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Differences of Articulation Rate and Utterance Length in Fluent and Disfluent Utterances of Preschool Children Who Stutter

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Abstract

Purpose—The purpose of this study was to investigate characteristics of four types of utterances in preschool children who stutter: perceptually fluent, containing normal disfluencies (OD utterance), containing stuttering-like disfluencies (SLD utterance), and containing both normal and stuttering-like disfluencies (SLD+OD utterance). Articulation rate and length of utterance were measured to seek the differences. Because articulation rate may reflect temporal aspects of speech motor control, it was predicted that the articulation rate would be different between perceptually fluent utterances and utterances containing disfluencies. The length of utterance was also expected to show different patterns.

Method—Participants were 14 preschool children who stutter. Disfluencies were identified from their spontaneous speech samples, and articulation rate in syllables per second and utterance length in syllables were measured for the four types of utterances.

Results and discussion—There was no significant difference in articulation rate between each type of utterance. Significantly longer utterances were found only in SLD+OD utterances compared to fluent utterances, suggesting that utterance length may be related to efforts in executing motor as well as linguistic planning. The SLD utterance revealed a significant negative correlation in that longer utterances tended to be slower in articulation rates. Longer utterances may place more demand on speech motor control due to more linguistic and/or grammatical features, resulting in stuttering-like disfluencies and a decreased rate.

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Keywords

childhood stuttering; articulation rate; length of utterance; types of utterances; stuttering-like disfluencies; other disfluencies

1. Introduction

One of the suprasegmental features of speech that has been used to define speech fluency is speech rate. Speakers who stretch or prolong consonants or vowels, or who insert pauses into their speech may be perceived as less fluent than speakers who do not lengthen sounds or add hesitations. Slower or faster rates have been shown to affect intelligibility (Riding & Vincent, 1980) or the attitudes of the listener (Stewart & Ryan, 1982). Speech rate encompasses a number of processes, and has been defined as a function of the speed of movement of the articulators, as well as pausing and the duration of speech sounds (Starkweather, 1987). Speech rate is considered to be one measure of speech motor performance, as it reflects coordinating the respiratory, phonatory, and articulatory processes involved in speaking (Hall, Amir, & Yairi, 1999; Tasko, McClean, & Runyan, 2007; Tumanova, Zebrowski, Throneburg, & Kayikci, 2011).

In addition to being a marker of fluency, speech rate can also be indicative of a speech disorder or an immature speech motor system. Dysarthria and apraxia of speech are characterized by slow speech rates (Kent & Rosen, 2004; McNeil, Pratt, & Fossett, 2004), whereas a faster than average speech rate is one hallmark of cluttering (St. Louis, Raphael, Myers, & Bakker, 2003). Children learning to speak have slower speech rates than do adults, with faster speech developing as children mature (Logan, Byrd, Mazzochi, & Gilliam, 2011; Sadagopan & Smith, 2008; Walker, Archibald, Cherniak, & Fish, 1992). The process of developing more rapid speech rates does not necessarily follow a linear trajectory, but has been shown to fluctuate across speaking tasks (Walker & Archibald, 2006). The progression toward a mature speech rate is likely influenced by cognitive and linguistic factors and the growing maturity of the speech motor system (Moore, 2004; Smith & Goffman, 2004).

The speech rate of normally fluent adults ranges from approximately 162 to 230 syllables per minute (Andrews & Ingham, 1971) or roughly 5 syllables per second (Manning, 2010), and there is much individual variability (Miller, Grosjean, & Lomanto, 1984). Factors that affect rate variability are not only inherent to the articulatory movements of the individual speaker, but are also influenced by linguistic processes. Utterance length and complexity could be related to speech rate, with longer utterances produced at faster rates (Malecot, Johnston, & Kizziar, 1972), and more complex utterances shaped at slower rates (Abbeduto, 1985; Sadagopan & Smith, 2008).

1.1. Stuttering and speech rate

Speech rate is an important paralinguistic behavior related to stuttering, both clinically and theoretically. As a part of treatment, adults and children who stutter are often asked to slow their rate of speech to produce fluent speech (Conture & Melnick, 1999; Guitar, 2006). A slower rate may be a strategy to gain control of speech movements.Tasko et al. (2007) found that adults completing an intensive fluency treatment program slowed their speech rate as they became more fluent, even though slowed rate was not a target of the therapy. Conversely, faster speech rates may work to destabilize speech motor control. In the motor skill theory of stuttering, Van Lieshout, Hulstijn, and Peters (2004) suggest that at faster speech rates the person who stutters loses flexibility, and may be limited in the kinds of articulatory strategies needed to maintain fluency.

Many studies have been conducted to determine the characteristics and influences of speech rate in children who stutter (See Sawyer, Chon, and Ambrose, 2008, for a review). Results have been mixed, partly due to differences in what was measured and how the measurements were made. Generally, speech rate has two components: (a) the rate at which speech is produced, and (b) the duration of pauses between words (Adams & Ramig, 1980; Miller et al., 1984). In studies of people who stutter, speech rate has been separated to overall speaking rate and articulation rate in response to manipulating disfluencies and pauses (Hall et al., 1999; Ingham & Riley, 1998; Kelly & Conture, 1992; Yaruss, 1997). Overall speaking rate is measured as the speech produced in terms of words or syllables per minute or second, including both disfluencies and pauses which are shorter than 1–2 seconds. It is viewed as a traditional and clinical measurement which reveals verbal output (Costello & Ingham, 1984; Hall et al., 1999; Ingham & Riley, 1998).Hall et al. (1999) further specified overall speaking rate. To measure overall speaking rate more accurately, they reasoned, the entire duration of speech, including pauses, prolonged speech, and other interruptions such as interjections should be measured, but because extra repetitions of syllables and words would influence the counting of these linguistic units, they should be removed.

On the other hand, articulation rate, the measure of how fast the articulators move for speech production, reflects the temporal aspects of motor speech as well as motor transition ability for speech production (Andrade, Cervone, & Sassi, 2003; Ingham & Riley, 1998; Walker et al., 1992). Articulation rate is measured across some type of perceptually fluent linguistic unit, for example syllables, words, and phones produced across a unit of time, such as seconds or minutes (Ingham & Riley, 1998). When measuring articulation rate, investigators have manipulated pauses by deleting those longer than 250 milliseconds (ms) from the utterance (e.g., Goldman-Eisler, 1968; Hall et al., 1999; Manning 2010; Miller et al., 1984). In general, pauses shorter than 250ms have been included in fluent phonation time to reduce the possibility that discontinuities in speech were due to more than three-sequences of unvoiced sounds, plosive consonants and fricative consonants (Andrews, Howie, Dozsa, & Guitar, 1982). Articulation rate is more easily measured in perceptually fluent utterances of those who stutter, but has also been measured in utterances that contain disfluencies. In the latter case, articulation rate was determined by calculating the number of perceptually fluent syllables in each utterance divided by the duration (in seconds) of the utterance, removing all instances of stuttering-like disfluencies, other disfluencies, and pauses that were longer than 250 ms (Miller et al., 1984; Walker et al., 1992; Yaruss, 1997). Stuttering-like disfluencies (SLD) are those disfluencies that typify stuttered speech, including single syllable and part word repetitions, and disrhythmic phonations, which include blocks and prolongations (Ambrose & Yairi, 1999; Conture, 1990; Van Riper, 1971). Other disfluencies

(OD) typify the speech of fluent speakers, and include phrase repetitions, interjections, multisyllabic word repetitions, and revisions.

1.2. Speech rate studies in children who stutter

Studies that have examined speech rate in children who stutter have compared either the overall speaking or articulation rates of children who stutter with that of normally fluent peers. These two measures have yielded different results in specific populations. A recent study of school-age children by Logan et al. (2011) measured both overall speaking rate and articulation rate in 34 children who stuttered and their non-stuttering peers, and examined how factors such as age and disfluency could influence rate. Children were divided into older and younger groups, and age, rather than disfluency, was a better predictor of articulation rate. When looking at overall speaking rates, however, Logan et al. found that the frequency of disfluency was a better predictor than age, and children who stutter had slower speech rates than those who did not.

