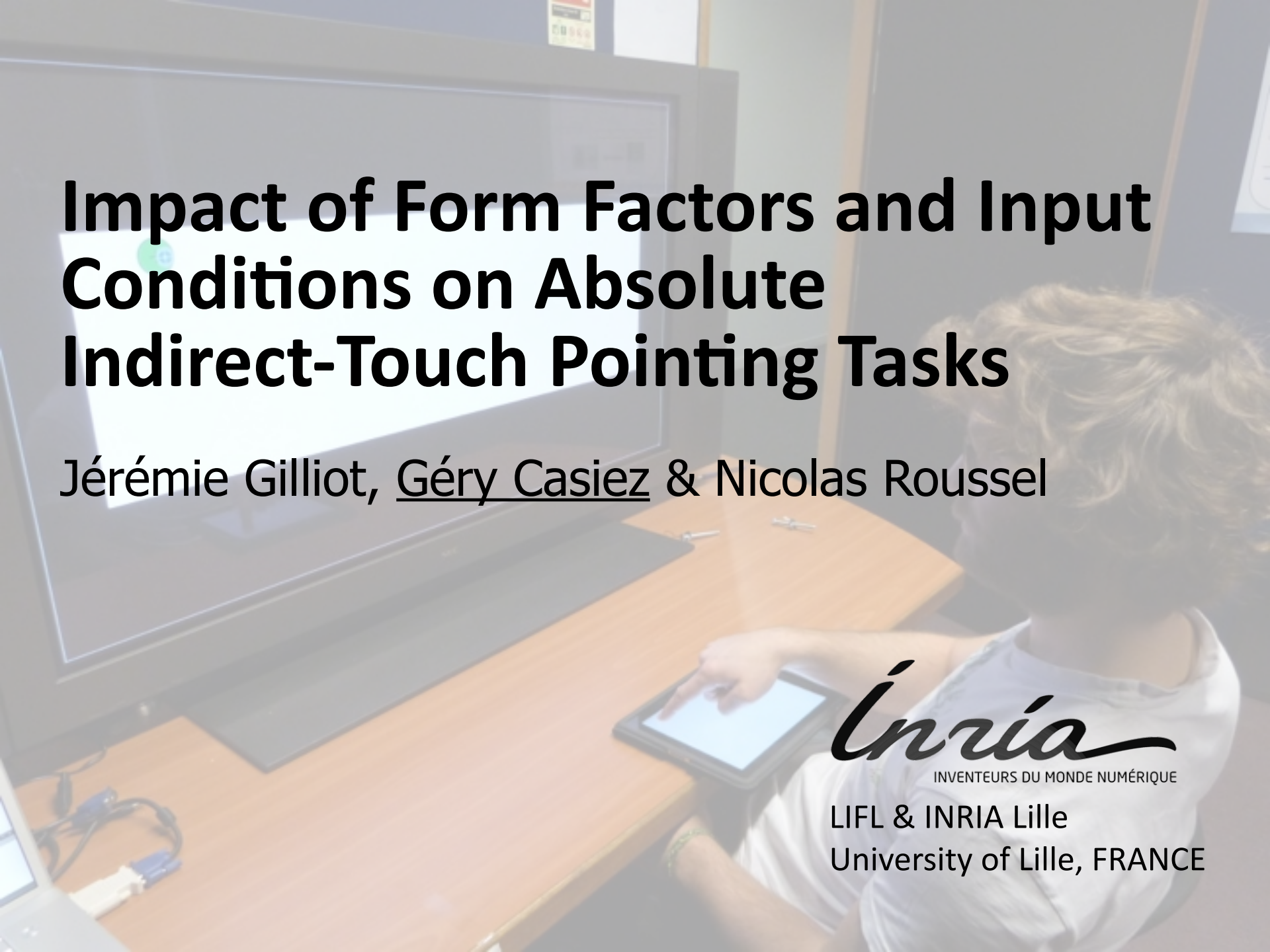


Impact of Form Factors and Input Conditions on Absolute Indirect-Touch Pointing Tasks

Jérémie Gilliot, Géry Casiez & Nicolas Roussel

INVENTEURS DU MONDE NUMÉRIQUE

LIFL & INRIA Lille
University of Lille, FRANCE

Absolute indirect pointing

	Direct	Indirect
Relative		
Absolute		

Absolute indirect pointing

	Direct	Indirect
Relative		
Absolute		

Absolute indirect pointing

	Direct	Indirect
Relative		
Absolute	+ directness + multitouch - precision - fatigue	

Absolute indirect pointing

	Direct	Indirect
Relative		
Absolute	+ directness + multitouch - precision - fatigue	

Absolute indirect pointing

	Direct	Indirect
Relative		+ precision + fatigue - multitouch
Absolute	+ directness + multitouch - precision - fatigue	

Absolute indirect pointing

	Direct	Indirect
Relative		+ precision + fatigue - multitouch
Absolute	+ directness + multitouch - precision - fatigue	

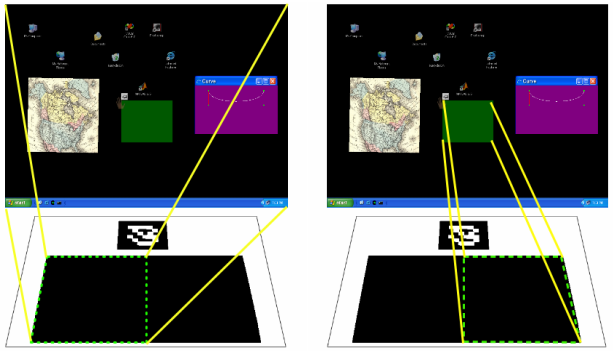
Absolute indirect pointing

	Direct	Indirect
Relative		+ precision + fatigue - multitouch
Absolute	+ directness + multitouch - precision - fatigue	+ fatigue + multitouch - precision

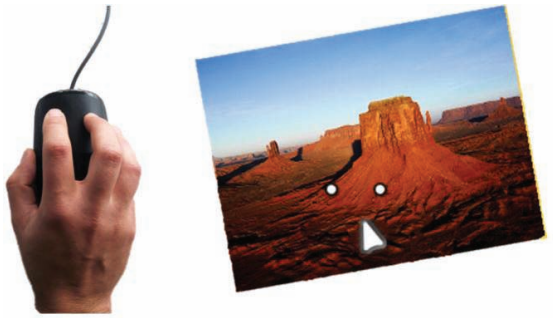
Absolute indirect pointing

	Direct	Indirect
Relative		+ precision + fatigue - multitouch
Absolute	+ directness + multitouch - precision - fatigue	+ fatigue + multitouch - precision

