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Using Old Words In News Ways: The Effect Of Argument Structure, Form Class And Affixation

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Williams (1981) and others (e.g., Kiparsky 1983; Pinker & Prince 1987) have noted that new verbs which are semantically extended from nouns take the regular past-tense (as in the baseball sense of *fly*), while verbs extended from an irregular verb inherit the irregular past-tense marker, as happens with compounding and affixation (e.g. *oversleep*). This type of data has motivated the view that the mental lexicon is governed by abstract principles which are sensitive to formal grammatical categories such as noun and verb but not to the meaning of lexical items or the vicissitudes of their use. If only abstract principles can adequately describe morphological regularities, then it is reasonable to propose that notions such as lexical class, the root/affix distinction, and inheritance of feature markings are explicitly implemented as mental symbols in the language processing system (Marcus, Brinkmann, Clahsen, Wiese, Woest & Pinker 1993).

Contrasting with this is the view that formal constructs are emergent properties (or even side effects) of functional pressures (Bybee 1985; Wurzel 1989) and of the distributed nature of human conceptual representation (Dougherty & Seidenberg in press; Hare & Elman 1992). The current paper uses the domain of the English past tense to illustrate how descriptive morphological constructs may relate to functional and psychological descriptions. Speakers' judgements of past-tense well-formedness of novel verbs will be used to argue that inheritance of an irregular past-tense marker is a function of semantic similarity to an existing irregular verb. This will be related to a view of the lexicon in which affixes are stored with their stems, yet morphemes may come to have independent status (and variable productivity) depending on frequency and semantic transparency (Cutler 1980).

Novel Word Use

When speakers hear known words combined into a novel compound or collocation, clues to interpretation usually include the pragmatics of the discourse context, the conventional meaning of the component words, and learned generalizations about how meaning elements of two words are typically integrated. In the *sound-bite* example in (1), readers have these clues and an additional one, which reinforces the contextual clues: the writer has used the *-ed* suffix, rather than *bite's* irregular past participle, *bitten*.

- (1) And Ross Perot thought he couldn't be sound-bited. (Newsweek, October 1992)
- (2) The batted flied out to center field. (Kim, Pinker, Prince & Prasada 1991)

(3) He grandstanded to the crowd. (Kiparsky 1983)

If the Newsweek essayist had used the irregular past, “...and Ross Perot thought he couldn't be sound-bitten” our intuition is likely to be that the writer was purposefully drawing attention to the conventional sense of *to bite* (to seize with teeth, to wound); a near-pun which could be accompanied by a cartoon of Ross scampering away as a flying sound-bite snapped at his heels. Similarly, use of the irregular past-tense in (2) and (3) would draw attention to the conventional sense of the verbs *fly* and *stand*, while the *-ed* past-tense signals that the intended meaning is closer to the nouns *fly ball* and *grandstand*. Do descriptive tools or theoretical frameworks exist for capturing these intuitions?

The regular *-ed* form applies to new forms, such as when a new verb is made out of an onomatopoeic form, as in *I dinged her car*). This suggests that English past-tense formation is rule governed, not formed by analogy to words with similar phonology, as is the case with German plural formation (Marcus et al. 1993). English irregular inflections *can* be applied to new verb senses, but only in those cases in which the new word is morphologically related to an existing irregular verb. Williams (1981) gave the following explanation for why verbs extended from irregular verbs retain the irregularity marker, but not verbs extended from nouns extended from irregular verbs (the $V_{\text{irreg}} \rightarrow N \rightarrow V_{\text{new}}$ case). He proposed that morphologically complex words have hierarchical constituent structure. On analogy to phrase structure trees, the constituent of a complex word **C** which is the same syntactic category as **C** is considered the “head” of **C**. Thus, the head of *overeat* is *eat*. The semantic consequence of the headedness relation is that **C** is generally the same type of entity as **C**'s head, and so overeating is a type of eating.

When a verb V_{irreg} is made into a noun **N**, V_{irreg} can not be **N**'s head, by definition of the concept of “head” (because if it were, it would have to be the same lexical category as **V**, and then it wouldn't be a noun). Williams proposes that the absence of the headedness relation between **N** and V_{irreg} blocks the normal percolation of features from one derivational level to the next, so that inheritance of V_{irreg} 's irregularity marker is blocked. Thus, when **N** is used as the basis for a new verb sense V_{new} , V_{new} will take the regular past-tense as would any verb lacking an association with an irregular past-tense. I will call this the “feature percolation” account.

