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Repeated speech errors: Evidence for learning

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ABSTRACT

Three experiments elicited phonological speech errors using the SLIP procedure to investigate whether there is a tendency for speech errors on specific words to reoccur, and whether this effect can be attributed to implicit learning of an incorrect mapping from lemma to phonology for that word. In Experiment 1, when speakers made a phonological speech error in the study phase of the experiment (e.g. saying "beg pet" in place of "peg bet") they were over four times as likely to make an error on that same item several minutes later at test. A pseudo-error condition demonstrated that the effect is not simply due to a propensity for speakers to repeat phonological forms, regardless of whether or not they have been made in error. That is, saying "beg pet" correctly at study did not induce speakers to say "beg pet" in error instead of "peg bet" at test. Instead, the effect appeared to be due to learning of the error pathway. Experiment 2 replicated this finding, but also showed that after 48 h, errors made at study were no longer more likely to reoccur. As well as providing constraints on the longevity of the effect, this provides strong evidence that the error reoccurrences observed are not due to item-specific difficulty that leads individual speakers to make habitual mistakes on certain items. Experiment 3 showed that the diminishment of the effect 48 h later is not due to specific extra practice at the task. We discuss how these results fit in with a larger view of language as a dynamic system that is constantly adapting in response to experience.

1. Introduction

Several lines of converging evidence suggest that the adult language processing system is not a static system, but instead is dynamic, and shares many mechanisms with language acquisition. That is, every act of language use is also an act of language learning, (e.g. Bock & Griffin, 2000; Dell, Reed, Adams, & Meyer, 2000; Elman et al., 1996; Goldinger, 1998). This could have the effect of ensuring that the language system is optimally tuned to process recent input. However, one potential result of this systemic plasticity is that making an error during language production might predispose a speaker to make that same error again; that is, the error itself may be learned. In this paper, we test whether making a phonological speech error once (e.g. producing "flute fries" when trying to say "fruit flies") makes a speaker more likely to make that same error again.

This error-learning effect has been shown in the propensity for speakers who get into a tip-of-the-tongue state on a particular word once, to then get into a tip-of-the-tongue (TOT) state on that same word again at a later time, despite having been told the correct answer on the first occasion (Warriner & Humphreys, 2008). The reoccurrence of errors in and of itself, however, is difficult to interpret. If a particular error reoccurs, the critical question is whether the error is actually learned on the first occasion, hence the reoccurrence, or whether that item is simply particularly difficult for an individual, and thus an error is likely both times. Warriner and Humphreys (2008) demonstrated that the effect is likely due to error learning rather than item-specific difficulty. They did this by eliciting TOT states by giving definitions of words, and asking speakers to respond

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as to whether they knew a word, did not know it, or were in a TOT state. When speakers indicated that they were in a TOT state, they were then randomly assigned either 10 or 30 s to keep thinking about the word and trying to retrieve it, before being told the correct answer. In this way, instead of manipulating *whether* an error occurred or not, Warriner and Humphreys (2008) manipulated how *long* one remained in the error state. When speakers returned 2 days later, they were tested on the same set of words they had seen on Day 1. The critical measure was the conditional probability of getting into a TOT state on a particular word on the second day, given a TOT on that same word the first day. Those results showed that first of all, errors do tend to reoccur (people were much more likely to TOT on a word that they had TOT'd on before, despite being told the correct answer). Second, and more importantly, the longer they had been made to stay in a TOT state on a particular word on the first day, the more likely the error was to reoccur 48 h later. Their conclusion was that these kinds of errors tend to reoccur because making an error once effectively reinforces that erroneous state, in this case an incomplete or incorrect mapping from the abstract word form (or lemma) to the phonological form of the word. In Warriner and Humphreys (2008), and in the present work, we assume a two-stage, spreading activation model of spoken word production, in which activation proceeds from a non-verbal concept to an abstract word (or lemma), and then to a phonological form for the word (e.g. Dell, 1986; Dell & Reich, 1981; Levelt, Roelofs, & Meyer, 1999). In these models, the learning of the mapping between lemma and phonological form is accomplished by adjusting connection weights between representations at each level, in response to experience (e.g. Dell, Juliano, & Govindjee, 1993; Plaut, McClelland, Seidenberg, & Patterson, 1996; Seidenberg & McClelland, 1989). In the TOT reoccurrence effect seen in Warriner and Humphreys (2008), there is evidence that it is the mapping between lemma and phonological form that is selectively disrupted, rather than the mapping between concept and lemma, as the parameters for likelihood of: (1) accessing a lemma and (2) accessing a phonological form, can be calculated from the distribution of "Know" "Don't Know" and "TOT" responses (for example, the probability of a TOT is the joint probability of accessing a lemma successfully, and failing to access phonology). Warriner and Humphreys (2008) showed that when the lemma and phonology parameters are calculated, a 30 s TOT delay on Day 1 (the condition where errors were most likely to reoccur), lead to a lower likelihood of accessing the phonology on Day 2, but if anything, improved the likelihood of accessing the lemma on Day 2, as compared to Day 2 performance following a Day 1 10 s delay.

