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Effect of gap detection threshold on consistency of speech in children with speech sound disorder

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ABSTRACT

Background and aims: The present study examined the relationship between gap detection threshold and speech error consistency in children with speech sound disorder.

Methods and procedures: The participants were children five to six years of age who were categorized into three groups of typical speech, consistent speech disorder (CSD) and inconsistent speech disorder (ISD). The phonetic gap detection threshold test was used for this study, which is a valid test comprised six syllables with inter-stimulus intervals between 20–300 ms. The participants were asked to listen to the recorded stimuli three times and indicate whether they heard one or two sounds.

Outcomes and results: There was no significant difference between the typical and CSD groups ($p=0.55$), but there were significant differences in performance between the ISD and CSD groups and the ISD and typical groups ($p=0.00$). The ISD group discriminated between speech sounds at a higher threshold.

Conclusions and implications: Children with inconsistent speech errors could not distinguish speech sounds during time-limited phonetic discrimination. It is suggested that inconsistency in speech is a representation of inconsistency in auditory perception, which causes by high gap detection threshold.

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What this paper adds?

The effect of auditory processing on speech sound disorder has been studied extensively, but the nature of the relationship between auditory processing and speech errors has been remained unclear. Most studies examine children with speech sound disorder as one heterogeneous group. The present study divided the subjects into subtypes of speech sound disorder to examine the effect of gap detection threshold on the consistency of speech errors. The results suggest a significant relationship between gap detection threshold and consistency in speech. One underlying deficit of the inconsistency in speech of children with speech sound disorder is the high gap detection threshold. Children with inconsistent speech errors required more time to precisely distinguish the boundaries between speech sounds.

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1. Introduction

Speech sound disorder (SSD) is a common developmental disorder that prevents a child from producing accurate speech. [Guenther \(1995\)](#) suggests that the achievement of accurate speech is related to development of adequate perceptual knowledge of speech sounds through mapping of the perception of acoustic patterns of speech sounds and productive gestures of speech. The acoustic patterns of perceived speech sounds allow a child to discover articulatory patterns in a phonetic context and increases perceptual knowledge of speech sounds as a reference for accurate speech.

The effect of deficits of auditory perception on accurate speech performance and the relationship between auditory processing and speech disorder has been studied extensively, but the results are inconclusive. [Schissel \(1980\)](#) and [Supple \(1983\)](#) suggested that there is no significant relationship between auditory discrimination and speech errors of children with SSD. [McReynolds, Kohn, and Williams \(1975\)](#) reported that children with SSD were able to discriminate sounds they did not produce. In contrast, a number of studies have shown that children with SSD have difficulty discriminating the speech sounds they themselves produce with errors ([Kronvall & Diehl, 1954](#); [Monnin & Huntington, 1974](#); [Hoffman, Raymond, Bengoa, & Schuckers, 1985](#); [Rvachew & Jamieson, 1989](#); [Shuster, 1998](#); [Edwards, Fox, & Rogers, 2002](#); [Rvachew, Chiang, & Evans, 2007](#)).

[Jamieson and Rvachew \(1992\)](#) examined the effect of auditory training on accurate production of speech errors of a small group of children who made a production error for /j/. Only one of the participants failed to show improvement; the rest achieved correct production with auditory training. Similar results were subsequently reported for the effect of auditory phonetic training on speech errors of children with SSD ([Rvachew, 1994](#); [Rvachew, Rafaat, & Martin, 1999](#); [Rvachew, Nowak, & Cloutier, 2004](#)).

One explanation for the contradiction in the results of previous studies was offered by [Edwards et al. \(2002\)](#), who indicated that although there is a relationship between auditory perception and articulatory abilities of children with SSD, the relationship is complex and is not solely dependent on speech errors. To develop a more clear understanding of the relationship between speech errors and auditory perception, this general relationship must be deconstructed into the constituent parts of auditory processing.

[Muniz, Roazzi, Schochat, Teixeira, and de Lucena \(2007\)](#) examined the relationship between auditory processing and SSD by comparing the gap detection thresholds of children with and without SSD. The gap detection threshold identifies temporal boundaries between sounds and is the most reliable parameter of auditory temporal processing in the speech of children ([Anderson & Linden, 2016](#)). [Muniz et al. \(2007\)](#) reported that participants with SSD exhibited higher thresholds for detection of temporal gaps between pure tones compared to children without SSD. Similar results have been reported in subsequent studies ([Liu & Whitesell, 2008](#); [Muluk, Yaçlinkaya, & Keith, 2011](#); [Vilela et al., 2012](#)); thus, difficulty in auditory discrimination by children with SSD may not be significantly related to specific speech errors ([Edwards et al., 2002](#)). It has been suggested by [Cabbage, Hogan, and Carrel \(2016\)](#) that the deficit could be of perception of the temporal structure of the speech sounds.

Studies have demonstrated a relationship between gap detection threshold and SSD, but one constraint of these studies is that the participants with SSD were examined as one heterogeneous group. Consistency in speech is known to influence speech errors in children with SSD ([Forrest, Elbert, & Dinnsen, 2000](#)). According to Dodd's differential diagnosis model ([Dodd, 1995](#)), there are two subtypes for speech sound disorder in children based on consistency in speech errors; inconsistent speech disorder (ISD) and consistent speech disorder (CSD). Children with ISD produce words with variability in phonological planning resulting in unpredictable speech patterns including correct and incorrect forms of production. Speech errors in CSD resulting from impaired acquisition of phonological system's constraints represent with consistent patterns of speech errors. [Dodd \(2014\)](#) stated that the clinical picture of CSD and phonological delay is similar, and both of these subtypes of speech sound disorder define with consistent patterns in speech errors. The difference is in atypical speech errors that are occurred with CSD, but phonological delay is diagnosed with typical speech errors to younger children. [Thyer and Dodd \(1996\)](#) stated that in order to increase efficacy in results, participants with speech sound disorder should be categorized into groups of children with CSD and ISD.

The relationship between perceptual knowledge and speech error consistency has been previously reported ([Ohde & Sharf, 1988](#); [Raaymarkers & Cruil, 1988](#)), but the results of [Thyer and Dodd \(1996\)](#) differ from previous reports. They categorized children with SSD into ISD and CSD groups and compared them to typically-developing children on an auditory perception task. The participants were asked to listen to competing sentences contralaterally or ipsilaterally and show the perceived message by pointing to a picture of the intended meaning. The responses of both groups of children with SSD were not significantly different from those of typically-developing children. Thyer and Dodd suggested that auditory perception does not affect speech errors of children with SSD, even when considering the consistency of speech errors. The task used by [Thyer and Dodd \(1996\)](#) to evaluate central auditory processing in children with CSD and ISD examined the ability to perceive semantically and under the influence of phonetic context. The study did not compare fine discrimination of speech sounds in children in subtypes of SSD to that of typically-developing peers.

[Dodd \(1995\)](#) stated that children with ISD have no difficulty with phonetic perception of speech sounds and that the underlying deficit of speech errors is lexical inconsistency and in planning the phonetic segments into a correct and consistent word. This contradicts the relationship between speech errors in children with ISD and the perceived phonetic features as reported by [Preston and Koenig \(2011\)](#). They found that phonetic characteristics of speech sounds affect the performance of children with inconsistent speech errors. [Muluk et al. \(2011\)](#) also reported that some participants with SSD showed

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