There have been several studies examining speech rates in preschool children who stutter. Overall, results have presented a mixed picture, with a majority of the studies showing that rate has no effect on stuttering. Chon, Ko, and Shin (2004) and Ryan (1992, 2000) measured both overall speaking rate and articulation rate and failed to find any significant differences between stuttering and non-stuttering preschool children. Results were similar to other studies which measured only articulation rate in preschool children who stuttered and their fluent peers (e.g. Kelly, 1994; Kelly & Conture, 1992). Yaruss and Conture (1996) examined children who had a concomitant phonological disorder and found their articulation rates did not differ significantly from a group of children with normal phonological development. Both groups had slower articulation rates in stuttered vs. perceptually fluent utterances, but these differences were not significant. When analyzing conversational speech samples of children who stutter, Yaruss (1997) found no relationship between stuttered utterances and articulation rate in individual utterances.Sawyer et al. (2008) examined the influence of articulation rate in two segments of speech in a long speech sample. The 300-syllable segment at the end of the speech sample contained significantly more SLD than the initial 300-syllable segment. The articulation rate at the beginning of the sample was faster than that at the end, but the differences were not significant. Similar findings were reported by Logan and Conture (1995), who found perceptually fluent utterances were spoken at rates faster than those which contained disfluencies, but the differences were not significant.

Four studies have found a significant relationship between disfluencies and articulation rate in preschool children. Meyers and Freeman (1985) found that children who stutter had a significantly slower rate of articulation than normally fluent children. They measured rate in perceptually fluent utterances, in syllables per second, and stated that the significant findings may have been due to the severity of stuttering in their 12 participants, with 7 children rated as having severe stuttering, and 5, moderate.

The way rate is measured made a difference in studies that found a significant relationship between articulation rate and stuttered speech.Hall et al. (1999) compared children who would recover from stuttering with those who would persist, and with normally fluent peers. They found no significant differences among the groups when measuring rate in syllables per second, but when rate was measured in phones per second, the children with normal fluency had significantly faster articulation rates than both groups of children who stuttered. Those who would recover had the slowest rate of the three groups near the onset of stuttering. Another study that showed a significant effect of articulation rate on stuttering measured rate across tone units, which are segments of prosodic tone structure (Howell, Au-Yeung, & Pi lgrim, 1999). Tone units classified as having a high speech rate contained more stuttering than those units with medium or slow rates.

A recent study by Tumanova et al. (2011) found a significant relationship between the frequency of certain types of disfluencies and articulation rate. A significant negative correlation between articulation rate and the frequency of SLD was found. A similar relationship occurred between the length of sound prolongations and articulation rate: the longer the prolongation or the more SLD, the slower the articulation rate. The authors posited that because sound prolongations, and not repetitions, were negatively correlated with articulation rate they may represent a "distinct type of SLD (p. 126)" and influence the production of the utterance in ways that other disfluencies do not.

1.3. Stuttering and length of utterance in children who stutter

Several studies have addressed the relationship between stuttering-like disfluencies and characteristics of utterances in terms of utterance length and/or grammatical complexity. The relationship between the two factors is complex, as it is difficult to separate the effects of complexity from length (see Hall, Wagovich, and Bernstein Ratner, 2007, for a review). Complexity and length are correlated, and when the effects of length are controlled, grammatical complexity has been shown to have influence on stuttered speech (Bernstein Ratner & Sih, 1987; Logan & Conture, 1995; Yaruss 1999). Gaines, Runyan, and Meyers (1991) examined the speech of 12 preschool children who stuttered, and found that stuttered utterances had a longer mean length of utterance (MLU) and were grammatically more complex. Logan and Conture (1995) examined utterance length, articulation rate, and grammatical complexity and found that utterances that were stuttered were significantly longer than those that were perceptually fluent. They did not find that stuttered utterances were more complex, but in a median split procedure, they found a combined influence of length and complexity. Zackheim and Conture (2003) suggested that grammatical complexity influences stuttered speech, as they found that preschool children who stuttered tended to have more disfluencies when they spoke above their typical MLU. It appears that length and complexity may affect more than stuttered disfluencies. A recent study examined syntactic complexity and length in utterances that contained specific types of disfluency. Buhr and Zebrowski (2009) found that both SLD and OD utterances were longer and grammatically more complex than fluent utterances in 12 preschool children who stuttered. This longitudinal study measured length using the total number of function and content words within a sentence, as MLU would not be a reliable measure for children older than four.

Regarding utterance length, studies have generally revealed that stuttered utterances are significantly longer than fluent utterances (Gaines et al., 1991; Logan & Conture, 1995; Weiss & Zebrowski, 1992).Sawyer et al. (2008) reported that the frequency of SLD as well as MLU were increased at the end of large spontaneous speech samples, which could be interpreted that length is a factor influencing the presence of SLD. Yaruss (1999) found that length was a better predictor of disfluency than was grammatical complexity in 12 preschool children who stuttered, but that length measured in clausal constituents, rather than morphemes or syllables, was a better predictor of disfluency.

1.4. Purpose of study

There is a small body of literature that suggests that increased stuttering is associated with a slower articulation rate (Howell et al., 1999; Meyers & Freeman, 1985; Tumanova et al., 2011). Children who stutter may have difficulties in linguistic planning, motor planning, or both. A child having difficulty with linguistic planning may take more time to formulate an utterance, resulting in disfluency. If motor planning affects articulation rate, the instance of stuttering could represent the effect of discoordination or mistiming between motor planning and production. One stutter could subsequently trigger the slower movement of articulators across the entire utterance, or require time for the speaker to stabilize speech motor control between speech segments, syllables, and/or words. Additionally, there is undoubtedly a linguistic influence inherent in stuttering, as both SLD and other disfluencies quite typically occur phrase and clause initially, positions indicative of sentence planning (Bloodstein & Gantwerk, 1967; Buhr & Zebrowski, 2009; Logan & LaSalle, 1999). It may be the case that difficulty in linguistic planning may precipitate disfluency of both types, SLD and other disfluencies. Articulation rate of utterances containing SLD as well as OD may be complex to explain but could reflect the influence of both linguistic planning and motor planning.

Other disfluencies have been associated with linguistic processes. In a study of normally fluent children, Wexler and Mysak (1982) proposed that phrase repetitions, revisions, and interjections were reflective of linguistic planning. Mannning and Shirkey (1981) also called these between-word disfluencies “formulative,” suggestive of planning. A speaker who inserts an “um” in a statement, for example, may be using it as filler while planning the remainder of the utterance. Other disfluencies have also been associated with sentence complexity (Bernstein Ratner & Sih, 1987; Buhr & Zebrowski, 2009; Rispoli & Hadley, 2001). Therefore, utterances containing these disfluencies that are typically not characteristic of stuttering may include more pausing as a linguistic planning strategy, which could make overall speaking rate slower. The pauses may not reflect articulation rate, however, as pauses over 250 ms are typically eliminated in calculating rate.

The first purpose of the current study was to add to the literature on the relationship of stuttering-like disfluencies and articulation rate and explore the relationship of other disfluencies to articulation rate. We aimed to investigate the relationship of both stuttering-like disfluencies and other disfluencies and articulation rate. Clearly, children who stutter produce more disfluencies that are of the SLD type, and fewer of the OD type, but there is evidence from the literature on clustering that they also tend to produce more than one disfluency in sequence. Near the onset of stuttering, over half of the disfluencies a child produces are in clusters (Hubbard & Yairi, 1988; Sawyer & Yairi, 2010). Disfluency clusters are robust, occurring at rates greater than chance near the onset of stuttering and for at least 6 months beyond onset (Sawyer & Yairi, 2010). Many of these clusters are mixed clusters, comprising both SLD and OD. In the Sawyer and Yairi study, mixed clusters represented almost 44 percent of all clusters found in the 32 preschool children who stuttered. Mixed clusters were the largest cluster class for preschool children in general, and for children who stuttered, they represented the second largest class, after SLD clusters. The finding that disfluencies tend to cluster together at rates greater than chance has led to suppositions that one disfluency could precipitate another (Hubbard & Yairi, 1988; LaSalle & Conture, 1995; Sawyer & Yairi, 2010). In studies of rate for preschool children who stutter, it is reasonable to examine utterances which contain both SLD and OD, as these utterance types are relatively common in their speech, and thus representative of what children are actually doing. The focus of the study was on measurement of articulation rates of utterances that were perceptually fluent, comparing them to utterances which contained normal disfluencies and/or those which had disfluencies typical of stuttered speech. Previous studies which have examined articulation rate in disfluent utterances have selected utterances containing stuttered speech (Kelly, 1994; Kelly & Conture, 1992; Logan & Conture, 1995; Tumanova et al., 2011; Yaruss, 1997; Zebrowski, Weiss, Savelkoul, & Hammer, 1996). There have been no studies, however, which measured the articulation rate of utterances containing between-word disfluencies (or labeled as other disfluencies as stated above), sometimes characterized as “normal” disfluencies (Conture, 1990). An examination of articulation rate in utterances which contain other disfluency types may reveal linguistic influences on rate.

