Circle a letter)

- a) by throwing a net over it
 - b) by shooting moistened Yrang seeds around it with a peashooter
 - c) by throwing moistened Yrang seeds around it
 - d) cannot be determined from the text
-

Note: Each subject saw only one question for each context. Question types were counterbalanced, so that if the subject saw the question about object properties for the first context, the second question dealt with manner of action, and vice versa.

Figure Captions

Figure 1. Results of Experiment 1: Mean ratings of naturalness in context for items in the Cloze and Definition conditions.

Figure 2. Results of Experiment 2: Percentage of answers reflecting targeted information.

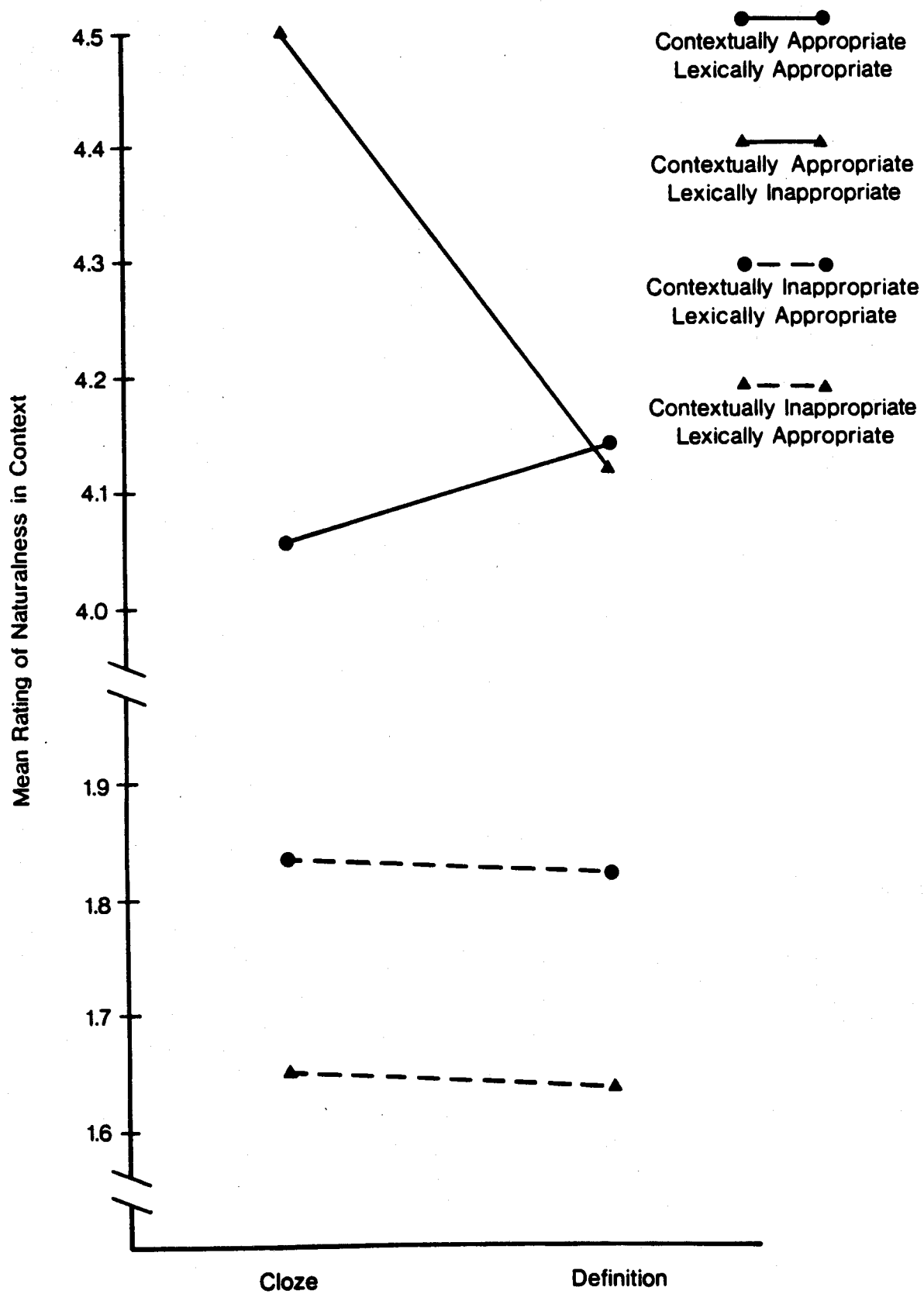


Figure 1

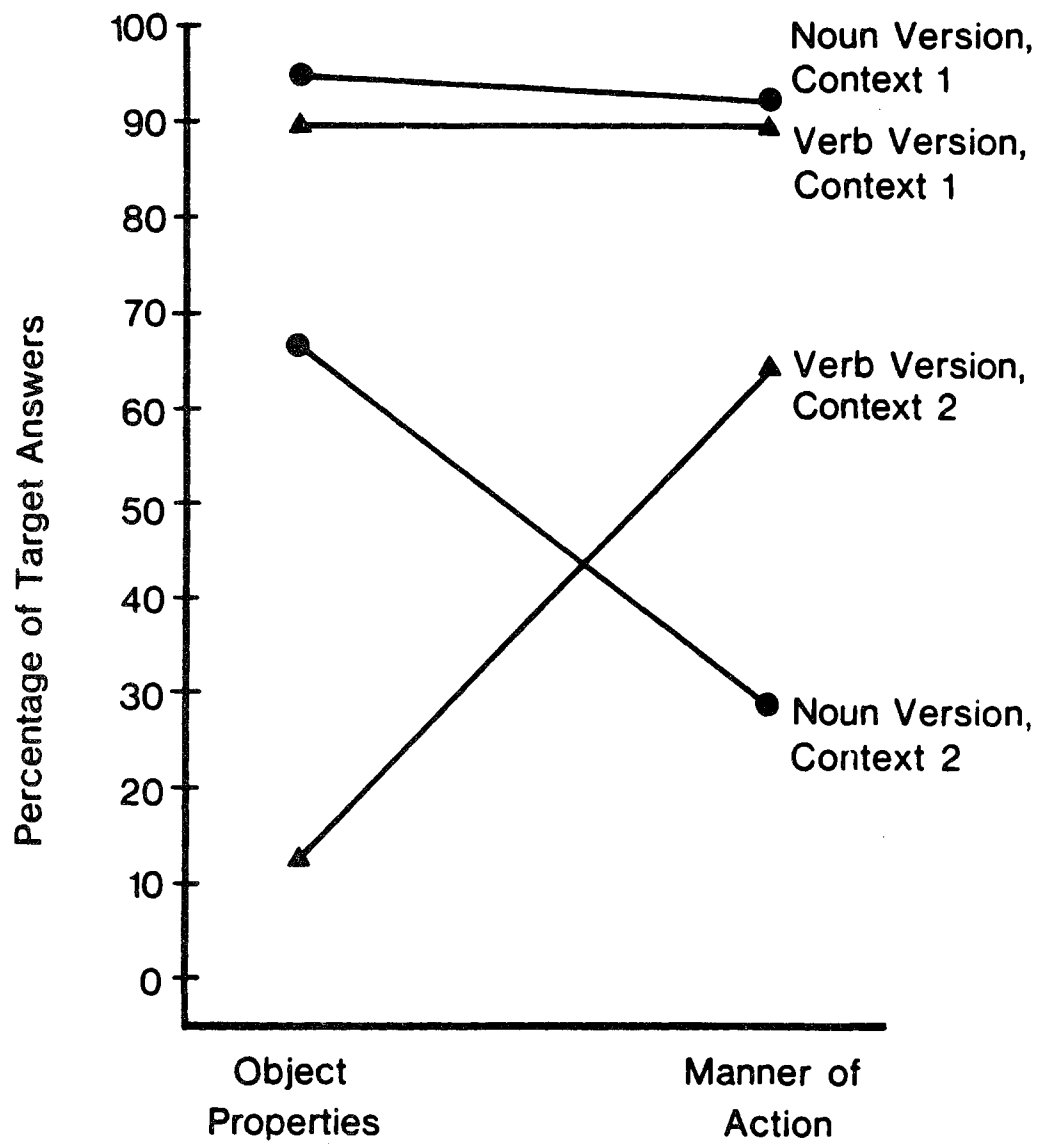


Figure 2

APPENDIX A

List of Constraints Investigated

For each hypothesized constraint on English word meanings considered in this experiment, there is a brief description of the constraint, followed by the two contextually appropriate phrases from the item(s) testing that constraint. The phrase violating the hypothesized constraint is marked with an asterisk, indicating that it should not constitute a well-formed word meaning in English. We also note whether we would expect this constraint to reflect a universal constraint on word meanings, or a possible restriction on word meanings in English.

Constraints on Nouns

1. **Taxonomic constraint on nouns (Universal).** Noun meanings tend to reflect taxonomic relationships rather than thematic relationships. For example, there is more likely to be a single word meaning "needles and pins" than a word meaning "needles and thread."

