Interspeaker Variation in Habitual Speaking Rate: Additional Evidence

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Purpose: The purpose of the present study was to test the hypothesis that talkers previously classified by Y.-C. Tsao and G. Weismer (1997) as habitually fast versus habitually slow would show differences in the way they manipulated articulation rate across the rate continuum.
Method: Thirty talkers previously classified by Tsao and Weismer (1997) as having habitually slow ($n = 15$; 7 males, 8 females) and habitually fast ($n = 15$; 8 males, 7 females) articulation rates produced a single sentence at 7 different rates, using a magnitude production paradigm. Hence, the participants were not randomly assigned to conditions.
Results: Quadratic regression functions relating measured to intended articulation rates were all statistically significant, and most important, there were significant differences between the slow and fast groups in the *y* intercepts of the functions, for both males and females.
Conclusions: This study provides a constructive replication of Tsao and Weismer (1997), showing a difference between slow and fast talkers with a new set of speech materials and in a new task. The findings appear to be consistent with a biological basis for intertalker rate differences.

KEY WORDS: interspeaker variation, speaking rate, direct magnitude production, autometric, scaling functions

In their review of the literature, Grosjean and Lane (1981), and Miller, Grosjean, and Lomanto (1984), highlighted two important parameters used to describe variations in speaking rate: (a) the speed of articulatory gestures throughout an utterance and (b) pause frequency (the number of pauses) and pause intervals that typically separate uninterrupted articulatory sequences. Speaking rate and articulation rate are both defined as the number of output units per unit of time (e.g., syllables or words per minute). Pause intervals are included in the computation of speaking rate, but not that of articulation rate. Large variations in speaking and articulation rates have been observed among talkers and within individual talkers during both normal conversation and more structured laboratory utterances (Crystal & House, 1982, 1988; Miller et al., 1984; Mullennix & Pisoni, 1990; Munhall, 1989). Similarly, large variations have been noted in speaking and articulation rates of various populations (young vs. elderly, normal vs. neurologically disordered), and there is some controversy concerning exactly how talkers voluntarily modify their rates.

An early explanation for variations in speaking rate was that they were largely attributable to the number of pauses used by individuals (Goldman-Eisler, 1961, 1968; Grosjean & Collin, 1979). Miller and colleagues

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(1984), however, argued that articulation rate was primarily responsible for variations in speaking rate. The nature of speaking and articulation rate variation across individuals, and the mechanisms of changing speaking and articulation rates within an individual, are of obvious importance because of the prominent role of rate in clinical applications (e.g., Yorkston, Miller, & Strand, 2004), as well as in theories of normal and disordered speech production and perception (Perkell, 1997; Pisoni, 2005; van Lieshout, Hulstijn, & Peters, 2004).

The Nature of Speaking Rate: A Neuromuscular Constraint Hypothesis

In contrast to the large number of studies on the *effects* of speaking and articulation rates (Gay, 1981; Howell & Sackin, 2000; Klatt, 1976; Lindblom, 1963; Nearey, 1989; Pickett, Blumstein, & Burton, 1999; Smith, 2002; Tsukada & Hirata, 2003; van Son & Pols, 1990; Weismer & Ingrisano, 1979), only a handful of studies (Adams, Weismer, & Kent, 1993; Nusbaum & Morin, 1992; Smith, Sugarman, & Long, 1983; Tsao & Weismer, 1997; Turner & Weismer, 1993) have investigated the *nature* of these rates. The effects of speaking and articulation rates refer to changes in physiological and acoustical signals as a consequence of varying rate; one well-known effect is that of vowel reduction. The nature of speaking and articulation rates refers to the underlying mechanisms in rate variation, either within or across talkers. For example, when Tsao and Weismer (1997) studied interspeaker variability of habitual and maximum rates, they found clear differences between habitually slow and fast talkers. They proposed two hypotheses to account for interspeaker variations in rate. In a neuromuscular hypothesis, they suggested that differing neurological capabilities determine habitual speech rates across individuals; in a sociolinguistic hypothesis, they suggested that social considerations and linguistic aspects influenced an individual's control of his or her speech rate. Tsao and Weismer's (1997) findings were interpreted to be more consistent with the neuromuscular hypothesis.

