

Spatial-Temporal Associations in Duration Perception: A Temporal Bisection Study Using Directional Cues

Testing the Mental Timeline Hypothesis in Adults

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How is time represented in the mind?

- **ATOM** (Walsh, 2003): Proposes that space, time, and number share a single magnitude system in the brain. The bigger something is, the longer it feels: small size = short duration, large size = long duration. Innate and cross-cultural. Asks: how big is it?
- **Mental Timeline** (Coull et al., 2014): Proposes that duration is mapped onto a horizontal axis: left feels short, right feels long. This mapping is culturally acquired through reading direction, and reverses in right-to-left readers. Asks: where is it?
- **SNARC effect** (Dehaene et al., 1993): This is the behavioural signature of this mapping. When the side of the cue matches the duration being judged, responses are faster. For example, a left cue paired with a short duration is faster than a left cue paired with a long duration. Asks: does the side match the duration?

So what does this mean for the present study?

- **Bringing the theories together:** ATOM gives us a shared magnitude system. The Mental Timeline maps duration onto a horizontal axis. SNARC is how we measure it in behaviour.
- If this account is correct, a left arrow should pull duration judgments toward "short" and a right arrow toward "long". This is what we test in the left-right block.
- The same participants also complete an up-down block. The vertical axis has no established mental timeline for duration, so this lets us **check** whether the effect is specific to the horizontal mapping or generalises to any spatial axis.
- **Research Question:** Does the SNARC effect for duration emerge with left-right arrow cues, and does it extend to the vertical axis where no mental timeline is established?

Hypothesis 1 (H1): We hypothesise that the SNARC effect for duration will be observed in the Left-Right block. Specifically, left-pointing arrows will produce shorter duration judgments and right-pointing arrows will produce longer duration judgments, resulting in a significant shift in the bisection point between the two conditions.

Hypothesis 2 (H2, exploratory): We hypothesise that the SNARC effect will also generalise to the Up-Down block, with down-pointing arrows producing shorter judgments and up-pointing arrows producing longer judgments. The mechanism underlying any such vertical mapping falls outside the scope of the present study.

What is a temporal bisection task?

- **Training phase:** Participants learn two anchor durations: a short standard (200 ms) and a long standard (800 ms). They practice categorising each as "short" or "long" with feedback.
- **Testing phase:** Stimuli are presented at intermediate durations between the two anchors. On each trial, participants judge whether the stimulus felt closer to short or closer to long. No feedback is given.
- **Dependent measure:** the Bisection Point (BP)
- The bisection point is the duration at which the participant is equally likely to say short or long, that is, where the probability of saying long is 0.50, $P(\text{long}) = 0.50$.
- Across many trials, we calculate the proportion of "long" responses at each test duration.
- **Higher BP** → participant needs a longer stimulus before calling it "long" → shorter durations feel long → overestimation
- **Lower BP** → participant calls stimuli "long" sooner → longer durations feel short → underestimation

Participants

- Total recruited: N = 30
- Exclusion criteria: Left-handed participants, to control for potential handedness effects on spatial-temporal mapping. (Dehaene, Bossini, & Giraux, 1993).
- Final sample: N = 23
- Age range: 18–22 years
- Sample: Undergraduate students

Dehaene, S., Bossini, S., and Giraux, P. (1993). *Journal of Experimental Psychology: General*, 122(3), 371–396.

Fischer, M. H. (2008). Finger counting habits modulate spatial-numerical associations. *Cortex*, 44(4), 386–392. <https://doi.org/10.1016/j.cortex.2007.08.004>

Experimental Design and Participants

Design:

Within-subjects repeated measures design

All participants completed both blocks: Block 1 (Left-Right arrows) and Block 2 (Up-Down arrows)

