Similarity in linguistic categorization: The importance of necessary properties*

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Abstract

Usage-based models of language propose that the acceptability of an element in a constructional slot is determined by its similarity to attested fillers of that slot (Bybee 2010, ch. 4). However, Ambridge and Goldberg (2008) find that the acceptability of a long-distance-dependency (LDD) question does not correlate with the judged similarity of the matrix verb to think *and* say*, which are by far the most frequently attested fillers of this slot. They propose instead that the acceptability of LDD questions is determined by the degree of fit between the information-structure properties of the matrix verb and those specified by the construction—specifically, the degree to which the matrix verb foregrounds its complement clause. This paper explores the possibility of reconciling this explanation with one based on similarity by suggesting that in this case the relevant aspect of similarity is precisely the verb's foregrounding of its complement. Evidence for this suggestion comes from psychological research showing that in a categorization task, the similarity of an item to the exemplars of a category is judged primarily with respect to the features common to all category members, as well as from the observation that virtually all attested matrix verbs in LDD questions strongly tend to foreground their complements.*

Keywords: *similarity; categorization; usage-based models; acceptability judgment; long-distance dependencies*

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1. Similarity and categorization

Many models of categorization presume that an item is assigned to a category on the basis of how similar it is to the various categories to which it could be assigned. This includes both prototype and exemplar models: in a prototype model, the likelihood of an item being assigned to a particular category depends on the similarity between the item and the category's central tendency; in an exemplar model, it depends on some combination (usually the sum) of the similarity of the item to each exemplar of the category (Medin and Schaffer 1978; Nosofsky 1986, 1992; see also Estes 1986).

While in many cases similarity provides a clear basis for categorization, there are situations in which similarity and categorization appear to yield contrasting category assignments. To take just one example, Rips (1989: 28–32) finds that when people are asked to imagine a circular object three inches in diameter, they usually say that it is more similar to a quarter than to a pizza (on account of its size), and yet more likely to *be* a pizza (because pizzas come in a range of sizes, whereas a quarter's size is invariable). Such dissociations have led some researchers to conclude that similarity cannot be used to explain judgments of category membership.

At the same time, it has been shown (Goldstone 1994: 127–130, 135–137; Medin et al. 1993) that similarity judgment is a highly variable process, and, in particular, that the properties with respect to which the similarity between two items is measured depend to no small degree on the particulars of the task for which the comparison is being made. This raises the possibility that categorization may still be capable of being explained in terms of similarity, but that the constraints imposed by the categorization task on the process of similarity judgment—in particular, the respects that are considered relevant to the comparison—may differ from those that apply to "plain" similarity, and that this may account for the dissociations between (plain) similarity and categorization observed by Rips (1989) and others (e.g. Thibaut et al. 2002; see also Goldstone 1994: 131–134, 143–145; Medin et al. 1993: 275).

In this paper, I review some psychological research suggesting constraints on the judgment of similarity as carried out in the context of categorization. I will try to show how a notion of similarity thus constrained may be used to address some apparent problems faced by an exemplar model of linguistic productivity. In particular, I will attempt to address the question of how to explain the relative acceptability of different matrix verbs in questions with long-distance dependencies, which has recently received some attention among usage-based researchers (Ambridge and Goldberg 2008; Dąbrowska 2008, under review).

2. Similarity and acceptability judgment

In a usage-based model, the processes of comprehending an utterance and judging its acceptability are viewed in terms of categorization. In particular, a speaker's knowledge of a language is taken to consist of a set of categories of symbolic structures encountered in usage; the interpretation of an utterance is then determined by the categories to which it and its subparts are assigned (its "structural description"; cf. Langacker 1987: 393, ch. 11), and its acceptability is determined by how much it and its subparts are sanctioned by each of these categories.[1] In this paper, I will be looking at acceptability insofar as it depends on the sanction of a *single* category.