In their study, Tsao and Weismer (1997) instructed 100 talkers (50 male, 50 female) to produce the Farm Script (Crystal & House, 1982) at a self-selected, habitual rate and at a maximally fast rate. Based on the passage reading at the habitual rates of all 100 talkers, the 15 fastest (hereafter, fast) and 15 slowest (hereafter, slow) talkers were identified. These fast and slow talkers exhibited statistically significant differences in their habitual speaking and articulation rates. Most interesting, the maximum speaking and articulation rates of slow talkers were found to approximate the habitual rates of fast talkers. In addition, a significant linear regression function was found between the habitual and maximum articulation rates for both slow and fast talkers; thus, a speaker's habitual articulation rate predicted his or her fastest possible rate. These findings led Tsao and Weismer to argue that neuromuscular constraints are a crucial factor in the control of an individual's habitual rate and to suggest that some kind of central timekeeping mechanism runs at different speeds in different people, dictating the timing of a variety of events, including speech output.

The assumption of such a mechanism in the human nervous system was first postulated a few decades ago (Allen, 1973; Kozhevnikov & Chistovich, 1965; Wiener, 1958). A study of timing and motor control in clumsy children by Williams, Woollacott, and Ivry (1992) lent additional support to the presence of a central timekeeping mechanism. Williams and colleagues suggested that deficits in a central timing mechanism may explain differences between normal and clumsy children in their timing of repetitive movements. Similarly, Franz, Zelaznik, and Smith (1992) suggested that there are common timing processes underlying the control of speech, orofacial nonspeech, and manual movements.

Control of Speaking Rate: Volitional and Nonvolitional

Control of speaking rate includes both volitional and nonvolitional components. Volitional control of speaking rate has been demonstrated using rate manipulation as an experimental condition (Kozhevnikov & Chistovitch, 1965; Logan, Boberts, Pretto, & Morey, 2002; Ostry & Munhall, 1985; Tsao & Weismer, 1997). In all these experiments, talkers were capable of varying their speaking rates on request. Other studies, such as those by Gay (1981), Adams (1990), and Turner and Weismer (1993), have demonstrated that talkers may consciously alter their habitual speech rate to suit particular speech materials (isolated sentences vs. paragraphs), speaking situations (reading vs. conversation), and listener populations (people who are hearing-impaired, young children, or elderly people). Several studies have demonstrated, however, that not every aspect of speaking rate control is entirely volitional (Fonagy & Magdics, 1960; Tsao & Weismer, 1997; Weismer & Cariski, 1984). For example, Weismer and Cariski found that individuals could not control their habitual speaking rate more precisely by volitional effort than they could control utterances produced under more "natural" conditions wherein they made no particular effort to reproduce the timing characteristics of an utterance. In other words, the stability of speaking rate under the 'natural' conditions was as good as it *could* be, suggesting some biological determinant of whatever timing mechanism is responsible for speaking rate.

Speaking Rate as Global Speech Timing

Both translation theories (e.g., Perkell, 1980) and gesture theories (e.g., Fowler, 1980; Fowler & Saltzman, 1993; Kelso, Saltzman, & Tuller, 1986) have been primarily concerned with segmental durations and their underlying gestures. Although these theories are similar in their emphases on gestures for segmental events, their assumptions concerning speech timing are not the same. Translation theories attribute speech timing to an external neural clock (like the central mechanisms discussed earlier), while gesture theories consider speech timing to be an intrinsic byproduct of the gestural events underlying a segment. In any event, it is clear that the global effects of speaking rate have a major effect on the local segmental durations that have been the focus of so much research (see Allen, 1973; Bell-Berti & Harris, 1981; and Fujimura, 1986 for relevant theoretical perspectives).

The present study extends Tsao and Weismer's (1997) earlier exploration of the nature of speaking/articulation rate variation across talkers by examining the way in which slow and fast talkers vary rates across a wide range of values. The basic research question is whether slow and fast talkers vary rates across the rate continuum in the same way. More specifically, we hypothesized that statistical functions fit to a wide range of articulation rates sampled across the rate continuum would reveal quantitative differences between slow and fast talkers consistent with the original findings of Tsao and Weismer (1997). Such differences would be taken as support for some sort of central timekeeper that runs at different speeds in different individuals, consistent with the neurobiological hypothesis of interspeaker rate variation put forth by Tsao and Weismer (1997). In the present study, a wide range of rate variation for a single sentence, constant for both groups of talkers, was obtained using a magnitude production paradigm (Lane & Grosjean, 1973).

