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Linking recognition and production: Cross-modal transfer effects between picture naming and lexical decision during first and second language processing in bilinguals

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ABSTRACT

The present study examined the extent to which word production and recognition rely on shared representations in lexical access by examining cross-modality transfer effects and frequency effects in a training paradigm. Participants were trained in reading high- and low-frequency words in a lexical decision task and were subsequently tested in producing picture names and vice versa, both in their second (Experiment 1) and in their first language (Experiment 2). The same pattern of results was found for first and second language processing. Both tasks showed strong, within-modality repetition effects with faster responses and smaller frequency effects for repeated items. Training with repeated lexical decision, sped responses, and reduced the size of the frequency effects in subsequent picture naming. In contrast, training with repeated picture naming sped responses in lexical decision, but did not significantly decrease frequency effects. The results imply an amodal representation (lemma) that is shared between production and recognition and is not sensitive to word frequency. Also, they imply that a frequency sensitive phonological representation (lexeme) is activated automatically during visual word recognition.

Introduction

Oral language processing involves four basic functions: reading, speaking, listening, and writing. People use these functions to convey meaning in communication. The word *coat*, whether written or spoken aloud, refers to the same object and activates the same basic concepts. Comprehension and production are intrinsically linked to each other, but also involve different cognitive processes. In psycholinguistic research, these processes are often investigated separately (i.e., by different investigators, in separate research studies, and in separate sessions or even separate scientific meetings). To the limited extent that comprehension and production have been studied together in monolinguals, no clear consensus has emerged as to what extent shared representations and processes are involved (e.g., Dell & Gordon, 2003; Monsell, 1987; Roelofs, 2003). Similarly, in the bilingual domain, functional interactions between comprehension and production have rarely been investigated (but see Gollan et al., 2011).

The present study was designed to examine the extent to which production and recognition rely on shared representations in lexical access by examining cross-modality transfer and frequency effects in a training paradigm. Specifically, participants repeatedly read or produced high- and low-frequency words and then switched modalities in a test phase (in which they read the words they had trained with picture naming, and produced the words they had trained with reading). This training is an experimental

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induction of additional language exposure. It has been argued that training effects in word production and visual word recognition can be explained by the same mechanisms as word frequency effects (e.g., Monsell, 1991; Wheeldon & Monsell, 1992). Thus, the main questions investigated were: will frequently reading a word later make it easier to produce the same word, and, similarly, will producing a word make it easier to later recognize that word in reading?

In addition to considering overall speed, we were interested in considering the size of the frequency effect, which is often considered to be a signature of lexical access (e.g., Almeida, Knobel, Finkbeiner, & Caramazza, 2007; Forster & Chambers, 1973; Levelt, Roelofs, & Meyer, 1999; Murray & Forster, 2004; Rayner, 1998). If recognition and production activate shared representations, cross-modal training effects should arise. Furthermore, if frequency sensitive lexical representations are accessed, the frequency effect should decrease in magnitude with training (e.g., Griffin & Bock, 1998; Scarborough, Cortese, & Scarborough, 1977), given that each additional exposure has a smaller effect on access speed (e.g., McCusker, 1977). Therefore low-frequency words benefit more from training than high-frequency words.

Production

In research on language production, there is general agreement that lexical access involves two major steps (e.g., Bock, 1987; Dell & O'Seaghdha, 1992; Levelt, 1989). The first step is the mapping of meaning onto an abstract representation of a word. The second step involves mapping this abstract representation onto the word's phonological characteristics. The distinction of two steps of lexical access is present in most models of speech production (e.g., Dell, 1986; Levelt et al., 1999; Rapp & Goldrick, 2000, but see Caramazza, 1997). A prominent model of lexical access in speech production is the WEAVER++ model (e.g., Levelt et al., 1999; Roelofs, 1992, 1997; Roelofs & Meyer, 1998). According to this model, speech production begins with the selection of a concept, after which lexical selection takes place with the retrieval of a syntactic representation (a lemma) from the mental lexicon. In subsequent processing steps, the word form is accessed so that morphological and phonological forms are activated. These phonological representations must be encoded to phonetic representations, which specify how the word should be articulated. In the final step, the phonetic plan is executed and the word is articulated. This multi-stage model adopts the spreading activation principle so that concepts and lemmas similar to the target also become activated and compete for selection. In cascading models (Dell, 1986; Rapp & Goldrick, 2000), such as the interactive two-step model of word production (Dell, 1986; Dell, Schwartz, Martin, Saffran, & Gagnon, 1997), phonological encoding can begin before word selection is completed. In bilinguals, concepts activate lexical representations in the target language as well as in the non-target language (e.g., Colomé, 2001; Costa, Caramazza, & Sebastian-Galles, 2000; De Bot, 1992; Green, 1986; Hermans, Bongaerts, De Bot, & Schreuder, 1998). Representations and processes in bilingual production models are similar to those invoked in the monolingual models.

There is disagreement regarding the locus of the frequency effect in models of word production. Two-stage models such as WEAVER++ attribute frequency effects mainly to phonological encoding (e.g., Jescheniak & Levelt, 1994; Levelt et al., 1999), whereas cascade models assume that frequency effects arise in both word selection and phonological processing (e.g., Dell, 1990). There is much evidence in favor of the phonological-level locus of frequency effects (Dell, 1990; Jescheniak & Levelt, 1994). For instance, Jescheniak and Levelt (1994) studied the processing of high- and low-frequency homophones and showed that the frequency effect arises in accessing the word form (phonological retrieval) rather than the lemma. Similarly, studies of speech errors also support a phonological-level locus of the frequency effect (e.g., Dell, 1990).

However, although there is general agreement that a major locus of the frequency effect is phonological encoding, frequency effects do not necessarily need to be mutually exclusive arising *only* during phonological encoding in lexical access. There is evidence suggesting that frequency also affects lemma access (but note that some studies failed to find conclusive evidence for frequency-sensitive lemmas; e.g., Jescheniak & Levelt, 1994). For example, frequency affects grammatical gender decision to pictures suggesting frequency is represented at the level of grammatical encoding (e.g., Navarette, Basagni, Alario, & Costa, 2006). Other studies have also suggested multiple frequency-sensitive levels of lexical access (e.g., Gollan et al., 2011; Kittredge, Dell, Verkuilen, & Schwartz, 2008; Knobel, Finkbeiner, & Caramazza, 2008). Thus, it seems that frequency in word production models might be represented primarily in the second step of lexical access in which phonological encoding occurs (lexeme access), but also (though to a lesser degree) in the first step of lexical access where meaning is mapped to a lemma (e.g., Kittredge et al., 2008). Assuming that lemmas are shared between production and recognition (e.g., Levelt et al., 1999; for a different view see Caramazza, 1997), in the present study this would imply that training should both speed responses, and reduce the size of the frequency effect, in both training directions (recognition to production and vice versa). Such a result would suggest that the same representations (lemmas) are accessed in both production and recognition, and that these amodal representations are also frequency-sensitive.

Recognition

In the domain of visual word cognition, similar semantic and phonological representational levels as in production have been proposed to explain how readers derive meaning from printed words. In the dual-route theory of Coltheart, Rastle, Perry, Ziegler, and Langdon (2001), word recognition proceeds via two distinct, but interactive procedures: the lexical and non-lexical routes. In the lexical route, reading relies on the activation of whole-word