A second purpose of the study was to compare the length of utterances among the types of utterance. Utterances containing only SLD have been shown to be longer than perceptually fluent utterances, but to our knowledge, only one other study has looked at length in utterances containing only other, or “normal,” between-word disfluencies, as stated earlier. We expected utterances containing SLD or OD would be longer than perceptually fluent utterances, as was found in the Buhr and Zebrowski study (2009), and utterances containing both SLD and OD, especially, would be longer than fluent utterances.

2. Material and methods

2.1. Participants

Participants were 14 preschool children who stutter (8 boys and 6 girls, ranging in age from 33 to 57 months with a mean of 40.9 months) whose native language is English. They were a subset of a group of over 200 participants in a longitudinal investigation conducted by the Illinois International Stuttering Research Program at the University of Illinois. The children were those selected for Sawyer et al. (2008) and fit the criteria for that study of having a sample size of at least 1,200 syllables. The longer sample size was helpful in the current study, as we excluded the first few minutes of the sample before analyzing a portion of the remainder of the sample. The children were regarded by their parents as having a stuttering problem, and by two certified speech-language pathologists as exhibiting stuttering. Their speech had a minimum of 3 stuttering-like disfluencies per 100 syllables, and their language development was in the normal range (± 1 standard deviation), determined with standardized language assessment inventories (i.e., Preschool Language Scale or Peabody Picture Vocabulary Test-3rd Edition and Expressive Vocabulary Test). The children had no neurological disorders or abnormalities. Stuttering severity was assessed following Ambrose and Yairi (1999), using a weighted SLD measure that reflected the frequency, type and extent of disfluency. For six children, stuttering was rated as mild, for 7, moderate, and for 1, severe.

2.2. Data collection

Conversational speech samples were collected during the interaction between a child and a parent and/or a clinician while playing with Play-Doh in a sound-treated booth. The speech samples were approximately 40 minutes long to collect enough utterances. Audio and video recordings were used to obtain all speech using a Crown PPC-160w phase coherent cardioid microphone and a lavalier microphone attached to the child's shirt. The microphones were connected to a Yamaha KM608 preamplifier (mixer). The audio signal was then directed to a Tascam 122 MKII stereo cassette recorder with Maxell II S-90 recording cassette tapes. The video recordings were obtained with a SONY digital camera model DCR-VX2000 and a Panasonic S-VHS AG-1980 video recorder with Quantegy S-VHS ST-126 videocassette tapes. The audio recorded speech samples were converted to acoustic wave files to analyze articulation rate with a sampling rate of 22 kHz and an audio sample size of 16 bits.

2.3. Data Analysis

2.3.1. Speech samples—Using the Systematic Analysis of Language Transcripts software program (SALT; Miller & Chapman, 1996), the entire conversational speech sample was orthographically transcribed and two classes of disfluencies were identified and coded by project staff with hundreds of hours of experience in disfluency analysis. The disfluencies were SLD, which typify stuttered speech, and OD, both described earlier. The second author, who has had extensive experience in disfluency analysis, re-listened to the samples in their entirety and rechecked the marking of disfluencies for all participants. Discrepancies were resolved through repeated listening and by final judgment of the second author. Interjudge comparisons for type and location of SLD was .93, and for OD, .96, using Baird and Nelson-Gray's percent occurrence agreement formula (1999). Specifically, the number of agreements of SLD and OD occurrence was divided by the number of agreements plus disagreements. Agreement was calculated only for disfluent events, not for fluent events. Intrajudge agreement for the second author was derived after a period of 6 months, and they were .92 for SLD and .95 for OD.

2.3.2. Data Analysis: Utterance length and articulation rate—Following literature, we defined articulation rate as the number of syllables per second of perceptually fluent speech, removing all instances of SLD, OD, and pauses greater than 250 ms (Chon et al., 2004; Hall et al., 1999; Miller et al., 1984; Walker et al., 1992; Yaruss, 1997). Approximately the first 10 minutes of the speech sample were excluded and the following 51 utterances that met criteria for inclusion were chosen for analysis. Each utterance had a minimum of three consecutive words, and simultalk and unintelligible talk were excluded (Hall et al., 1999; Logan & Conture, 1995; Sawyer et al., 2008; Yaruss, 1997; Yaruss & Conture, 1995). The number of syllables in each utterance was counted to calculate articulation rate and averaged for each type of utterance per participant to compare the length of utterance.

Using the Computerized Speech Lab (CSL), Model 4500 (Kay Pentax), the first and second authors captured all 51 utterances and measured the overall duration of each utterance and the duration of each pause within the utterance. The duration of all instances of SLD and OD was also measured to subtract this period of time from the overall duration. For accurate measurement of duration, the time waveform was used to determine the onset point and the offset point of each utterance and verified with the audio signal using a vertical cursor of CSL. If needed, the corresponding spectrogram was used to decide the exact onset and offset points. The onset point was the beginning of acoustic energy of the waveform and verified with the audio signal. The offset point was the termination of acoustic energy of speech identified on the waveform and verified with the audio signal. The pauses within the utterance were identified and the duration of each pause was measured using the time waveform: from the ending point of the speech to the beginning point of the following speech. The duration of SLD was measured following the acoustic measurements of Throneburg and Yairi (2001) and the duration of OD was measured similarly. When measuring the duration of repetitions (i.e., single-syllable word repetition, part-word repetition and multisyllable/phrase repetition), the entire period of disfluency including repetition units and pauses between the units was measured as one disfluent moment. For prolongations, interjections, and revision/abandoned speech, the duration from onset to offset points of disfluent sound was measured. For blocks, the duration from the onset point of unnatural and forced hesitation recognized with the corresponding audio signal to the end of the waveform of the disfluent speech was measured. Disfluency clusters on a word or syllable were considered as one disfluent moment for consistent analysis. Thus, if a word had multiple disfluencies, the entire disfluent period including any pauses between the disfluencies was deleted.

The duration of a silent gap of up to 250 ms was included in the overall duration of the utterance as part of the phonation, but if the silent period was 250 ms or longer, the pause was deleted (Andrews et al., 1982; Hall et al., 1999; Miller et al., 1984). Disfluent speech was removed from the utterance. If there was a pause after the disfluency and it was 250 ms or shorter, it was retained. If it was longer than 250 ms in length, it was deleted following the general rule. Figures 1 and 2 provide a visual example of the analysis. In Figure 1, the utterance “A-a-and-and also o-ones with F-Ford Taurus” has three part-word repetitions, “a-a-and,” “o-ones,” and “F-Ford,” and one single syllable word repetition, “and-and.” This seven-syllable utterance had an overall duration of 4.4457 seconds (sec). The utterance contained two long pauses of 469.5 ms and 281.9 ms between words, which were excluded. As illustrated in Figure 2, the durations of each disfluent event were excluded. Pauses following the disfluencies were retained if they are shorter than 250 ms: the pause after the disfluency cluster (i.e., part-word repetitions and single syllable word repetition) of “and” (i.e., D1) was included because it is shorter than 250 ms. The pause after the part-word repetition of “one” (i.e., D2) was also included due to the same reason. There was no pause after the part word repetition of “Ford” (i.e., D3). The length of the utterance then, was 1.8289 sec, yielding an articulation rate of 3.8274 syllables per second.

Following the rate analysis, each utterance was categorized as one of four types: perceptually fluent utterance (labeled as ‘Fluent utterance’), utterance containing only SLD (labeled as ‘SLD utterance’), utterance containing SLD and OD (labeled as ‘SLD+OD utterance'), and utterance containing only OD (labeled as 'OD utterance'). The perceptually fluent type had no discernable disfluencies. The SLD utterance had a minimum of one SLD. The SLD+OD utterance included at least one SLD as well as one OD. Finally, the OD utterance had at least one OD but did not contain any SLD. Overall, 714 utterances were analyzed to measure articulation rate; 341 perceptually fluent utterances, 175 SLD utterances, 127 SLD+OD utterances, and 71 OD utterances. Of the 127 SLD+OD utterances in the data collected, approximately 69 percent contained at least one disfluency cluster.

2.4. Reliability

Inter- and intra-judge measurements of reliability were made for articulation rate using the Pearson product-moment correlations, as these were ratio scale measurements. For each child, 20% of the utterances were randomly selected for re-analysis by the first and second authors. The data were re-analyzed approximately five months after the initial analysis. The coefficients were .91 for interjudge and .93 for intrajudge reliability.