The categories I will be concerned with are categories of complex symbolic structures—in other words, *constructions*. A complex structure, by definition, has components, and the corresponding components of the exemplars of a construction themselves form categories known as *slots* (or *paradigms*). Any instance of a slot is called a *filler*. It should be clear that the similarity between one instance of a construction and another is partly determined by the similarity of corresponding components.[2] To the extent that this is so, if acceptability depends on similarity, then the acceptability of an expression with respect to a construction depends on the acceptability of its components as fillers of the construction's slots.

Let us briefly consider a concrete example, to illustrate the above assumptions, and to elaborate on the role of similarity in acceptability judgment. Bybee and Eddington (2006) present a detailed study of a set of Spanish verb-phrase constructions consisting of a reflexive verb (with an animate subject) meaning roughly "to become", followed by an adjectival complement. Some examples are given below (using the citation forms of the verbs; Bybee and Eddington 2006: 330):

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1. The degree to which a category sanctions an item may be compared with what Nosofsky (1988: 55) calls the "strength" of a particular category response in a classification task (the summed similarity of the item to the exemplars of the category)—as opposed to the likelihood (*relative* strength) of that response. Note that being sanctioned by a category is different from being sanctioned by a schema: an item (e.g. **three muds*) may be sanctioned by a schema (e.g. the noun-phrase schema specifying the combination of a number other than 1 with a plural noun), and yet fail to be adequately sanctioned by the corresponding category. It is important to remember that a category is a *network* of schemas (Langacker 1987: 377–386, 409–411), and hence the sanction of a category can also be thought of as a function of the individual sanctions of its constituent schemas.
2. It may also depend on other properties of the expressions being compared, such as how similar the *relation* between two components of one is to the relation between the corresponding components of the other. See Stefanowitsch and Gries (2005: esp. 14–18) for studies of constructions with relations between their slots, where this kind of relational similarity may be crucial for explaining their productivity.

(1) *quedarse solo* 'to end up alone'
ponerse nervioso 'to get nervous'
quedarse tranquilo 'to calm down'
volverse loco 'to go crazy'

For two of the verbs considered (*quedarse* and *ponerse*), Bybee and Eddington (2006: 351–352) find that native speakers rate a verb phrase as acceptable to the extent that the adjective following the verb is similar to the adjectives that are known to appear with it (particularly those that appear most often), with the highest ratings given most often to verb phrases with those high-frequency adjectival complements themselves. (The other two verbs—*hacerse* and *volverse*—are not tested, since their attested complements do not exhibit much semantic coherence; see Bybee and Eddington 2006: 344–347.) Thus, to illustrate with *quedarse*, a verb phrase with *sorprendida* 'surprised' is rated by 42 out of 48 subjects as 4 or 5 on a scale of increasing acceptability from 1 to 5, whereas one with *pasmados* 'shocked' is thus rated by 30, and one with *orgullosísimo* 'extremely proud' by only 6 (Bybee, p.c.): *sorprendido* occurs quite frequently with *quedarse* (four times in Bybee and Eddington's written corpus and three times in the (smaller) spoken corpus), and although *pasmado* and *orgullosísimo* occur in this construction only once each (in the written and spoken corpus, respectively), the former is more similar in meaning to *sorprendido* than is the latter (as judged by one native speaker: Bybee and Eddington 2006: 330–331, 334, 336–337). (*Orgullosísimo* is also not very similar to any other adjective that occurs frequently as a complement of *quedarse*.)

To the extent that a Spanish verb phrase headed by a verb of "becoming" has its acceptability judged with respect to one of the constructions under investigation, Bybee and Eddington's results can be seen to be consistent with models of categorization that rely on similarity to exemplars. However, there are cases in which similarity to the exemplars of a construction's slot seems to be a very poor predictor of how acceptable an expression with a certain filler of that slot is with respect to the construction. One such case is introduced in the next section, and will serve to motivate and illustrate constraints on similarity in the context of acceptability judgment.