Kim, Pinker, Prince & Prasada (1992) have recently shown that college undergraduates appear to be sensitive to derivational status when judging novel compounds, even when these constructions are unusual and odd-sounding. Kim et al. constructed passages, such as those in (4) and (5), consisting of a preamble in which the target item appeared as either an irregular verb or a noun polysemous or homophonous to it. Novel semantic extensions of this noun or verb appeared in both the regular and irregular past-tense form, and subjects were asked to rate the naturalness of each form on a scale of 1 to 7 (mean naturalness ratings are at the right of each form).

New verb extended from the noun *Hurt* (the proper name *William Hurt*):

- (4) The actor William Hurt has a reputation for attracting the most female autograph seekers on the set during shooting, but this time Robert Redford attracted an even larger crowd.

Redford finally out-Hurted Hurt. 3.8125

Redford finally out-Hurt Hurt. 3.5625

New verb extended from the verb *hurt*:

- (5) The actor Sean Penn has a reputation for attacking nosy reporters and photographers in public places, but this time Jack Nicholson managed to hurt even more reporters.

Nicholson finally out-hurted Penn. 1.8750

Nicholson finally out-hurt Penn. 3.6875

Note that when *out-Hurt* is perceived by raters to be semantically extended from the proper name *William Hurt*, *out-Hurted* is judged more natural than *out-Hurt*. But when *out-hurt* is perceived to be semantically extended from the irregular verb *hurt*, then *out-hurt* is judged more natural than *out-hurted*.

Kim et al. found three exceptions to the predictions of the feature percolation account:

- (6) Both boxers managed to land heavy blows... Tyson (*out-blowed* 2.81 / *out-blew* 3.00) his opponent and won...
- (7) Janet was fed up with Sam's recurrent flings with young women... After her fifth willing partner she had actually (*outflinged* 3.31 / *out-flung* 3.62) the guy.
- (8) Pitcher Roger allowed the Orioles only three hits... He (*three-hitted* 3.12 / *three-hit* 4.43) them for the second...

Kim et al. argue that these three counter-examples can be assimilated into the feature percolation account if we imagine that raters may have *perceived* that the new usage was derived from the original irregular verb, rather than from the noun. Kim et al. call this addendum **the short circuit theory**, because the normal derivation from a noun is bypassed in favor of derivation from the root verb. Raters are most likely to "short-circuit" if they perceive that the new verb retains some semantic similarity to the original. Kim et al. collected ratings of the similarity between each new verb sense and the central sense of the verb root. They found that the semantic similarity ratings for the three exceptions were significantly higher than the mean similarity ratings of the rest of the items, suggesting that this perception of similarity had led previous raters to represent the above three items as deverbal instead of denominal.

If semantic similarity explains raters' preferences in these three cases, one wonders what role it plays in the other cases. One clue comes from the fact that half of Kim et al.'s denominal items were semantically extended from nouns homophones with irregular verbs. Of the denominals in which there was some meaning between the noun and an existing irregular verb, the relation was distant. Table 1 lists items from Kim et al.'s passages. Of 29 novel uses, half were clearly homophonous pairs¹, and the others were very distantly related (see Table 1). Kim et al.'s study thus only falsified the hypothesis that phonology is sufficient for

past-tense selection, a hypothesis which the authors had already noted to be false in previous work (Pinker & Prince, 1988). In Harris (1992) I described how a simple semantic hypothesis, **the shared meaning hypothesis**, could account for the pattern of results found by Kim et al.

Table 1: Verb and Nouns that Form the Basis for Novel Denominal and Deverbal Verbs in Kim et al. Study

Homophones		Polysemes	
Noun	Verb	Noun	Verb
reed	read Captain's mind	track meet	meet at airport
Go (board game)	go to the bathrm	wake (funeral)	wake the dead
Big-Sleep (movie)	oversleep	shrink (psychiatrist)	shrink clothing
William-Tell	tell a story	food and drink	drink up gossip
no	know	line-drive	drive on a line
flea	flee	banana split	split logs
beet	beat	hit (noun)	underhit *
bye	buy	fling (affair)	fling clothes *
stick (high-stick)	stick tape to wall	heavy blow	blow a bubble *
light beer	to light		
Lucky Strikes	strike a bell	*denominal item judged better with irregular past	
Hurt (William Hurt)	hurt		
mean (adjective)	mean		
interleaf	leave		

Shared Meaning Hypothesis (simple version)

regular past is judged most natural when:

the new verb **shares meaning** with an existing irregular verb

regular past is judged most natural when:

new verb **conflicts in meaning** with an existing irregular verb

An obvious counter-examples to this hypothesis is metaphoric usages. For example, there may be little similarity between a relatively central sense of *blow* (e.g. *the wind blowing through the trees*) and a clear metaphorical extension of *blow*, such as *a student blowing off a final*. On the other hand, two words may be semantically similar, but not lexically related, as with the verbs *hang* and *dangle*. These examples suggest that what is crucial is not shared meaning *per se*, but shared representational structure. In the next section I develop an account of how shared rep-