2.5. Statistical analysis

Because different numbers of perceptually fluent, SLD, SLD+OD, and OD utterances were collected from the 51 consecutive utterances per participant, the mean articulation rates of each type of utterance (fluent, SLD, SLD+OD, and OD) were calculated from each participant to achieve representative articulation rates. At least three utterances out of the 51 utterances were included in each type of utterance except for four participants: three participants had only one OD utterance or one SLD+OD utterance, and one participant had two SLD+OD utterances. Therefore, the articulation rates of their OD or SLD+OD utterances were excluded because the articulation rates from only one or two utterances would not be representative. A paired *t*-test with Bonferroni correction for multiple testing (overall alpha level = .05, corrected alpha level per comparison = .05 / 6 = .0083) was used to test the rate and length differences in the Fluent utterance and SLD utterance pair from all 14 participants, but 12 participants' data were used for the Fluent utterance and OD utterance pair, the Fluent utterance and SLD+OD utterance pair, the SLD utterance and SLD +OD utterance pair, and the SLD utterance and OD utterance pair. For the SLD+OD utterance and the OD utterance pair, 10 participants' data were analyzed. A correlation analysis was also performed to test possible covariates for articulation rate and length of utterance.

3. Results

3.1. Correlations between variables

The mean articulation rates and the mean utterance lengths of each type of utterance (fluent, SLD, SLD+OD, and OD) from each participant were used. To test whether a possible covariate, age, could influence articulation rates and utterance lengths (Sadagopan & Smith, 2008; Walker et. al, 1992), a correlation analysis between the variables was used. As seen in Table 1, the results showed no significant trends between each pair ($p > .05$). Whether the utterance lengths were related to the articulation rates was also tested. The results showed no significant correlations between each utterance pair ($p > .05$) except the SLD pair showing a significant negative correlation ($p < .05$).

3.2. Difference of articulation rates among perceptually fluent, SLD, SLD+OD, and OD utterances

Figure 3 shows the descriptive results of the overall mean articulation rates of four types of utterance. The overall mean articulation rates of fluent and SLD utterances of the 14 participants were 3.68 SPS (SD = 0.42) and 3.60 SPS (SD = 0.37), respectively, and the overall mean articulation rate of SLD+OD and OD utterance of the 12 participants were 3.47 SPS (SD = 0.52) and 3.38 SPS (SD = 0.47).

The Shapiro–Wilk test was performed to test the normality of the distribution of rate differences calculated for each pair at $\alpha = .01$ (i.e., Fluent and SLD utterances, Fluent and OD utterances, Fluent and SLD+OD utterances, SLD and SLD+OD utterances, SLD and OD utterances, and SLD+OD and OD utterances). Because results revealed that the differences in articulation rate between each type of utterance were normally distributed ($p > .01$), a paired *t*-test with Bonferroni correction for multiple testing was used. As shown in Table 2, there was no significant difference in articulation rates between the types of utterance.

3.3. Difference of utterance lengths among perceptually fluent, SLD, SLD+OD, and OD utterances

As shown in Figure 4, the mean utterance length of SLD+OD utterance was relatively longer than other types of utterance. Also, variance was the highest in the OD utterance and lowest in the Fluent utterance. The normality test, the Shapiro-Wilk test, was also conducted to assess the distributions of utterance length differences for each utterance pair. The differences were normally distributed ($p > .01$), so, a paired *t*-test with Bonferroni correction for multiple testing could also be used. The significant difference was shown only in the Fluent and SLD+OD utterance pair ($t(11) = -4.32$, $p = .001$) indicating that the utterance length of the SLD+OD utterance was significantly longer than that of the Fluent utterance (see Table 3).

4. Discussion

The purpose of the study was to investigate articulation rate and utterance length in fluent and disfluent utterances spoken by children who stutter. Results revealed that articulation rates of four types utterances (perceptually fluent utterances, utterances containing only SLD, utterances containing only OD, and utterances containing both SLD and OD) were not significantly different. As for the length of utterance measured in syllables, the SLD+OD utterances were significantly longer than the Fluent utterances. The SLD utterances showed a significant negative correlation between articulation rate and utterance length.

4.1. Articulation rate

In general, the results in the current study support Logan and Conture (1995) that showed no significant trends for slower speech in disfluent utterances. The methodology in that study differed from that of the current study, but results were similar. Logan and Conture measured 25 perceptually fluent utterances and 25 utterances that contained within-word disfluencies. They deleted repetitions from the analysis, as well as pauses related to stuttering and “unusually long pauses (p.41)” that they estimated to be approximately 330 ms in length. The current study, which analyzed several types of disfluent utterances, showed no differences in mean articulation rates between perceptually fluent utterances and SLD, OD, or SLD+OD utterances.

If SLD reflected instability in speech motor control, articulation rate was not a predictor to explain the phenomena. SLD could also be affected by linguistic factors, as they have been found to occur in grammatically complex utterances (Buhr & Zebrowski, 2009; Gaines et al., 1991). Grammatical complexity was not controlled for in this study, so it is not known if the SLD utterances were more complex than the fluent utterances. Still, articulation rate did not distinguish the SLD utterances from any other.

OD are considered to be normal disfluencies, and are present in the speech of both children who stutter and normally fluent speakers. Because OD have been considered to be related to planning and/or formulating language (Mannning & Shirkey, 1981; Wexler & Mysak, 1982), it could be assumed that the actual speech articulatory system would not be disrupted when producing OD. If a faster or slower rate than fluent utterances is evidence of some type of perturbance, this study has shown that OD utterances do not reflect any type of disruption. The utterances containing both SLD and OD did not show significantly slower mean articulation rates than the fluent utterances. These utterances did have more variability in articulation rate than other types of utterances in terms of standard deviation. This particular type of utterance was found to be longer in length than the other types. That longer utterances tend to be spoken faster than shorter ones (Malecot et al., 1972) might explain some of the variability. If the SLD+OD utterances were also more complex than the other types, they may have been spoken at slower rates.

4.2. Utterance length

Utterance length has been considered as a factor influencing disfluencies as well as rate of speech. The current study also showed length is related to disfluencies in that SLD+OD utterances were longer than perceptually fluent utterances. They were not, however, longer than those utterances containing only SLD or OD. That no significant difference in length between the Fluent and SLD utterances was found failed to support previous findings (Gaines et al., 1991; Logan & Conture, 1995). The current finding that utterances containing both normal and stuttering-like disfluencies were longer may suggest that utterance length (and likely grammatical complexity) is related to efforts in executing motor as well as linguistic planning. This was not a study of clusters, but it was noted earlier that almost 70 percent of the utterances of the SLD+OD type contained at least one disfluency cluster. Studies of preschool children who stutter have found that utterances containing disfluency clusters were significantly longer than those that contained only single disfluencies (Logan & LaSalle, 1999). It is possible that the SLD+OD utterances in this study were longer due to the number of disfluency clusters they contained.

4.3. Relationship between articulation rate and utterance length

The relationship between utterance length and articulation rate is far from clear. In general, it has been reported that longer utterances are faster in rate (Malecot et al., 1972). In normally fluent children, Walker and Archibald (2006) did not find any significant correlation between utterance length and rate. Also in Logan et al. (2011), mean length of utterance was not considered as an influence variable on articulation rate for children who stutter. The significant negative correlation between rate and utterance length in SLD utterance may reflect the characteristics of stuttering-like disfluencies. In the current study, other types of utterances did not show significant correlations between rate and utterance length, supporting earlier reports. SLD may reflect instability in linguistic or speech motor control. SLD in an utterance could either serve as a destabilizing influence, or act as a disruption that unbalances production of the utterance, in terms of articulation rate. Longer utterances may place more demand on speech motor control to complete articulatory movements due to more linguistic units and/or grammatical features, resulting in a decreased rate of speed.

4.4. Clinical implications

Speech rate reduction has played a prominent role in therapies for preschool children who stutter. Several techniques such as increasing the number or duration of pauses between words and prolonging speech sound (vowels) have been used to slow speech rate. Indirect therapies working with parents have focused on reduction of caregiver's speech as a mechanism to facilitate fluency in the child (Bernstein Ratner, 2004; Guitar, 2006; Yaruss, Coleman, & Hammer, 2006). Some programs work directly with the child to reduce speaking rate as a fluency-enhancing tool (Conture & Melnick, 1999; Gottwald, 2010; Yairi & Seery, 2011).

The SLD utterances in the current study were produced at similar rates as the children's perceptually fluent speech. If children can speak fluently with a similar articulation rate as when they produce SLD, slower speech training, especially prolonging speech sounds, may result in unnatural prosody or intonation.Hall et al. (1999) found that children who went on to persist had slower rates near the onset of their stuttering than typically fluent peers, leading Pellowski (2010) to suggest that reduction of speech rate may not be indicated for all children who stutter. Reducing speech rate may be easier for children to gain control over their speech and reduce tension (Gottwald, 2010). There have been very few well-designed efficacy studies on direct treatment using slow easy speech; clearly there is a need for more research in this area (Yairi & Ambrose, 2005).

