Articulatory Performance in Talkers with ALS: Comparisons of Clear and Slow Speech Effects

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INTRODUCTION

• Instructions to speak slower or as clearly as possible are widely used behavioral strategies to improve speech intelligibility during the early stages of ALS (e.g., Trottier, Beacham, & Roll, 2002).

Clear speech → presumably targets reduced phonetic distinctiveness.

• In healthy talkers, clear speech elicits an increase in articulatory displacements, an increase in movement durations, and an increase in the relative contributions of the jaw to tongue and lip movements (Mefferd, in press; Trottier & Goodin, 2013). Further, clear speech tends to decrease articulatory variability (Kuruvilla-Dugdale & Mefferd, 2017).

Slow speech → presumably targets articulatory speed constraints.

In healthy talkers, slow speech is associated with an increase in articulatory displacement, increase in movement duration, an increase in the independent movements of tongue and lip, and an increase in articulatory variability (e.g., Ackerman & Fleishman, 2010; Mefferd & Green, 2013; Mefferd, Custer, et al., 1999).

• Although slow speech has been investigated in talkers with ALS (e.g., Kuruvilla-Dugdale & Mefferd, 2017; Mefferd, Passage, & Green, 2014), there is a lack of research addressing how an increase in clear and slow speech affects articulatory performance and motor control in this clinical population.

• It is unclear if and how clear and slow speech may affect articulatory and articulatory control differently in talkers with ALS.

• Such insights may provide guidance in the selection of a speech treatment approach for talkers with ALS and may also provide a context to better understand the decline in speaking rate and articulatory changes during the early stages of speech deterioration.

STUDY AIM & HYPOTHESES

STUDY AIM: To determine the effects of clear and slow speech on articulatory performance and articulatory control in talkers with ALS and healthy controls.

HYPOTHESIS (TASK EFFECTS)

• PERFORMANCE: Movement durations will increase during clear and slow speech. Path length will show task-specific and articulator-specific changes. Inter-articulator coupling (jaw-tongue, jaw-lip) will increase during clear speech but decrease during slow speech for controls; however, no predictions were made for talkers with ALS.

• MOTOR CONTROL: In controls, articulatory variability will decrease during clear speech but increase during slow speech. In talkers with ALS, articulatory variability will increase during slow speech; however, no specific predictions could be made for clear speech.

HYPOTHESIS (GROUP EFFECTS)

• PERFORMANCE: Groups will differ across all articulatory performance measures for habitual speech. No predictions were made for slow and clear speech.

• MOTOR CONTROL: Talkers with ALS will have lower articulatory variability than controls during habitual speech; however, groups will not differ during slow speech. No specific predictions were made for clear speech.

METHODS

EXPERIMENTAL TASKS

• Participants were asked to repeat the sentence ‘Say that I owe you a yoyo today’

10 X habitual rate and loudness
10 X slow speech (i.e., half the habitual speaking rate)
10 X clear speech (i.e., overarticulation)

ARTICULATORY PATH LENGTH

• Articulatory path length – the total distance a sensor moved from movement onset to offset.

1 Movement duration – the time from movement onset to offset.

2 Inter-articulator decoupling – ratio of average speed of the lower lip – jaw and tongue – jaw, a higher ratio indicates more decoupling between jaw and lip/tongue.

ARTICULATORY VARIABILITY

• Tongue motor control was indexed using the spatiotemporal variability index (STI)

• STI – consistency of articulatory movement patterns are across ten repeated productions of the same utterance.

RESULTS

1) Articulator Path Length

- ALS: Habitual > Clear = Slow
- Controls: Habitual < Slow = Clear

2) Movement Duration

- ALS: Habitual > Clear = Slow
- Controls: Habitual < Slow = Clear

3) Inter-Articulator Decoupling

- ALS: Habitual < Clear = Slow
- Controls: Habitual > Clear > Slow

DISCUSSION & CONCLUSIONS

ARTICULATORY PERFORMANCE

• As predicted, movement durations increased for both groups. Compared to controls, talkers with ALS had longer durations for habitual and clear speech, but not for slow speech.

• Trends of task group interactions can be observed for all three articulators, showing greater articulatory performance differences in talkers with ALS relative to controls.

• However, this remains unclear if these exaggerated jaw movements indicate a compensatory strategy (i.e., clear speech) or a pathology.

• Findings suggest that larger jaw movements in talkers with ALS result in greater inter-articulator coupling (jaw-lip, jaw-tongue) during habitual speech. Trends of larger tongue composite movement during habitual, clear, and slow speech in talkers with ALS relative to controls are also likely jaw-driven.

• May explain small vowel space areas during habitual and slow speech in talkers with ALS in the presence of large tongue composite movements (Mefferd, 2016; Trottier, Tjaden, & Waser, 1995).

ARTICULATORY CONTROL

- Significantly lower articulatory variability in talkers with ALS compared to controls during habitual speech replicate previous findings for jaw and lip movements (Mefferd et al., 2016).

- Large jaw movements during habitual speech in talkers with ALS may indicate that the jaw is used as an active articulator (vs. stabilizing role) with more goal-directed movements compared to controls, which may explain jaw variability during habitual speech in ALS.

- Increased jaw-lip and jaw-tongue coupling in talkers with ALS may explain the lower variability of lower lip and tongue movements in talkers with ALS for habitual speech.

- Jaw variability increased from habitual to clear and slow speech in talkers with ALS. Increasing the already large jaw movements may tax the speech motor system for talkers with ALS. In addition, on-going changes may contribute to increased jaw variability (e.g., Mefferd et al., 2016; Smith et al., 1980).

CLINICAL IMPLICATIONS

• Because of the high degree of inter-articulator coupling (jaw-lip, jaw-tongue) that were observed in talkers with ALS, treatments may need to focus on more independent tongue and lip movement to improve phonetic distinctiveness and ultimately intelligibility in these talkers. Based on findings of this study, neither slow or clear speech appear to achieve this.

• Talkers with ALS may already implement an articulatory strategy that balances articulatory performance and control while also managing fatigue.

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