

Voluntary Actions Compress the Experience of Time

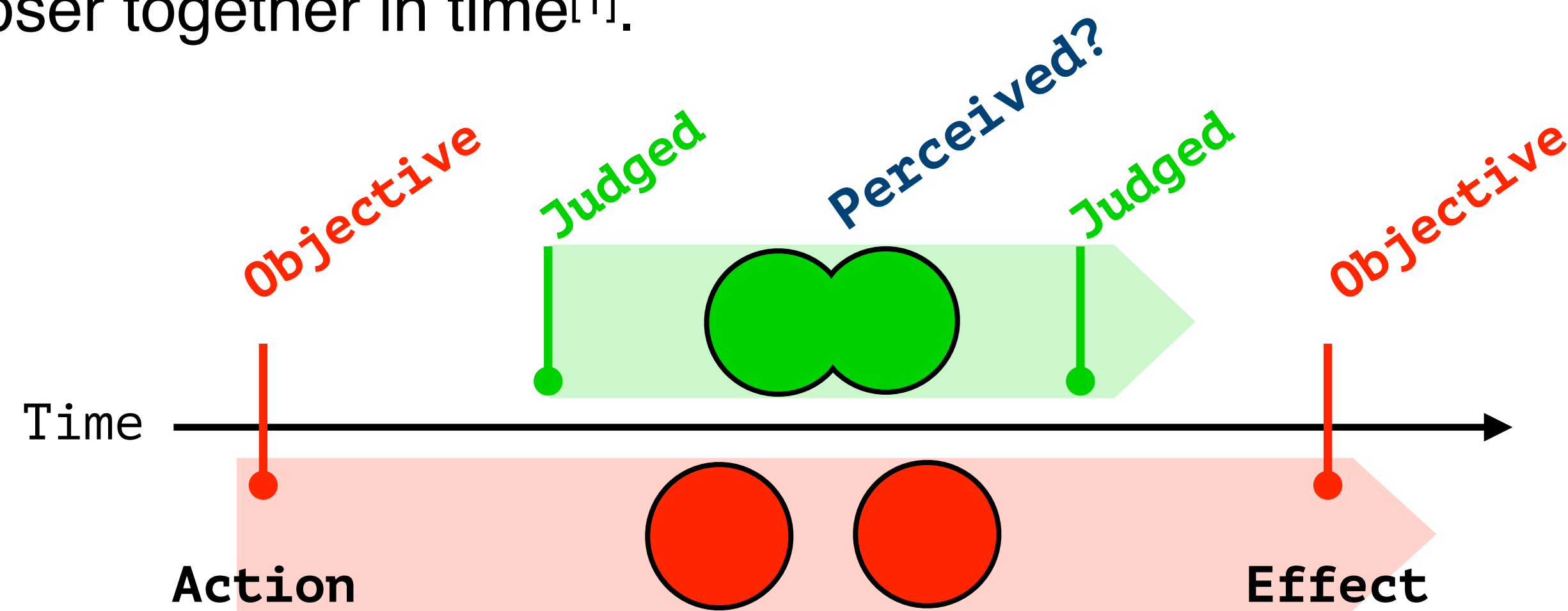
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Introduction

Intentional Binding

Intentional binding: Past research has established that relative to their **objective time of occurrence**, voluntary actions and their effects are **retrospectively judged** to occur closer together in time^[1].



Retrospective or perceptual? Might intentional binding reflect a retrospective illusion only, or an on-line perceptual compression of time? According to the slowed clock hypothesis^[2], voluntary actions compress time; we sought to examine this hypothesis in the visual domain.

Hypothesis

If voluntary actions compress subjective time, inter-stimulus intervals (ISI) should be retrospectively reported as shorter, and subjects should perceive motion at longer ISI in the voluntary action condition.

