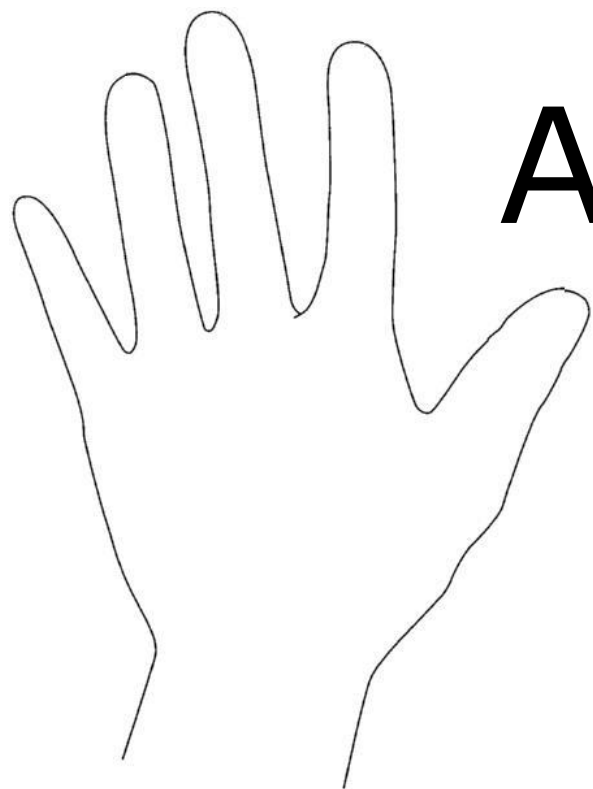


Perceptual Evaluation Methods for Haptics Research

Adaptation



Scinob Kuroki

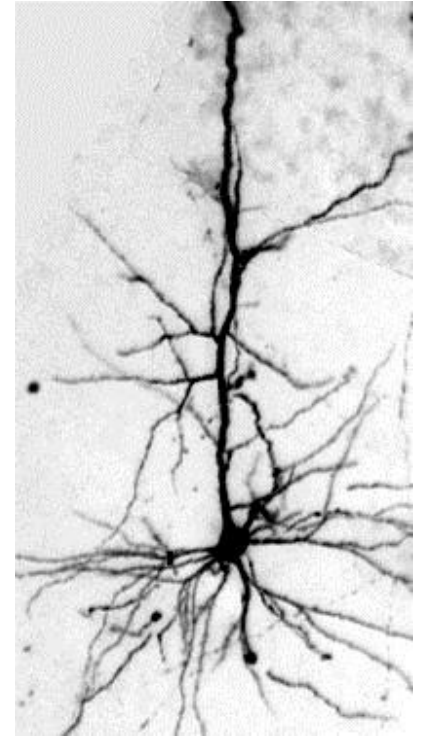
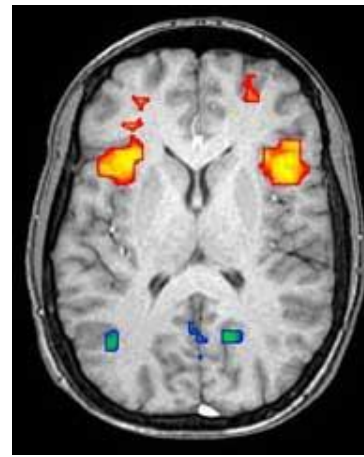
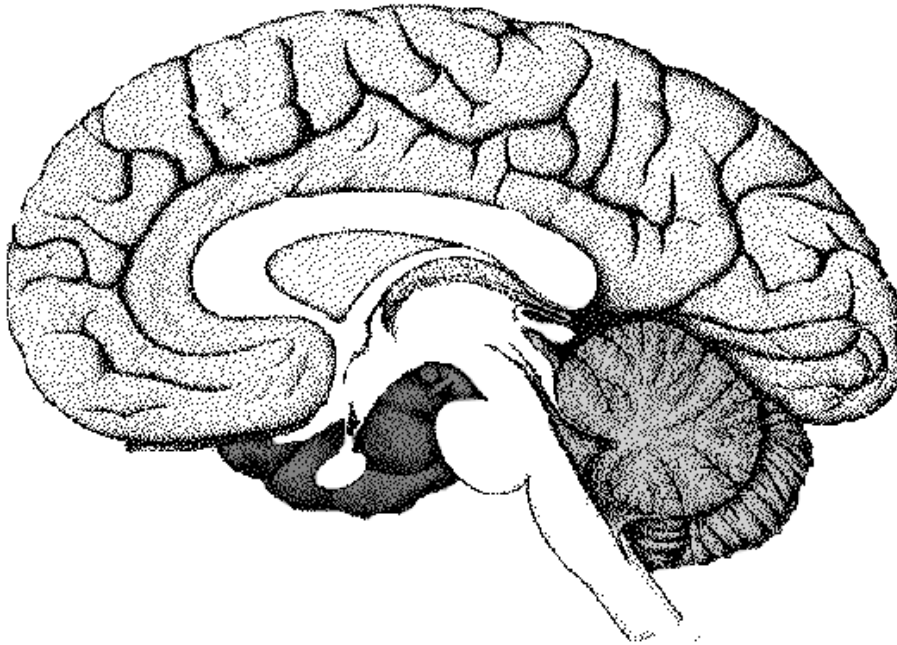
NTT

kuroki.shinobu@lab.ntt.co.jp

Adaptation

順応

Introduction



The adaptation phenomenon has been useful to investigate information processing in the brain without imaging or neurophysiology.

Masking

遮蔽

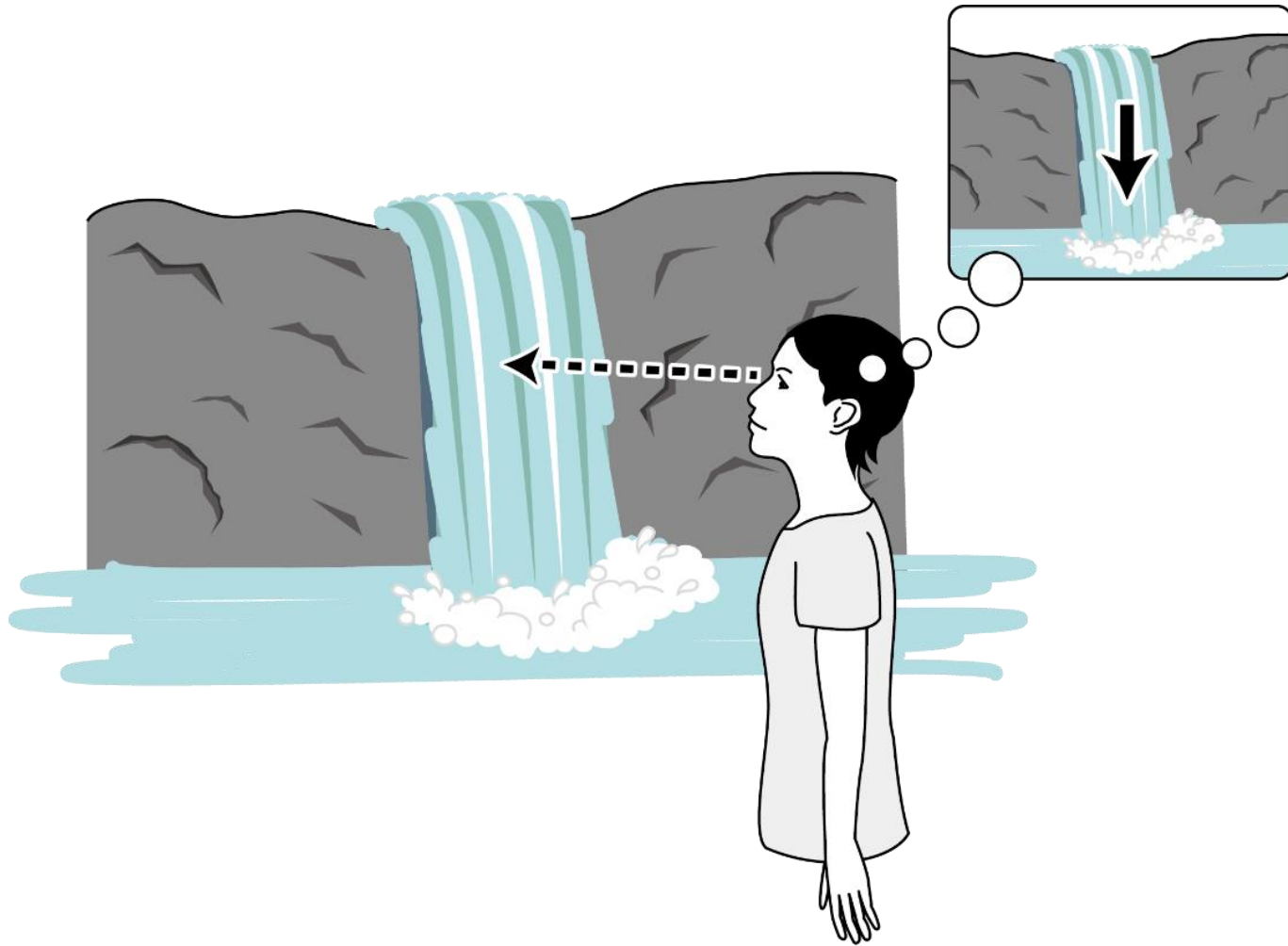
Subthreshold
summation

閾下加算

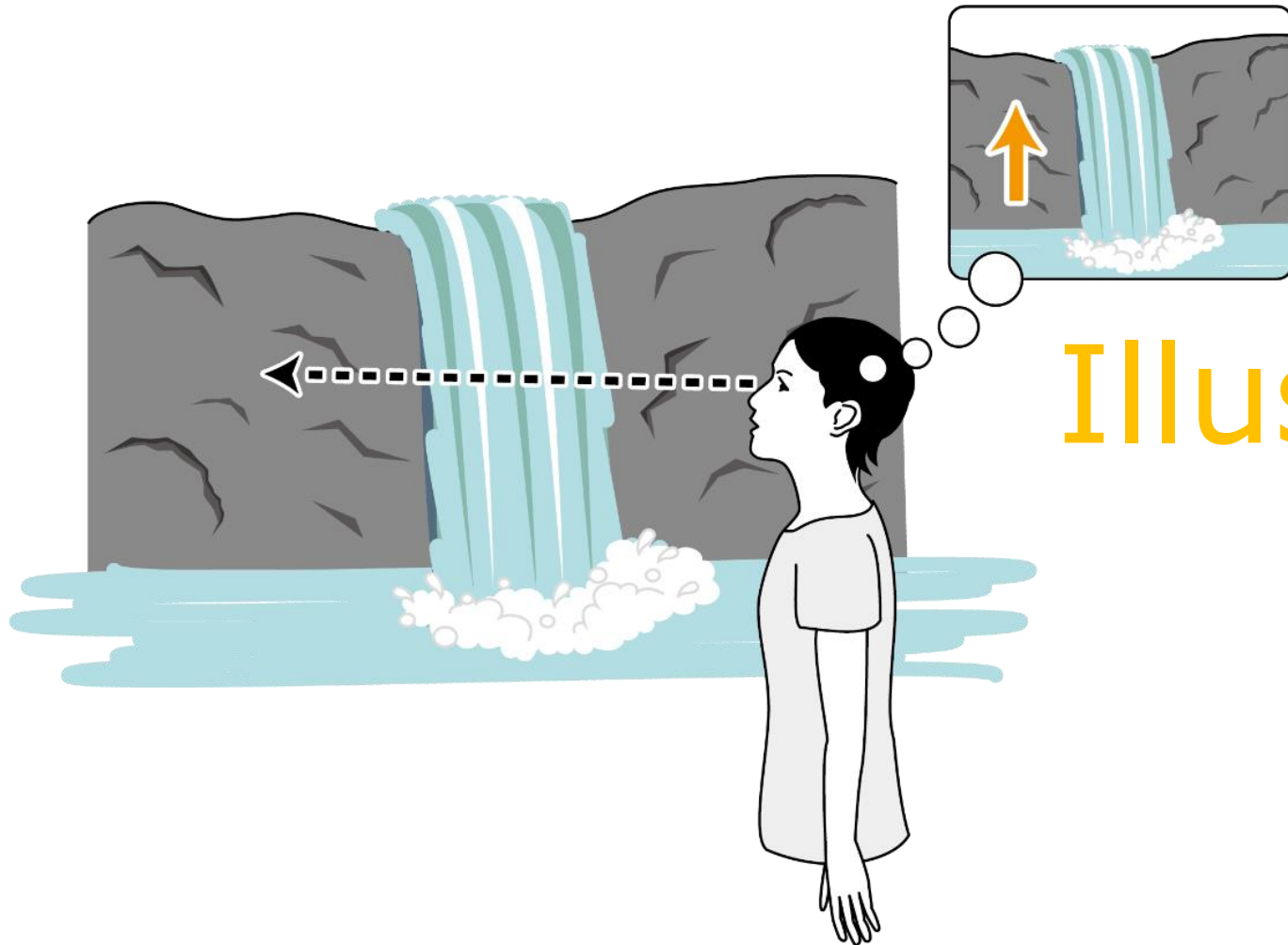
Adaptation

順応

Adaptation



Aftereffect



Illusion



Adaptation is a proof of function

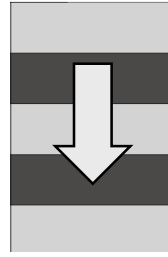
Motion is estimated based on the opposing neurons

Pre



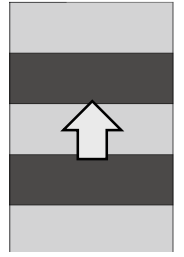
Physical : static
Perceived : static

Adapt

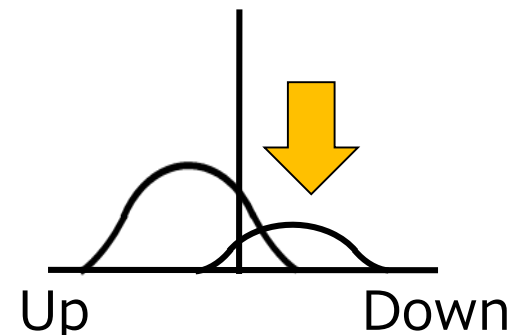
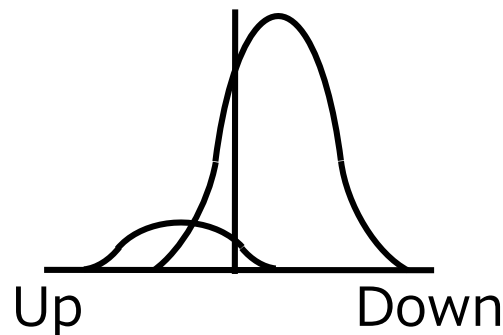
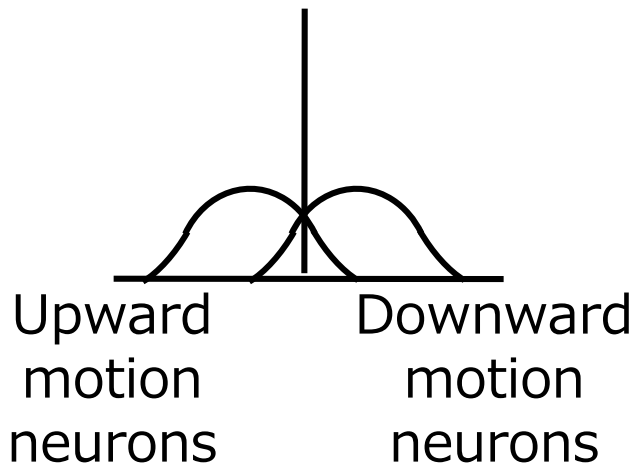


Physical : downward
Perceived : downward

Post



Physical : static
Perceived : upward



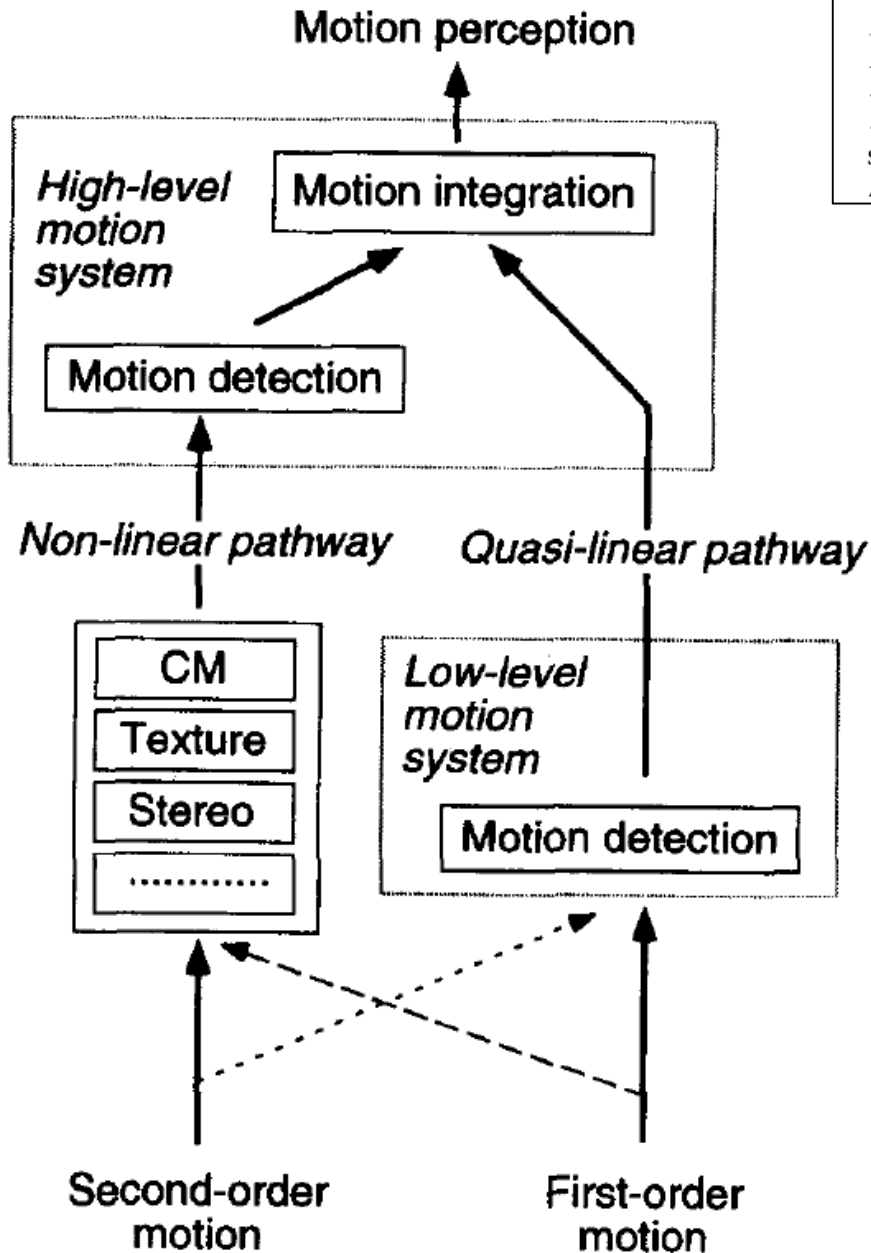
[Adelson&Bergman, 1850]



Motion Aftereffect with Flickering Test Patterns Reveals Higher Stages of Motion Processing

SHIN'YA NISHIDA,*† TAKAO SATO*

Received 31 August 1993; in revised form 3 March 1994; in final form 10 June 1994

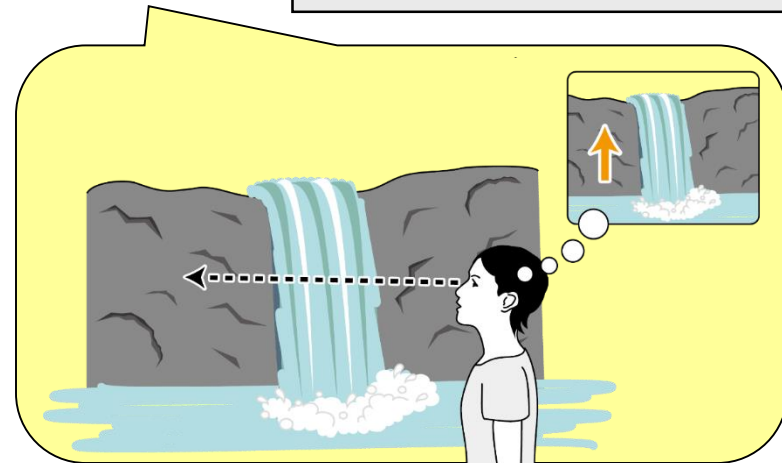


Flicker
MAE



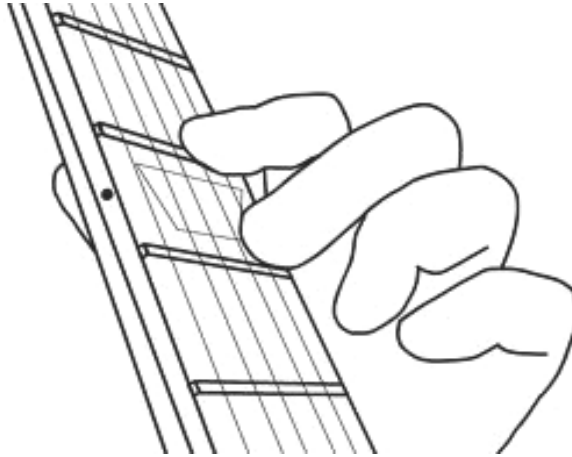
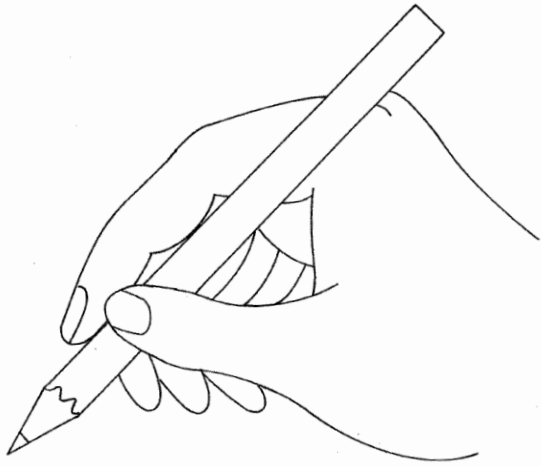
Static
MAE

Motion adaptation have been used to reveal complex motion mechanism in vision



Motion adaptation in Touch

Motion in Touch...is Important!