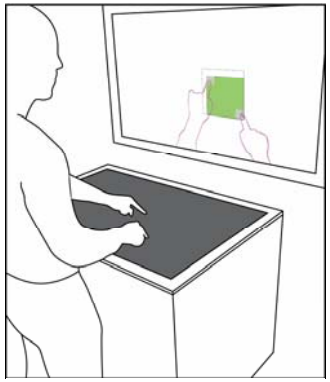
Absolute indirect pointing



Malik *et al.* UIST'05

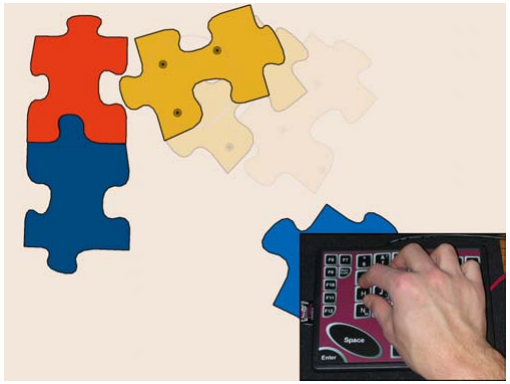


Benko *et al.* GI'10

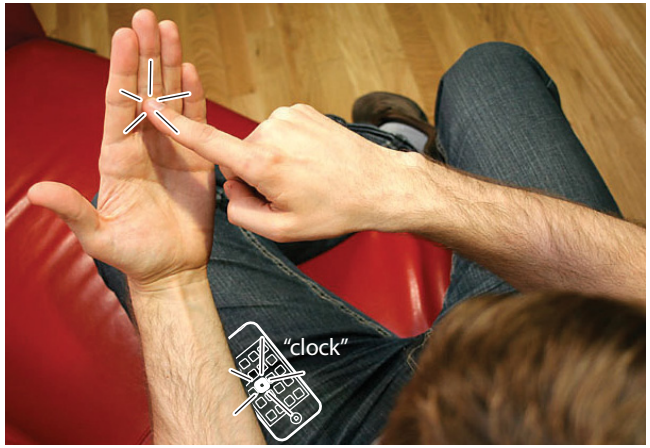


Schmidt *et al.* Interact'09

McCallum *et al.* UIST'09

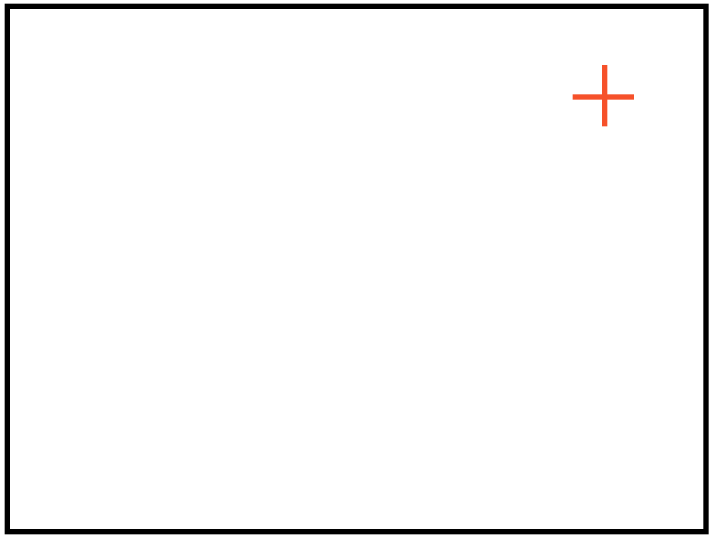


Moscovich *et al.* GI'06

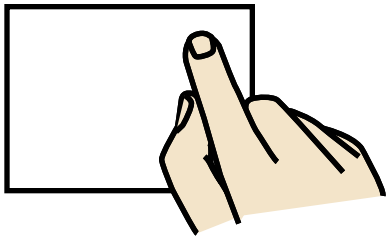


Gustafson *et al.* UIST'11

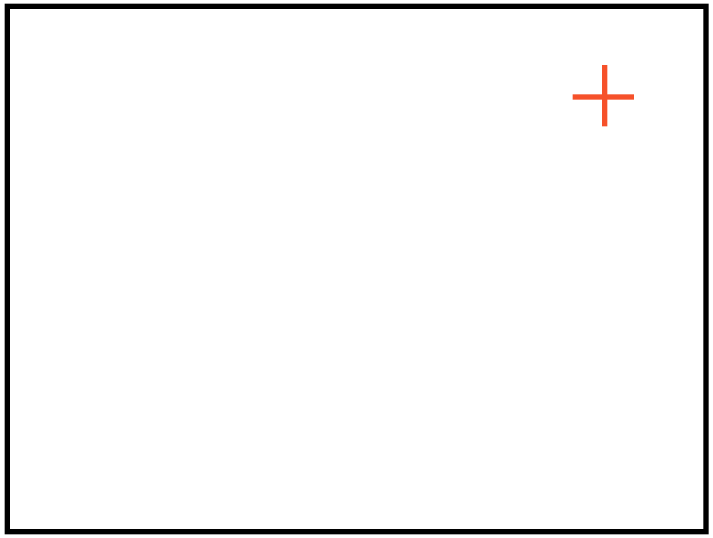
Absolute indirect pointing



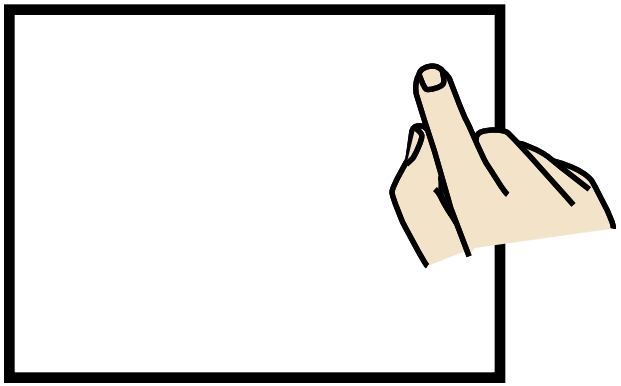
Screen



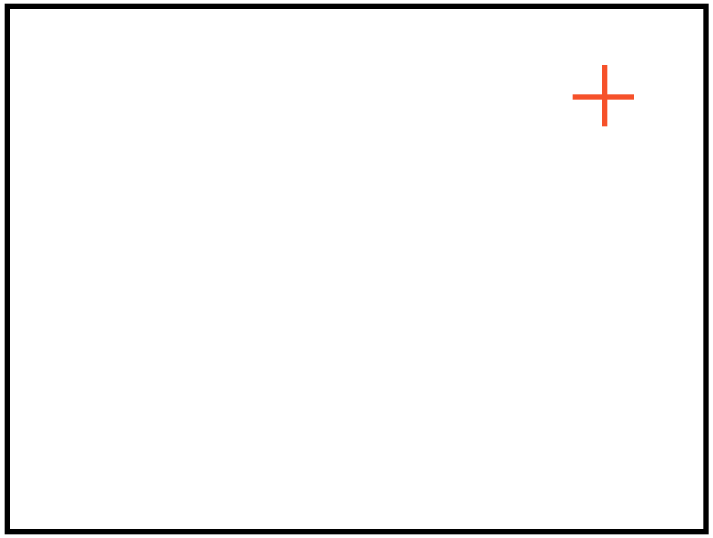
Absolute indirect pointing



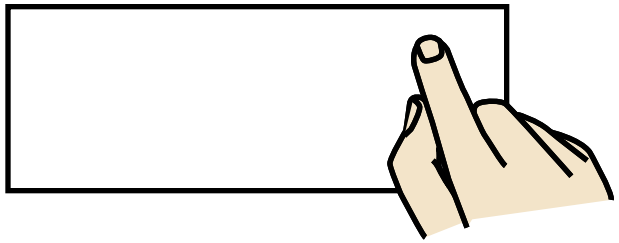
Screen



Absolute indirect pointing



Screen



Form Factors and Input Conditions

Form Factors and Input Conditions

- input form factors (size and aspect ratio)

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- input form factors (size and aspect ratio)

- input conditions (ability to look at the device, ability to use both hands)

Form Factors and Input Conditions

- input form factors (size and aspect ratio)

- input conditions (ability to look at the device, ability to use both hands)

- display form factors (device size and aspect ratio, target size)

EXPERIMENT 1: device size and input conditions

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Hypothesis:

EXPERIMENT 1: device size and input conditions

Hypothesis:

1. Despite the lack of feedback, looking at the input surface would help position the index finger

EXPERIMENT 1: device size and input conditions

Hypothesis:

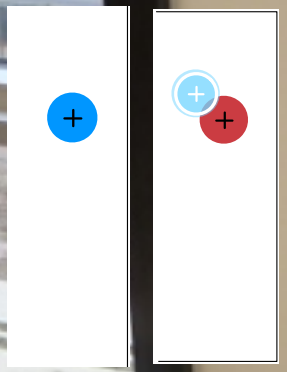
1. Despite the lack of feedback, looking at the input surface would help position the index finger

2. The non-dominant hand could act as a reference frame to position the finger if users were unable to look at the device

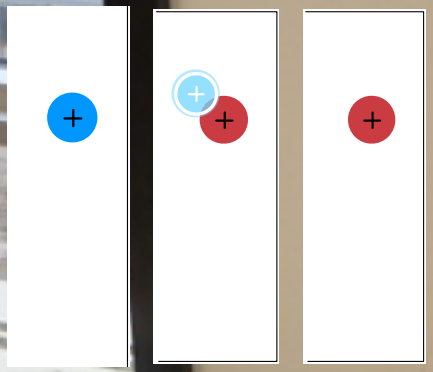
Task

Task

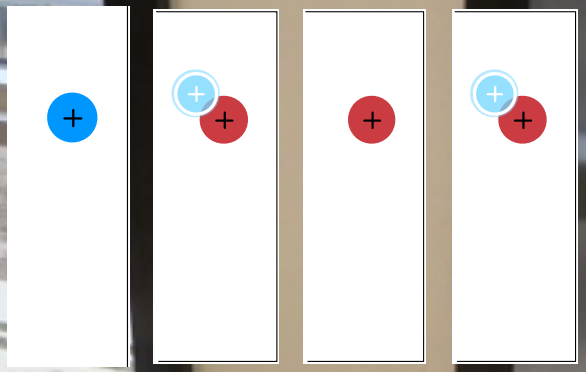
Task



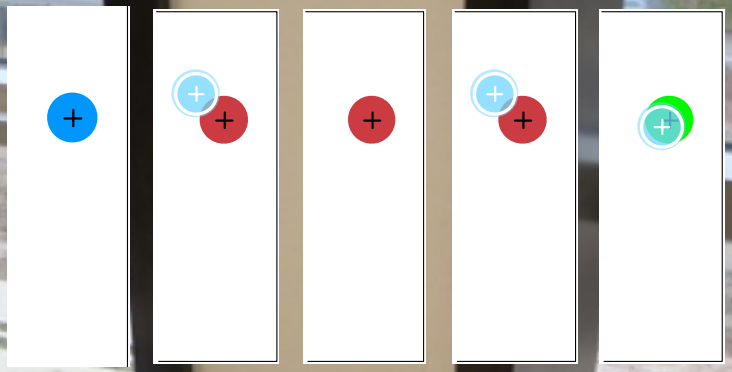
Task



Task



Task



Design

Design

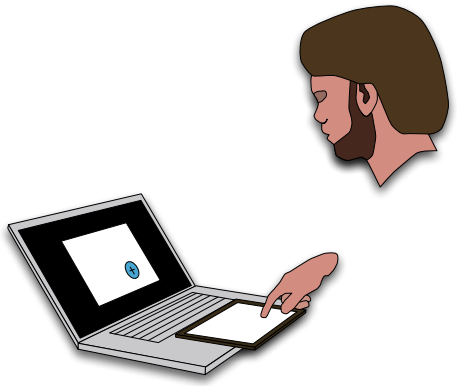
12 participants

Design

12 participants
x 3 input conditions (1 hand, 1hand-blinders, 2handsBlinders)

