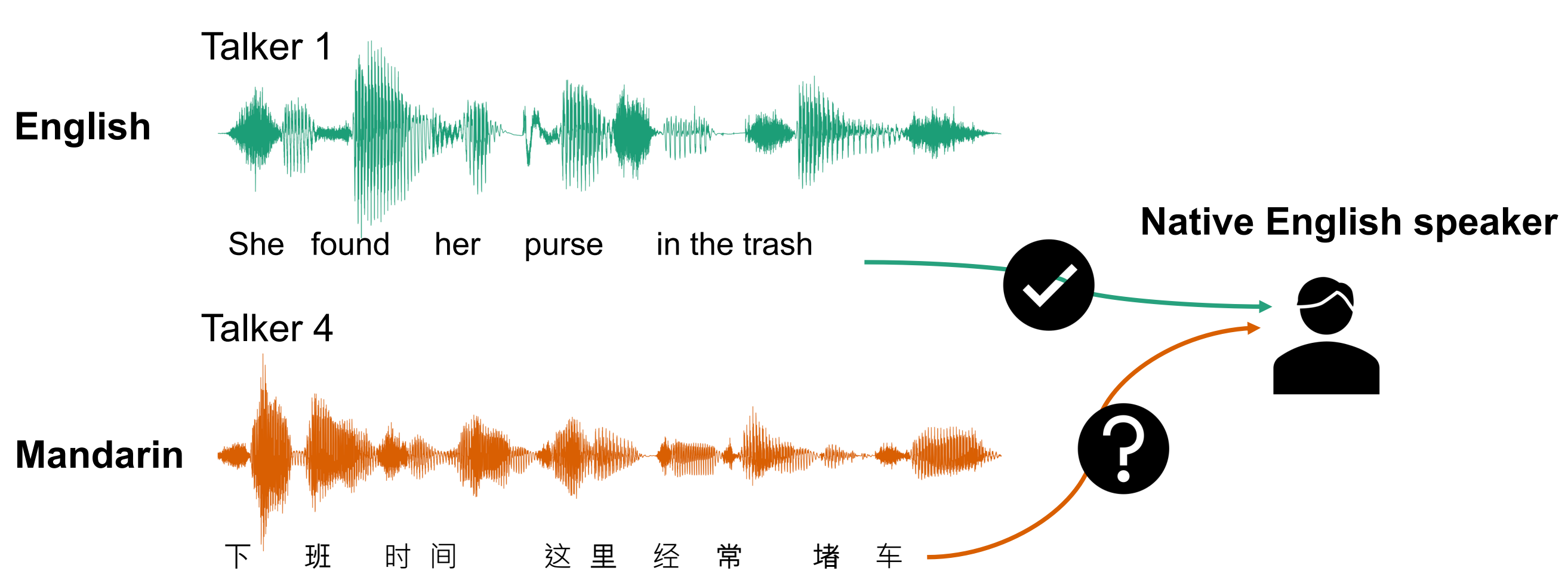# Pupillary measures of identifying talkers in native and unfamiliar languages