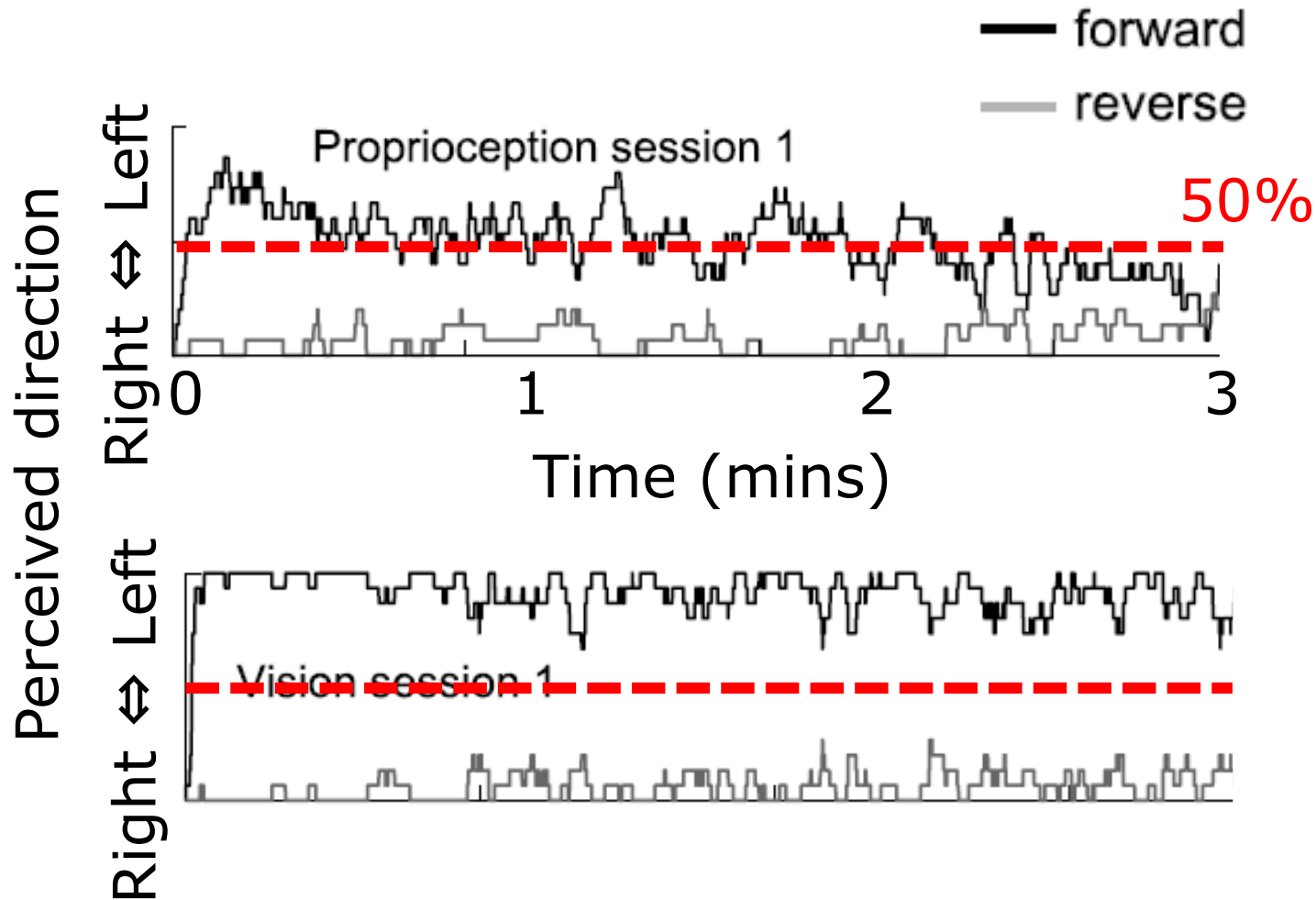
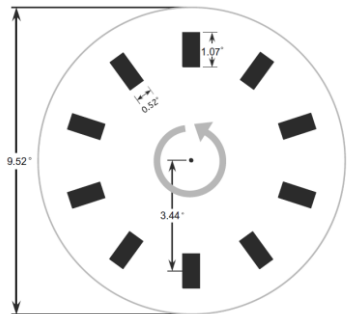


Precise grip
Safe grip



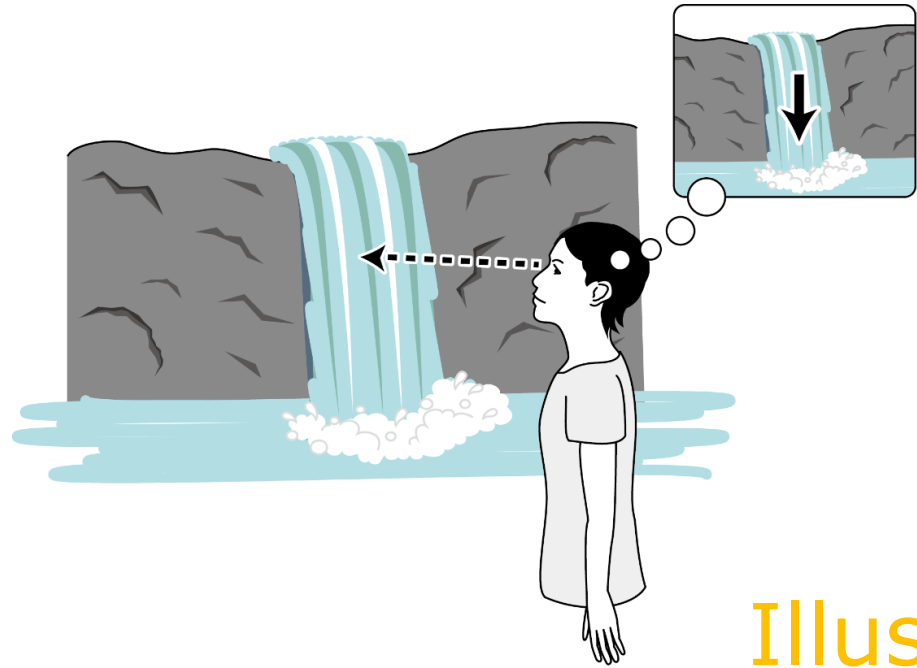
Motion in Touch...is mysterious

Perceived direction is not stable



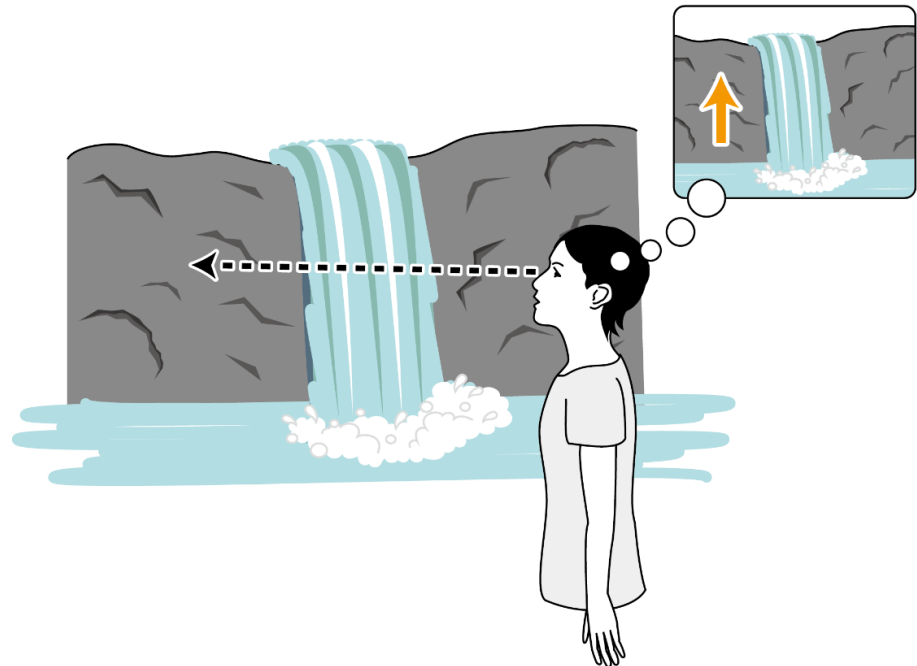
[Holcombe; Vis Res 2008]

Adaptation



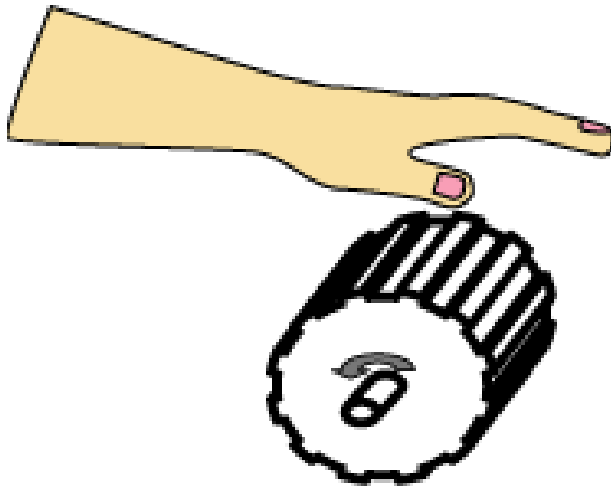
Illusion

Aftereffect



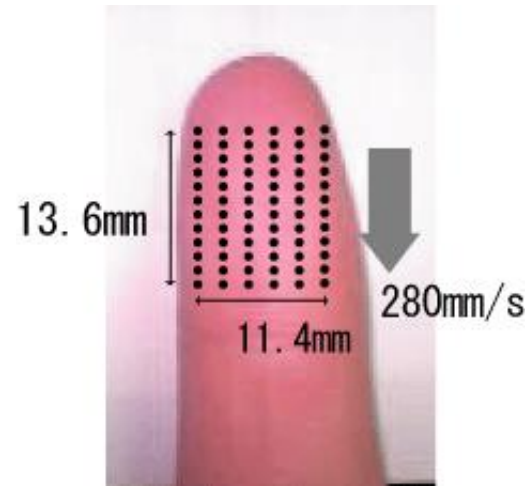
Clear aftereffects like in vision were
NOT observed with static test stimuli

Hollins (1994), Lerner (2002)
Rotating Drum -> Palm



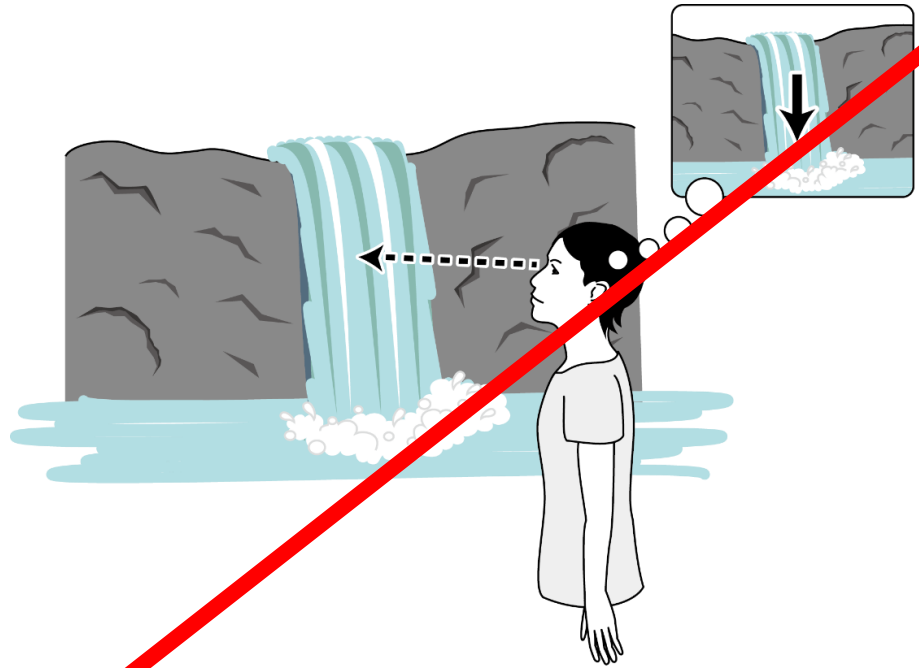
Touch static drum
as test stimuli

Lerner (2002)
Optacon -> Finger Cushion

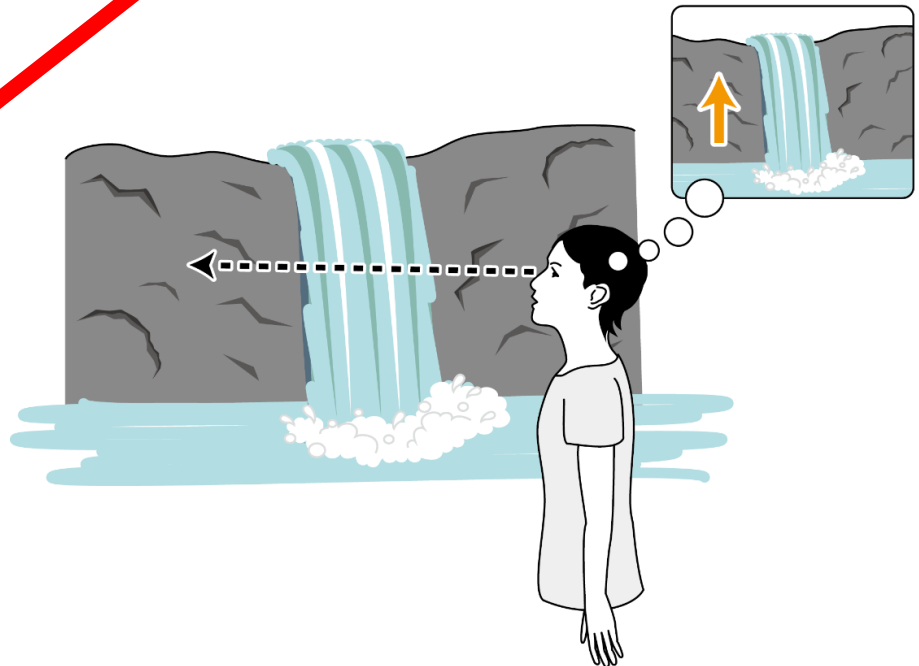


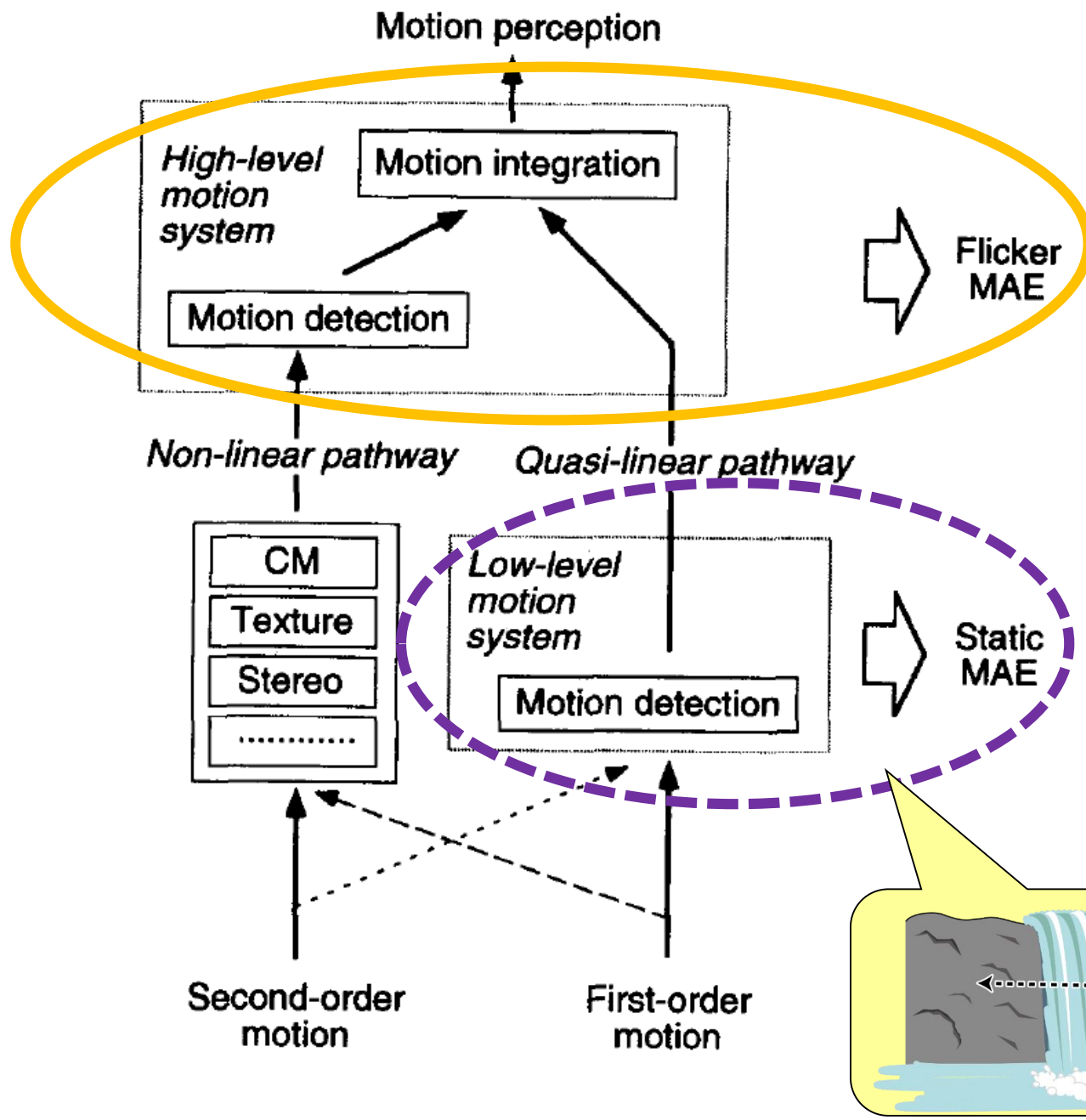
Hold finger
in the mid air
and answer aftereffect

