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Effect of discrete and continuous movements on visual time perception

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Introduction

Visual time perception (VTP) is crucial to successfully interact with the surrounding environment [1]. It allows the observer to estimate the duration of an object's occlusion by compensating for delays in the transmission and processing of sensory information. Human perception of time in the range of hundreds of milliseconds is far from accurate and is subject to distortions [2].

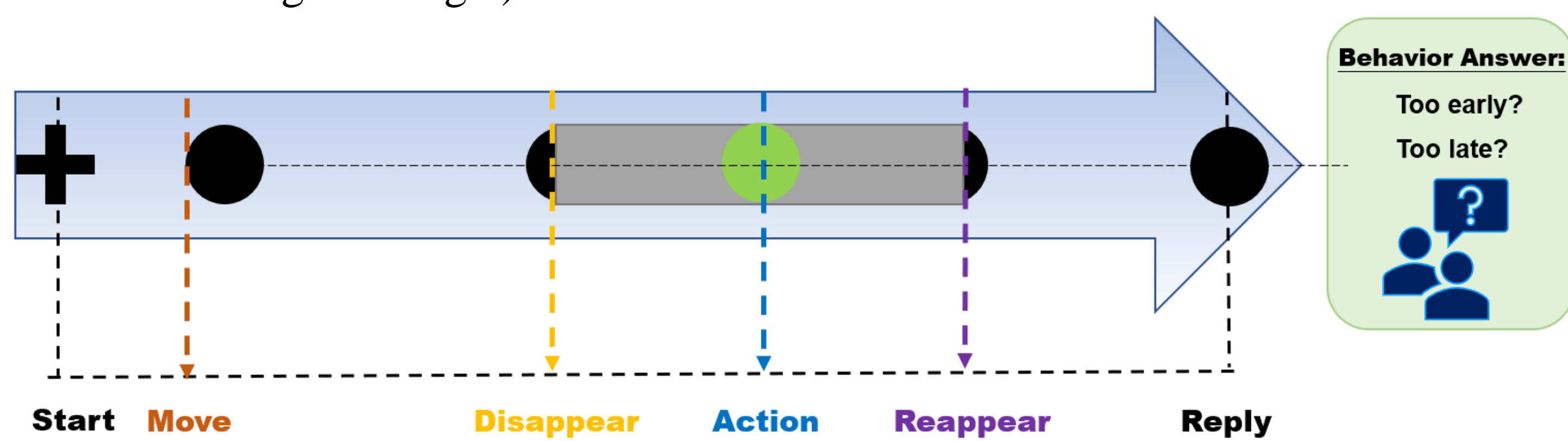
In particular, VTP is altered when concurrent action is performed [3]. The magnitude of the alteration depends on action parameters (e.g., timing, speed, duration, direction) [4]. Motor control theories suggest that action can be distributed into two classes, namely discrete and continuous movements [5]. However, to our knowledge, no research investigated the influence of movement types on VTP in an interruption paradigm.

This work investigated whether there are differences in VTP when discrete and continuous movements and the timing of continuous movements. We expected that only discrete movement significantly alters VTP.

Methods

Experimental procedure:

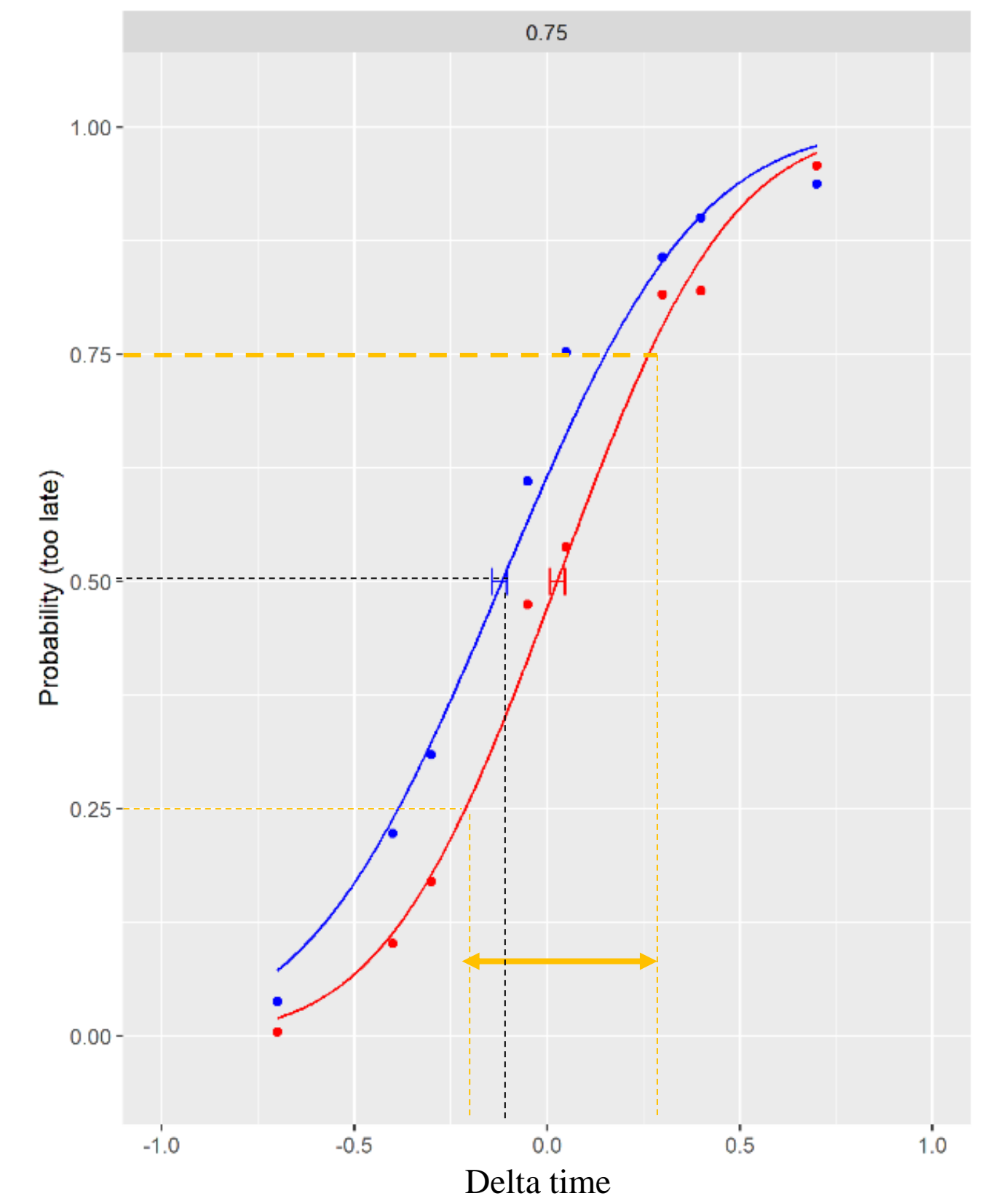
- 38 participants (26.08 ± 3.32 years) had to evaluate whether a moving disc reappeared from occlusion too early or too late while performing (or not) an action.
- The continuous group 1 had to perform a continuous elbow extension from the movement the disc started moving until the trial ended. The continuous group 2 had to perform a continuous elbow extension from the disc contacted with the target moving until the trial ended. The discrete group had to press a key when the disc reached the position it would have had 0.75s after occlusion (displayed on the screen with a green target).



- Participants performed 320 trials (8 occlusion durations x 2 conditions x 20 trials) randomly distributed in 5 separated blocks.

Statistic analysis:

- The Point of Subjective Equality (PSE) and Just Noticeable Difference (JND) were determined for each participant with the psychometric curve.
- PSE corresponds to the delta time computed at 50% points of the psychometric function (black dashed line).
- The JND corresponds to half of the difference between the Delta time computed at the 25% and 75% points of the psychometric function (yellow dashed line).
- ANOVA with repeated measures was performed on PSE and JND to evaluate the effects of Action conditions (Action vs. NoAction) and Movement types (Continuous vs Discrete).



Results

- The ANOVA revealed a significant interaction between Movement types and Action Conditions effect on the PSE ($F(2,35) = 9.42$, $p = .001$, $\eta^2 = 0.062$) (Fig 1).
- Post-hoc tests showed that PSE was modulated by Action Conditions only for the Discrete group, with higher PSE for the Action condition compared to the NoAction condition (respectively, 39.80 ± 187 ms and -114 ± 177 ms) (Figure 2).
- No effect of Action conditions ($F(2,35) = 1.72$, $p = .19$, $\eta^2 = 0.069$), Movement type ($F(1,35) = 1.80$, $p = .188$, $\eta^2 = 0.012$), or their interaction ($F(2,35) = 0.037$, $p = .96$, $\eta^2 = 0.001$) was revealed on the JND.