Method and Results

Method

Subjects either pressed a key at a time of their choosing, or waited for the stimuli to appear automatically

Subjects then reported whether they saw motion, or estimated ISI verbally

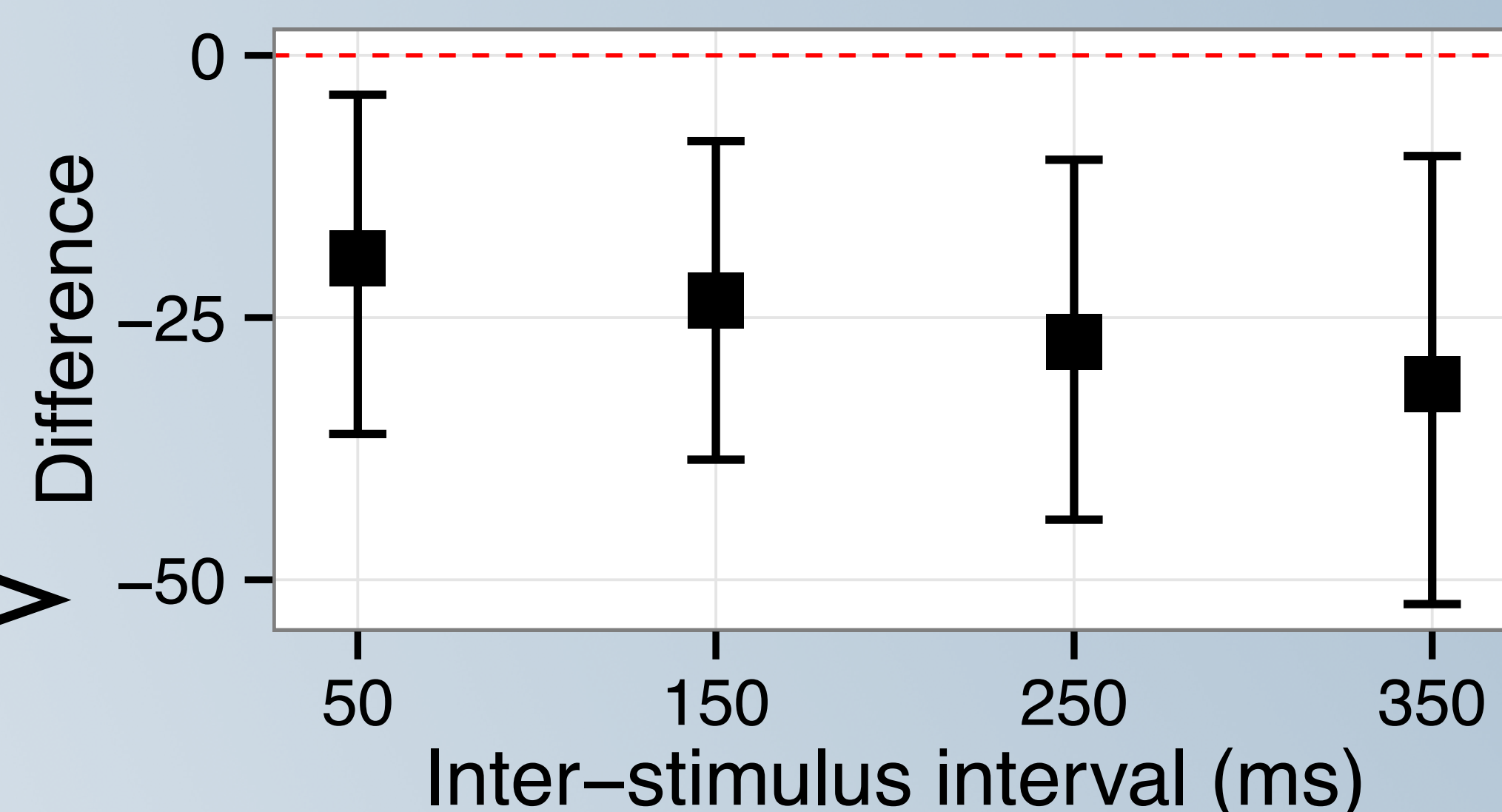
Inter-stimulus interval

Estimate ISI

Did you see motion?