*native foods and cooking utensils

vs. small nocturnal mammals with scent glands

*things like needles, thread & scissors

vs. things like pieces of sil, bits of flowered cotton, and scraps of corduroy"

2. **Durative constraint on nouns (Universal).** Nouns are usually differentiated in terms of relatively long-term properties rather than relatively short term properties. For example, there is more likely to be a term for "red bird" than for "flying bird." We expect this constraint to reflect a universal tendency. However, it clearly applies to morphologically simple nouns, and not to deverbal nouns such as *batter* (i.e., the person currently at bat).

*angry baboon

vs. poisonous snake

3. **Transparency of agency (Universal).** Nouns that have an agentive meaning, i.e., "person who does X," usually are fully transparent in English, e.g., letter carrier or mailman. Those that are not fully transparent, e.g., *doctor* or *dentist*, still have an overt agentive suffix. We expect this to be a universal tendency, but with exceptions, e.g., *architect* and *secretary* in English.

*furniture carriers

vs. groups of soldiers

4. **No specification of linearity in kinship terms (English-specific).** English does not have kinship terms which specify side of the family (father's or mother's). There are clearly other languages in which this constraint does not apply.

*mother's parents

vs. the people next door

5. **No specification of age in sibling terms** (English-specific). English does not have terms which distinguish siblings by relative age. There are languages which have such terms (e.g., a word meaning "younger brother") which are not possible in English.

*younger brothers and sisters

vs. nieces and nephews

Constraints on Verbs

6. **No incorporation of patients in verbs** (English-specific). English verbs do not include specifications of particular properties of patients (i.e., typically, direct objects). For example, English does not have, and is not likely to acquire, a word meaning "to wave a long rigid object," or a word meaning "to eat crackers." Languages appear to differ in the extent to which they allow the incorporation of properties of objects into verbs. (Note that English verbs can incorporate the meanings of *instruments*, especially when they are overtly marked in the morphology, as in the verb *to hammer*; see Clark & Clark, 1979).

*to eat snails

vs. to eat with chopsticks

*to spill some dirt

vs. to roll end over end

7. **No specification of time in verbs** (English-specific). English verbs do not incorporate information about clock or calendar time (i.e., time of day or season of the year, as opposed to tense) that the event referred to occurs.

*to spend the afternoon

vs. to walk aimlessly

*to wake up early

vs. to wake up quickly

*to arrive exactly on the hour

vs. to tip generously

8. **No cessation-of-X constraint on verbs** (Weakly universal). English verbs do not incorporate the meaning "cessation" along with a specific activity; there are verbs like *stop* and *cease*, but not verbs with a meaning like (for example) "to stop eating."

*to stop sewing

vs. to laugh nervously

9. No continuation-of-X constraint on verbs (English-specific). English verbs do not usually incorporate a component of iteration or continuation of an action. That is, there is not likely to be a verb distinct from *dance* that means "to keep on dancing." There at least some apparent exceptions in English, e.g., *beat* vs. *hit*.

*keep on inspecting

vs. quickly grab

10. No combination of actions constraint on verbs (Universal). Verb meanings tend not to include two distinct actions. This is presumably a universal tendency, although it is not clear that this constraint can avoid circularity, given the difficulty of finding any non-linguistic criteria for what constitute "distinct actions."

*to soak and bend

vs. to get completely ready

*to run around singing

vs. to run around frantically

11. Constraints on the incorporation of direction into verbs of motion (English-specific). English motion verbs only infrequently incorporate direction into their meaning, and there are tight restrictions on what types of derivational meanings can be incorporated. Directional information also represented independently by prepositions can be incorporated, as in *enter*, *exit*, *transverse*, *penetrate*, *leave*, *arrive*, as can vertical direction, as in *rise*, *descend*. However, other types of directional information, e.g., cardinal points of the compass, cannot be incorporated into verb meanings.

*to go north

vs. disappear quickly

12. No incorporation of direction in verbs of speaking (English-specific). English verbs of speaking do not incorporate information about direction.

*to shout over (a barrier)

vs. to jump over (a barrier)

13. No incorporation of speed in verbs of thought (English-specific). English verbs referring to mental processes tend not to include manner specifications concerning speed.

*to make decisions quickly

vs. move very quickly

14. No incorporation of mood in verbs of writing (English-specific). English verbs of writing, unlike verbs of speaking, do not incorporate specifications of mood.

