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Research report

Homographic and heterographic homophones in speech production: Does orthography matter?

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ABSTRACT

This paper investigates homophone naming performance in an individual with impaired word retrieval. The aim of the study is to investigate the status of homophone representations using treatment of homophone picture naming in aphasia. The focus of this paper is the representation of heterographic homophones (words which sound the same but are spelled differently, e.g., 'knight' vs. 'night'). Additionally, we replicate and expand previous findings regarding homographic homophones of Biedermann and Nickels (2008) in English and Biedermann et al. (2002), in German.

Two theoretical positions about the mental representation of homophones are tested. First, do homophones – regardless of whether they are spelled the same or differently – share a phonological word form (e.g., Levelt et al., 1999; Dell, 1990)? Or second, do they have independent phonological word forms? (e.g., Caramazza et al., 2001; Miozzo and Caramazza, 2005)? In addition, might it be the case that homographic and heterographic homophones behave differently in word production reflecting different word form representations? These theoretical accounts are put to the test by looking at the generalisation of improvement following the treatment of homophone naming in aphasia, in particular, whether picture naming improves for both homophone meanings if only one is treated using a phonological cueing hierarchy.

Treated and untreated homophones improved significantly, regardless of their spelling. Homographic and heterographic homophones showed the same pattern of generalisation. There was no generalisation for phonologically related controls. The pattern of generalisation extends our previous findings (Biedermann et al., 2002; Biedermann and Nickels, 2008) by showing evidence that heterographic homophones benefit to the same extent as homographic homophones. These results are interpreted as favouring a theory where both homographic and heterographic homophones share a single phonological representation. It is inferred that facilitation of naming takes place at the level of phonological representations, where orthography seems to have no influence.

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Homophones are words which sound the same but have two or more different meanings. They can be spelled the same (e.g., 'ball' (dancing event) and 'ball' (sports equipment)) and are therefore called *homographic* or spelled differently (e.g., 'knight' and 'night') and are therefore called *heterographic*[1]. The representation of homophones for speech production has been investigated in several recent studies (e.g., Biedermann et al., 2002; Biedermann and Nickels, 2008; Caramazza et al., 2001; Dell, 1990; Jescheniak and Levelt, 1994; Jescheniak et al., 2003; Miozzo et al., 2004; Miozzo and Caramazza, 2005). While a lot of time has been spent investigating how homophones are represented for speech production, no study has contrasted homographic and heterographic homophones directly.

1. Different theories of homophone representation

1.1. *Phonological representation of homophones*

One of the major debates in the literature is whether homophones *share a* phonological representation at the word form level as in the Two-Stage model (Levelt et al., 1999, see Fig. 1a) or if there are *independent* representations as in the Independent Network (IN) model (Caramazza, 1997, see Fig. 1b).

According to the Two-Stage model, there are distinct representations for homophones at the semantic level and syntactic (lemma) level, but a shared representation at the word form level (in the remainder of this paper referred to as 'Shared Representation' view). These three levels of representation are necessary to access a whole lexical entry, which subsequently activates its corresponding phonemes at the segment level (see Roelofs et al., 1998; see Fig. 1a). A similar view is postulated by Dell (1990) and Cutting and Ferreira (1999). However, both these authors make different assumptions about the flow of activation, by allowing feedback connections between levels: segments feed back to word forms, word forms feed back to lexical syntax (lemmas), and lemmas feed back to semantics. This contradicts the strictly serial flow of activation in the Two-Stage model.

Caramazza proposes a contrasting view in the IN model, postulating that there are independent representations for homophones at the word form level (in the remainder of this paper referred to as 'Independent Representation' view). The IN model consists only of a semantic and a lexical level. There is no distinct syntactic level that corresponds to the lemma level in Levelt et al.'s model. The lexical level incorporates both syntactic *and* phonological features and is connected to a segment level. Activation is strictly feed forward in the original version of this model (Caramazza, 1997). However, in a later paper (Caramazza and Miozzo, 1998), the authors allow feedback links between word form and segment level, whereby activation can spread in both directions between these two levels. This modification was suggested to explain a *homophone inheritance effect* found by Jescheniak and Levelt (1994) (see Caramazza and Miozzo, 1998, p. 239), whereby a low frequency homophone with a high frequency partner is produced faster/more accurately than non-homophones of a similar frequency. According to the 'Shared Representation' view, this effect is due to accumulation or summing of the frequency of both homophone partners at the word form level. By this account, low frequency homophones should be processed faster than low frequency non-homophones. This contrasts with the 'Independent Representation' view which predicts that a high frequency homophone is processed faster and more accurately than a low frequency homophone, and that homophones do not to behave differently from non-homophones with the same frequency.

This paper tests the 'Shared Representation' view of the Two-Stage model and the 'Independent Representation' view of the IN model. The approach we undertake is neuropsychological, using aphasic word production impairments to inform us about the representation of homophones. Specifically, we investigate whether improving picture naming by treating only *one* homophone meaning improves the naming of the other homophone meaning. In the remainder of this paper, we refer to the improvement of untreated homophones as *homophone generalisation*. So far, there is evidence that there is generalisation when homographic homophones are used (in both German and English; for German see Biedermann et al., 2002; for English, Biedermann and Nickels, 2008).

The 'Shared Representation' view (e.g., Levelt et al., 1999; Dell, 1990) can account for this homophone generalisation effect, if treatment affects the accessibility of entries at the word form level. However, in the IN model, which incorporates an 'Independent Representation' view, improved naming of one homophone partner should not improve naming performance of its mate. However, with the suggested modification of including feedback between word form and segment level (Caramazza and Miozzo, 1998), homophone generalisation could also be explained in the IN model.

There is some evidence in the literature that heterographic and homographic homophones may behave differently. For example, Wheeldon and Monsell (1992) found no *homophone priming effect*[2] with heterographic homophones in a picture naming study with normal speakers but a trend for facilitation with homographic homophones (e.g., naming (or word retrieval) in response to the definition 'the main stem of a tree' facilitated the picture naming of the elephant's 'trunk'; while naming in response to the definition 'white powder used to make bread' did *not* facilitate the naming of the picture of a 'flower').

In addition, there is a suggestion that orthographic status may be important in order to explain the contradictory results found in experiments investigating homophone frequency inheritance effect mentioned earlier. Jescheniak and Levelt (1994) and Jescheniak et al. (2003) used exclusively homographic homophones and found a frequency

[1] Words which only differ in syntactic class, but overlap partly in semantics and fully in phonology, have also been referred to as homophones in the previous literature (e.g., Caramazza et al., 2001) Here we take a more restricted definition of homophones including only those words with no semantic, but only overlapping phonology.

[2] Howard D. *Naming & Repetition of 1,2,3, Syllable Words*, unpublished material.