4.5. Directions for further research

There are several suggestions for future studies:

First, the characteristics of articulation rates before and after SLD was produced, which are similar to the tone units examined by Howell et al. (1999), would give more insight into the temporal aspects of speech-motor control of children who stutter. It has been suggested that the production of SLD may have a "carry-over" or "anticipatory" effect on pauses or words preceding or following the SLD (Tumanova et al., 2011; Zebrowski, 1994). Measuring rates prior to and following an SLD, or deleting pauses before and after an SLD, might reveal this effect.

Second, examining the effects of frequency of disfluencies on articulation rate would help to understand the characteristics of articulation rates in preschool children who stutter. Logan and colleagues (2011) reported that changes in speech rate could be predicted with the frequency of disfluency with school-age children who stutter. Articulation rates in utterances with more disfluencies may be slower than in utterances with fewer disfluencies.

Third, severity may have had an impact but was not controlled for in this study. Meyers and Freeman (1985) found slower articulation rates in their children, who had a moderate and severe rating of severity. If SLD are disruptive to the motor plan and generally lead to a slower articulation rate than perceptually fluent utterances, a person who stutters severely may have a slower articulation rate than one who stutters more mildly. A replicated study with more children at different levels of severity may show differences in articulatory rate related to the numbers of SLD in utterances.

Fourth, in the current study the age range of children was from 2;9 to 4;9 years. Previous studies measuring articulation rates of different age groups have revealed inconclusive results. For example,Walker et al. (1992) reported that the articulation rate of their 5-year-old group was significantly faster than their 3-year-old group. Pindzola, Jenkins and Lokken (1989)'s study, however, revealed that there was no significant difference between 3-, 4-, and 5-year-old groups in articulation rates.Hall et al. (1999) measured the development of articulation rates of stuttering children (persistent and recovered subgroups) and normally fluent children whose age range was 3;1 – 4;10 years longitudinally. The results, however, did not show linear trends. Even though correlations of age and articulation rate failed to find significant relationships in current study, a study which examined the articulation rates of more speakers at narrower age ranges might reveal more interesting trends of articulation rate.

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REFERENCES

Abbeduto L. The effects of linguistic complexity on children's and adult's motor programming of speech. Language and Speech. 1985; 28:361–375. [PubMed: 3842874]

Adams MR, Ramig P. Vocal characteristics of normal speakers and stutterers during choral reading. Journal of Speech and Hearing Research. 1980; 23(2):457–469. [PubMed: 7442204]

Andrews G, Howie PM, Dozsa M, Guitar BE. Stuttering: Speech pattern characteristics under fluency-inducing conditions. Journal of Speech and Hearing Research. 1982; 25:208–216. [PubMed: 7120960]

Andrews M, Ingham RJ. Stuttering: Considerations in the evaluation of treatment. British Journal of Disorders in Communication. 1971; 6:129–138.

Ambrose NG, Yairi E. Normative disfluency data for early childhood stuttering. Journal of Speech, Language, and Hearing Research. 1999; 42:895–909.

Andrade CRF, Cervone LM, Sassi FC. Relationship between the stuttering severity index and speech rate. Sao Paulo Medical Journal. 2003; 121:81–84. [PubMed: 12870056]

Baird, S.; Nelson-Gray, RO. Direct observation and self monitoring. In: Hayes, SC.; Barlow, DH.; Nelson Gray, RO., editors. The scientist practitioner: Research and accountability in the age of managed care. 2nd ed. Boston: Allyn & Bacon; 1999. p. 353-386.

Bernstein Ratner N. Caregiver-child interactions and their impact on children's fluency: Implications for treatment. Language, Speech, and Hearing Services in Schools. 2004; 35:46–56.

Bernstein Ratner N, Sih CC. Effects of gradual increases in sentence length and complexity on children's disfluency. Journal of Speech and Hearing Disorders. 1987; 52:278–287. [PubMed: 3455450]

Bloodstein O, Gantwerk BF. Grammatical function in relation to stuttering in young children. Journal of Speech and Hearing Research. 1967; 10:786–789. [PubMed: 5586944]

Buhr A, Zebrowski PM. Sentence position and syntactic complexity of stuttering in early childhood: A longitudinal study. Journal of Fluency Disorders. 2009; 34:155–172. [PubMed: 19948270]

Chon H, Ko D, Shin M. Disfluency characteristics and speech rate of stuttering children. Korean Journal of Communication Disorders. 2004; 9:102–115.

Conture, E. Stuttering. 2nd ed. Englewood Cliffs, NJ: Prentice-Hall; 1990.

Conture, E.; Melnick, K. The parent-child group approach to stuttering in preschool children. In: Onslow, M.; Packman, A., editors. The handbook of early stuttering intervention. San Diego: Singular; 1999. p. 17-52.

Costello, JM.; Ingham, RJ. Stuttering as an operant disorder. In: Curlee, RF.; Perkins, WH., editors. Nature and treatment of stuttering: New directions. San Diego, CA: College-Hill; 1984. p. 187-213.

Gaines ND, Runyan CM, Meyers SC. A comparison of young stutterers' fluent versus stuttered utterances on measures of length and complexity. Journal of Speech and Hearing Research. 1991; 34:37–42. [PubMed: 2008079]

Goldman-Eisler, F. Psycholinguistics: Experiments in spontaneous speech. London: Academic Press; 1968.

Gottwald, S. Stuttering prevention and early intervention: A multidimensional approach. In: Guitar, B.; McCauley, R., editors. Treatment of stuttering: Established and emerging interventions. Philadelphia: Wolters-Kluwer; 2010. p. 91-117.

Guitar, B. Stuttering: An integrated approach to its nature and treatment. 3rd ed.. Baltimore, MD: Lippincott Williams & Wilkins; 2006.

Hall KD, Amir O, Yairi E. A longitudinal investigation of speaking rate in preschool children who stutter. Journal of Speech, Language, and Hearing Research. 1999; 42:1367–1377.

Hall, N.; Wagovich, S.; Bernstein Ratner, N. Language considerations in developmental stuttering. In: Conture, E.; Curlee, R., editors. Stuttering and related disorders of fluency. 3rd edition. NY: Thieme; 2007. p. 153-167.

Howell P, Au-Yeung J, Pilgrim L. Utterance rate and linguistic properties as determinants of lexical disfluencies in children who stutter. Journal of the Acoustical Society of America. 1999; 105:481–490. [PubMed: 9921672]

Hubbard CP, Yairi E. Clustering of disfluencies in the speech of stuttering and nonstuttering preschool children. Journal of Speech and Hearing Research. 1988; 31:228–233. [PubMed: 3294506]

Ingham JC, Riley G. Guidelines for documentation of treatment efficacy for young children who stutter. Journal of Speech, Language, and Hearing Research. 1998; 41:753–770.

Kelly EM. Speech rates and turn-taking behaviors of children who stutter and their fathers. Journal of Speech and Hearing Research. 1994; 37:1284–1294. [PubMed: 7877287]

Kelly E, Conture G. Speaking rates, response time latencies, and interrupting behaviors of young stutterers, nonstutters, and their mothers. Journal of Speech and Hearing Research. 1992; 35:1256–1267. [PubMed: 1494271]

Kent, RD.; Rosen, K. Motor control perspectives on motor speech disorders. In: Maassen, B.; Kent, R.; Peters, H.; van Lieshout, P.; Hulstijn, W., editors. Speech motor control in normal and disordered speech. New York: Oxford University Press; 2004. p. 283-312.

LaSalle LR, Conture EG. Disfluency clusters of children who stutter: Relation of stuttering to self-repairs. Journal of Speech and Hearing Research. 1995; 38:965–977. [PubMed: 8558887]

Logan KJ, Byrd CT, Mazzocchi EM, Gillam RB. Speaking rate characteristics of elementary-school-aged children who do and do not stutter. Journal of Communication Disorders. 2011; 44:130–147. [PubMed: 20947095]

Logan KJ, Conture E. Length, grammatical complexity, and rate differences in stuttered and fluent conversational utterances of children who stutter. Journal of Fluency Disorders. 1995; 20:35–61.

Logan KJ, LaSalle L. Grammatical characteristics of children's conversational utterances that contain disfluency clusters. Journal of Speech, Language and Hearing research. 1999; 42:81–91.

Malecott A, Johnston R, Kizziar PA. Syllabic rate and utterance length in French. Phonetica. 1972; 26:235–251. [PubMed: 4670762]

Manning, WH. Clinical decision making in fluency disorders. 3rd ed. Clifton Park, NY: Delmar Cengage; 2010.

