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Semantic weight and verb retrieval in aphasia ☆

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Abstract

Individuals with agrammatic aphasia may have difficulty with verb production in comparison to nouns. Additionally, they may have greater difficulty producing verbs that have fewer semantic components (i.e., are semantically "light") compared to verbs that have greater semantic weight. A connectionist verb-production model proposed by Gordon and Dell (2003) learns through error correction to "divide the labor" between syntax and semantics. Verbs that are semantically heavier come to depend less on syntax and more on semantics. For lighter verbs, the reverse is true. We performed this study to clarify the role of semantic weight in aphasic verb production and to test the prediction from Gordon and Dell that a brain lesion that impairs the syntactic input to verb retrieval will impair lighter verbs more than heavier ones. Consistent with this prediction, we found that the decrement for lighter verbs was present in a group with agrammatic aphasia but not in a matched group without agrammatism.

Keywords: Aphasia; Agrammatism; Semantic weight; Verb weight; Verb complexity; Verb production; Light verbs; Syntax

1. Introduction

Impaired access to verbs is a hallmark of agrammatic speech in persons with Broca's aphasia, along with underutilization of closed-class morphemes and simplification of phrase structure (e.g., Saffran, Berndt, & Schwartz, 1989). Agrammatic aphasics also generally retrieve verbs worse than nouns in single word production tasks, such as picture naming (Miceli, Silveri, Nocentini, & Caramazza, 1988; Miceli, Silveri, Villa, & Caramazza, 1984; Zingeser & Berndt, 1990). However, the correlation between verb access in single and multi-word tasks is imperfect (Berndt, Haendiges, Mitchum, & Sandson, 1997; Berndt, Mitchum, Haendiges, & Sandson, 1997; Luzzatti et al., 2002; Zingeser & Berndt, 1990) and the verb-worse-than-noun pattern is multi-determined (e.g., Berndt, Haendiges, Burton, & Mitchum, 2002; Bird, Howard, & Franklin, 2003; Kemmerer & Tranel, 2000; Luzzatti et al., 2002).

Consequently, some researchers have sought to elucidate the nature of agrammatics' verb retrieval difficulties by looking at performance differences internal to the verb category (reviewed in Druks, 2002). A consistent, albeit not universal, finding is that verbs that license more arguments are harder for agrammatics to retrieve than verbs with fewer arguments, even in single word production tasks like naming (Jonkers, 2000; Jonkers & Bastiaanse, 1996; Kemmerer & Tranel, 2000; Kim & Thompson, 2000, 2004; Kiss, 2000; Thompson, 2003; Thompson, Lange, Schneider, & Shapiro, 1997). Other evidence shows that the complexity of the *semantic* representations of verbs also influences retrieval accuracy. This paper explores semantic complexity, or as we term it, semantic weight, as a factor in agrammatics' verb retrieval.

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1.1. The semantic weight effect

Verb meanings are often characterized as structured entities that vary in type and number of constituents (i.e., compositional representations: see Jackendoff, 1990; Pinker, 1989). Adopting this framework, Breedin, Saffran, and Schwartz (1998) (hereafter, BSS) investigated how variation in the number of features in the verb representation would affect verb retrieval in eight non-fluent aphasics all of whom showed the verb-worse-than-noun pattern on action/object picture naming.

First, they documented a tendency to under-represent classic light verbs in narrative production (Bird & Franklin, 1996; but see Berndt & Haendiges et al., 1997). This small, closed set of classic light verbs, such as DO, GO, MAKE, and TAKE, has been much studied in the linguistics literature (Jespersen, 1954; Pinker, 1989). Their under-representation in agrammatic speech was of interest to BSS because of their semantic simplicity; it is thought that their meaning representations contain a single constituent (e.g., MOTION in the case of GO) that can also occur as a component of other verbs with more complex semantic representations (e.g., FLY, which additionally expresses the manner of MOTION).

For their experimental investigation of the verb weight dimension, BSS assembled pairs like GO-FLY, as well as others in which one member was deemed to have a simpler representation than the other. For example, in the pair HIT-SMASH, both express what the action does to a thematic patient, but SMASH additionally connotes how the patient is affected. The experimental task was a verb story completion test. Subjects were read short, three-sentence stories and were then asked a question designed to elicit the verb mentioned in the second sentence. Each story was presented twice, the only difference being which of the contrasting verbs was mentioned. In this example, the contrast is between the simple verb, COME, and the more complex verb, DRIVE:

Story:	The bar closed at 2:00 a.m.
	Henry *CAME/DROVE* home.
	Nobody heard him come in.
Query:	What did Henry do after the bar closed?
Intended response:	(He/Henry) CAME/DROVE (home).

Subjects were instructed to respond with a sentence; however, in the scoring, everything but the target verb was considered optional. The third sentence was presented to discourage rehearsal by imposing a filled delay between hearing the target verb and saying it in response to the query. Most individuals with significant aphasia have difficulty holding on to the phonological content of what they hear across a filled delay, although they tend to be able to paraphrase the message. The assumption behind BSS's use of story completion to study verb retrieval is that subjects would retain the semantic specification of the verb targeted in the story and, unable to repeat it verbatim, would be forced to retrieve it from the mental lexicon.

The key finding in BSS was that six of eight patients had more difficulty producing the semantically simpler verbs than their more complex counterparts at a trend (or higher) level of significance (i.e., p's ranged from .18 to .0005), even though the more complex verbs were often of lower frequency. The remaining two patients showed neither the complex verb preference nor the negative frequency effect: instead, they showed a simple verb preference and a positive frequency effect. Although BSS did not report clinical diagnoses, it happens that the six patients who showed the decrement for simpler verbs all carried a diagnosis of Broca's aphasia with varying degrees of agrammatism, whereas the other two (CN and VP) were non-agrammatic and not of the Broca's type.

Kim and Thompson (2004) replicated the advantage for complex over simple verbs in a group of agrammatic aphasics and suggested that this pattern might be the norm. Using a production task similar to BSS but involving completion of modeled sentences rather than stories, they found that agrammatic aphasics, along with age-matched normal controls, were more accurate with the complex verb stimuli. This pattern was not observed in patients with probable Alzheimer's disease. There is some basis for the suggestion that complex verbs' added weight may generally aid in their retrieval (see Plaut & Shallice, 1993); however, it is also possible that Kim and Thompson's agrammatic and control subjects performed similarly for different reasons. We return to this point in Section 4.

Taken together, the above findings present two puzzling questions as yet unanswered in the aphasia literature: why would agrammatic Broca patients be sensitive to number of meaning constituents? And why would they derive benefit from more constituents, presumably representing greater complexity? To answer these questions, we turned to a connectionist model designed to illustrate how the influences of syntactic and semantic information might trade off in lexical access.

1.2. Gordon and Dell's "division of labor" model

Gordon and Dell (2003) sought to model BSS's finding of a double dissociation between simple and complex verbs that roughly mapped onto the agrammatic/anomic distinction. Their small connectionist model was trained with an error-based algorithm to output simple sentences word-by-word in accordance with a semantic message. In learning which words to select, the model came to "divide the labor" between syntactic and semantic inputs according to the predictive power of these inputs. Gordon and Dell's model provides the theoretical basis for our study, so it is necessary to describe it in some detail. However, we must first make a point about terminology. In Gordon and Dell's paper, the terms "light" and "heavy" are used in place of "simple" and "complex" to denote verbs of contrasting weight. Because our study proceeds from theirs, we continue to use their terminology here. We caution readers that "light," in this sense, is a relative thing, and the set of verbs