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Research Note

Speech Rate Varies With Sentence Length in Typically Developing Children

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Purpose: The primary purpose of this study was to examine the effect of sentence length on speech rate and its characteristics, articulation rate and pauses, in typically developing children.
Method: Sixty-two typically developing children between the ages of 10 and 14 years repeated sentences varying in length from two to seven words. Dependent variables included speech rate (syllables per second), articulation rate (syllables per second), and proportion of time spent pausing.
Results: Speech rate and articulation rate significantly increased with increases in sentence length, but proportion of time spent pausing did not increase with sentence length. There were no significant main effects of age.
Conclusions: This is the first study to suggest that sentence length differentially impacts the component parts of speech rate, articulation rate and pause time. Increases in sentence length led to increases in speech rate, primarily due to increases in articulation rate and not increases in pause time. Articulation rate appears to be highly sensitive to the impact of sentence length, while a higher cognitive–linguistic load may be required to see sentence length effects on pause time.

Speech rate has long been recognized as an important factor in an individual's ability to communicate a message in an effective manner. In fact, speech rate is a common target in speech intervention to improve speech production in individuals with speech motor involvement. As a result, a primary focus of the speech rate literature has been to interrogate the factors that influence speech rate in order to place the speech rate performance of individuals with speech motor involvement in the appropriate context. These factors include, but are not limited to, age and cognitive–linguistic load (i.e., formulation demands) of the speaking task.

Like many speech motor processes, speech rate follows a protracted developmental time course (e.g., Haselager et al., 1991; Hodge & Gotzke, 2014; Kent & Forner, 1980; Kowal et al., 1975; Logan et al., 2011; Nip & Green, 2013; Walker et al., 1992; Walsh & Smith, 2002; Whiteside, 1999) with increases throughout development until approximating adultlike speeds between 12 and 13 years of age (Nip & Green, 2013; Walsh & Smith, 2002).

Developmental increases in speech rate are thought to relate to increased efficiencies in both the speech motor and the cognitive–linguistic systems (Kowal et al., 1975; Nip & Green, 2013). Speech rate is the product of the rate in which our articulators move to produce an utterance (i.e., articulation rate) plus pause time. Articulation rate is often thought to reflect speech motor control, whereas pausing is thought to reflect cognitive–linguistic processes related to the load (i.e., formulation demands) of the speaking task. Developmental increases in speech rate are achieved through both increases in articulation rate (Haselager et al., 1991; Logan et al., 2011; Nip & Green, 2013; Walker et al., 1992; Whiteside, 1999) and decreases in pause time (Kowal et al., 1975; Nip & Green, 2013; Whiteside, 1999). While both systems are important to this process, the work of Nip and Green (2013) suggests that increased efficiency in cognitive–linguistic processing is the driver of the developmental increases in speech rate.

Despite the influential role that cognitive–linguistic processes play during the development of speech rate, the way in which the cognitive–linguistic load of any particular speech task influences speech rate is an emerging area of research. Evidence suggests that both articulation rate and pause time vary with cognitive–linguistic load (Darling-White et al., 2018; Haselager et al., 1991; Logan et al., 2011; Nip & Green, 2013; Walker & Archibald, 2006; Walker et al., 1992). While pause time consistently increases with cognitive–linguistic load (Darling-White et al., 2018; Greene, 1984;

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Greene & Cappella, 1986; Mitchell et al., 1996; Nip & Green, 2013), the way in which articulation rate varies with cognitive–linguistic load is much more complicated. Articulation rate has been found to increase (Darling-White et al., 2018; Haselager et al., 1991), remain the same (Logan et al., 2011; Walker & Archibald, 2006; Walker et al., 1992), and decrease (Logan et al., 2011; Nip & Green, 2013; Walker & Archibald, 2006; Walker et al., 1992) as cognitive–linguistic load increases. One reason for these mixed results is the way in which these studies varied cognitive–linguistic load. Cognitive–linguistic load was either varied by changing sentence length and/or complexity within a task (e.g., four-word sentences vs. five-word sentences in a repetition task; Darling-White et al., 2018; Haselager et al., 1991; Logan et al., 2011; Walker & Archibald, 2006; Walker et al., 1992) or by changing the task itself (e.g., sentence repetition vs. narrative retell; Logan et al., 2011; Nip & Green, 2013; Walker & Archibald, 2006; Walker et al., 1992). Evidence also suggests that there may be an interaction between the impact of cognitive–linguistic load and age given that speech rate follows a nonlinear developmental course such that there are periods of stability followed by periods of growth or reversal (Smith & Kenney, 1999). For example, 13-year-olds produced faster speech rates than 16-year-olds during diadochokinetic, syllable repetition, and sentence repetition tasks, but not during a narrative recall task (Nip & Green, 2013).