Manning, WH.; Shirkey, EA. Fluency and the aging process. In: Beasley, DS.; Davis, GA., editors. Aging: Communication processes and disorders. New York: Grune & Stratton; 1981.

McNeil, R., Mr; Pratt, SR.; Fossett, TRD. The differential diagnosis of apraxia of speech. In: Maassen, B.; Kent, R.; Peters, H.; van Lieshout, P.; Hulstijn, W., editors. Speech motor control in normal and disordered speech. New York: Oxford University Press; 2004. p. 389-414.

Meyers SC, Freeman FJ. Mother and child speech rates as a variable in stuttering and disfluency. Journal of Speech and Hearing Research. 1985; 28:436–444. [PubMed: 4046584]

Miller, JF.; Chapman, R. SALT: Systematic analysis of language transcripts. Madison: University of Wisconsin; 1996.

Miller JL, Grosjean F, Lomanto C. Articulation rate and its variability in spontaneous speech: An analysis and some implications. Phonetica. 1984; 41:215–225. [PubMed: 6535162]

Moore, CA. Physiologic development of speech production. In: Maassen, B.; Kent, R.; Peters, H.; van Lieshout, P.; Hulstijn, W., editors. Speech motor control in normal and disordered speech. New York: Oxford University Press; 2004. p. 191-210.

Pellowski M. Speech-language pathologists' knowledge of speaking rate and its relationship to stuttering. Contemporary Issues in Communication Science and Disorders. 2010; 37:50–57.

Pindzola RH, Jenkins MM, Lokken KJ. Speaking rates of young children. Language, Speech, and Hearing Services in Schools. 1989; 20:133–138.

Riding RJ, Vincent DJT. Listening comprehension: The effects of sex age, passage structure and speech rate. Educational Review. 1980; 32:259–266.

Rispoli M, Hadley P. The leading edge: The significance of sentence disruptions in the development of grammar. Journal of Speech, Language, and Hearing Research. 2001; 44:1131–1143.

Ryan BP. Articulation, language, rate, and fluency characteristics of stuttering and nonstuttering preschool children. Journal of Speech and Hearing Research. 1992; 35:333–342. [PubMed: 1573873]

Ryan BP. Speaking rate, conversational speech acts, interruption, and linguistic complexity of 20 pre-school stuttering and non-stuttering children and their mothers. Clinical Linguistics & Phonetics. 2000; 14:25–51. [PubMed: 22091696]

Sadagopan N, Smith A. Developmental changes in the effects of utterance length and complexity on speech movement variability. Journal of Speech, Language, and Hearing Research. 2008; 51:1138–1151.

Sawyer J, Chon H, Ambrose NG. Influences of rate, length, and complexity on speech disfluency in a single speech sample in preschool children who stutter. Journal of Fluency Disorders. 2008; 33:220–240. [PubMed: 18762063]

Sawyer J, Yairi E. Characteristics of disfluency clusters over time in preschool children who stutter. Journal of Speech, Language, and Hearing Research. 2010; 53:1191–1205.

Smith, A.; Goffman, L. Interaction of motor and language factors in the development of speech production. In: Maassen, B.; Kent, R.; Peters, H.; van Lieshout, P.; Hulstijn, W., editors. Speech motor control in normal and disordered speech. New York: Oxford University Press; 2004. p. 225-252.

St. Louis KO, Raphael LJ, Myers FL, Bakker K. Cluttering updated. ASHA Leader. 2003; 8(19):4–22.

Starkweather, CW. Fluency and stuttering. Englewood Cliffs, NJ: Prentice-Hall; 1987.

Stewart MA, Ryan EB. Attitudes toward younger and older adult speakers: Effects of varying speech rates. Journal of Language and Social Psychology. 1982; 1:91–109.

Tasko S, McClean M, Runyan C. Speech motor correlates of treatment-related changes in stuttering severity and speech naturalness. Journal of Communication Disorders. 2007; 40:42–65. [PubMed: 16765980]

Throneburg RN, Yairi E. Durational, proportionate, and absolute frequency characteristics of disfluencies: A longitudinal study regarding persistence and recovery. Journal of Speech, Language, and Hearing Research. 2001; 44:38–51.

Tumanova V, Zebrowski P, Throneburg R, Kayikci M. Articulation rate and its relationship to disfluency type, duration, and temperament in preschool children who stutter. Journal of Communication Disorders. 2011; 44:116–129. [PubMed: 20934188]

van Lieshout, PHHM.; Hulstijn, W.; Peters, HFM. Searching for the weak link in the speech production chain of people who stutter: A motor skill approach. In: Maassen, B.; Kent, R.; Peters, H.; van Lieshout, P.; Hulstijn, W., editors. Speech motor control in normal and disordered speech. New York: Oxford University Press; 2004. p. 313-356.

Van Riper, C. The nature of stuttering. Englewood Cliffs, NJ: Prentice-Hall; 1971.

Walker J, Archibald L. Articulation rate in preschool children: A 3-year longitudinal study. International Journal of Language & Communication Disorders. 2006; 41:541–565. [PubMed: 17050470]

Walker J, Archibald L, Cherniak S, Fish VG. Articulation rate in 3- and 5-yearold children. Journal of Speech and Hearing Research. 1992; 35:4–13. [PubMed: 1735975]

Weiss AL, Zebrowski PM. Disfluencies in the conversations of young children who stutter: Some answers about questions. Journal of Speech and Hearing Research. 1992; 35:1230–1238. [PubMed: 1494268]

Wexler KB, Mysak ED. Disfluency characteristics of 2-4-, and 6-year-old males. Journal of Fluency Disorders. 1982; 7:37–46.

Yairi, E.; Ambrose, NG. Early childhood stuttering for clinicians by clinicians. Austin, TX: 2005. Pro-ed

Yairi, E.; Seery, CH. Stuttering: Foundations and clinical applications. Boston: Pearson; 2011.

Yaruss JS. Utterance timing and childhood stuttering. Journal of Fluency Disorders. 1997; 22:263–286.

Yaruss JS. Utterance length, syntactic complexity, and childhood stuttering. Journal of Speech, Language, and Hearing Research. 1999; 42:329–344.

Yaruss JS, Coleman C, Hammer D. Treating preschool children who stutter: Description and preliminary evaluation of a family-focused treatment approach. Language, Speech and Hearing Services in Schools. 2006; 37:118–136.

Yaruss JS, Conture EG. Mother and child speaking rates and utterance lengths in adjacent fluent utterances: Preliminary observations. Journal of Fluency Disorders. 1995; 20:257–278.

Yaruss JS, Conture EG. Stuttering and phonological disorders in children: Examination of the covert repair hypothesis. Journal of Speech and Hearing Research. 1996; 39:349–364. [PubMed: 8729922]

Zackheim CT, Conture E. Childhood stuttering and speech disfluencies in relation to children's mean length of utterance: A preliminary study. Journal of Fluency Disorders. 2003; 28:115–142. [PubMed: 12809748]

Zebrowski P. Duration of sound prolongation and sound/syllable repetition in children who stutter. Journal of Speech and Hearing Research. 1994; 37:254–263. [PubMed: 8028307]

Zebrowski PM, Weiss A, Savelkoul E, Hammer C. The effect of maternal rate reduction on the speech rates and linguistic productions of children who stutter: Evidence from individual dyads. Clinical Linguistics and Phonetics. 1996; 10:189–206.

CONTINUING EDUCATION

Differences of Articulation Rate and Utterance Length in Fluent and Disfluent Utterances of Preschool Children Who Stutter

QUESTIONS

1. Articulation rate in stuttering has been shown to be influenced by:
   a. selection of participants
   b. linguistic components
   c. selection of utterances
   d. measurement techniques
   e. all of the above
2. Which of the following statements is true regarding the studies of articulation rate of preschool children who stutter?
   a. Many of the studies have measured articulation rate inaccurately because they have included pauses greater than 250 ms.
   b. No studies have found a significant relationship between the production of stuttering and articulation rate.
   c. The studies have used a range of methodologies to study articulation rate, resulting in discrepant findings.
   d. Studies have shown that children with mild levels of stuttering have similar articulation rates as children with severe levels.
   e. Studies that have followed children who stutter over time revealed that normally fluent children have slower speaking rates than children who stutter.
3. The present study came to its conclusions about articulation rate in fluent and disfluent utterances by measuring articulation rate of utterances:
   a. that contained only SLD, only OD, both SLD and OD, and were perceptually fluent
   b. which contained only SLD and those that contained only OD
   c. that were either perceptually fluent or contained SLD, but not OD
   d. that contained pauses of less than 250 ms
   e. that were free of disrhythmic phonation
4. In regard to the relationship among articulation rate, utterance length, and disfluency, this study suggests that:
   - SLD+OD utterances were spoken at longer utterances than perceptually fluent utterances.

