Audiovisual Temporal Recalibration Exerts an Influence on Sound-Induced Flash Illusion

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Introduction

- **Audiovisual temporal recalibration:** the shift of point of subjective simultaneity (PSS) towards the direction of the adapted audiovisual lag
- Previous research on temporal recalibration has mostly utilized explicit temporal judgment tasks (simultaneity judgment, temporal order judgment tasks)

To investigate **whether temporal recalibration can be captured through an indirect task,** we used the **sound-induced flash illusion (SIFI)** and measured the temporal binding window (TBW).

Methods

Baseline

Sound-induced flash illusion (SIFI)

Adaptation sessions

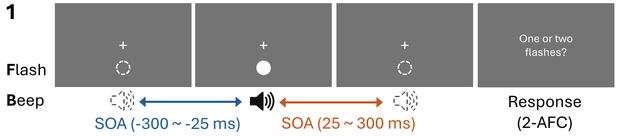
Adaptation 3 min → SIFI trials → Top-up adaptation audiovisual pairs

SIFI

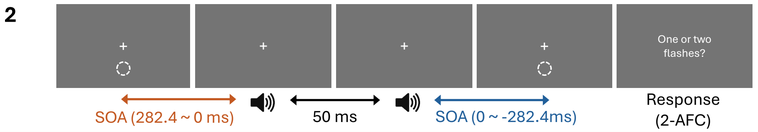
Stimuli:
[Visual] 2° diameter, 5° eccentricity, 16.5ms(Exp. 1) / 11.7ms (Exp. 2)
[Auditory] 1800 Hz, 10 ms

Conditions:
1F2B (illusion) / 1F1B / 2F2B

Exp. 1



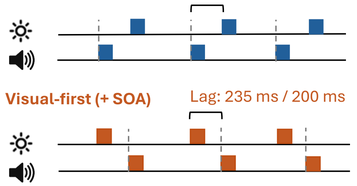
Exp. 2



Adaptation

Auditory-first (- SOA) Lag: -235 ms (Exp. 1) / -200 ms (Exp. 2)

Visual-first (+ SOA) Lag: 235 ms / 200 ms



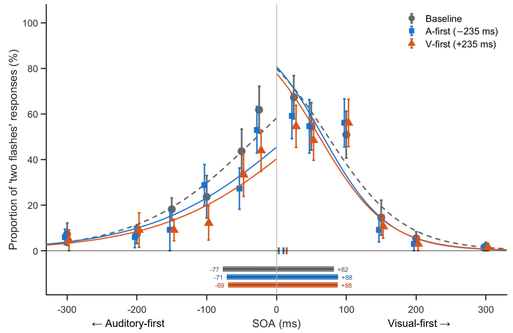
Oddball detection task
- Bigger flash (3/2 size)
- Lower pitch (1500Hz)

Adaptation sessions
Exp. 1: 4 sessions (random order)
Exp. 2: 8 sessions (block design)
- 5-minute rest between blocks
- Order counterbalanced between participants

	Exp. 1	Exp. 2
Participants (# males)	12 (2)	20 (7)
SIFI trials between top-up adaptations	24-25	8
Audiovisual pairs during top-up adaptation	8	10

Results

Exp. 1 Illusion rate and temporal binding window (TBW)

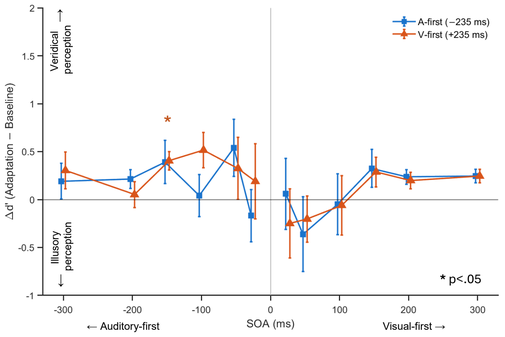


Illusion rate
- Participants experienced SIFI (SOA main effect: p<.001)
- There was no significant Lag * SOA interaction

TBW
- TBW center and width did not differ between lag conditions (6 valid participants)

TBW: Estimated by fitting logistic sigmoid functions to auditory-first and visual-first SOA directions separately. Boundaries were defined as the SOA at which the fitted curve reached 50% of each individual's peak illusion rate.

