

LEXICAL SELECTION IS NOT A COMPETITIVE PROCESS:
A REPLY TO LA HEIJ ET AL. (2006)

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In their commentary on our paper, La Heij et al. (2006, this issue) say that “if the lexical competition account of semantic interference would prove to be incorrect, this would have major implications for all current theories of language production” (p. 4). We suggest that this overstates the facts. We agree that undermining the lexical competition account of semantic interference would have major implications *for those models that have been developed to explain the semantic interference effect*, but this would have few (if any) implications for those models of speech production that were developed to explain general properties of lexical access. Lexical access involves the set of cognitive and motoric processes that are needed to translate one’s intention to speak into articulated speech. A critical stage in lexical access processes is the point at which the lexical representations that correspond to an individual’s intentions, or “preverbal message”, are selected. This stage is referred to as lexical selection and, generally speaking, there are *two different views* of how lexical selection proceeds. Common to both views is the assumption that activation at the conceptual level cascades down onto the lexical level. As a result, several lexical representations become activated simultaneously and this requires the lexical selection mechanism to “decide” which representation among many is to be selected for further processing. On one view, lexical selection proceeds on the basis of absolute activation levels, whereby the representation that is most highly activated at some point in time is selected or whereby the first representation to reach a predetermined threshold is selected (Caramazza and Hillis, 1990; Coltheart et al., 2001; Dell, 1986). The motivation for positing this “lexical selection by activation” mechanism follows directly from the core assumptions of the activation framework, which is common to all models of speech production (Caramazza, 1997; Coltheart et al., 2001; Dell, 1986; Levelt et al., 1999).

In addition to the assumptions of the “selection by activation” hypothesis, the “lexical selection by competition” proposal adds the stipulation that selection latencies are modulated by the activation levels of unselected lexical representations. La Heij et al. (2006, this issue) hold this position.

According to this view, the more highly activated non-target representations become, the longer it takes for the selection mechanism to select the target representation¹. The motivation for this added stipulation comes from findings obtained in the Stroop-like picture-word interference (PWI) paradigm. In this paradigm, participants take longer to name a picture (e.g., dog) when a “semantically related” distractor word (e.g., ‘cat’) is superimposed on the picture. On the assumption that the PWI effect arises at the point of lexical selection, this finding would be difficult to reconcile with the “selection by activation” proposal, but it would follow directly from the “selection by competition” hypothesis – after all, this hypothesis was proposed to account for the PWI effect.

Which position is correct? If one holds that the picture-word interference effect were an accurate reflection of task-independent lexical processing, then clearly the selection by competition proposal should be favored. But we are skeptical of the connection that has been made between performance in the PWI task and the dynamical properties of lexical access. Let us consider the basis of this connection. If lexical selection were subject to competition, why is it that, as La Heij et al. (2006, this issue) point out in their commentary on our paper, there is no semantic interference in the word-word version of this paradigm? Why is it that there is no interference in the picture-picture version (c.f., Damian and Bowers, 2003; Navarrete and Costa, 2005)? In both of these examples, the non-target lexical representation presumably receives activation from both the target and the non-target stimulus (in the semantically related condition), yet lexical selection latencies do not appear to be modulated by this increase in the activation levels of non-target representations. With this in mind, it seems reasonable to be skeptical of the claim that the so called “semantic interference effect” in the picture-word naming paradigm reflects a fundamental and task-independent property of lexical access.

¹According to one often-cited version of this hypothesis (Levelt et al., 1999; Roelofs, 1992), lexical selection is completely deterministic. On their model, there is no question at the point of lexical selection as to *which* node is to be selected; the only question is *when* that node will be selected.