- A faster articulation rate in OD utterances may be the result of grammatical complexity.
- SLD utterances were spoken at faster articulation rates than OD utterances.
- The lengths of both SLD utterances and OD utterances were longer than that of fluent utterances.
- all of the above.

5. A significant correlation was found between articulation rate and utterance length in:

   a. Fluent utterances

   b. SLD utterances

   c. SLD+OD utterances

   d. OD utterances

   e. all of the above

ANSWERS

1. e

2. c

3. a

4. a

5. b

Learning Outcomes

Learning outcomes: The reader will learn about and be able to: (a) distinguish the difference between measures of overall speaking rate and articulation rate; (b) explain the theoretical and clinical trends of articulation rate in stuttering; (c) discuss how utterances containing stuttering-like disfluencies, utterances containing other disfluencies, and utterances containing both stuttering-like disfluencies and other disfluencies influence articulation rate; and (d) discuss how the length of utterances is related to disfluencies.

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Highlights

- We examine rate and length in fluent/disfluent utterances from stuttering children.
- Stuttered utterances show correlation between articulation rate and length.
- There is no significant difference in rate among the different types of utterances.
- Utterances containing normal and stuttering-like disfluencies are longer in length.

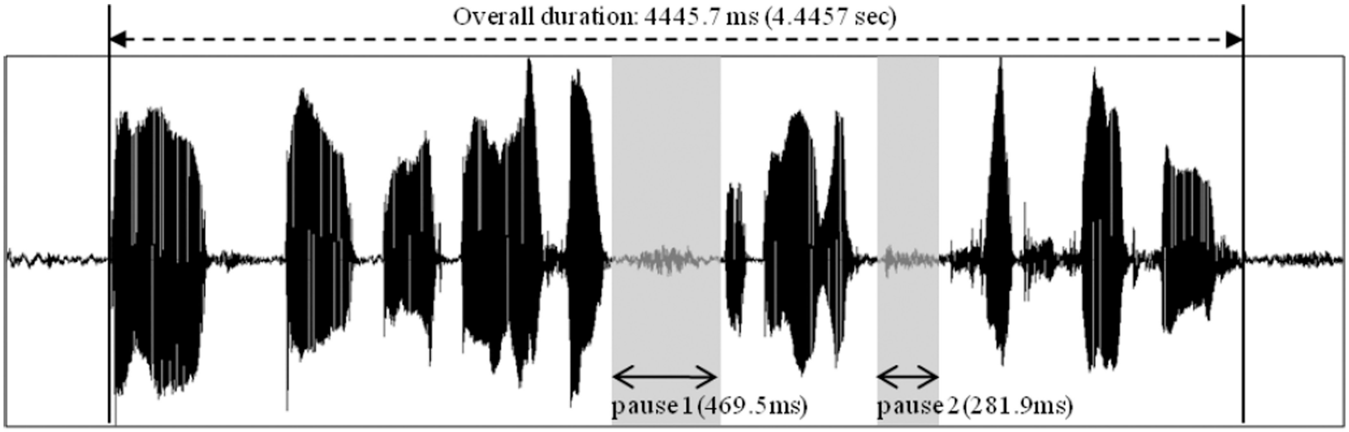

Figure 1.

An utterance, “A-a-and-and also o-ones with F-Ford Taurus,” containing four SLD (part-word repetitions and single syllable word repetition) and two pauses had 7 fluent syllables, and the overall duration of the utterance was 4.4457 seconds.

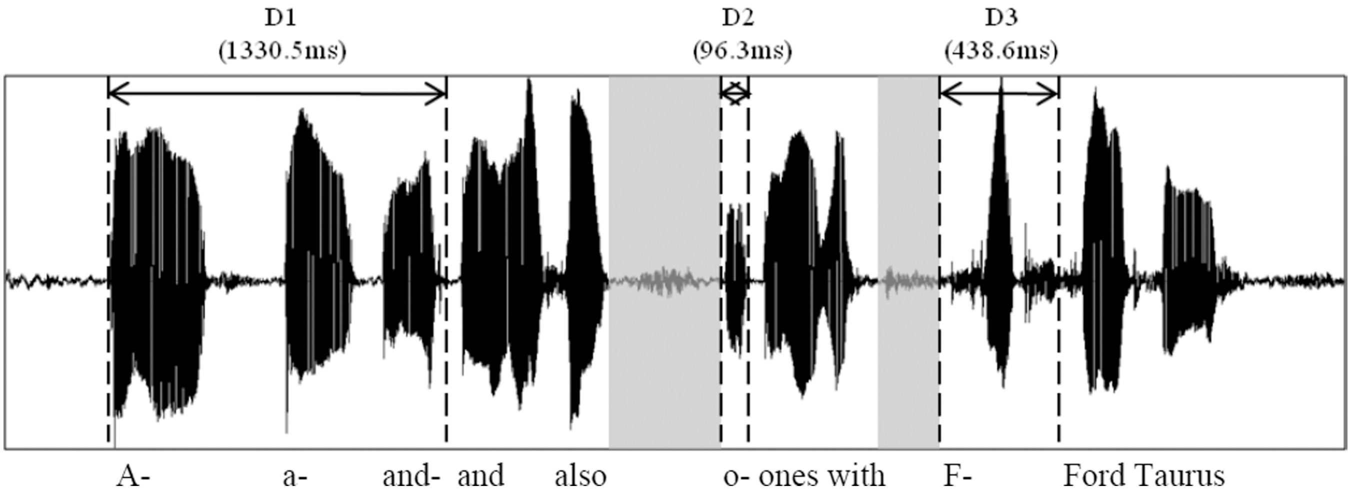

Figure 2.
The durations of SLD (i.e., D1, D2, and D3) and the following pauses greater than 250 ms were excluded from the overall duration of the utterance. After the part-word repetition of "Ford," there was no pause. Therefore, the articulation rate was 3.8274 SPS.

