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Speaking two languages at once: Unconscious native word form access in second language production

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ABSTRACT

Bilingualism research has established language non-selective lexical access in comprehension. However, the evidence for such an effect in production remains sparse and its neural time-course has not yet been investigated. We demonstrate that German-English bilinguals performing a simple picture-naming task exclusively in English spontaneously access the phonological form of –unproduced– German words. Participants were asked to produce English adjective-noun sequences describing the colour and identity of familiar objects presented as line drawings. We associated adjective and picture names such that their onsets phonologically overlapped in English (e.g., *green goat*), in German through translation (e.g., *blue flower* – 'blaue Blume'), or in neither language. As expected, phonological priming in English modulated event-related brain potentials over the frontocentral scalp region from around 440 ms after picture onset. Phonological priming in German was detectable even earlier, from 300 ms, even though German was never produced and in the absence of an interaction between language and phonological repetition priming at any point in time. Overall, these results establish the existence of non-selective access to phonological representations of the two languages in the domain of speech production.

1. Introduction

During speaking, we access mental representations (conceptual, lexico-syntactic, and phonological) via spreading of activation (cf. Dell, 1986; Levelt, Roelofs, & Meyer, 1999). In bilinguals, activation spreads to such representations not only in one but two languages. Whereas language non-selective lexical access is well established for speech comprehension in bilinguals with various proficiency levels and language pairs (e.g., Dijkstra & van Heuven, 2010), this phenomenon is rather counterintuitive in production since the speaker controls the information to be accessed and articulated.

Still, some evidence that a non-produced language is nevertheless phonologically activated comes from chronometric studies (e.g., Colomé, 2001; Colomé & Miozzo, 2010; Costa, Caramazza, & Sebastián-Gallés, 2000) and ERP studies (e.g., Acheson, Ganushchak, Christoffels, & Hagoort, 2012; Rodriguez-Fornells et al., 2005).

In a meta-analysis, Indefrey and Levelt (2004) provided estimates of the critical times at which phonological representations and articulatory programs are being retrieved from memory during picture naming. They estimated that

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the phonological code becomes activated between 250 and 330 ms and that syllabification unfolds between 330 and 455 ms after presentation of a picture to be named. Consistent with these estimates, ERP studies such as that of Christoffels, Firk, and Schiller (2007) found a cognate effect between 275 and 375 ms and between 375 and 475 during picture naming (see also, Strijkers, Costa, & Thierry, 2010).

However, previous studies suffer from a number of limitations. Non-selective language access identified using cognates (or by manipulating translations) may not generalise to every instance of language production. Additionally, some of these studies involve language switches or meta-linguistic tasks. Therefore, despite a number of findings we still do not know what happens to a speaker's native language if the speaker operates exclusively in his or her L2. Here, we focussed on this very issue using a hidden phonological priming manipulation during production in a purely monolingual L2 context.

Furthermore, such investigations have so far provided no information regarding the relative time-course of phonological access in the two languages. That is, while we can conclude that phonological representations of both languages must have been active at some point, we do not know how the activation of both languages unfolds over time.

In a paradigm originally developed to test monolingual production (Damian & Dumay, 2007, 2009), participants were presented with coloured line drawings and produced adjective-noun pairs containing a phonological overlap (e.g., *blue bear*) faster than pairs containing no such overlap (e.g., *blue goat*). We developed a bilingual version of this paradigm to test phoneme repetition priming in L1 (German) although naming occurred exclusively in L2 (English). Adjective-noun pairs were selected such that initial phonemes overlapped in L2, in L1, or in neither. We expected phoneme repetition in L2 to modulate ERPs circa 350 ms after picture onset based on Indefrey and Levelt (2004). We further hypothesised that the hidden phoneme repetition in L1 would induce a priming effect if participants had accessed L1 phonology.

2. Materials and methods

2.1. Participants

Eighteen participants (11 women) took part in the experiment. All were late German–English bilinguals with a proficiency level of at least C1 according to the European reference frame. The council of Europe has introduced six reference levels (A1, A2, B1, B2, C1, C2) which have become a standard in most European assessments of foreign language proficiency. C1 reflects a level at which participants can understand complex demanding texts and express themselves fluently.

Participants had been living in the UK for at least 6 months at the time of testing. All had normal or corrected-to-normal vision (see Table 1 for a summary of participant characteristics). Participants received monetary compensation for their participation in the experiment, which was approved by the Ethics Committee of Bangor University. Four of the participants had to be removed from the analyses due to unacceptable amounts of EEG artefacts. Statistical analyses are thus based on 14 individual data sets.

2.2. Materials

Fifty line drawings of familiar objects and animals were selected from Szekely and et al. (2004). Two coloured versions (red, green, or blue) were created from each line drawing. Twenty-five line drawings had names starting with 'r', 'g', or 'b' in English, but not in German. Twenty-five line drawings had names starting with 'r', 'g', or 'b' in German, but not in English. Two independent variables were manipulated: Language of overlap and phoneme repetition. For the phoneme repetition condition, a picture was paired with a colour starting with the same phoneme as the object name. This condition was compared to a non-overlapping control condition. In the L1 overlap condition, the repetition occurred in the participants' L1 (which was never produced during the experiment), e.g., *red skirt* vs. *green skirt* (German translation: *roter Rock* vs. *grüner Rock*). In the L2 overlap condition, the repetition occurred in the participants' L2 (e.g., *blue bird* vs. *green bird*). Hence, L1 and L2 overlap concerned different items, whereas phoneme repetition was tested within items. Care was taken that the three colours *red*, *green*, and *blue* occurred equally often in the course of the experiment. Each picture was presented three times in each condition, adding up to 75 stimuli per condition. Five different pseudo-randomisations were created with the following constraints: subsequent items did not start with the same phoneme, a colour was repeated no more than three times, and there were no more than three items with phoneme overlap in a row. An additional four items were included as practice items.

2.3. Procedure

Participants were tested individually. Instructions were administered in English. After signing a consent form, participants filled in the Edinburgh Handedness Inventory and a questionnaire regarding language use and proficiency in their two languages. A summary of the results from the language questionnaire is provided in Table 1. Next, participants were shown all the items in black outlines twice and asked to name them. If a participant could not come up with the English name, the experimenter provided it. Picture presentation was experimenter-paced. In the main experiment, participants were asked to name each coloured picture in English with a combination of colour and name, e.g., 'blue bird'. Speed and accuracy were both emphasized. The experiment started with a practice consisting of 10 trials. Each experimental trial had the following structure: (1) a picture was displayed at the centre of the screen until a response was given or for a maximum of 2000 ms; (2) a blank inter-trial interval of variable duration (1800, 1850, 1900, 1950, 2000, 2050, or 2100). An asterisk was presented for 500 ms before the first trial to signal the beginning of a block. Response latencies were measured from the onset of the stimulus by means of a