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Spoken-word processing in aphasia: Effects of item overlap and item repetition

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Abstract

Two studies were carried out to investigate the effects of presentation of primes showing partial (word-initial) or full overlap on processing of spoken target words. The first study investigated whether time compression would interfere with lexical processing so as to elicit aphasic-like performance in non-brain-damaged subjects. The second study was designed to compare effects of item overlap and item repetition in aphasic patients of different diagnostic types. Time compression did not interfere with lexical deactivation for the non-brain-damaged subjects. Furthermore, all aphasic patients showed immediate inhibition of co-activated candidates. These combined results show that deactivation is a fast process. Repetition effects, however, seem to arise only at the longer term in aphasic patients. Importantly, poor performance on diagnostic verbal STM tasks was shown to be related to lexical decision performance in both overlap and repetition conditions, which suggests a common underlying deficit.

Keywords: Spoken-word processing; Aphasia; Inhibition; Lexical activation; Priming; Lexical deactivation; Repetition priming

1. Introduction

During auditory word recognition, lexical word candidates compete for recognition and influence each other's activation levels. Evidence for lateral inhibition between competing word candidates comes from interference effects found with high-similarity word-initial form-overlap between a prime (e.g., *difficult*) and a following target (e.g., *diffident;* cf. Monsell & Hirsh, 1998; Slowiaczek & Hamburger, 1992). When the prime is being processed, several word candidates compete. In the TRACE (McClelland & Elman, 1986) model of auditory word recognition, there are direct inhibitory connections between words. An increase in the level of activation of one candidate then automatically leads to a decrease in the activation level of others. McClelland and Elman (1986) claim that this 'winner-takes-all' principle makes the recognition process more efficient. Once one of the candidates has been isolated and recognised, the other candidates are decreased in activation. When one of these once-activated candidates is subsequently presented as the next item, recognition of this item is inhibited, relative to unrelated (control) targets. Monsell and Hirsh (1998) describe the competitor interference effect (i.e., slower lexical decision responses to *diffident* if preceded by *difficult* than if preceded by an unrelated control word) and the facilitatory effect of repetition (faster lexical decision responses to *diffident* if preceded by *diffident* than if preceded by an unrelated control word) as two sides of the same coin: recognition of a word makes it easier to recognise on the next encounter, but at the cost of making similar words (i.e, onset-overlapping words) more difficult to recognise.

Whereas theories as TRACE describe the competition process as "lateral" inhibition between several lexical candidates, others have argued for bottom-up inhibition: if there is a mismatch between the input form and the lexical entry's form, activation of that candidate is lowered (Marslen-Wilson, Moss, & van Halen, 1996; Marslen-Wilson &

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Warren, 1994). The extent to which activation is lowered may be gradient: in the shortlist model of word recognition (Norris, 1994), mismatching information may deactivate a lexical entry depending on the phonological distance between the input signal and the form of the lexical entry. Frauenfelder, Scholten, and Content (2001) found evidence for bottom-up inhibition in a study in which they investigated to which extent later-arriving *mismatching* information (e.g., in the French pseudoword *vocabulaise*, initially activating the entry *vocabulaire*) reduced the activation provided by earlier *matching* information. Their results obtained with pseudowords show that spoken-word recognition models need to include some form of bottom-up inhibition. (Partial) deactivation must have occurred through bottom-up mismatch, rather than through lateral inhibition, because there was no winning lexical candidate in the end. Inhibition in spoken-word recognition, as in found in studies with onset-overlapping real-word primes and target words (cf. the *difficult-diffident* example), can be the result of either bottom-up deactivation or of lateral deactivation, or of both.