Design

12 participants
x 3 input conditions (1 hand, 1hand-blinders, 2handsBlinders)



Design

12 participants
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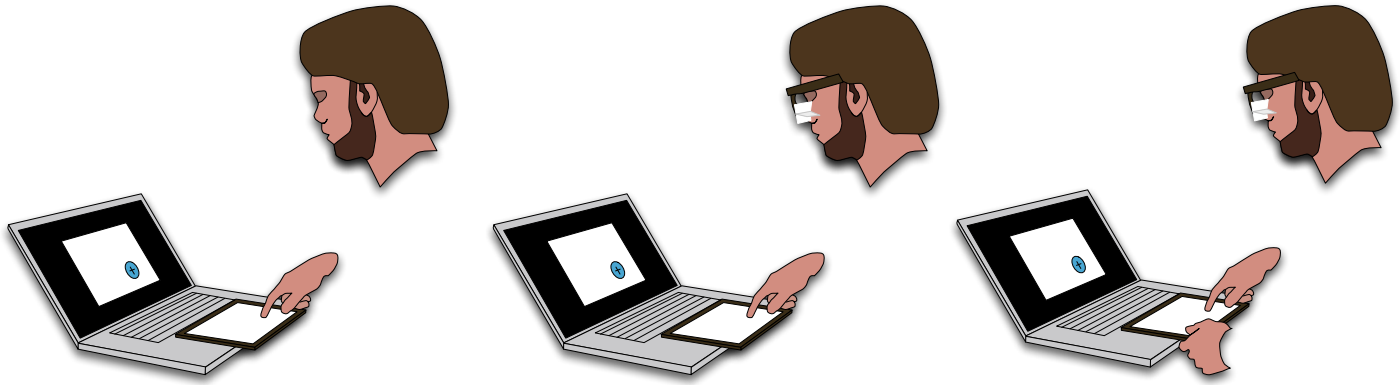

Design

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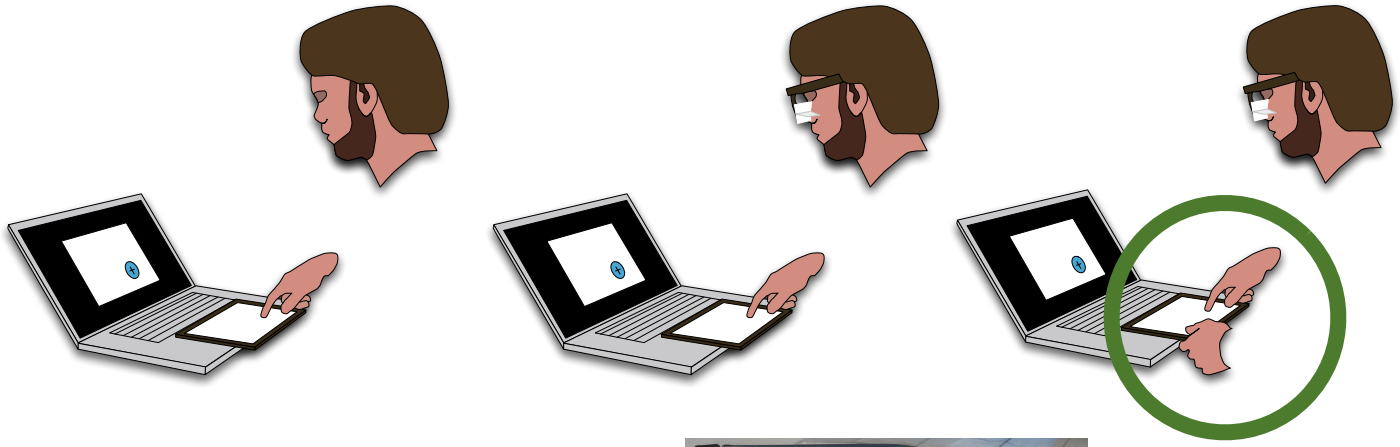
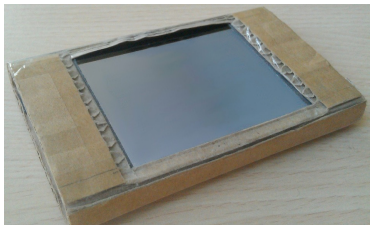
x 3 input conditions (1 hand, 1hand-blinders, 2handsBlinders)



Design

12 participants
x 3 input conditions (1 hand, 1hand-blinders, 2handsBlinders)
x 2 device size (iPod, iPad)



Design

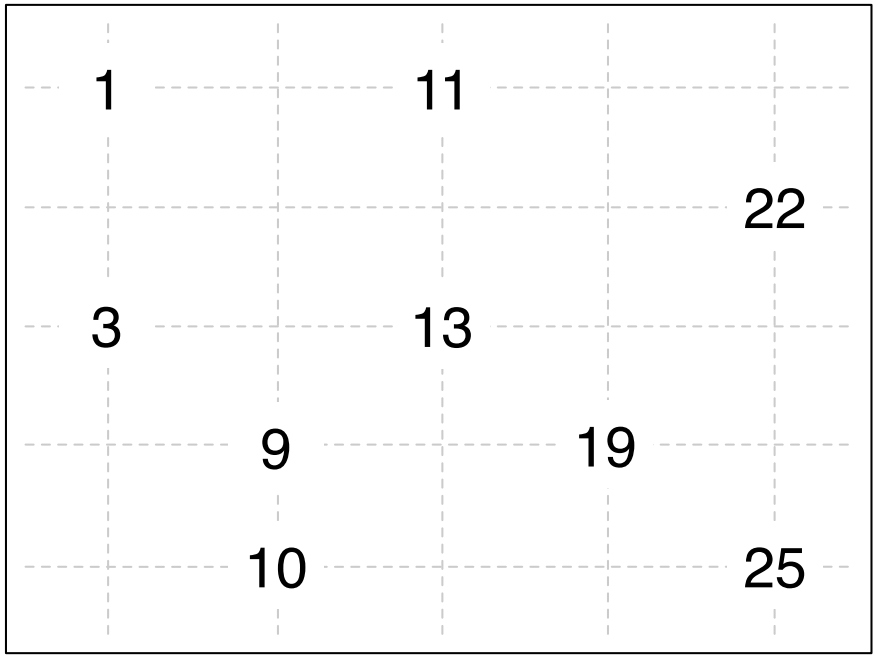
12 participants
x 3 input conditions (1 hand, 1hand-blinders, 2handsBlinders)
x 2 device size (iPod, iPad)
x 3 blocks

Design

12 participants
x 3 input conditions (1 hand, 1hand-blinders, 2handsBlinders)
x 2 device size (iPod, iPad)
x 3 blocks
x 3 target size (10, 20, 40 mm)

Design

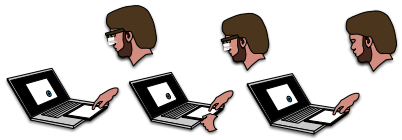
12 participants
x 3 input conditions (1 hand, 1hand-blinders, 2handsBlinders)
x 2 device size (iPod, iPad)
x 3 blocks
x 3 target size (10, 20, 40 mm)
x 9 target position