3. Questions with long-distance dependencies

Ambridge and Goldberg (2008) study a restriction on the matrix verbs that can appear in *wh*-questions where the question word is "extracted" from (denotes an argument or adjunct in) the main verb's finite complement clause. (These structures are known as *long-distance dependency questions*—henceforth, *LDD questions*; cf. Dąbrowska 2004: 196–199; 2008, *inter alia*.) Consider

the following examples (Ambridge and Goldberg 2008: 360, rearranged; the underscore represents the "gap" in the complement clause that is "filled" by the *wh*-word):

(2) (a) Who did she say that he saw _?
(b) Who did she think that he saw _?

(3) (a) ??Who did she mumble that he saw _?
(b) ??Who did she realize that he saw _?

In general, if the matrix verb is a "light" or "bridge" verb (*say*, *think*, etc.; further characterization to be given below), the sentence is considered more acceptable than if it is either a manner-of-speaking verb (*mumble*, *shout*, etc.) or a factive verb (one that presupposes its complement: *realize*, *notice*, etc.).

Ambridge and Goldberg (2008) test the hypothesis that this restriction is due to a potential conflict between the information structure properties of the main verb and those of the construction. They propose (following Goldberg 2006: 315, who calls this the "Backgrounded constructions are islands", or BCI, hypothesis) that in any filler-gap construction, the constituent that serves as the gap *cannot be backgrounded*: it must either be the topic of the corresponding non-gapped clause, or it must be in its potential focus domain (i.e. part of what is asserted, rather than what is presupposed or otherwise non-asserted). Since a complement clause is usually not a topic, this means that in order for a gap to occur in the complement clause, that clause must be in the potential focus domain.

In sentences in which the main verb is a manner-of-speaking or factive verb, the complement clause is usually backgrounded. To see this, consider the following sentence pairs (Ambridge and Goldberg 2008: 364–365, rearranged):

(4) (a) She shouted that he left.
(b) She didn't shout that he left.

(5) (a) She realized that he saw the roses.
(b) She didn't realize that he saw the roses.

In (4), neither sentence indicates whether he left; they only make a claim about the manner in which this content was conveyed. In (5), both sentences presuppose that he saw the roses; they differ only in terms of what they say about whether she was aware of this fact. Hence, in both (4) and (5), the complement clause is not part of what is asserted, and thus, being neither the topic nor part of the focus domain, it is backgrounded. Thus we can see that, according to the BCI hypothesis, manner-of-speaking and factive verbs cannot easily be used as main verbs in LDD questions (yielding the double-question marks in (3)).

On the other hand, "light" or "bridge" verbs (*think*, *say*, *believe*, and a few others) are defined partly by the fact that their complement clause *need not* be

backgrounded (i.e. may be asserted or foregrounded). To see this, consider the following sentence pairs (cf. Ambridge and Goldberg 2008: 368–369):

(6) (a) She said that he left.
(b) She didn't say that he left.

(7) (a) She thought that he saw the roses.
(b) She didn't think that he saw the roses.

To some extent, (6b) can be taken as implying that he didn't leave, and (7b) as implying that he didn't see the roses. (This also depends on, among other things, how strongly the speaker identifies with the main-clause subject; cf. the discussion of "argumentative strength" in Verhagen 2005: 105–107.) Since negating an (a) sentence may result in negating the content of the complement clause, the complement clause may be part of what is asserted by these sentences, and thus may be foregrounded. Accordingly, BCI predicts that it *is* possible to use a bridge verb as a main verb in an LDD question; hence, the absence of question marks in (2).