This general finding of error learning fits more generally with a view that adult language processing is a dynamic system that is continually modified as a result of experience. Mostly, this idea can be seen in the literature as the fact that practice improves performance. Saying a word or phrase helps one to say it faster (Scarborough, Cortese, & Scarborough, 1977), and more accurately (Dell, Burger, & Svec, 1997; Jacoby & Dallas, 1981) the next time. Similar effects are observed in the visual or auditory perception of words (e.g. Roediger & Blaxton, 1987). Frequency effects are omnipresent throughout language processing, as well as cognition more generally. Frequent words are faster to say and recognize and they also tend to be less errorful (Dell, 1990; Forster & Chambers, 1973; Howes & Solomon, 1951; Whaley, 1978).

In addition to these straightforward and well-known practice effects, recent work has shown how the adult language processing system can be tuned in markedly more complex ways via experience. For example, in language production, repeated exposure to a practice set can create new phonotactic constraints that speakers observe in subsequent speech errors (Dell et al., 2000; Goldrick, 2004; Taylor & Houghton, 2005; Warker & Dell, 2006; Warker, Dell, Whalen, & Gereg, 2008; Warker, Xu, Dell, & Fisher, 2009). A similar effect of learning new phonotactic constraints is also observed in speech perception (Onishi, Chambers, & Fisher, 2002). These are typically interpreted as implicit learning effects.

At a grammatical level, structural priming effects show that speakers tend to repeat syntactic structures, and that comprehending or producing a syntactic structure once facilitates its processing in subsequent presentations. Several studies have demonstrated this effect showing that when speakers are primed to use a particular word order they will use this same order in ensuing sentences irrespective of specific word properties (e.g. Bock, 1986, 1989; Bock & Irwin, 1980; Bock & Loebell, 1990; Branigan, Pickering, Liversedge, & Stewart, 1995). In addition, structural priming makes subsequent formulation of those syntactic structures faster (Smith & Wheeldon, 2001) and more fluent (Bock & Loebell, 1990). These effects can be attributed to implicit learning, in which the grammatical encoding system is slightly altered every time it is used (Bock & Griffin, 2000; Chang, Dell, Bock, & Griffin, 2000; Ferreira, Bock, Wilson, & Cohen, 2008; although see Ferreira & Bock, 2006, for a discussion of other mechanisms that also contribute to structural priming).

Generally, these effects add up to the idea that every act of speaking is also an act of learning. However, most of these practice effects have shown how people learn to become more skilled, or fluent at specific acts of language production. However, it is somewhat less clear whether these effects also apply to incorrect performance. That is, correct practice reinforces later correct performance, but to what extent does making an error reinforce that particular error? Does this kind of tuning discriminate between incidents of correct performance and incorrect performance? It is also important to note here that the kinds of speech errors we refer to are ones in which a speaker's intention does not match the output. We can compare this to cases in which a word is produced in a way that may be non-standard, but does not constitute an error from the speaker's point of view (e.g. "nukular" for "nuclear"). The idea that we should learn from our correct performance, but not from our errors has a long history in psychology. Thorndike (1913) stated his law of effect as follows:

> When a modifiable connection between a situation and a response is made and is accompanied or followed by a satisfying state of affairs, that connection's strength is increased. When made and accompanied or followed