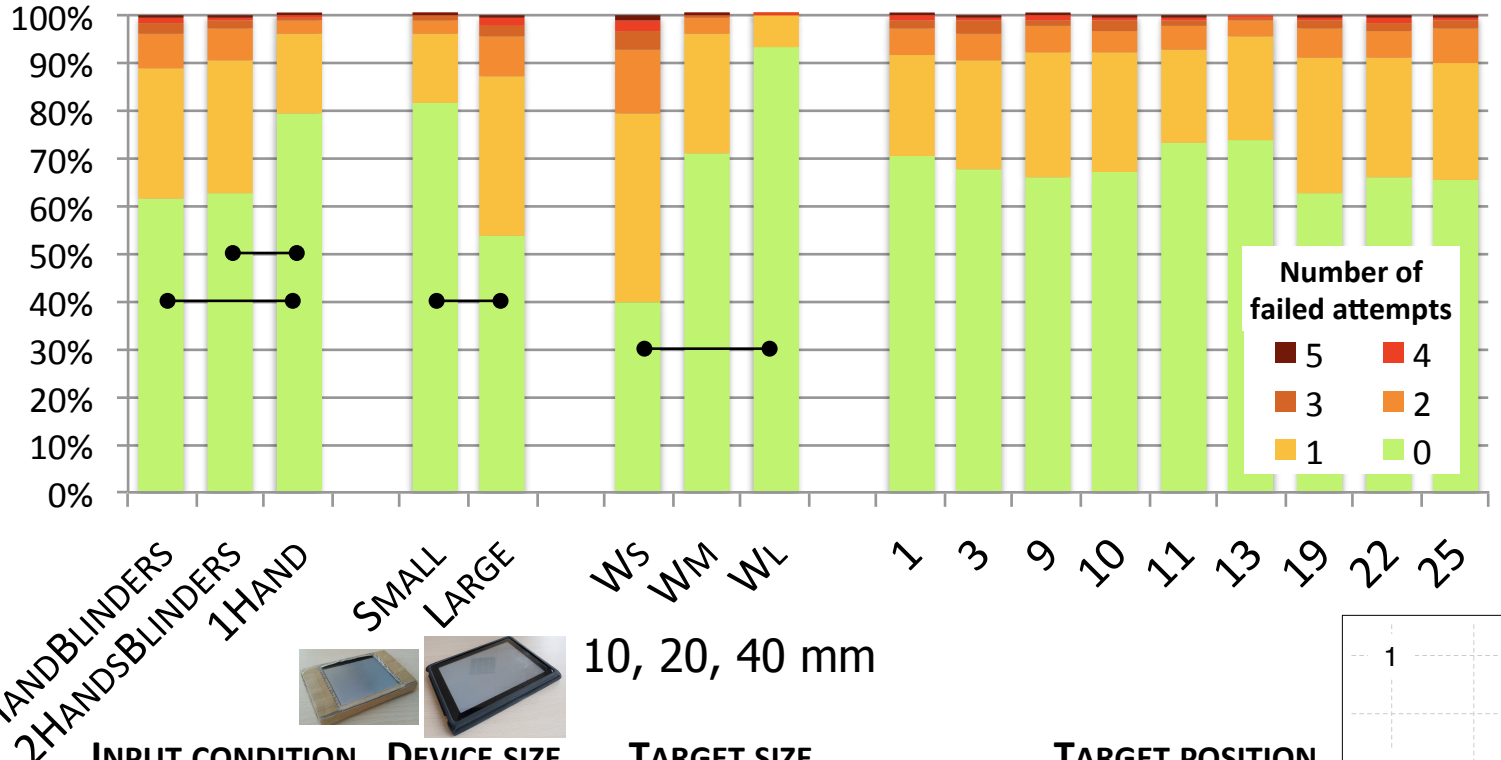
Design

12 participants
x 3 input conditions (1 hand, 1hand-blinders, 2handsBlinders)
x 2 device size (iPod, iPad)
x 3 blocks
x 3 target size (10, 20, 40 mm)
x 9 target position
x 3 repetitions
= 17,496 total trials

Success rate and number of failed attempts

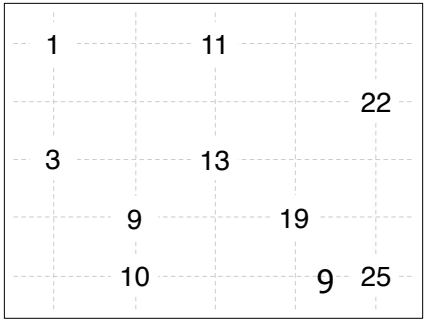


sig. diff.

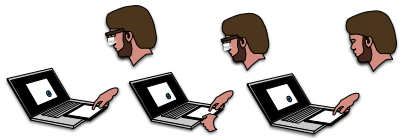


10, 20, 40 mm

Input condition **Device size** **Target size** **Target position**



Success rate and number of failed attempts



sig. diff.

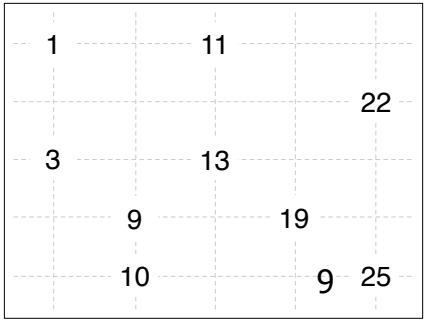
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%

Number of failed attempts
5 4
3 2
1 0

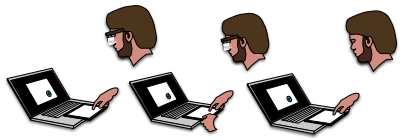
1HANDBLINDERS
2HANDSBLINDERS
1HAND
SMALL
LARGE
WS
WM
WL
1
3
9
10
11
13
19
22
25

10, 20, 40 mm

INPUT CONDITION
DEVICE SIZE
TARGET SIZE
TARGET POSITION



Success rate and number of failed attempts



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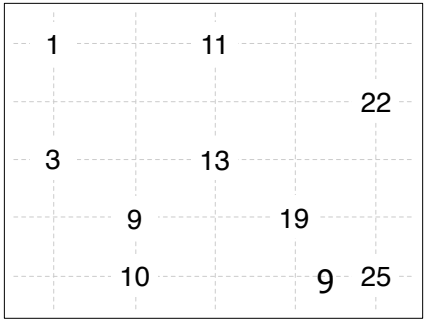
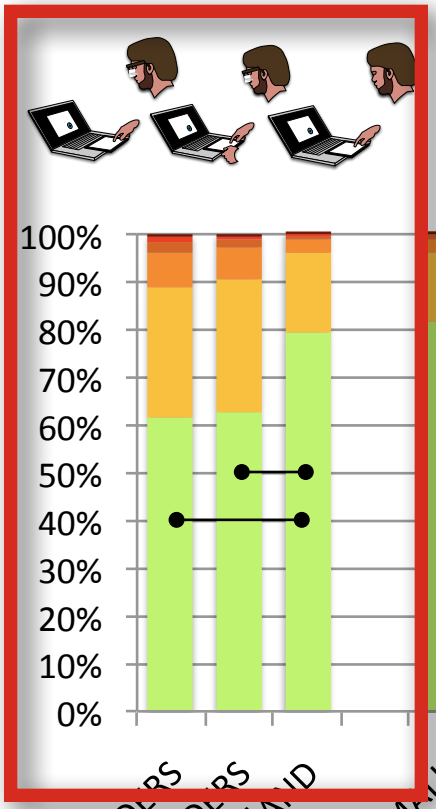
10, 20, 40 mm

INPUT CONDITION DEVICE SIZE TARGET SIZE TARGET POSITION



Success rate and number of failed attempts



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90%
80%
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60%
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40%
30%
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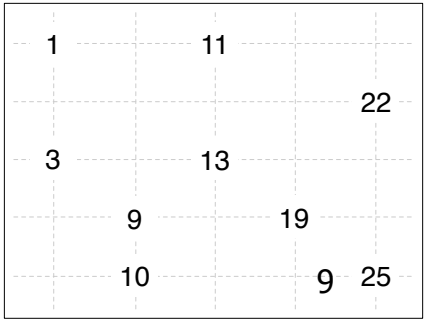
10, 20, 40 mm

INPUT CONDITION DEVICE SIZE TARGET SIZE TARGET POSITION



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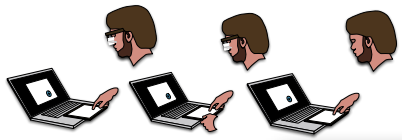