Ambridge and Goldberg (2008) contrast their account of LDD questions with one suggested by the work of Dąbrowska (2004: 197–198, 217–219; 2008: 392–393), who finds that in natural speech, almost all LDD questions are instances or minimal variations of two high-frequency schemas: *WH do you think S-GAP?* and *WH did you say S-GAP?*.[3] (See also Verhagen 2005: 121–126 for similar patterns in written Dutch.) She proposes that these two schemas constitute prototypes of the category of LDD questions, and that instances of the category that are not subsumed by these prototypes are produced and interpreted by analogy with them: by making substitutions for the fixed elements (*do|did*, *you*, *think|say*) and by inserting elements at certain positions (e.g. the complementizer *that* after the main verb). She provides experimental evidence (Dąbrowska 2008: 412–414) that subjects rate sentences that deviate from the prototypes as consistently worse than those that conform to them (with the exception that changing the main-clause subject to a proper noun has no sig-

3. Notice that, unlike the sentences used by Ambridge and Goldberg (2008), the schemas that Dąbrowska describes have no complementizer, and the auxiliary is in the present tense when the matrix verb is *think* (cf. also Dąbrowska under review). Of course, this does not bear directly on the question of which matrix verbs are most acceptable.

A construct such as S-GAP (representing a finite clause with a gap in it, i.e. lacking an argument or adjunct) may seem to violate the content requirement (Langacker 1987: 53–54), since it is defined in terms of something that is absent, i.e. that does *not* "actually occur in [a] linguistic expression". See Kalyan (in preparation a) for discussion of such apparent violations (and why they may be only apparent), as well as the suggestions on how to analyze "*wh*-movement" in relative clauses in Langacker (1991: 465–466) and Langacker (2008: 423–426).

nificant effect on acceptability). In particular, she finds that when the main verb is something other than *think* or *say*, the rated acceptability drops significantly. While Dąbrowska does not test different degrees of deviation from the main verbs of the prototypes, her claim that these schemas form the basis for analogical extension suggests that the more similar the main verb is to *think* or *say*, the more prototypical the sentence will seem, and the more acceptable it will be judged. (This would be consistent with the assumptions and findings noted in the previous section, which would suggest that the acceptability of an LDD question partly depends on the similarity of the matrix verb to the most frequently attested fillers of that slot.)

Ambridge and Goldberg (2008: 363) do not exclude the possibility that the two schemas proposed by Dąbrowska are stored in the speaker's mind (although they do not find any positive evidence for it; but see Dąbrowska under review). However, their experimental results seem to contradict the hypothesis that the acceptability of an LDD question depends on how similar the main verb is to *think* or *say*, thereby casting doubt on the idea that these two schemas form the basis for analogical extension. For each of a set of bridge, manner-of-speaking and factive verbs, they measure (a) how much less acceptable it is rated in an LDD question than in a corresponding declarative (its "dispreference for extraction" or "difference score"); (b) how strongly its negation is judged to imply the negation of its complement (its "negation test score", a measure of how much it foregrounds its complement clause); and (c) how similar it is judged to be to *think* and to *say* in the context of a polar question (as well as independently of context, using Latent Semantic Analysis). They find a striking (negative) correlation between the difference scores and the negation test scores, but no significant correlation between a verb's difference score and its similarity to *think* or *say.* Thus, their results support the information-structure account, but appear to be problematic for an account of acceptability that depends on similarity to exemplars.

It is possible, however, to accept Ambridge and Goldberg's (2008) findings without rejecting a similarity-based account. What is needed is the idea that the acceptability of an LDD question depends on how similar the matrix verb is to attested LDD question matrix verbs (chiefly *think* and *say*), *in terms of foregrounding its complement clause*—in which case the more the matrix verb foregrounds its complement, the more acceptable the sentence is, in accordance with the BCI hypothesis.

But how does a speaker know that in this case, similarity should be judged with respect to foregrounding of the complement, as opposed to some other property of the verb? More generally: In what respects must a component of an expression be similar to the attested fillers of a construction's slot in order for it to be able to fill that slot? This is a problem for any exemplar model of productivity. Goldberg (1995: 133–134) writes the following in relation to the

proposal that the range of verbs that can appear in the English ditransitive construction is circumscribed by a set of "narrowly defined verb classes":

> Narrowly defined verb classes, then, are implicitly represented as clusters of semantically related verbs known to occur with a given construction. New or previously unclassified verb forms are attracted to existing clusters on the basis of similarity to existing cases. However, judgments of similarity are notoriously variable across speakers and contexts, and two activities can almost always be said to be similar in some respect. Therefore, in order to adequately defend the idea that the use of new and novel senses is determined by similarity to existing cases, one must be able to define the similarity metric which is to be used as the basis of comparison.