The primary purpose of this study was to examine the impact of cognitive–linguistic load on speech rate and its characteristics, articulation rate and pauses, in typically developing children between the ages of 10 and 14 years. Cognitive–linguistic load was varied by systematically altering sentence length from two to seven words during a sentence repetition task. To ensure that any changes in speech rate with sentence length could not simply be explained by development, we also examined the effect of age. The results of this study will provide (a) a better understanding about the impact of cognitive–linguistic load on speech rate during typical development and (b) normative data for a commonly used task in speech intervention, sentence repetition, that will allow clinicians and researchers to place the speech rate performance of children with speech motor involvement in the appropriate developmental context.

Method

Participants

Sixty-two typically developing children (28 boys, 34 girls; M = 12.25 years) divided into the following age groups participated in this research study: 10-year-olds (seven boys, seven girls; M = 10.40 years), 11-year-olds (seven boys, seven girls; M = 11.35 years), 12-year-olds (four boys, six girls; M = 12.35 years), 13-year-olds (four boys, nine girls; M = 13.29 years), and 14-year-olds (six boys, five girls; M = 14.45 years). According to parent-reported race and ethnicity information, 4.84% of participants were Asian, 8.06% of participants were Black or African American, 14.52% of participants were more than one ethnicity, 1.61% of participants had unknown ethnic origins, 70.97% of participants were White, and 14.52% of participants were Hispanic or Latino.

Participants were recruited via community postings and public websites that prompted parents or guardians to contact the research team if interested. Participants were included in this study if they were fluent speakers of American English and had no speech, language, learning, or hearing problems per parent report. Prior to data collection, legal guardians provided written consent and participants provided verbal assent. Based on the perceptual assessment of the first author, a certified speech-language pathologist, all participants demonstrated typical speech production skills. Each participant demonstrated average or above average language scores as determined by the core language score of the Clinical Evaluation of Language Fundamentals–Fifth Edition (Wiig et al., 2013). All participants passed a pure-tone hearing screening at 20 dB HL for 500, 1000, 2000, and 4000 Hz bilaterally, except one. One of the 10-year-old male participants had a threshold of 25 dB HL for 500 Hz bilaterally. This participant had recently been diagnosed with bilateral ear infections, which were the likely cause of the elevated thresholds at 500 Hz. As this participant did not have a history of hearing problems per parent report and passed at 20 dB HL for all other frequencies, he was included in the study. Participants were compensated $30 for their time. All study procedures were approved by the University of Arizona Human Subjects Review Board (Protocol 16055837A005).

Acquisition of Speech Samples

Participants were part of a larger study that consisted of two 60- to 90-min sessions that occurred approximately 1 week apart. Acoustic data were collected within a period of 30 min during one of the sessions at the Motor Speech Research Laboratory at The University of Arizona. The larger study contained six different speech tasks. The speech tasks were initiated approximately 30 min into the session. The speech task presented in the current study was one of the first four speech tasks in the protocol. The order of those speech tasks was counterbalanced across participants. Participants were given frequent breaks to prevent fatigue.

Equipment

The acoustic signal was transduced via an omnidirectional headset microphone (Shure WBH53) with a flat frequency response up to 20 kHz and recorded to a digital audio recorder (Marantz PMD-671) with a compact flash card. The mouth-to-microphone distance was a constant 6 cm. The acoustic signal was transferred to a computer and resampled at 18 kHz with a low-pass filter at 9 kHz for anti-aliasing using Goldwave.

Speech Task

Participants were asked to produce sentences from the Test of Children's Speech (*TOCS*+; Hodge & Daniels, 2009) using their comfortable pitch and loudness. The *TOCS+* procedure employs an imitation paradigm in which participants repeat each stimulus sentence following a prerecorded adult model. Stimulus sentences ranged from two to seven words in length. The stimulus sentences were presented, both visually and auditorily, to participants via a laptop computer.