Two subsidiary questions were also asked. First, to evaluate the generality of the difference between habitual rates of slow and fast talkers, habitual rate estimates obtained for the single sentence were compared with the estimates available from the passage reading rates reported by Tsao and Weismer (1997). Second, the variability of the rate estimates was compared for slow and fast talkers as another probe of possible biological differences between the two groups.

Method

Participants and Group Classification Procedures

The 30 talkers in the present study were part of a larger group of 100 native English talkers originally studied by Tsao and Weismer (1997); these talkers were all judged to have dialects heard in the upper midwestern part of the United States. The 100 original participants (50 males, 50 females) were classified into slow, normal, or fast talker groups based on their individual total reading time (phonation time and pause intervals) for the Farm Script (Crystal & House, 1982). The two rate groups of interest for the present study (slow vs. fast) were determined based on a statistical criterion formulated from data published by Miller, Grosjean, and Lomanto (1984). Participants whose total reading time exceeded one standard deviation above the mean of the 100 original participants were classified as slow talkers; similarly, participants whose total reading time was less than one standard deviation below the mean were classified as fast talkers. The means and standard deviations and the classification of slow and fast talkers were obtained separately for males and females. As reported by Tsao and Weismer (1997), this criterion yielded 30 participants, including 15 slow talkers (7 males, 8 females) and 15 fast talkers (8 males, 7 females).

Data Collection: Apparatus, Speech Materials, and Speech Samples

Each participant's speech was recorded using a high-fidelity audiotape recorder (Tandberg, TCD 420A, Type I tape setting with Dolby NR) equipped with an external head-mounted microphone (Shure 1800). The distance and angle of the microphone relative to the speaker's lips were held constant by attaching the microphone to a headband. Cspeech, a speech analysis computer program (Milenkovic, 1994), was employed to analyze the acoustic waveforms of the recorded speech samples. All tape-recorded utterances were filtered at 9.8 kHz and digitized at 22 kHz.

The Farm Script (Crystal & House, 1982), a reading separately passage consisting of 313 monosyllabic words and 880 phones, was used to estimate the participants' speaking and articulation rates. Based on extensive investigation of the segmental composition of this passage, Crystal and House (1982, 1988, 1990) claimed that the Farm Script represented a reasonable approximation of informal spontaneous speech. For the magnitude production task (see below), the single sentence *The sun is so big* constituted the speech sample. Both kinds of speech sample were collected from each talker in a single recording session.

Speech Measures and Data Analysis

Data obtained from the Farm Script, basically the measurement of total reading time, were used in the present study to derive overall speaking rate (syllables per minute) and to compare the rates of different speakers. Articulation rates (syllables per minute), measured for individual runs through the passage, were also measured. As described by Turner and Weismer (1993), and Tsao and Weismer (1997), a run was defined as a stretch of speech between two pauses, where a pause was operationally defined as any silent interval exceeding 150 ms. Mean articulation rate for the entire Farm Script was based on the average of all runs within the passage. Conventional acoustic–phonetic criteria (Klatt, 1976; Weismer, 1984) were used to define onsets and offsets of articulatory runs. In the case of the experimental utterance *The sun is so big,* onset of the utterance was defined as the first evidence of frication noise for the voiced fricative /ð/; offset, as the release of the word final /g/. In Tsao and Weismer (1997), as well as the current experiment, we use the terms *speaking rate* and *articulation rate* in the global sense, recognizing that a reading task (Tsao & Weismer, 1997) and a single-sentence production task (current experiment) may yield quantitative differences from rates extracted from spontaneous speech samples (see the Discussion section).

Experimental Utterance and Direct Magnitude Production Task

A single sentence, *The sun is so big,* was used in the direct magnitude production task to provide data about individuals' rate manipulations across the rate continuum. This sentence consists solely of monosyllables with minimal complexity, thus making it possible to avoid phonetic complications that may affect rate (MacKay, 1974), and is comparable in syllable structure to the Farm Script. The use of a single, relatively brief sentence also allowed the entire utterance to be produced on a single exhalation for all points along the rate continuum.