(For comments of a similar [!] nature, see Bybee 2010: 62.) The problem of variable similarity is hardly unknown in cognitive psychology. Indeed, it is the flip side of the arguments against similarity-based categorization referred to in Section 1: whereas Rips (1989) and other dissociation studies take similarity as a fixed construct, and show that it differs systematically from categorization, others have argued that similarity is too unconstrained a notion to be of any use in explaining other processes (cf. Goldstone 1994: 135; Medin et al. 1993: 254–257). It has already been suggested in Section 1 that while similarity is flexible, it is not totally unconstrained, and that constraints on similarity judgment can be found in the nature and purpose of the task being performed. In the following section, I survey some of the psychological literature that bears on such constraints, particularly in the context of a categorization task.

4. Constraints on similarity

The way in which we measure similarity obviously depends on the kind of representation we assume for the items being compared. There are two common ways of representing items: as points in a multidimensional space, and as (structured or unstructured) collections of features (Thibaut 1997: 705–718). Here I consider a featural representation.[4]

4. I use the word "feature" for consistency with the papers being cited. However, I do not mean to commit myself to the existence of a fixed set of features into which all items can be exhaustively decomposed. See Schyns, Goldstone and Thibaut (1998) and Langacker (1987: 19–22) for more flexible approaches to features (see also Thibaut (1997: 704, my translation): "features are aspects of real entities, often posited on the basis of the researchers' or subjects' intuition, i.e. without any theoretical constraints"). (Cruse [1986: 22] uses the term "trait" as an alternative without the connotations of universality and exhaustiveness. I thank Adele Goldberg for cautioning me on this terminological issue.)

   The issue of the relative appropriateness of dimensional and featural representations is an intricate one. Thibaut (1997: 704) suggests that "[f]ormally, dimensions can be represented in

In most feature-based models of similarity, starting with Tversky's (1977) seminal paper, similarity between two items increases with the number and salience of shared features, and decreases with the number and salience of non-shared features. (For further details, see Tversky 1977; for important refinements to his model, see Gati and Tversky 1984; Ortony 1979; Ortony et al. 1985.) There are many factors affecting the salience of a feature; let us look at one that is particularly relevant for categorization.

Medin et al. (1993) cite an unpublished experiment where Doberman pinschers are rated as more similar to raccoons than to sharks, and yet more likely to belong to the set {boar, lion, shark} than to the set {boar, lion, raccoon}. They explain this by saying that " '[f]erocious' becomes important [in the first category] because it emerges as a similarity between all three category members" (Medin et al. 1993: 275).

A more systematic demonstration is provided by Thibaut et al. (2002). They construct two categories of drawings of jellyfish-like creatures that vary by the shape of the body and the arrangement of its four legs. Each category has one feature that is salient and present in most members (its "characteristic feature", in this case round vs. T-shaped body; this is known to be salient because most participants sorted the stimuli by this feature in a free-sorting task), as well as one feature that is present in all members, but is not very salient (its "necessary feature", in this case legs grouped as 1 and 3 vs. 2 and 2; only two out of 22 participants sorted by this feature). They find that a novel item with the characteristic feature of one category and the necessary feature of the other (e.g. a jellyfish with a round body and legs arranged in two groups of two) is nearly always classified according to the necessary feature (the arrangement of legs), despite this being less salient.

