The Representation of Letter Position in Orthographic Representations

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Introduction

Tasks that require serial information must encode the positions (order) of items in a sequence. One such task is spelling, where representations encode not only the letters in a word, but also the positions of the letters. How, though, is position represented? Is the G in DOG the third letter, the first letter to the right of center, or the last letter? Several position-encoding schemes have been proposed, but relevant evidence is sparse. We present evidence from two dysgraphic individuals, LSS and CM, and we consider three position-representation hypotheses: left–aligned, center–aligned, and edge-aligned.

Experimental Study

When writing, both LSS and CM frequently produced letters that did not appear in the correct spelling (e.g., the G in CM's spelling of CHANCE as CHANGE). Analyses described in McCloskey, Macaruso and Rapp (2006) revealed that these intruded letters were present in each of the five previous responses (e.g. ROUGH) more often than expected by chance ($p < 0.0001$), suggesting that these errors were perseverations from earlier responses.

To examine the representation of letter position, we analyzed errors in which (a) a single letter was intruded and (b) the intruded letter was a potential perseveration, because it was present in one or more of the five immediately preceding responses. We refer to the response with the intruded letter (e.g., CHANGE) as the perseveration response, and the most recent preceding response that included this letter (e.g., ROUGH) as the source response.

First we addressed the question of whether the intruded letter appeared in the same position in the source and perseveration responses more often than expected by chance. To avoid assuming a particular position-encoding scheme, we analyzed source-perseveration pairs in which the two responses were of the same length. Imagine LINK was spelled as LIRK after the subject correctly spelled BARN. Because BARN and LIRK have the same number of letters, the R in BARN is in the same position as the intruded R in LIRK, regardless of how we define position. We tabulated the proportion of source-perseveration pairs in which maintained position, and calculated the proportion expected by chance. Monte Carlo simulations established that perseverations maintained position far more often than expected by chance ($p < .0001$) for both subjects.

Second, we contrasted alternative position-encoding hypotheses by analyzing source-perseveration pairs in which the two responses differed in length. Suppose that the response LIRK to the stimulus LINK was preceded by the response DEPORT. The R in LIRK is in the same position as the P in DEPORT by left-alignment, as the O by center alignment, and as the R by an edge-aligned hypothesis, which assigns position based on the left edge to letters in the first half of the word, and the right edge to letters in the second half of the word. Thus, the R in LIRK maintains the position of the source only if position is defined by the edge-aligned hypothesis. In a comparison of the edge- and left-aligned hypotheses, we found that both LSS's and CM's errors maintained edge-aligned position more often than expected by chance ($p < .02$ and .001, respectively), while neither subject maintained left-aligned position at above chance rates. In a comparison of the edge- and center-aligned hypotheses, neither subject maintained center-aligned position at above chance rates, while CM maintained edge-aligned position more often than expected by chance ($p < 0.01$), and LSS's tendency to maintain edge-aligned position approached significance ($p = 0.11$).

Conclusions

Analyses revealed that the subjects' perseveration errors maintained letter position more often than would be expected by chance. Of the three hypotheses evaluated, the edge-aligned hypothesis best fits the data. Competitive queueing simulations of spelling (Houghton, Glasspool, & Shallice 1994) have represented position based on of the edges of the word. Similar encoding schemes have also been proposed for other cognitive processes (e.g., short-term memory for serial order; Henson, 1998).

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