Interval estimates

Voluntary actions led to shorter inter-stimulus interval estimates

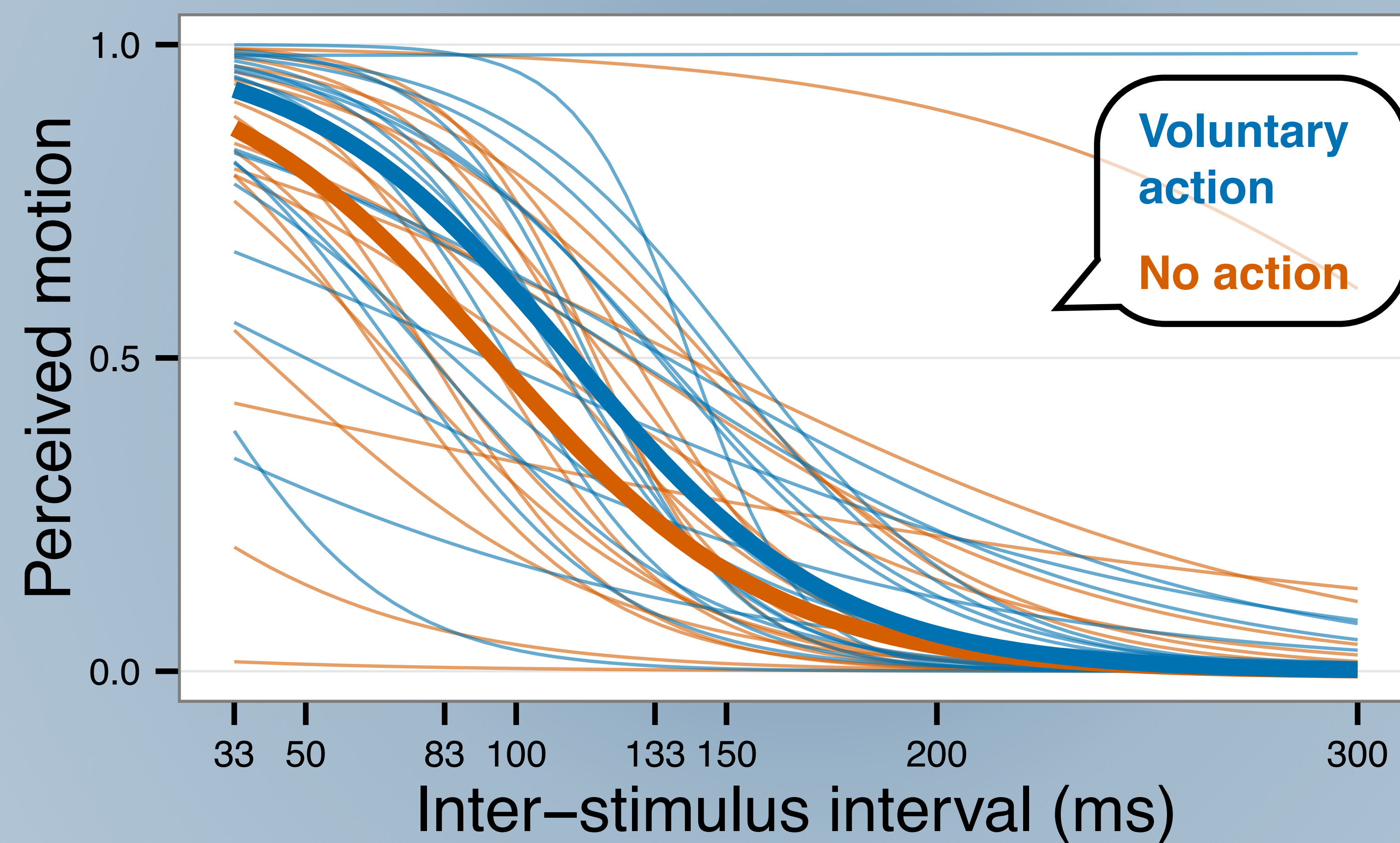


Conclusion