Finally, Nosofsky (1986), using dimensional (as opposed to featural) representations of stimuli, finds that if subjects learn categories that differ along one dimension (e.g. the size of dial-like figures as opposed to their needle angle), their subsequent performance in classifying novel stimuli is best accounted for by a representation in which the crucial dimension (in this case, size) is "stretched" with respect to the representation revealed by other tasks. In other words, when the categories that are learned are defined by necessary values (or ranges of values) on a dimension, that dimension (and hence the values on it) becomes highly salient in a categorization task.

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terms of features" (cf. Gati and Tversky 1982), while the converse is not true. However, Glazer and Nakamoto (1991: 214–215) prove mathematically that there are many kinds of dimensional structures that cannot be expressed in terms of features. The choice between the two kinds of representation must ultimately be determined on empirical grounds (and it need not be an exclusive choice; see Nosofsky and Zaki 2003 for a successful hybrid model).

Thus, an important constraint on similarity in categorization seems to be that necessary features of the category—features exhibited by all members—assume high salience, and hence have a large effect on the similarity between each exemplar of the category and the item to be categorized.[5] We can now explain the result obtained by Rips (1989), mentioned in the first section, where a circular object 3 inches in diameter is judged more similar to a quarter but more likely to be a pizza. The diameter of a quarter, being fixed, is a necessary feature of the category of quarters, and hence becomes highly salient when the target item is being judged against it. Since the diameter of a quarter is not shared by an object 3 inches in diameter, this amounts to a very salient non-shared feature, which results in very low similarity, and hence a very low likelihood of category membership. Pizzas, by contrast, being widely variable in size, cannot easily be said to have a size feature that is necessary (or at least, not one that is not shared by a 3-inch object).

5. Back to LDD questions

As mentioned in Section 3, Dąbrowska's (2008) findings suggest that a verb is judged acceptable in an LDD question to the extent that it is similar to *think* and *say*. According to the present proposal, this view can be reconciled with Ambridge and Goldberg's (2008) seemingly contradictory experimental results, provided we assume that in this context, the similarity between the target verb and *think* and *say* is judged with respect to the verb's foregrounding of its clausal complement. The question, then, is how a speaker knows that this is the relevant respect.

Given that the vast majority of LDD questions have *think* or *say* as the main verb (96% in the Manchester corpus [Dąbrowska 2004: 197], and 86% in the British National Corpus [Dąbrowska under review]), and given that both of these verbs strongly tend to foreground their complement (Ambridge and Goldberg 2008, Figure 3; Dąbrowska under review, Figures 4, 7–9), we can see that the property of foregrounding the complement comes quite close to being

5. It is by no means the case that non-necessary features of the category cease to have any influence whatsoever (*pace* Thibaut et al. 2002). For instance, Thibaut and Gelaes (2006) find that even when the necessary features of a category are perfectly clear, people may mistakenly classify an item missing necessary features into that category if it exhibits sufficient similarity to one exemplar.

   Also, with respect to the Medin et al. (1993) experiment, one might wonder why "mammal", being a shared property of {boar, lion, raccoon}, should not enjoy the high salience that "ferocious" has in the other category—especially since the fact that Doberman pinschers are ordinarily judged more similar to raccoons than to sharks seems to suggest that "mammal" is *more* salient than "ferocious"! Clearly, there is more to the salience of "ferocious" here than simply its being a necessary feature (though this is certainly a contributing factor).

a necessary feature of LDD main verbs. Thus, from the results in the previous section, it seems likely that when the speaker judges the extent to which a sentence is sanctioned by the LDD question construction, this property of the verb will have a strong (if not determining) effect on the similarities thus computed. In other words, the greater the extent to which the verb foregrounds its complement, the more likely it is to possess the property of being a complement-foregrounding verb; the more likely this property is to be counted as a shared feature; and the greater the similarity of the verb to attested LDD main verbs.

