The intentional binding of auditory and visual action effects

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Background

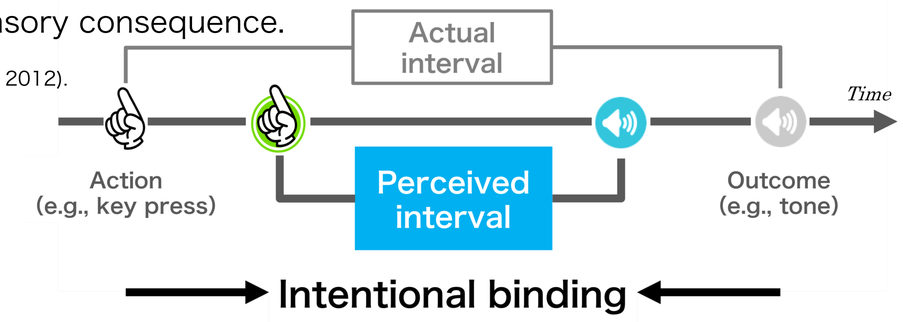
⊙ Intentional binding

The subjective compression of the temporal interval between a voluntary action and its external sensory consequence.

The effect size of this binding has been used as the implicit measure of **sense of agency** (Moore & Obhi, 2012).
= The feeling that one's intentional actions cause specific events in the outside world (Gallagher, 2000).

➠ The similar binding effects can occur in spatial perception of the distance between action onsets and their visual feedback (Kirsch, Pfister & Kunde, 2015).

Q1. Do the temporal and spatial binding have shared mechanisms?
Q2. Do they reflect the sense of agency in the same way?



Method

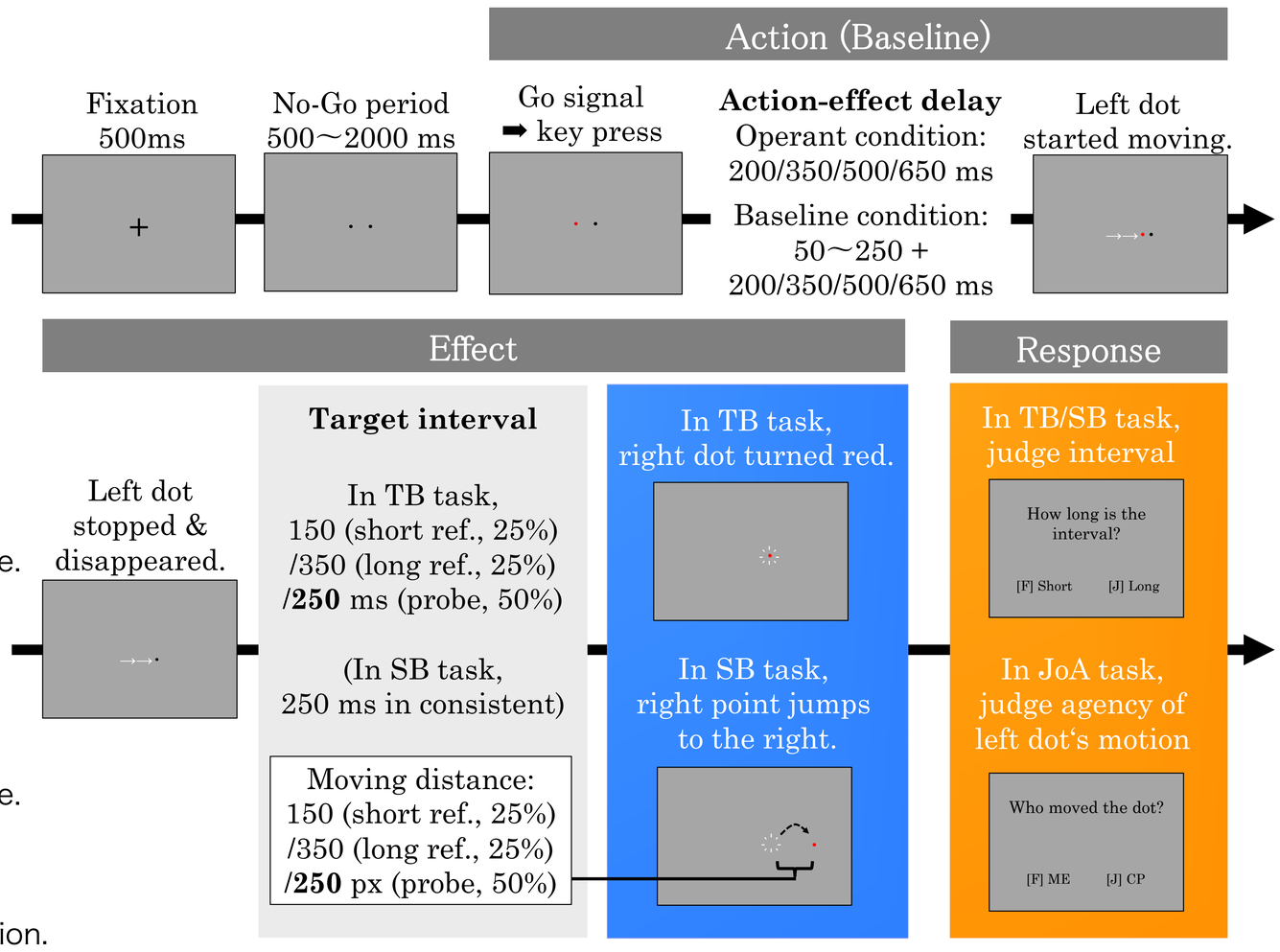
【Participants】24 right-handed adults（13 female, M_{age}=21.5 ± 1.31 *SD*）