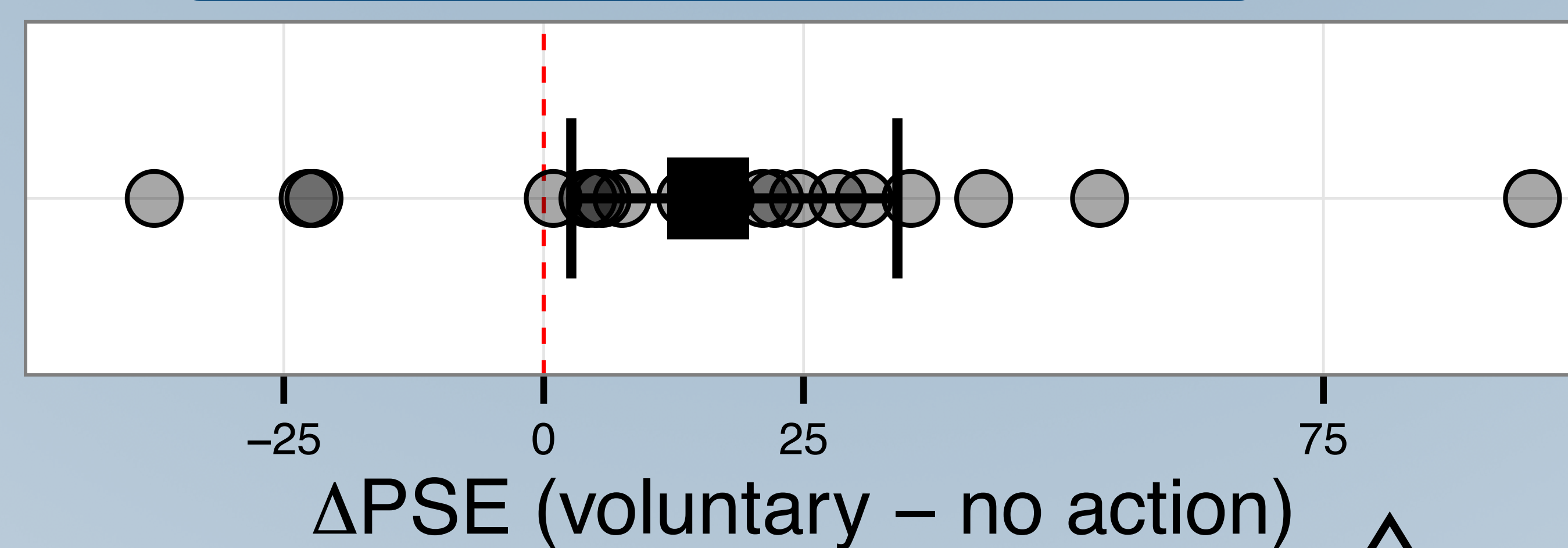
Voluntary actions compress subjective time as measured by retrospective estimation and on-line perception.



