Exploring the dynamics of aphasic word production using the picture–word interference task: A case study[☆]

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Abstract

In this study, we use an auditory picture–word interference task to examine an anomic individual, NP. NP produced semantic errors in picture naming, but his comprehension was relatively well preserved. In the task, pictures to be named were accompanied by semantically, phonologically or unrelated distractors, presented at onsets ranging from −200 ms (before target) to +400 ms (after target). Naming latencies were measured. A group of 12 older controls showed semantic interference (slower latencies with semantic than with unrelated distractors), which was significant at −200 ms, and steadily diminished across later onsets. In contrast, at 0 ms, NP showed powerful semantic *facilitation*. There were no significant semantic effects at other onsets, but the trends, particularly at later onsets, were towards *interference*. Phonological effects for NP were in the same direction as for controls (facilitation) but were of greater magnitude. Indeed, NP showed a reliable facilitatory effect at 0 ms (and trends at −200 ms and +200 ms), but a similar trend in controls failed to reach significance. Within recent models of this task, in which semantic facilitation effects are attributed to an early, pre-lexical semantic processing stage, NP's pattern indicates that semantic processing is abnormally prolonged. The phonological facilitation effects are also consistent with this interpretation. We discuss their implications and future applications of the task to aphasia.
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According to most current theories, word production involves at least two major processes or stages—lexical selection and phonological encoding (e.g., Caramazza, 1997; Dell, 1986, 1988; Levelt, 1989; Levelt, Roelofs, & Meyer, 1999; MacKay, 1987; Roelofs, 1992, 1997; Stemberger, 1985). During lexical selection, the speaker retrieves a representation of the word that best matches the concept to be expressed, which is not yet specified as to its form.[1] During phonological encoding, the speaker then generates a complete phonological plan for the word. Recent research has utilised this two-stage framework to characterise word production impairments in aphasia (e.g., Badecker, Miozzo, & Zanuttini, 1995; Foygel & Dell, 2000; Laine & Martin, 1996; Lambon Ralph, Sage, & Roberts, 2000; Rapp & Goldrick, 2000; Wilshire & Saffran, 2005). Within this framework, a word production disorder can be attributed to any one of three primary types of impairment. The first is a general impairment activating semantic representations, which will lead to errors in both production and comprehension, particularly semantic errors (e.g., Howard & Orchard-Lisle, 1984; Rapp & Goldrick, 2000 (patient KE)). The second is an impairment involving the lexical selection stage of word production, which will lead to semantic and other whole-word errors in production, but should not affect word comprehension (e.g., Lambon Ralph et al., 2000; Rapp & Goldrick, 2000 (patient PW)). The third is a phonological encoding impairment, which will lead to the production of phonological errors (e.g., Rapp & Goldrick, 2000 (patient CSS); Wilshire & Nespoulous, 2003).

[1] Unless otherwise specified, the term "lexical representation" refers to that representation accessed during spoken word production. For most of the ensuing discussion, it is not necessary to specify whether this lexical representation is the same one that is activated during auditory word recognition (and during reading or written production), or whether it is unique to production. We address this issue only where relevant to our particular theoretical account.

Crucially, within this framework, high rates of semantic para-phasias can occur with both lexical selection and more general semantic processing impairments. These two impairments are distinguished primarily by comparing word *production* and *comprehension*. One problem with this method is that production and comprehension tasks are not of equivalent difficulty: comprehension tasks usually involve making selections between alternatives, and can often be done on the basis of quite skeletal information, whereas picture naming requires a full understanding of the item's identity. A mild semantic processing impairment might therefore be evident only in the more difficult task of word production, and could easily be misdiagnosed as a lexical selection impairment. It would therefore be extremely useful to be able to tease apart these two hypothesised processing stages by using some kind of direct experimental manipulation. In this study, we investigate one particular experimental task that may offer potential in this respect, the auditory picture–word interference task. In this task, the participant must name a picture while ignoring an auditory distractor word. It is possible to manipulate not only the nature of the distractor word, but also its precise onset, and in so doing to examine the types of variables that affect performance at different times during the word production process. The task therefore has the potential to tell us a great deal about the nature of the impaired processing stage(s) in aphasic individuals and their temporal dynamics.

