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Rethinking the graphemic buffer?

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Introduction

One of the processes involved in spelling is the short-term buffering of graphemes prior to serial production of their corresponding letter forms in written spelling and letter names in oral spelling. Recent cognitive neuropsychological and computational work has been directed at developing a more detailed understanding of this buffering process (Rapp & Kong, 2002; Sage & Ellis, 2004).

Rapp and Kong (2002) argued that graphemic buffering consists of (at least) two major operations: the activation of a word's constituent graphemes, followed by the serial selection of the graphemes for the temporally ordered production of their names or forms (see also Houghton, Glasspool, & Shallice, 1994). Contrary to a commonly-held position, Sage and Ellis (2004) argued that representations at the level of the graphemic buffer (GB) are sensitive to lexical factors such as lexical frequency, age of acquisition, imageability and neighborhood size. They also questioned the robustness of two common manifestations of GB deficits—length effects, and the bow-shaped accuracy function across letter positions. Sage and Ellis specifically claimed that length effects are largely attenuated when word sets are matched for lexical factors, and that the bow-shaped accuracy function may be an artifact of limiting analyses to words with single errors.

In the work presented here, we: (1) integrate these two sets of claims by showing that activation deficits are sensitive to lexical frequency, while selection deficits may not be; and (2) report, contra Sage and Ellis, robust length effects and bow-shaped accuracy functions even under conditions they predicted would cause their attenuation or elimination.

Cases

BWN is a 79-year old, right-handed man who holds a Ph.D. and worked as a high-level school system administrator. CT scans indicate an older left parietal lesion and a more recent right parietal lesion.

RSB, 59, is a right-handed man who holds a Ph.D. and worked as toxicology research. MRI scans reveal a lesion in the left anterior parietal region.

JRE is a 61-year old right-handed woman who worked as a rehabilitation nurse. MRI scans reveal left frontal and temporo-parietal lesions.

Several analyses led Rapp and Kong (2002) to conclude that while all three individuals suffer from GB deficits, BWN and RSB suffer GB activation deficits and JRE has a GB selection deficit.

Analysis 1: Lexical effects

The spelling accuracy of RSB and BWN is sensitive to lexical frequency, while JRE's is not. Although RSB and BWN rarely exhibit significant effects on individual word lists that contrast high and low frequency words, the differences in letter accuracy are significant when data from several lists are combined. RSB: 90 vs. 83% (high vs. low frequency; $\chi^2 = 12.52$, $p < .01$). BWN: 89 vs. 84% ($\chi^2 = 10.95$, $p < .01$). In contrast, JRE shows no significant frequency effect, even when combining several lists: 84 vs. 83% ($\chi^2 = .54$, ns).

These differences can be understood if we assume that the activation component of graphemic buffering is sensitive to the strength of lexical encoding while the selection component is not.

Analysis 2: Bow-shaped accuracy function

We administered words containing 4–10 letters to each individual. The accuracy by position *for all errors* is reported in Fig. 1 using a five-position scheme (Wing & Baddeley, 1980) to combine words of different lengths. The clear bow-shaped function frequently reported elsewhere is readily apparent for each participant in Fig. 1.

Analysis 3: Length effects

Sage and Ellis (2004) argued that the influence of letter length on performance may have been exaggerated in previous reports of GB deficits if items of different lengths were not matched for a full range of lexical factors. For the case they report, they obtain only weak length effects on a list that compares 5- and 8-letter words matched on relevant lexical factors. However, their list contains a potential confound: the set of 8-letter words includes more inflected and compound words than the 5-letter word set. Multi-morphemic words may allow for the separate processing of component morphemes, reducing the load on the GB (Badecker, Hillis, & Caramazza, 1990). We administered both the list used by Sage and Ellis (List A) as well as a modified version we developed that matches for morphological complexity (List B) to BWN and RSB.

Both individuals showed small or no differences (BWN: 7%; RSB: 0%) in letter accuracy for 5- and 8-letter words on List A; in contrast, both showed highly significant length effects on List B (BWN: 12%; $\chi^2 = 13.22$, $p < .001$; RSB: 10%; $\chi^2 = 8.43$, $p < .01$).

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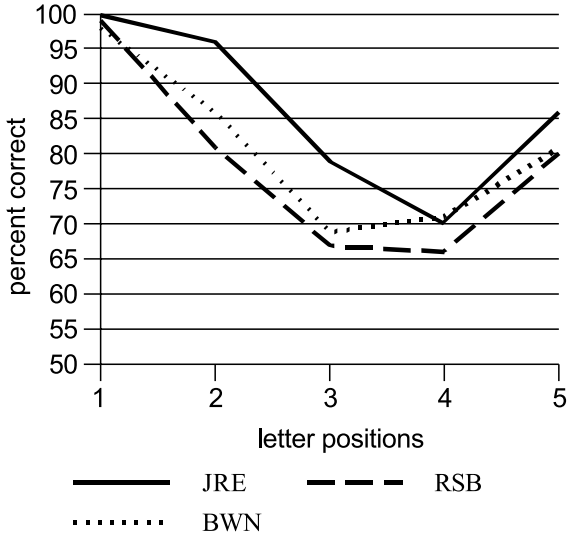

Fig. 1. Letter accuracy across positions.

Conclusions

Sage and Ellis (2004) propose a number of modifications to current views of the GB. We report evidence contrary to their suggestion that length effects and the bow-shaped accuracy functions—often the hallmark of these deficits—may be largely artifactual. Instead, we present clear evidence of strong effects of length even when words are matched for relevant lexical factors. Additionally, we find a clear bow-shaped accuracy function even when both simple and complex errors are analyzed. Importantly, however, we do find evidence consistent with their more fundamental claim of lexical influence on the activation strength of representations maintained by the GB. We further elaborate on their claim by proposing that the GB's activation component is sensitive to lexical factors, whereas the subsequent selection process is not. This set of findings serves to advance our understanding of the processes involved in producing written words.

References

Badecker, W., Hillis, A., & Caramazza, A. (1990). Lexical morphology and its role in the writing process: Evidence from a case of acquired dysgraphia. *Cognition, 35*, 205–243.

Houghton, G., Glasspool, D., & Shallice, T. (1994). Spelling and serial recall: Insights from a competitive queueing model. In G. D. A. Brown & N. C. Ellis (Eds.), *Handbook of spelling: Theory, process, and intervention*. Chichester, UK: John Wiley & Sons.

Rapp, B., & Kong, D. (2002). Revealing the component functions of the graphemic buffer. *Brain and Language, 83*, 112–114.

Sage, K., & Ellis, A. (2004). Lexical influences in graphemic buffer disorder. *Cognitive Neuropsychology, 21*, 381–400.

Wing, A. M., & Baddeley, A. D., (1980). Spelling errors in handwriting: A corpus and distributional analysis. In U. Frith (Ed.), *Cognitive processes in spelling*. London: Academic Press.