1. The homophonous items are not relevant to the hypothesis that a category change blocks percolation of an irregular feature. Consider Kim et al.'s finding that speakers prefer *The Dolphins out-meant the rest of the NFL* ["were meaner on the field than their opponents"] to *The Dolphins out-meant the rest of the NFL*. In this usage, the item *mean-V_{irreg}* is not a constituent of *out-mean*, and thus there is no feature whose percolation needs to be blocked by a category change.

representational structure relates to both shared meaning and well-formedness of the irregular past tense. I will then relate this mechanistic account to functional factors involved in meaning extension and conflict.

The Shared Representations Hypothesis

We can propose a principle of representational conservatism: avoid duplicating meaning structures unless necessary. When a speaker invents or hears a new use of an existing word, the speaker resists creating a new lexical entry, but if necessary, creates a “skeletal” entry. “Skeletal entries” don’t duplicate representational material, but instead use pointers to existing representations. The meaning of “pointers to existing representations” can be explained using our intuitions about the productivity of common prefixes, as illustrated by *Webster’s Dictionary Explanatory Notes*. One of these notes provides a list of prefixes and combining forms (such as *anti-*, *co-*, *mis-*, *out-*) and asserts, “These words are not defined because they are self-explanatory; their meanings are simply the sum of a meaning of the prefix or combining form and a meaning of the root word.”

Figure 1a illustrates how prefixation creates a “skeletal entry” for the compound *out-hurt*. This word gets its meaning via passive pointers to existing lexical entries for *out* and *hurt*. Figure 1b depicts a word used in Kim et al., *out-fling*. In this case, only some of the meaning between the irregular verb, *to fling*, is shared with the new verb, *out-fling*. Note that this view of representational conservatism is not incompatible with other proposals, such as Hankamer’s (1989) economy of storage principle.

The case of meaning conflict. In a case of meaning conflict between the original sense of a word W_{old} and extended sense W_{new} , pointers to the semantic associations of W_{old} are likely to be minimized. The baseball sense of *fly* is explained using this account as follows.

He hit a fly out to center field!	$fly_{irreg} \rightarrow fly_N$
fly_N	a ball that appears to fly through the air; shared meaning minimized, especially as fly_N gains its own associations through its history of use as a baseball term
$fly_{irreg} \rightarrow fly_N \rightarrow fly_{reg}$	fly_{reg} shares more meaning elements with fly_N than with fly_{irreg}
He flew out to center field	Sounds odd because $Virreg$ <i>flew</i> evokes fly_{irreg}

Lexical relatedness. Two words share meaning associations by virtue of one word pointing to elements of the other word’s representational structures. When a new use of an old word shares substantial meaning structures with the original word, the new entry “inherits” the associations of the original word by virtue of sharing in the set of connections with meaning associations, horizontal co-occurrence associations (i.e. argument structure) and any association with an irregular past tense. When a noun N is created by semantically extending an irregular verb V_{irreg} (as in *flyball*), and N later forms the basis for a new verb, the new verb may be regular