Our skepticism receives support from a long line of empirical findings. For example, it is now clear that the “semantic interference effect” in the picture-word naming paradigm is restricted to just those distractors that share a coordinate relationship with the target response. That is, the word “truck” superimposed on a picture of a car produces interference, but the word “bumper” produces *facilitation* (Costa et al., 2005). To the extent that the representations *bumper* and *car* are semantically related, the representation *bumper* should be more highly activated than an unrelated representation (by virtue of receiving activation from the target and distractor stimuli) and, hence, should produce interference. Yet semantically related distractor words produce facilitation unless they share a coordinate relationship with the target (see also Alario et al., 2000; Lupker, 1979). Interestingly, not even coordinates always produce interference. As we reported in the target article, picture-word pairs like *lion* – TIGER produce interference when the distractor word is clearly visible but facilitation when it is presented subliminally.

Similarly, if the interference produced by a distractor word were due to lexical competition, then lexical nodes with relatively low levels of activation (low-frequency words) should interfere less than those with higher levels of activation (high-frequency words). Yet low-frequency distractors interfere more than high-frequency distractors (Miozzo and Caramazza, 2003). Likewise, according to the selection by competition hypothesis, closely related distractor words (e.g., ‘dolphin’ superimposed on a picture of a whale) should produce more interference than distant distractors (e.g., ‘horse’). Yet, in a series of carefully constructed experiments in which semantic distance was manipulated within categories, Mahon et al. (submitted) have found that this is not the case. In fact, if anything, the more closely related a distractor word is to the picture, the less interference that word produces. Similarly, if interference were due to lexical competition, then no interference should be observed when the presentation of the picture precedes the word by a sufficient period of time to allow for the selection of the picture name. Yet, in a recent series of experiments (Janssen et al., submitted) in which the distractor word was presented one second after the picture and in which the distractor word served as a cue to name the picture, semantically related distractor words were found to produce interference. In these experiments, no effect of target frequency was obtained, indicating that lexical selection of the picture’s name had been completed (even for those with low frequency names) by the time the distractor word was presented. This finding is quite compelling in suggesting that the semantic interference effect, when it is obtained, is not due

to competition at the stage of processing where lexical selection occurs.

In light of these findings, we suggest that the coordinate interference effect in the picture-word naming paradigm does not reflect a general property of lexical access, but, rather, that this effect is tied to a highly-specific experimental context. Although we are much more interested in investigating general properties of lexical access than we are in formulating accounts of task-specific effects, we have suggested an account of the PWI effect which places the locus of this effect outside of lexical processing. Specifically, we have suggested that interference may arise at the point of deciding which of two articulatory programs should be excluded from the output buffer in order that the correct response may be produced. This “response selection” account of the PWI effect is very different from one that appeals to general properties of the lexical selection mechanism and should not be taken as anything more than an account of performance in Stroop-like tasks. Our account is very simple and, contrary to the objections raised by La Heij et al. (2006, this issue) in their commentary, makes explicit claims. As we stated in the target article (see also Miozzo and Caramazza, 2003), we assume that individuals in Stroop-like tasks are unable to avoid formulating a (covert) response to the distractor word. On this assumption, printed words have a privileged relationship with the articulators and, thus, *always* engage the articulators, albeit covertly². Because only one response can be produced over the output channel, the inadvertent response to the word distractor has to be rejected or “blocked” before the response to the picture may be produced.

As we stated in the target article, there are two factors that affect the time it takes to reject an inadvertent response. One factor has to do with *when* the response becomes available for rejection. The sooner a non-target response becomes available, the sooner it may be rejected (c.f., Miozzo and Caramazza, 2003). There are several variables that may influence when a response becomes available for rejection, including frequency, priming, length and others. The other factor has to do with response blocking. If, within the context of the task and the target stimulus, the non-target response is not relevant on any dimension (e.g., conceptual category, language of response, “grammatical” category, etc.), it can be rejected very quickly. If, though, the non-target response is relevant on some dimension, then it must be “considered” as a possible response on at least this one dimension (e.g., categorical information for coordinate distractors). In the target article, we suggested that relevant responses were

²Note that this is different from the early “race horse” models insofar as we stipulate that the articulators are *always* captured by the word distractor, regardless of the temporal delay between picture and word stimuli.

rejected on the basis of their provenance: picture or word. Importantly, we assume that the delay incurred when responses are relevant on some dimension is discrete. For example, the time it takes to consider and then reject a coordinate level distractor is assumed to be the same for close and distant distractors (for more discussion of this claim, see Mahon et al., submitted). The interplay between these two independent factors (time of response availability and response rejection) is able to account for a wide range of findings, including those that were reviewed above (see target article for discussion). In this regard, we agree with La Heij et al. (2006, this issue), who say that our proposal is powerful, but we disagree with the assessment that our proposal is underspecified.

