

# Neighbourhood density effects in auditory nonword processing in aphasia

E. Janse

*Utrecht institute of Linguistics OTS, Utrecht University, The Netherlands*

Accepted 8 July 2005

Available online 29 August 2005

## Introduction

The question how prior knowledge of words affects processing of nonwords is important with respect to the study of lexical access and lexical competition. According to the Neighbourhood Activation model (Luce & Pisoni, 1998), the auditory presentation of a word or nonword yields automatic activation of all words in the mental lexicon that sound similar. Experimental results with unimpaired listeners on a lexical decision task showed that nonwords with dense lexical neighbourhoods led to slower responses and lower accuracy rates than nonwords with sparse neighbourhoods: the nonword must be compared against existing entries, which takes more time when there are more neighbours.

The present study examined these effects of neighbourhood density on auditory lexical decision performance for nonwords with three groups of listeners: Broca's aphasic patients, Wernicke's aphasic patients, and age-matched nonbrain-damaged participants.

Broca's and Wernicke's aphasic patients have been shown to be differentially impaired in lexical access: whereas a number of auditory lexical access studies have shown that lexical activation levels are reduced in Broca's aphasic patients (Aydelott Utman, Blumstein, & Sullivan, 2001; Milberg, Blumstein, & Dworetzky, 1988), these levels are increased in Wernicke's aphasic patients (Milberg et al., 1988) who may thus be impaired in selecting one winning word candidate among the activated candidates. In unimpaired speech processing, words are activated relative to the overall goodness of fit with the auditory input. In Wernicke's aphasia, less appropriate acoustic forms seem to be able to activate lexical items almost to the same extent as exact-match items. Broca's aphasics, on the other hand, did not activate words such as *coat* when presented with an acoustically distorted form (VOT-manipulated *c\*oat*) if there was a lexical competitor (such as *goat*: cf. Aydelott Utman et al., 2001). If overall lexical activation is reduced for Broca's aphasic patients, the difference between nonwords from dense neighbourhoods and from sparse neighbourhoods may be reduced as well. For Wernicke's aphasic patients with increased lexical activation levels, however, neighbourhood density may exert a bigger influence.

Thus, based on the assumption that the magnitude of the neighbourhood density effect is influenced by the overall level of lexical activation, smaller neighbourhood density effects on lexical decision performance were expected for Broca's aphasic patients, whereas enlarged density effects were expected for Wernicke's aphasic patients, compared to age-matched control participants.

## Method

Eighty monosyllabic Dutch CVC nonwords were constructed: 40 with a high number of real-word neighbours (16 or more neighbours) and 40 with a low number of real-word neighbours (10 or less neighbours). In addition, 80 Dutch monosyllabic real words were chosen to balance for lexical status. The words and nonwords were spoken in isolation by a male native speaker of Dutch. An experimental software programme randomised the order of presentation of the words and nonwords for each participant. Participants were presented with the materials via headphones. They were asked to provide a lexical decision response after each auditory presentation by pressing either of two buttons (labelled YES and NO) on a response box as fast and accurately as possible.

Participants included 8 patients classified as Broca's aphasic patients (on the basis of the Dutch version of the Aachen Aphasia Test), five patients classified as Wernicke's aphasic patients, and 11 age-matched nonbrain-damaged control participants.

## Results

Lexical decision times were initially measured from target onset. However, because Low Density nonwords were generally longer than High Density nonwords, each item's duration was subtracted from the lexical decision time. Subsequently, the mean item duration of 606 ms was added again to avoid negative response times. The obtained response times (collapsed over correct NO responses) and accuracy percentages are presented in Fig. 1.

Analyses of accuracy rates showed a main effect of Density: accuracy scores were significantly lower for the High Density nonwords than for the Low Density nonwords ( $F(1, 21) = 6.30$ ,

*E-mail address:* [esther.janse@let.uu.nl](mailto:esther.janse@let.uu.nl).

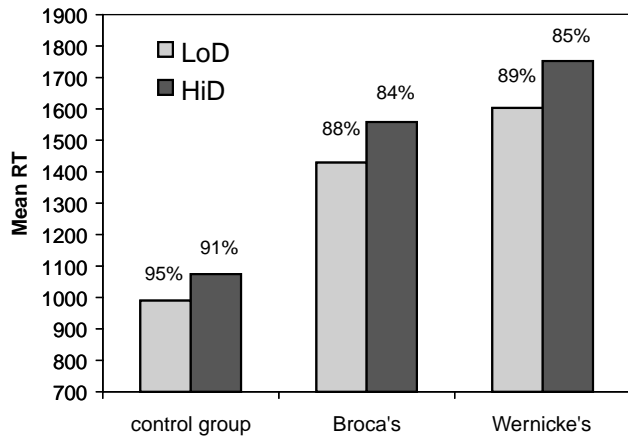


Fig. 1. Mean response time for correct nonword decisions to Low and High Density nonwords for the three participant groups. Accuracy rates are given above each bar.

$p = .020$ ). The Density  $\times$  Subject Group interaction was not significant ( $F(2, 21) < 1$ , ns). The lexical decision times (only for correct NO responses, transformed to  $1/RT$  values) were analysed in the same way to investigate Density and Subject Group effects. There were significant main effects of Density (slower response times to High than to Low Density nonwords:  $F(1, 21) = 56.00$ ,  $p < .001$ ;  $F(1, 78) = 7.43$ ,  $p = .008$ ) and Subject Group (slower response times for the aphasic patients than for the control participants:  $F(2, 21) = 15.65$ ,  $p < .001$ ;  $F(2, 77) = 379.4$ ,  $p < .001$ ), but the interaction between Density and Subject Group was not significant ( $F(2, 21) < 1$ , ns;  $F(2, 77) < 1$ , ns).

## Discussion

The results of this study show that neighbourhood density affects accuracy rates and lexical decision times for all three participant groups. The results do not support the prediction that neighbourhood density has a reduced effect in Broca's aphasia and a bigger influence in Wernicke's aphasia, compared to the nonbrain-damaged group. Even when lexical activation levels are reduced, as claimed for Broca's aphasic patients, or increased, as claimed for Wernicke's aphasic patients, lexical neighbourhood competition affects nonword processing to the same degree. The results are in line, however, with Boyczuk and Baum (1999) who found that neighbourhood density affected phonetic categorisation of the same three groups of participants equally. This, coupled to the more direct assessment of neighbourhood density effects here, suggests that neighbourhood density effects occur regardless of overall lexical activation levels and do not interact with these global levels of activation. Further research with larger populations of aphasic patients would be necessary to confirm this preliminary conclusion.

## References

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