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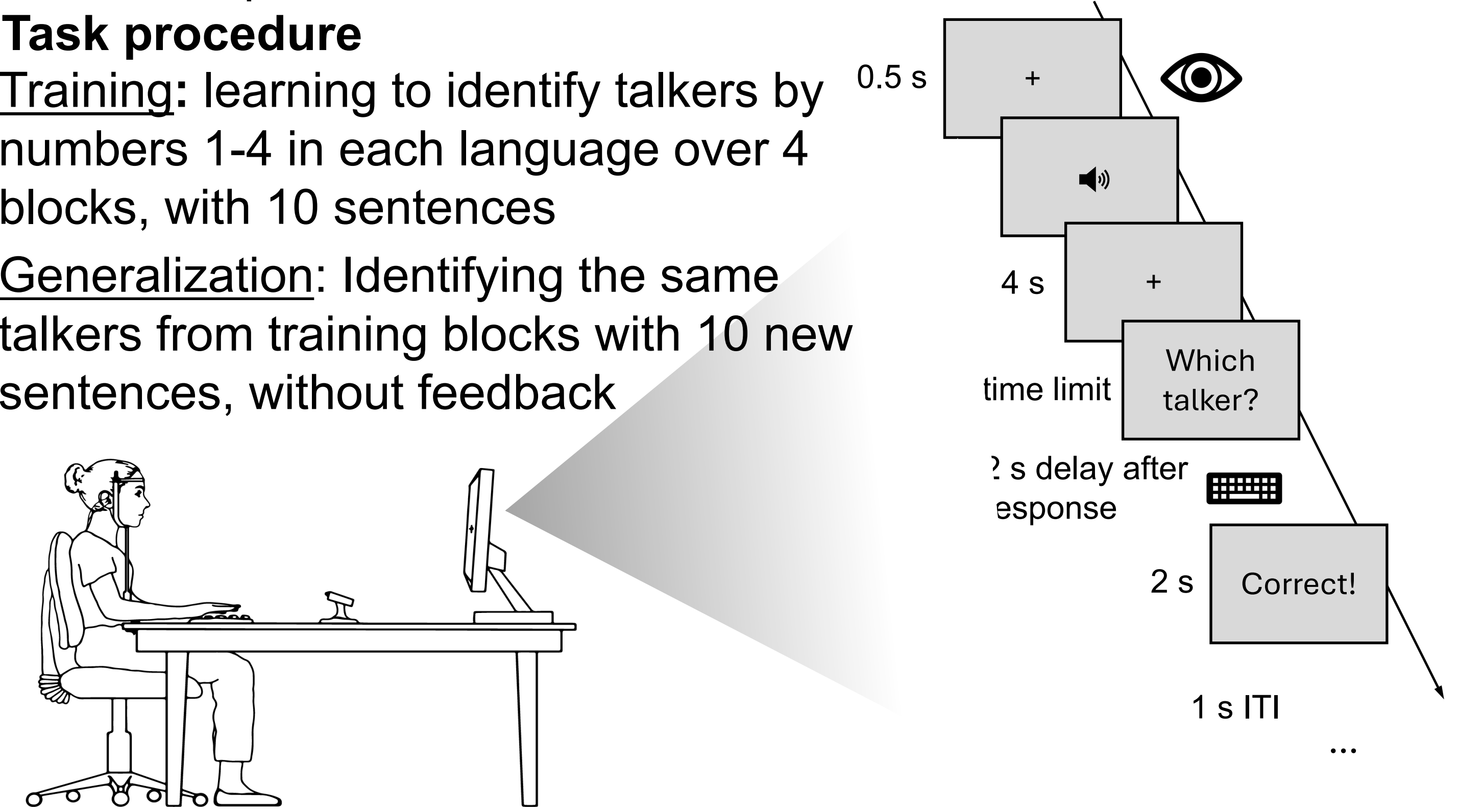
SoundBrain Lab

Introduction

- Learning to distinguish and identify people's voices is an essential part of our everyday speech communication.
- **Language familiarity effect**[1,2]: Listeners are more accurate when identifying talkers who speak in their native language than those who speak in their non-native language.
  - Acoustic characteristics of the voice + Familiarity with phonology and higher-level lexical representations of the native language

English — Talker 1 — She found her purse in the trash

Mandarin — Talker 4 — 下班 时间 这里 经常 堵车

Native English speaker

- **Pupillometry**: Real-time measure of cognitive effort – greater pupil dilation indicating more processing demands[3]
- **Does processing more features of the native-language stimuli lead to greater pupil dilation while identifying talkers?**
- **Does language familiarity also decrease effort and increase efficiency with which listeners identify talkers?**
- Drift diffusion models (DDMs)[4,5]: integrate accuracy and response time to uncover decision-making processes
 - Parameters such as evidence accumulation rates and decision thresholds, reflected by task-evoked pupillary responses[6]

Methods

- **Participants**: N=24 native English speakers (age 19-33 yrs; M=24.7), normal hearing, no previous experience with Mandarin
- **Stimuli**: 20 English sentences from 4 male native American English speakers and 20 Mandarin sentences from 4 male native Mandarin speakers[7]
- **Task procedure**
  Training: learning to identify talkers by numbers 1-4 in each language over 4 blocks, with 10 sentences
  Generalization: Identifying the same talkers from training blocks with 10 new sentences, without feedback

0.5 s — + — (eye)
4 s — (speaker)
time limit — + — Which talker?
? s delay after response — (keyboard)
2 s — Correct!
1 s ITI ...