Prior to data collection, the *TOCS+* software was used to create 30 unique lists of sentences (from a pool of 2,000 phrases) that varied in length from two to seven words. The software randomizes the order of sentence length presentation. Each *TOCS+* list contained 34 sentences. The number of sentences at each length varied slightly with each *TOCS+* list, but a representative *TOCS+* list contained four 2-word sentences, five 3-word sentences, six 4-word sentences, seven 5-word sentences, six 6-word sentences, and six 7-word sentences. The order of *TOCS+* list presentation was counterbalanced such that each *TOCS+* list was generally produced 1 time per age group. One *TOCS+* list was repeated in the 13-year-old age group, and two *TOCS+* lists were repeated in the 14-year-old age group.

The adult model in this study was prerecorded by the first author in a sound-attenuating booth. As there were 30 different TOCS+ lists, it was important to verify that the speech characteristics produced by the adult model were reliable from list to list. There were no pauses in the adult model, so articulation rate and speech rate were identical. A series of *t* tests with an alpha level of .05 revealed that there were no significant differences in speech rate between any of the *TOCS+* lists.

Measurements

Acoustic analyses for this study were performed on 2,108 sentences (62 participants × 34 sentences). Members of the research team listened to each sentence to determine the number of words and syllables produced. There were 249 two-word sentences, 311 three-word sentences, 370 four-word sentences, 437 five-word sentences, 373 six-word sentences, and 368 seven-word sentences. The majority of sentences (n = 1,696) contained only single-syllable words, but 412 sentences contained multisyllabic words. Sentences contained between two syllables and 12 syllables.

Sentence duration was defined as the amount of time (in seconds) between the initiation of the sentence and the termination of the sentence. Using the software Praat (Boersma & Weenink, 2016) to display the spectrographic signal, sentence initiation was marked as the onset of acoustic energy associated with the first phoneme of the sentence and sentence termination was marked as the offset of acoustic energy associated with the final phoneme of the sentence. Pauses were defined as any period of silence within the sentence greater than or equal to 0.150 s (Darling-White et al., 2018). The dependent variables included:

1. Speech rate (syllables per second): Speech rate was calculated by dividing the number of syllables produced by sentence duration.
2. Articulation rate (syllables per second): Articulation rate was defined as sentence duration minus total pause time divided by the number of syllables produced.
3. Proportion of time spent pausing (Darling-White et al., 2018): Proportion of time spent pausing was calculated by dividing the total pause time by the sentence duration. Values closer to one indicate that a sentence contained mostly pauses.

Data from 10 participants (one boy and one girl from each age group) were randomly chosen to be reanalyzed by a second measurer. Intermeasurer reliability was evaluated by computing the Cronbach α between the two sets of measurements for the number of syllables produced, sentence duration, and total pause time because the dependent variables were based on calculations derived from these measurements. The mean difference between the two sets of measurements for these variables ranged from .01 to <.001. The Cronbach α for all measurements fell between .94 and 1 indicating high intermeasurer reliability.

Statistical Analysis

A general linear mixed-model analysis of variance was used with sentence length as the within-subject variable and age as the between-subjects variable. Tukey's honestly significant difference post hoc tests were used to examine statistically significant pairwise comparisons. The level of significance was set as $p \leq .01$ for all statistical tests.

Results

Descriptive results (means and standard deviations) for each dependent variable are presented by age and sentence length in Table 1. Pairwise comparisons for the main effect of sentence length for each dependent variable are presented in Table 2.

Speech Rate

There was no significant main effect for age, $F(4, 57) = 1.06$, $p = .385$. There was a significant main effect for sentence length, $F(5, 285) = 105.02$, $p < .001$. There was no significant interaction effect for Age × Sentence Length, $F(20, 285) = 0.83$, $p = .681$.

In general, speech rate significantly increased with each sentence length. The only pairwise comparisons that were not significant were the contrasts between four-word sentences and five-word sentences and between five-word sentences and six-word sentences.

Articulation Rate

There was no significant main effect for age, $F(4, 57) = 1.22$, $p = .311$. There was a significant main effect for sentence length, $F(5, 285) = 100.07$, $p < .001$. There was no

Table 1. Means (standard deviations) for each dependent measure by age and sentence length.