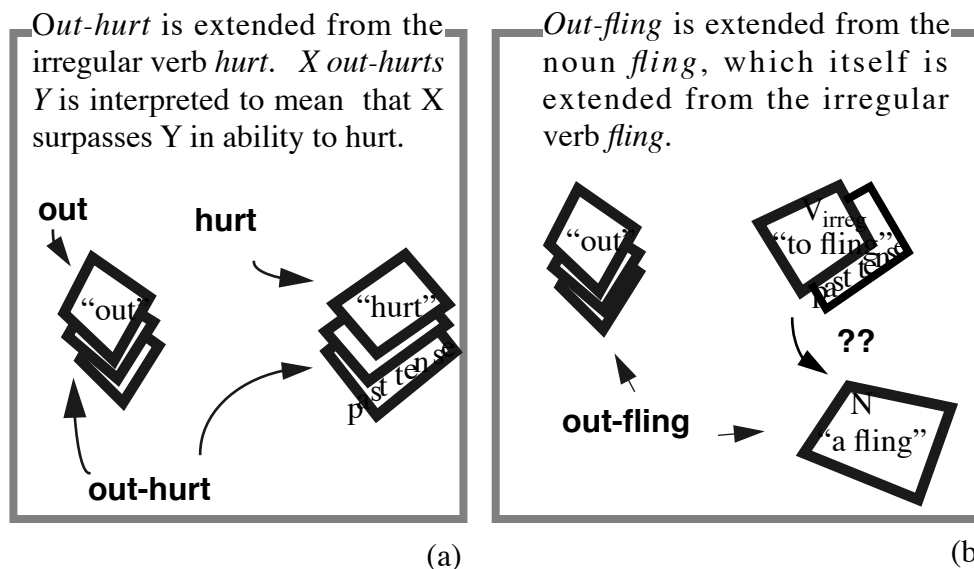


Figure 1. Layered boxes in diagrams stand for the diverse information associated with each lexical entry, including aspects of meaning and any association with an irregular past-tense form. Skeletal lexical entries, such as *out-hurt* and *out-fling* are thought to get their meaning from pointing to existing lexical entries. (a) *Out-hurt* is proposed to be a new form that assimilates the meanings of *hurt* to the pattern *out* + verb. Because its meaning is a composition of the independent meanings of its components, there is no conflict in meaning between *out-hurt* and *hurt*_{Virreg}. By the principle of representational conservatism, there is thus no need to duplicate meaning structures, and so *out-hurt* can be represented with just a “skeletal” entry, an entry that contains the form *out-hurt* and pointers to existing lexical entries. The irregular past-tense is thus passively inherited along with other information associated with the lexical entry for *hurt*. (b) *Out-fling* is also a skeletal entry, but it points to *fling*_N. *Fling*_N and *fling*_{Virreg} are likely to share some meaning structures, yet there is substantial meaning conflict. *Fling*_N, for example, doesn’t share the argument structures of *fling*_{Virreg}. In addition, *fling*_N has specialized meanings that are not shared by *fling*_{Virreg}. Therefore, *fling*_N must be set up as a separate lexical entry, with few meaning structures in common with *fling*_{Virreg}, which reduces the association with the past-tense form *flung*.

because N’s association with the past-tense of V_{irreg} decayed due to disuse or because meaning conflict necessitated that shared structures be minimized. Figure 2 shows how **feature percolation theory** and the **shared representations hypothesis** (SRH) predict blocked inheritance of V_{irreg} in cases of $V_{irreg} \rightarrow N \rightarrow V_{new}$.

Open questions for feature percolation include the set of principles which can predict degree of vacillation or uncertainty in preference for regular or irregular past-tense forms. SRH predicts that, for cases of $V_{irreg} \rightarrow N \rightarrow V_{new}$, conflict in meaning between V_{irreg} and V_{new} increases speakers’ use of and preference for *-ed* past tense. Degree of acceptance of the irregular past tense for V_{new} should depend on degree of shared meaning between V_{new} and V_{irreg} .

Functional Constraints on Meaning Extension

I will refer to this vocabulary as “functional” because it describes linguistic

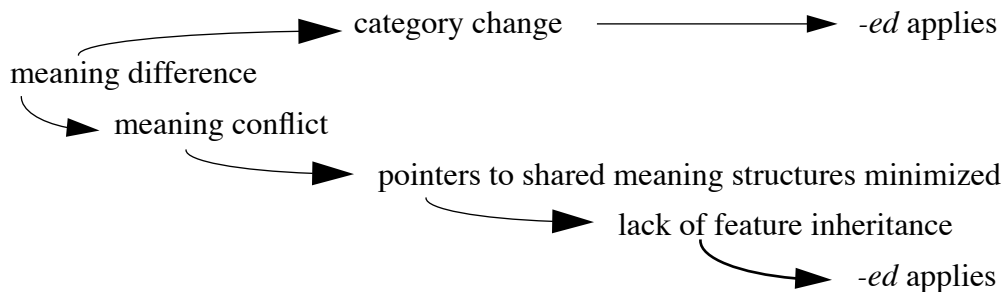


Figure 2. The upper pathway shows that, according to feature percolation, V_{irreg} is blocked because $V \rightarrow N$ is posited to be a headless rule, yielding a derived structure that does not have an irregular verb as its head. Irregular markers can only be inherited if an irregular verb is the head of the newly derived structure. The lower pathway shows the shared meaning hypothesis. Following Langacker (1987) it is assumed that a category change always entails a meaning difference (extent of the meaning difference of course varies, with some noun/verb pairs being extremely semantically similar). Meaning conflict (or lack of shared meaning) results in minimal sharing of meaning structures, and reduced inheritance of inflectional features.

behavior (such as speakers' production choices and naturalness ratings) in terms of speakers' communicative goals and comprehension strategies.

Viewing speakers' task to be one of **minimizing processing costs while maximizing communicative impact** (following Wurzel 1989; Lehmann 1985; Givón 1989 and others) allows us to characterize the costs and benefits of using a new word. A new word (or compound formed from old words) may be invented to fill a lexical gap, especially if the new form saves speech time (deCordova 1992). Humans, like all animal species, grow accustomed to the commonplace and dishabituate to novelty. A new word has the impact of novelty and thus may further the goal of maximizing communicative impact. But using a novel word has several costs. Costs include inventing and encoding a phonological string, and associating the string with the appropriate meaning structures. Polysemy and compounding are methods of filling lexical gaps and/or introducing novelty which minimize the cost of inventing and accessing a new form, and which capitalize on existing associations between the string and meaning structures.