I do not wish to imply that foregrounding of the complement is the *only* property of LDD main verbs that behaves as a necessary feature. Another property common to *think* and *say* is that both indicate that the subject asserts the content of the complement clause: e.g. *Mary said it was going to rain* indicates not only that Mary conveyed a certain message through speech, but also that she asserted this belief, and is thus committed to the consequences of holding it. (I am grateful to an anonymous reviewer for pointing this out.) Yet another is that these verbs minimize the distinction between the subject's attitude towards the content of the complement, and that of the speaker (or addressee, in the case of a question; cf. Verhagen 2005: 127–131; Dąbrowska 2008: 415). The argument I am making is consistent with all of these properties being relevant; I am focusing on complement-foregrounding simply in order to show that the present proposal is capable of explaining the findings of Ambridge and Goldberg (2008). I would like to point out, though, that such properties as these, which pertain more to the speech situation than to the object of conceptualization, are unlikely to be the ones that are most salient when explicitly judging the similarity of a verb to *think* and *say*.

The explanation proposed in this paper is thus very similar to that of Ambridge and Goldberg (2008), in that the acceptability of an LDD question is a matter of the degree of fit between the verb's specifications and those of the construction. However, it differs in terms of the nature of the potential mismatch: in the model assumed by Ambridge and Goldberg (2008: 366; see also Goldberg 2006: 135), the reason why a main verb in an LDD question cannot background its complement is that if it did, the *wh*-word would be at once foregrounded (by the construction, which places it at the front of the sentence) and backgrounded (by the verb, which backgrounds the clause to which the *wh*-word belongs), resulting in a "pragmatic clash" (Goldberg 2006: 132).[6] The present proposal states merely that a complement-backgrounding verb

6. Doubts have been expressed concerning the validity of the notion "pragmatic clash" (e.g. Croft 2009: 160–161: ". . . it is not clear to me why the pragmatic clash is allowed in the [*wh*-in situ] languages that allow [questioning of backgrounded elements]. Do these languages have the ability to express an information structure configuration that English (and similar languages) cannot?"). See Kalyan (in preparation b) for further discussion of this issue.

would be a poorly-sanctioned filler of the main verb slot of the LDD question construction (see also Ambridge in press).

There are a few questions that are left unanswered by the present account. First, the two prototypical LDD schemas, *WH do you think S-GAP?* and *WH did you say S-GAP?*, share many properties apart from those of their main verbs. In particular, they both specify *you* as the subject. Yet Dąbrowska (2008: 409–410) finds no significant effect on acceptability of changing the subject from a second-person pronoun to a lexical noun phrase, despite the fact that the property of having a second-person subject is shared among attested LDD questions almost as widely as the main verbs *think* and *say* (91% in the Manchester corpus [Dąbrowska 2004: 197], 90% in the spoken BNC [Dąbrowska 2011]). Dąbrowska (2008: 398–399) suggests that this is because nominals are conceptually autonomous, and hence can be easily substituted for each other. This can also be thought of in terms of the relative salience of properties of the subject and properties of the verb. Croft and Cruse (2004: 318–320, 323–324) provide evidence that the properties of arguments in a sentence are less salient than properties of the predicate (see also Healy and Miller 1970), and explain this in terms of a relevance hierarchy for sentential meaning (similar to the relevance hierarchy for verbal meaning in Bybee 1985: 24). If the property of having a second-person subject is relatively non-salient, an LDD question with a different subject would not be judged substantially dissimilar to attested instances on account of that, and hence its acceptability would not suffer much.

Secondly, there should be some way of explaining why, in certain contexts, an LDD question with a complement-backgrounding verb is acceptable. For example, Ambridge and Goldberg (2008: 365) note that a question such as *What did you whisper that the house was?* is acceptable in a context where the manner of speaking coded by the main verb is presupposed (e.g. in a game of whisper-down-the-alley). One possibility is that in such contexts, the main verb takes on a special, complement-foregrounding sense. Alternatively, we could say that the verb retains its ordinary meaning, but that because the manner of speaking (foregrounded by the verb) is already established in the discourse, the difference between this verb and one that does not foreground manner (such as *think* or *say*) loses salience. The matter remains indeterminate until we have a way of determining the meaning of a word in a given context (see Kalyan in preparation b).

