Cognition 125 (2012) 491–497

Contents lists available at SciVerse ScienceDirect

Cognition

journal homepage: www.elsevier.com/locate/COGNIT

Brief article

Does bilingualism twist your tongue?

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ARTICLE INFO

Article history:
Received 8 April 2012
Revised 3 August 2012
Accepted 6 August 2012
Available online 6 September 2012

Keywords:
Bilingualism
Tongue twister
Nonwords
Speech error
Phonological
Structural similarity
Competition

ABSTRACT

The current study investigated whether bilingualism affects the processing of sub-lexical representations specifying the sound structure of words. Spanish-English bilinguals, Mandarin-English bilinguals, and English-only monolinguals repeated English tongue twisters. Twister materials had word or nonword targets (thus varying in whether lexical information did or did not support sound processing), and similar or dissimilar sounds (thus varying in difficulty with respect to competition at a sub-lexical level). Even though bilinguals had learned English at an early age, and spoke English without an accent, Spanish-English bilinguals produced significantly more twister errors than monolinguals, particularly in the absence of lexical support. Mandarin-English bilinguals were also disadvantaged, but more consistently across all twister types. These results reveal that bilingual disadvantages extend beyond the lexical level to affect the processing of sub-lexical representations. More generally, these findings suggest that experience with sound structures (and not simply their intrinsic complexity) shapes sub-lexical processing for all speakers.

1. Introduction

One of the more challenging tasks in second language acquisition is learning to produce target language sounds fluently. Native speakers of foreign languages seem to do amazing things with their articulators, producing sounds that seem impossible to produce, and on the receptive side, hearing distinct differences between sounds that seem undistinguishable. Perhaps even more amazing are bilinguals who learned two languages early in life. These speakers seem to comfortably navigate back and forth between sound systems without any noticeable accent in either language. Setting these casual observations aside, relatively little is known about how (if at all) proficient bilingualism affects on-line retrieval and planning of speech sounds. Research on bilingualism has focused on lexical retrieval, revealing a number of processing differences between bilinguals and monolinguals and leading to two explanations of those differences.

On one view, by virtue of speaking each language only some of the time, bilinguals have used each language less frequently than monolinguals – the *frequency-lag* hypothesis (Gollan, Slattery, Van Assche, Duyck, & Rayner, 2011; also known as the *weaker links* hypothesis; Gollan, Montoya, Cera, & Sandoval, 2008). This view predicts that bilingual disadvantages should emerge at processing loci where frequency effects are strongest, (e.g., in lexical processing tasks (Jescheniak & Levelt, 1994; Kittredge, Dell, Verkuilen, & Schwartz, 2008). Supporting frequency lag, bilinguals name pictures more slowly than monolinguals, particularly when producing low-frequency names (Gollan et al., 2008, 2011; Ivanova & Costa, 2008). Disadvantages have also been reported in other language production tasks, including reduced category fluency (Rosselli et al., 2000), and more frequent tip-of-the-tongue states (Gollan & Brown, 2006).

A second explanation of bilingual disadvantages relies on the more obvious possibility that bilinguals might need to overcome competition between translation equivalents

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http://dx.doi.org/10.1016/j.cognition.2012.08.002

– the *interference* hypothesis. This account was inspired by experimental evidence that bilinguals can never "shut a language off" so that even when they speak in just one language, words in both languages are activated (Kroll, Bobb, Misra, & Guo, 2008). Also supporting the interference account are bilingual *advantages* on non-linguistic tasks that require resolution of competition (e.g., Costa, Hernández, Costa-Faidella, & Sebastian-Galles, 2009; for review see Bialystok, Craik, Green, & Gollan, 2009). Although bilinguals are usually disadvantaged in language tasks, they sometimes outperform monolinguals in this domain in tasks that emphasize competition (e.g., Stroop interference; Bialystok, Craik, & Luk, 2008).

