The Interference and Intelligibility of Speech Articulation

Nadine Lee, Dept. of Psychology Trinity College
Advisor: Professor Elizabeth Casserly

Trinity College
HARTFORD CONNECTICUT

Introduction

Researchers have looked at distracted speech intelligibility with acoustics but not with articulation. Previous research has shown a decrease in speech intelligibility in *acoustics* when speaking (interference task) in front of a mirror (Thulin, 2018).

The current study explored what would happen to *articulation* while doing an interference task.

If distraction causes a decrease in speech intelligibility…

- How does articulation change between the "No Distraction" and "Digit Memory Task" conditions?

Hypothesis: The "Digit Memory Task" condition will show a decrease in articulatory effort compared to the "No Distraction" condition.

Results

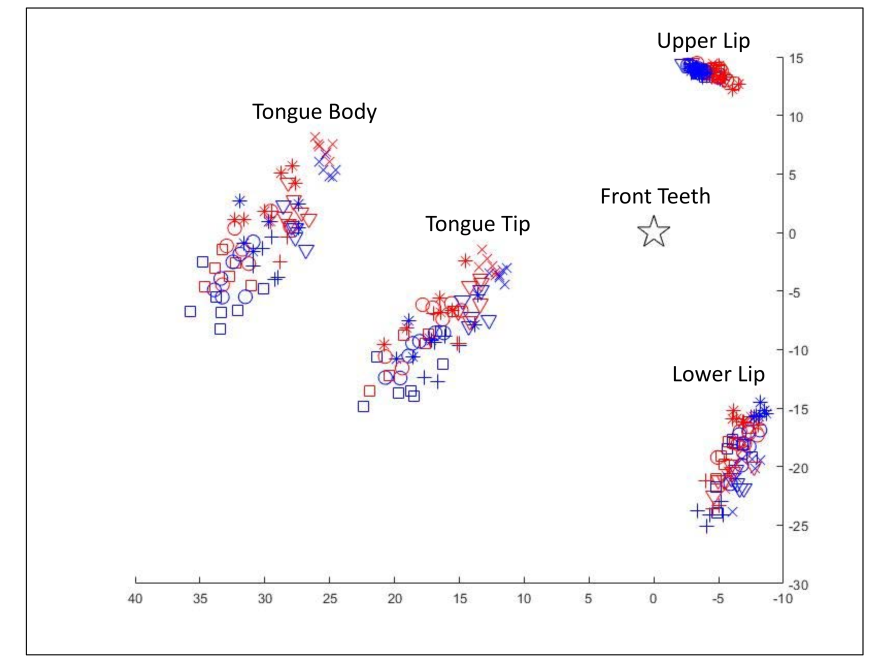
Key

Symbol	Vowel	Sounds Like
×	i	The "ee" sound in "bee"
▽	ɛ	The "eh" sound in "bed"
✳	u	The "oo" sound in "boo"
+	æ	The "a" sound in "bad"
○	ʌ	The "uh" sound in "bus"
□	ɑ	The "aw" sound in "saw"
☆ Reference Sensor		

Block 1
Block 2

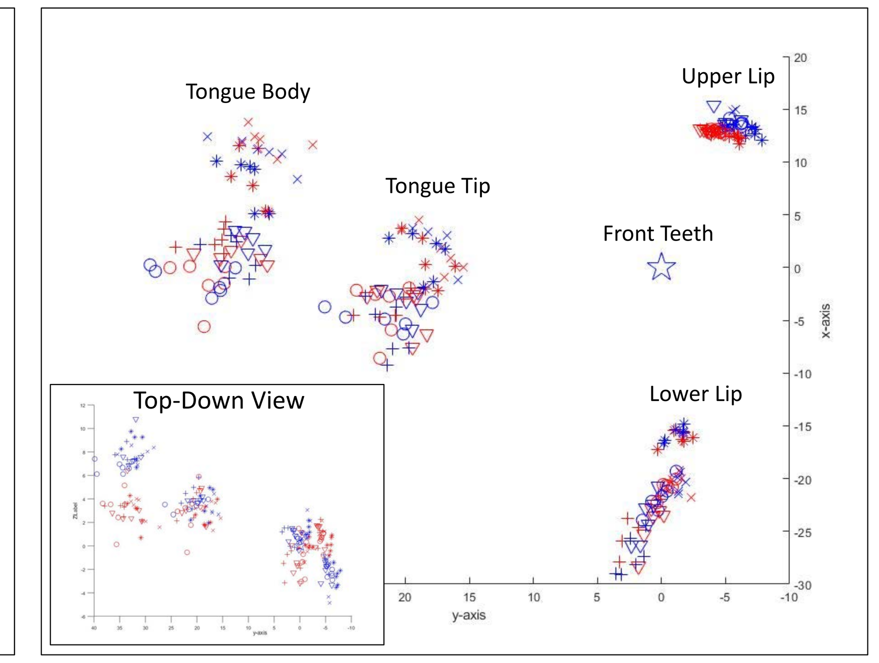
*Within-participant RM-ANOVA on x, y, z positions of each sensor. Significance criterion of $p < .0125$ with correction for multiple test across sensors.