Adaptation



Aftereffect



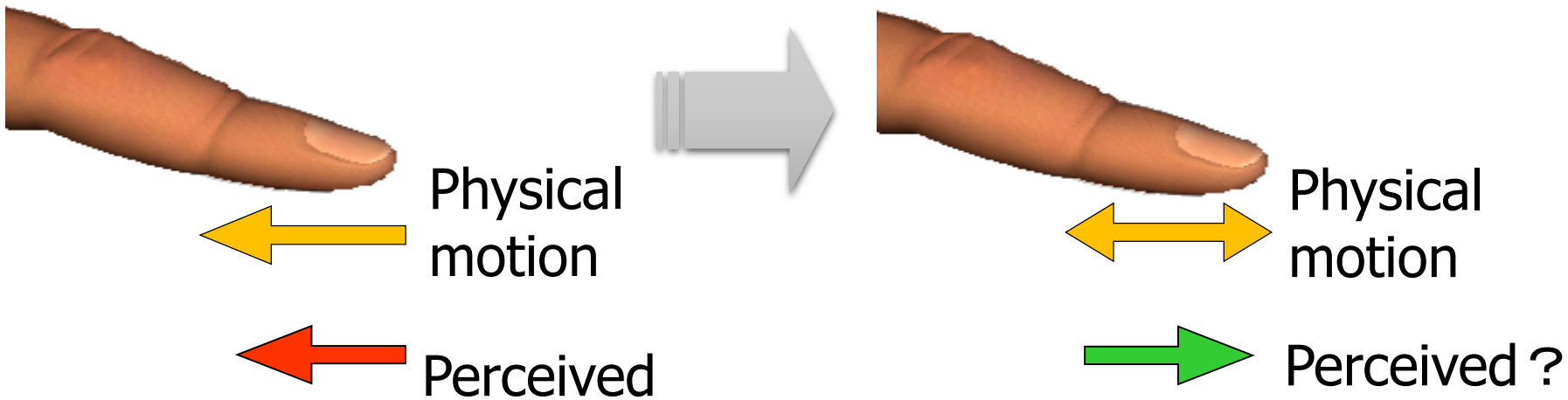


Different stimuli can tap
different mechanism

Flicker MAE

Adaptation
(directional motion)

Test stimuli
(**ambiguous motion**)

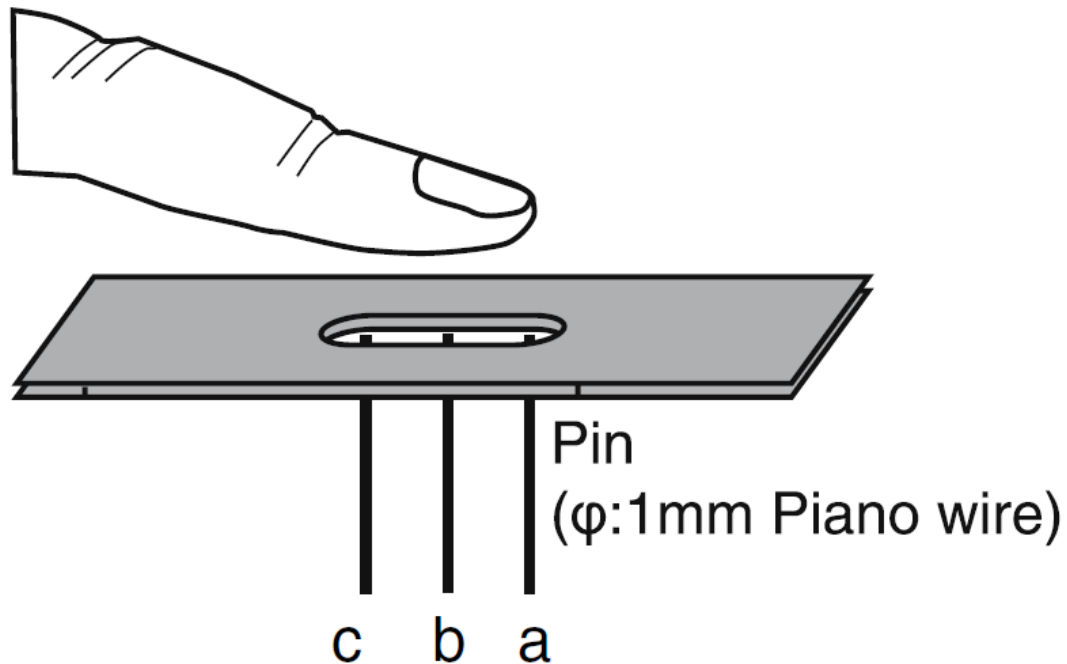


Though static MAE is fragile in touch, flicker MAE, which taps high-level motion system, may occur.

One-finger MAE

Stimulus for Experiment

To generate tactile motion sensation
we used apparent motion

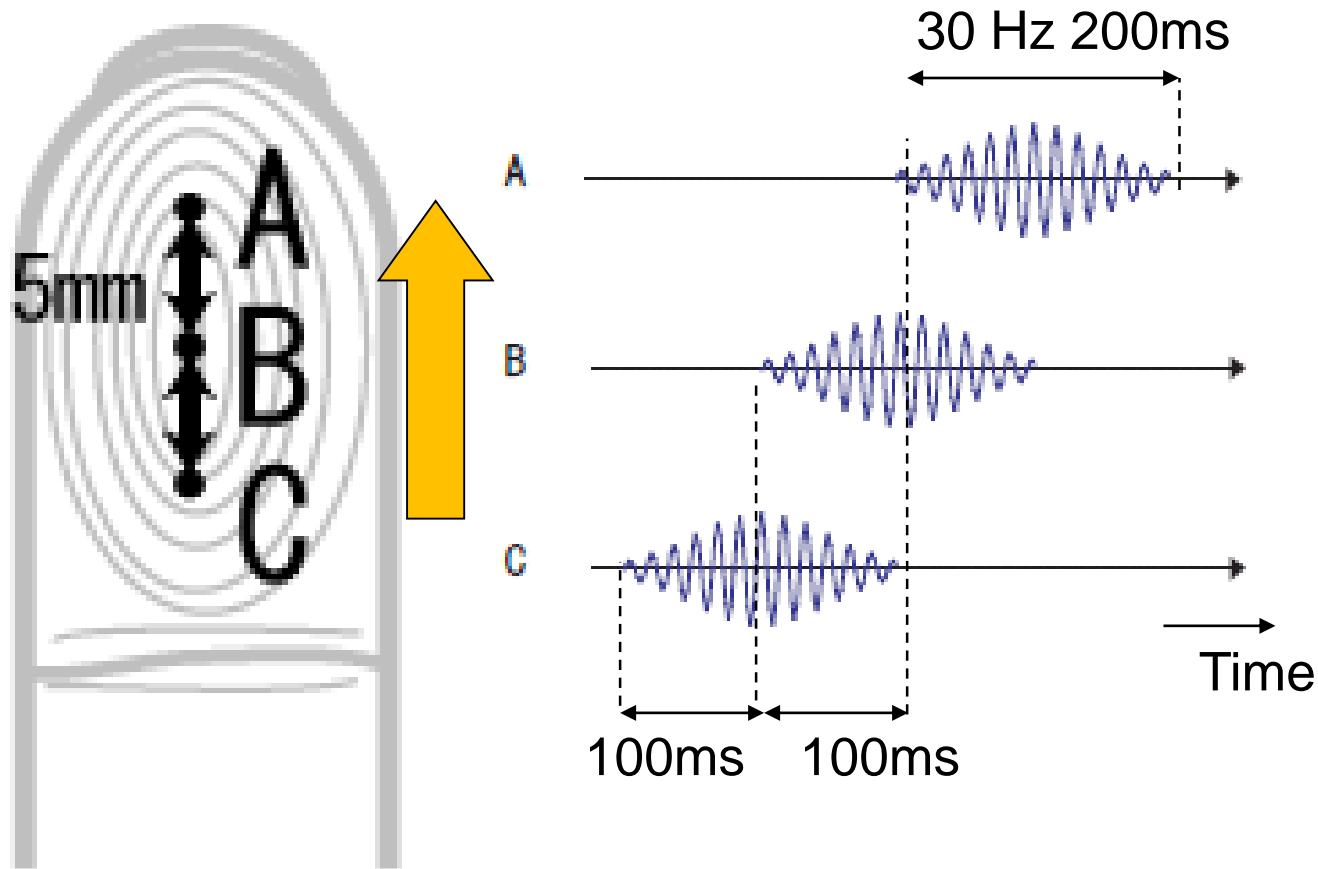


Visual
apparent motion



Stimulus for Experiment

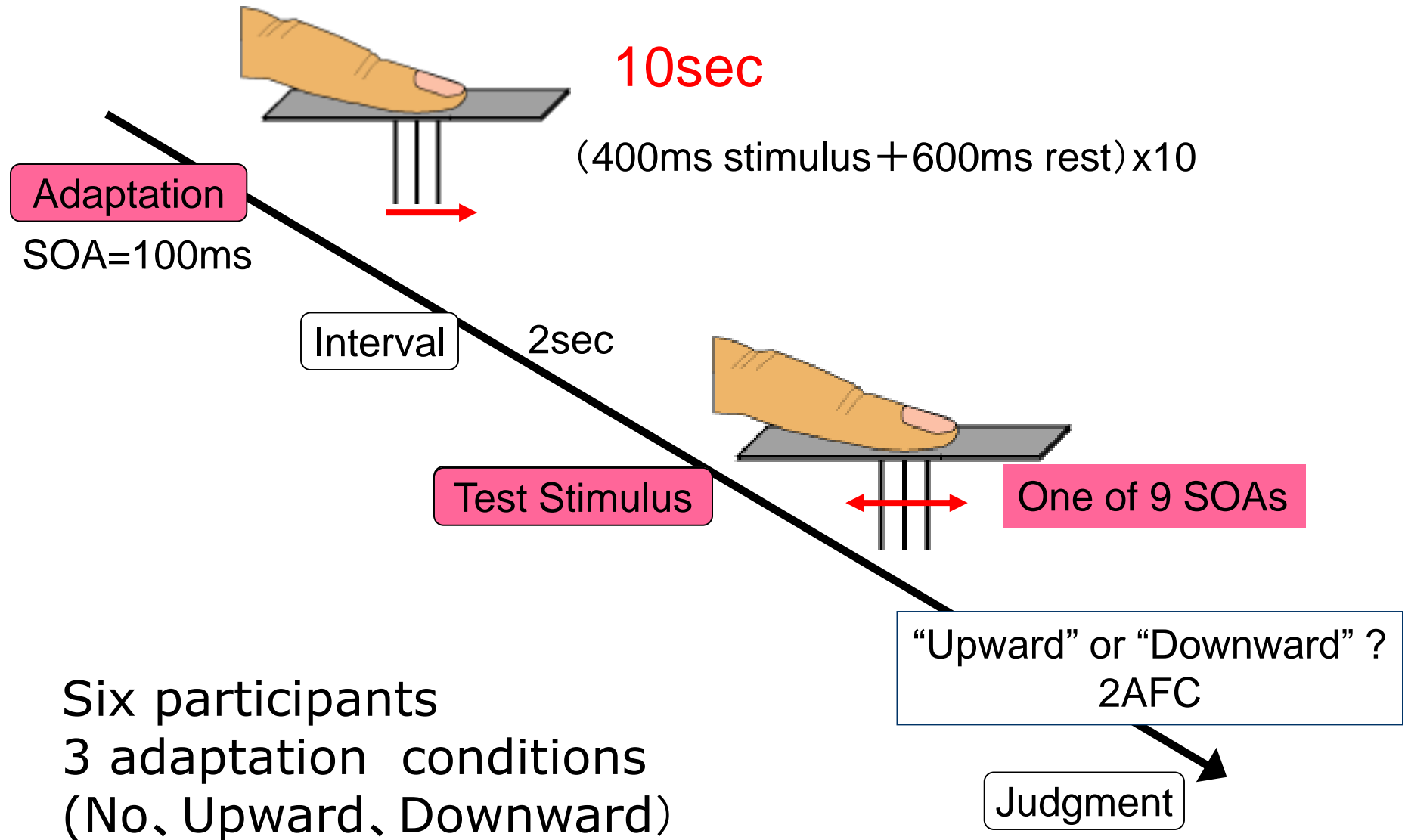
To generate tactile motion sensation we used apparent motion



Adaptation is VERY time consuming...

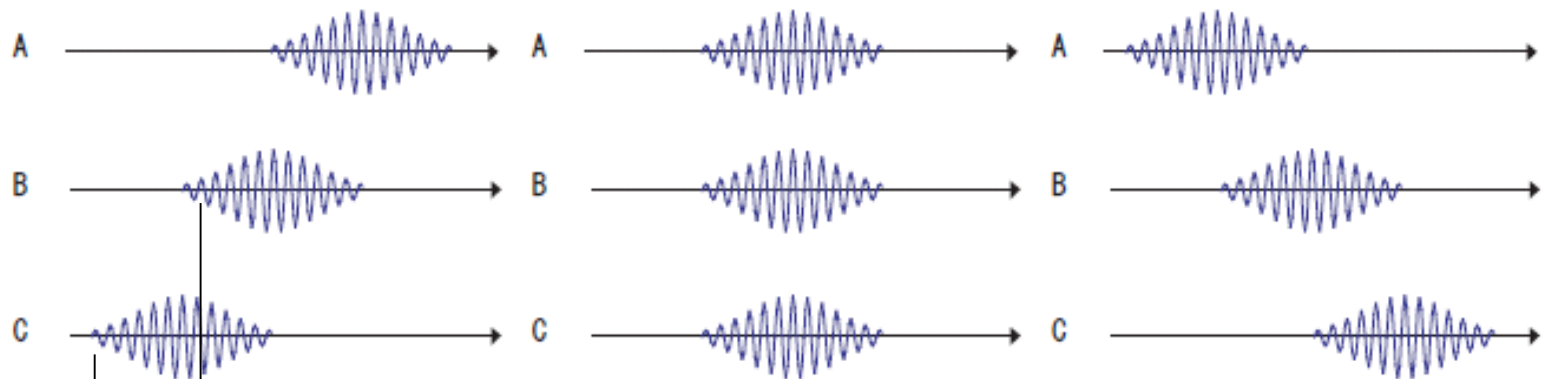
But it's worth it!

Experimental Procedure

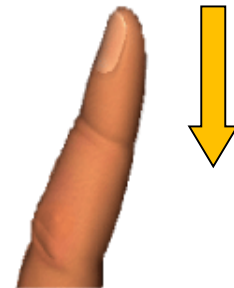


Test Stimulus

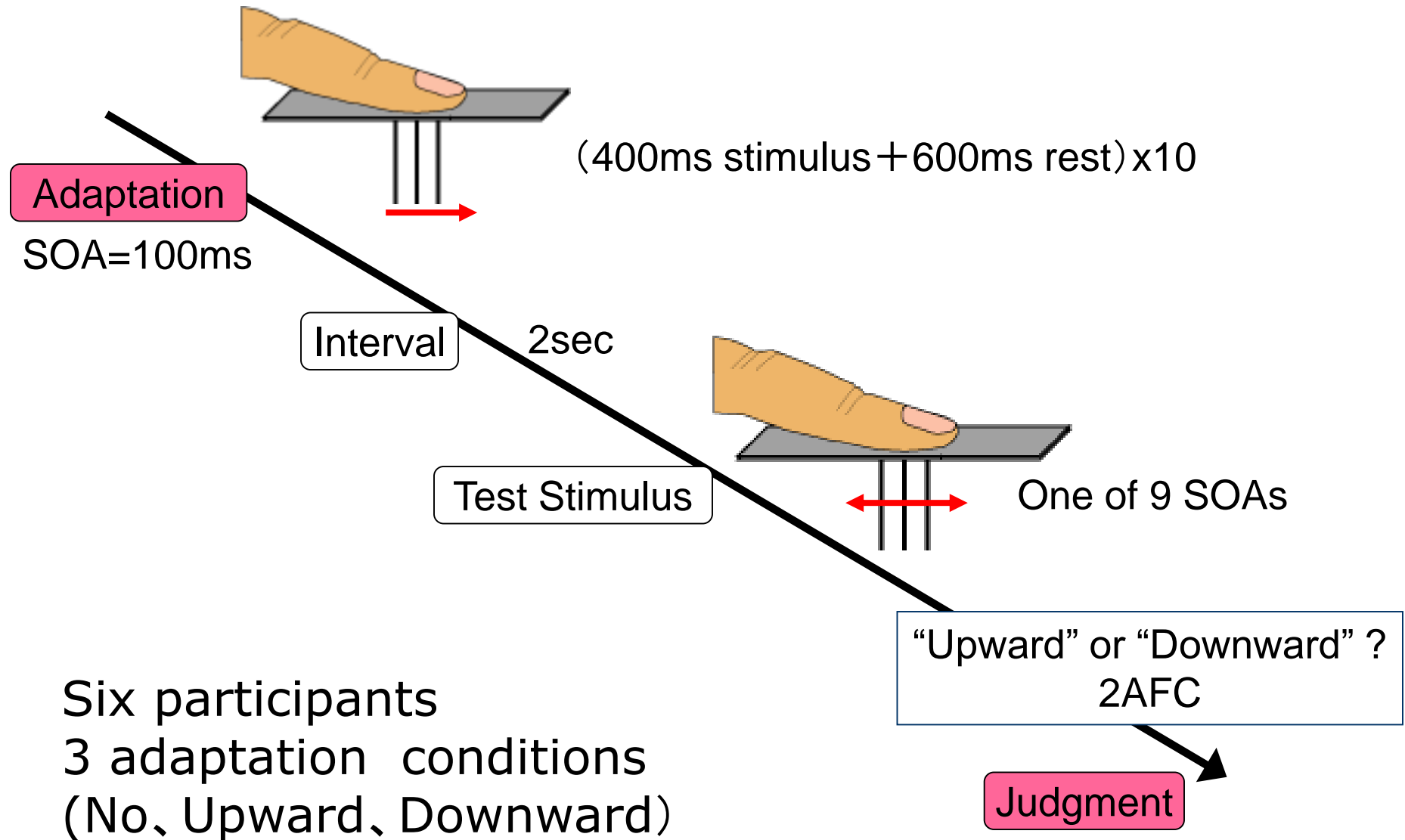
SOAs of test stimuli were selected among following durations.
(120, 60, 30, 15, 0, -15, -30, -60, -120ms)