Behavioral Results

- Participants were **significantly more accurate and faster when identifying talkers in English than Mandarin**. (*p*s < 0.01)
- Over the blocks, participants got significantly more accurate and faster at identifying talkers. (*p*s < 0.05)
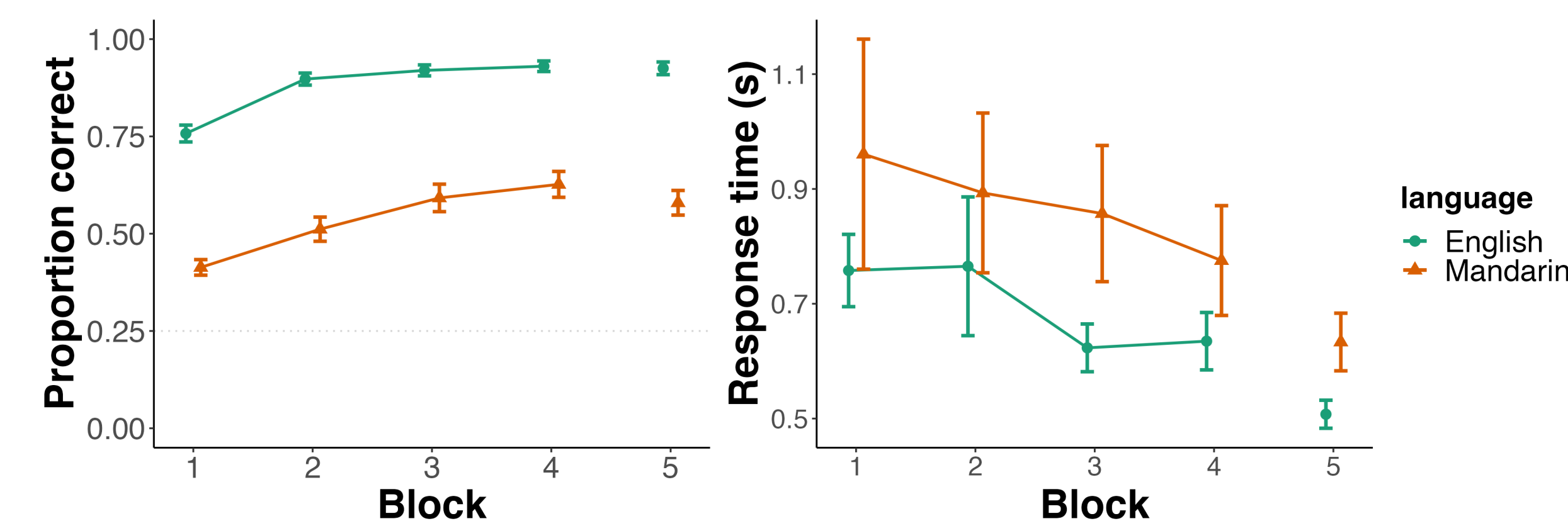