Temporal binding and spatial binding were measured with **bisection task with voluntary action (i.e., key press).**

＊ Temporal binding task ＜TB task＞
① After a left dot turned red,
(in operant condition,)
participants moved the left dot with key press as quickly as possible.
(in baseline condition,)
the left dot starts to move automatically at random timing.
② After the left dot stopped and disappeared,
a right dot turned red after a certain interval.
③ Participants answered the time interval from the disappearance of the left dot to the color change of the right dot as to whether it was closer to the long reference or the short reference.

＊ Spatial binding task ＜SB task＞
① Same as TB task with two following changes.
② 250ms after the left dot stopped and disappeared, the right dot jumped to the right at a certain distance.
③ Participants answered the moving distance of the right dot as to whether it was closer to the long reference or the short reference.

＊ Judgement of agency task ＜JoA task＞
① Same as TB and SB task with the following change in response.
② Same as TB task in temporal condition and as SB task in spatial condition.
③ Participants judged whether the dot was moved by "ME" (participants) or "CP" (computer).
(Participants were informed that there were some trials where the dot moved by itself regardless of the key press.)



Results and Discussion

◎ Temporal binding (TB) and spatial binding (SB)

2 (modality: temporal vs. spatial) × 4 (action-effect delay: 200/350/500/650 ms) within-participants ANOVA showed
a significant main effect of action-effect delay ($F(3,23)=11.72$, $p<.01$) and
a significant interaction effect ($F(3,23)=4.32$, $p<.01$).

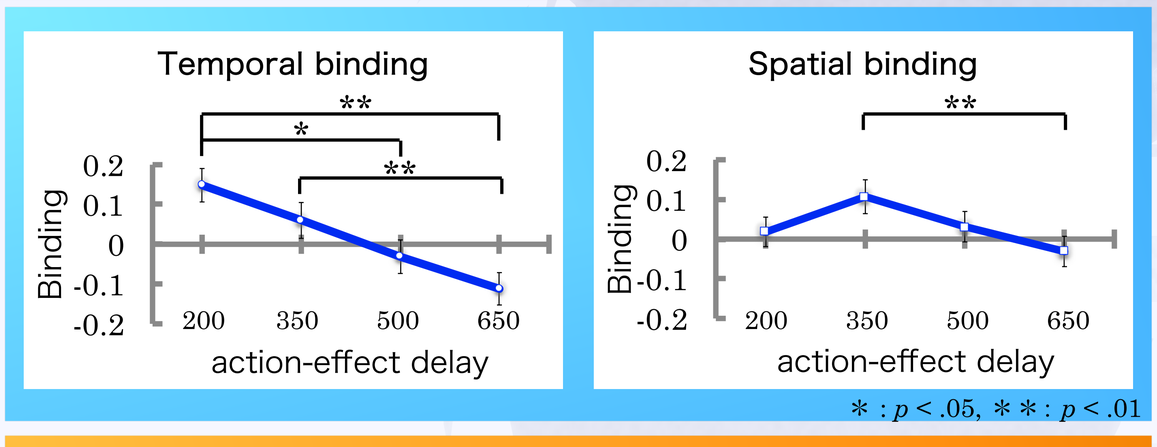
The multiple comparison with Ryan method showed
significant differences in TB between 200ms vs. 500ms, 200ms vs. 650ms, and 350ms vs. 650ms ($t(23)=3.96$, $p<.05$; $t(23)=5.74$, $p<.01$; $t(23)=3.79$, $p<.01$) and
a significant difference in SB between 350ms vs. 650ms ($t(23)=3.04$, $p<.01$).