Using old words in new ways has its own cost, that of possible failed communication, of which we can distinguish two types: (a) The listener fails to understand that the new sense is related to the old, and thus can't use the meaning of the known word as a clue to the intended semantic extension; and (b) meaning elements from the known word are incorrectly transferred to the new use.

For the case of $V_{\text{irreg}} \rightarrow N \rightarrow V_{\text{new}}$, both of the above types of comprehension failures are likely if the irregular past is used for V_{new} , as noted with the examples prevented in (1)-(3). Research on lexical access of morphologically complex words illuminate this issue. Segui & Zubizarreta (1985) suggest that the percep-

tual system processes complex words in left-to-right order, and that suffixed words are accessed via the lexical entry for the root, because the processor comes to it first. This means that the past tense form *flew* takes the processor directly to the lexical entry for $fly_{V_{irreg}}$. In contrast, the form *fly+ed* will take the processor to the lexical entry for the form *fly*, which will be a type of composite entry with pointers to the different senses of *fly*, including the several noun senses. For this reason, the perceptual processor accesses $fly_{V_{irreg}}$ before fly_N when encountering *He flew out to center field*.

Below I list some types of meaning extensions for which signaling meaning connection or disavowing shared meaning might be more or less important.

- i. **Metonymy.** In metonymy, the new usage picks out one aspect of the meaning conveyed by the standard usage. This is typically employed by speakers to reduce processing costs, as the conventional meaning is salient in the discourse or extralinguistic environment, and is thus easier to access than the lexical item that conventionally codes for the intended concept (Deane 1989). Because metonymy is usually used with contextual support (often with a subgoal of emphasizing shared knowledge) the risk of comprehension failure may be minimal. If a new verb V_{new} is created by metonymy from an existing irregular verb V_{irreg} , it is reasonable that both conversation participants will treat V_{new} as essentially the same lexical item as V_{irreg} , and the irregular past-tense will be most felicitous because it is uniquely associated with V_{irreg} .
- ii. **Metaphor.** The new usage builds on abstract relations present in the original. The partial mapping of elements is usually thought to be determined by conceptual factors such as highest structural match (Gentner 1989). The intended meaning builds on the original meaning, and may do so in ways that require the original meaning to be available for processing for a significant time period. Our predictions are thus the same as for metonymy: **Emphasize shared meaning by using the irregular past tense.**
- iii. **Inclusion.** New usage completely contains original usage, but adds to it. **Prediction: emphasize shared meaning.**
- iv. **Concatenative compounding.** Like inclusion, but two existing words are joined together, so that the resulting form may be different (as in *oversleep*). **Prediction: emphasize shared meaning.**
- v. **Aspect change.** Central to a verb's meaning is whether it describe an abstract, atemporal relation, or a process. If a process, the verb can refer to a punctate or temporally extended event. Example: *I told the children a story yesterday* (completive aspect). *I story-told the children for two hours* (durative aspect). **Prediction: Mixed.** Aspect is basic to verb meaning, and is part of listeners' automatic inferences about an event described with a certain verb. Therefore, if the new meaning conflicts with the aspect of the original, few meaning structures of V_{irreg} will be shared and the new verb will be given the default -

ed form. On the other hand, there are verbs in English that have malleable aspect, and many verbs can sound felicitous with a different aspect if the context is right (Langacker, 1987).

- vi. **Argument structure change.** Arguments of the original verb are incorporated into the meaning of the new verb or dropped completely. Example: Basic meaning of *fly* assigns to its subject the agent or experiencer of flying (moving through the air). The *base ball* meaning of *fly* incorporates the sense of a ball moving through the air, and assigns to its subject the causative role (initiator of the ball's flight). **Prediction: Mixed, but some meaning disavowal likely.** Maintaining predictable argument structure decreases processing costs: the nouns in a clause can be rapidly assigned the semantic roles defined by the verb, giving the listener a quick way to find out who is doing what to whom (Bates & MacWhinney, 1987). This rapid (and perhaps automatic) argument assignment is intuitively one good reason to disavow, with whatever devices are at hand, the image of the batter sailing through the sky.
- vii. **Denominalization.** If a noun with no meaning association is made into V_{new} , then there is no reason to expect V_{new} to take an irregular past, even if homophonous with some V_{irreg} , because access to irregular forms is through the lexical root, not through phonology. But in the case of $V_{irreg} \rightarrow N \rightarrow V_{new}$, some similarity in meaning between V_{irreg} and V_{new} may remain. Under the shared representations hypothesis, the felicity of the irregular form will depend on whether V_{new} is closer in meaning to the N or to V_{irreg} . If the former, then meaning conflict will lead to miscommunication if the irregular past is used for V_{new} .