Both Adams, Weismer, and Kent (1993), and Turner and Weismer (1993) have argued that the direct magnitude production technique generates a continuum of speaking rates that is more natural than, say, metronome pacing of various rates. For the direct magnitude production procedures of the current study, participants were told to assign their habitual rate of speech a value of 100 and to consider that a reference for instructions on varying their speech rates. A number value (i.e., 33, 50, 75, 100, 125, 200, or 300) was presented to participants, and they were asked to produce the experimental utterance at a rate they considered to correspond to that number relative to their habitual rate. Specifically, the number values corresponded to the following target rates:

100 = (the reference point) one's habitual rate
75 = 25% slower than one's habitual rate
50 = twice as slow as one's habitual rate
33 = three times slower than one's habitual rate
125 = 25% faster than one's habitual rate
200 = two times faster than one's habitual rate
300 = three times faster than one's habitual rate

It was assumed that these seven target rates provided a reasonable approximation of the full scale of possible rate variations for each participant. For each production of the participant's speech on the rate continuum, target rate was shown on a card with one of the numerical values (i.e., 33, 50, 75, 100, 125, 200, or 300).

To ensure that the utterances were produced in one breath without pauses, each participant was given three trial practices before seven repetitions at each rate were recorded. The decision to record seven repetitions was based on the concept of trimmed distributions previously described by Tsao and Weismer (1997), whereby a representative mean can be established by eliminating the top and bottom scores of a distribution. Thus, articulation rates were expressed as a mean of five repetitions of the experimental utterance for each speaker at each speaking rate. The order of the presentation of the rates and the seven repetitions per intended rate were randomized for each participant.

Measurement Reliability for the Speaking Rates

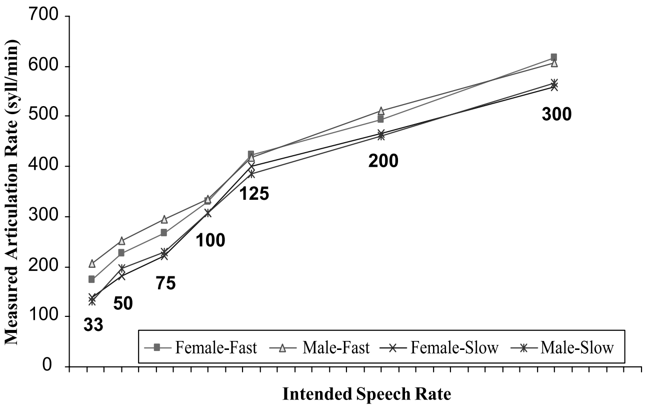
As reported in Tsao and Weismer (1997), intrameasurer reliabilities were obtained based on 10 participants (5 males, 5 females), or 10% of the data set for all 100 participants. The correlation coefficient for repeated measures of the same data set was 1, whereas the correlation coefficient between the two measurements for each individual was greater than .9 for both male and female talkers. The articulation data and pause rate data of 4 participants (2 males, 2 females) from the 30 participants in the slow and fast groups were remeasured. All correlations between original measurement and remeasurements exceeded .9. Two sample *t*-test results showed no significant difference between the values of the original measurements and those of the remeasurements. Similarly, high correlation coefficients (e.g., r = 1, .999, .956, etc.) were found for the direct magnitude production measurements.

Results

Autometric Scaling Functions

Linear-log autometric scaling functions are shown for the two rate groups, separated by sex, in Figure 1. The x axis shows the intended speech rate (33, 50, 75, 100, 125, 200, and 300), and the y axis shows the measured articulation rate in syllables (i.e., word) per minute. Quadratic regression functions ($Y = B_0 + B_1x + B_2x^2$) were determined to be the best fit for all four sets of data. Table 1 presents the quadratic regression equations and analyses of variance for two rate groups and for both sexes; it can be seen that all four regression functions were statistically

Figure 1. Measured articulation rate (*y* axis) as a function of intended speech rate (*x* axis) for the two rate groups, separated by sex. Intended rate of 100 = speakers' estimate of their habitual rate.



