Integration of somatosensory and proprioceptive sensation for the localization of touch in visual space

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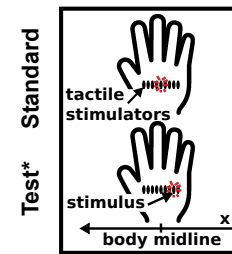
Introduction

- Touch is initially encoded in somatotopic coordinates.
- Localizing touch in external space requires integration of tactile (skin) and proprioceptive (limb) locations.
- Do humans integrate tactile and proprioceptive information optimally?
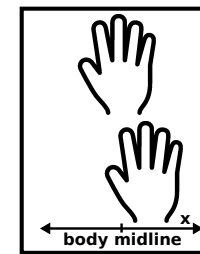
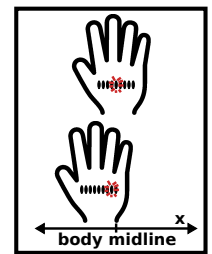## Setup
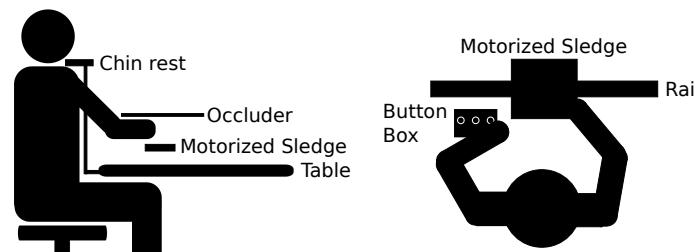
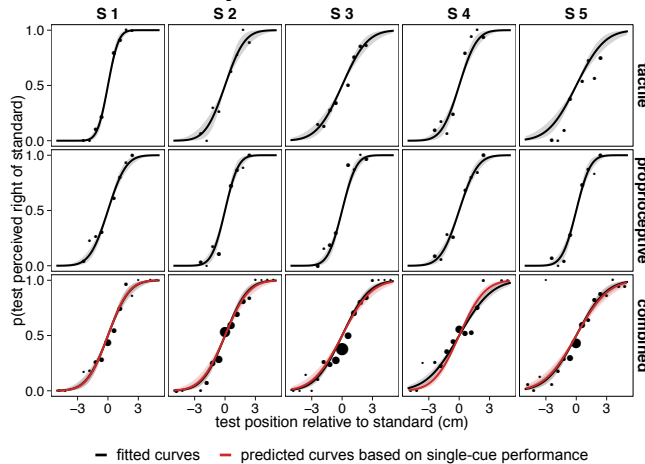## Which interval was further to the right?
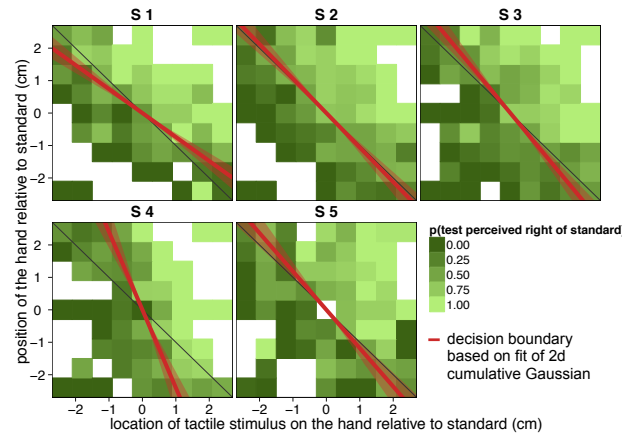

Tasks: Tactile, Proprioceptive, Combined

Standard / Test*

tactile stimulators

stimulus

body midline x

* Standard-test order randomized across trials

Psychometric functions

S 1 S 2 S 3 S 4 S 5

p(test perceived right of standard)

tactile / proprioceptive / combined

test position relative to standard (cm)

— fitted curves   — predicted curves based on single-cue performance

Combined task: Choice data

S 1 S 2 S 3 S 4 S 5

position of the hand relative to standard (cm)

p(test perceived right of standard)
0.00
0.25
0.50
0.75
1.00

— decision boundary based on fit of 2d cumulative Gaussian

location of tactile stimulus on the hand relative to standard (cm)

Ideal Observer

Tactile Task
$$\hat{x}_t \sim \mathcal{N}(x_t, \sigma_t^2)$$

Proprioceptive Task
$$\hat{x}_p \sim \mathcal{N}(x_p, \sigma_p^2)$$

Combined Task
$$\hat{x}_c \sim \mathcal{N}(x_t + x_p, \sigma_t^2 + \sigma_p^2)$$

Conclusion

- Almost all slopes in the combined condition are indistinguishable from optimal.
- Yet, observers give the more reliable cue higher weight in a circumstance where that is irrational. Possibly reflects per-cue midline priors.