1. The auditory picture–word interference task

In the auditory picture–word interference task (henceforth, the *picture–word task*), the participant must name a picture while ignoring an auditory distractor word (e.g., Cutting & Ferreira, 1999; Damian & Martin, 1999; Jescheniak & Schriefers, 1998, 2001; Schriefers, Meyer, & Levelt, 1990). Naming latencies have been found to be slower with an unrelated distractor than with no distractor. Further, the effects are modulated by the target–distractor relationship. A categorical semantic relationship between target and distractor generally elicits *interference*—that is, slower naming latencies than when distractor and target are unrelated. A phonological relationship, on the other hand, elicits *facilitation*. Importantly, both these effects vary with distractor onset time. Semantic interference is most reliably found when the distractor is presented 200–0 ms before the target. Phonological facilitation is generally maximal around 100–200 ms later than semantic interference. This indicates that the two types of distractor relationships might influence different stages of the picture naming process, and suggests that the task might have potential as a tool for examining the time course of word production. For this reason, researchers have been greatly interested in better understanding the nature of the distractor effects in the picture–word task.

Explanations for the semantic interference effect commonly emphasise processes occurring at the lexical selection stage: the target and distractor activate each other's lexical representations via their shared semantic connections, but the target activates the distractor's representation more than vice-versa. This increased distractor competition slows processing (see e.g., Roelofs, 1992; Roelofs, Meyer, & Levelt, 1996; Starreveld & La Heij, 1996).

Consistent with this account is the finding that semantic interference is not obtained when the task does not involve actual production of the target; when the task involves categorising the target picture or identifying whether it has previously been presented, facilitation has been obtained under similar timing conditions (Glaser & Glaser, 1989; Schriefers et al., 1990). Also, semantic facilitation, rather than interference, is generally observed in tasks where the distractor is a picture. This suggests activation of the *distractor's* lexical representation is also critical (Bloem & La Heij, 2003; Damian & Bowers, 2003; Humphreys, Lloyd-Jones, & Fias, 1995; but see Glaser & Glaser, 1989; Morsella & Miozzo, 2002 for some exceptions). Again, this supports the lexical competition account. However, not all authors subscribe to this view: some argue that the semantic interference effect occurs at an earlier stages when a decision has to be made about which of the two activated semantic representations (target or distractor) should be lexicalised (e.g., Costa, Alario, & Caramazza, 2005; Miozzo & Caramazza, 2003). Others suggest it occurs at a very late stage, when the phonological representations of both target and distractor have been activated and a decision must be made about which to produce (e.g., Finkbeiner & Caramazza, 2006).

A crucial aspect of the semantic interference effect that needs to be dealt with by any theoretical account is the fact that it is indeed an *interference* effect. In the standard priming paradigm, a categorical semantic relationship between prime and target most commonly elicits *facilitation,* even under conditions that are otherwise optimal for eliciting interference (that is actual production of the target, use of an auditory distractor; see Alario, Segui, & Ferrand, 2000; Bajo, 1988; Barry, Johnston, & Scanlan, 1998; Carr, MacCauley, Sperber, & Parmlee, 1982; Lucas, 2000; Lupker, 1988; McEvoy, 1988). Some researchers have suggested this difference between the two paradigms may be due to idiosyncratic variations in the stimuli used in picture–word interference and standard priming tasks (see Roelofs, 1992), but recent evidence suggests this factor alone is unlikely to provide a complete account (Caramazza & Costa, 2000, 2001). One factor that does seem to be critical is prime/distractor presentation time. Recent picture–word studies have shown that, as the distractor–target SOA is successively widened towards one that more closely resembles the sequence of events in priming (at least −400 ms), the usual semantic interference effect gives way to a trend towards facilitation (Glaser & Düngelhoff, 1984; La Heij, Dirkx, & Kramer, 1990; see also Alario et al., 2000, footnote 1). This, although the facilitatory trend has not always been statistically reliable. However, a recent study where the target task was word translation (L2 to L1) has obtained a significant effect (Bloem, van den Boogaard, & La Heij, 2004). Bloem et al. (2004) proposed that semantic facilitation and interference occur at different processing stages: they suggested that the interference effect is due to events occurring during lexical selection, and the semantic facilitation effect is due to events occurring during semantic processing. Specifically, they suggested that for an early presented distractor, the semantic overlap between distractor and target reduces the time required to activate the target's semantic representation. The longer this semantic stage takes the more it will benefit (for example, translation might