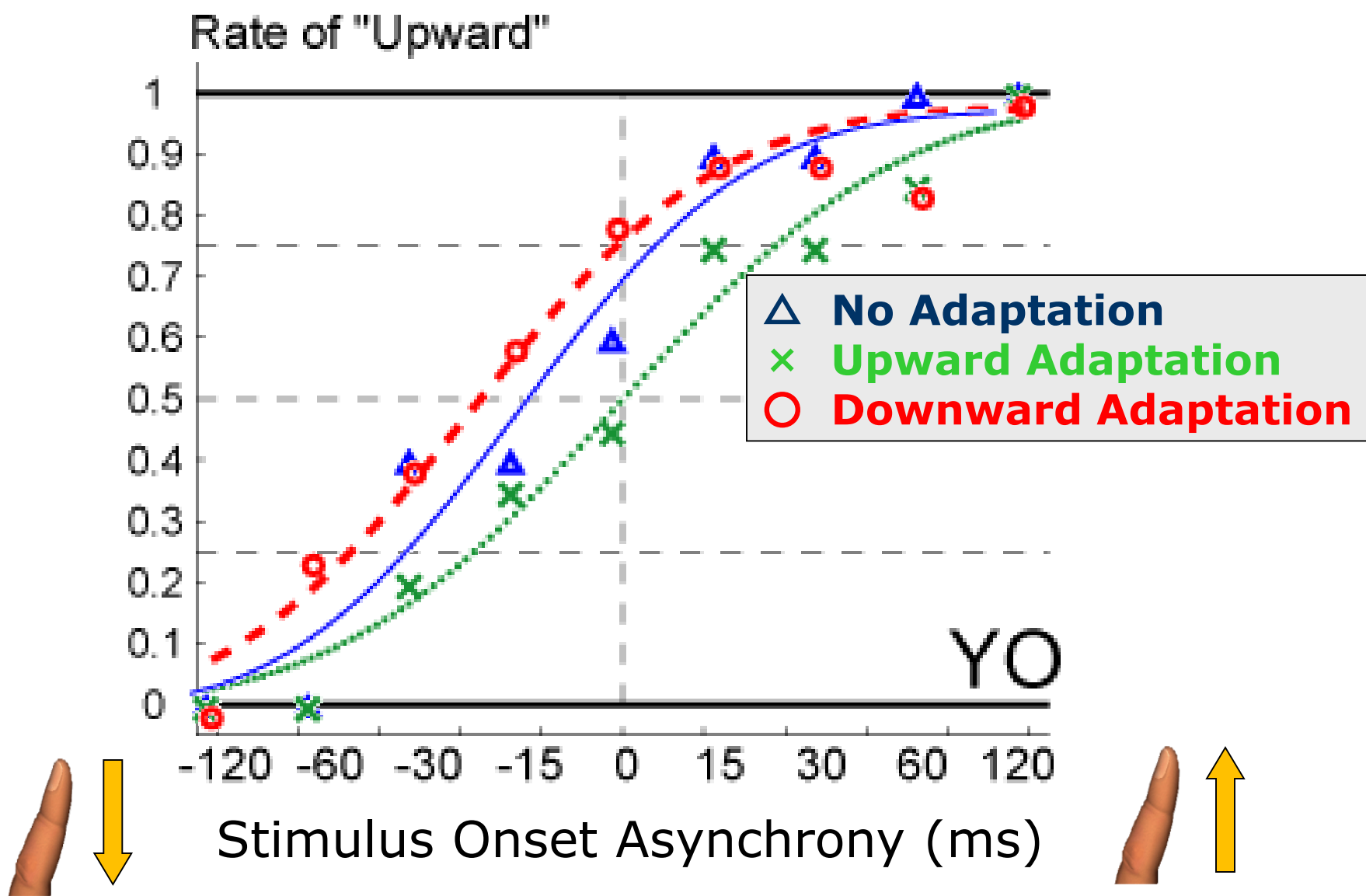
SOA: stimulus onset asynchrony



Experimental Procedure

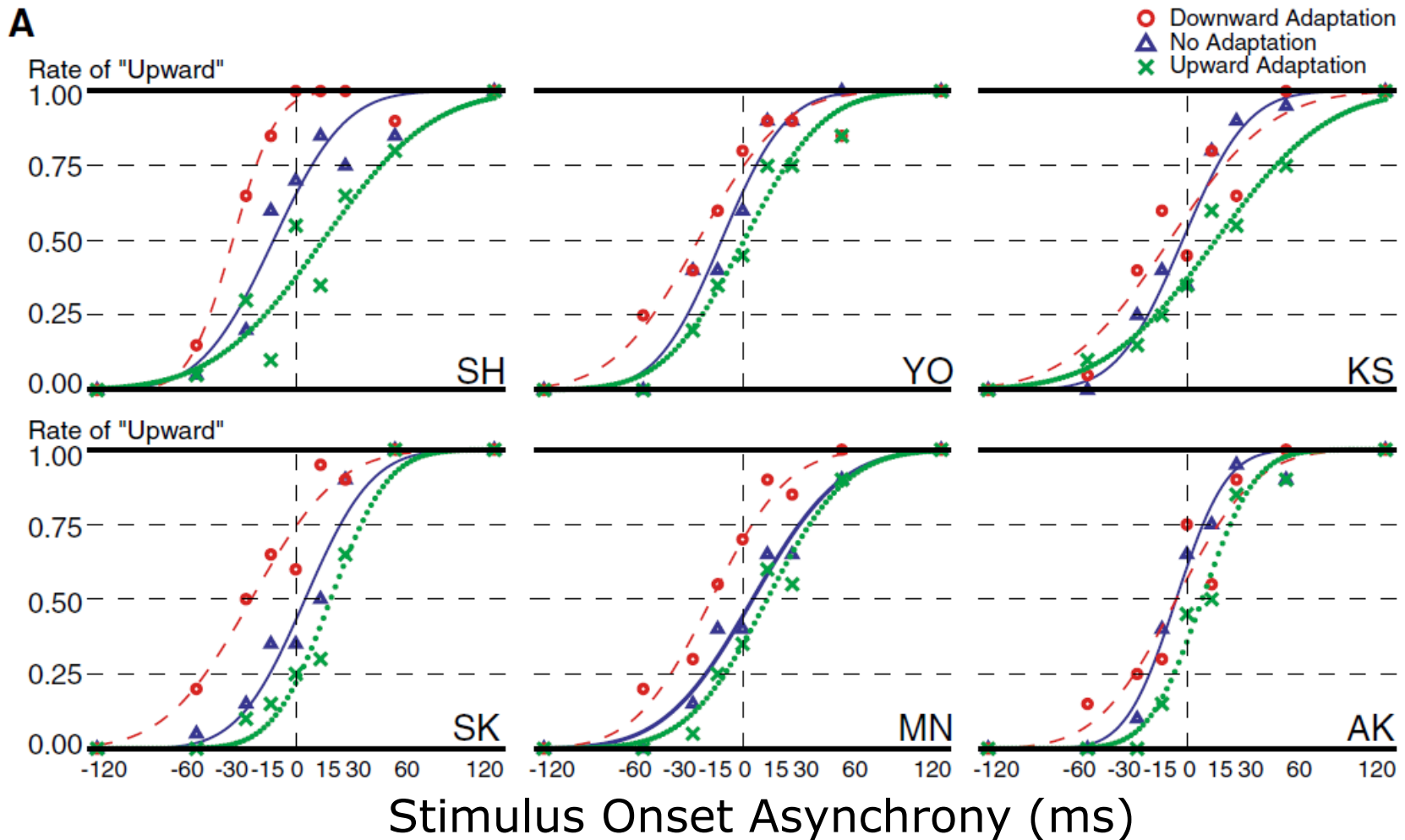


Experimental Result: Typical example



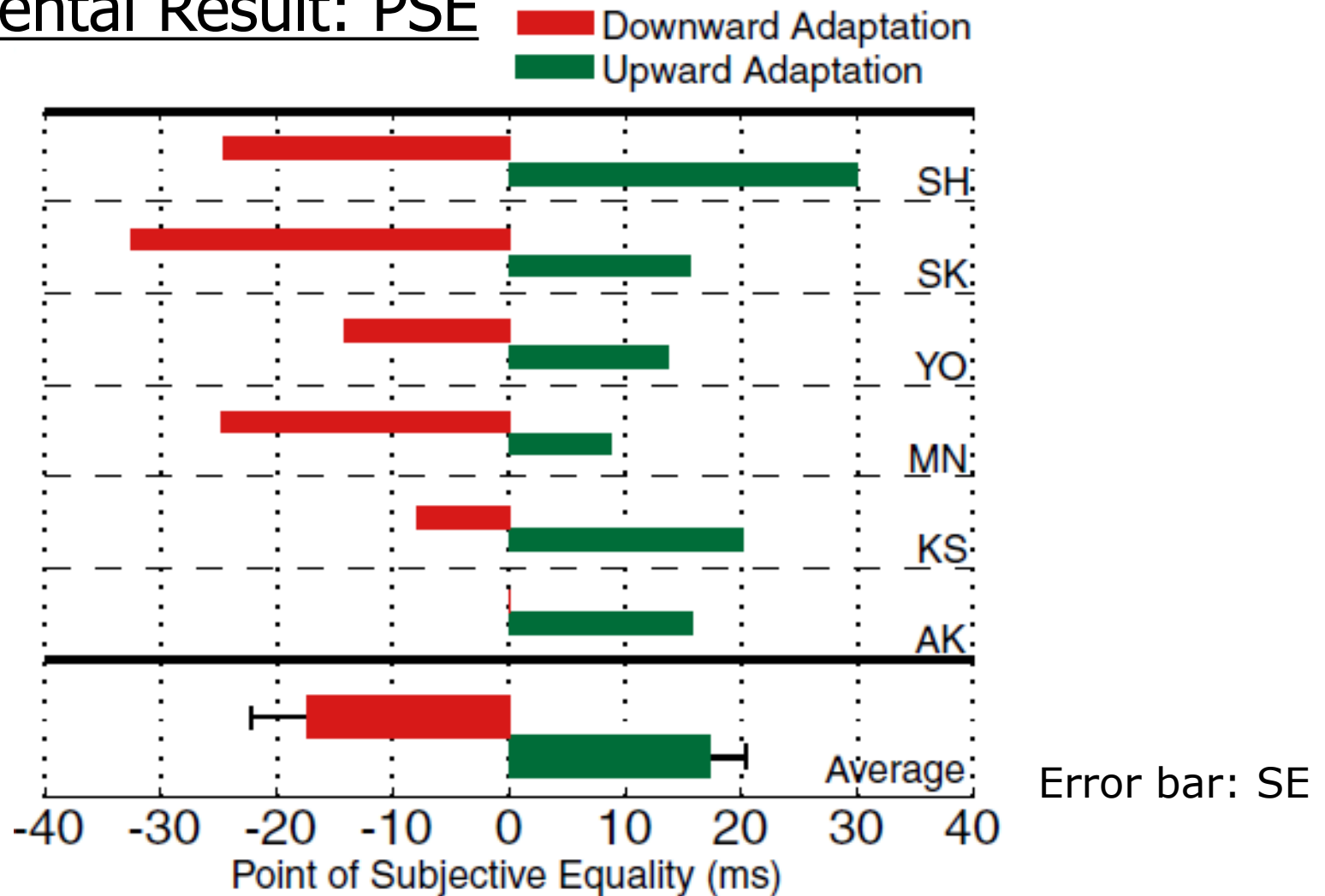
Experimental Result: All participants

**NOTE: Don't add the data across participants!
First, fit the curve. Calculate PSE. Then average them.**



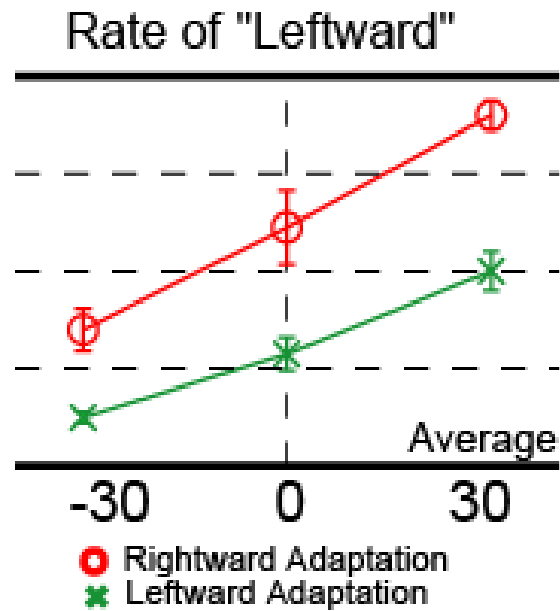
[Watanabe; Exp Brain res 2007]

Experimental Result: PSE

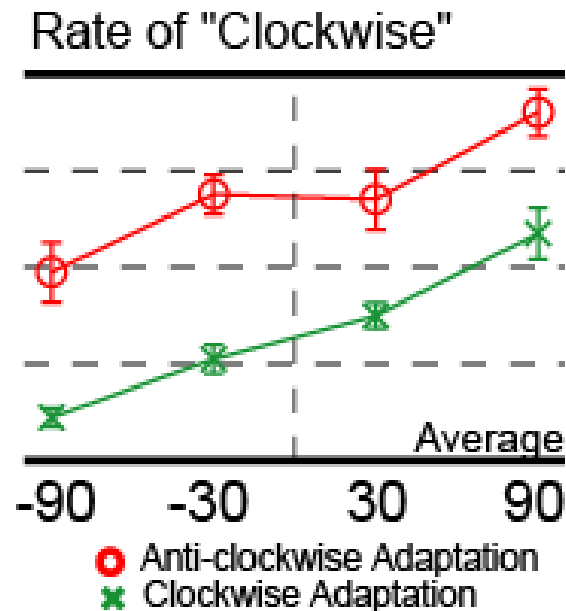


This result indicates that
flicker MAE can be observed in touch

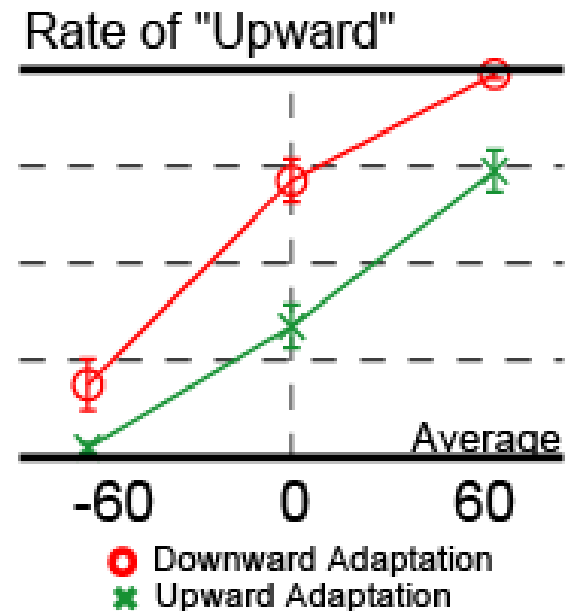
Tactile MAEs also occur for various motions



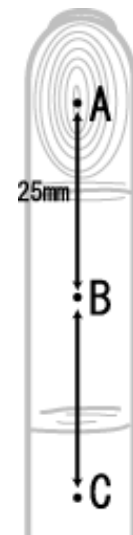
(a) Horizontal motion



(b) Rotation



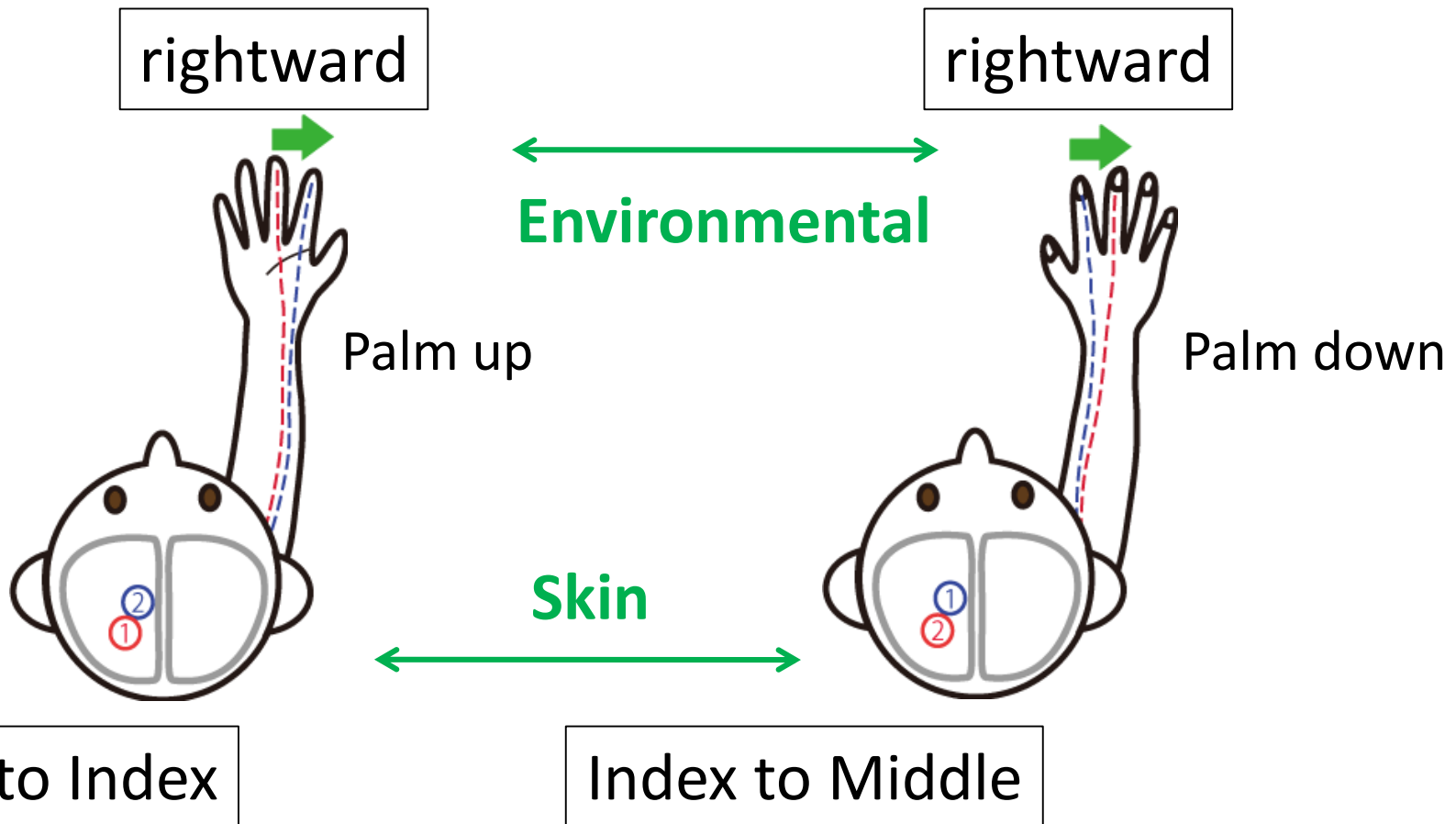
(c) Long distance



Inter-finger MAE

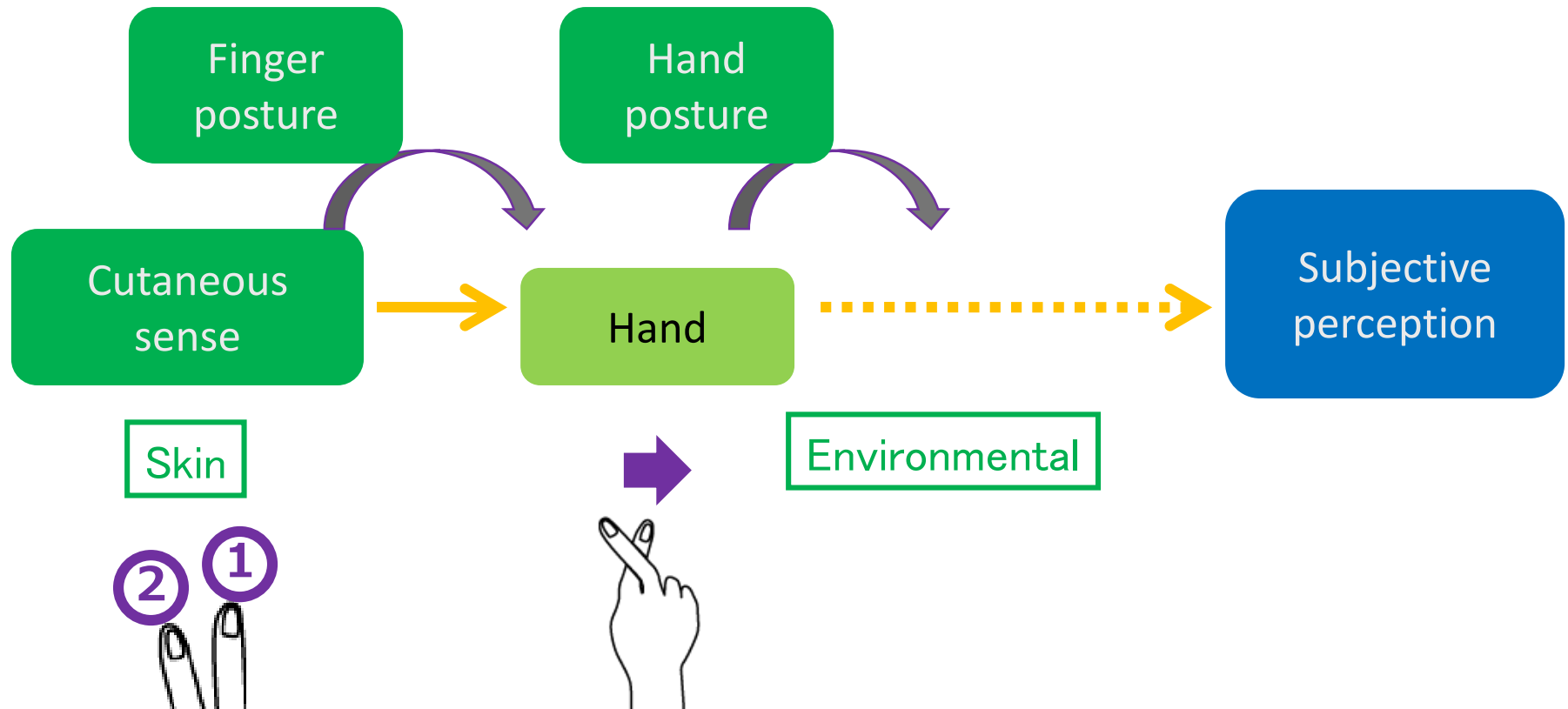
Motivation

- Whether detection system exist for inter-finger motion
- In which coordinate motion is detected

