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The Effect of Lexical Frequency on Language Production Error Incidence

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Abstract

The present study examined the effects of long-term potentiation on production errors by manipulating the Brown frequency of words in three pairs of tongue twisters and counting the number of tongue twister productions that contained errors for high- and low-frequency conditions (Brown, 1984). A student at the University of Texas at Austin was shown six tongue twisters (three high-frequency, three low-frequency) and asked to repeat them for 96 productions.

The researcher has suggested that there is a strong correlation between Brown frequency and error rate, so tongue twisters with high Brown frequency will be produced with fewer errors than tongue twisters with low Brown frequency. The total number of tongue twister productions with errors in the low-frequency condition (n = 10, 20.8%) was higher than the total number of tongue twister productions with errors in the high-frequency condition (n = 5, 10.4%), but this was not significant, $p > .26$.

Keywords: tongue twister, production error, language production, semantic, phoneme, LTP

The Effect of Lexical Frequency on Language Production Error Incidence

For more than a century, neuropsychologists have generally agreed that frequency of exposure to a stimulus contributes to long-term potentiation and easier retrieval from the associated semantic network (Ramón y Cajal, 1894; Hebb, 1949; Bliss & Lømo, 1973; Gamble & Koch, 1987). Since many cognitive activities, including language production, are guided by memory retrieval through top-down processing, common words must be easier to produce than less common words. This study examines whether tongue twisters composed of common words, denoted by high Brown frequency, cause fewer production errors than tongue twisters composed of less common words, denoted by low Brown frequency (Brown, 1984).

According to Griffin and Ferreira (2006), language production incorporates semantic and pragmatic properties. A speaker must first decide upon an intended meaning (conceptualization), then choose a word (lexical representation) that illustrates the meaning. Only then can the speaker assemble sounds through morpheme and phoneme selection and articulate those sounds. When reading a phrase out loud, a speaker must further retrieve the semantic properties of the phrase through bottom-up processing as well as engage in the top-down processing of the language production chain (Griffin & Ferreira, 2006).

These two processes happen almost simultaneously, and, as a result of their complexity, language errors occur along nearly every step of the language production chain. Semantic errors, i.e. incorrectly saying a word that is similar in meaning or context, result from activation of similar nodes in the semantic network. Phoneme and word errors result from their role as building blocks in a lexical framework—sometimes the brain misplaces phonemes or words as the intended meaning or the framework change (Dell, 1995). Lastly, preservation and

anticipation errors result from trying to conceptualize space and time (Dell, Burger & Svec, 1997).

In order to understand how language production errors occur in everyday speech, Acheson and MacDonald (2009) successfully used tongue twisters to simulate production errors within the mechanisms of working memory. They found that syllable position and phoneme context play an important role in production when subjects are required to remember the tongue twisters (Acheson & MacDonald, 2009).

The tongue twister experimental framework can also be used to study how increased long-term potentiation of common words affects language production errors. In the present study, the researcher examined the effects of long-term potentiation on production errors by manipulating the Brown frequency of words in three pairs of tongue twisters and counting the number of tongue twister productions that contained errors for high- and low-frequency conditions (Brown, 1984).

The researcher has suggested that there is a strong correlation between Brown frequency and error rate, so tongue twisters with high Brown frequency will be produced with fewer errors than tongue twisters with low Brown frequency.

Method

Participant(s)

The participant was a 21-year-old male psychology student at the University of Texas at Austin. The participant was fluent in English and capable of seeing and reading the words presented during the study. The participant consented to participation, but this study was exempt from review by the Institutional Review Board of the University of Texas at Austin. In return for his time, the participant was compensated with class credit in PSY 341K: Language Processing.

Design

The present study used a one-way within subjects design. The independent variable was the Brown frequency (Brown, 1984) of words in a tongue twister. The dependent variable was error rate in participant speaking.

Materials

Three tongue twister pairs were constructed using 24 words from the MRC Psycholinguistic Database (Wilson, 1988). Each pair consisted of one tongue twister with four high-frequency words—Brown frequency above 130—and one tongue twister with four low-frequency words—Brown frequency below 35 (Brown, 1984). In order to control for potential confounds, the tongue twisters in each pair were symmetrical along the following characteristics: syntactical construction, tense, starting letter, number of syllables, and imagability within half a standard deviation (Pavio, Yuille, & Madigan, 1968).

Tongue twisters were displayed to the participant in 48 pt. Arial font, boldface black ink on a white background, in Microsoft PowerPoint on a Windows 7 laptop PC with a 15.6-in. screen. The participant was recorded using Audacity version #1.2.6, and a Sennheiser gaming headset.

