

Production variability and single word intelligibility in aphasia and apraxia of speech

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Abstract

This study was designed to estimate test–retest reliability of orthographic speech intelligibility testing in speakers with aphasia and AOS and to examine its relationship to the consistency of speaker and listener responses. Monosyllabic single word speech samples were recorded from 13 speakers with coexisting aphasia and AOS. These words were transcribed phonetically by two trained listeners and also presented to non-brain-damaged listeners for identification in a computerized speech intelligibility test. Overall intelligibility scores were computed for each speaker, and word-by-word responses for individual words were examined for both speaker and listener consistency. The clinical feasibility of the approach was supported by a strong correlation between scores from the phonetic transcription and speech intelligibility tests and by strong test–retest reliability for all speakers. Detailed analyses of individual responses indicated that the intelligibility test stability was not due to consistency either in the kind of errors speakers made or in the responses listeners gave when they heard a word different from the target.

Learning outcomes: The reader will be able to describe the purpose of single word speech intelligibility testing in individuals with aphasia and apraxia of speech and to discuss the relationship between word-by-word production consistency and overall test–retest reliability.

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1. Introduction

Impaired speech production is a common and persistent symptom following focal damage to the left cerebral hemisphere. Mechanisms underlying these difficulties include disruption of sensorimotor and language networks in perisylvian cortical and subcortical areas. The behavioral manifestations are multifaceted, including varying degrees and patterns of speech sound distortions and substitutions, reduced speaking rate, and altered fluency. Contemporary assessment practices focus on impressionistic ratings of severity impairment and integration of qualitative observations concerning speech articulation, fluency, and prosody to differentially diagnose among aphasia, apraxia of speech (AOS), and dysarthria. This lack of quantification and objective documentation presents serious limitations to

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the study and clinical management of speech production difficulties following left-hemisphere damage (Haley & Wisneski, 2002; Wambaugh, 2006).

In this paper, we focus on the quantification of one factor that has direct application to documenting production severity and indirect application to the process of differential diagnosis. In previous work, we have suggested that speech intelligibility, when quantified via a single word identification procedure, may be a sensitive and valid measure of articulatory involvement in individuals with aphasia and AOS (Haley, Wertz, & Ohde, 1998). As such, it can help researchers accomplish severity matching across diagnostic groups, provide an index of change over time for both clinical and research applications, and may ultimately help ensure proper selection of evidence-based treatment procedures and prognostic indications in clinical applications. When supplemented by other quantitative measures relevant to the clinical management of speech production difficulties in aphasia, AOS, and dysarthria, the approach can increase transparency and objectivity of both differential diagnosis and severity estimation (Haley, Jacks, de Riesthal, Abou-Khalil, & Roth, 2010; Haley et al., 1998). To accomplish these clinical objectives, we have elected to study AOS in its typical manifestation where it almost always is accompanied by aphasia.

1.1. Single word intelligibility testing in aphasia and AOS

Experimental single word intelligibility testing in individuals with aphasia and AOS has strong face validity, with several apparent advantages compared to other perceptual severity estimates, such as subjective rating or error frequency derived from broad or narrow phonetic transcription. For example, because the task requires reliance on normal speech perception abilities rather than the acquisition of new observation skills, there should be only limited need for listener training or familiarization; assuming the target words are properly disguised, bias introduced by listener expectations is effectively minimized due to the lack of syntactic, semantic, or morphologic context; and potentially confounding effects from categorical perception can be limited through the integration of results across multiple stimulus presentations across listeners. Moreover, by focusing the speech sample on single words elicited through a repetition task, it is possible to limit lexical access problems and grammatical difficulties that would otherwise influence the speech output. Finally, the expression of intelligibility as a percentage of words understood allows for a potentially wide range of levels to be captured.

The use of monosyllabic rather than multisyllabic words in speech intelligibility testing is motivated by two factors. First, most aphasic and apraxic speakers can approximate monosyllabic words in a repetition task and the task can be applied confidently to a large number of speakers; in contrast, many aphasic and apraxic speakers fail to produce multisyllabic words and/or exert extensive energy as they attempt to do so. Second, monosyllabic words are highly confusable with each other so that even relatively small consonant and vowel changes are likely to cause listeners to hear another word than the intended, especially when the target is unknown; multisyllabic words on the other hand are much more predictable and less likely to cause listeners to suggest that a different word was produced. Previous work has indicated that monosyllabic single word intelligibility is sensitive to a large range of production variation in aphasia and AOS and that it can be quantified with satisfactory speaker and listener reliability (Haley & Diakaki, 2002; Haley et al., 1998). However, the empirical support for test–retest reliability from this work was based primarily on the results of multiple-choice identification testing, with limited exploration of the stability for an open set orthographic response format.

1.2. Production variability in AOS

The main potential threat to test–retest reliability in individuals with AOS is the very real likelihood that words are produced differently in repeated samples even when these samples are recorded on the same day and there is no change in the underlying condition. According to traditional behavioral definitions, AOS is characterized by highly variable speech production and error patterns (Johns & Darley, 1970; Wertz, LaPointe, & Rosenbek, 1984). This traditional view is supported by numerous perceptual and acoustic investigations that have reported greater than normal variability for both spatial and temporal aspects of speech production in speakers with AOS (see McNeil, Robin, & Schmidt, 2009 for a review). If production variability is a prominent, and possibly defining characteristic of AOS, then it is critical to determine whether reliable overall intelligibility test scores can be obtained despite this variability and to understand the conditions necessary for establishing such reliability.

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