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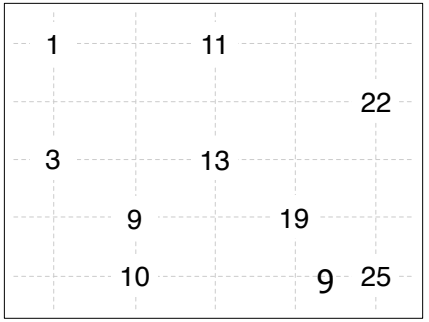
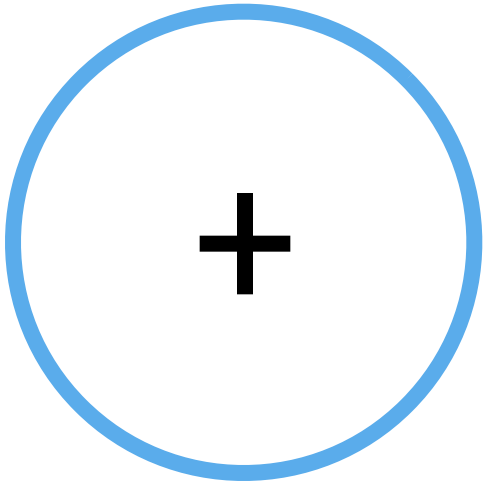
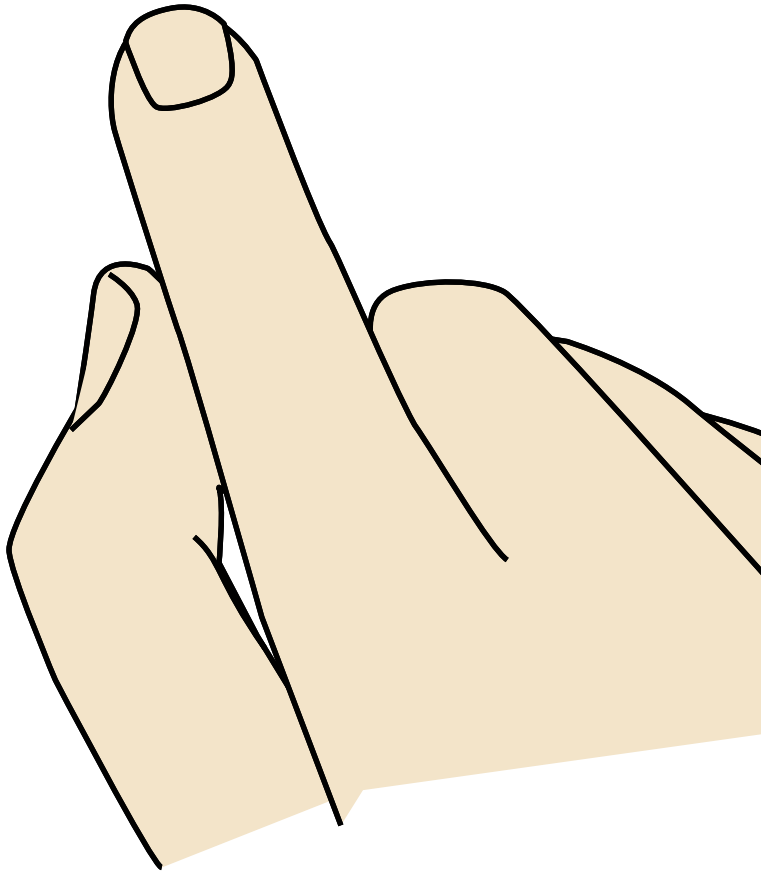
10, 20, 40 mm