The foregoing list of types of meaning change shows that shared representational structures are not likely to passively reflect absolute amount of semantic similarity. Nor are representational structures likely to depend on an all-or-none notion of "derivational relatedness." Instead, old words used in new ways can vary in the amount of representational structure that is shared between the new and old senses.

To compare the predictions of the percolation theory and the "shared representations" hypothesis, a study similar to that done by Kim et al. was conducted. Two types of meaning extension were studied: category change ($V_{irreg} \rightarrow N \rightarrow V_{new}$) and argument structure change ($V_{irreg} \rightarrow V_{new}$). According to feature percolation, only a category change will block inheritance, while according to the shared representations hypothesis, the factors determining feature inheritance is shared representational structures, and thus degree of shared meaning will mediate feature inheritance for both types of semantic extension.

I have proposed that feature inheritance depends on the amount of shared representational structure between lexical items. Two lexical items will share representational structure on a principle of representational conservatism (don't duplicate structures unnecessarily).

Experiment

Design of Passages

A total of 24 passages, varying in length from three to five sentences, were designed around 24 irregular verbs, each of which has a noun polyseme (e.g., *run*, *sleep*, *mistake*). I will refer to this noun or verb as the **target item**. Passages were designed to permit parametric variation of two factors: **form class**, with two levels (**noun, verb**) and **affixation**, with two levels (**affix, barestem**). There were thus four versions of each passage. Each passage has three parts:

- i. Characters and situation are introduced.
- ii. The target item is given a salient role in the story. In the **noun condition**, it appears as a noun. In the **verb condition**, it appears as a verb.
- iii. In the final sentence, the target item appears as a past-tense verb. Raters saw two versions of the final sentence and were asked to judge the naturalness of each: one in which the target verb ends with *-ed* (e.g. *stinged*), and the other in which it has the irregular past tense (*stung*). In the **affix condition**, target verbs appear with a hyphenated prefix (*out-hurted*, *out-hurt*) or as the right-most item in a compound (*zap-stinged*, *zap-stang*). In the **barestem condition**, target verbs appear as a simple verb (*stinged*, *stang*, *hurted*, *hurt*).

An additional factor, **argument structure** (with two levels, familiar or novel argument structure) was investigated as a between-passages factor, meaning that half the passages were designed with novel argument structure for the target item, and half the passages were designed with familiar argument structure.

Example of a passage which was designed around **familiar argument structure**:

Tom, the kid next door, is always bothering me and my sister. Every time Tom sees us he...

(**Noun condition**) ...gives us a zapping sting...

(**Verb condition**) ...stings us...
...with his toy laser gun. It hurts! The last time he

(**Affix condition**) ...zap-stinged/zap-stang...

(**Barestem**) ...stinged/stang... (Raters judge both past-tense versions)

...us our arms hurt so bad we couldn't finish our handball game.

Example of a passage which was designed around **novel argument structure**:

At the fair, I found a wiley old fellow who will rig his game-of-chance so every swing of my bat strikes the ball just right. I can't take credit for it--

(**Noun condition**)...he gives me the strike I need.

(**Verb condition**) ...he makes me strike it lucky
But today I guess he's mad at me. I played all day and he...

(**Affix condition**) ...lucky-striked/lucky-struck...

(**Barestem**) ...striked/struck...
...me only once.

For this study, “familiar argument structure” means that the target verb’s subject and object(s) both filled case roles (and respected selectional restrictions) that are conventional for at least one dictionary definition of the verbs. For example, in the case of *strike*, when both subject and object are animate, the subject is the agent (the striker) and the direct object is the entity being struck. In the novel argument structure example above, the agent of *strike* (or *lucky-strike*) is the causer/creator of an activity in which the subject experiences or obtains a benefit.

Procedure

Twenty-nine Boston University undergraduates (participating for course credit) filled out a paper-and-pencil questionnaire containing one version of each passage and filler items in random order. The raters judged the naturalness of both the regular and irregular past-tense versions by placing a hash mark on a line (containing 7 ticks) with the labels *unnatural* and *natural* at opposing ends. Whether the regular or the irregular past-tense appeared first on raters’ questionnaire was manipulated as a within-item factor.