Measure	2 words	3 words	4 words	5 words	6 words	7 words
Speech rate						
10-year-olds	2.92 (0.80)	3.16 (0.71)	3.48 (0.65)	3.63 (0.61)	3.64 (0.49)	3.88 (0.54)
11-year-olds	3.16 (1.02)	3.34 (0.81)	3.70 (0.74)	3.78 (0.76)	3.75 (0.54)	4.00 (0.64)
12-year-olds	2.85 (0.85)	3.20 (0.80)	3.41 (0.59)	3.63 (0.62)	3.58 (0.52)	3.89 (0.62)
13-year-olds	2.96 (0.71)	3.21 (0.64)	3.46 (0.52)	3.59 (0.55)	3.68 (0.45)	4.06 (0.51)
14-year-olds	2.88 (0.70)	3.40 (0.67)	3.63 (0.64)	3.60 (0.65)	3.79 (0.49)	4.05 (0.67)
Articulation rate						
10-year-olds	2.92 (0.80)	3.18 (0.72)	3.50 (0.67)	3.66 (0.64)	3.67 (0.49)	3.90 (0.53)
11-year-olds	3.23 (1.05)	3.35 (0.80)	3.73 (0.77)	3.80 (0.77)	3.79 (0.54)	4.03 (0.62)
12-year-olds	2.95 (0.91)	3.21 (0.80)	3.41 (0.59)	3.63 (0.62)	3.59 (0.52)	3.90 (0.62)
13-year-olds	2.99 (0.73)	3.22 (0.64)	3.48 (0.52)	3.60 (0.55)	3.69 (0.45)	4.08 (0.49)
14-year-olds	2.90 (0.69)	3.41 (0.65)	3.68 (0.65)	3.64 (0.68)	3.83 (0.46)	4.08 (0.66)
Proportion of time spent pausing						
10-year-olds	0 (0)	0.004 (0.02)	0.005 (0.02)	0.008 (0.03)	0.009 (0.03)	0.004 (0.02)
11-year-olds	0.02 (0.06)	0.004 (0.02)	0.004 (0.02)	0.007 (0.03)	0.01 (0.03)	0.006 (0.03)
12-year-olds	0.03 (0.08)	0.002 (0.02)	0 (0)	0 (0)	0.003 (0.02)	0.004 (0.02)
13-year-olds	0.007 (0.04)	0.002 (0.01)	0.005 (0.03)	0.002 (0.01)	0.001 (0.01)	0.005 (0.02)
14-year-olds	0.006 (0.04)	0.005 (0.03)	0.01 (0.04)	0.009 (0.03)	0.01 (0.03)	0.006 (0.02)

Note. Speech rate and articulation rate are measured in syllables per second.

significant interaction effect for Age × Sentence Length, $F(20, 285) = 0.92$, $p = .557$.

In general, articulation rate significantly increased with each sentence length. The only pairwise comparisons that were not significant were the contrasts between four-word sentences and five-word sentences and between five-word sentences and six-word sentences.

Proportion of Time Spent Pausing

There was no significant main effect for age, $F(4, 57) = 0.85$, $p = .50$. There was a significant main effect for sentence length, $F(5, 285) = 3.83$, $p = .002$, and a significant interaction effect for Age × Sentence Length, $F(20, 285) = 2.51$, $p < .001$.

Participants spent a significantly longer amount of time pausing during two-word sentences than during four-, five-, and seven-word sentences. This effect appears to be primarily driven by the 12-year-olds. The 12-year-olds spent a significantly greater proportion of the sentence pausing during two-word sentences than during any other sentence length, two-word versus three-word sentences, $t(285) = 4.80$, $p = .001$; two-word versus four-word sentences, $t(285) = 5.44$, $p < .001$; two-word versus five-word sentences, $t(285) = 5.58$, $p < .001$; two-word versus six-word sentences, $t(285) = 4.92$, $p < .001$; two-word versus seven-word sentences, $t(285) = 4.84$, $p < .001$. The 12-year-olds also spent a significantly greater proportion of the sentence pausing during two-word sentences ($M = 0.03$, $SD = 0.08$) than 10-year-olds spent pausing during two-word sentences ($M = 0$, $SD = 0$; $t(285) = -4.93$, $p < .001$).

Discussion

The primary purpose of this study was to examine the effect of sentence length on speech rate and its characteristics, articulation rate and pauses, in typically developing children between the ages of 10 and 14 years. Based on our findings, sentence length significantly impacts speech rate. Speech rate significantly increased with increases in sentence length. This effect was primarily driven by increased articulation rate and not by increased pause time.