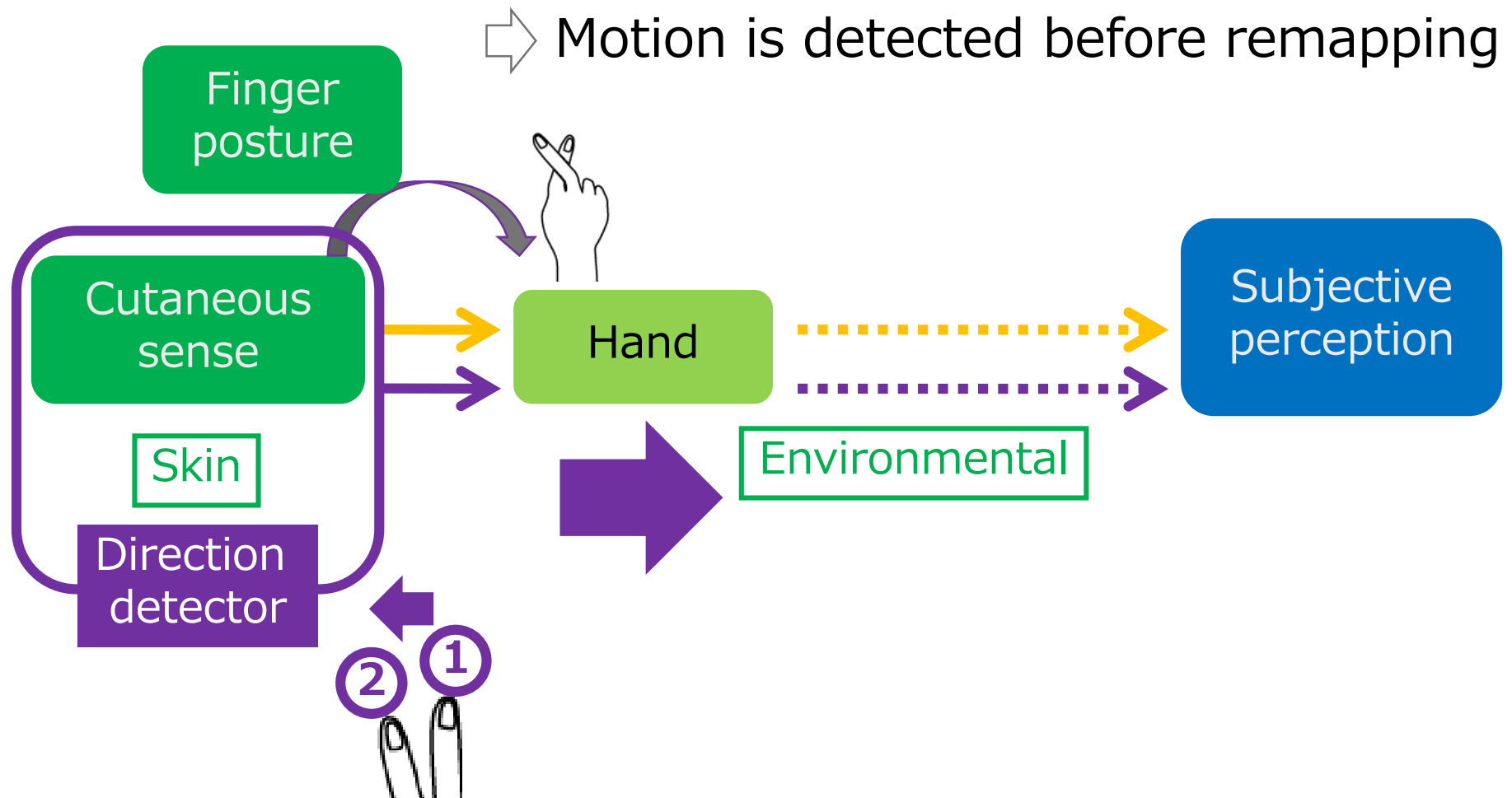


Background

Environmental coordinate is defined after integration of body posture.

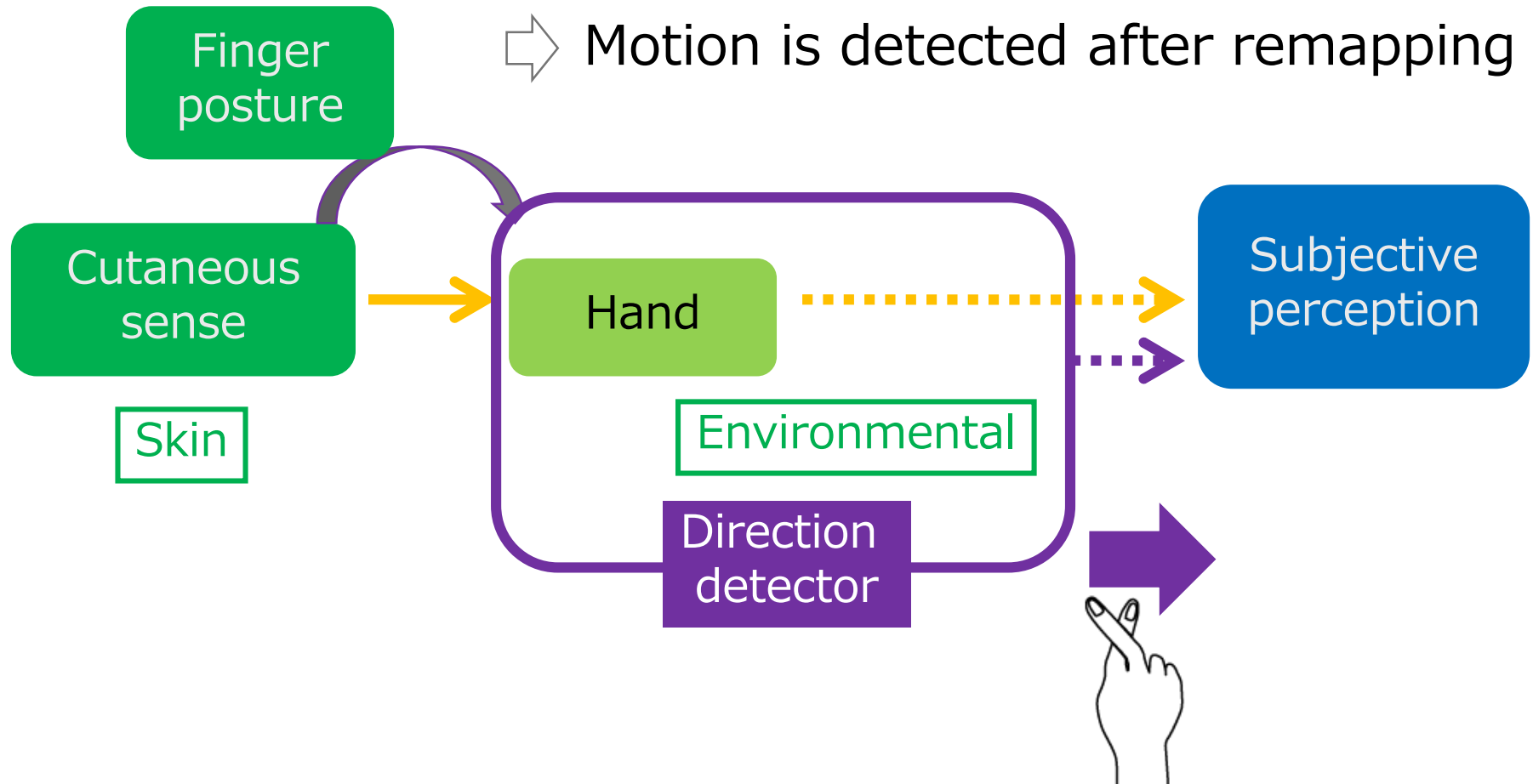


Where does the direction detector exist?

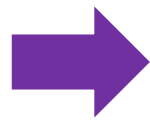


Where does the direction detector exist?

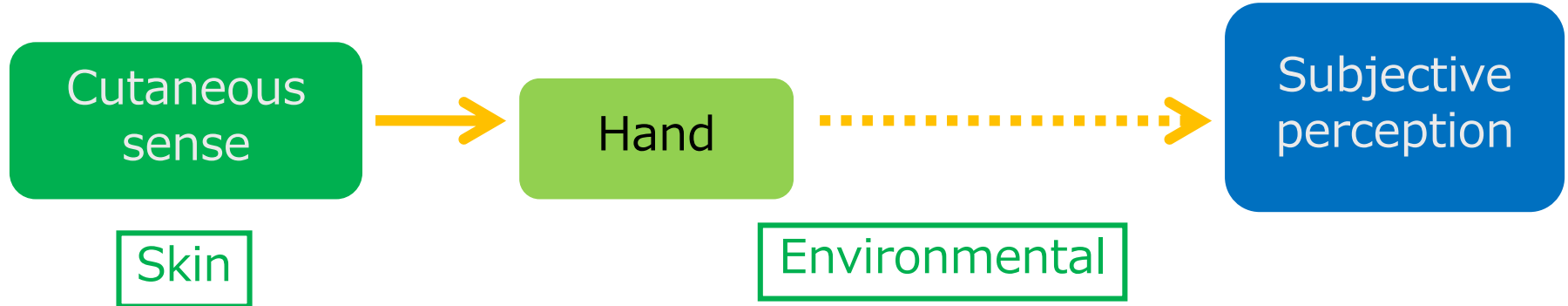
⇒ Motion is detected after remapping



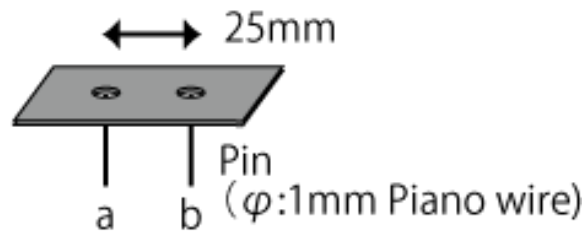
Where does the direction detector exist?



Investigate it by using
Inter-finger motion after effect

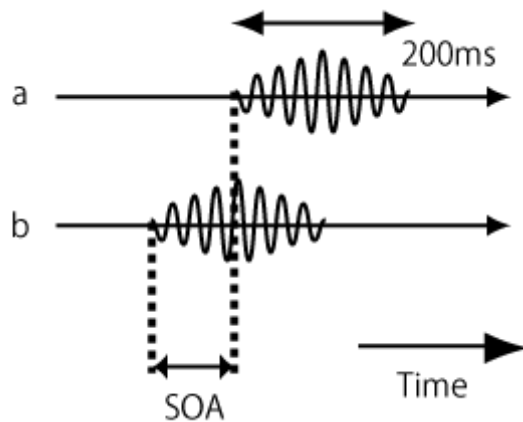


Apparatus & Procedure

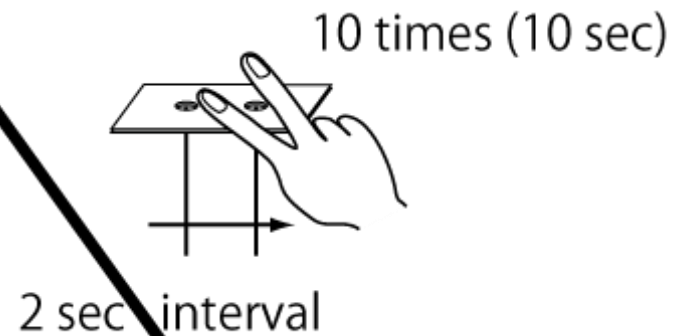


25mm

a b

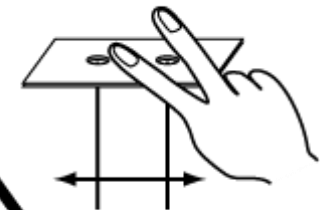


Adaptation



Test

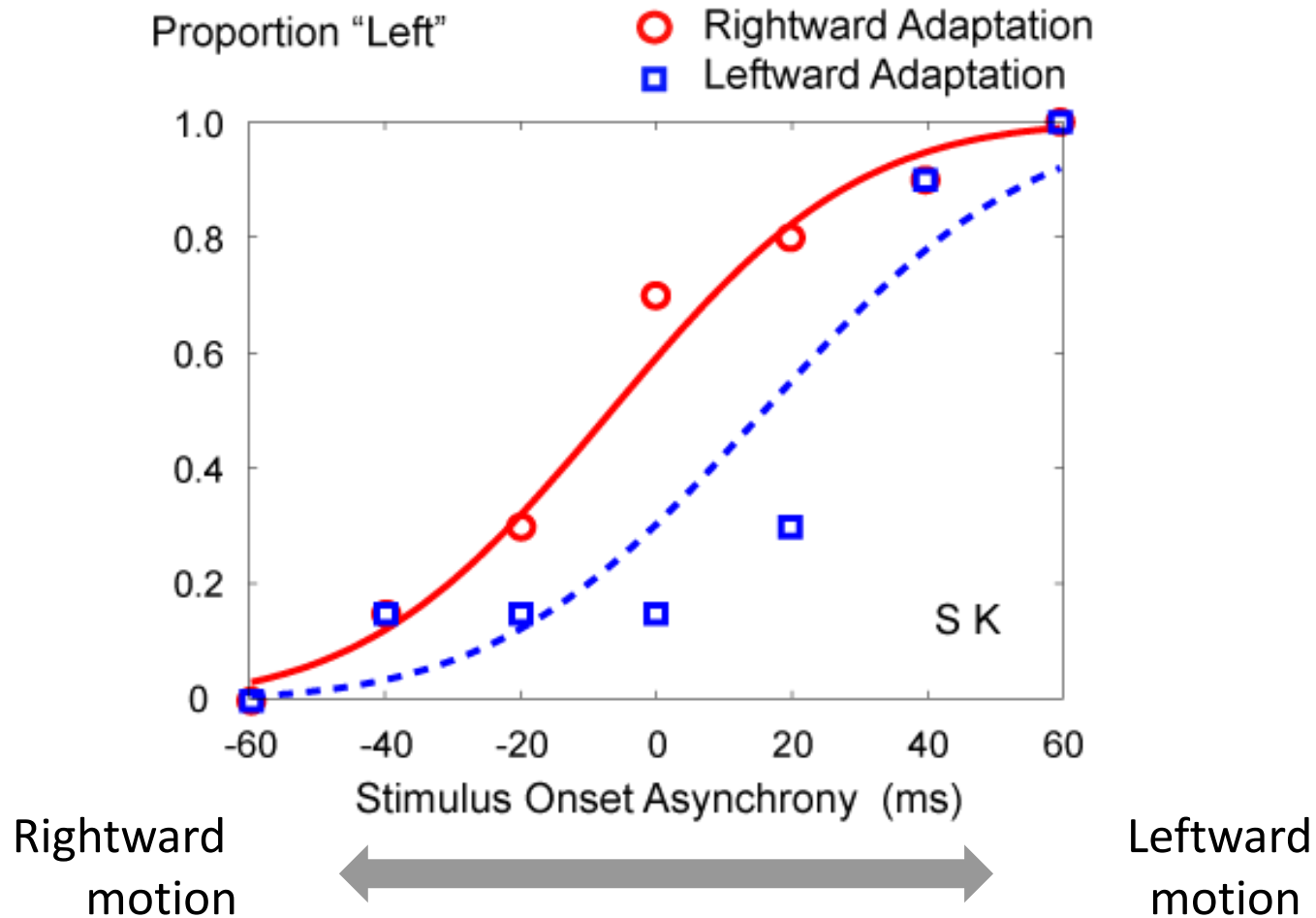
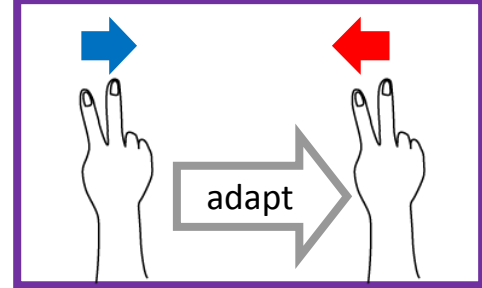
One of 7 conditions



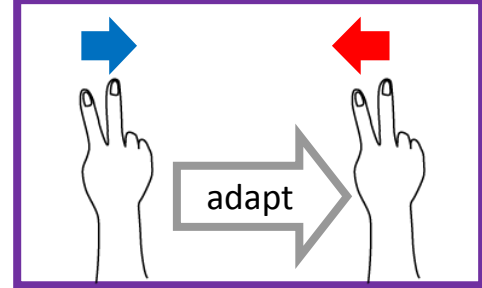
Judgment

Rightward or
Leftward?