All subjects were recruited for the study with the understanding that they would return for a second session three weeks after the first. None were informed as to the relationship between the first and second sessions. At the second session, they judged the same experimental passages (in the same condition) as at time1, although they saw different filler items. Of the 29 subjects, 26 returned for the second session. All results reported use the time1 ratings only, and include all 29 subjects, unless otherwise stated.

Results

Raters’ judgements were analyzed in two ways: (a) Each subject was counted as preferring the regular past tense if the regular was given a higher naturalness rating than the irregular. (b) Ratings on the 7-point scale were summarized into mean naturalness ratings for regular and irregular in each of the experimental conditions.

Percent Preference For Regular Past Tense. The percent of raters who preferred the regular past tense form to the irregular was calculated for the four conditions of the 24 experimental items. The means over all items are plotted in Figure 3. Analysis of variance on the means revealed significant effects of argument structure, $F(1, 22) = 4.77, p < .05$, and affixation, $F(1, 22) = 6.90, p < .02$. The mean percentage of raters who preferred the regular past tense was 14% (same as the grand mean) for both the noun and verb conditions when averaged over all conditions. Because the mean preferences for the regular past tense did not vary as a function of whether the target verb was semantically extended from the noun or verb polyseme, the noun/verb condition was not distinguished in Figure 1.

Mean Naturalness Ratings. The mean naturalness rating for each condition of each item were calculated and subjected to analysis of variance (summarized in Table 2). The means over items are plotted in Figure 4. Raters overwhelmingly

Figure 3. Percent of subjects in each condition who gave higher naturalness ratings to the regular past tense.

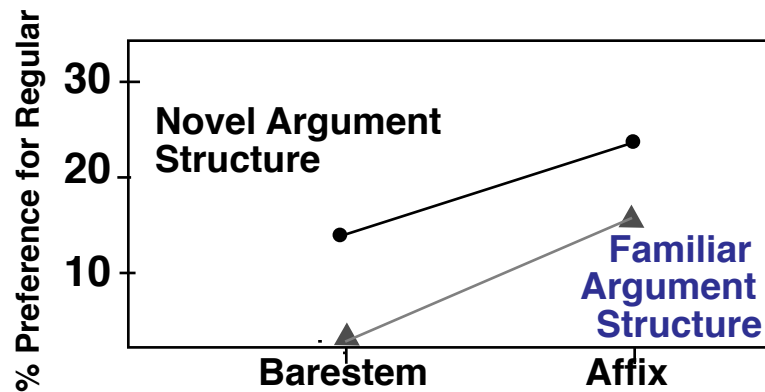
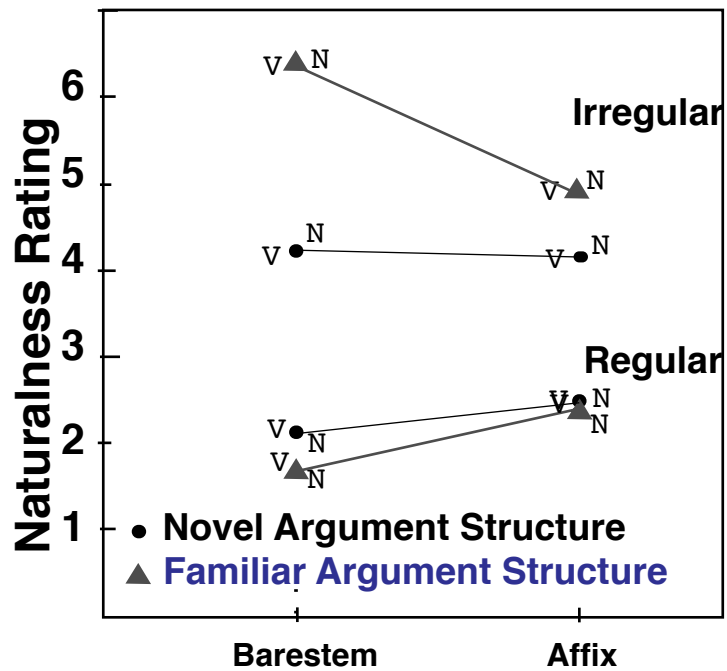


Figure 4. Mean naturalness ratings for both irregular and regular past-tense forms. Because the verb/noun condition was not significant, these were collapsed in making this graph. The graph was then annotated with the V and N symbols, to show that the noun and verb means varied little from each other.



judged the irregular past-tense form to sound more natural than the regular past-tense form. Looking just at ratings of the irregular past-tense (upper data points in

Table 2: Summary of Analysis of Variance on Mean Naturalness Ratings

Factor	<i>F</i> (1,22)	<i>p</i>	Interpretation
Past-tense Form	162.3	<.0001	Irregular past tense rated as more natural overall
Past-tense Form X Arg Struc	16.6	<.001	Novel argument structure reduces naturalness for irregular past-tense, increases it (but nonsignificantly; <i>p</i> = .18) for regular past-tense
Past-tense Form X Affix	18.2	<.0001	Affix reduces naturalness for irregular past-tense increases naturalness for regular past-tense forms
Past-tense Form X noun/verb	1.9	> .15	The <i>-ed</i> form and the irregular form were judged nodifferently when the passage was designed to highlight the novel verb's semantic extension to a noun or verb polyseme.

