

The time course of lexical activation in Broca's and Wernicke's aphasia: Evidence from eye-movements[☆]

Eiling Yee, Sheila E. Blumstein,^{*} and Julie Sedivy

Department of Cognitive and Linguistic Sciences, Brown University, USA

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Studies of spoken word recognition in Broca's and Wernicke's aphasics suggest that the lexical processing deficits displayed by these patients are in part due to abnormal levels of lexical activation (Milberg, Blumstein, & Dworetzky, 1988). Specifically, it has been proposed that Broca's aphasics have abnormally low levels of lexical activation, and that Wernicke's aphasics have abnormally high levels of lexical activation. A number of studies have measured the time course of lexical activation in these patients at various points after word offset by varying the ISI in a semantic priming paradigm. However, a more direct and continuous measure of lexical activation could provide further insight into the lexical processing deficits of these patients.

A simple eye-tracking paradigm has recently been used to uncover fine-grained information about the time course of spoken word recognition in normal subjects (e.g., Allopenna, Magnuson, & Tanenhaus, 1998). In this paradigm, participants' eye movements are monitored as they hear a word and select the matching picture from a four picture display. When normal subjects hear a word (e.g., *hammer*), it has been found that initially, they are more likely to fixate on a picture of a distractor object whose name is an onset competitor (e.g., *hammer*) of the uttered word, than on unrelated distractors (Allopenna et al., 1998). Furthermore, it has also been found that normal subjects show onset mediated semantic competitor effects in that they preferentially fixate on a distractor object that is *semantically* related to an onset competitor of the uttered word, despite the fact that the onset competitor itself is absent from the display (e.g., when subjects hear *hammer*, they preferentially fixate on *nail*, even though there is no *hammer* in the display, Yee & Sedivy, 2001).

The eye-tracking paradigm described above was used to investigate the time course of spoken word recognition in 5 Broca's and 4 Wernicke's aphasics, and in 12 age-matched controls. If Broca's aphasics indeed have reduced levels of lexical activation, a simple prediction would be that the (limited) amount of acoustic input that matches the onset competitor might only weakly activate the onset competitor's lexical representation. If true, then Broca's aphasics should show both a smaller onset competitor effect and a smaller onset mediated semantic competitor effect than normal subjects (i.e., when Broca's aphasics hear *hammer*, they should be less likely to fixate on *hammer*, and also less likely to fixate on *nail* compared to normal subjects). On

the other hand, if Wernicke's aphasics have abnormally high levels of lexical activation, even the (limited) amount of acoustic input that matches the onset competitor might be enough to strongly activate the onset competitor's lexical representation. If true, then Wernicke's aphasics might show both a larger onset competitor effect, and a larger onset mediated semantic competitor effect than normal subjects.

Materials and Methods

Subjects included 5 Broca's and 4 Wernicke's aphasics, and 12 age-matched controls. Subjects selected a picture from a four-stimulus array given an auditorily presented target word while their eye movements were being monitored. In critical trials (12) in the onset competitor condition, the target, e.g., *camel* was accompanied by a picture of an onset competitor, e.g., *camera* and two unrelated pictures. In critical trials (12) in the onset mediated semantic competitor condition, the target, e.g., *hammock* was accompanied by a picture of an onset mediated semantic competitor, e.g., *nail* and two unrelated pictures. Forty-eight filler trials were included in which the target was not related to any of the distractor pictures. No pictures or words were repeated.

Results

The age-matched control subjects showed, similar to young normal subjects, both onset competitor and mediated semantic competitor effects. Results for the Broca's aphasics are shown in the top left panel of Fig. 1. As can be seen, they showed a weak onset competitor effect. That is, they were not significantly more likely to fixate on onset competitors of the uttered word than on unrelated distractors, although they showed a non-significant preference for looking at onset competitors compared to unrelated distractors. Consistent with the pattern of results obtained for onset competitors, Broca's aphasics failed to show a mediated competitor effect (top right panel of Fig. 1). That is, they showed no preference to fixate on distractors that were semantically related to the onset competitor.