Experimental Result: One subject



Experimental Result: One subject

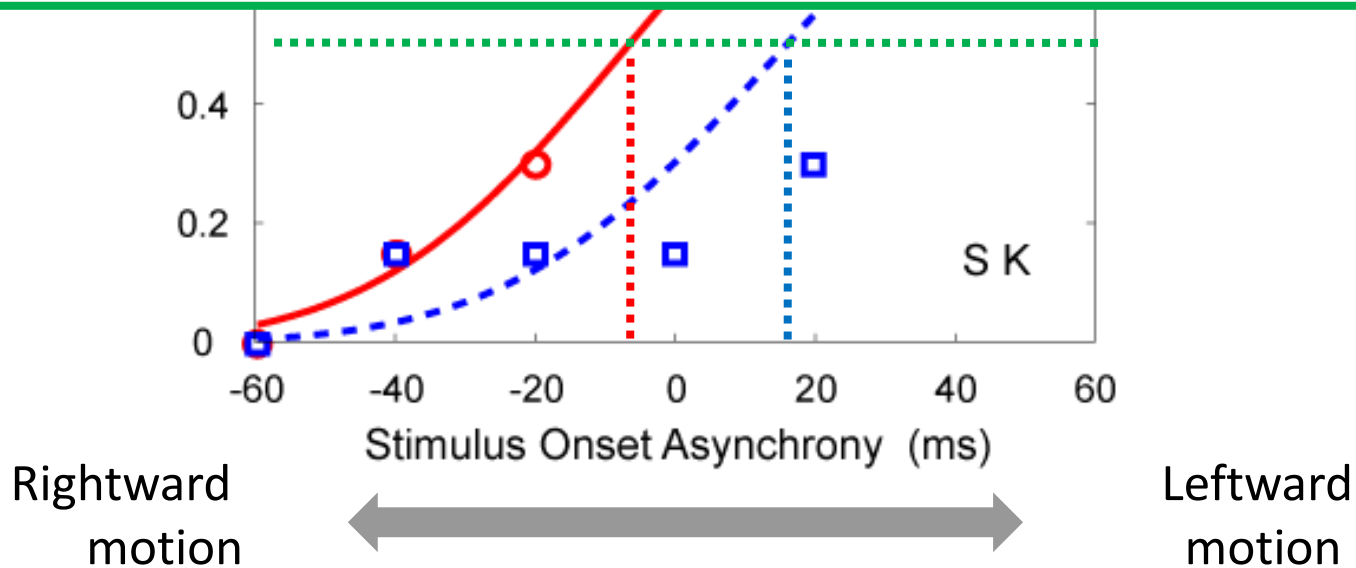


Proportion "Left"

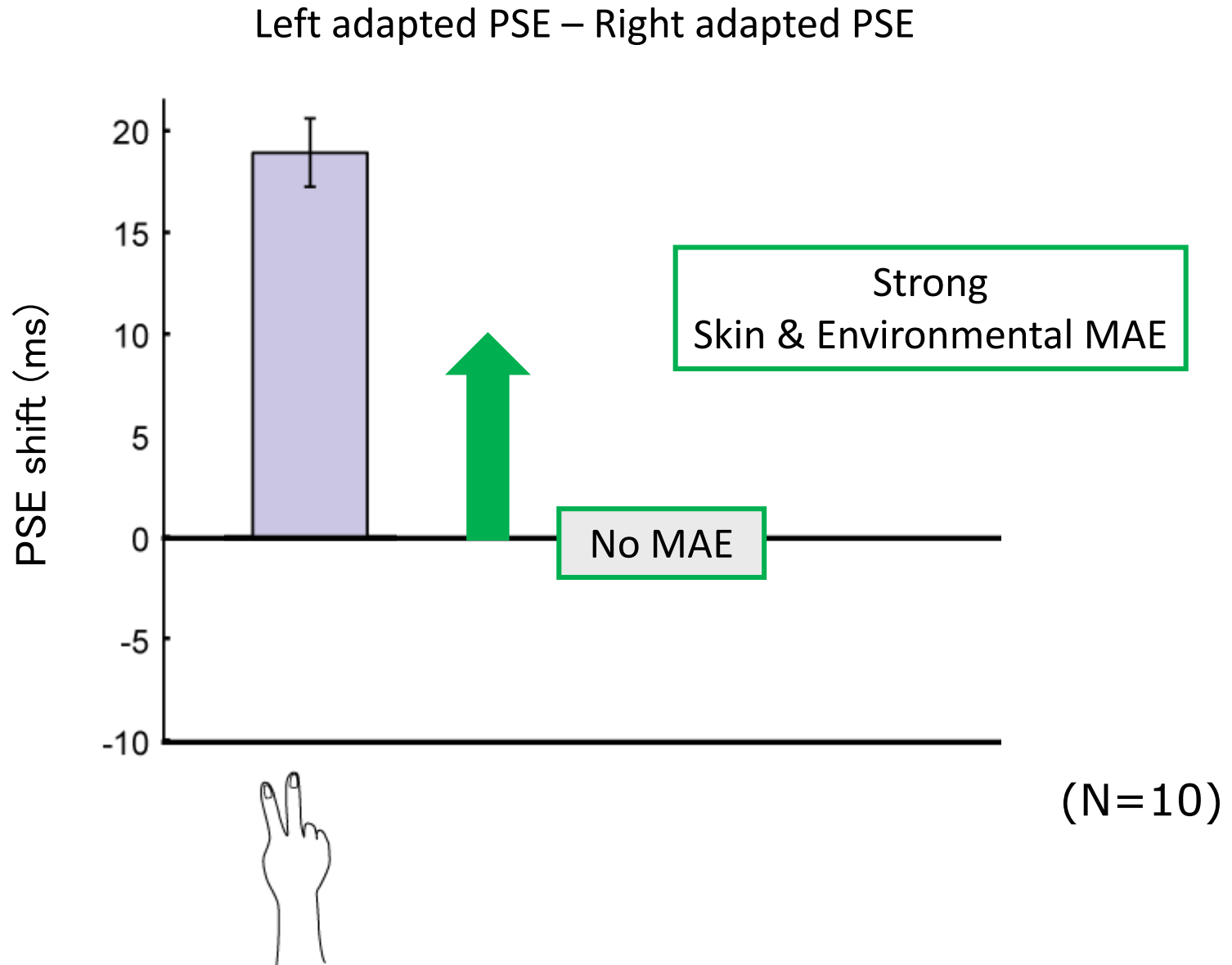
○ Rightward Adaptation
■ Leftward Adaptation

Index of PSE shift

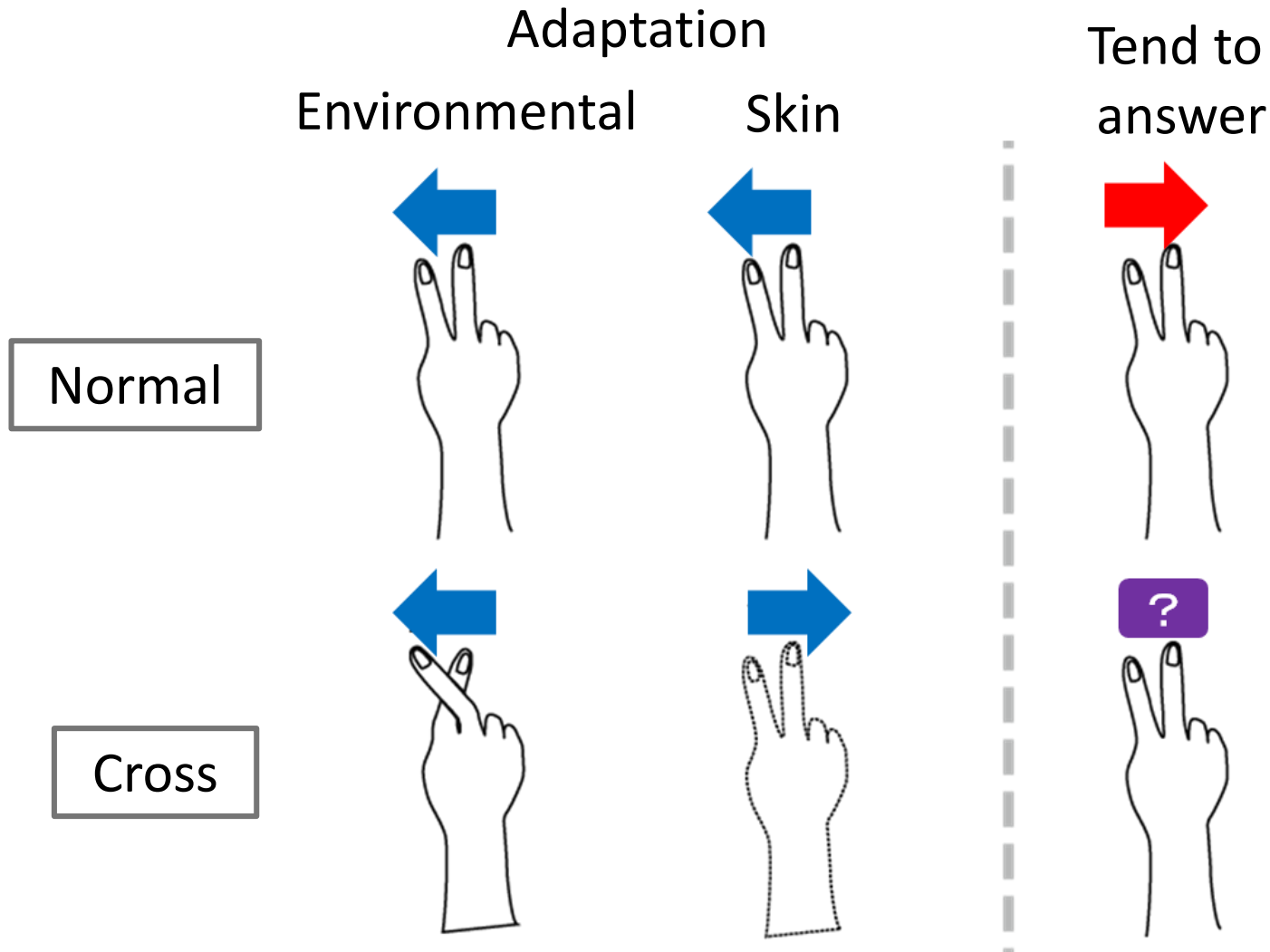
= Left adapted PSE – Right adapted PSE



Experimental Result: All participants

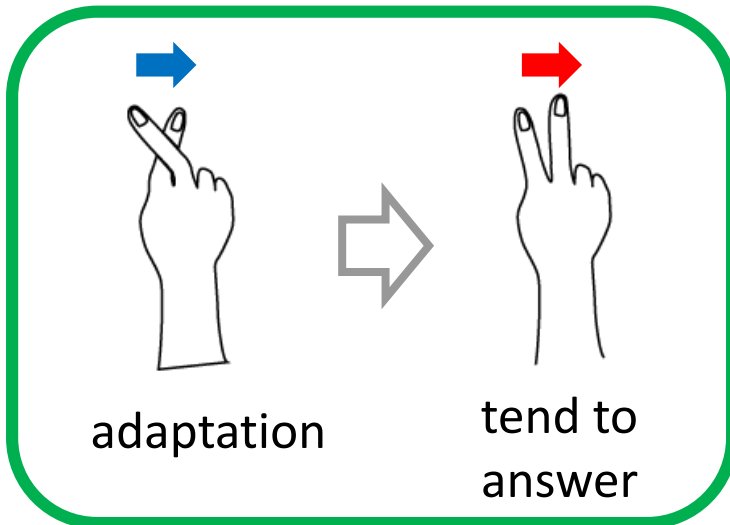


Direction race condition

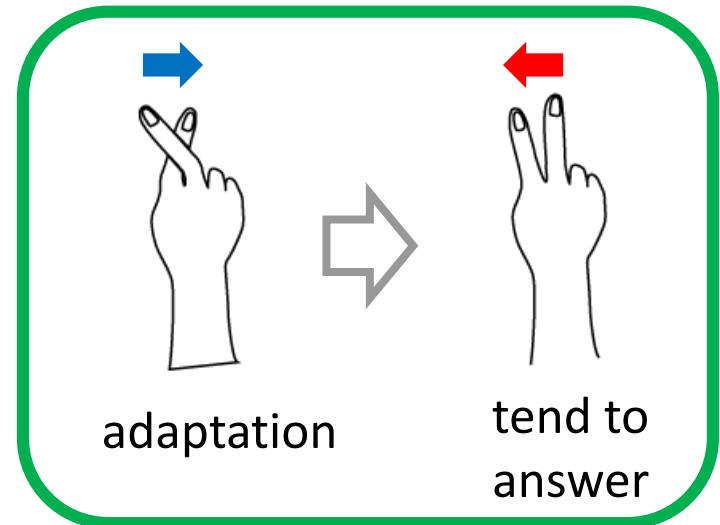


Hypothesis

Adapted by
stimulated finger order

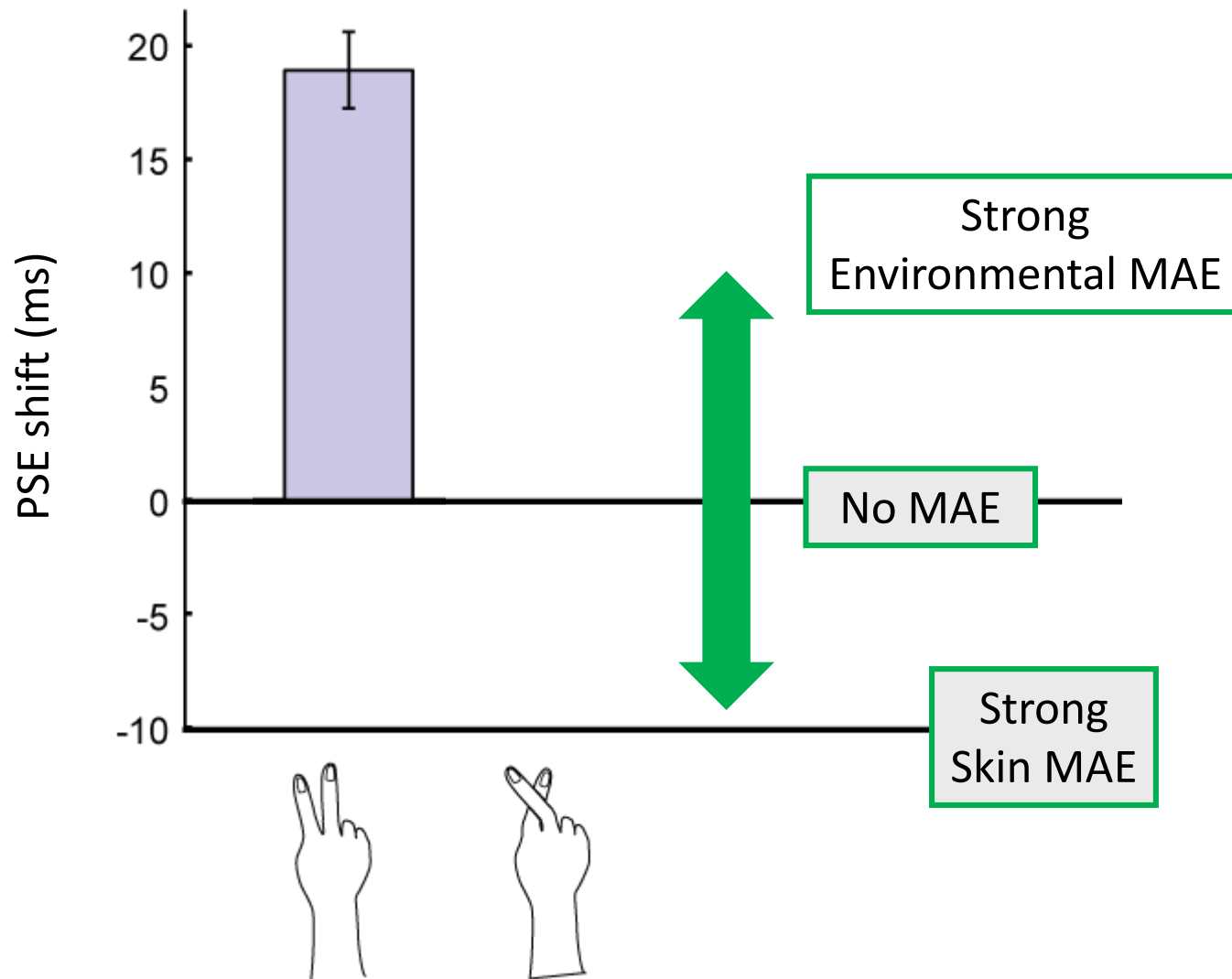


Adapted by
environmental direction

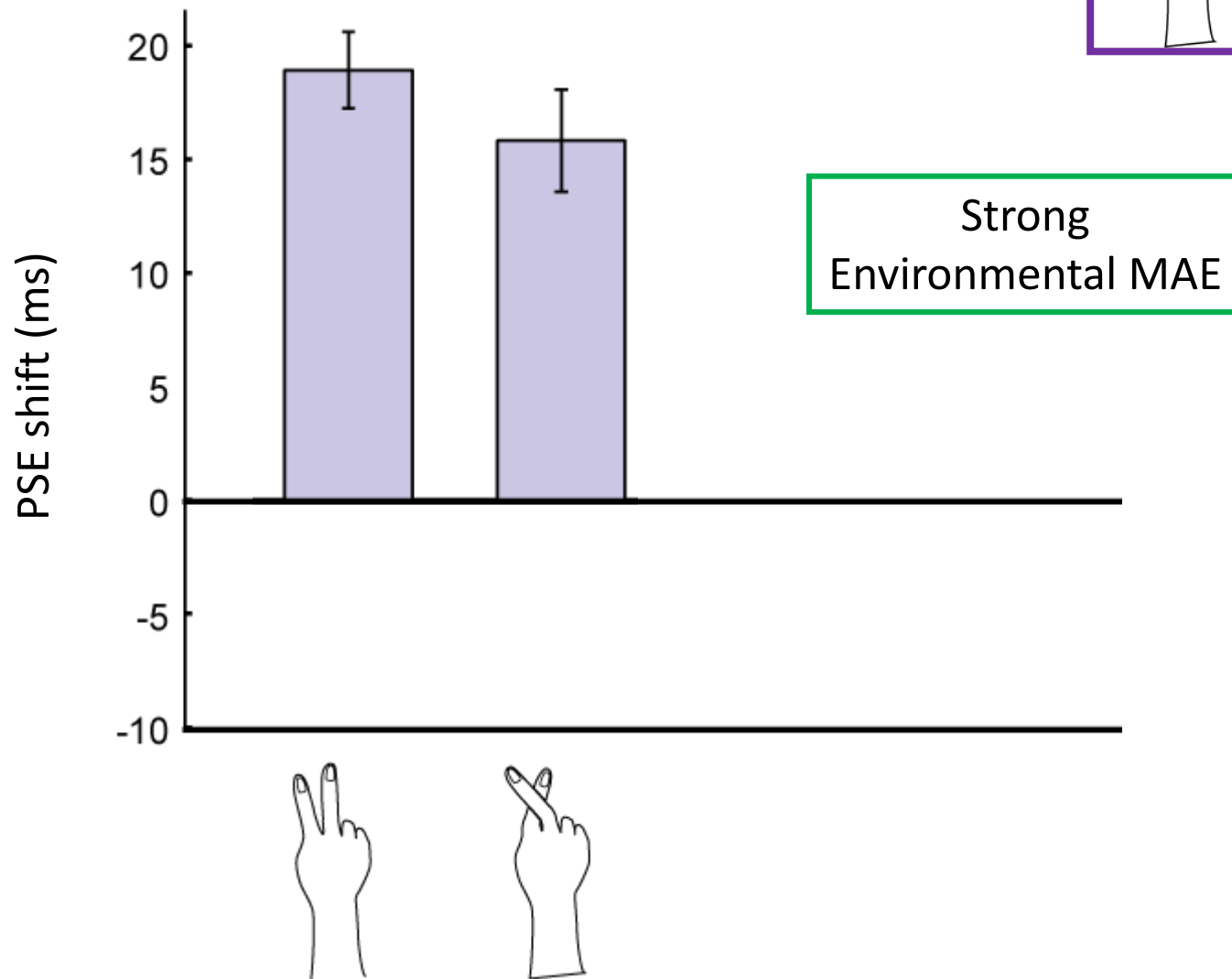
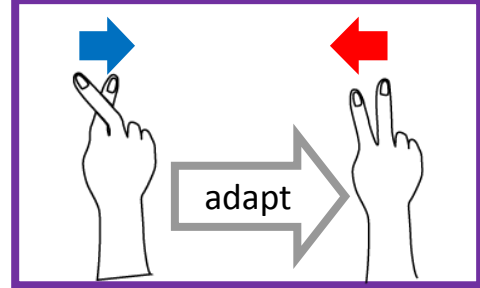