Participant A



Participant A. The tongue tip and tongue body were significantly* higher in the distraction condition relative to baseline. The upper lip was significantly* more protruded in the distraction condition than at baseline. The lower lip was significantly* more protruded in the baseline than in the distraction condition.

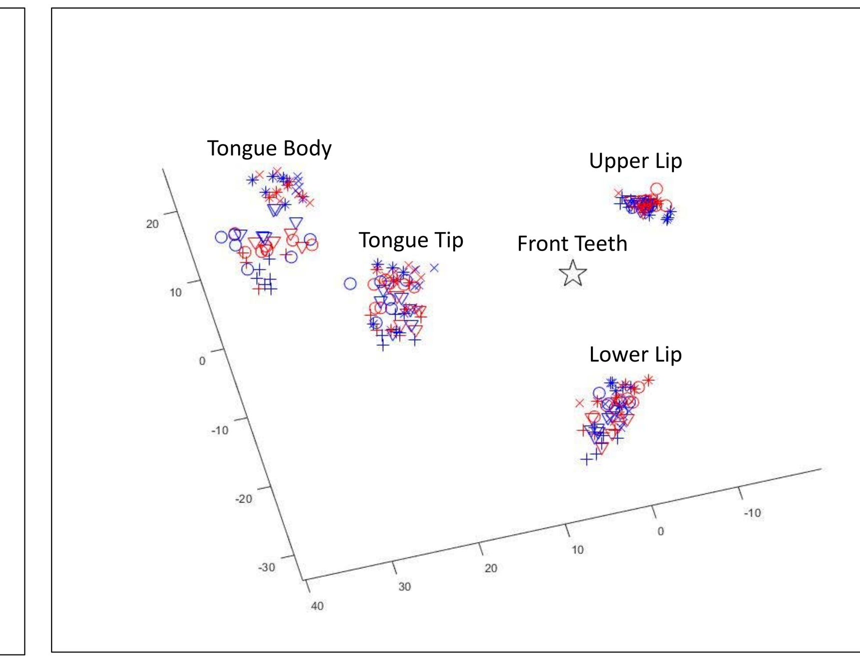
Participant C



Participant C. There were significant* differences in all three dimensions for the upper lip. For the tongue tip, tongue body, and lower lip, there were significant* differences only in the z-axis.

Top Down View. Shows the z-axis – meaning there were lateral differences in the two blocks

