# Does orthographic overlap influence lexical selection?


**100 word abstract:**

Understanding whether and how various processes interact in language production can help us both understand aphasic errors and develop theoretically motivated treatment approaches. We examined semantic errors produced in writing-to-dictation by an individual with acquired dysgraphia to determine whether letter-level information – particularly overlap between the target and the semantic error – can affect lexical selection processes in these errors. Our results indicated that the particular semantic errors that were produced were significantly more likely to share orthographic structure than would be expected by chance alone, indicating interaction in the form of feedback from letter-level processes to lexical selection.


**1200 word abstract:**

## Introduction

Individuals with aphasia frequently have a language deficit affecting both spoken and written language. While spoken language is typically prioritized in treatment and clinical research, written language is essential for many everyday tasks. This is especially true in the digital age, with emails and texts often supplanting verbal interactions. The degree of linguistic competence required varies among written tasks, but all require the ability to spell individual words (Beeson, 2002) and the processes involved in spelling have been examined in individuals with aphasia. The cognitive system responsible for spelling words (Rapp,2002) in the commonly used writing-to-dictation task consists of several levels of processing, including both word-level processing (e.g., phonological input lexicon, semantic system, orthographic output lexicon) and letter-level processing (e.g., graphemic buffer; letter-shape conversion). In this paper, we investigate whether there is interaction among these levels by examining semantic errors produced in the writing-to-dictation task.

Research in spoken language production has indicated that activation cascades from word-level to phoneme-level in spoken word production (Rapp & Goldrick, 2000). Recent findings suggest activation cascades from word-level to letter-level processes in written spelling processes as well. Falconer, Miner, Velez & Buchwald (2011) reported on an individual with acquired dysgraphia who produced significantly more letter errors in spelling weak lexical-semantic targets (i.e., when a semantic error was produced; *iron* → STEELE) compared to strong targets (i.e., when the target word *steel* was produced). These findings indicated that differences in activation at the lexical-semantic level cascaded down to the letter level. But there is little evidence for feedback from letter-level to word-level processes in spelling. It has been shown that phonemic overlap affects lexical selection in spoken word production. For example, Rapp and Goldrick (2000) reported that mixed errors -- semantic errors with a high phonological overlap index (POI) -- were more common than would be expected by chance, indicating that phonological structure affects lexical selection in spoken semantic errors.

Here we present an analysis indicating that there is feedback between letter-level orthographic processes and lexical-semantic processes in written spelling. We use an analogous written measure to the POI, the orthographic overlap index (OOI). If feedback from letter-level processes affects lexical selection, we expect a higher incidence of orthographic overlap in written semantic errors than would be predicted by chance. In order to estimate chance, we used a normed word association database (Nelson, McEvoy & Schreiber, 1998) and generated random datasets by randomly selecting an associate of the target word from the database. We generated 10,000 random datasets, thus creating a distribution of OOI values expected by chance. A higher OOI in the aphasic errors compared to chance would indicate that semantic associates sharing orthographic structure are more likely to be selected, a result that would suggest feedback from letter-level processes to lexical selection.

**Methods**

***Participant***

RMI, 36, is a right-handed male with a history of L-MCA CVAs and mild right hemiplegia. He presented with conduction aphasia as per the Western Aphasia Battery (WAB, Kertesz 1982) classification. Spoken production was characterized by frequent phonological, semantic and morphological errors over all spoken tasks including spontaneous speech, reading and naming. No distortions or dysprodic speech were present. Non-verbal semantic knowledge (49/52 correct on the Pyramids and Palm Trees Test;Howard & Patterson, 1992) and hearing (minimal pair discrimination 99%correct) were intact.

Over one year of testing, RMI made frequent errors in writing-to-dictation tasks (39.7% correct). His error productions (N=1428) include 15.7% lexical-semantic errors (*chipmunk*→SQUIRREL), 16.5% morphological errors (*eaten*→ ATE), 7.9% other words (*tarnish*→BRINK), and 18.9% mixed errors (*chipmunk*→SQUIRLE). Additionally, RMI showed evidence of sublexical impairment as he made very few phonologically plausible (squirrel → SQUIREL) errors (2%) and was unable to spell any non-words (/dut/ → DURP) accurately (0%, N=133).

***Procedure***

Semantic errors (N=64) made in writing-to-task were analyzed for orthographic overlap. The orthographic overlap index (OOI) was determined for each error by comparing the number of letters it shared with the stimulus word. For example, in the case of *saint*→PRIEST, eight of the eleven letters are shared between the target and response (OOI=.727). The mean OOI of the semantic errors was calculated for comparison to the chance distribution of OOI scores. Errors that were morphologically related to the target were excluded from the analysis. Morphological errors contain many shared letters with the stimulus word and would therefore exhibit high OOI as a group.

The University of South Florida (USF) Free Association Norms Appendix A was used for this purpose (Nelson, McEvoy & Schreiber, 1998). For each of RMI's errors present on the USF database, the top ten most common word associations were obtained and their overlap with the target word was determined. If many words tied for the tenth ranking, then all tied words (up to five) were included. If more than five words tied for the tenth ranking then none of those words were included. To determine the chance OOI distribution, we simulated 10,000 random datasets using a Monte Carlo procedure. Each run of the simulation randomly selected one of the semantic associates for each of the 64 target words from the USF database, and the average OOI was computed. This procedure was run 10,000 times, yielding a distribution of OOI scores to compare with the OOI obtained from RMI's errors.

**Results**

Mean orthographic overlap (OOI=38.8) between the target words and RMI's semantic errors ($N = 64$) was higher than expected by the chance selection of the letters contained in common associates (OOI=29.1; range 17.8-41.3). In particular, only three simulated datasets exceeded RMI's mean OOI, indicating that an OOI as high as his would be expected to occur only three times out of 10,000 by chance alone ($p=.0003$). In addition to this analysis, we computed the mean OOI for the strongest associate according to the USF database (OOI=30.0). Our Monte Carlo analysis obtained 3,862 datasets with an OOI that exceeded this value, indicating that always selecting the closest semantic neighbor (according to the database) would have yielded an OOI expected by chance ($p=.3862$).

**Discussion/Conclusion**

Our results suggest the presence of feedback between letter-level processing and lexical selection. The mean OOI of 64 semantic errors produced by RMI yielded a value that shares more orthographic structure between the target and the response than predicted by chance; this would not have been true if RMI had always selected the strongest word associate of the target. Additional analyses will include repeating the Monte Carlo procedure with weighting based on the strength of the associated word. In addition, our analysis was limited because some semantic errors made by RMI do not appear in the USF database (N=31). To address this, we will independently determine obtain norms for these words as well as those included here to extend this analysis to the full set of semantic errors obtained from RMI.

Our finding that the graphemes activated during lexical selection influence the lexical access of non-target semantic errors, may have clinical implications for dysgraphic individuals. For example, in individuals with relatively intact sublexical systems, improved selection among semantic competitors might be accomplished by constraining output to a particular initial letter (or sound) during spelling to dictation. This approach would be consistent with phonological approaches to the treatment of anomia in spoken naming (Raymer et al,1993; Kendall et al, 2008).

**References**

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