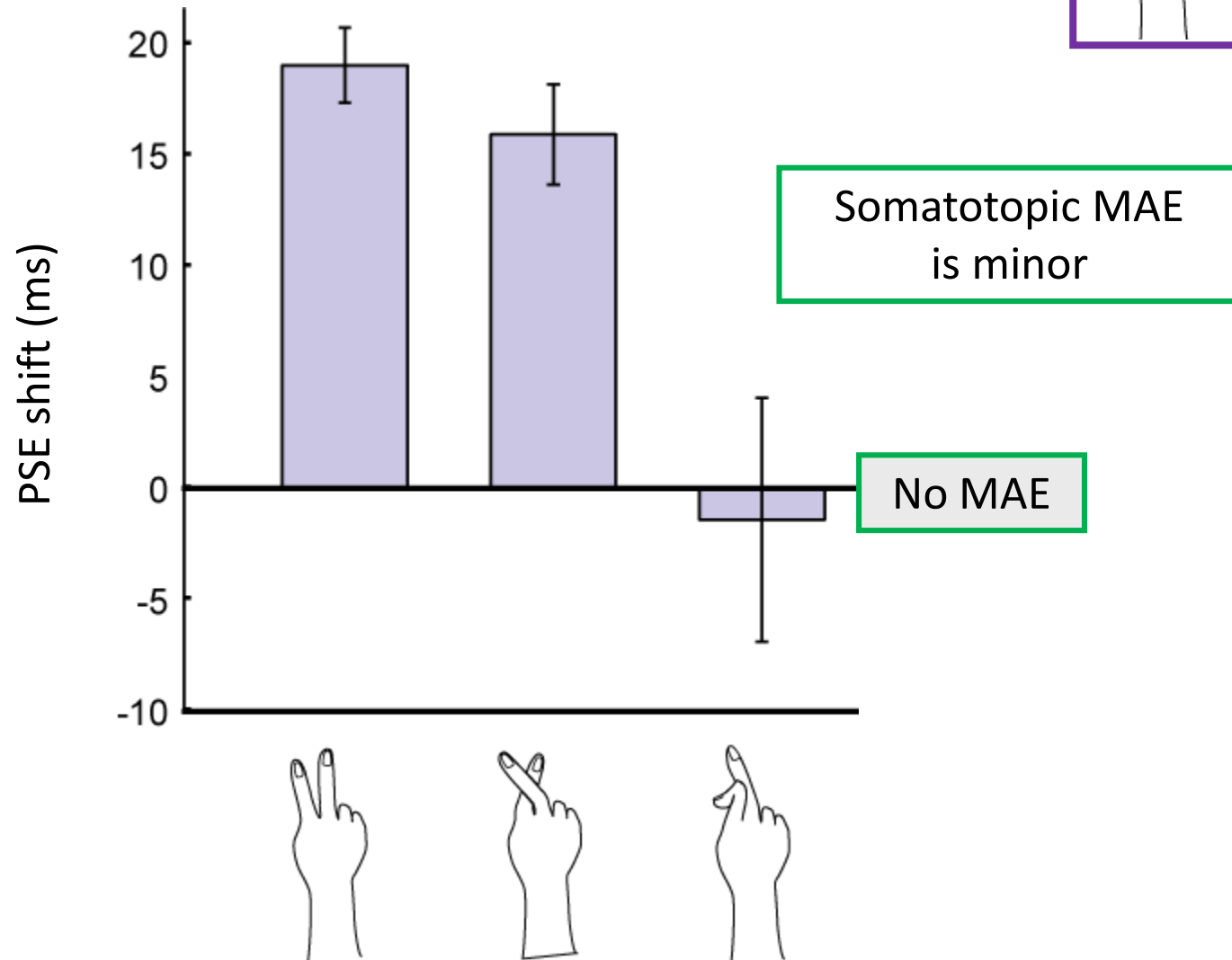
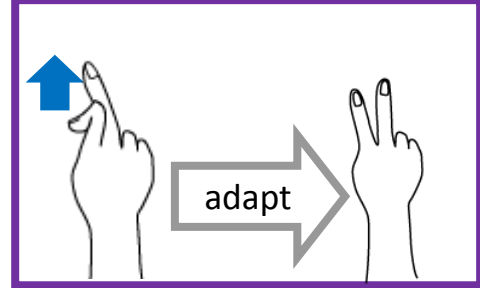
By using tactile motion aftereffect,
we can investigate the definition of coordinate
on inter-finger direction judgment

Direction race condition

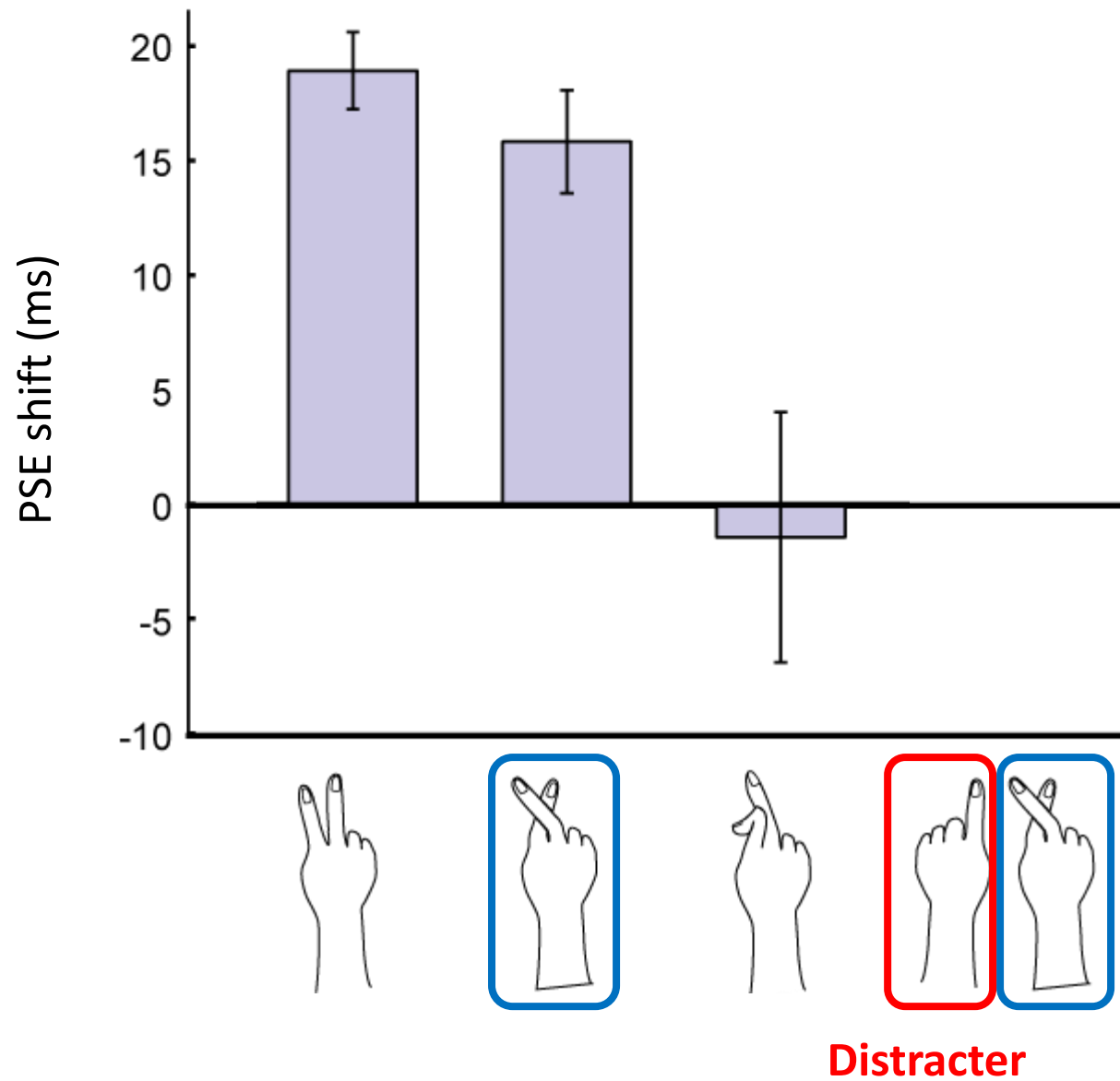


Direction race condition





No awareness condition

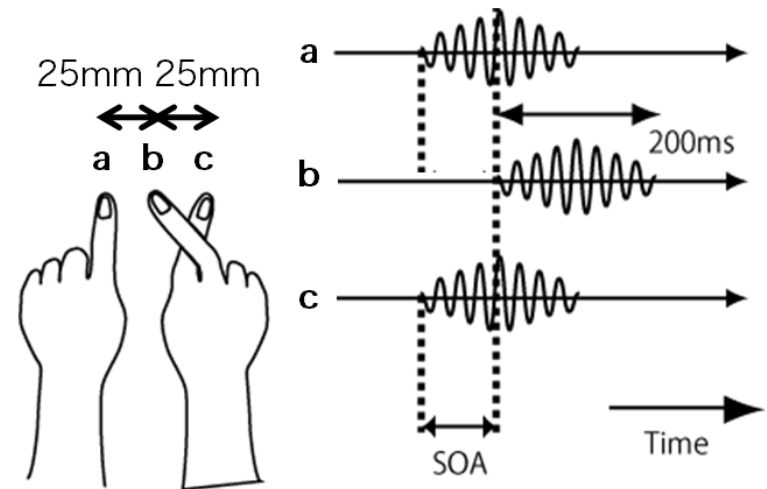


Ambiguous motion

Adapt to direction-uncertain motion

Expansion stimuli

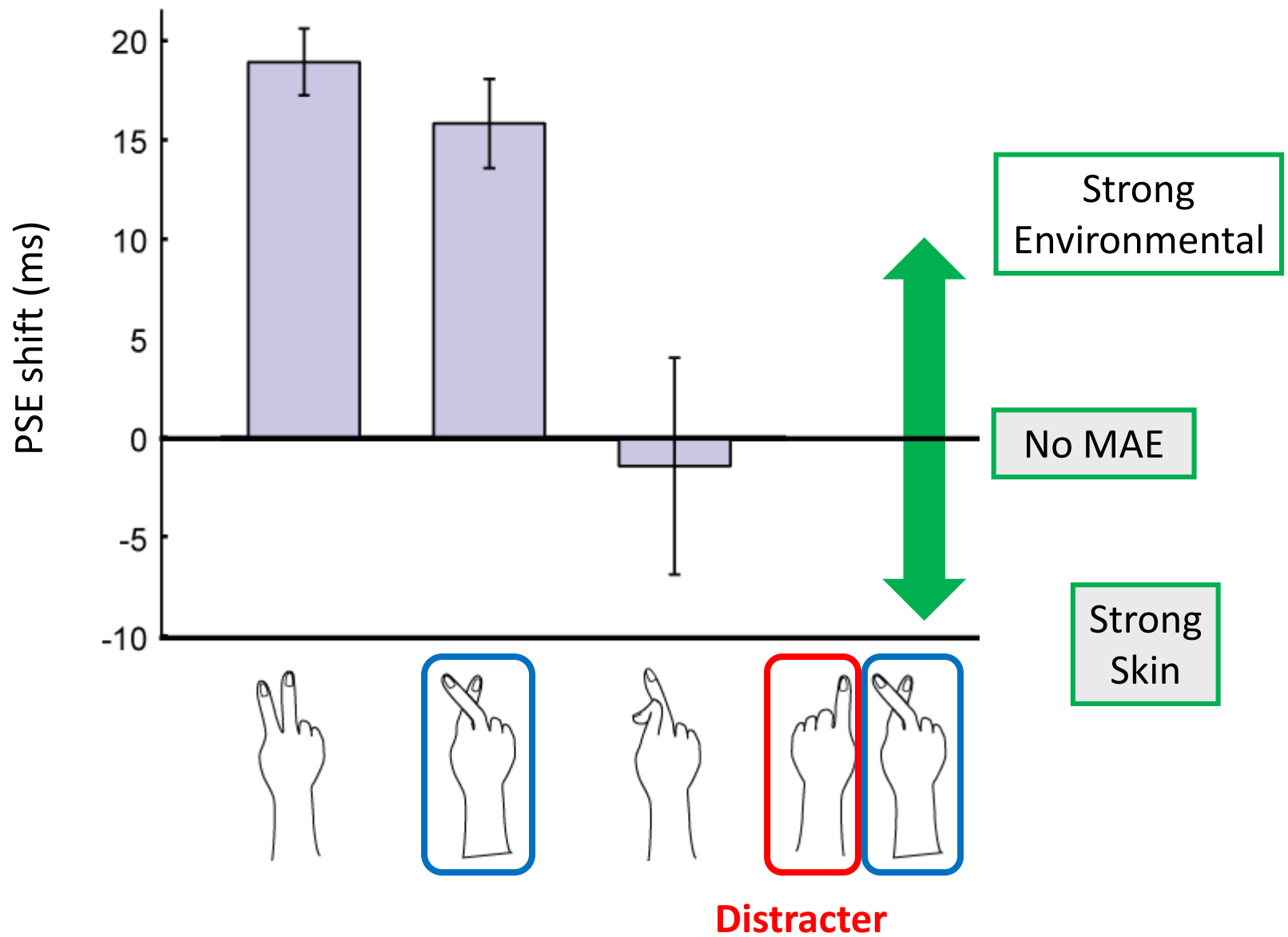
Contraction stimuli



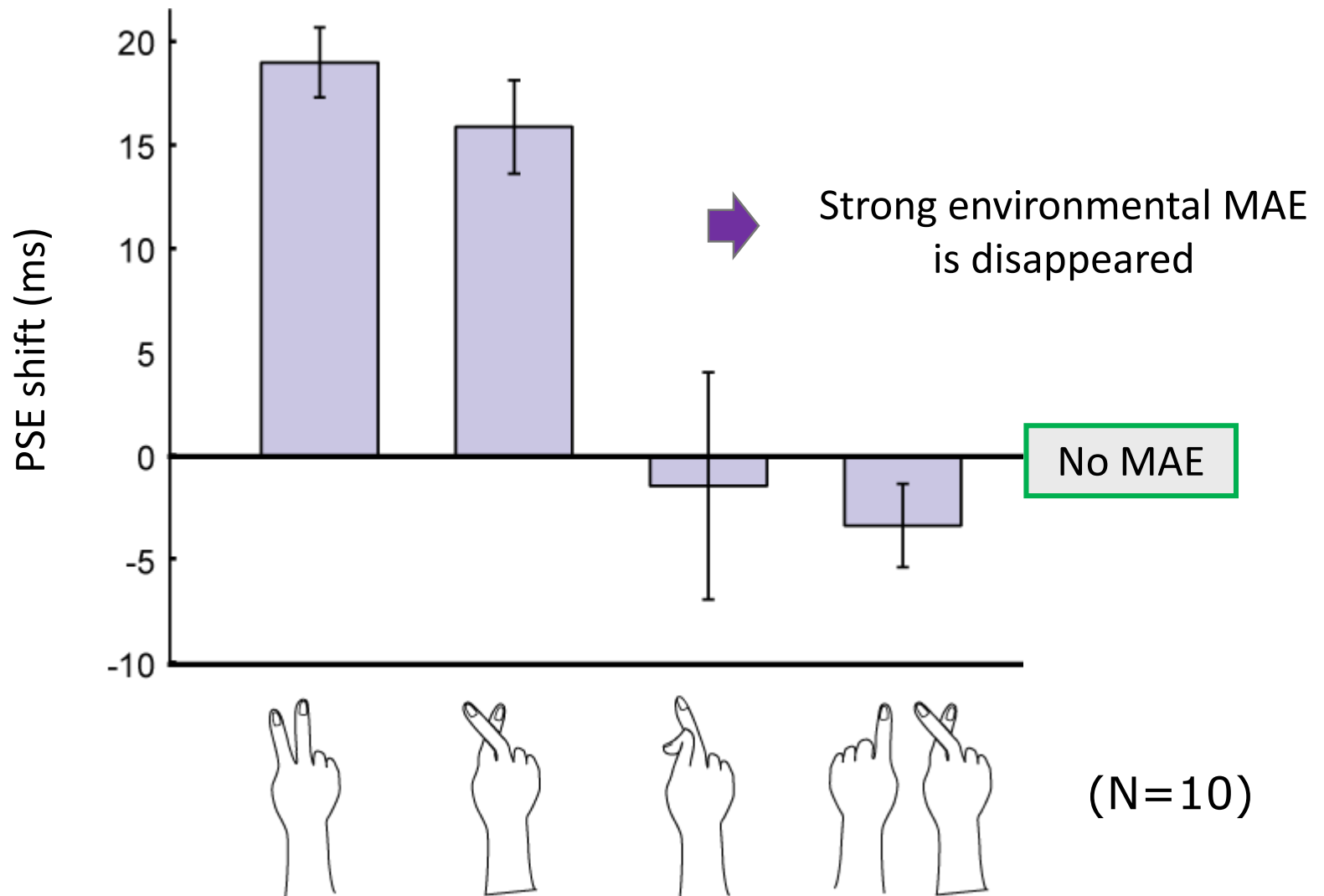
Same sensory signal to cross condition

Without subjective direction perception

No awareness condition

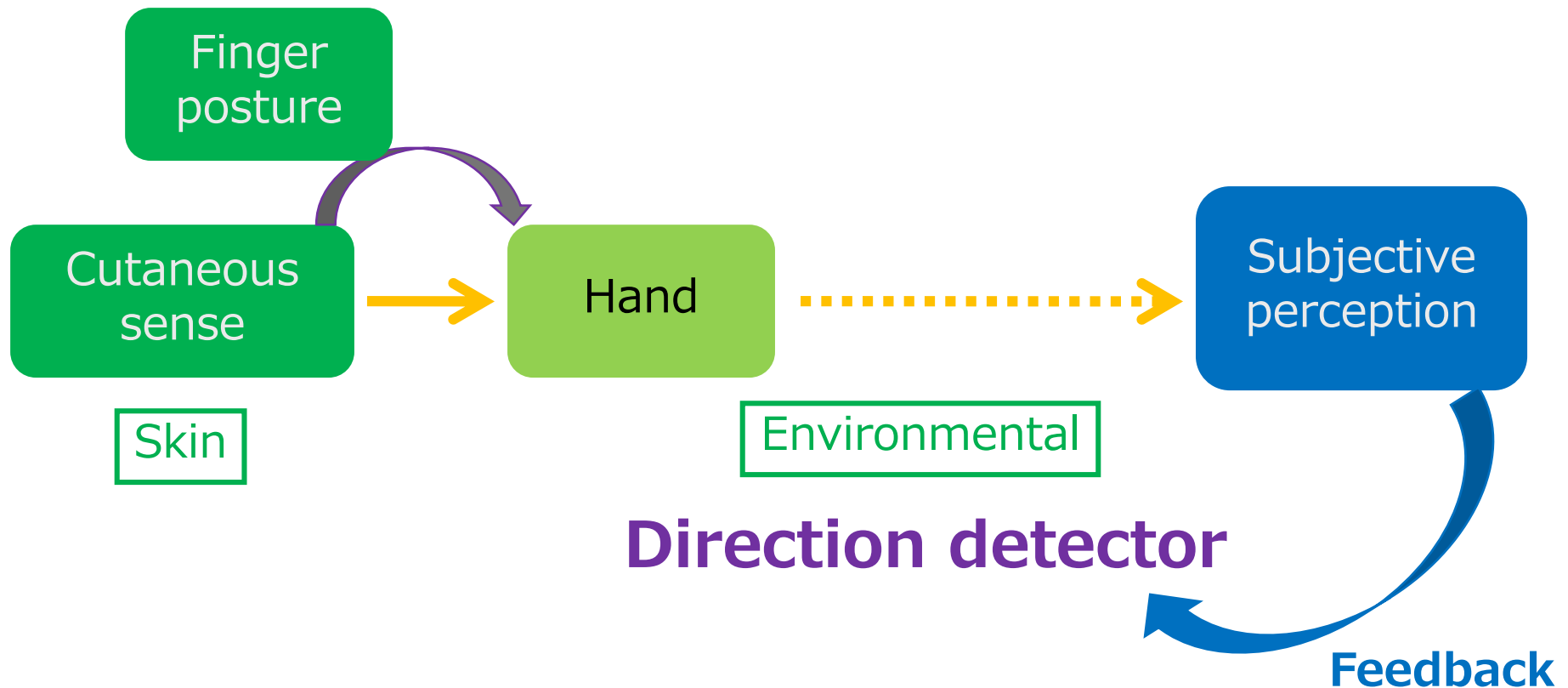


No awareness condition

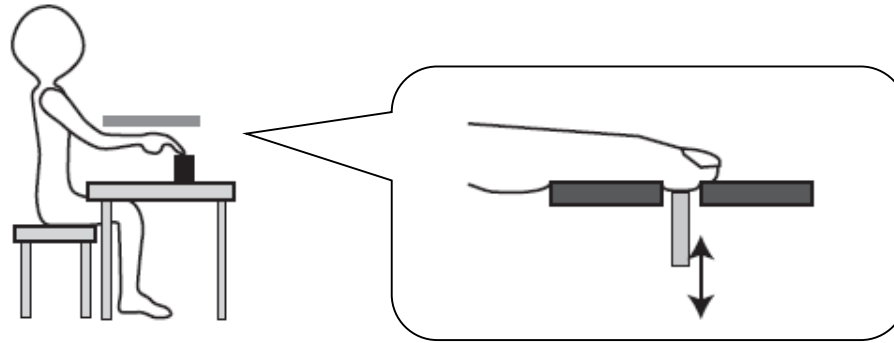


In sum, we found

- Environmental MAE dominance
- Tactile MAE needs subjective perception



There are many other
aftereffect illusions!