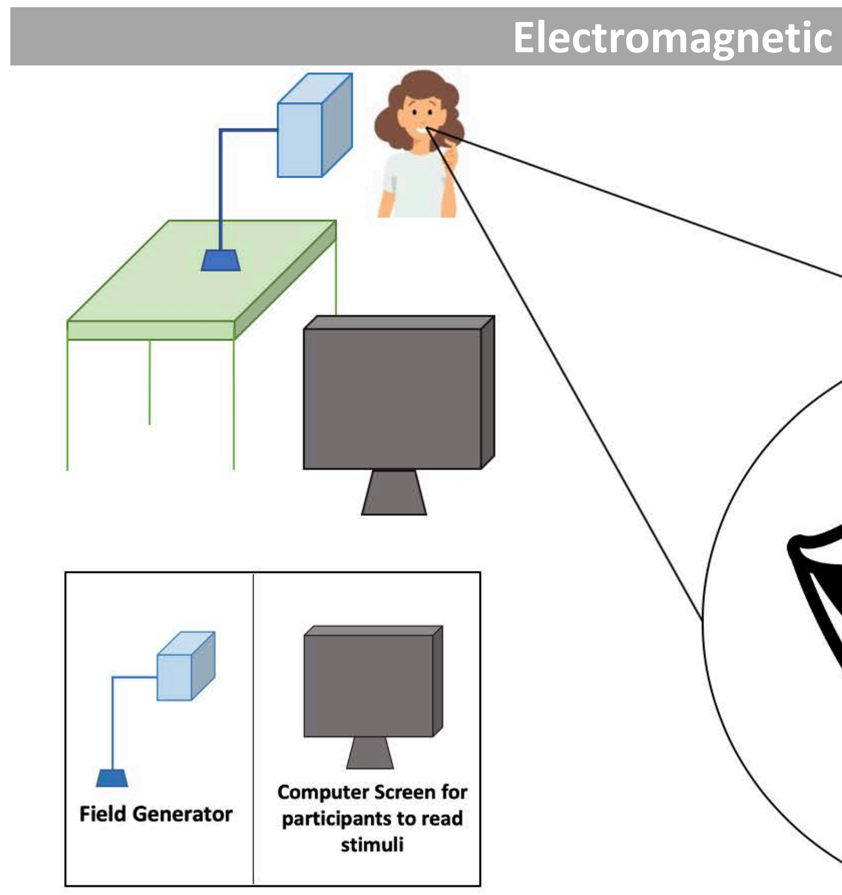
Participant D



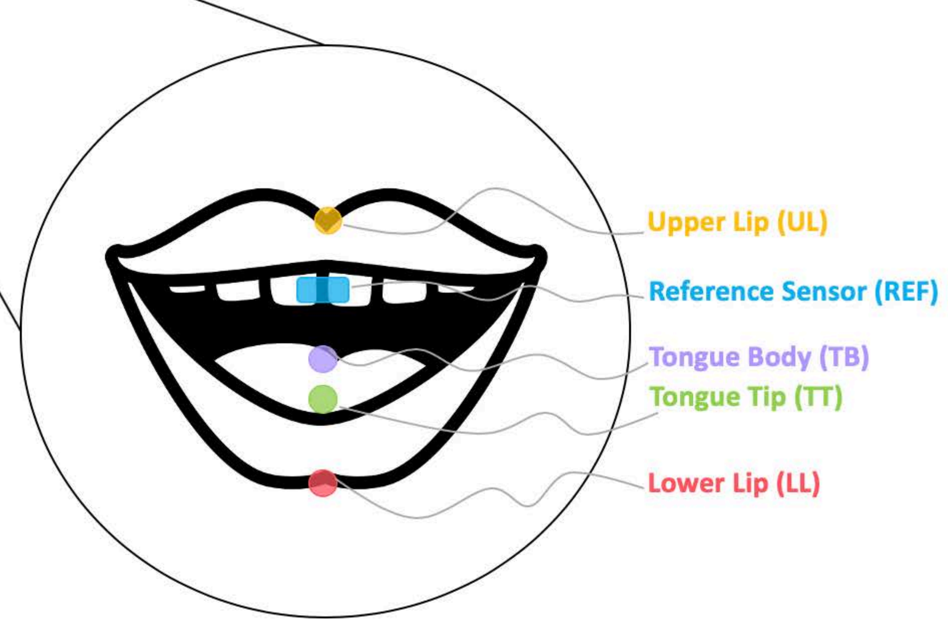
Participant D. There were no significant differences in any of the three dimensions (x, y, and z axes).
Note: We did find significant differences across vowels.

Methods

Electromagnetic Articulography

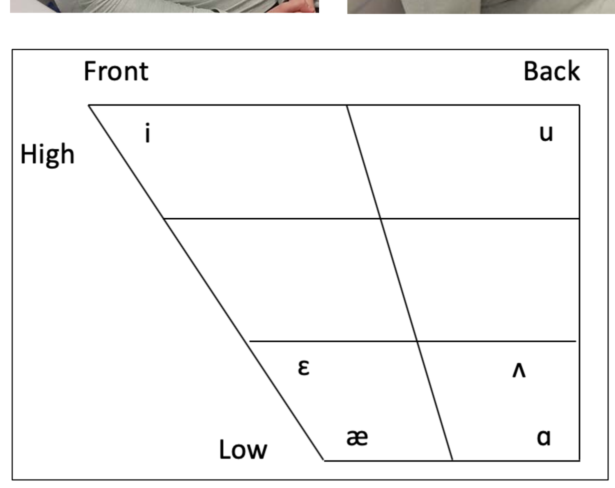


The participant sat next to the Field Generator so that the sensors were registered by the Wave Software



Glustitch Periacryl® Oral Adhesive used to apply five sensors onto the areas of the mouth

A hairdryer helped to dry the tongue for best sensor application



Vowel Chart. The six vowels that were used for stimuli. Three front vowels and three back vowels.

