Invariants and priors in tactile perception of object motion

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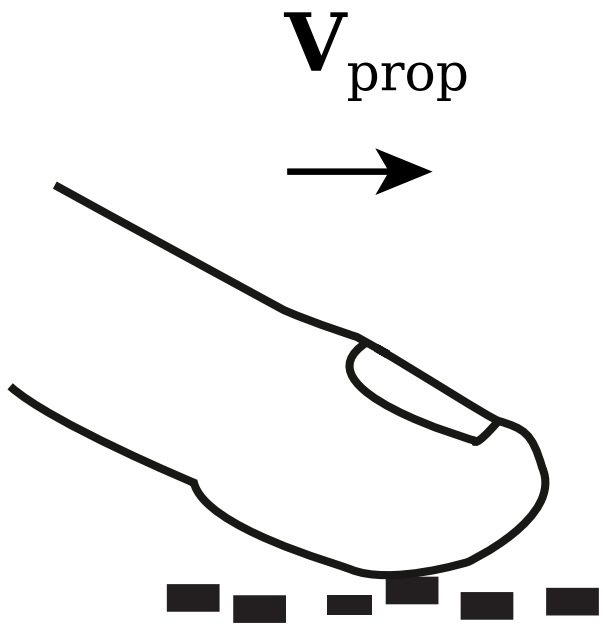
Universität Bielefeld - Università di Roma "Tor Vergata"

Motion Invariants and Spatial Constancy



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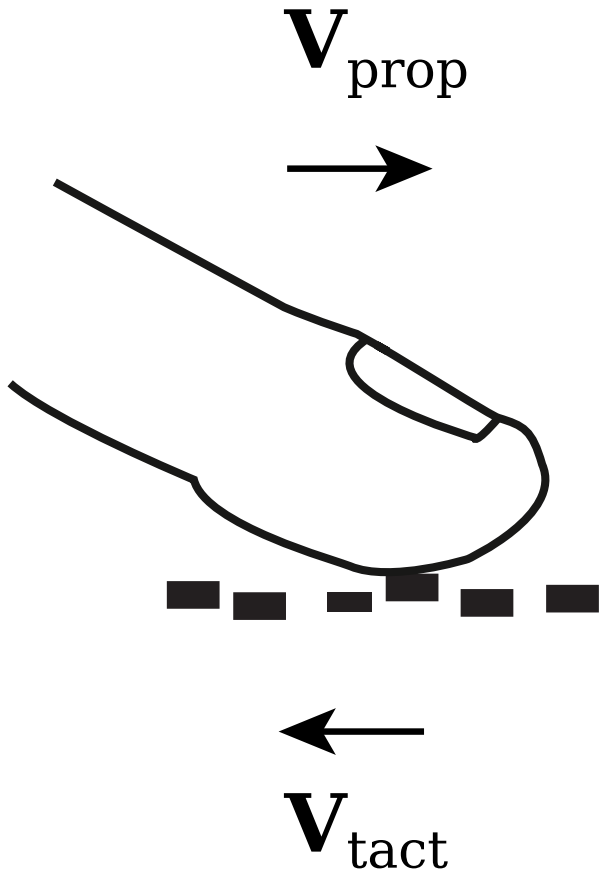

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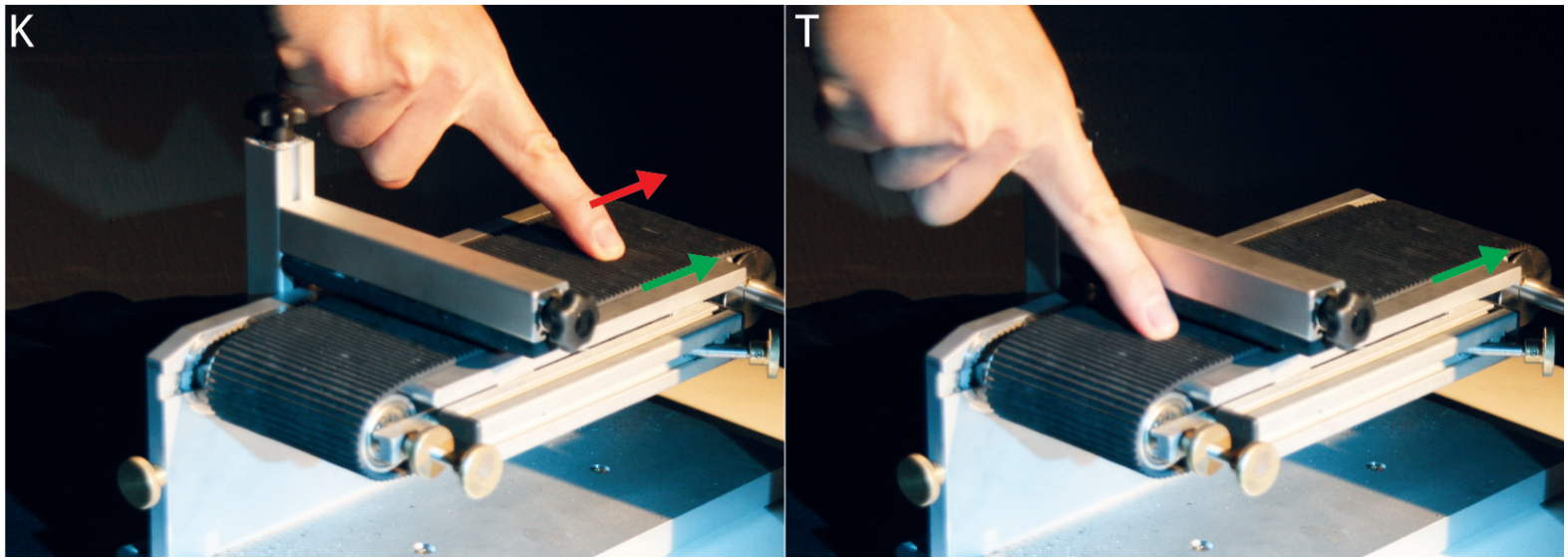
Spatial constancy refers to the capacity of the perceptual system of estimating accurately the velocity of an external surface, $\mathbf{v}_{surf}$, in a world-framed coordinates.
Human tactile system partially lacks of spatial constancy:

$$\hat{\mathbf{v}}_{surf} = 04\mathbf{v}_{prop} + \mathbf{v}_{tact}$$

Experimental Paradigm



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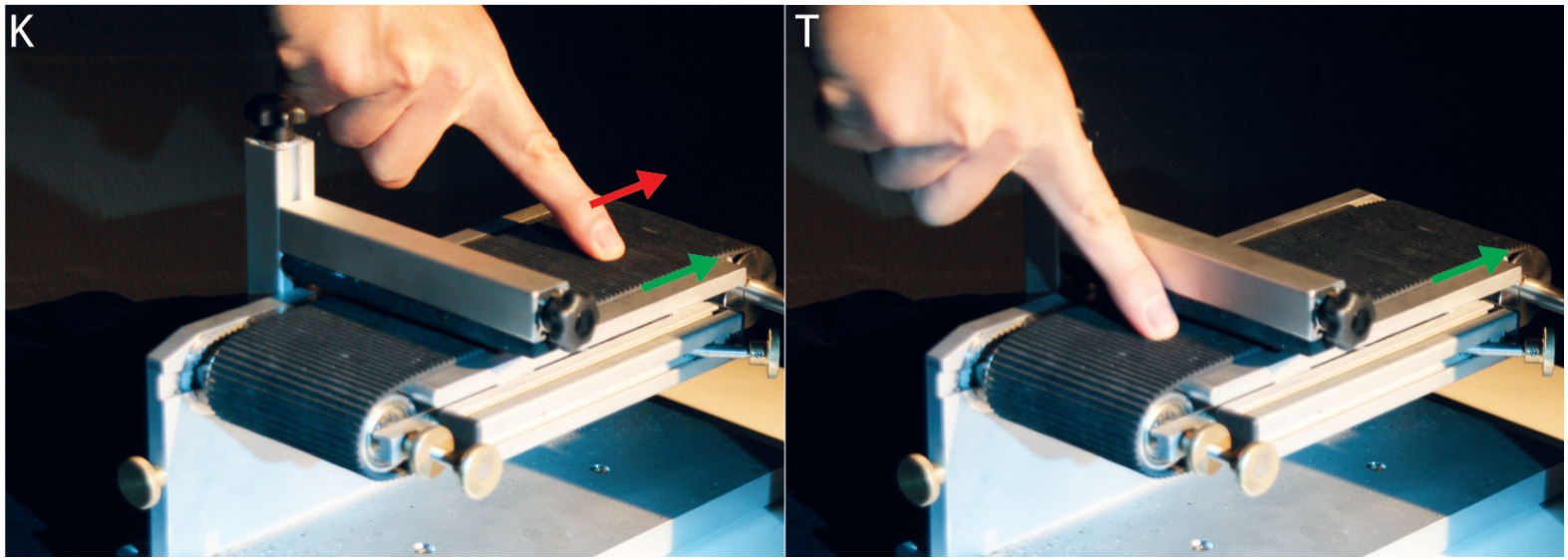
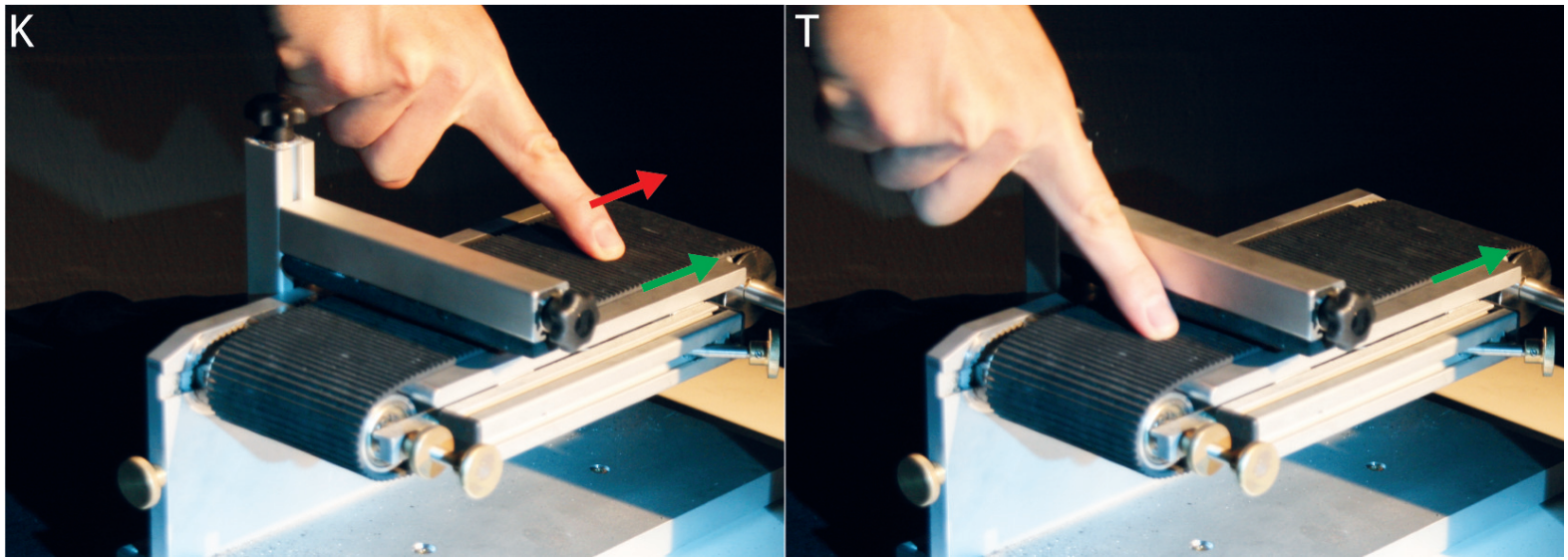


2AFC Experiment:

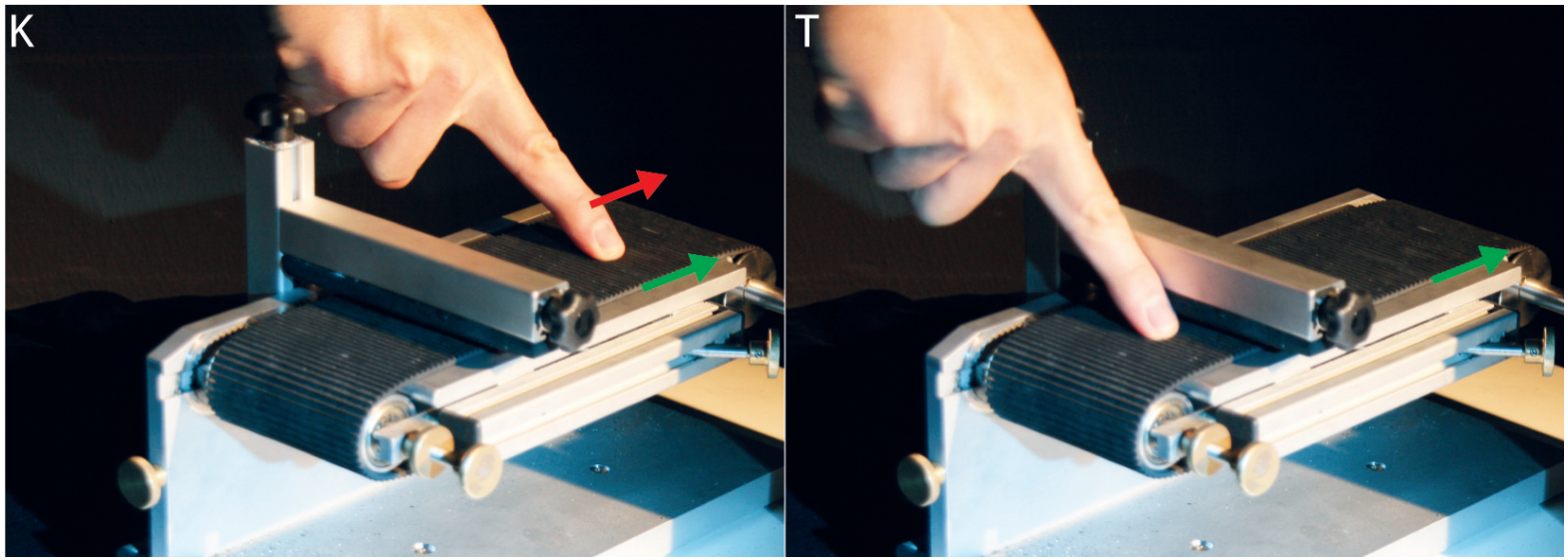
Experimental Paradigm



2AFC Experiment:

- K (reference) Vs T (comparison)

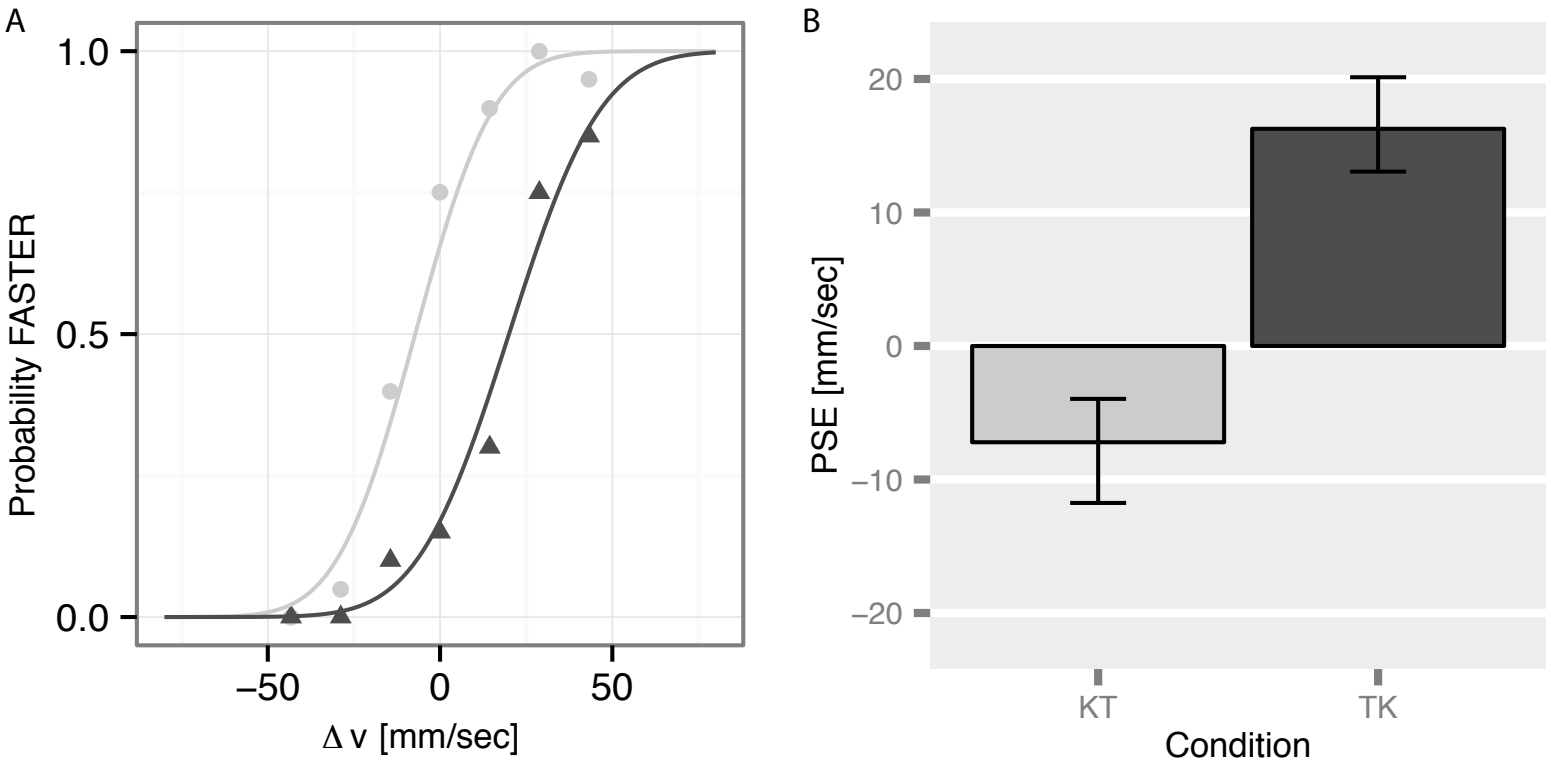
Experimental Paradigm



2AFC Experiment:

- K (reference) Vs T (comparison)
- T (reference) Vs K (comparison)

Results


A
1.0
0.5
0.0
Probability FASTER
−50
0
50
Δ v [mm/sec]
B
20
10
0
−10
−20
PSE [mm/sec]
KT
TK
Condition

Three Hypotheses

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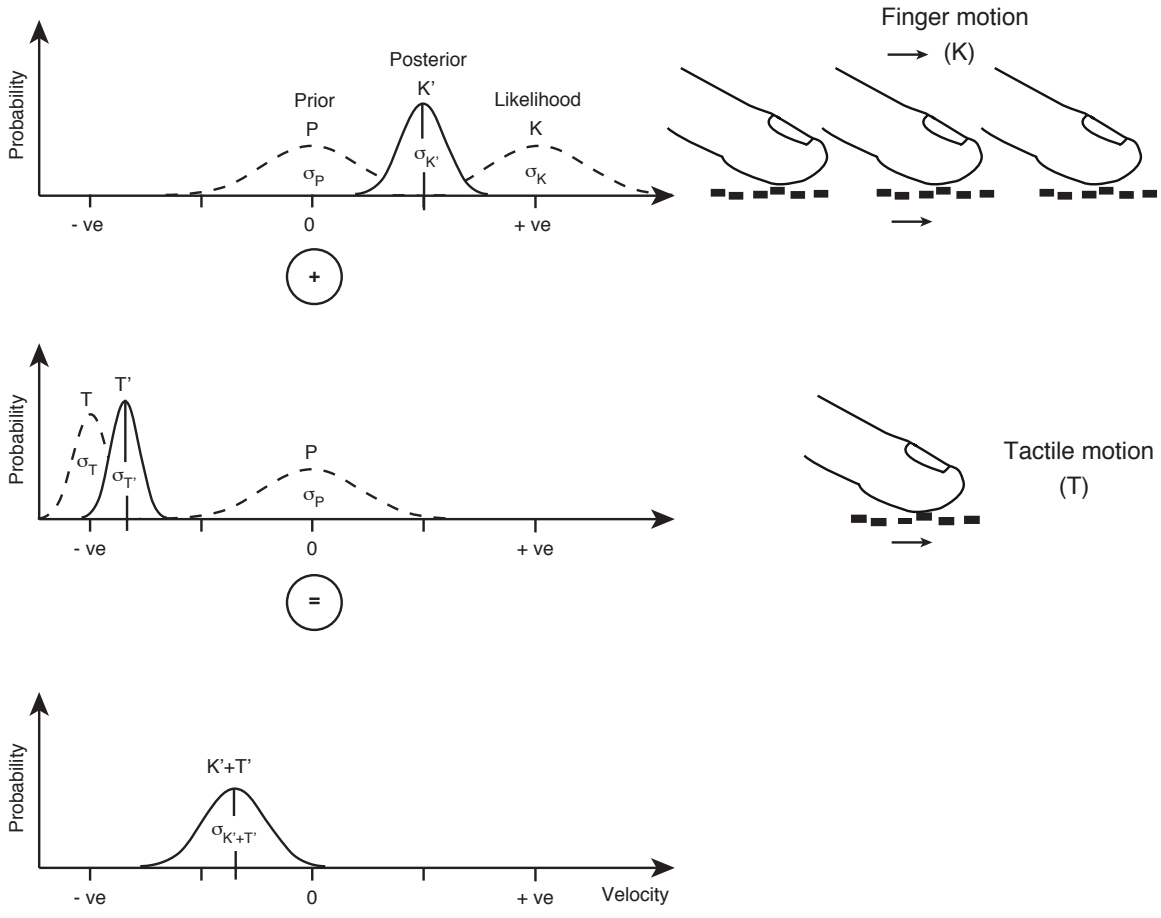
3. The difference in precision between the two signals generates the illusion (Bayesian hypothesis).