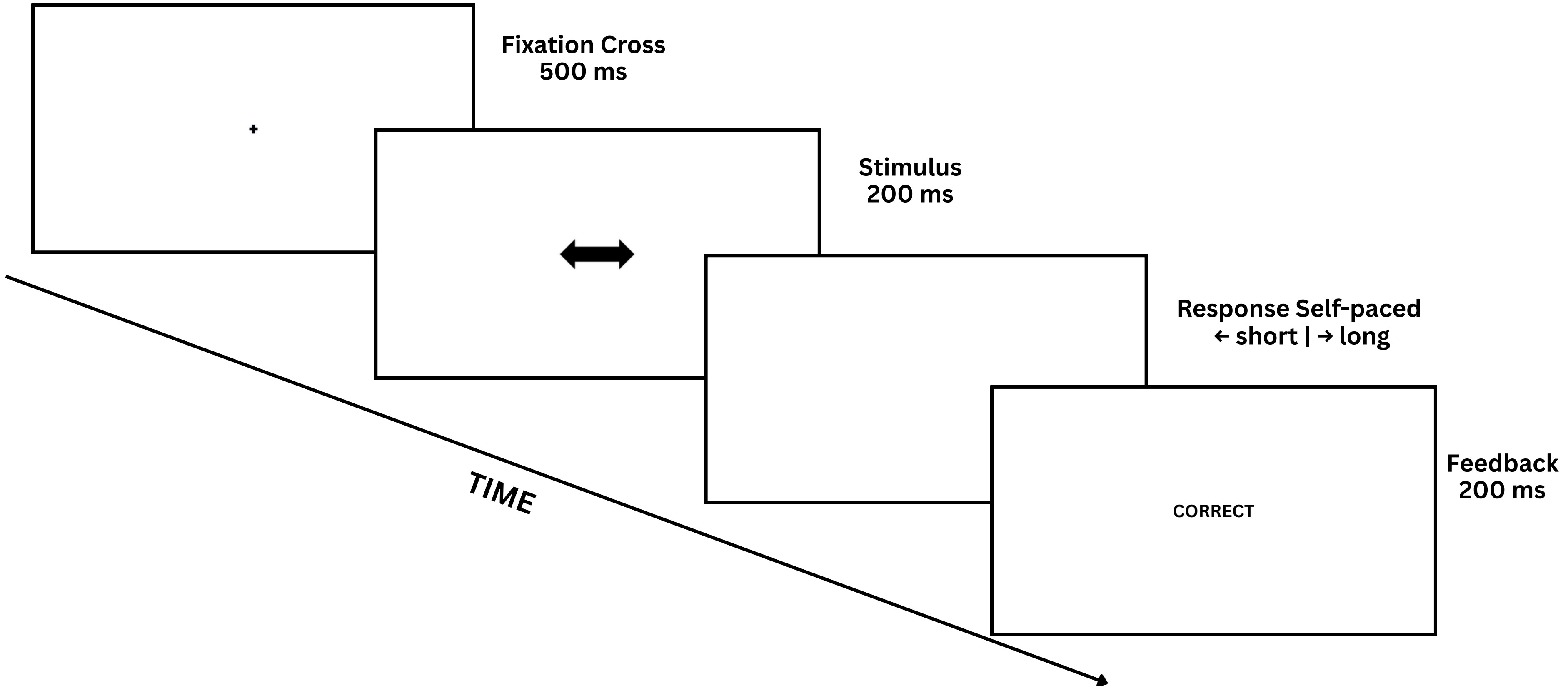
Training phase (per block):

- 10 training trials, feedback phase: 10
- Participants saw the 200 ms and 800 ms anchors and practiced categorizing them as long or short duration