Stimuli Screen

- Participants were asked to say the phrase in the middle of the screen
- The vowel key to the right assisted in certain vowel pronunciation
- The unvoiced consonants (s, t, k) came before or after vowels
- 36 trials per condition

Experimental Design

Four undergraduate female students participated in this study

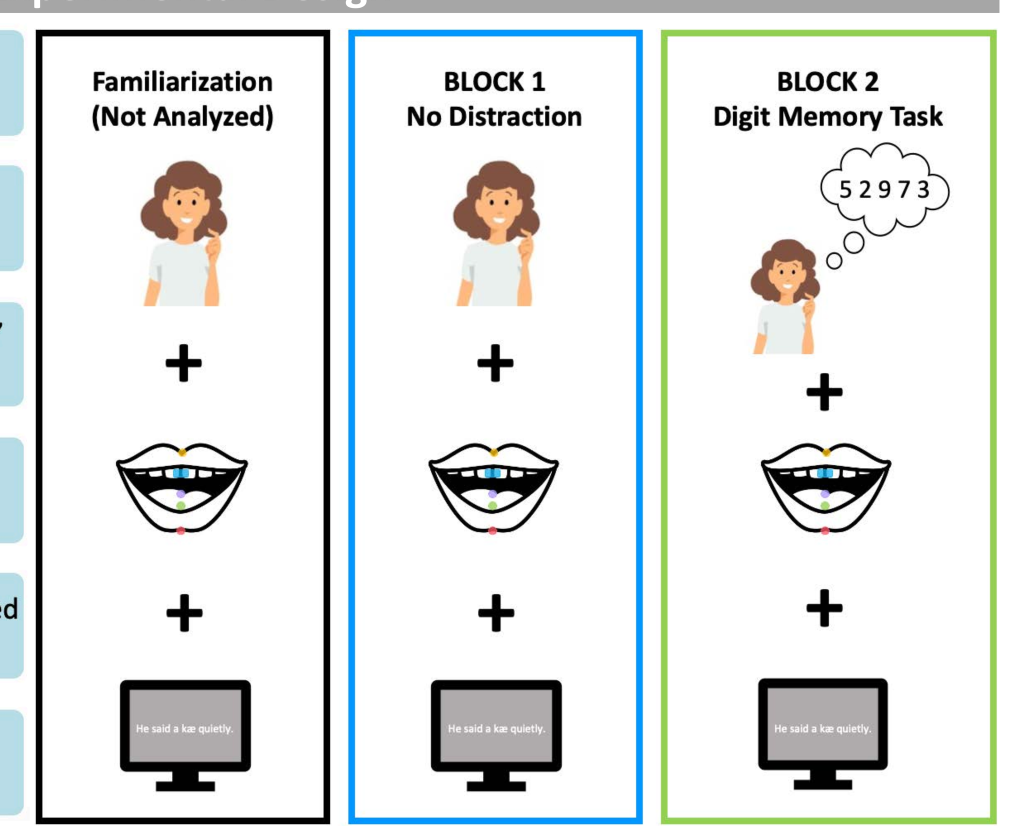
Stimuli (phrases) were adapted from Kim and Max (2014)

Stimuli Formula: "He said a kV quietly." (V = vowel)