The Stationarity Prior Model



Experimental Paradigm

Same task as in Experiment 1. Participants (N = 12) where divided in three groups, using each one of the following:

1. A belt having an homogeneous, smooth surface
2. A belt having a low-frequency, textured surface ($\xi = 0.07$ mm^{-1})
3. A belt having a high-frequency, textured surface ($\xi = 0.3$ mm^{-1})

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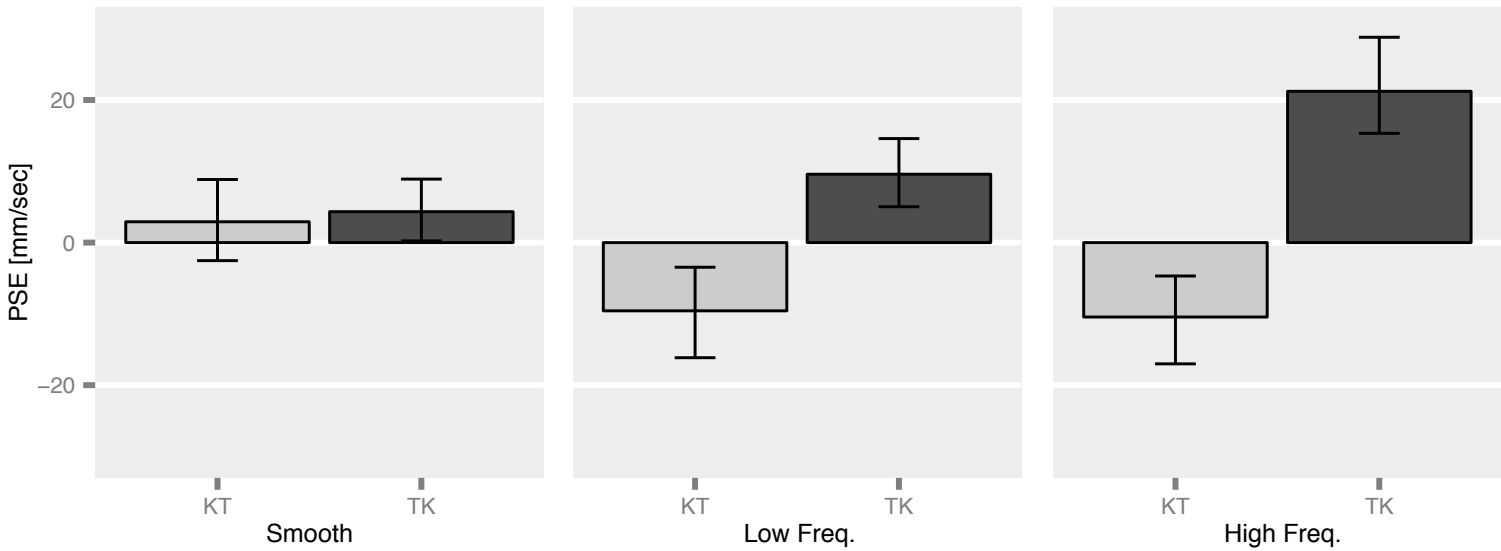
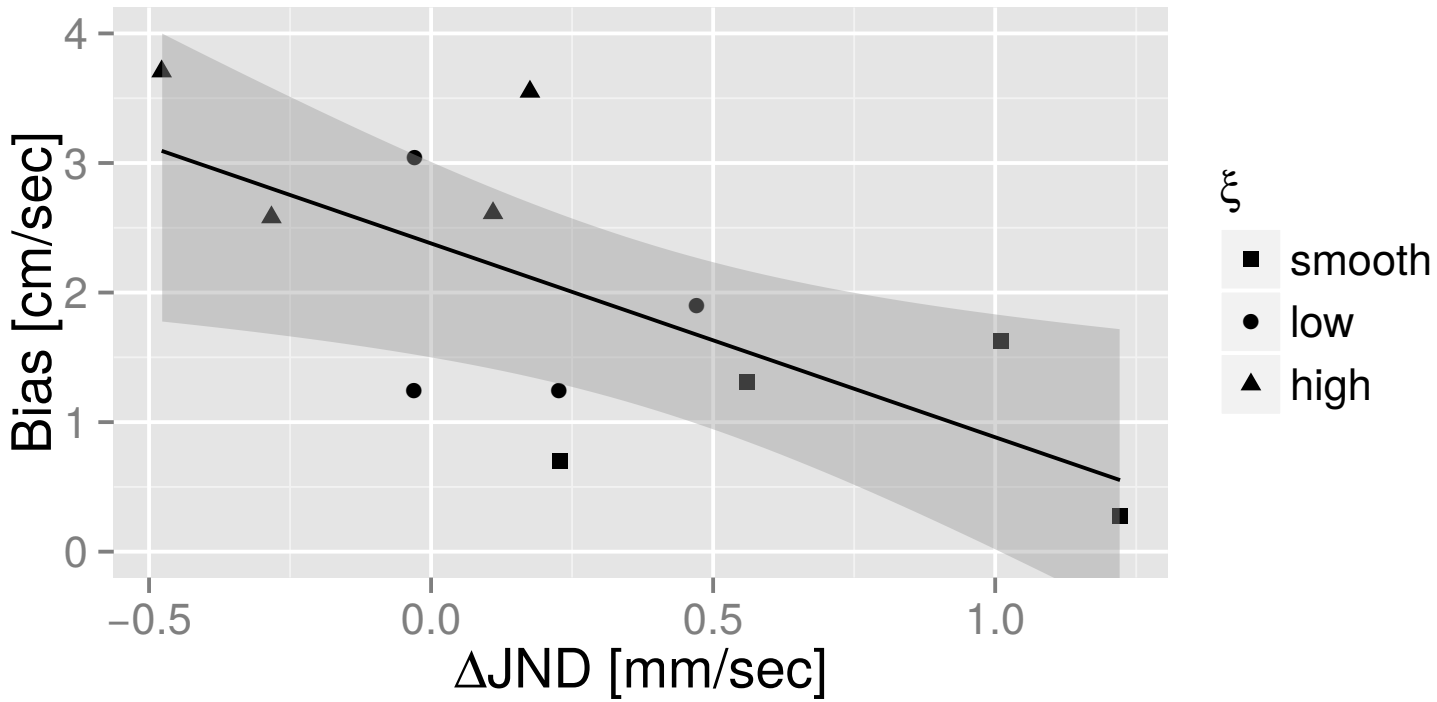
We modeled the response as follows:

$$\Phi^{-1}\left[P(Y_{ij} = 1)\right] = \beta_1 \Delta v \pm \beta_2 \xi$$

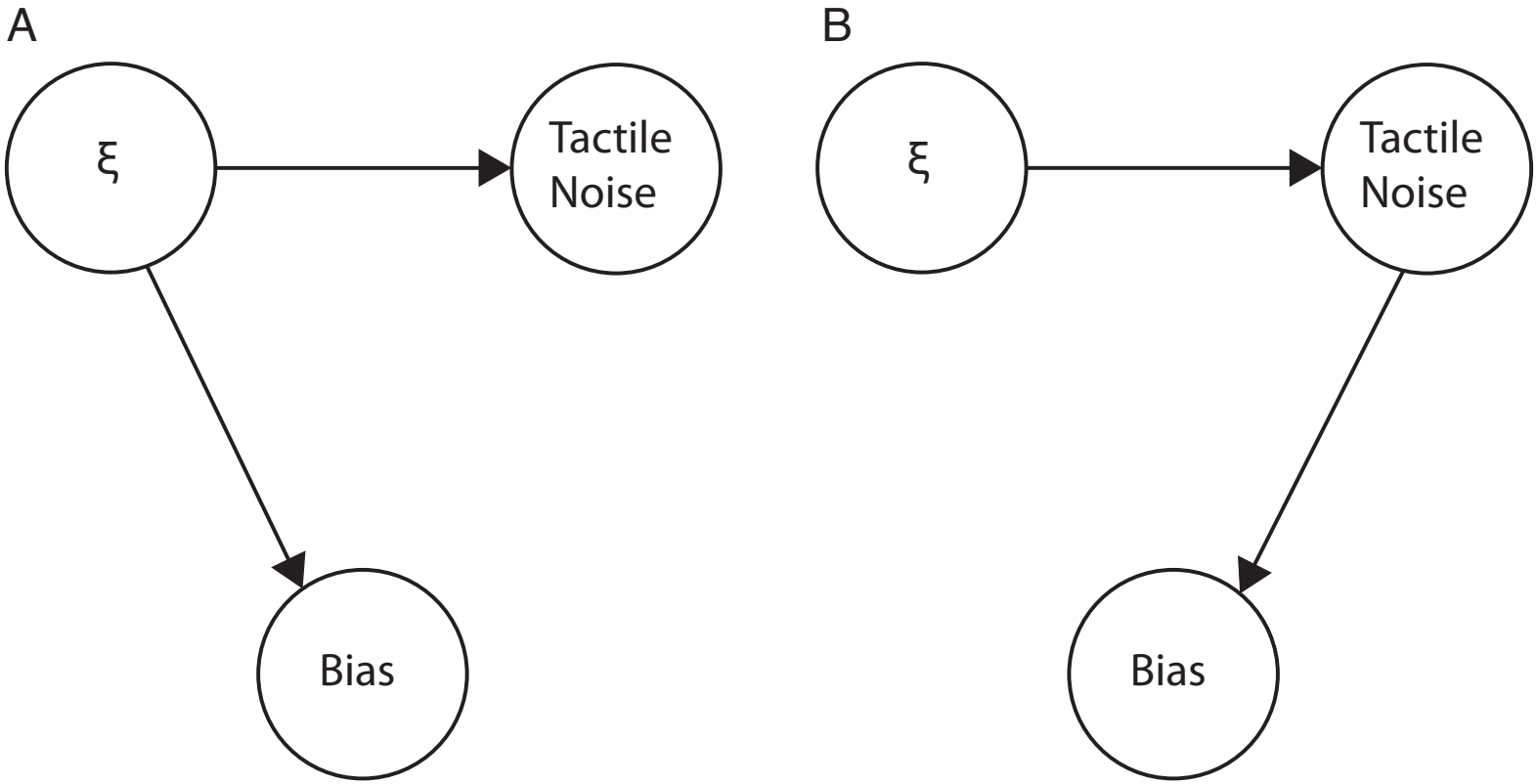
Results: PSE



Results: Noise



Mechanism



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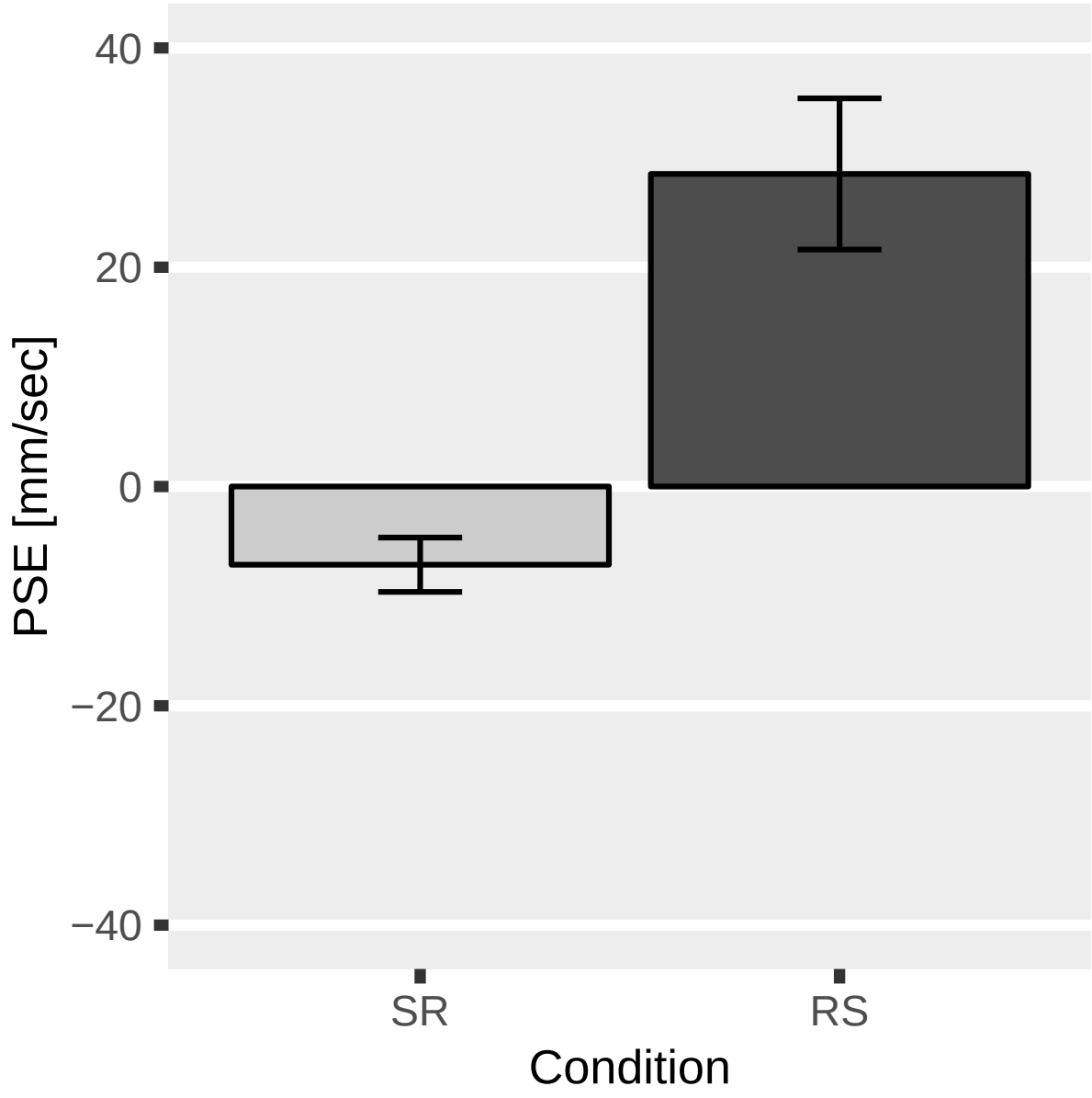
- Unimodal, tactile discrimination task.