McNellis and Blumstein (2001) developed a model describing the process of auditory word recognition in aphasia. They argue that lexical-processing impairments in aphasia are due to alterations in the dynamics of lexical activation, and the resulting spread of activation from one lexical representation to another. Furthermore, the deficit in the dynamics of lexical activation is different for Broca's and Wernicke's aphasics: whereas nonfluent or Broca's aphasic patients seem to have initial underactivation of the lexicon, compared to a non-brain-damaged control group, fluent or Wernicke's aphasic listeners have been claimed to show increased lexical activation (cf. Milberg, Blumstein, & Dworetzky, 1988; Misiurski, Blumstein, Rissman, & Berman, 2005; Utman, Blumstein, & Sullivan, 2001, but also see Baum, 1997; Gordon & Baum, 1994). Following Dell, Schwartz, Martin, Saffran, and Gagnon (1997) who modelled aphasic speech production errors by making global parameter adjustments to the 'normal' model, McNellis and Blumstein (2001) altered the parameter of lexical resting state to lower-than-normal for Broca's and to higher-than-normal for Wernicke's aphasics. McNellis and Blumstein showed that by such a simple parameter adjustment, experimental findings of Milberg et al. (1988) and of Utman et al. (2001) could be simulated. Thus, the effect of brain damage can be regarded in terms of systemic properties, rather than in terms of impairment of specific functions localisable in the brain (cf. Dell et al., 1997; Laine, Tikkala, & Juhola, 1998; McNellis & Blumstein, 2001). In this view, normal performance is the upper limit of a performance continuum and aphasic performance is spread over the continuum.

Whereas the Broca's aphasic patients seem to have difficulty in *activation* of word candidates (Misiurski et al., 2005; Utman et al., 2001), *deactivation* of inappropriate candidates seems to be the main problem for Wernicke's aphasics. This was also found in an eye-tracking study (Yee, Blumstein, & Sedivy, 2004) in which the effect of onset competitors was investigated for Wernicke's patients. When presented with an auditory stimulus (e.g., *camera*), Wernicke's patients fixated longer on onset-overlapping distractors (such as *camel*) than control adults. This implies that, even in the presence of negative bottom-up information, these patients are impaired in the deactivation of once-appropriate word candidates. The results from an adapted Stroop color word test by Wiener, Connor, and Obler (2004) also showed a larger Stroop interference effect for Wernicke's aphasic patients than for an age-matched control population.

Further confirmation for this impaired deactivation was found in a study specifically designed to investigate lexical competition effects in Wernicke's aphasia (Janse, 2006). The results showed inhibition in the overlap condition for the control adults (prime *salaris* 'salary' preceding target *salami* 'salami'), but facilitation was found in this same condition for the Wernicke's aphasic patients. Even after several intervening items, co-activated word candidates showed persisting activation for the Wernicke's aphasic patients. The present study elaborates on this finding in two ways.

First, there is evidence that aphasic receptive deficits in syntax processing can be elicited in unimpaired subjects under stressful conditions (Dick et al., 2001). This is the other side of the continuity hypothesis coin: if normal performance is the upper limit of the continuum and aphasic performance is spread over the continuum, then normals can be "made to perform in an aphasic way" when put under pressure. Time compression of speech has been shown to eliminate inhibitory effects found at a normal speech rate, without affecting the size of facilitatory effects (Aydelott & Bates, 2004). This suggests that facilitation through spreading of activation in the semantic network occurs rapidly, whereas inhibition is a slower process that can be affected by attentional demand. Importantly, the Aydelott and Bates (2004) results concerned inhibitory or facilitatory effects of a preceding *sentence context*.

The first part of the present study (Part I) was set up to investigate whether and how reduced-processing-time interferes with effects on the lexical-level due to word-initial item overlap or item repetition. If inhibition is a relatively slow process, the lack of lateral inhibition between competing word candidates observed in Janse (2006) may be elicited in young non-brain-damaged listeners. This was operationalised by applying time compression: it was investigated whether *lexical-level* inhibitory effects are also modified or eliminated by moderate time compression, as found for *sentence-level* inhibitory effects in Aydelott and Bates (2004). A second question was whether facilitation through item repetition is affected by moderate time compression. Auditory word recognition is known to be facilitated by an earlier auditory encounter with the same word: both in case it has just been said, but the effect is also seen over lags of hours or weeks (cf. Monsell & Hirsh, 1998). If these repetition priming effects still occur over such long lags,