The results for the Wernicke's aphasics are shown in the bottom two panels of Fig. 1. In contrast to Broca's aphasics, Wernicke's aphasics were significantly more likely to fixate on onset competitors of the uttered word than on unrelated distractors (bottom left panel). Consistent with the onset competitor's representation being strongly activated, Wernicke's aphasics also preferentially fixated on distractors that were semantically related to the onset competitor (bottom right

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^{*} Corresponding author.

E-mail address: Sheila_Blumstein@brown.edu (S. Blumstein).

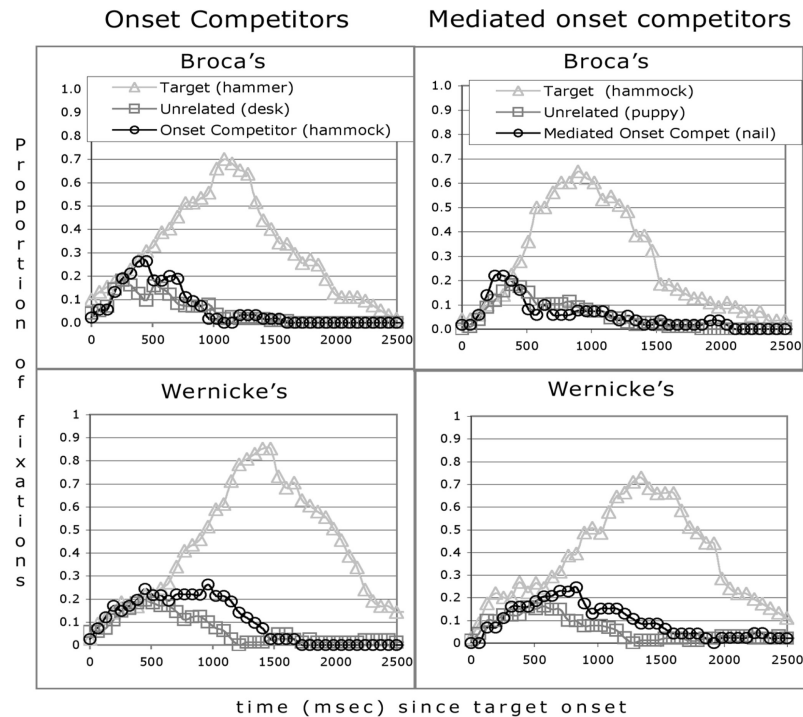


Fig. 1. Proportion of fixations over time on the target, the competitor and the average of the two unrelated distractors. Left panels: fixations of Broca's (top) and Wernicke's (bottom) aphasics in the onset competitor condition. Right panels: fixations of Broca's (top) and Wernicke's (bottom) aphasics in the mediated onset competitor condition.

panel). Furthermore, both effects appeared larger in Wernicke's aphasics compared to the age-matched control subjects.

Conclusion

Taken together, the results of this study are consistent with the view that both Broca's and Wernicke's aphasics have lexical processing deficits, and that the basis of these deficits relate to the dynamics of lexical activation. Of importance, the lexical processing deficits which were originally identified using a metalinguistic lexical decision paradigm emerge as well using the eye-tracking paradigm, a paradigm that is both more natural and provides a more continuous measure of lexical activation.

References

- Allopenna, P. D., Magnuson, J., & Tanenhaus, M. K. (1998). Tracking the time course of spoken word recognition using eye movements: Evidence of continuous mapping models. *Journal of Memory and Language*, 38, 419–439.
- Milberg, W., Blumstein, S., & Dworetzky, B. (1988). Phonological Processing and Lexical Access in Aphasia. *Brain and Language*, 34, 279–293.
- Yee, E., & Sedivy, J. (2001). *Do eye movements reflect semantic activation during spoken word recognition?* Poster presented at the 42nd annual meeting of the Psychonomic Society, Orlando, FL. Abstracts of the Psychonomic Society, 6.