Apparent motion

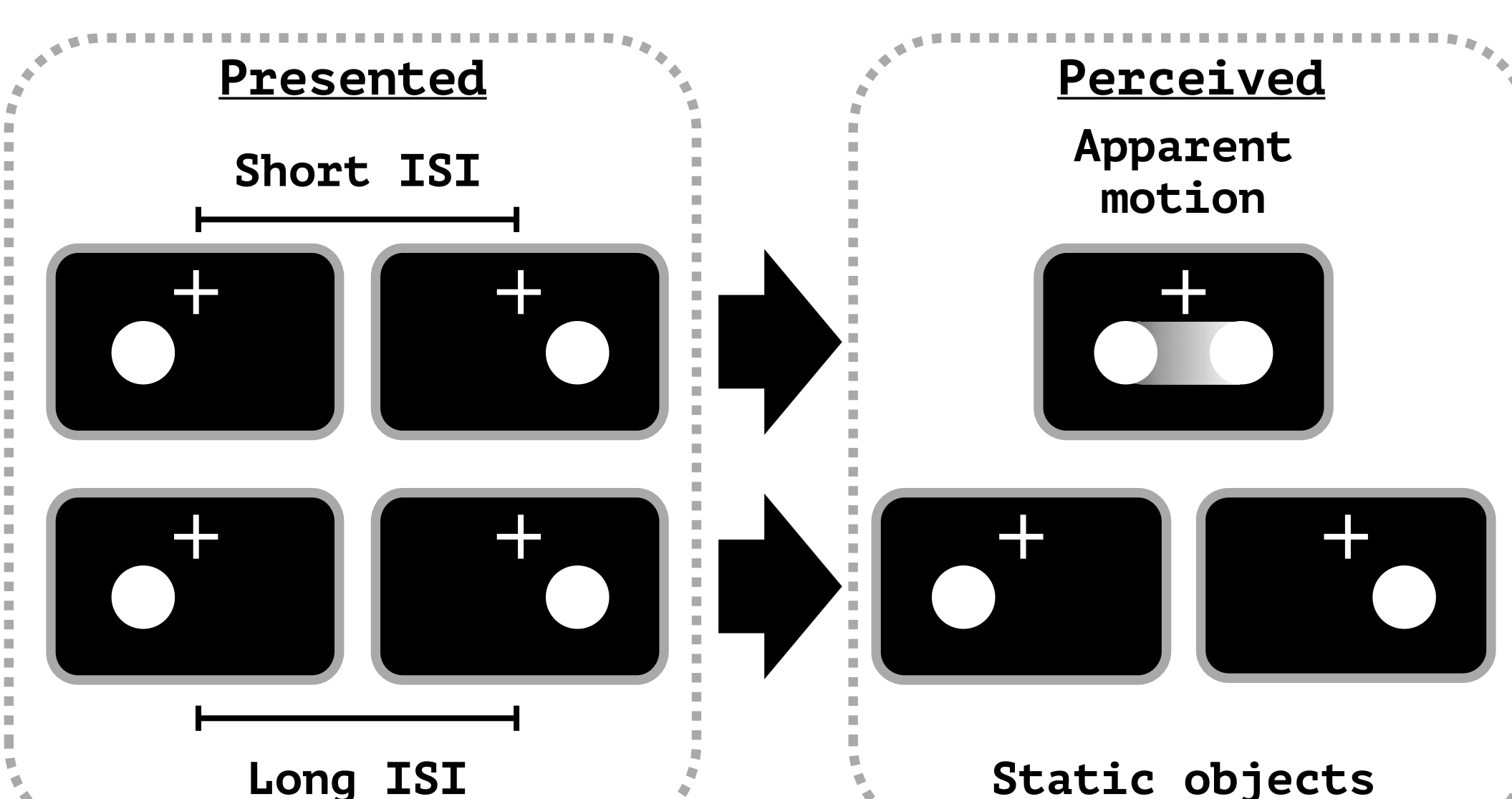


Point of subjective equality



Subjects observed motion at longer ISI (18ms, 95% CI [3, 34]) in the **voluntary action** condition.

Apparent Motion



Two stimuli appear as one moving object if the inter-stimulus interval (ISI) is short enough^[3].

Movies and TV are based on apparent motion.

These results indicate that voluntary actions compress the experience of time with a rate-shift equivalent to ~18ms in visual awareness.



References

- [1] Haggard, P., Clark, S., & Kalogeras, J. (2002). Voluntary action and conscious awareness. *Nature neuroscience*, 5.
- [2] Wenke, D., & Haggard, P. (2009). How voluntary actions modulate time perception. *Experimental brain research*, 196.
- [3] Wertheimer, M. (1912). Experimentelle studien über das Sehen von Bewegung. *Zeitschrift für Psychologie*, 61.

Results from multilevel regression models estimated with Bayesian methods. (Bars = 95% Credible Intervals.)

Thank you to everyone in Columbia Psychology & Metlab for comments, questions, and support.