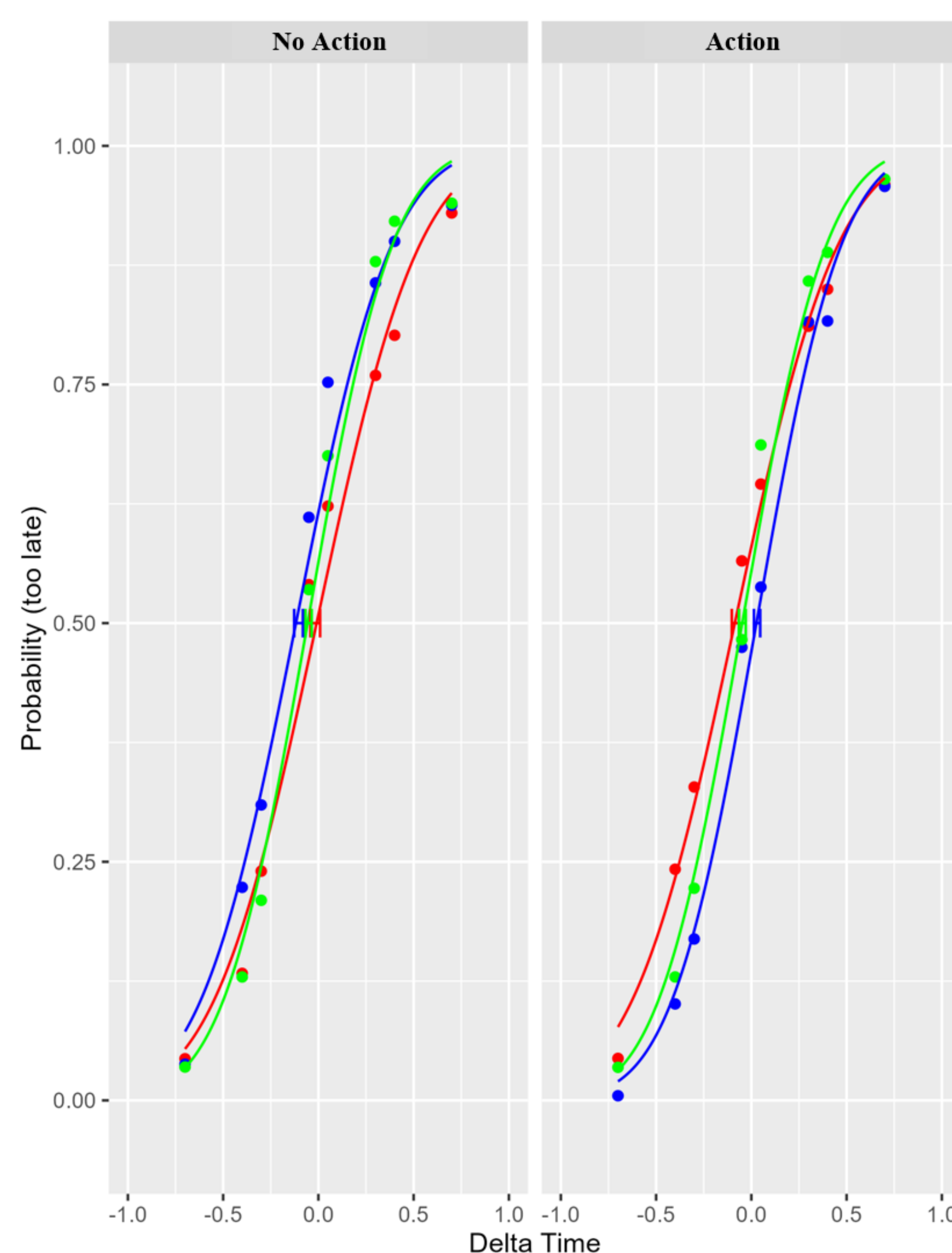


Figure 1. Psychometric function for Movement types and Action Conditions for participants

