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Research report

The timing of spontaneous detection and repair of naming errors in aphasia

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ABSTRACT

This study examined the timing of spontaneous self-monitoring in the naming responses of people with aphasia. Twelve people with aphasia completed a 615-item naming test twice, in separate sessions. Naming attempts were scored for accuracy and error type, and verbalizations indicating detection were coded as negation (e.g., "no, not that") or repair attempts (i.e., a changed naming attempt). Focusing on phonological and semantic errors, we measured the timing of the errors and of the utterances that provided evidence of detection. The effects of error type and detection response type on error-to-detection latencies were analyzed using mixed-effects regression modeling. We first asked whether phonological errors and semantic errors differed in the timing of the detection process or repair planning. Results suggested that the two error types primarily differed with respect to repair planning. Specifically, repair attempts for phonological errors were initiated more quickly than repair attempts for semantic errors. We next asked whether this difference between the error types could be attributed to the tendency for phonological errors to have a high degree of phonological similarity with the subsequent repair attempts, thereby speeding the programming of the repairs. Results showed that greater phonological similarity between the error and the repair was associated with faster repair times for both error types, providing evidence of error-to-repair priming in spontaneous self-monitoring. When controlling for phonological overlap, significant effects of error type and repair accuracy on repair times were also found. These effects indicated that correct repairs of phonological errors were initiated particularly quickly, whereas repairs of semantic errors were initiated relatively slowly, regardless of their accuracy. We discuss the implications of these findings for theoretical accounts of self-monitoring and the role of speech error repair in learning.

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1. Introduction

Monitoring one's own speech is critical for successful communication. Theories of speech monitoring postulate multiple processes in language production and comprehension systems that may be involved in this important behavior. One method of testing these proposed monitoring processes is to examine differences in the rate and/or timing of different monitoring behaviors. In the present study, we analyzed the timing of self-monitoring in the naming performance of individuals with aphasia to elucidate detection and repair processes that are associated with semantic and phonological naming errors.

1.1. *Temporal characteristics of speech monitoring models*

Theories of speech monitoring differ with regard to the proposed stages of speech production at which errors are detected, resulting in different predictions regarding the timing of monitoring processes. Speech production involves a sequence of complex cognitive and motoric computations beginning with conceptualization of a preverbal message, followed by the formulation of an internal representation of speech that is then articulated and finally perceived as audible speech (see Levelt, 1989; Postma, 2000). According to Levelt's (1983, 1989) influential theory of speech monitoring, the auditory feedback from one's own speech is parsed and monitored using the same comprehension system employed to understand others' speech. The self-monitoring of audible speech is supported by evidence that rates of error detection and repair decrease when auditory feedback is masked with white noise (Lackner & Tuller, 1979; Oomen, Postma, & Kolk, 2001; Postma & Kolk, 1992). However, auditory comprehension of one's own speech is a relatively slow process that does not explain the detection of errors prior to articulation (Motley, Camden, & Baars, 1982; Postma & Noordanus, 1996; Trewartha & Phillips, 2013) or rapid error detection in overt speech, such as the interruption of the incorrect word "yellow" observed in the utterance "to the ye …, to the orange node" (Levelt, 1983). To account for instances of fast error detection, the comprehension-based theory also postulates monitoring of inner speech by the comprehension system, which occurs after phonological or phonetic encoding of speech but prior to articulation (Levelt, 1983, 1989; Wheeldon & Levelt, 1995). In this framework, monitoring can occur prior to the formulation of inner speech only when detecting inappropriateness (e.g., ambiguity or incoherence) arising in the preverbal conceptualization stage (Levelt, 1983, 1989).

Other theories of monitoring propose that errors can be detected relatively early in speech production by relying on processes that occur during the formulation of speech. Production-based accounts postulate that error detection can utilize information generated by the production system directly, without involvement of comprehension systems. Proposed mechanisms include: specialized monitors capable of detecting erroneous output at multiple levels of speech production (De Smedt & Kempen, 1987; Laver, 1980; van Wijk & Kempen, 1987); an attention-summoning error signal that arises from unusual co-activation patterns among nodes in a connectionist network when units are erroneously selected (MacKay, 1987); and a domain-general monitoring system that is sensitive to conflict arising from competing representations at multiple levels of speech formulation (Nozari, Dell, & Schwartz, 2011). In addition, Pickering and Garrod (2013, 2014) propose a prediction-based account of monitoring that features internal models like those in motor control theory. This account assumes that the speaker constructs internal models of the intended utterance at multiple levels of production, each model specifying a production operation along with its predicted consequences. Such predictions are compared against the utterance prior to or after articulation, and the error signal resulting from this comparison forms the basis for speech monitoring.

Theories of monitoring also make different predictions with regard to how the timing of detection may differ for specific types of speech errors. During speech production, semantic errors arising from the selection of incorrect lexical items originate at an earlier stage than phonological errors arising from the selection of incorrect speech sounds. Hence, in Pickering and Garrod's (2014) prediction-based model and in production-based models that propose that errors can be detected as soon as they arise, semantic errors should be detectable earlier than phonological errors. Levelt's (1983, 1989) comprehension-based theory does not specify the timing of detection for semantic errors as compared to phonological errors, but other researchers have made suggestions within this framework. Hartsuiker, Kolk, et al. (2005) and Hartsuiker, Pickering, et al. (2005) argue that post-articulatory monitoring, which uses the acoustical information in overt speech, is particularly important for detecting phonological errors. This would seem to predict relatively slow detection of phonological errors compared to other errors that are more likely to be monitored prior to articulation. In contrast, Pickering and Garrod (2014) suggest that comprehension-based monitoring predicts *earlier* detection of phonological errors compared to semantic errors because the input to the monitor must be a phonological or phonetic representation of inner or overt speech. Consistent with a phonological basis for the comprehension-based monitor, a series of experiments showed that speakers' ability to halt their own word production as they monitored other auditory or visual words was sensitive to phonological similarity but not semantic similarity with the intended word (Slevc & Ferreira, 2006). Although few studies have tested differences in the timing of monitoring for specific types of errors, there is some evidence that phonological errors are detected more quickly than semantic- or syntactic-based lexical errors in one's own spontaneous speech (Nooteboom, 2005) and when monitoring others' speech (Oomen & Postma, 2002). Distinguishing between different types of speech errors may be particularly important when examining the monitoring abilities of people with aphasia, which is discussed in the following section.

1.2. *Self-monitoring in aphasia*

Research involving participants with aphasia provides important evidence regarding the relationships between

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