Adaptation

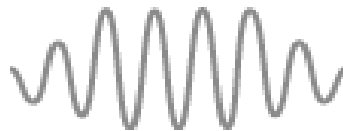
Test

Perception

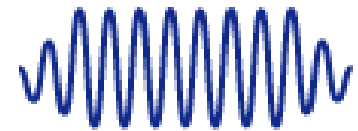
15 Hertz



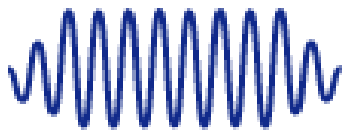
25 Hertz



30 Hertz



35 Hertz

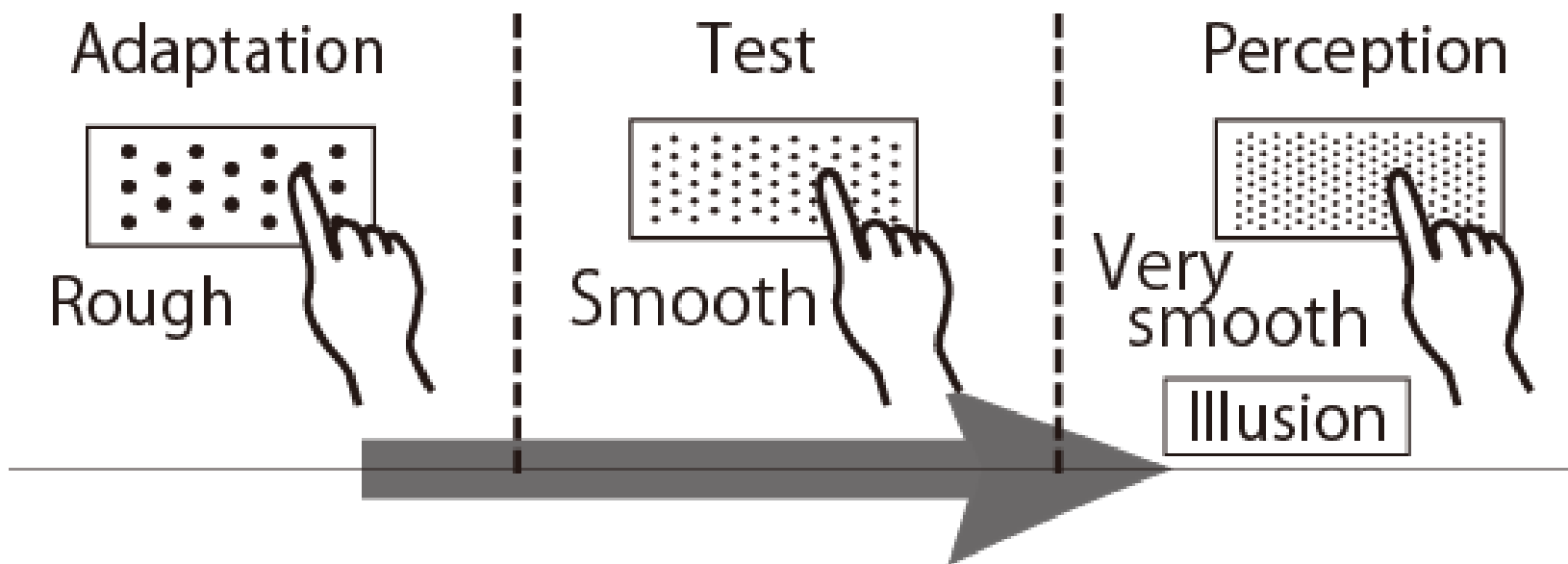


25 Hertz

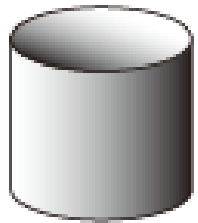
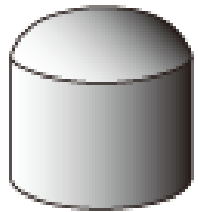


20 Hertz

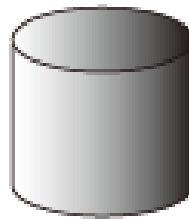
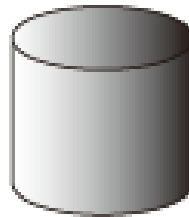




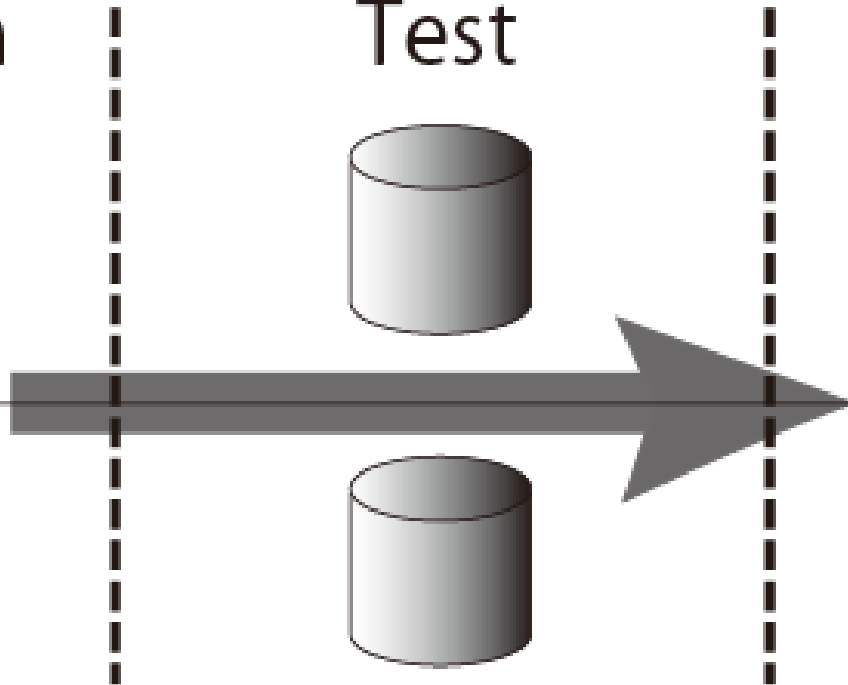
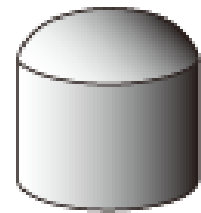
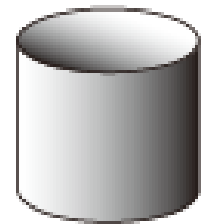
Adaptation



Test

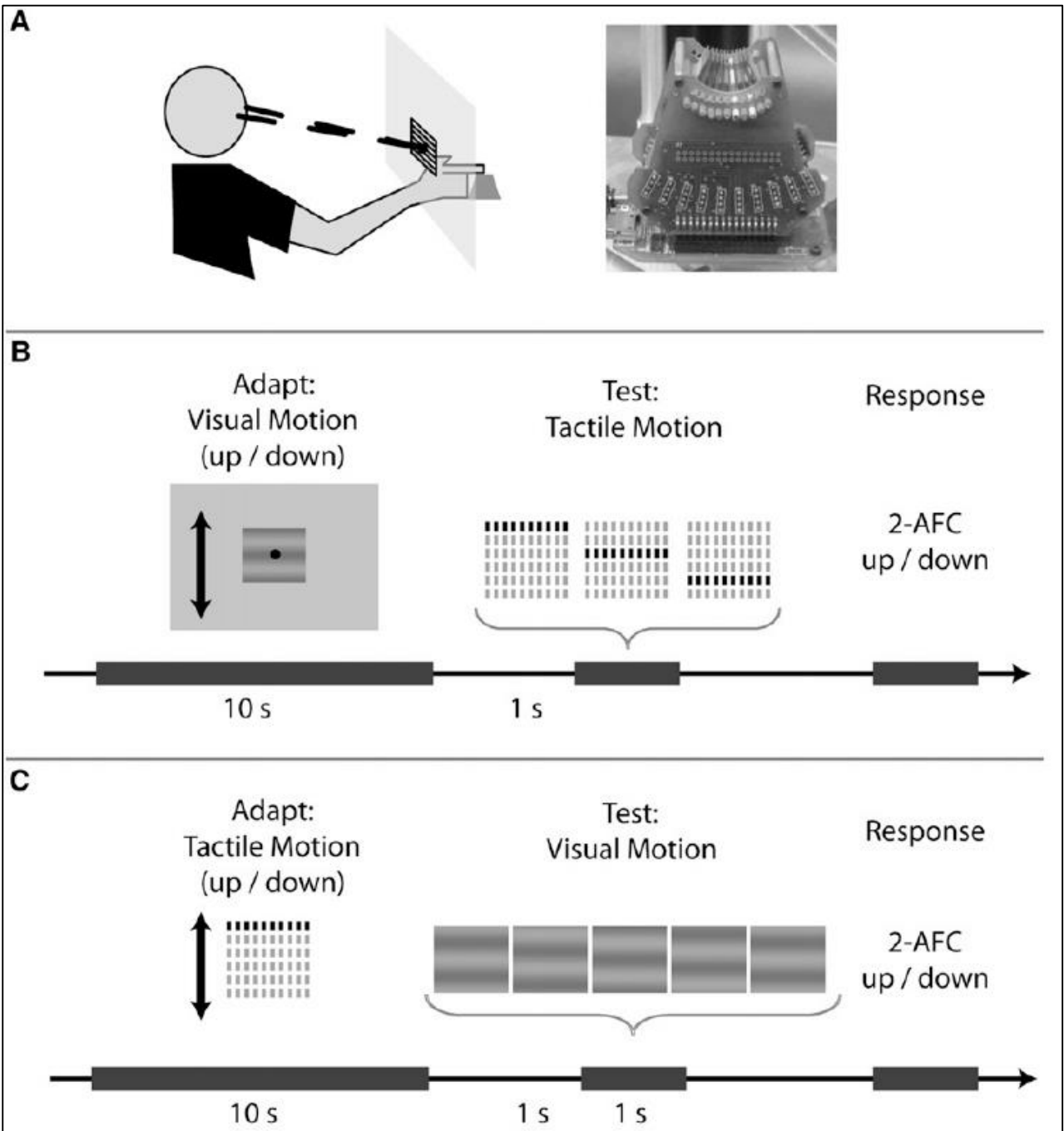


Perception

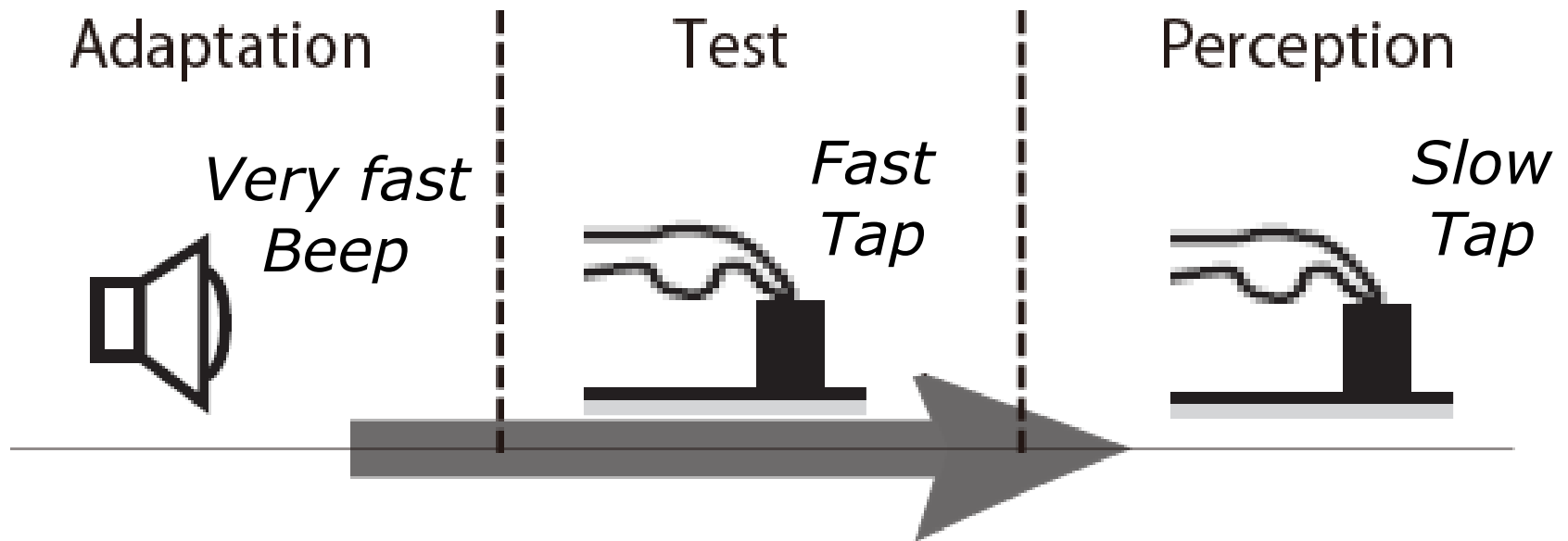


There are more...

Vision + Touch

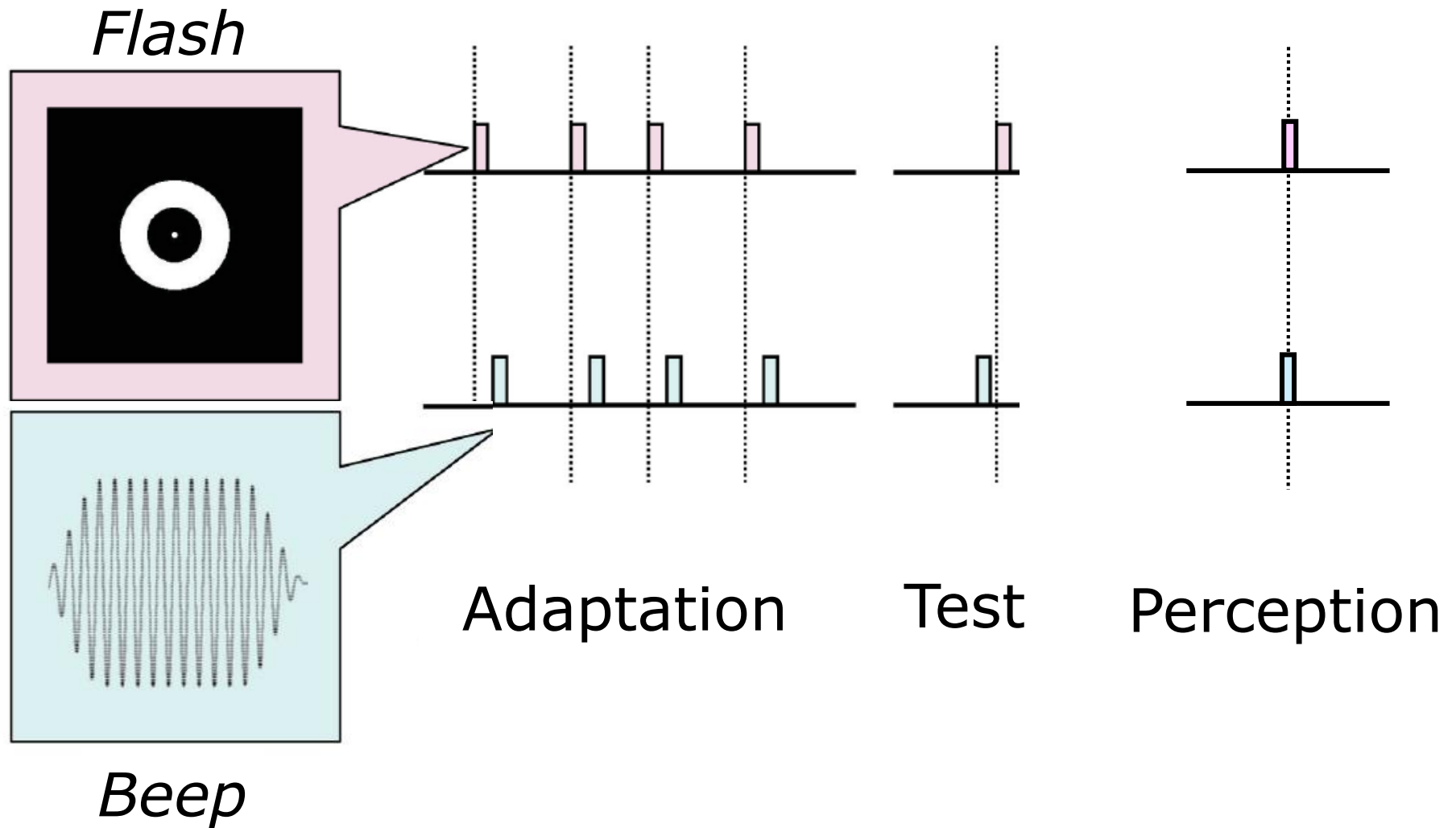


Audition + Touch



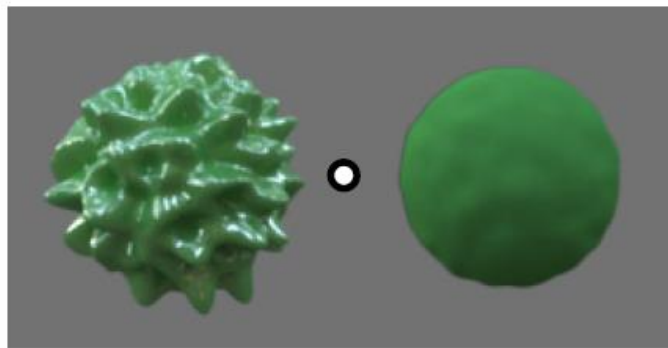
To be precise, what they did was auditory tempo reproduction by tapping.
Not perceiving tap and reporting it's tempo.

Audition + Vision

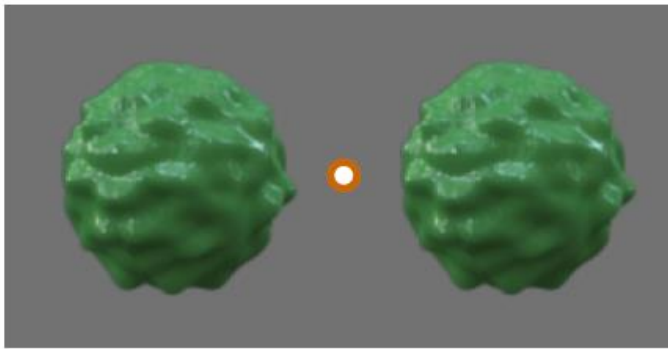


Vision

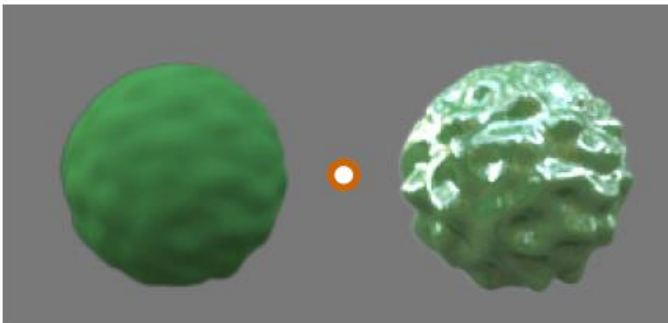
Adapt



Test



Percept



[Motoyoshi; JoV 2012]

The paper does not contain this image, but the idea was the same.

Image comes from our web site.

http://www.kecl.ntt.co.jp/openhouse/2013/exhibition/human7/index_en.html

Adapt

Test

Percept



Image comes from our web site.

http://www.kecl.ntt.co.jp/openhouse/2013/exhibition/human7/index_en.html

In future...

we may find this kind of illusions
even in touch!