Procedure

The participant was seated with the computer screen at eye level approximately 2.5 ft. away. The participant was shown the first PowerPoint slide, which contained a written series of instructions (See **Appendix 1**). The researcher also presented the instructions verbally.

The PowerPoint presentation was pre-loaded with each of the six tongue twisters in four different randomized orders for a total of 24 slides with four occurrences per tongue twister. To control the rate of speaking, the words on each slide changed color at a rate of six words per

second (approx. three times normal speaking rate). The participant read through the tongue twister on each slide four times with the option to pause between every two repetitions. After reading through all 24 slides, the participant had made 96 verbal productions.

The researcher noted each verbal error during the experiment and tagged the recorded audio after the experiment.

Results

The total number of tongue twister productions with errors in the low-frequency condition (n = 10, 20.8%) was higher than the total number of tongue twister productions with errors in the high-frequency condition (n = 5, 10.4%). Errors included misplacements or repetition of phonemes and morphemes but not disfluencies such as pauses. A two-tailed Fisher's exact test on the frequency of erroneous and correct tongue twister productions showed that this difference was not significant, $p > .26$.

Discussion

The results indicate that there is no significant difference in number of production errors between low-and high-frequency tongue twisters. This rejects the hypothesis. Due to the limited sample set, however, the results may not be conclusive. That said, the study contributes to the current body of language production research by confirming results from previous studies.

The study supports the validity of the tongue twister experimental framework used by Acheson & MacDonald (2009), who successfully used tongue twisters to simulate production errors within the mechanisms of working memory (Acheson & MacDonald, 2009).

However, the framework has two limitations: (a) rehearsal between trials may cause temporal decreases in number of production errors and (b) inability to control rate of language production may cause significant rate differences between types of tongue twisters. For example,

although the study attempted to control the reading rate of all tongue twisters, the researcher noted that the participant read the low-frequency tongue twisters more slowly, perhaps due to slower processing time. Thus, the very effects of long-term potentiation on the language production process may have manifested in a way that reduced its measurable effect within the context of the experiment.

The study also confirms research by Dell (1995) and Dell, Burger, and Svec (1997), which identified semantic, phonemic, and word errors and preservation and anticipation errors, respectively. The participant's production errors included phonemic errors, such as stumbling on parts of words, and preservation and anticipation errors, such as repeating words from earlier in the tongue twister or producing upcoming words too soon.

Lastly, the study appears to confirm the complexity of the language production process because of the reduced production time in the low-frequency condition. According to Griffin & Ferreira (2006), language production follows a process of conceptualization, lexical representation, and sound production. When reading a phrase out loud, a speaker must further retrieve the semantic properties of the phrase through bottom-up processing as well as engage in the top-down processing of the language production chain (Griffin & Ferreira, 2006). Since the initial conceptualization step was harder in the low-frequency condition, the participant needed more time to produce those tongue twisters.

Ultimately, this supports the theory of long-term potentiation, which suggests that frequency of exposure to a stimulus will strengthen nerve impulses through the biophysical process of calcification and make it easier to retrieve that semantic information in the future (Ramón y Cajal, 1894; Hebb, 1949; Bliss & Lømo, 1973; Gamble & Koch, 1987).

Further research with more participants is needed to confirm whether the effects of long-term potentiation manifested in slower read time in the low-frequency condition. Perhaps slowing down the suggested read time for both low- and high-frequency conditions would allow the slower processing time in the low-frequency condition to translate to a significantly higher number of production errors. However, an experimental study can only control participant behavior to a certain extent, so this bias might never be removed.

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Appendix 1. Participant instructions

1. You will be shown a series of tongue twisters.
2. You will be recorded throughout this entire process.
3. You must read each tongue twister at a rate of six words per second. PowerPoint will underline each word in succession at this rate, so you will need to say each word at the rate it is underlined.
4. After you read through each tongue twister once, try to repeat it three more times at the same rate. You may pause between every two repetitions, e.g. you can say the tongue twister twice, pause, and then say it two more times.
5. You will be shown six tongue twisters repeated four times (for a total of 24 slides). You will need to say each of them four times for a total of 96 times.
6. Once the experiment starts, you will not get any breaks except for the brief pauses between every two repetitions.
7. However, if at any point during the experiment, you feel uncomfortable, you may state this, and the experiment will end immediately.
8. If you have any questions, please ask them now.

Appendix 2. Stimuli

High Frequency (BF > 130)

Twos time through thought.

May means much more.

Ways will well want.

Low Frequency (BF < 35)

Toll tasks thwart ting.

Malls move main mien.

Woe wears wild wish.

Figure 1. Total number of tongue twister productions with errors per condition