significant. The linear and quadratic coefficients for the slow groups were greater than those for the fast groups, and the constants were greater for the fast groups than for the slow groups. The differences in the functions across the rate groups, for both sexes, are apparent in Figure 1, especially in the slower part of the rate continuum where, between intended rates of 33 and 100, the slow talkers had a steeper slope than the fast talkers, lower *y* intercepts, and hence slightly greater curvature in their functions. In other words, the separation between the groups is most apparent for autometric estimates of slower rates, where slow talkers covered a larger range of rates than the fast talkers; functions for rates above 100 appear to be quite similar, with perhaps some offset between groups along the *y* axis.

Statistical evaluation of the regression coefficients between the slow and fast talkers revealed a significant difference for the constant B_0, $t(21) = 2.34$, $p = .029$; the linear and quadratic coefficients were statistically equivalent across the rate groups. The mean constant difference in B_0 between the fast and slow talkers was 71.2 syllables per minute (~ 1.19 syllables per second).

Table 2. Means and standard deviations (*SD*s) of habitual articulation rates (syllables per minute) for the males and females (pooled across rate group), and for the slow and fast talkers (pooled across sex) on the Farm Script (left two data columns) and for an intended rate of 100 on the sentence task. Units are in syllables per minute.

	Farm Script		Direct magnitude sentence production	
	M	*SD*	*M*	*SD*
15 Slow	273	13	294	47
15 Fast	349	21	329	59
15 Male	314	21	309	66
15 Female	308	12	314	40

Relationship Among Articulation Rates for Sentence Production and the Farm Script Reading

Table 2 reports data by rate group (pooled across sex) and by sex (pooled across rate group) for the Farm Script reading at the self-selected, habitual speaking rate and sentence production at the intended rate of 100. The mean articulation rate of fast talkers for the Farm Script reading was 28% faster (349 vs. 273 syllables per minute) than that of slow talkers, but only 12% faster (329 vs. 294 syllables per minute) for sentence production. Note the very similar estimates of habitual rate for males and females in both tasks.

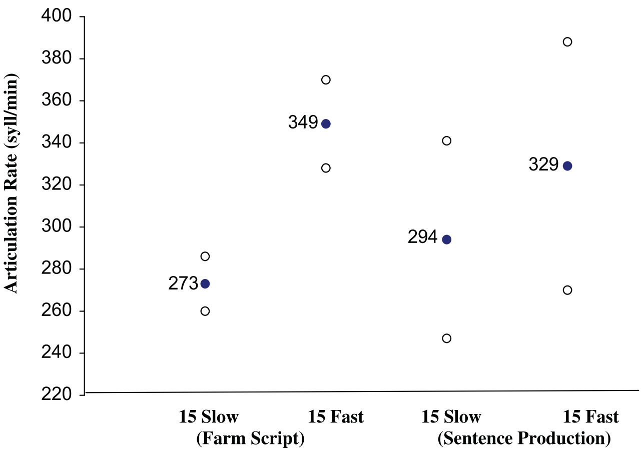
Figure 2 illustrates the relationships among mean articulation rates of the two rate groups for the Farm Script reading and for the direct magnitude sentence production. A nonoverlapping separation in mean articulation rate exists between the two rate groups for the Farm Script, but not for sentence production. As shown in Figure 2, the greater standard deviation for both rate groups in sentence production suggests that some talkers in the slow group were able to speak at rates approximately equal to the mean articulation rates of fast talkers.

Table 1. Quadratic regression functions for relationship between intended (IR) and measured articulation rate (AR). Functions are given for rate groups separated by gender.

	Quadratic regression function $Y = B_0 + B_1x + B_2x^2$	*F*	$R^2 \times 100$	*p*
Slow, male	AR = 11.139 + 3.157 IR − 0.00423 IR^2	$F(2, 4) = 112.3$	98.3%	.0003*
Slow, female	AR = 19.204 + 3.362 IR − 0.00534 IR^2	$F(2, 4) = 137.6$	98.6%	.0002*
Fast, male	AR = 76.936 + 2.959 IR − 0.00411 IR^2	$F(2, 4) = 252.5$	99.2%	<.0001*
Fast, female	AR = 78.172 + 2.814 IR − 0.00374 IR^2	$F(2, 4) = 202.9$	99.0%	<.0001*

*$p < .05$.