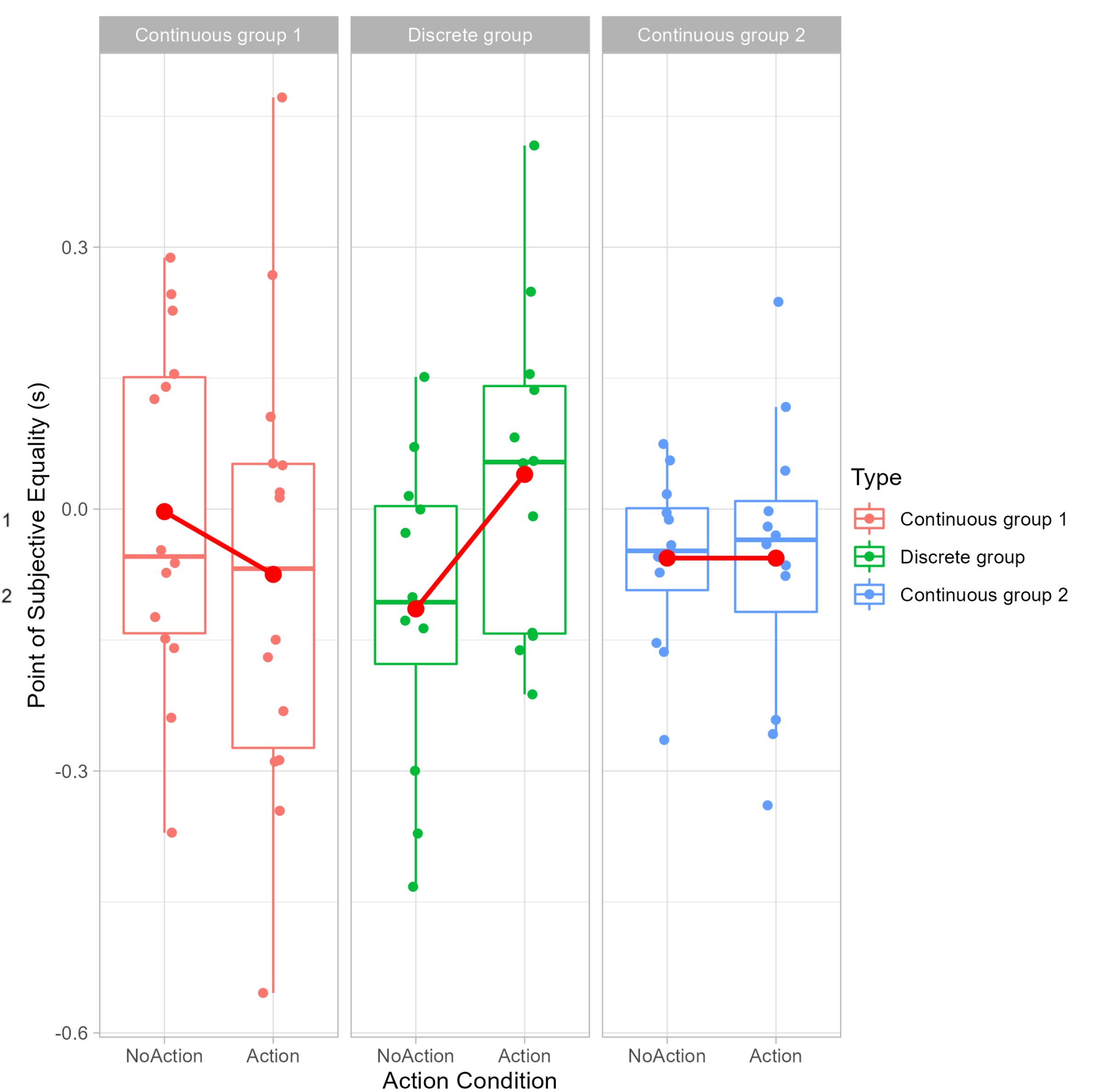


Figure 2. Average PSE (s) according to the Movement types and Action Conditions

Discussion

Three experiments were conducted to investigate the influence of Movement types and Action conditions on VTP performance in an interruption paradigm. As previously reported [3], VTP was significantly altered only when participants perform discrete movement. To be specific, a shift toward positive PSE, indicating an underestimation of the duration of occlusion, was observed on temporal estimation in the Action condition compared to the NoAction condition.

This suggests that discrete movements may require increased attentional resources and cognitive processing in comparison to Continuous movements, making observers more focused on the VTP [6]. This heightened focus could be attributed to the start-stop nature of discrete movements, which might require more precise timing and coordination, leading to alterations in the perception of time. Consequently, the findings underscore the role of movement types in modulating time perception, with discrete movement leading to more significant perceptual shifts.

As take-home message, discrete movements, rather than continuous movements, influence visual time perception.

Reference

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