The literature regarding the impact of cognitive–linguistic load on articulation rate in typical development is highly variable due to the differences in the way in which cognitive–linguistic load has been manipulated. The majority of studies that have examined the impact of sentence length on articulation rate have done so within spontaneous speech tasks (Haselager et al., 1991; Logan et al., 2011; Walker & Archibald, 2006; Walker et al., 1992). The major limitation to this method is that the number of sentences at each length is not controlled and there may not have be enough variety in sentence length to adequately examine the question. Hence, studies that ran correlations between articulation rate and utterance length within spontaneous speech samples did not find any relationship between the two variables (Logan et al., 2011; Walker & Archibald, 2006; Walker et al., 1992). However, when systematically separating and comparing short (two to four syllables) versus long (eight or more syllables) utterances within spontaneous speech samples, Haselager et al. (1991) found increases in articulation rate with longer sentences similar to our study.

The current study manipulated cognitive–linguistic load by systematically varying sentence length within a sentence repetition task. To our knowledge, only one other study used a similar methodology to examine cognitive–linguistic load in older typically developing children. Sadagopan and Smith (2008) reported decreased speech rate in 10-word sentences as compared to four-word sentences. However, this study did not examine articulation rate and pause time making it difficult to directly compare

Table 2. Pairwise comparisons for the main effect of sentence length.

Measure	Contrast	Mean difference	*SE*	*p*
Speech rate (syllables per second)	2 words vs. 3 words	–0.31	0.05	< .001*
	2 words vs. 4 words	–0.58	0.05	< .001*
	2 words vs. 5 words	–0.69	0.05	< .001*
	2 words vs. 6 words	–0.73	0.05	< .001*
	2 words vs. 7 words	–1.02	0.05	< .001*
	3 words vs. 4 words	–0.28	0.05	< .001*
	3 words vs. 5 words	–0.38	0.05	< .001*
	3 words vs. 6 words	–0.42	0.05	< .001*
	3 words vs. 7 words	–0.72	0.05	< .001*
	4 words vs. 5 words	–0.11	0.04	.102
	4 words vs. 6 words	–0.15	0.04	.009*
	4 words vs. 7 words	–0.45	0.04	< .001*
	5 words vs. 6 words	–0.04	0.04	.931
	5 words vs. 7 words	–0.33	0.04	< .001*
	6 words vs. 7 words	–0.29	0.04	< .001*
Articulation rate (syllables per second)	2 words vs. 3 words	–0.27	0.05	< .001*
	2 words vs. 4 words	–0.56	0.05	< .001*
	2 words vs. 5 words	–0.67	0.05	< .001*
	2 words vs. 6 words	–0.71	0.05	< .001*
	2 words vs. 7 words	–1	0.05	< .001*
	3 words vs. 4 words	–0.28	0.05	< .001*
	3 words vs. 5 words	–0.4	0.05	< .001*
	3 words vs. 6 words	–0.44	0.05	< .001*
	3 words vs. 7 words	–0.72	0.05	< .001*
	4 words vs. 5 words	–0.11	0.04	.103
	4 words vs. 6 words	–0.16	0.05	.008*
	4 words vs. 7 words	–0.44	0.05	< .001*
	5 words vs. 6 words	–0.04	0.04	.916
	5 words vs. 7 words	–0.33	0.04	< .001*
	6 words vs. 7 words	–0.29	0.05	< .001*
Proportion of time spent pausing	2 words vs. 3 words	0.009	0.002	.001*
	2 words vs. 4 words	0.008	0.002	.011*
	2 words vs. 5 words	0.007	0.002	.01*
	2 words vs. 6 words	0.006	0.002	.08
	2 words vs. 7 words	0.008	0.002	.008*
	3 words vs. 4 words	–0.002	0.002	.956
	3 words vs. 5 words	–0.002	0.002	.932
	3 words vs. 6 words	–0.003	0.002	.621
	3 words vs. 7 words	–0.002	0.002	.974
	4 words vs. 5 words	< –0.001	0.002	1
	4 words vs. 6 words	–0.002	0.002	.977
	4 words vs. 7 words	< 0.001	0.002	1
	5 words vs. 6 words	–0.001	0.002	.981
	5 words vs. 7 words	< 0.001	0.002	1
	6 words vs. 7 words	0.002	0.002	.958

Note. *SE* = standard error.
**p* ≤ .01.

the data. One possibility for the discrepant results is that articulation rate may increase with longer sentences until an inflection point and then decrease again, creating a "u-shape" effect of sentence length. Future work should examine speech rate and its component parts, articulation rate, and pause time across an even broader range of sentence lengths to test this hypothesis.