To illustrate the “large explanatory power” and the “lack of specificity” of our proposal, La Heij et al. (2006, this issue) point to our account of the findings reported by Costa et al. (2005), who found that coordinate level distractors (e.g., truck) produced interference but “has-a” distractors (e.g., bumper) produced facilitation. In our explanation of these findings, we said that in a picture naming context, in which whole objects were being named (e.g., car), that “has-a” distractors would not constitute a possible (relevant) response and, hence, should be rejected very quickly. To explain the polarity shift, from interference to facilitation, we appealed to semantic priming³. La Heij et al. (2006, this issue) suggested that our account amounted to little more than “providing the decision process with a characteristic that fits the data” (p. 6). They also indicated that the account of the Costa et al. (2005) data that they favor (proposed by Morris et al., submitted) was “more parsimonious because no additional decision process has to be assumed” (p. 7). But this is not the case. La Heij et al. (2006, this issue) report that on the Morris et al. (submitted) account, “has-a” distractors do not induce lexical competition because only “contextually similar” words become activated. Leaving aside the fact that it isn’t at all clear how a spreading activation mechanism can prevent the activation of semantically related lexical representations, there are two problems with this. First, if the “has-a” distractors were not activated, how did they produce facilitation? Second, we do not see how the stipulation that only contextually similar distractors produce interference is any more parsimonious than our claim that only contextually-relevant properties of a word can be used by the production decision mechanism to determine which phonological form to produce. On both accounts, a “decision” has to

be made. The only difference is whether the decision determines that the distractor is “contextually relevant” or “contextually similar”.

Perhaps more compelling than the “parsimony” concern or the “lack of specification” concern is the concern that the response selection account is incompatible with extant findings. La Heij et al. (2006, this issue) point to three empirical observations that provide, in their words, “compelling evidence against [the] response selection account of semantic interference” (p. 7). The first of these that we discuss is the lack of interference in the word-word variant of Stroop-like tasks. This is not a problem for our account. In fact, it follows directly from a core assumption of our account. We assume that written words have privileged access to the articulators such that words obligatorily engage the articulators. On this assumption, it does not matter if the distractor word is presented first and the target word second because, by hypothesis, the most recently displayed word engages the articulators directly. This means that any to-be-articulated response already in the output buffer will be overwritten by the response to the most recently presented written word (unless it has already met the relevant provenance criteria for production and is already in the course of being produced). In the case of the word-word paradigm, then, interference effects are not observed because non-target responses are not excluded on the basis of their response relevance, they are overwritten, directly and obligatorily, by the target word stimulus.

The second empirical observation raised by La Heij et al. (2006, this issue) against our account was the finding that phonological relatedness interacts with semantic relatedness (Damian and Martin, 1999). The nature of this interaction is that the semantic interference effect is reduced when the distractor word is both semantically and phonologically related to the picture. We do not dispute this effect, and we agree with both Damian and Martin (1999) and Starreveld and La Heij (1996) that one way to account for these data is to posit interactivity between the semantic and phonological levels within the speech production system. Importantly, though, we fail to see how evidence that one might take as suggesting the existence of interactivity supports or follows from selection by competition. Models which posit selection by activation are equally capable of implementing interactivity (see Dell, 1986; Rapp and Goldrick, 2000). Thus, it is not clear to us how evidence of interactivity can serve to distinguish between models that assume selection by competition *versus* those that assume selection by activation. Furthermore, there is no reason why the response selection proposal should have difficulty accounting for this interaction insofar as the semantic interference effect is posited to arise in the processes that operate over phonologically well-formed responses.