Figure 4) we see that changing the argument structure and adding an affix both decreased perceived naturalness. For ratings of the regular tense, novel argument structure *increased* naturalness, though this increase was not statistically significant. Affixation did significantly increase ratings of the naturalness of the regular past tense.

Discussion and Conclusions

Derivational status. Speakers ratings of past-tense naturalness to novel verbs extended from irregular verbs revealed equally low ratings of the regular past tense for the $V_{\text{irreg}} \rightarrow N \rightarrow V_{\text{new}}$ case and the $V_{\text{irreg}} \rightarrow V_{\text{new}}$ case across all argument structure and affixation conditions. This could be viewed as a failure to find support for the proposal that a category-change rule blocks inheritance of the irregular marker. An alternative approach is to adopt the position of Kim et al.'s "short circuit theory": Raters, confronted with $V_{\text{irreg}} \rightarrow N \rightarrow V_{\text{new}}$, did not perceive V_{new} to be derived from N, but instead perceived it to be derived directly from V_{irreg} . But this explanation strips the percolation account of predictive ability, since derivation from a noun only blocks inheritance if there is a change in meaning. If meaning change is required to block inheritance, then an explanation in terms of form class alone may have no advantage over an explanation in terms of shared meaning representations.

Affixation and meaning conflict. According to the shared representations hypothesis, when a new word is created by affixation or compounding, the new lexical entry can be created as a skeletal entry with pointers to existing mental representations, as long as the new sense is close to a concatenation of the component items. Information associated with the older lexical entries, such as an association with an irregular past-tense form, can then be passively inherited. In the case of meaning conflict, however, the compound needs to be set up as a separate lexical entry, and thus inheritance will be minimized. The passages in the current study crossed affixation (vs. a barestem) with a significant meaning change (an argument structure change) or no meaning change (the familiar argument structure condition). Feature percolation predicts no difference among these conditions, because derivation by affixation yields a hierarchical structure in which the old irregular verb is the head of the new structure, thus allowing the irregular tense marker to percolate up to the surface of the new form. In contrast, the shared representations hypothesis predict that meaning conflict (in this case, caused by an argument structure conflict) decreases the amount of shared structures, thus decreasing the availability of the irregular tense marker. This prediction was supported in that speakers' preferred the regular past tense when an argument structure change was present.

Compatibility with formal grammatical theory. This paper has positioned the shared representations hypothesis (SRH) as a rival to accounts based in formal grammatical theory (FGT), such as Williams' (1981) feature percolation account. However, the two accounts are similar in many ways. Both acknowledge that cate-

gory changes affect inflectional morphology, and that new words semantically extended from old words (or created by affixation of existing words) are lexically related to the words from which they are extended or composed.

FGT defines lexical relatedness in terms of hierarchical links between representations of new and old senses. Features flow along these links depending on the headedness relation. FGT uses the notion 'head' to identify the component of a word which determines its syntactic category, and then distinguishes between rules that create a headless structure (such as $V \rightarrow N$) and those in which the head is preserved (such as $V_{old} \rightarrow V_{new}$), with irregular past inherited in the latter but not the former.

SRH defines lexical relatedness in terms of shared representational structures. This could be implemented with nodes and pointers to symbolic information, or as a distributed network in which a word is a pattern of activation over a large set of processing units. Two words share representational structure to the extent that the same units are active in the two words. What FGT accomplishes with headed and headless rules, SRH accomplishes by proposing shared vs. distinct representations (e.g. shared processing units). Feature inheritance occurs when processing nodes are shared, and is blocked when shared nodes are minimal. One advantage of SRH is that it allows lexical relatedness to be a matter of degree. Feature inheritance may thus also be a matter of degree. These advantages were supported by the rating study. A second advantage is that degree of shared representations can be related to the communicative goals of language users, as briefly described in an earlier section.

One could thus view SRH as either an implementation of FGT in which formal terms are given a processing definition or an extension of FGT, in which formal terms are seen to be an approximate description to phenomena that emerge from processing and communicative factors. Future work will consider how other lexical and morphological phenomena can be assimilated to the views that meaning distinctions drive lexical organization, while frequency of usage and similarity to existing stored patterns determine whether a particular form is maintained as a distinct representational structure, or is assimilated to existing patterns.

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