Pupillary response as a measure of cognitive load in the processing of accented speech

Marc Barnard[1], Scott Kunkel[1], Rémi Lamarque[1], and Adam J. Chong[1]

[1]*Queen Mary University of London*

As a physiological indicator of cognitive load, pupil dilation can serve as a measure of listening effort in speech perception. This is the case even when speech is fully comprehensible. For instance, it has been found that American listeners' pupil sizes increase when listening to accurately understood Chinese-accented speech compared to when listening to American English speech [1], indicating that greater cognitive load is imposed when processing non-native speech. However, it remains unclear whether the same effect extends to listeners' processing of speech produced in less familiar native accents. This is important given evidence that the processing of native and non-native speech may entail different normalization procedures, as non-native speech may be phonetically less coherent and predictable for a native listener [2, 3]. Despite this, the relative effortfulness involved in processing accurately understood non-native and unfamiliar native speech remains underexplored in the literature.

In this study, we examined listeners' processing of native and non-native accents. We conducted a pupillometry experiment in which participants from the South of England heard 120 sentences produced in four different accents: Southern British English (SBE; the participants' own accent), American English (AmE; an accent widely used in media but otherwise not regularly encountered by participants), Glaswegian English (GE; a less familiar regional accent), and Chinese-accented English (CaE; a non-native English accent). Pupil dilation was measured by tracking changes in pupil size between a resting baseline period and a period during which participants heard an accented sentence. After hearing each sentence, participants repeated what they heard aloud, to ensure that sentences were accurately understood. Time-course of pupil dilation was analyzed using Growth Curve Analysis [4].

Preliminary results (n = 34; Figure 1) demonstrate the predicted pattern in pupillary response, with listeners' own SBE accent requiring less listening effort overall to process. Participants showed significantly higher pupil dilation when listening to non-native CaE speech ($p<0.001$). Moreover, when participants heard less familiar native AmE and GE speech, mean pupil dilation was higher than when hearing SBE. However, the overall effect was just above significance in the AmE case ($p<0.052$) and did not reach significance for GE. Interestingly, pupil dilation was numerically higher in the AmE than GE condition, despite presumably wide familiarity with AmE through popular media exposure.

Initial results replicate [1] in showing that non-native accents impose a significantly greater cognitive load on listeners than speech in the participants' own accent, even when accurately perceived. Our data further suggest that some accurately perceived regionally accented speech (i.e., AmE) might also impose a cognitive cost, but to a much lesser extent than non-native accented speech. This lends support to the hypothesis that the normalization of non-native speech may impose a greater cognitive load than unfamiliar native speech [2]. More generally, this extends an executive recruitment account of speech perception beyond non-native speech to include native regional and national varieties [5]. Further, this study validates the utility of pupillometry as a fine-grained measure of listening effort, and contributes to a growing body of work examining sociophonetic perception through more implicit methods.

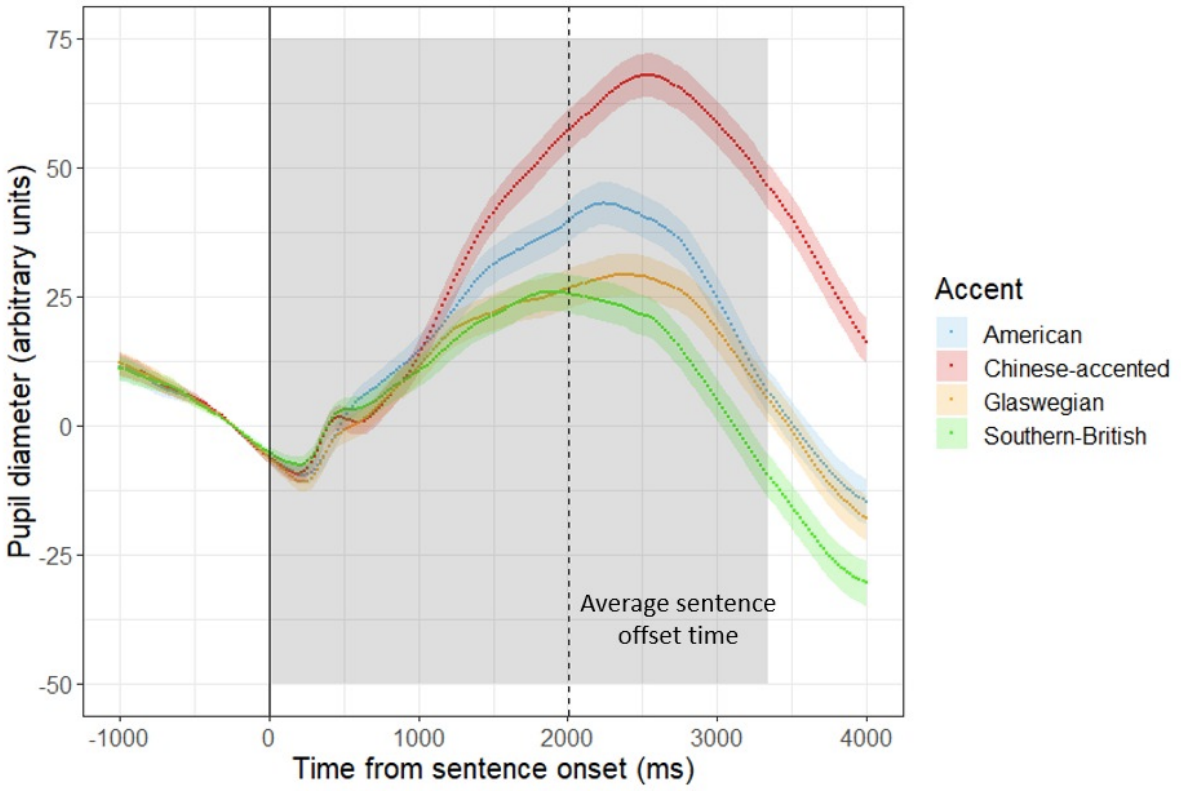

Figure 1. Mean pupil dilation response across participants by accent. In gray is the area of interest from which data were fed into the statistical models.

References

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