Figure 2. Mean articulation rates (filled circles) and plus and minus one standard deviation (unfilled circles) for the Farm Script and direct magnitude sentence production at intended rate of 100, shown by rate groups (slow vs. fast). Units are syllables per minute.



Similarly, some talkers in the fast group spoke at rates that were slower than the mean articulation rates of the slow talkers.

Discussion

The current study has yielded two major findings. First, both slow and fast talkers produce speaking rate continua that are fit almost perfectly by quadratic regression functions; however, the functions for the slow and fast talkers are statistically different with respect to their *y* intercepts, a finding that can be considered to have been replicated within the study because the result is remarkably similar for male and female talkers when analyzed separately (see Table 1). Second, the difference between slow and fast talkers originally demonstrated by Tsao and Weismer (1997) and suggested by the current regression analyses may depend on the type of speech material used to elicit the rate estimates. Both findings are considered below in greater depth.

Regression Fits and y Intercept

The main reason for using the direct magnitude production task was to derive functions reflecting one aspect of the psychophysical properties of speaking rate. These can be called autometric scaling functions, in analogy to the autophonic scaling functions described for vocal loudness (e.g., Lane, Catania, & Stevens, 1961). The finding of well-fit functions relating the psychophysical estimates of speaking rate to actual measured rates suggests that talkers have a good deal of control in modulating their speaking rates in more precise steps than typically employed in rate experiments. Most commonly, rate-related experiments use an habitual-fast (e.g., Ostry & Munhall, 1985; van Son & Pols, 1990) or, rarely, a slow-habitual-fast comparison (Wieneke, Janssen, & Be lderbos,1987; see Adams, 1990; Byrd & Tan, 1996; Lindblom, 1963; Tjaden & Weismer, 1998; and Weismer & Berry, 2003, for exceptions), but these are the first data to describe variation in intended articulation rate across a continuum sampled at multiple points. Examination of the functions suggests that the seven sampling points along the rate continuum, from very slow to very fast, were probably sufficient to capture the true behavior and did not miss important deviations from the statistical fits.

The quadratic fit of the functions suggests that the speaking rate continuum is treated in two different ways, depending on where the rate manipulation is taking place. At the slow end of the continuum, talkers change rate by larger amounts than they do at the faster end, even when the intended step size (that is, the ratio between the magnitude production steps) is the same for the two regions of the continuum. This is seen easily in Figure 1 where the slope of the functions below the habitual rate is clearly greater than the slope above the habitual rate. This finding is probably not surprising because there is a ceiling effect for maximum speaking rates, and talkers tend to produce habitual rates toward the high rather than the low end of the speaking rate continuum (Tiffany, 1980; Turner & Weismer, 1993). Perhaps the quadratic functions can be described more simply as the product of two linear functions, one below habitual speaking rate and one above. Adams (1990) also advanced this interpretation to explain his rate data (cf. Lane & Grosjean, 1973).

The finding of significantly different *y* intercepts for the slow versus fast talkers, especially the essentially identical intercept effects for the male-only and female-only comparisons (see Table 1), supports the hypothesis of Tsao and Weismer (1997) that there is a central timekeeper difference between talkers who use very different habitual rates. The *y* intercept can be thought of as the theoretical, intended rate value of zero, like a baseline "launch point" for speaking rate increments anywhere along the continuum. The significantly greater *y* intercept for fast, as compared with slow talkers, suggests clearly that these two groups of talkers implement rate manipulations from different launch points. That the direction of the *y*-intercept difference across rate groups is fully consistent with their group classification based on an independent speech task (the Farm Script), with lower intercepts for the slow groups, is a remarkable finding. Otherwise, slow and fast talkers seem to treat the speaking rate continuum in roughly the same way, because there were no statistically significant differences between them for the linear or quadratic components of the functions.