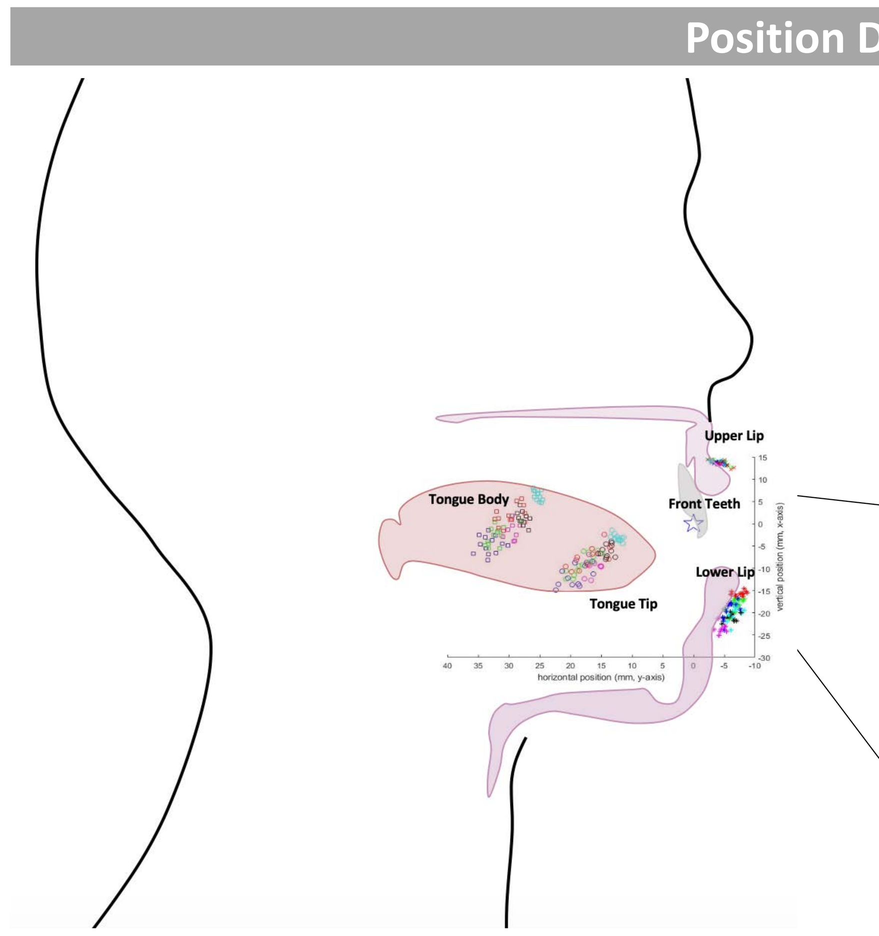
Stimuli Formula: "He spoke Vk again." (V = vowel)

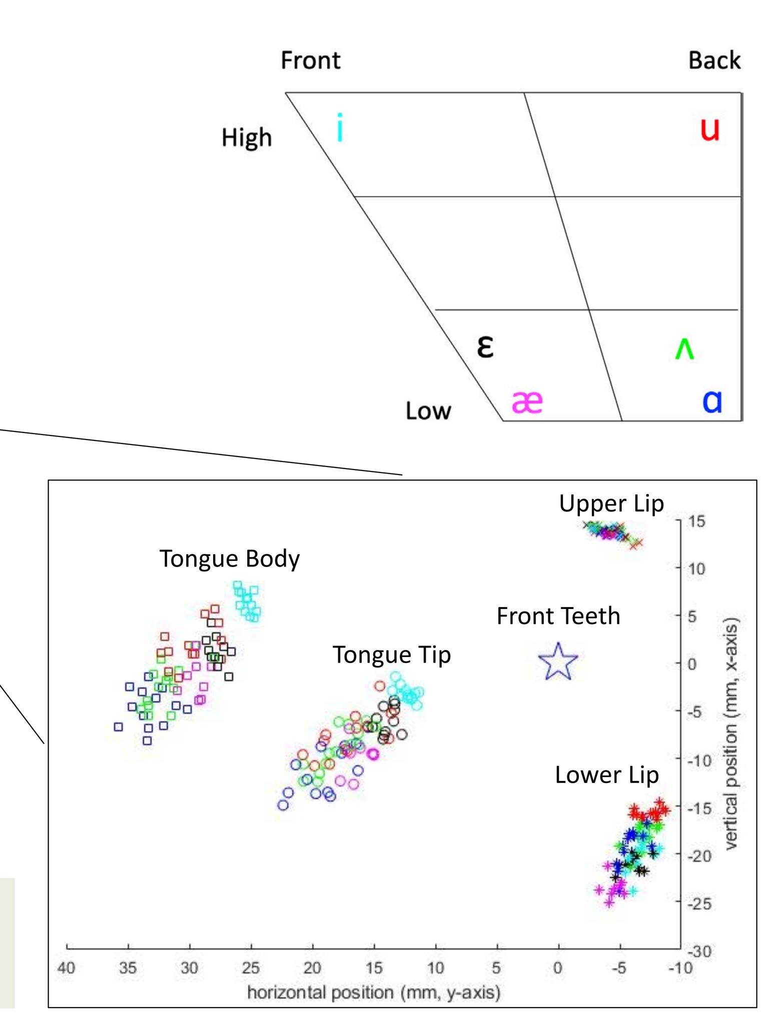
All three conditions: Participants recited phrases with sensors in their mouth

Block 2 included a digit memory task



Position Data





Position Data Graph. The data gathered from the Electromagnetic Articulographer. Use this data to observe if there are changes in position.

