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# Volubility, consonant, and syllable characteristics in infants and toddlers later diagnosed with childhood apraxia of speech: A pilot study

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ABSTRACT

*Purpose:* This pilot study explored the volubility, consonant singleton acquisition, and syllable structure development between infants and toddlers (birth–24 months) with typical speech sound production (TYP) and those later diagnosed with childhood apraxia of speech (CAS).

*Method:* A retrospective longitudinal between- and within-subjects research design was utilized (TYP $N = 2$; CAS $N = 4$). Vocalizations from participants were analyzed between birth–24 months from home videotapes, volunteered by the children's parents, according to type (nonresonant vs. resonant), volubility, place and manner of consonant singletons, and syllable shape (V, CV, VC, CVC, VCV, CVCV, VCVC, and "Other").

*Results:* Volubility between groups was not significant but statistically significant differences were found in the number of: resonant and non-resonant productions; different consonant singletons; different place features; different manner classes; and proportional use of fricative, glottal, and voiceless phones. Infants and toddlers in the CAS group also demonstrated difficulty with CVCs, had limited syllable shapes, and possible regression of vowel syllable structure.

*Conclusions:* Data corroborate parent reports that infants and toddlers later diagnosed with CAS present differently than do those with typical speech sound skills. Additional study with infants and toddlers later diagnosed with non-CAS speech sound disorder is needed.

**Learning outcomes:** Readers will: (1) describe current perspectives on volubility of infants and toddlers later diagnosed with CAS; (2) describe current perspectives of the consonant singleton and syllable shape inventories of infants and toddlers later diagnosed with CAS; and (3) discuss the potential differences between the speech sound development of infants and toddlers later diagnosed with CAS and those with typical speech sound skill.



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## 1. Introduction

In the study of childhood communication disorders, small-scale investigations of infant and toddler vocalizations have played an important role in the development of effective early assessment and intervention practices. These preliminary studies, typically limited to examining consonant and syllable profiles within specific populations or subgroups, have aided our understanding of children with typical speech sound development, at high risk for speech-language disorder (Oller, Eilers, Neal, & Schwartz, 1999), Down's syndrome (Smith & Oller, 1981), and hearing impairment (Ertmer et al., 2002; Ertmer & Mellon, 2001; Ertmer, Kloiber, Jung, Kirleis, & Bradford, 2012). Although initially descriptive in nature, small-scale single subgroup studies provide important direction for larger comparative studies within heterogeneous populations (Receveur et al., 2005).

A proposed subgroup of particular interest to speech-language pathologists (SLPs) is childhood apraxia of speech (CAS), a disorder in which sensory and speech praxis motor deficits result in inconsistent errors on consonants and vowels, difficulty with segmental and syllable transitions, and/or inappropriate lexical or phrasal prosody (American Speech-Language-Hearing Association ASHA, 2007). Studies of CAS have concentrated on children older than 3 years and are rarely longitudinal, though one notable exception is a longitudinal study reported in three related articles (exploring consonant and syllable structure patterns, vowel production, and phonetic variability) of three children with CAS between the ages of 4.6 and 7.7 years (Davis, Jacks, & Marquardt, 2005; Jacks, Marquardt, & Davis, 2006; Marquardt, Jacks, & Davis, 2004).

While studies of older children with CAS are important, a growing body of evidence points to genetic underpinnings of the disorder, suggesting the impairment should be manifested prelinguistically in early vocal development (Fisher, Lai, & Monaco, 2003; Highman, Hennessey, Sherwood, & Leitão, 2008; Highman, Hennessey, Leitão, & Piek, 2013; Lewis, Freebairn, Hansen, Taylor, et al., 2004; Worthey et al., 2013). However, most of what is hypothesized about the early course of CAS has come from parents' anecdotal recall of their child's speech development (Highman et al., 2008, 2013; Le Normand, Vaivre-Douret, Payan, & Cohen, 2000; Teverovsky, Bickel, & Feldman, 2009), and although longitudinal studies of the early speech sound behaviors of children who later present with CAS would be helpful in further understanding the disorder, there are currently no such studies. To address this gap, this is the first in an anticipated series of longitudinal studies exploring the speech sound skills between birth and 24 months for a small opportunistic sample of infants who later presented with suspected childhood apraxia of speech (CAS).

### 1.1. Suspected early descriptors of childhood apraxia of speech (CAS)

As reported by Marquardt et al. (2004), children with CAS may demonstrate high levels of token and error token variability, low levels of word target stability, and variability across and within children. Though little is known about the speech sound development of infants and toddlers later diagnosed with CAS, they are reported by their parents and by investigators to be different from children with typical speech sound development across several parameters.

#### 1.1.1. Low volubility

Volubility, the amount of vocalization produced regardless of the type of vocalization, has not been studied in infants and toddlers later diagnosed with CAS. Parents of children with CAS have reported their children were "quiet" as infants (Aziz, Shohdi, Osman, & Habib, 2010; Velleman & Strand, 1994) and reduced overall vocal output has been speculated to be descriptive of children with CAS (Davis & Velleman, 2000). In a retrospective study of 192 parents of children with CAS, 71% of parents reported their child had minimal speech at the time of diagnosis, 52% had poor intelligibility, and 42% struggled to speak (Teverovsky et al., 2009). However, children were identified with the disorder based solely on parent report.

Aziz et al. (2010) explored the language, speech, and non-speech oral skills of 30 children (aged 4–6 years): 10 with multiple phonological disorders (MPD); 10 with suspected CAS (CAS); and 10 with typical speech-language development. A majority (80%) of the parents of the children with CAS stated their children babbled very little (or had little phonetic diversity) compared to 50% of the MPD group and 30% of the control group.

Highman et al. (2008) compared parental recall of early babbling and vocalizations among parents of children with suspected CAS (CAS) ($n = 20$), Specific Language Impairment (SLI) ($n = 20$), and typically developing (TD) speech-language skills ($n = 20$). Multiple measures of volubility were determined by asking parents if they heard their child "make many sounds," "make vowel noises," or produce different types of babbling. Overall volubility was significant between the CAS and TD groups ($p < .001$) but not the CAS and SLI groups ($p < .402$). For "make many sounds," there was statistical significance between the CAS and TD groups ($p < .001$) and marginal significance ($p < .053$) between the CAS and SLI groups.

Highman and colleagues (2013) found that low volubility in infancy and toddlerhood was not necessarily a diagnostic indicator of CAS. The authors compared parent reports of communication, gross motor, fine motor, problem-solving, and personal-social skills for eight infants with a family history of CAS ("at-risk") to eight infants with typical development. Infants were assessed at 9, 12, 15, 18, and 24 months, and although differences at 9 months on the Receptive-Expressive Emergent Language Test – Third Edition (Bzoch, League, & Brown, 2003) revealed less vocalization, babbling, and gesture use for at-risk infants, at 24 months only one demonstrated all features of CAS suggested by Davis and Velleman (2000).

#### 1.1.2. Emergence of consonant inventories

Davis and Velleman (2000) cite some of the most frequently reported phonetic and phonological indicators of CAS in infants and young children as systematic gaps in consonant or vowel repertoire and limited variety of consonants or