INPUT CONDITION
DEVICE SIZE
TARGET SIZE
TARGET POSITION

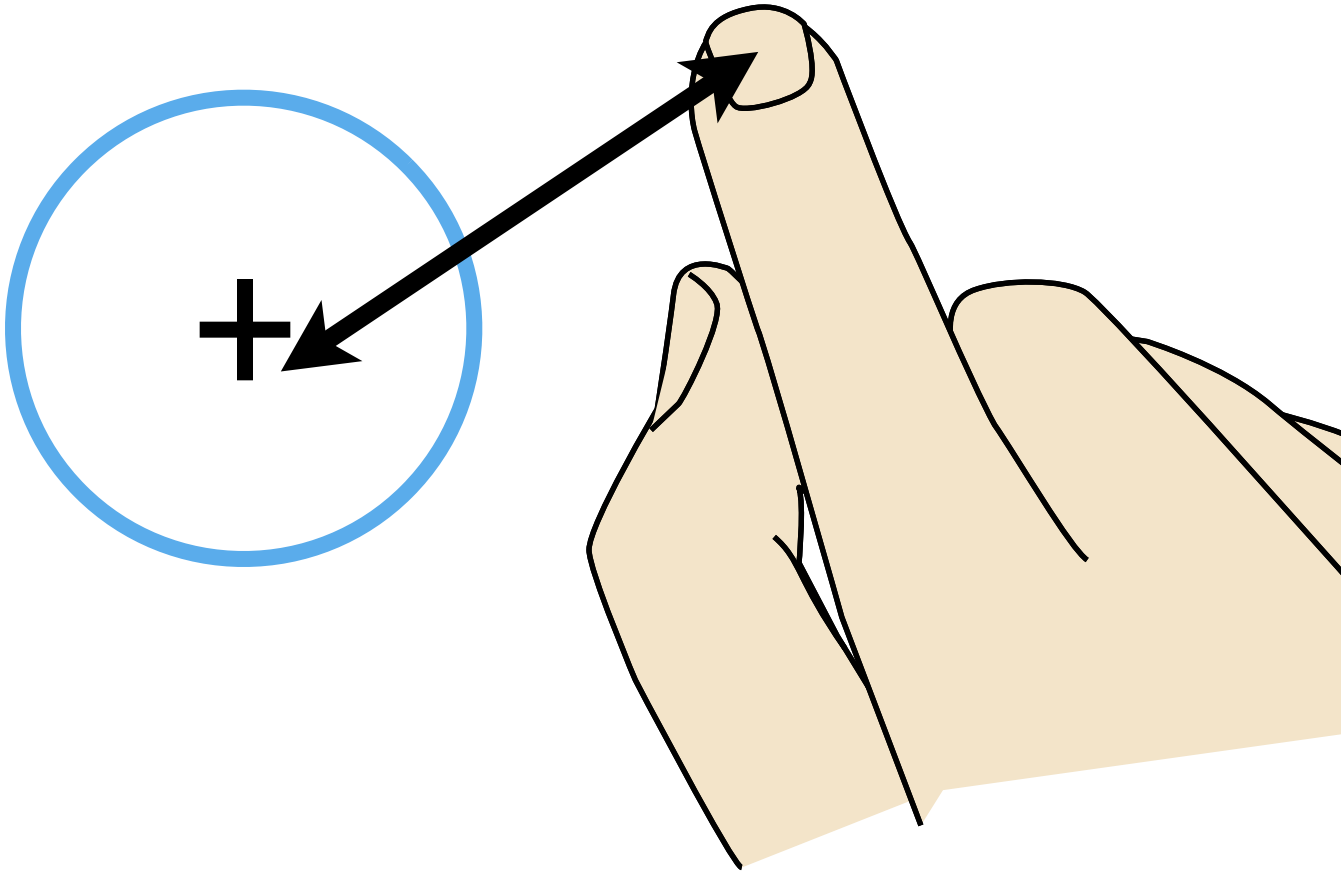


Targeting error

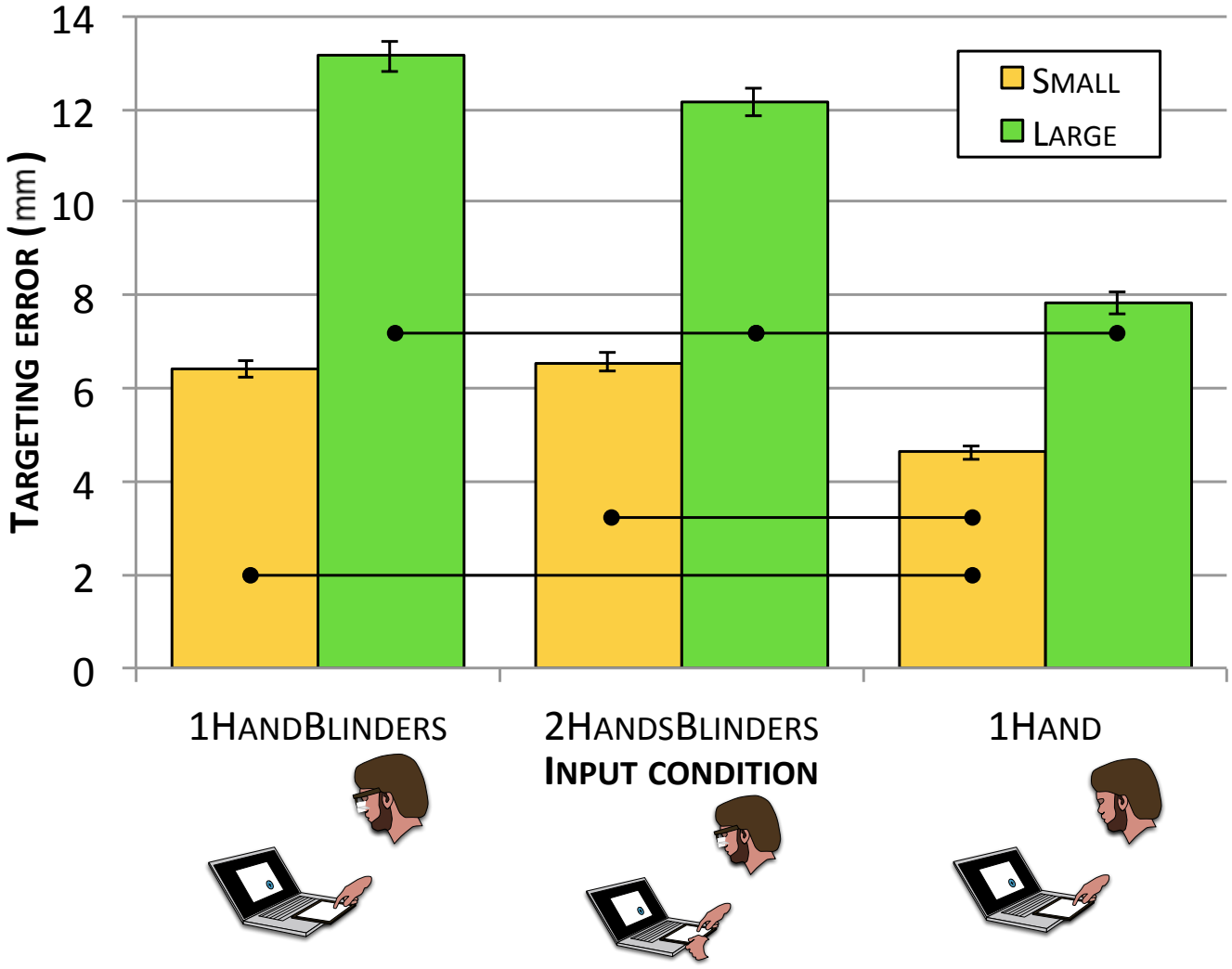




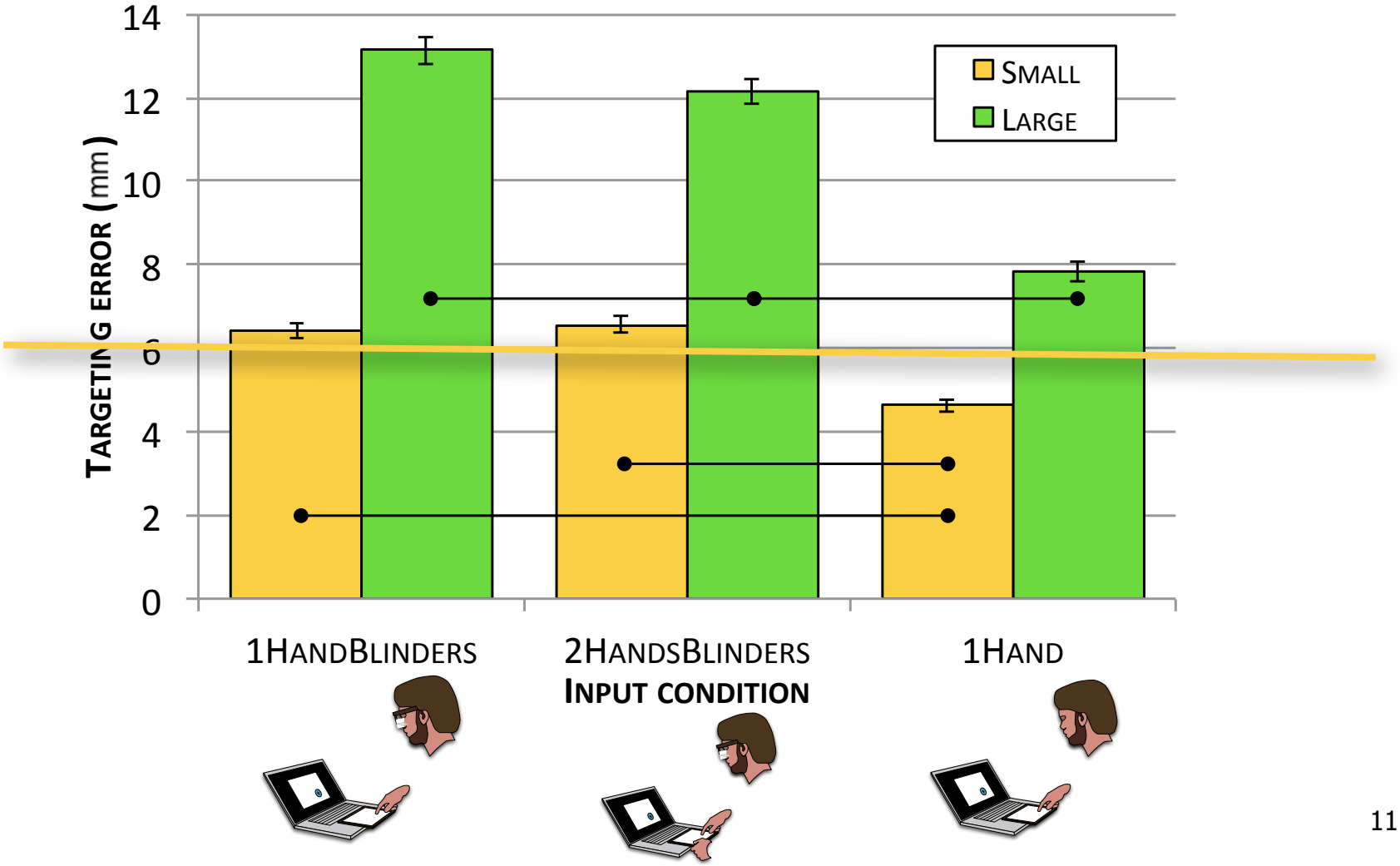
Targeting error



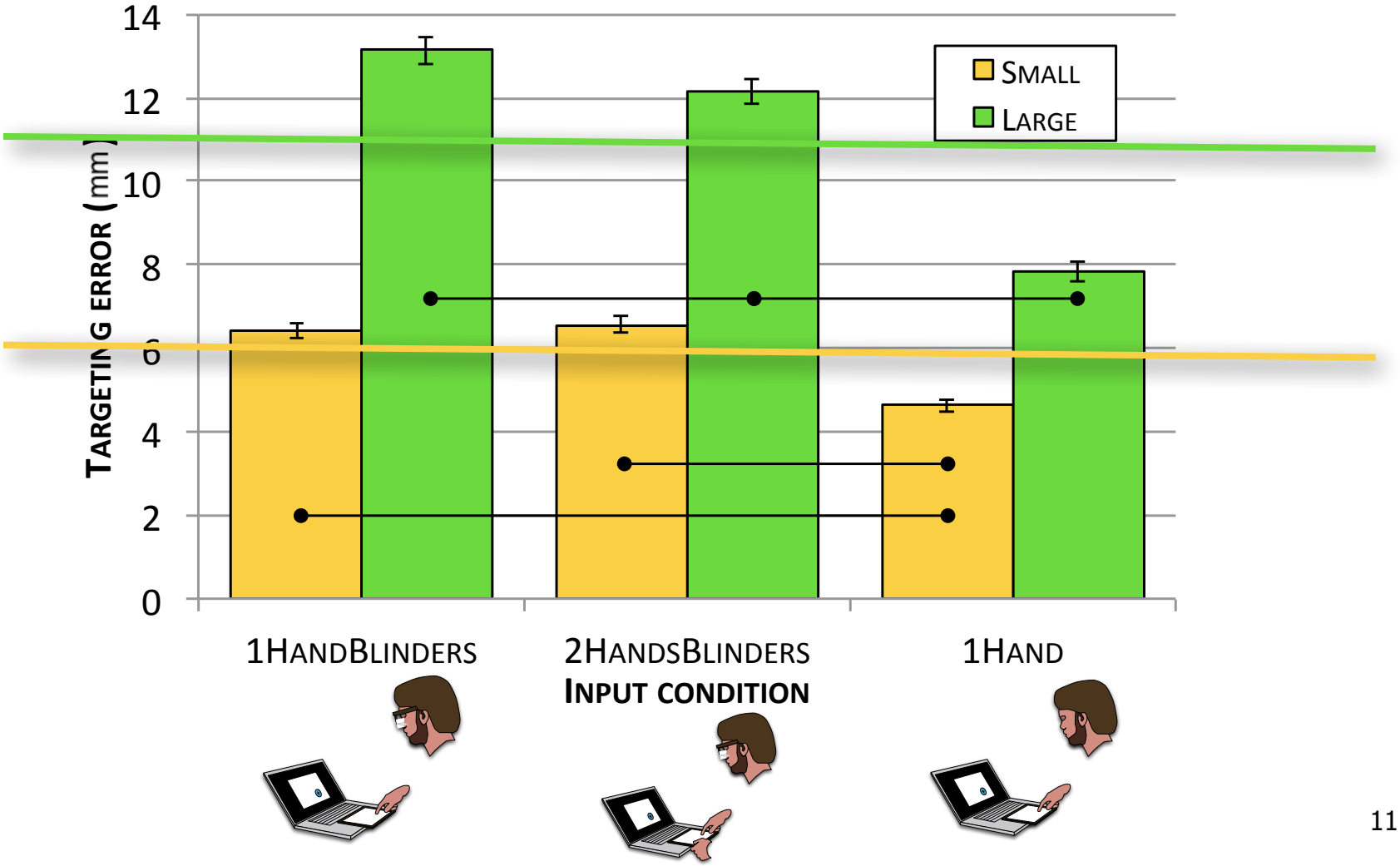
Targeting error



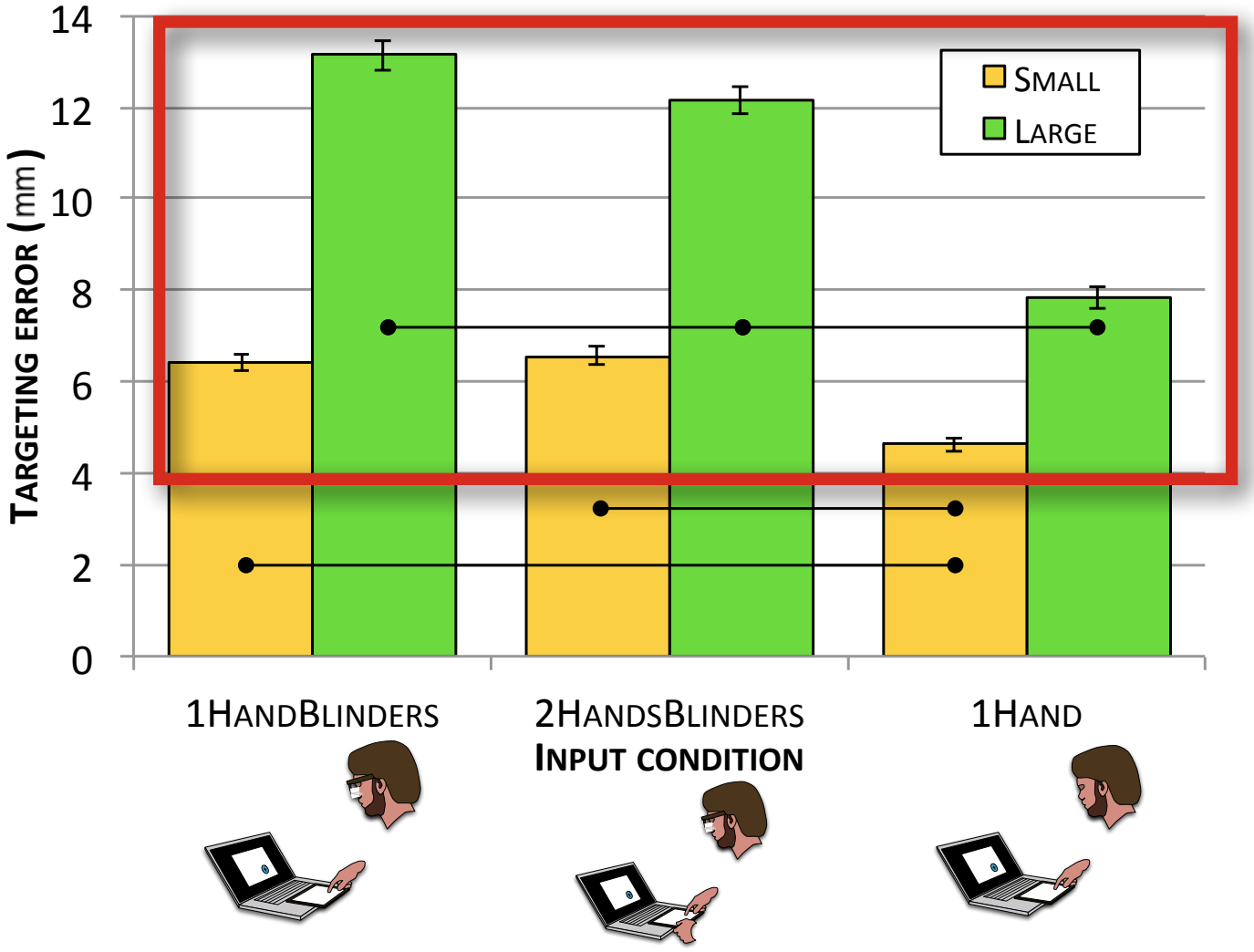
Targeting error



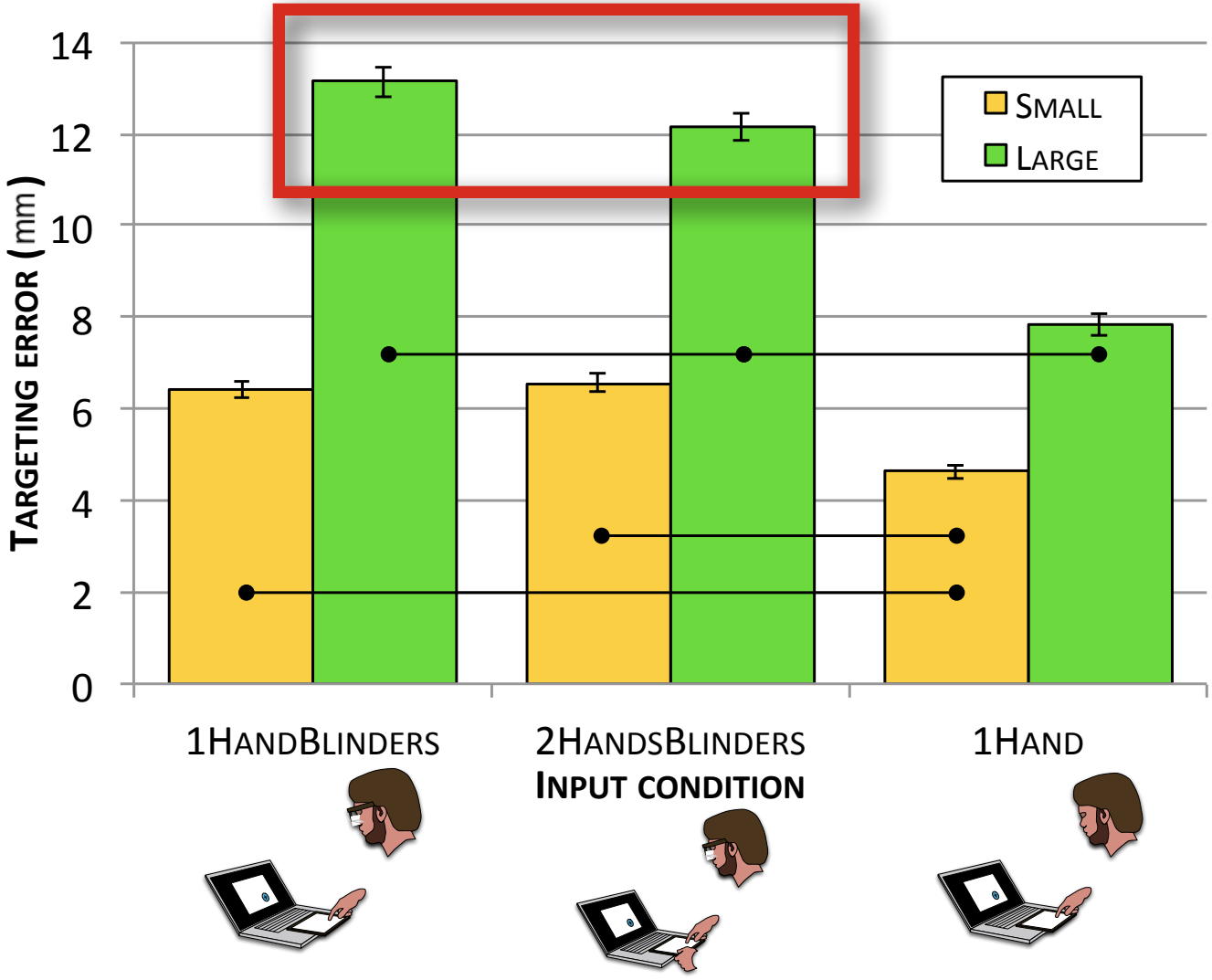
Targeting error



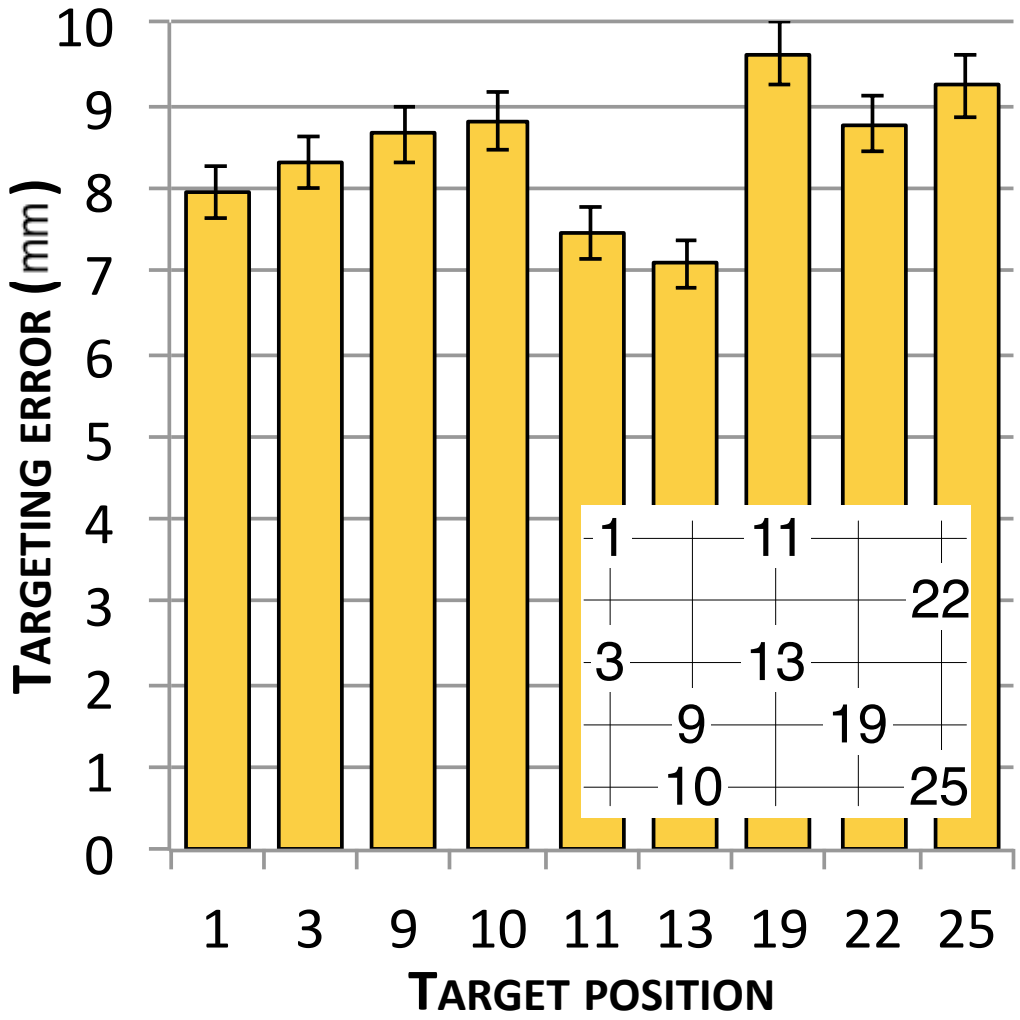
Targeting error



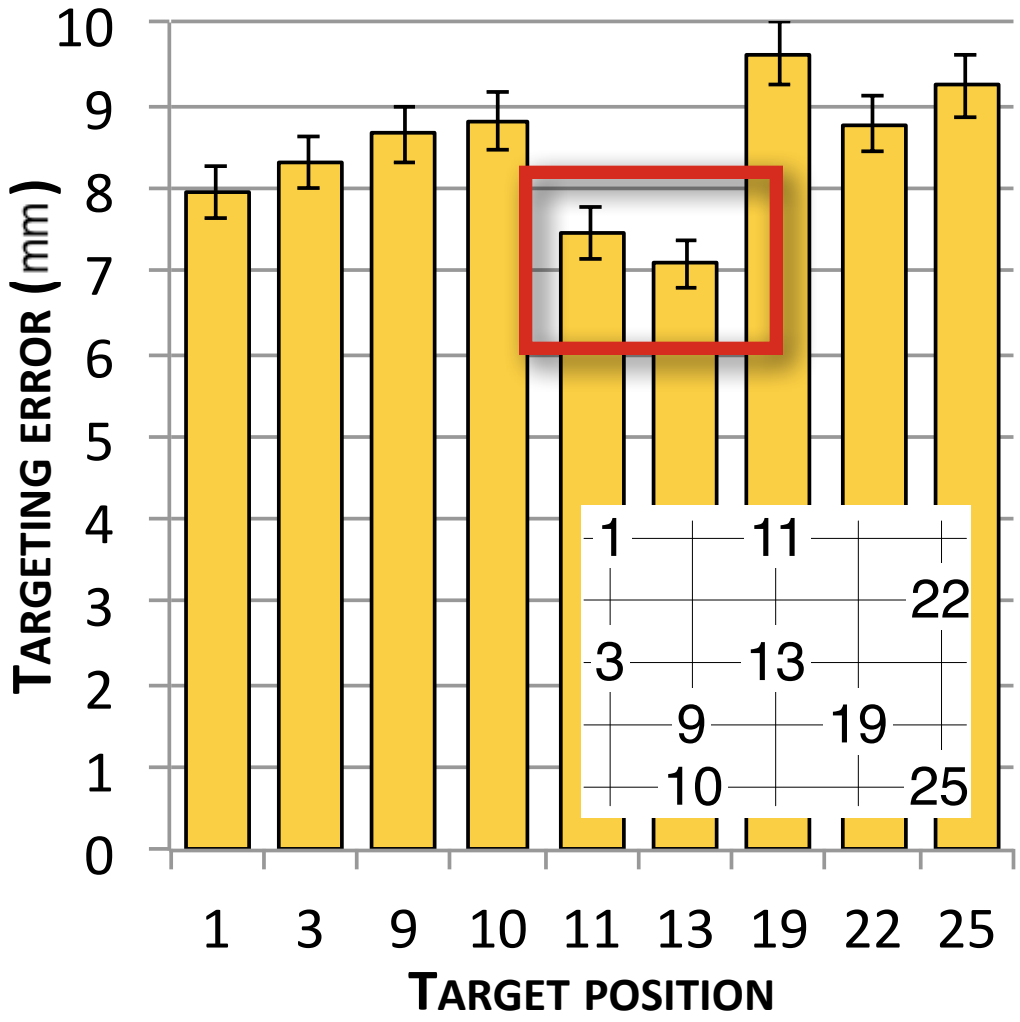
Targeting error



Targeting error



Targeting error



Minimum target size in motor space

Minimal target size in motor space participants can select on first attempt with a 95% probability