- The belt consisted of two distinct surfaces, having either a smooth or a high-frequency texture ($\xi = 0.25$ mm^{-1})
- In two intervals, participants (N = 8) contacted either the smooth (S) or the rough (R) textured part of the belt and reported in which interval the belt moved faster.

Results



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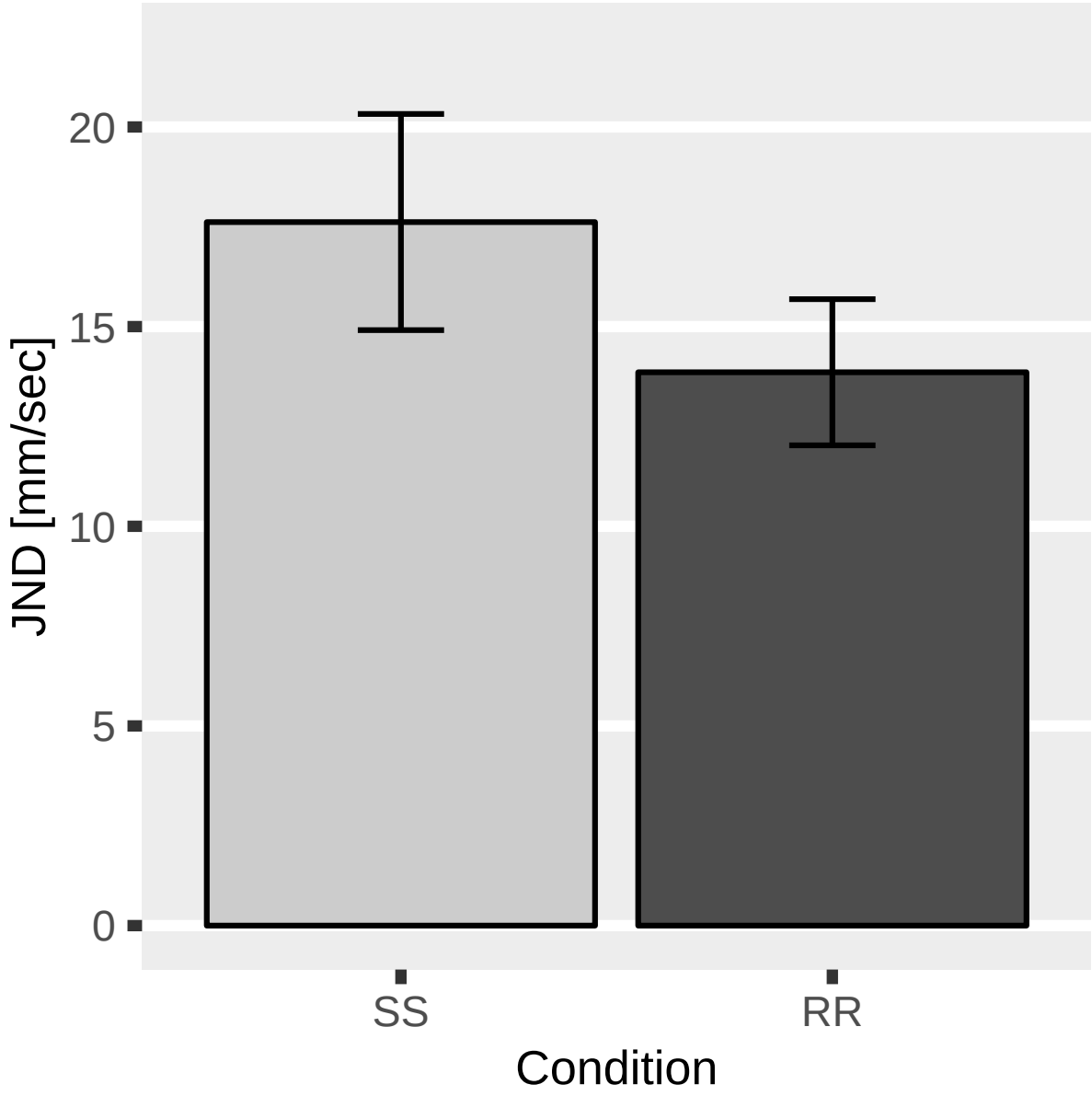