Discussion & Conclusion

Participant A: This participant's results are most aligned with our hypothesis that the "Digit Memory Task" condition (Block 2) would show a decrease in articulatory effort compared to the "No Distraction" condition (Block 1). Participant A's entire tongue was higher in Block 2 than at baseline which corresponds to less opening of the mouth and less effort.

Participant C: This participant showed significant differences in lateral position of the lips and tongue. This may be due to the realigning of the sensors during the study or it may be evidence for lateral movement as a strategy for articulatory effort.

Participant D: This participant showed no changes between the two blocks. This is not surprising and may imply that some people do not change in their articulatory strategy regardless of multiple cognitive demands.

Participant B: This participant's results were not analyzed due to technical difficulties in keeping sensors in place.

Limitations: The reapplication of sensors for Participant C may have been a reason for the significant differences in lateral movement. It is important to restart the study if sensors need to be reapplied. For future research, it would be important to verify that acoustic intelligibility matches up with what we see in articulation. We want to see if we yield the same results (Participant A and Participant C get less intelligible; Participant D has no change) when we measure acoustic intelligibility (asking people to listen and respond).

Conclusion: Articulatory effort looks different for different people when speaking while doing another task.

Acknowledgements

I would like to thank Professor Elizabeth Casserly for her dedication to advising and supporting me throughout this project. I would also like to thank the professors of the Psychology Department, particularly Professor Senland, for their guidance throughout the thesis process.

References

[1] Bernhardt, B., Gick, B., Bacsfalvi, P., & Ashdown, J. (2003). Speech habilitation of hard of hearing adolescents using electropalatography and ultrasound as evaluated by trained listeners. *Clinical Linguistics & Phonetics*, *17*(3), 199–216. https://doi.org/10.1080/0269920031000071451
[2] Buz, E., Tanenhaus, M. K., & Jaeger, T. F. (2016). Dynamically adapted context-specific hyper-articulation: Feedback from interlocutors affects speakers' subsequent pronunciations. *Journal of Memory and Language*, *89*, 68–86. https://doi.org/10.1016/j.jml.2015.12.009
[3] Harnsberger, J. D., Wright, R., & Pisoni, D. B. (2008). A new method for eliciting three speaking styles in the laboratory. *Speech Communication*, *50*(4), 323–336. https://doi.org/10.1016/j.specom.2007.11.001
[4] Katz, W. F., McNeil, M. R., & Garst, D. M. (2010). Treating apraxia of speech (AOS) with EMA-supplied visual augmented feedback. *Aphasiology*, *24*(6–8), 826–837. https://doi.org/10.1080/02687030903518176
[5] Katz, W. F., & Mehta, S. (2015). Visual Feedback of Tongue Movement for Novel Speech Sound Learning. *Frontiers in Human Neuroscience*, *9*. https://doi.org/10.3389/fnhum.2015.00612
[6] Kim, K. S., & Max, L. (2014). Estimating feedforward vs. Feedback control of speech production through kinematic analyses of unperturbed articulatory movements. *Frontiers in Human Neuroscience*, *8*. https://doi.org/10.3389/fnhum.2014.00911
[7] *Lindblom (1990)—H&H theory copy.pdf*. (n.d.).
[8] Lisman, A. L., & Sadagopan, N. (2013). Focus of attention and speech motor performance. *Journal of Communication Disorders*, *46*(3), 281–293. https://doi.org/10.1016/j.jcomdis.2013.02.002
[9] Pashler, H. (n.d.). *Dual-Task Interference in Simple Tasks: Data and Theory*. 25.
[10] Smiljanić, R., & Bradlow, A. R. (2009). Speaking and Hearing Clearly: Talker and Listener Factors in Speaking Style Changes. *Language and Linguistics Compass*, *3*(1), 236–264. https://doi.org/10.1111/j.1749-818X.2008.00112.x
[11] Thulin, J. (2018). The role of sensorimotor feedback and the intelligibility of speech. Undergraduate Thesis. Trinity College.
[12] Ullman, M. T., Earle, F. S., Walenski, M., & Janacsek, K. (2020). The Neurocognition of Developmental Disorders of Language. *Annual Review of Psychology*, *71*(1), 389–417. https://doi.org/10.1146/annurev-psych-122216-011555