As argued by Tsao and Weismer (1997) from a different analysis, this kind of difference suggests biological differences between talkers, rather than conscious choices concerning speaking rate characteristics. The actual y-intercept differences between the slow and fast groups amount to approximately 60 words per minute, which in the more familiar dimensions of speech production time means that for every second of speech produced, there is roughly a 200-ms offset between slow and fast talkers; it is as if slow talkers lag behind fast talkers by roughly one syllable for every second of speech produced.

Type of Speech Material and Differences Between Slow and Fast Talkers

When articulation rate data from the self-selected habitual rates for the Farm Script were compared to the articulation rates derived from the habitual rate target (100) for the isolated sentence, fast talkers had greater rates than slow talkers for both types of material, but the difference was significant only for the Farm Script. As reported in Table 2 and shown in Figure 2, there was virtually complete separation of fast and slow talkers for mean articulation rates from the Farm Script, but substantial overlap between groups for the single-sentence rates. Moreover, when correlation coefficients between means for the intended rate of 100 in the sentence task and means from the habitual rate for the Farm Script were computed across talkers, the values were relatively low and nonsignificant.

The finding that habitual rates of isolated sentence productions do not differ statistically between the rate groups does not invalidate the rate difference findings of Tsao and Weismer (1997) and of the present study. As stated earlier, the y-intercept difference between groups is a reliable effect and, therefore, suggests that something about the single-sentence speech sample or its rate manipulation by magnitude production accounts for the diminished habitual rate difference between the slow and fast groups. Most obviously, the production of isolated utterances may not be the best way to estimate articulation rate, especially with the magnitude production procedure. One indication of this is the relatively large intertalker standard deviations obtained at the intended habitual rate target of 100 in the sentence production task. As reported in Table 2, the group standard deviations for the sentence task were typically three times larger than the standard deviations obtained in the Farm Script. Part of this difference could reflect a better estimate of mean articulation rate in the Farm Script because each participant mean is based on a fairly large number of runs per passage, whereas the sentence means for each participant are based on five repetitions of the intended rate. Alternatively, perhaps the production of an articulation rate equal to 100 in the sentence production task is not the same as the production of a comfortable, habitual rate in the Farm Script reading. Nevertheless, the current findings suggest that the specification of habitual rate and rate variation within a group of individuals may depend to some degree on the type of speech material from which the rate estimates are derived. It may even be the case that articulation rates derived from a reading passage or a single sentence, as in the current study, would be different from estimates obtained from spontaneous speech.

One available comparison is to the spontaneous rate data published by Miller, Grosjean, and Lomanto (1984) for 30 talkers. Expressing their articulation rate data in ms/syllable, Miller and colleagues reported an intertalker range of 173 to 294 ms/syllable; when the current data are transformed into comparable units, the range for 30 talkers is 150 to 237 ms/syllable. The overall slower rates obtained by Miller and colleagues are perhaps not surprising, because their talkers were responding to questions (that is, in an interview format) and the kinds of formulation processes in question answering may have produced some rather long syllables for each speaker, possibly inflating the talker means. Nevertheless, these are not insignificant rate differences, and it would be useful to know, for a set of talkers selected from the two ends of the rate continuum, how their spontaneous and reading articulation rates compare and if the spontaneous rates divide the talkers in the same way as the reading rates.

The y-intercept findings of the current study, which are in precisely the direction predicted by the original Tsao and Weismer (1997) findings, are not from reading material, but rather from repeated and presumably automatic single-sentence productions. Another perspective for these findings, therefore, is that they serve as an independent replication of Tsao and Weismer with a different kind of speech material. Of course, the extrapolation of this effect to spontaneous speech remains unknown.

Conclusions

The original working hypothesis of this study was that there would be differences in the way slow and fast talkers manipulated articulation rate across the rate continuum. In this precise form, the findings do not support this hypothesis, because there were no differences between the linear and quadratic coefficients of the regression fits. The difference between the groups, rather, appears to be a rate offset, revealed by the statistically different y intercepts between the slow and fast talkers. Thus, the manipulation of speaking rate is the same for both groups, but is performed against a constant difference in a theoretical construct of starting rate (i.e., the "launch point" discussed earlier). This result replicates Tsao and Weismer's (1997) finding with different speech materials and a different task, and it supports their claim that biological, not sociolinguistic, factors largely produce intertalker rate variation.

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