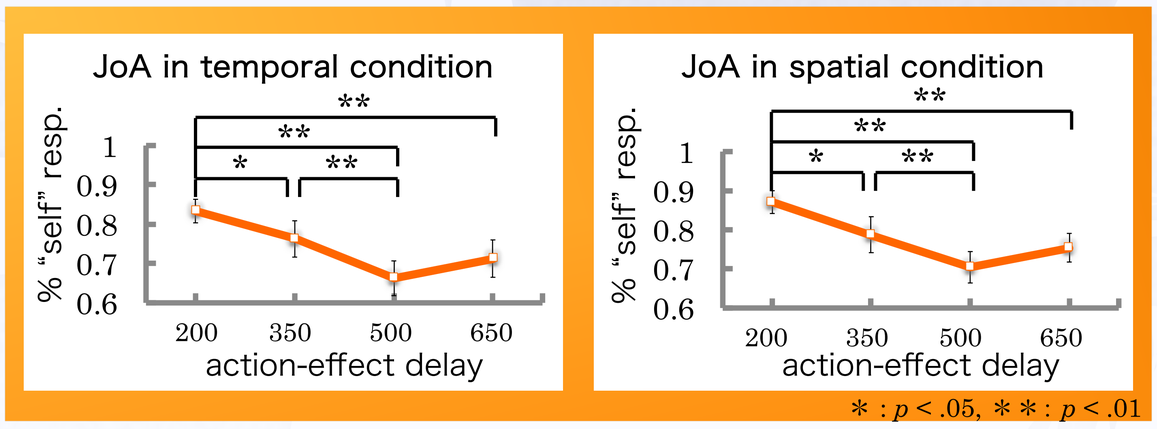
◎ Judgement of agency (JoA)

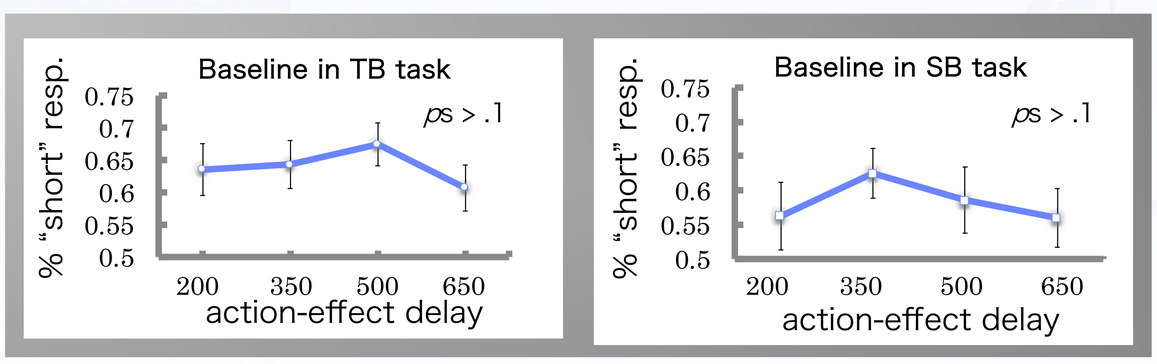
ANOVA with the same two factors only showed
a significant main effect of action-effect delay ($F(3,23)=11.70$, $p<.01$).

◎ The relationship between binding effects and sense of agency

No significant correlations were found between each binding and JoA（$ps>.1$）







✓ Although both temporal binding and spatial binding changed with the increase of temporal delay of the action-effect, the relationship was partially different.

A1. Two binding may have different time characteristics independent bases.

A2. Each binding was inconsistent with the explicit judgment of agency.

Explicit judgments may work independently in situations where the binding is not available as a potential cue.

Keeping the key pressed may have made the difference between the binding and JoA more pronounced.

➡ Do continuous movement and instantaneous movement cause binding and JoA in the same way?