Decision-making processes

- DDM assumption: listeners noisily accumulate evidence when a stimulus is presented, and a decision is reached when enough evidence has been accumulated.
- **Evidence accumulation rate**: efficiency of extracting relevant sensory information from stimulus
- **Decision threshold**: amount of information needed to make the decision; decision cautiousness
- Evidence accumulation rate for English increased significantly from block 1 to 2, while for Mandarin, evidence accumulation did not change across blocks.
- There was no significant difference in decision thresholds across blocks in either language.
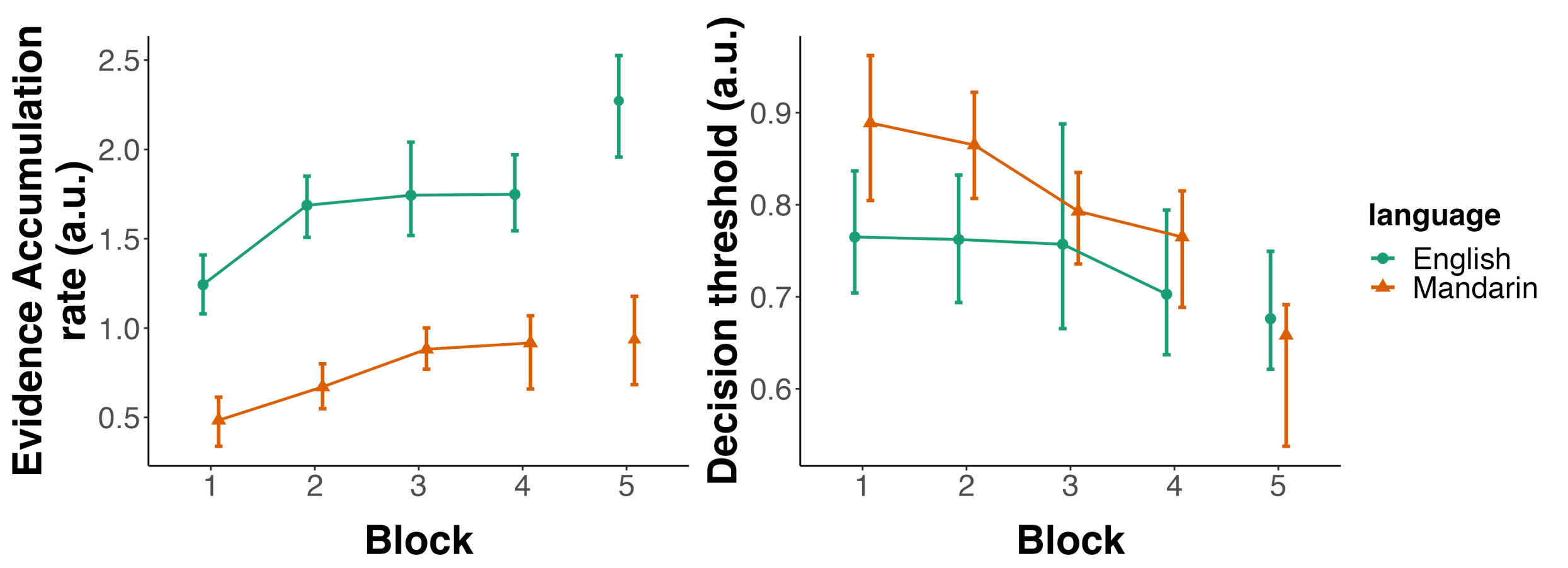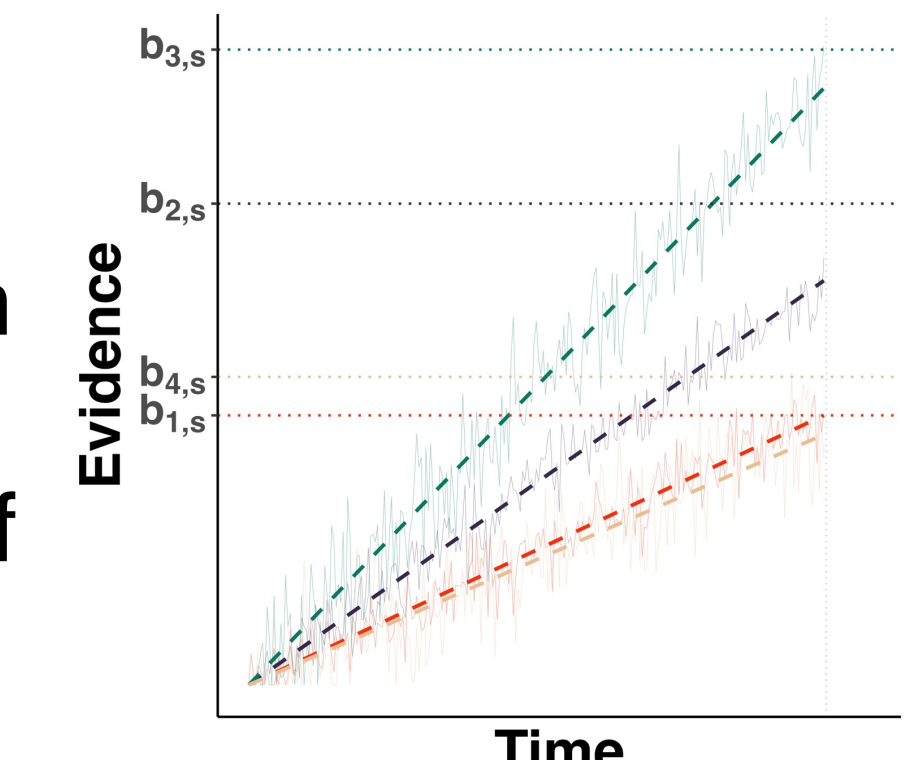
- **Greater pupil dilation was associated with lower evidence accumulation rate and lower decision threshold.**
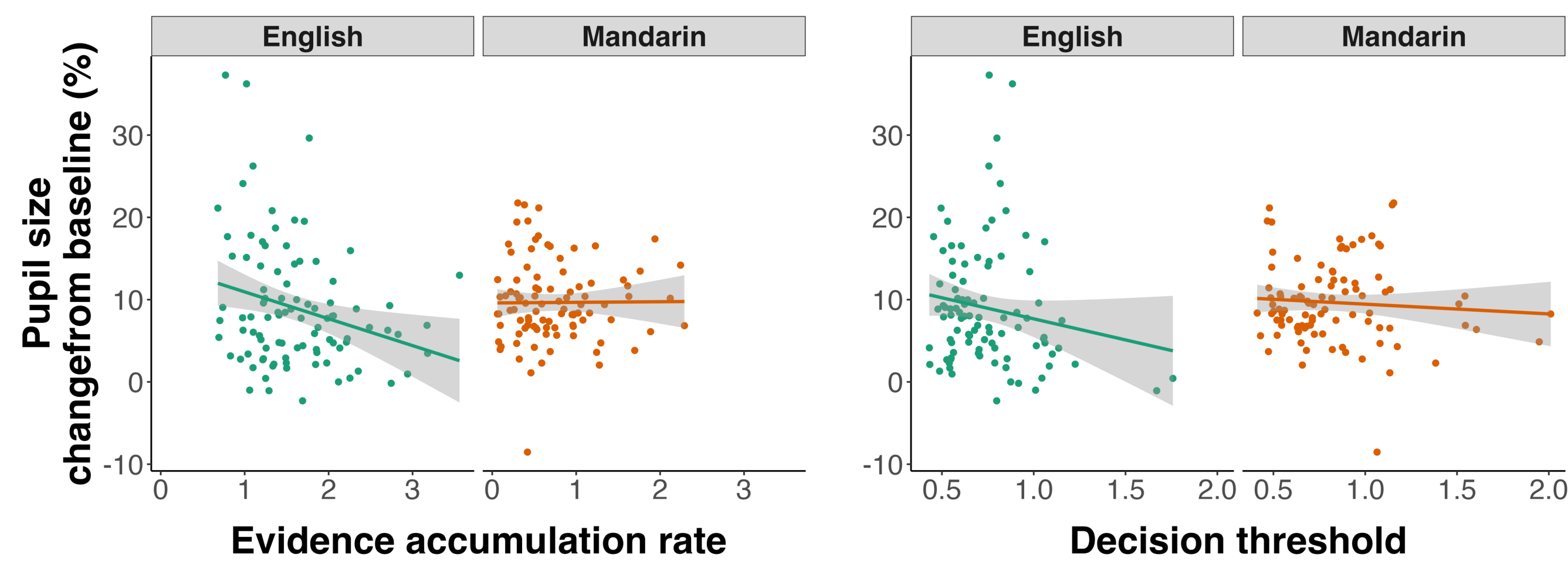
Pupillometry Results