*to write angrily

vs. to shout defiantly

Constraints Across Part-Of-Speech Categories

15. Transparency of meanings involving proper names (Weakly universal). Proper names are not included in a word's meaning unless they are present in its form. For example, *Americanize* is a legitimate English word, and *Frenchify* is a possible English word, but there could not be a morphologically opaque word, e.g., *raxificate*, meaning "to translate into Polish."

*drive around in a Buick

vs. take a leisurely tour

APPENDIX B

Sample Passage from Experiment 2 - The Darsts of Zurdine

Noun Version

The planet Zurdine has the unique feature that its plants grow very fast and its animals move very slowly. In fact, many of its plant forms grow more quickly than any of its animal forms are able to move. This fact has led to some very interesting adaptations, especially among the Darsts, a humanoid species inhabiting the plains of Zurdine. The Darsts, although surrounded by fast-growing plants, are intelligent enough to capitalize upon their environment.

Fortunately for the Darsts, the planet is extremely dry, so by controlling the available water they can manage plant growth to some extent. Their way of life depends heavily on the use of the seeds of the Yrang plant, which begin to sprout between one and two seconds after they have been exposed to any moisture, and grow at speeds of up to 15 feet a second. For defense, a hunting party can erect a temporary enclosure simply by scattering Yrang seeds and spitting around the perimeter. This is often a necessary defense since there are several types of dangerous animals on Zurdine. Some of the worst are large six-legged predators, which, although slow-moving, are relentless, and the roving herds of poisonous razor-spined herbivores.

There are also a number of hunting techniques involving Yrang seeds. The most common is simply to throw moistened Yrang seeds around the quarry, so that the animal is quickly enveloped in a net of vines.

I observed other techniques as well while on a hunting expedition with the Darsts. Our goal that day was to bring in a particular species of smaller rodent-like animals which are prized as a special delicacy by the Darsts. But so far we had seen nothing but larger predators, which we had been careful to avoid. Finally, after several hours, we caught sight of a small animal moving to our right. While the rest of the party stood motionless, the head of the hunting party pulled out a hollow reedlike peashooter, and moistened some Yrang seeds with saliva. She slipped them into the peashooter and with accuracy that amazed me, she ensnared the unsuspecting *saptyn*. The entire hunting party was soon ambling in that direction to put their prey into a more permanent net.

Although I was untrained in Darst hunting techniques, I was able to be of help at a moment of real danger. One of the younger Darsts, who move even more slowly than their languid elders, was somewhat behind the group, and not even making much effort to stay close. Without warning, the young Darst found himself face to face with a *saptyn*. The youngster tried to ensnare it, but in his inexperience he dropped several moistened seeds. By the time I got to him, a vine was wrapped chokingly tight around his neck. I pulled him free, and carried him back to the group.

Verb Version

The planet Zurdine has the unique feature that its plants grow very fast and its animals move very slowly. In fact, many of its plant forms grow more quickly than any of its animal forms are able to move. This fact has led to some very interesting adaptations, especially among the Darsts, a humanoid species inhabiting the plains of Zurdine. The Darsts, although surrounded by fast-growing plants, are intelligent enough to capitalize upon their environment.

Fortunately for the Darsts, the planet is extremely dry, so by controlling the available water they can manage plant growth to some extent. Their way of life depends heavily on the use of the seeds of the Yrang plant, which begin to sprout between one and two seconds after they have been exposed to any moisture, and grow at speeds of up to 15 feet a second. For defense, a hunting party can erect a

temporary enclosure simply by scattering Yrang seeds and spitting around the perimeter. This is often a necessary defense since there are several types of dangerous animals on Zurdine. Some of the worst are large six-legged predators, which, although slow-moving, are relentless, and the roving herds of poisonous razor-spined herbivores.

There are also a number of hunting techniques involving Yrang seeds. The most common is simply to throw moistened Yrang seeds around the quarry, so that the animal is quickly enveloped in a net of vines.

I observed other techniques as well while on a hunting expedition with the Darsts. Our goal that day was to bring in a particular species of smaller rodent-like animals which are prized as a special delicacy by the Darsts. But so far we had seen nothing but larger predators, which we had been careful to avoid. Finally, after several hours, we caught sight of a small animal moving to our right. While the rest of the party stood motionless, the head of the hunting party pulled out a hollow reedlike peashooter, and moistened some Yrang seeds with saliva. She slipped them into the peashooter and with accuracy that amazed me, she *saptyned* the unsuspecting animal. The entire hunting party was soon ambling in that direction to put their prey into a more permanent net.

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