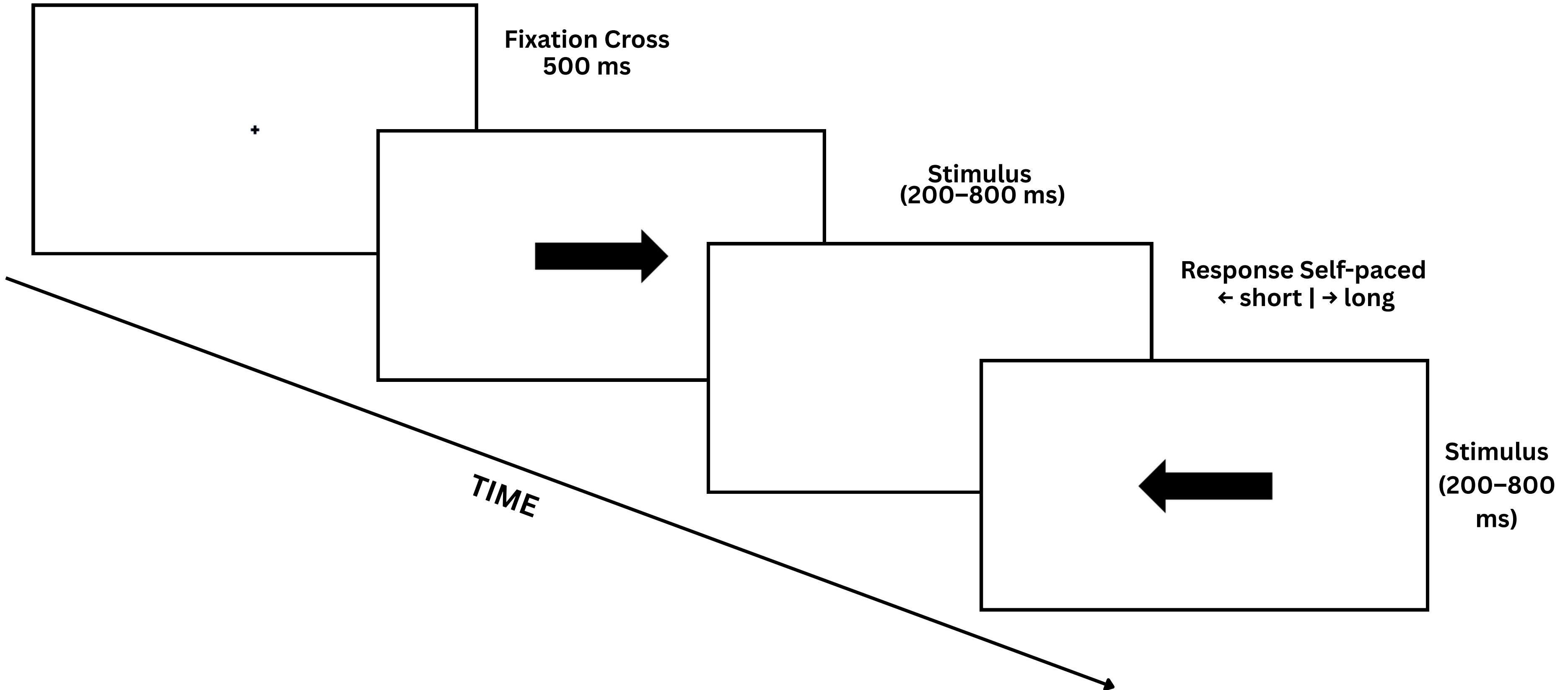
Testing phase (per block):

- 7 test durations: 200, 300, 400, 500, 600, 700, 800 ms
- 10 repetitions per duration = 140 trials per block