- Main effect of language: **significantly greater pupil dilation in Mandarin than in English** (*p* < 0.001)
- No main effect of block on pupil dilation
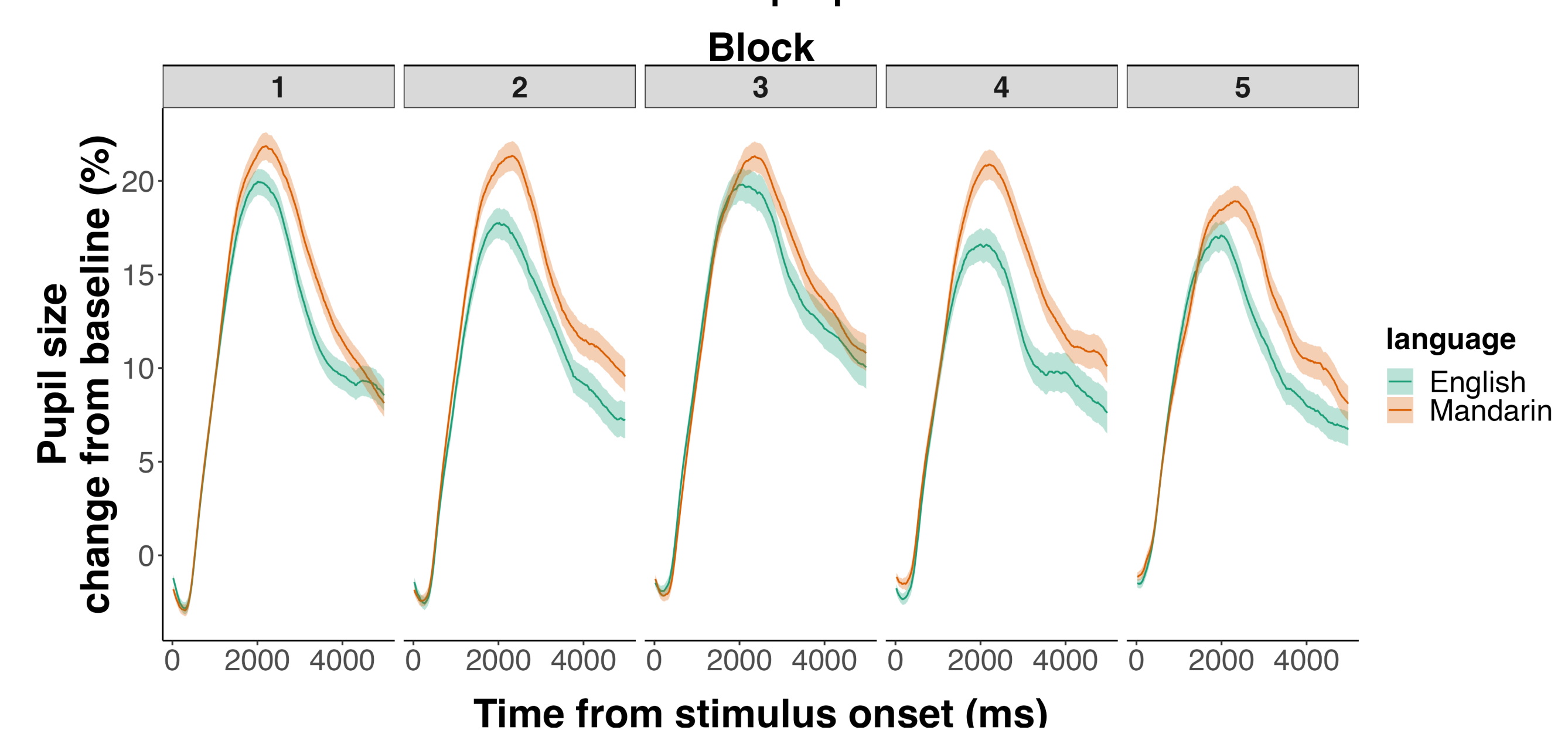
Discussion

- Greater pupil dilation being associated with lower accuracy in identifying talkers in non-native language indicates greater mental effort in non-native talker identification.
- Processing and comprehending one's native language at multiple different linguistic levels does not add cognitive load to talker learning but rather facilitate talker identification, highlighting the intricate connection between speech perception and voice learning.
- Greater mental effort, as indexed by greater pupil dilation, was associated with less efficient evidence accumulation and lower response caution during talker learning, suggesting that an overall inefficiency and insufficient understanding of necessary information lead to greater mental effort in learning voices.

References

[1] Goggin et al. (1991). *Memory & cognition.*
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[6] McHaney et al. (2024). *bioRxiv*, 2024-04.
[7] Bradlow, A. R. (n.d.) ALLSSTAR: Archive of L1 and L2 Scripted and Spontaneous Transcripts And Recordings.

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