Audiovisual Recalibration and Stimulus Reliability

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Introduction

Research questions: Does audiovisual recalibration depend on stimulus reliability? Does causal inference for localization impact recalibration?

Audiovisual integration: Perceived auditory location is attracted towards a temporally co-occurring visual stimulus.

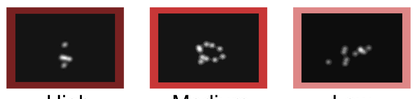
Audiovisual recalibration: The shift of perceived auditory stimulus location persists in the absence of a visual stimulus.

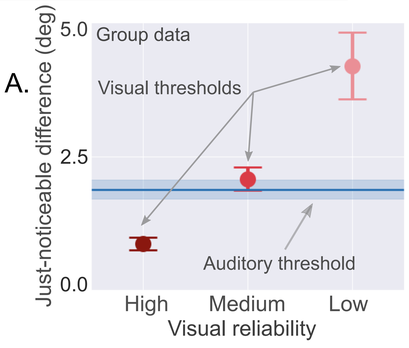
1. Unimodal Spatial Discrimination Task

Goal: Adjust spatial uncertainty of visual stimuli; adjust relation between visual and auditory reliability to: V > A, V ≈ A, and V < A.

Tasks: 2IFC unimodal spatial discrimination (1 auditory and 3 visual conditions)

Visual stimuli:

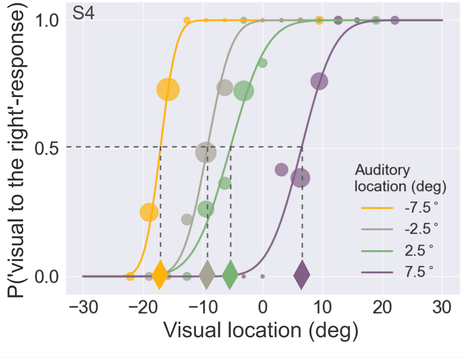


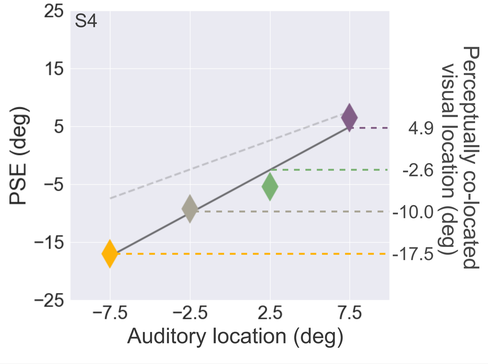


2. Bimodal Spatial Discrimination Task

Goal: Adjust for perceptual bias; for each of four auditory locations, find visual locations perceived as co-located.

Task: 2IFC bimodal spatial discrimination



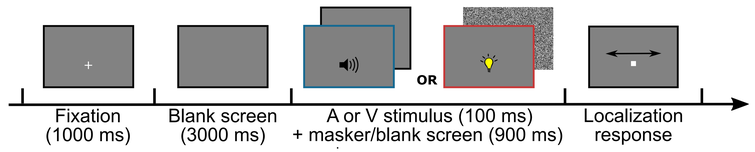


3. Audiovisual Recalibration Expt.

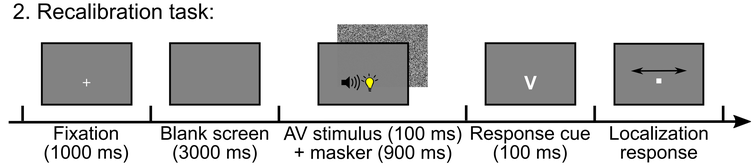
Goal: Investigate whether audiovisual recalibration varies with stimulus reliability.

Tasks: Unimodal spatial localization
1. Baseline (unimodal auditory/visual stimuli)
2. Recalibration (spatially discrepant audiovisual stimuli)
3. Post-recalibration (identical to Baseline)

1. Baseline & 3. Post-recalibration tasks:

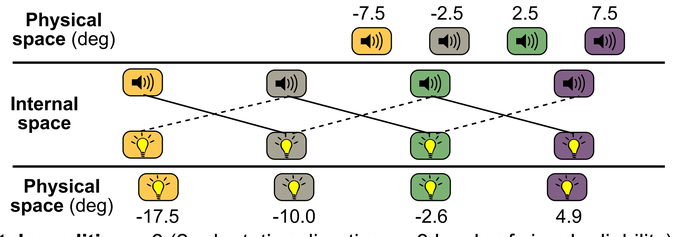


2. Recalibration task:

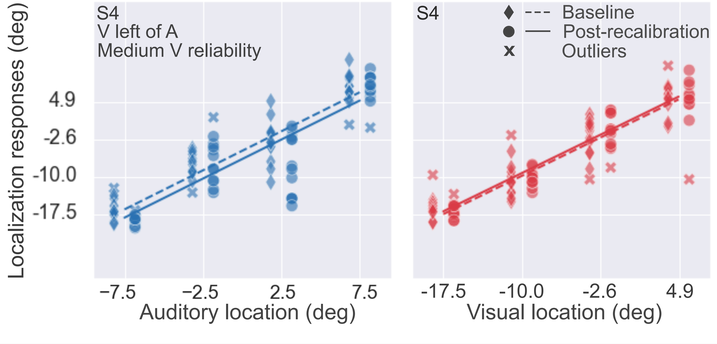


Stimuli and conditions:

Adaptation direction: - - - Visual left of auditory —— Visual right of auditory



Total conditions: 6 (2 adaptation directions x 3 levels of visual reliability)



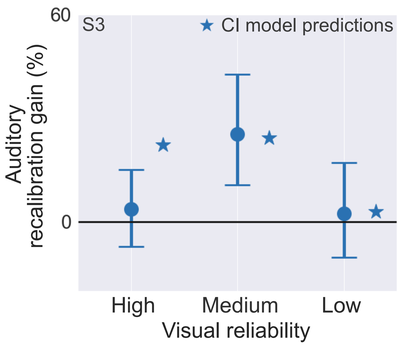
Modeling

General assumptions:
- Sensory measurements are biased; bias is a linear function of stimulus location.
- Sensory-measurement shifts change to compensate for audiovisual discrepancy.
- Sensory reliability differs between unimodal and bimodal conditions.
- People have a prior for stimulus location.

Model fitting:

Data jointly fit using maximum-likelihood procedure:
- Bimodal Spatial Discrimination Task
- Baseline Task
- Post-recalibration Task

Models of recalibration:
- Fixed-ratio (FR) (Zaidel, Turner, & Angelaki, 2011)
- Reliability-based (RB) (Ghahramani, Wolpert, & Jordan, 1997)
- Causal-inference (CI) (Körding, Beierholm, Ma, Quartz, Tenenbaum, & Shams, 2007; Sato, Toyoizumi, & Aihara, 2007)



AIC - AIC_{min}

Subject	RB	FR	CI
S1	8.2	14.2	0
S2	0	5.6	0.4
S3	11.4	12.2	0
S4	4.4	8.6	0
S5	24	21	0
S6	0	4.8	3.6

Model

Conclusions

Auditory recalibration is best captured by the CI model, suggesting that auditory recalibration is contingent on visual reliability and location estimates based on causal inference about a common audiovisual source.

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