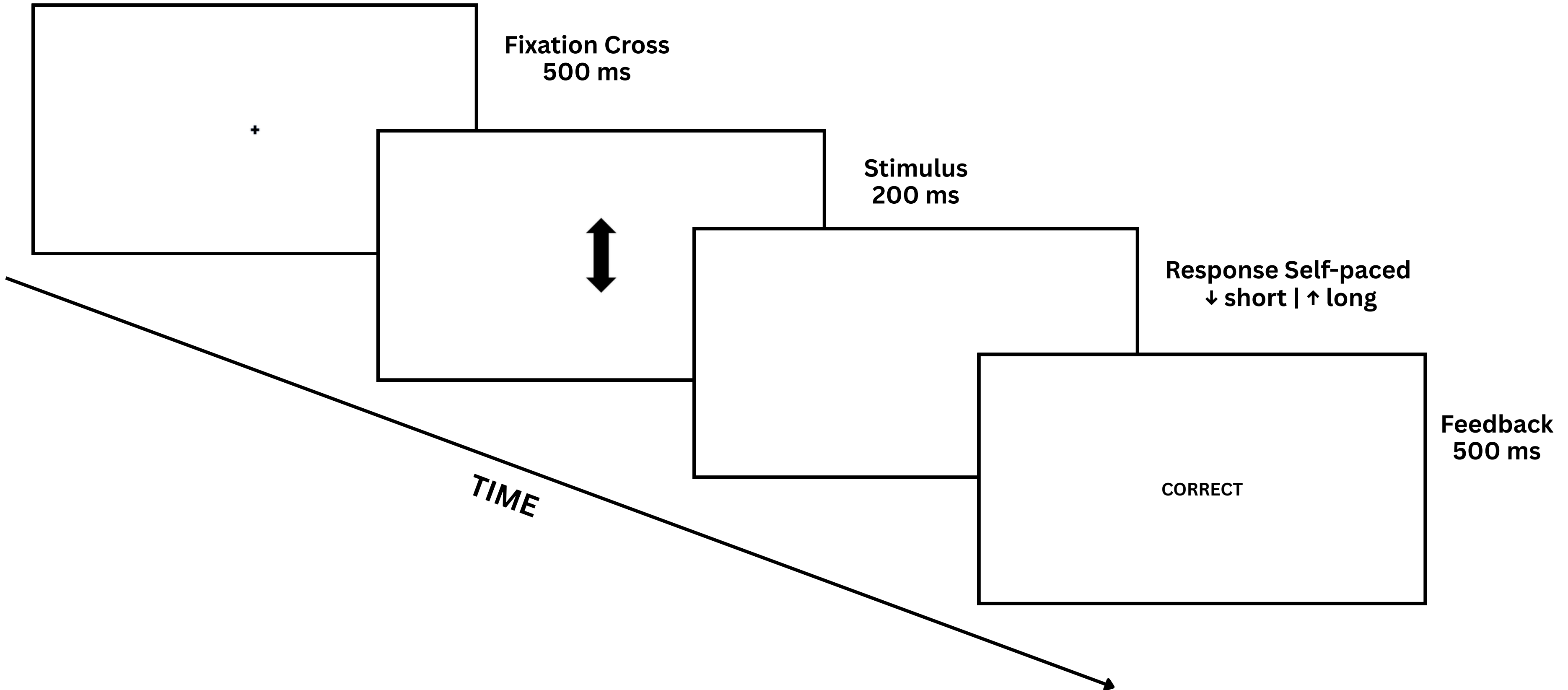
Trial Structure: Left Right Block (Training Phase)