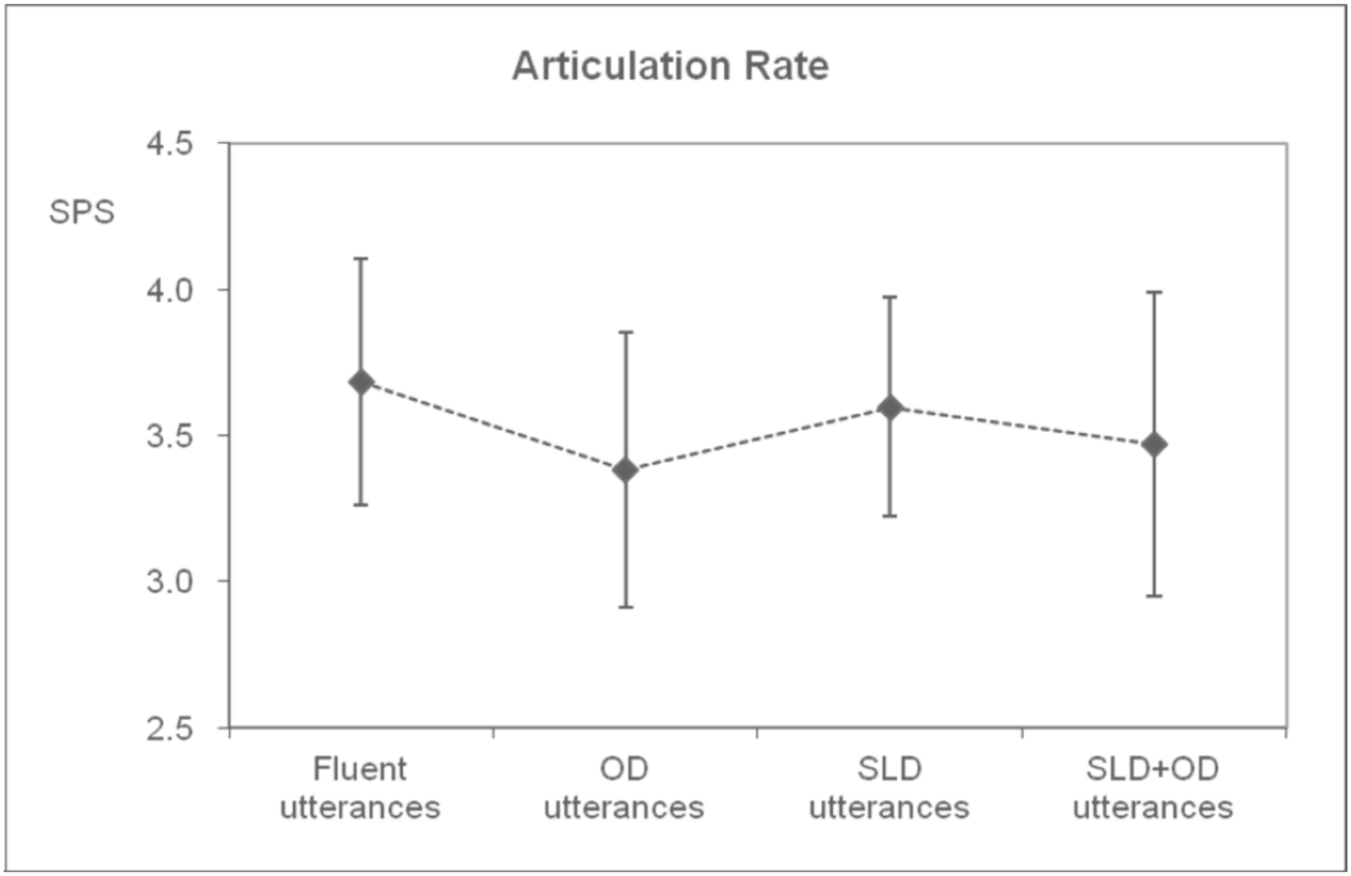

Figure 3.
Overall mean articulation rates of Fluent utterances (N = 14), SLD utterances (N = 14), SLD +OD utterances (N = 12), and OD utterances (N = 12). Error bars indicate one standard deviation.

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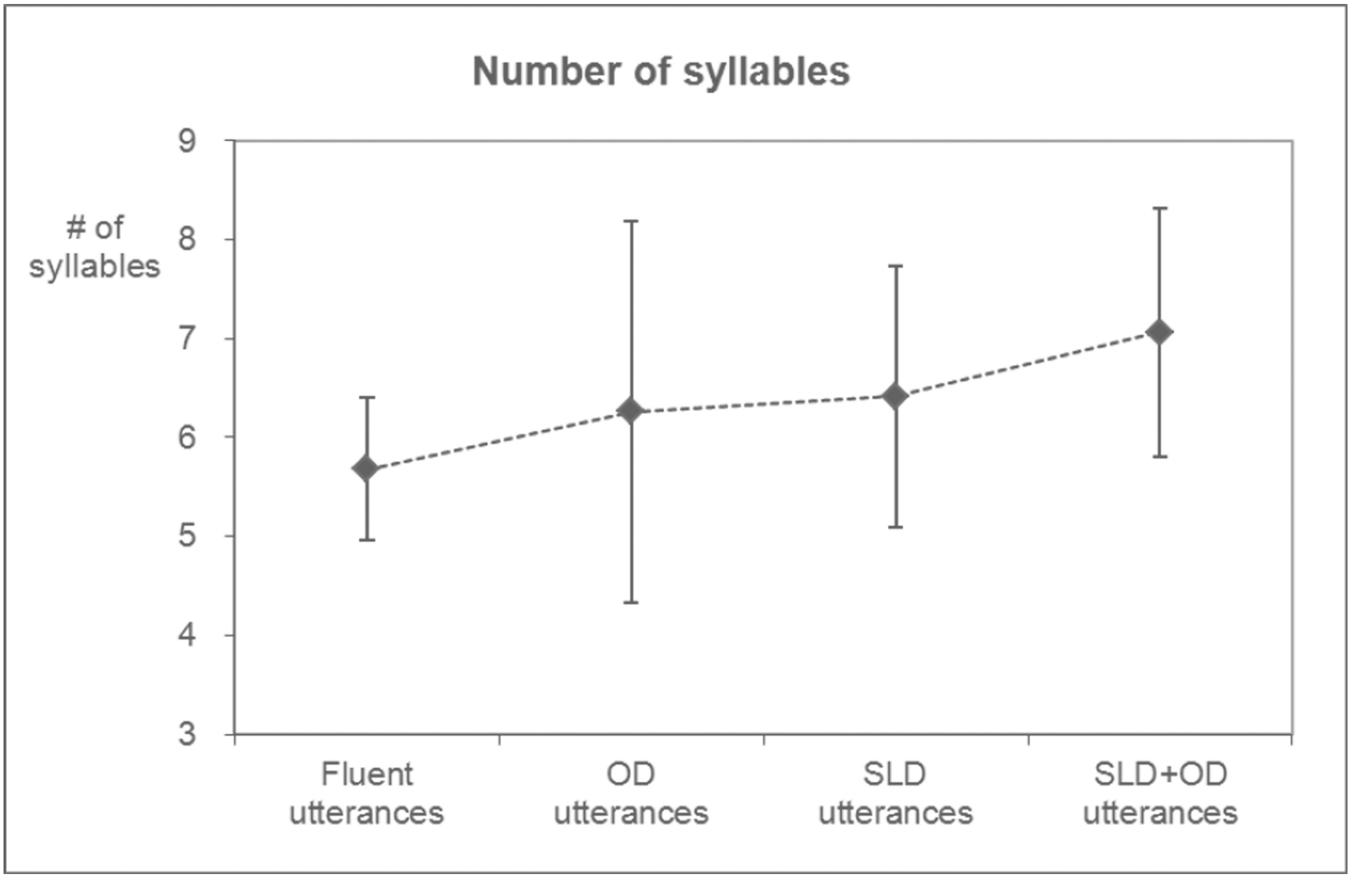

Figure 4.

Overall mean utterance lengths of Fluent utterances (N = 14), SLD utterances (N = 14), SLD +OD utterances (N = 12), and OD utterances (N = 12). Error bars indicate one standard deviation.

Table 1

The results of correlations (1) between the participants' age in months and the mean articulation rates and the mean utterance lengths of each type of utterance, and (2) between the mean length of utterances and the mean articulation rates of each type of utterance.

`			AGE	Mean Articulation Rate ^{2}			
				Fluent Utterances	SLD Utterances	SLD+OD Utterances	OD Utterances
AGE		Correlation coefficient		.270	.326	.201	−.011
		Sig. (2-tailed)		.351	.256	.531	.972
		N		14	14	12	12
Mean Utterance Length ^{1}	Fluent Utterances	Correlation coefficient	.233	−.304			
		Sig. (2-tailed)	.423	.291			
		N	14	14			
	SLD Utterances	Correlation coefficient	.215		−.572		
		Sig. (2-tailed)	.461		**.033***		
		N	14		14		
	SLD+OD Utterances	Correlation coefficient	−.137			.031	
		Sig. (2-tailed)	.672			.924	
		N	12			12	
	OD Utterances	Correlation coefficient	−.091				.087
		Sig. (2-tailed)	.777				.788
		N	12				12

* $p < .05$

1 number of syllables;

2 syllables per second

Table 2

The results of the paired *t*-test with Bonferroni correction for articulation rate measured in syllables per second.

Pair		N	Mean	SD	*t*	*p*
Fluent – SLD utterance pair	Fluent	14	3.68	.42	1.09	.295
	SLD	14	3.60	.37		
Fluent – OD utterance pair	Fluent	12	3.63	.36	1.81	.097
	OD	12	3.38	.47		
Fluent – SLD+OD utterance pair	Fluent	12	3.74	.40	2.89	.015
	SLD+OD	12	3.47	.52		
SLD – OD utterance pair	SLD	12	3.55	.35	1.18	.264
	OD	12	3.38	.47		
SLD – SLD+OD utterance pair	SLD	12	3.60	.39	1.26	.236
	SLD+OD	12	3.47	.52		
OD – SLD+OD utterance pair	OD	10	3.35	.50	.37	.718
	SLD+OD	10	3.42	.35		

$p < .0083$ (Corrected alpha level per comparison = .0083; Overall alpha level = .05)

Table 3

The results of the paired *t*-test with Bonferroni correction for utterance length in syllables.

Pair		N	Mean	SD	*t*	*p*
Fluent – SLD utterance pair	Fluent	14	5.68	.71	−2.60	.022
	SLD	14	6.41	1.32		
Fluent – OD utterance pair	Fluent	12	5.68	.70	−1.29	.224
	OD	12	6.26	1.93		
Fluent – SLD+OD utterance pair	Fluent	12	5.81	.69	−4.32	**.001** *
	SLD+OD	12	7.06	1.26		
SLD – OD utterance pair	SLD	12	6.51	1.27	.42	.680
	OD	12	6.26	1.93		
SLD – SLD+OD utterance pair	SLD	12	6.64	1.27	−1.03	.324
	SLD+OD	12	7.06	1.26		
OD – SLD+OD utterance pair	OD	10	6.62	1.92	.55	.595
	SLD+OD	10	6.90	1.29		

* $p < .0083$ (Corrected alpha level per comparison = .0083; Overall alpha level = .05)