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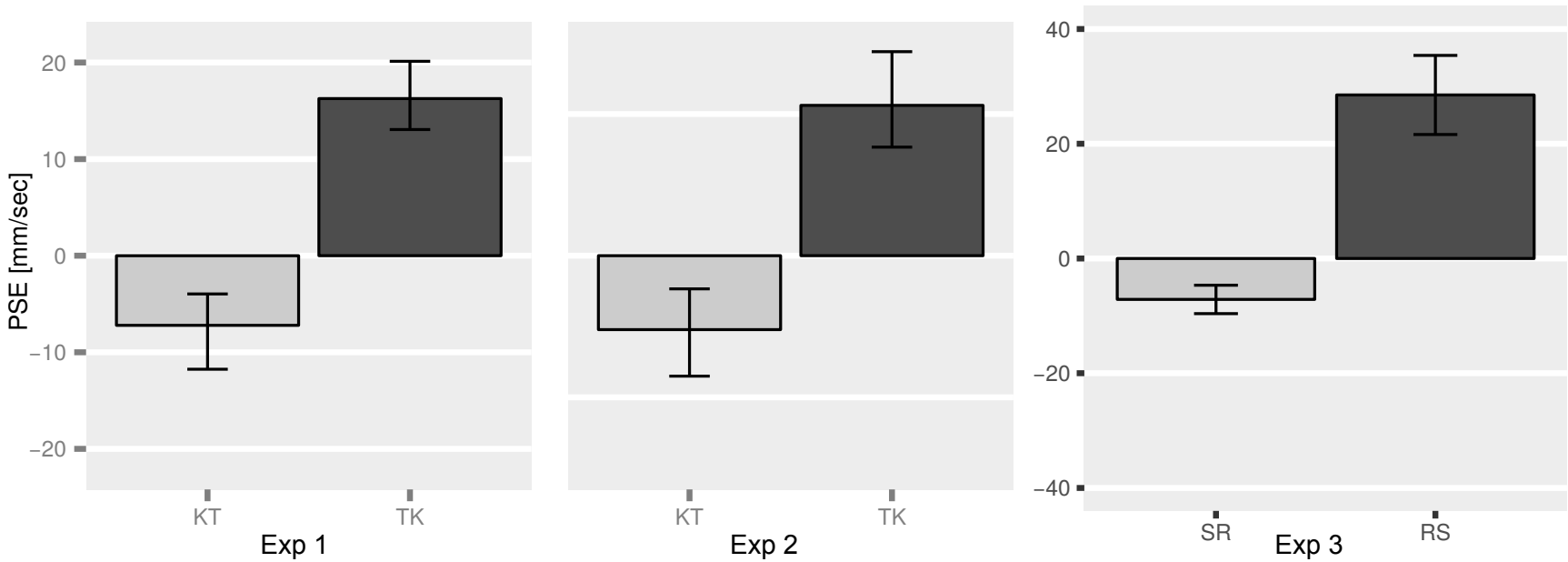
PSE [mm/sec]
20
10
0
−10
−20
KT
TK
Exp 1
KT
TK
Exp 2
40
20
0
−20
−40
SR
RS
Exp 3

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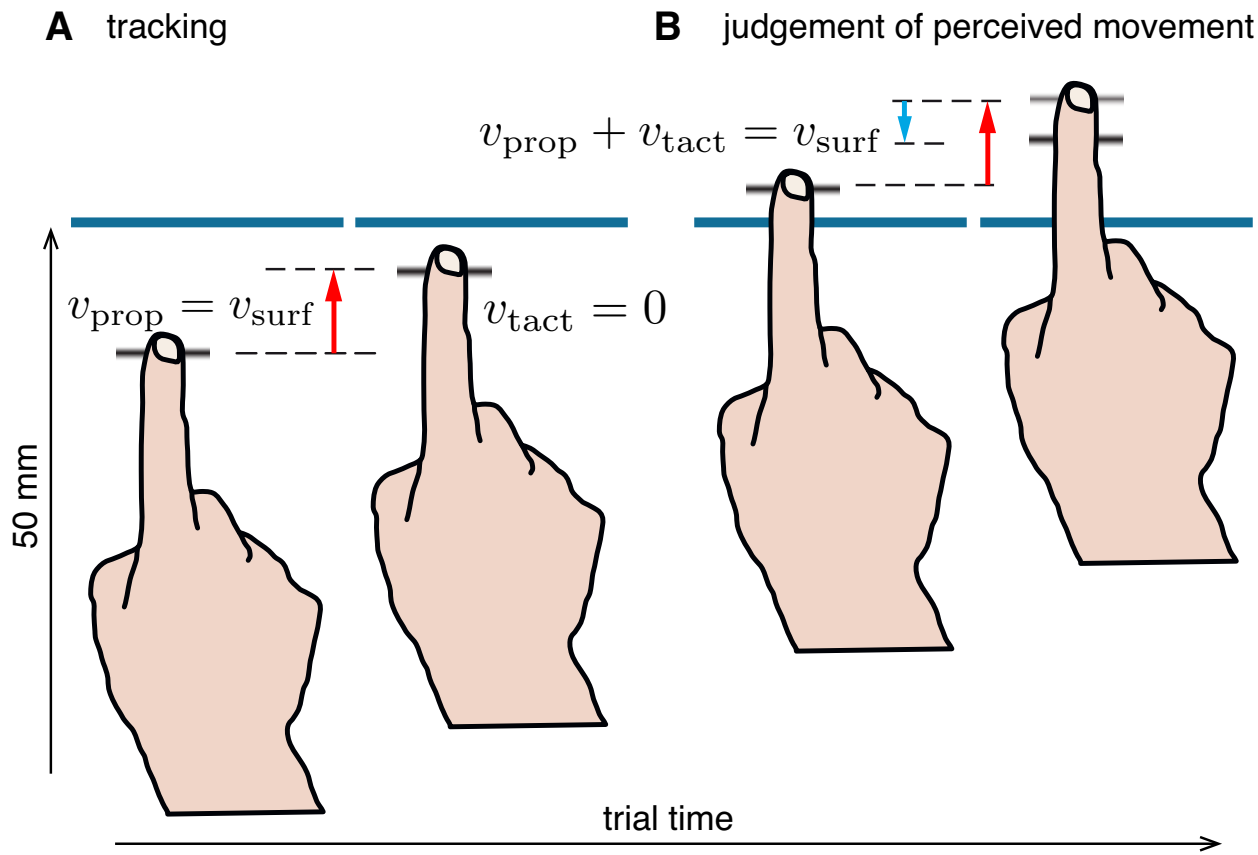
$$\hat{v} = f\lambda$$

References

- Moscatelli, A., Hayward, V., Wexler, M., Ernst, M. O. (2015). Illusory Tactile Motion Perception: An Analog of the Visual Filehne Illusion. Scientific Reports, 5, 14584.
- Moscatelli, A., Scotto di Cesare, C., Ernst, M. O. (In Prep.). A novel illusion provides insight in motion processing in touch.
- Dallmann, C. J., Ernst, M. O., Moscatelli, A. (2015). The role of vibration in tactile speed perception. Journal of Neurophysiology, 114(6), 3131-3139.