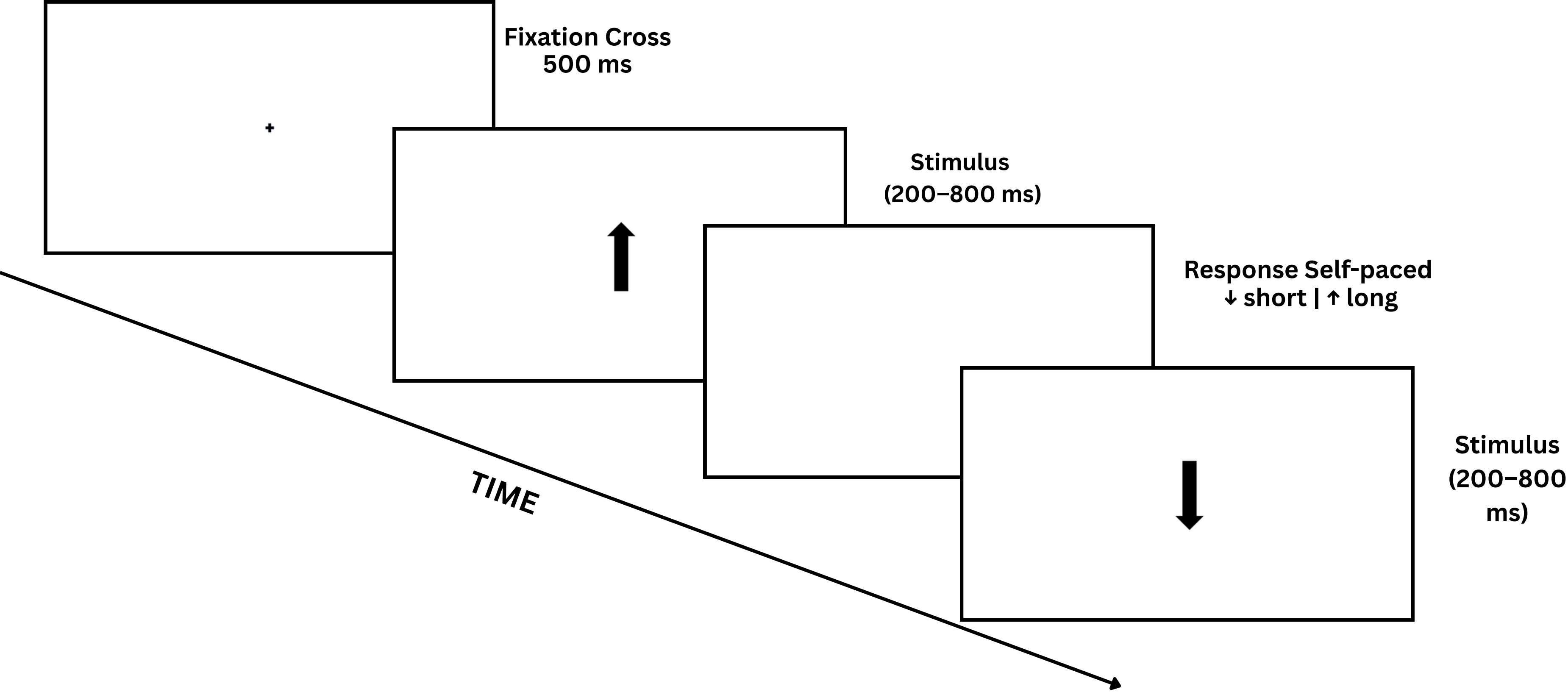
Trial Structure: Left Right Block (Testing Phase)