The current study extends this research to explore whether bilingualism affects sub-lexical processing levels during production of English tongue twisters. Although frequency-lag and cross-language interference are generally assumed to arise at the lexical level, these general mechanisms could also influence sub-lexical processing levels. With respect to frequency-lag, recent studies suggest that there may be frequency effects within sub-lexical processes (Goldrick, 2011; Goldrick & Larson, 2008). If so, bilinguals might have more difficulty retrieving language-unique sounds than monolinguals. With respect to cross-language interference, difficulty could arise when selecting between co-active representations (Colomé, 2001; Costa, Roelstraete, & Hartsuiker, 2006) of subtly different sounds. Typically, in different languages even sounds that are largely the "same" are produced with distinct acoustic/articulatory properties (Pierrehumbert, Beckman, & Ladd, 2000). For example, the Spanish /d/ is a prevoiced stop whereas in English it is an unaspirated, short-lag stop. Even just momentary confusion about which segment to select (i.e., which language is the target language) could disadvantage bilinguals (e.g., when producing the /d/ in *dog*).

On the other hand, several considerations suggest that bilingualism might not affect sub-lexical processing as much as it affects lexical processing. First, with respect to frequency-lag, bilingual disadvantages in lexical retrieval are much smaller for retrieval of high-frequency than low-frequency words (Gollan et al., 2008, 2011; Ivanova & Costa, 2008). Individual phonemes – which appear in many different words – have likely been retrieved more frequently than even the highest frequency words. Thus, if bilingual disadvantages become smaller and smaller with progressively higher frequency, then it would seem unlikely that bilinguals should be disadvantaged for retrieval of individual phonemes. Indeed, all proficient speakers of a language, whether bilingual or monolingual, might be at ceiling levels of ability for such retrieval events. Second, since phonological competition is strong between similar phonemes (and weaker between dissimilar phonemes; Wilshire, 1998, 1999), cross-language interference at the phonological level might be more likely to occur when translation equivalents share similar sounds. However, most translation equivalents are non-cognates i.e., they do not do not resemble each other in phonological form (e.g., the Spanish word for *dog* is *perro*). More specific to our study, interference effects would further be minimized by our English-only materials with sound combinations that are unlikely in the bilingual speakers' other language.

To examine this issue, we compared bilinguals' and monolinguals' production of word and nonword twisters with similar versus dissimilar phonological representations. Prior studies revealed *lexicality* and *similarity* effects, such that monolinguals produced more errors when repeating nonword than word twisters, and when repeating twisters with similar than with dissimilar sounds (e.g., Wilshire, 1998, 1999). If bilingualism affects speech production exclusively at a lexical level, bilinguals should have no particular difficulty with sub-lexical processing, and should produce the same number of errors as monolinguals on nonword twisters (which should be unaffected by disadvantages in lexical retrieval). Alternatively, frequency-lag or competition between languages could arise at a sub-lexical level as well, in which case bilinguals should produce more twister errors than monolinguals for both word and nonword twisters. To test these hypotheses, as well as the generality of any bilingual effects observed, we tested both Spanish-English and Mandarin-English bilinguals.

2. Method

2.1. Participants

Forty-eight undergraduates at UCSD in each of three language groups (Spanish-English bilinguals, Mandarin-English bilinguals, and English speaking monolinguals) participated for course credit. Data from a small number of participants were excluded due to experimenter or recording errors (4 Spanish-English bilinguals, 2 Mandarin-English bilinguals, and 1 monolingual) or persistent failure to maintain production tempo (1 Spanish-English bilingual, and 1 monolingual).

Table 1 shows self-reported participant characteristics, vocabulary (Shipley, 1946) and non-verbal reasoning scores (Matrices subtest, KBIT-2; Kaufman & Kaufman, 2004), and accent ratings [i.e., recordings of each participants' English picture-naming responses were rated by three research assistants (one monolingual, one Spanish-English bilingual, and one Mandarin-English bilingual)]. Most bilinguals were rated as having no accent, or only a very slight accent, and bilingual groups did not differ on accent scores ($t < 1$). Bilingual groups differed from monolinguals on a number of characteristics but these did not have robust effects on performance (see below).

2.2. Materials and procedure

Tongue twisters were taken from Wilshire (1998) and included 32 alliterating word and 32 alliterating nonword twisters with four words or nonwords in each twister. Word and nonword twisters were evenly divided between phoneme-similar (*dirt bus boot dose*) and phoneme-dissimilar[1] twisters (*date fern foot den*), and between ABBA

[1] Wilshire (1998) defined similarity empirically by the rate of segment interactions in spontaneous speech errors.