Finally, I would like to mention Dąbrowska's (under review) finding that not all speakers are sensitive to the BCI constraint, i.e. that for some speakers, an LDD question whose main verb is something other than *think* or *say* is just as (un)acceptable regardless of how strongly the verb foregrounds its complement. While I have no evidence to offer, this result is what one would expect, for example, if some speakers encountered *think* and *say* in LDD questions with such extreme frequency that even the properties of these verbs that are not

necessary features of LDD main verbs became highly salient. In this case, even if a verb (other than *think* or *say*) had a strong tendency to foreground its complement, this would not significantly improve its similarity to attested LDD main verbs, since some of the non-shared features would be highly salient.

A recurring issue here is that of how to determine the salience of a feature. It does not seem to be enough to say that necessary features of a category tend to be more salient than non-necessary features; as seen above, there are many other factors affecting salience, which may reduce the salience of a necessary feature or boost the salience of a non-necessary one. Moreover, even to the extent that the hypothesis concerning necessary features of a category is valid on its own, it only raises another question: How do we know which categories are relevant in judging the acceptability of a usage event? So far it has been implicitly assumed that the acceptability of an LDD question is determined largely by the extent to which it is sanctioned by the category of LDD questions. It could well be the case, however, that the acceptability is determined by a more general *WH AUX THING* VP_{bare}*-GAP?* construction where nearly all attested fillers of the VP slot are such that the constituent containing the gap is foregrounded in a corresponding declarative—or even by an argument-structure frame for the main verb, with respect to which the (a)typicality of foregrounding the complement may be judged—or, most likely, by some combination of the above. To answer this question, we would need to be able to determine the relative saliences of the schemas involved. Hopefully the above comments give an idea of the true scope of the problem: A clearly articulated theory of similarity is attendant on a clearly articulated theory of salience.

6. Conclusions

In this paper I have tried to show how an exemplar view of linguistic categorization may be qualified in such a way as to address what might otherwise be a fundamental weakness. Exemplar models propose that people classify an item on the basis of how similar it is to the exemplars of the available categories (Nosofsky 1986; 1992). However, when applied to language, and particularly when the exemplars are represented in terms of semantic properties, the exact basis for the measurements of similarity is often left unspecified. In addition, researchers have tended to treat similarity as a largely invariant construct, predicting a construction's productivity using judgments of similarity obtained in other tasks (as in, e.g. Bybee and Eddington 2006). While this is often a useful assumption (as in that study), work such as that of Ambridge and Goldberg (2008) suggests that it does not always hold. It must be recognized that constraints on similarity judgment have to be determined separately for each context.

In reviewing the relevant literature in cognitive psychology, I have tried to provide one such constraint in the context of categorization tasks. In particular, I have cited evidence that the aspects that one considers most relevant when evaluating similarity to the exemplars of a category tend to be those features that characterize the category itself. By way of illustration, I have tried to reinterpret the findings of Ambridge and Goldberg (2008) and show that the relative acceptability of main verbs in questions with long-distance dependencies can indeed be explained as being determined by similarity to verbs that have been attested in the construction. This is possible because nearly all attested LDD questions have main verbs that strongly tend to foreground their clausal complements, and hence similarity in this context may be understood to be judged with respect to the verbs' tendency to foreground their complements.

Let me conclude by quoting further from Goldberg's analysis of the productivity of the English ditransitive construction (Goldberg 1995: 134):

> On the present account, the characterizations of the verb classes themselves can be viewed as providing a similarity metric. For example, if one of the verb classes associated with the ditransitive is "verbs of ballistic motion," then we can consider *shin* to be relevantly like *kick* in that it is a verb of ballistic motion.

The main intended contribution of this paper has been to add psychological flesh to the bones of this idea.

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