Trial Structure: Up Down Block (Training Phase)



Trial Structure: Up Down Block (Testing Phase)



Results: Left-Right Block

Descriptives

	N	Mean	SD	SE	Coefficient of variation
p1_50_Left	23	0.532	0.073	0.015	0.137
p2_50_Right	23	0.477	0.063	0.013	0.132

Within-subjects design: each participant gave one bisection point per condition (left arrow, right arrow).

Mean difference: 0.055 s in the predicted direction ie:

Left arrows → durations felt shorter

Right arrows → durations felt longer

Paired Samples T-Test

Measure 1	Measure 2	t	df	p	Cohen's d	SE Cohen's d
p1_50_Left	- p2_50_Right	4.137	22	< .001	0.863	0.227

Note. Student's t-test.

Assumption Checks

**Significant: $t(22) = 4.14, p < .001,$
Cohen's $d = 0.86$ (large effect).
Shapiro-Wilk: (to test normality of difference scores)
& normality assumption met
($W = 0.965, p = .570$).
H1 supported.**

Test of Normality (Shapiro-Wilk)

	W	p
p1_50_Left - p2_50_Right	0.965	.570

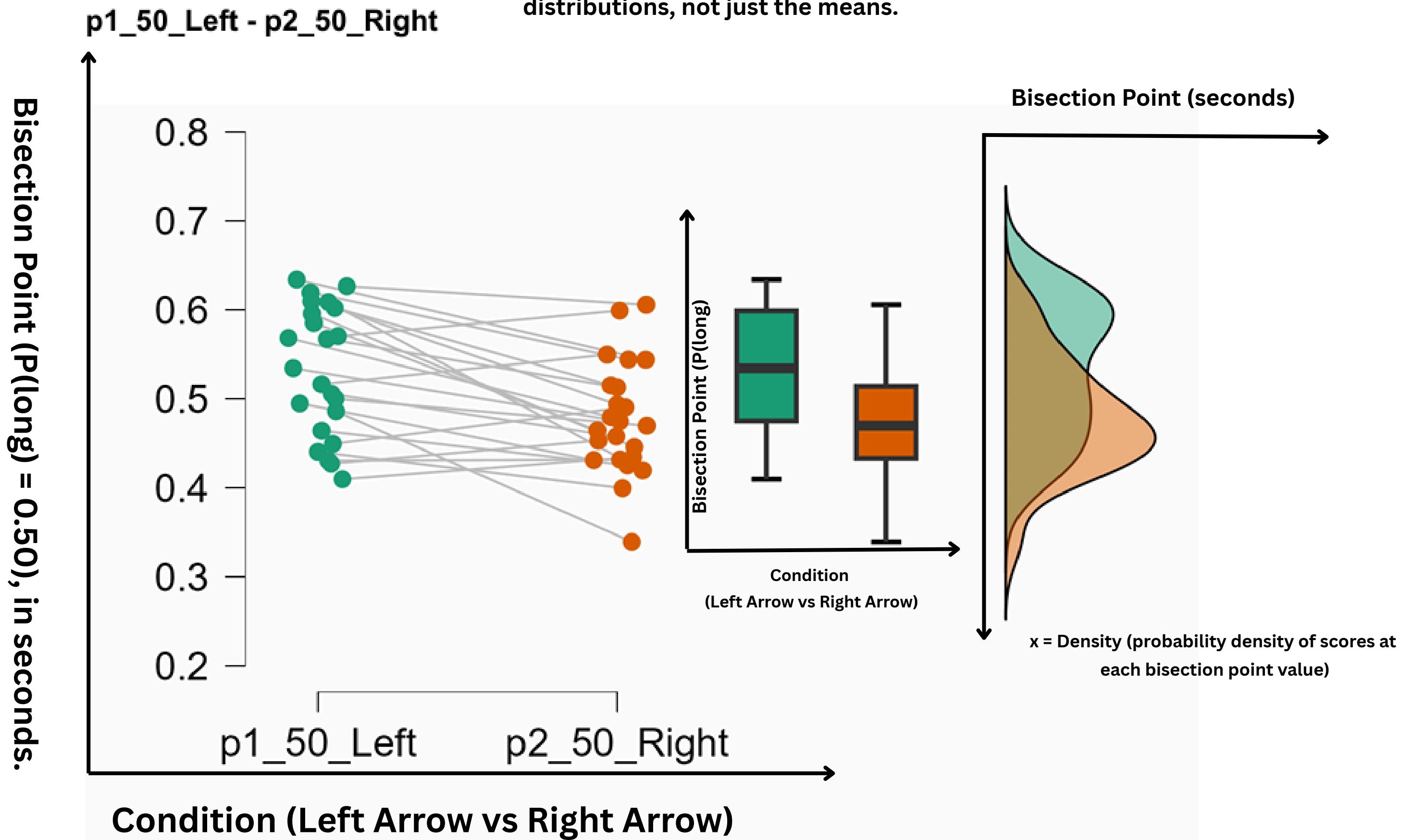
Note. Significant results suggest a deviation from normality.

Raincloud Plots

Scatter (left): Each dot is one participant. Grey lines connect each person's down and up scores. Most lines slope downward → effect held person by person.

Box plots (middle): Left distribution sits clearly above up at the group level.

Density curves (right): Two separated peaks confirm the difference is in the shape of the distributions, not just the means.



Results: Up-Down Block

Descriptives

	N	Mean	SD	SE	Coefficient of variation
p1_50_Down	22	0.478	0.089	0.019	0.185
p2_50_Up	22	0.400	0.087	0.018	0.217

Within-subjects design: each participant gave one bisection point per condition (Up arrow, Down arrow).

Mean difference: 0.078 s in the predicted direction ie:

Down arrows → durations felt shorter

Up arrows → durations felt longer

Paired Samples T-Test

Measure 1		Measure 2	t	df	p
p1_50_Down	-	p2_50_Up	5.145	21	< .001

Note. Student's t-test.

Significant: $t(21) = 5.15, p < .001$.
 Shapiro-Wilk: (to test normality of difference scores) & normality assumption met
 ($W = 0.954, p = .382$).
 H2 supported.

Test of Normality (Shapiro-Wilk)

Note: vertical shift (78 ms) > horizontal shift (55 ms).