Interestingly, sentence length effects differentially impacted articulation rate and pause time. Based on these data, it appears that articulation rate may be more sensitive to cognitive–linguistic load than pause time. Pause time was significantly longer in two-word sentences when compared with several other sentence lengths, but pause time did not significantly change across any other sentence lengths. The pausing behavior in two-word sentences was primarily attributed to the performance of the 12-year-olds and will be discussed further in a later paragraph. The lack of change in pause time with longer sentences was surprising given that previous literature suggests that pause time consistently increases with cognitive–linguistic load (Darling-White et al., 2018; Greene, 1984; Greene & Cappella, 1986; Mitchell et al., 1996; Nip & Green, 2013). However, most of this literature involved extemporaneous speech tasks, which provide a higher cognitive–linguistic load than sentence repetition. The only study that utilized a similar methodology, Darling-White et al. (2018), examined this phenomenon in young children with cerebral palsy, so we are unable to directly compare our results. Future work could continue to use a sentence repetition task, but increase cognitive–linguistic load by taking the text away and forcing older children to rely on their working memory to produce the sentences or by increasing the complexity of the sentences to determine if increasing cognitive–linguistic load in this type of task would alter pause time.

This study also examined effects of age on speech rate and its characteristics, articulation rate and pause time, to ensure changes with sentence length could not be explained by age. Consistent with the literature indicating that speech rate is considered approximately adultlike around 12 or 13 years of age (Nip & Green, 2013; Walsh & Smith, 2002), there were no age-related differences between the ages of 10 and 14 years. Additionally, we did not find compelling evidence for an interaction between sentence length effects and age. There were some significant interaction effects found during two-word sentences for 12-year-olds. The 12-year-olds paused for a significantly longer proportion of time during two-word sentences than any other sentence length. The 12-year-olds also paused for a significantly longer proportion of time during two-word sentences than 10-year-olds producing two-word sentences. This could have been a product of the fact that the 12-year-old group had the smallest number of participants ($n = 10$). It is possible this effect may disappear if a larger number of 12-year-olds are studied. The only other study we could find that examined the interaction between utterance length and age in typically developing children near our age range did so in spontaneous speech and similarly found no interaction effects (Haselager et al., 1991).

Limitations

The primary limitation of this study is the use of the adult model during the sentence repetition task. It is possible that the adult model influenced the articulation rates and pause times chosen by the children. This is an inherent problem with any speech production task that relies on repetition or imitation. Based on *t* tests with a significance level of .05, children in the current study spoke with a faster articulation rate and spent more time pausing at each sentence length than the adult model. Our results also support those of Haselager et al. (1991), which used a spontaneous speech sample, not a sentence repetition task. Given that children did not directly copy the adult model and that our results support previous work from a different laboratory, it is unlikely that the adult model unduly influenced the behavior of the children in this study. However, future work on this topic should examine the impact of sentence length on speech rate in speech tasks that do not require an adult model to produce.

Clinical Implications

Clinically, this study provides normative data regarding speech rate performance during a sentence repetition task in typically developing children at every age between 10 and 14 years. Normative data are invaluable when interpreting the performance of a child with speech motor involvement within the appropriate developmental context. For example, the finding that older typically developing children do not produce many pauses regardless of sentence length during sentence repetition tasks, like the *TOCS+*, could be useful for differential diagnosis. Identifying speech motor involvement in children can be difficult, especially if intelligibility is relatively unimpaired. However, inappropriate pause patterns are a hallmark characteristic of speech motor involvement (e.g., Yorkston et al., 2010). If a speech-language pathologist is evaluating a child between the ages of 10 and 14 years, they should expect that child to pause infrequently during the *TOCS+* regardless of sentence length based on these data. Thus, if an older child produces numerous pauses during the *TOCS+*, particularly with increased sentence lengths, the speech-language pathologist can be relatively confident that the child is not typically developing.

Conclusions

This is the first study to suggest that sentence length differentially impacts the component parts of speech rate, articulation rate and pause time. Increases in sentence length led to increases in speech rate, primarily due to increases in articulation rate and not increases in pause time. Articulation rate appears to be highly sensitive to the impact of sentence length, while a higher cognitive–linguistic load may be required to see sentence length effects on pause time. Given the differential impact of cognitive–linguistic load on the component parts of speech rate, it is imperative that future work examining the relationship between speech rate and cognitive–linguistic load continue to analyze articulation rate and pause time separately.

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