³On our account, semantic priming may, and probably does, take two forms. One possibility is that priming from the word to the picture speeds up the availability of the target response. Another possibility is that priming from the picture to the word makes the non-target response available for rejection earlier, which serves to clear the output channel for the target response sooner.

The third empirical observation raised by La Heij et al. (2006, this issue) is the finding reported by Warren (1974) that associatively related primes (e.g., girl) interfere with the color naming of subsequently presented words (e.g., BOY presented in red ink). La Heij et al. (2006, this issue) argued that this finding follows directly from the selection by competition account (a primed *boy* would interfere with the selection of *red* more than an unprimed *boy*), and that it does not follow from our response selection account. We suggest that this particular paradigm is rather complicated and produces findings that are difficult to understand on any account, including the selection by competition account. First, the interference effect reported by Warren (1974; see also Burt, 1994) is strongly modulated by the associative strength between the prime and the target and is only obtained when the direction of the association is from the prime to the target, not from the target to the prime. This fact is at odds with the standard selection by competition account of the interference effect insofar as interference, on this account, is said to arise as a result of semantic relatedness, not associative relatedness (see Lupker, 1979; Alario et al., 2000). Second, and more importantly, interference in the Warren (1974) paradigm arises only in those cases in which participants are asked to recall the prime word (see Burt, 1994). When participants are asked simply to read the prime word silently and then name the ink color of the target, no interference effect is obtained. Again, this is at odds with the selection by competition account insofar as that account assumes that interference effects arise automatically upon word recognition of the distractor. Yet, apparently, word recognition is not sufficient in this paradigm as interference arises only when participants are required to encode the distractor words into memory for later recall. Given these facts, we suspect that interference in the Warren (1974) paradigm, when it is obtained, is due to a complex interaction between lexical associative strength and memory recall processes. It is unclear, therefore, what relationship there might be between those results and lexical access as such. Presently, it is difficult to say how one should best formulate an account of these findings, but we are fairly certain that the findings obtained in the Warren (1974) paradigm do not follow straightforwardly from the selection by competition account.

CONCLUSION

In conclusion, we appreciate La Heij et al.'s (2006, this issue) critical stance toward our paper since it has helped clarify crucial issues concerning the role of Stroop-like tasks for understanding normal lexical access processes. In their commentary on our paper, La Heij et al. (2006, this

issue) did not seek to call into question our empirical findings; rather, the thrust of their commentary was to undermine our interpretation of those findings. This is because our interpretation, if shown to be correct, would undermine the connection that has been made in the literature between the "semantic" interference effect in Stroop-like tasks and the dynamical properties of lexical access – and, specifically, the lexical selection mechanism. In both the target article and above, we have laid out our reasons for being skeptical of this connection. The so called semantic interference effect that is obtained in the picture-word interference effect is restricted to a highly specific set of stimuli and experimental contexts and, thus, hardly seems to reflect a general property of the lexical selection mechanism.

In contrast, we have suggested that the semantic interference effect, when it is obtained, serves as an index of how individuals perform Stroop-like tasks, not how they select lexical representations in normal communicative contexts. While reducing the semantic interference effect to a task-specific effect arising outside of lexical processes would have major implications for those models that account for this effect within the lexical selection mechanism (e.g., Starreveld and La Heij, 1996; Levelt et al., 1999), we see two possible benefits for this approach. First, by uncoupling our theoretical accounts of lexical access from those experimental paradigms that reveal more about the allocation of attention and control than about lexical access, we may gain some clarity on how best to explain the architectural and dynamical properties of human speech. Second, without the motivation to incorporate an explanation of the semantic interference effect into the lexical selection mechanism, it is reasonable to adopt the simpler "selection by activation" mechanism (e.g., Caramazza, 1997; Coltheart et al., 2001; Dell, 1986) – and any step towards simplifying our models of speech production should be seen as a positive step.

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