		W	p	
p1_50_Down	-	p2_50_Up	0.954	.382

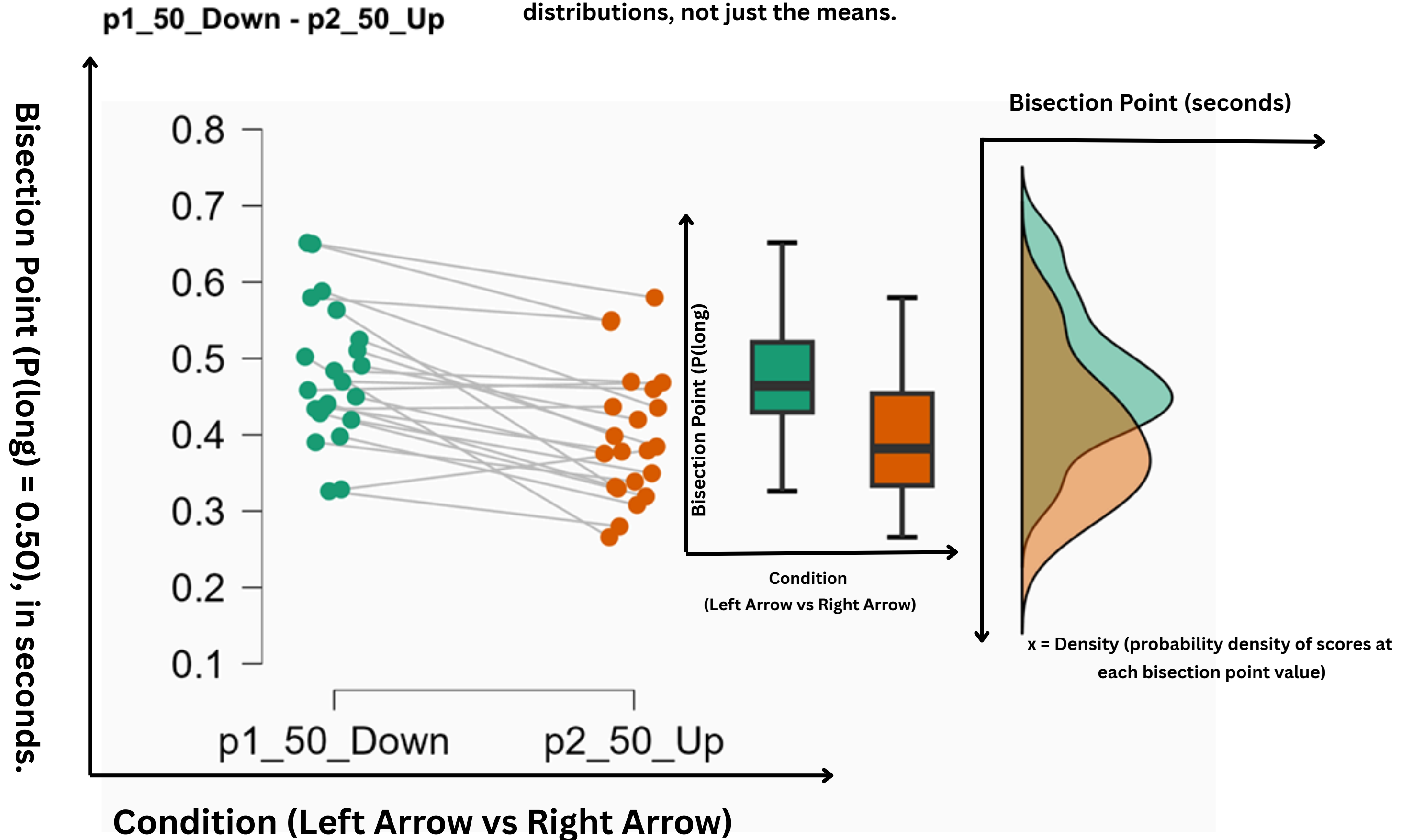
Note. Significant results suggest a deviation from normality.

Raincloud Plots

Scatter (left): Each dot is one participant. Grey lines connect each person's down and up scores. Most lines slope downward → effect held person by person.

Box plots (middle): Down distribution sits clearly above up at the group level.

Density curves (right): Two separated peaks confirm the difference is in the shape of the distributions, not just the means.



Interpretation + Limitations

Interpretation

- Horizontal mental timeline shapes duration perception in adults (H1 replicated).
- The vertical effect was larger than the horizontal (78 ms vs 55 ms). Up behaved like right; down like left.
- Open question: is the vertical mapping culturally acquired ("up = more"), or driven by response-key configuration?

Limitations

- Block order not counterbalanced (LR always first).
- Response key mappings fixed across participants.
- Mechanism for vertical mapping requires future work.

References

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Thank You!