Discrimination of real vs. illusory flashes after adaptation



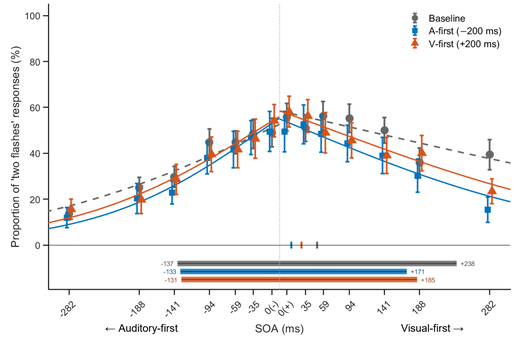
***d'* (2-flash discriminability)**
- There was no significant Lag * SOA interaction (RM-ANOVA)

Δ*d'* after adaptation
- At −150 ms SOA, *d'* significantly increased from baseline after visual-first adaptation (p=.021) (one-sample t-test, Bonferroni-corrected)

Visual-first adaptation may have reduced audiovisual integration at auditory-first SOAs

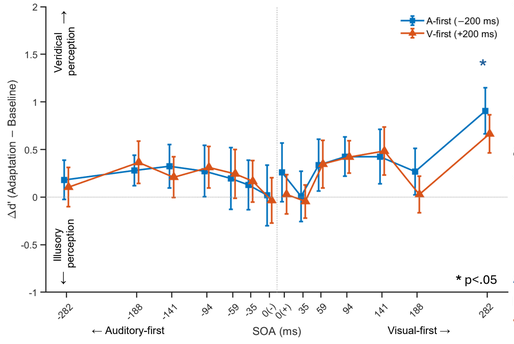
d' = z(hit rate) − z(false alarm rate)
- *Hit: "2 flashes" at 2F2B*
- *False alarm: "2 flashes" at 1F2B*

Exp. 2



Illusion rate
- Participants experienced SIFI (SOA main effect: p<.001)
- Lag * SOA interaction effect approached significance (p=.060)

TBW
- TBW center shifted significantly toward auditory-first SOAs after auditory-first adaptation, hinting at temporal recalibration (Baseline: 64.9 ± 18.2 ms; Auditory-first: 23.0 ± 13.0 ms; p=.014) (9 valid participants)



***d'* (2-flash discriminability)**
- There was a significant Lag * SOA interaction (p=.022), largely driven by elevated *d'* after auditory-first adaptation at +282 ms SOA (RM-ANOVA)

Δ*d'* after adaptation
- At +282 ms SOA, *d'* significantly increased from baseline after auditory-first adaptation (p=.028) (one-sample t-test, Bonferroni-corrected)

Auditory-first adaptation may have reduced audiovisual integration at visual-first SOAs

Repeated Measures ANOVA (RM-ANOVA)
3 Lag (Baseline, Visual-first, Auditory-first) *
14 SOA (±0, 35, 59, 94, 141, 188, 282ms)

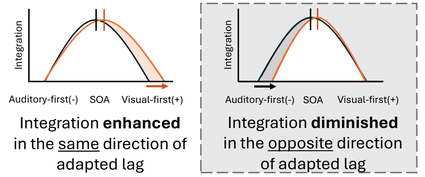
Across both experiments, lag adaptation seems to have reduced audiovisual integration at SOAs opposite to the adapted lag direction

Discussion

Temporal recalibration influenced SIFI, an indirect task of audiovisual integration.
- Exp. 1: visual-first adaptation increased *d'* at auditory-first SOA
- Exp. 2: auditory-first adaptation shifted TBW center toward auditory-first SOAs and increased *d'* at visual-first SOA

⇒ Temporal recalibration captured through SIFI may operate by diminishing integration in the direction opposite to the adapted lag rather than enhancing integration in the adapted direction.

Potential mechanism of temporal recalibration



Integration **enhanced** in the same direction of adapted lag

Integration **diminished** in the opposite direction of adapted lag

[1] Fujisaki, W., Shimojo, S., Kashino, M., & Nishida, S. (2004). Recalibration of audiovisual simultaneity. *Nature Neuroscience, 7*, 773–778.
[2] Vroomen, J., Keetels, M., de Gelder, B., & Bertelson, P. (2004). Recalibration of temporal order perception by exposure to audio-visual asynchrony. *Cognitive Brain Research, 22*, 32–35.
[3] Shams, L., Kamitani, Y., & Shimojo, S. (2000). Illusions: What you see is what you hear. *Nature, 408*, 788.

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