Thank you for your attention

Spatial Constancy in the Tactile System



Spatial Constancy in the Tactile System

Moscatelli et al (2015)

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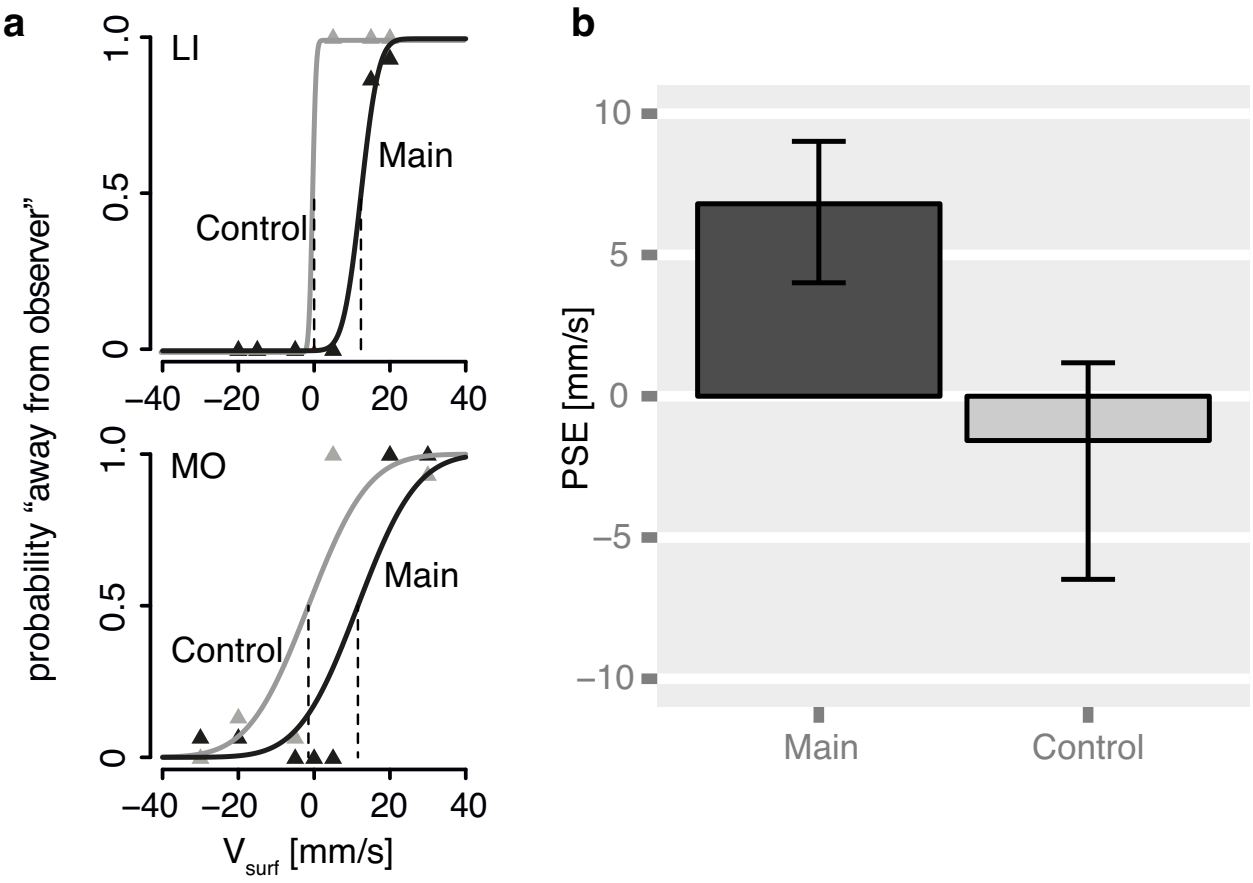

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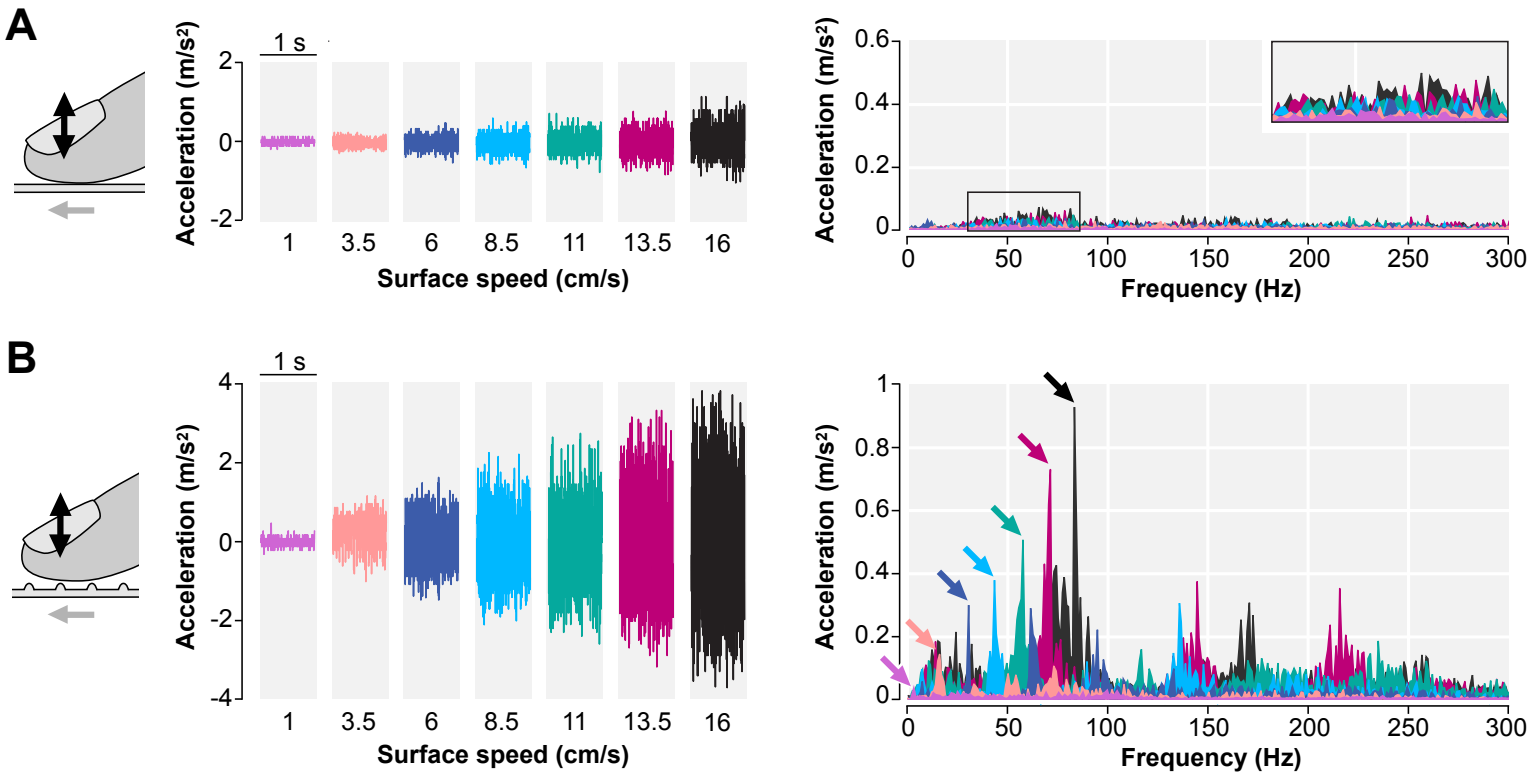
- We run a second experiment to further test this hypothesis

Vibration as Cue to Tactile Speed



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Results: Model Fit