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Minimal target size in motor space participants can select on first attempt with a 95% probability

Input condition		1Hand Blinders	2Hand Blinders	1Hand
Device size	Small	22.3	23.2	16.8
	Large	45.2	41.3	27.8

Minimum target size in motor space

Minimal target size in motor space participants can select on first attempt with a 95% probability

Input condition		1Hand Blinders	2Hand Blinders	1Hand
Device size	Small	22.3	23.2	16.8
	Large	45.2	41.3	27.8

EXPERIMENT 2: scale effect and aspect ratio

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Hypothesis:

EXPERIMENT 2: scale effect and aspect ratio

Hypothesis:

1. The size of targets relative to that of the display would have no impact on performance

EXPERIMENT 2: scale effect and aspect ratio

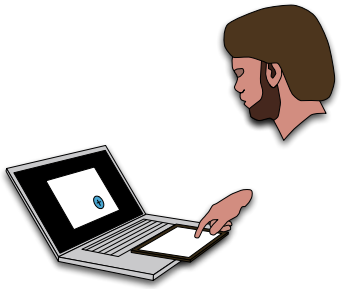
Hypothesis:

1. The size of targets relative to that of the display would have no impact on performance

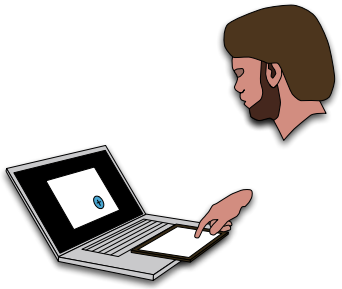
2. Similar input and output aspect ratios would lead to better performance

Task

Design

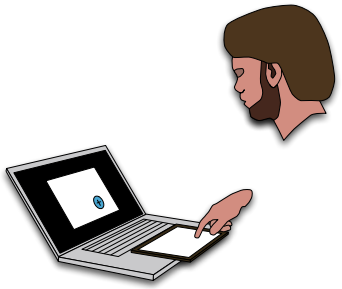


Design



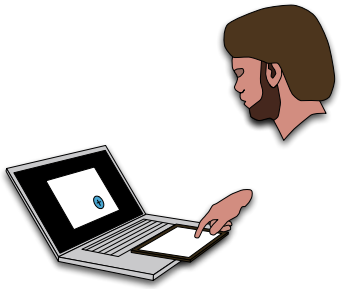
12 participants

Design



12 participants
x 3 workspace height (74, 147, 294 mm)

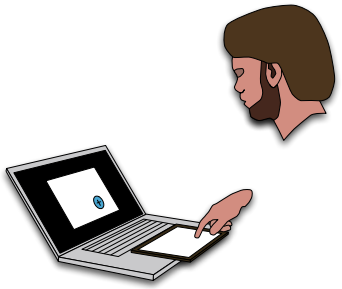
Design



12 participants
x 3 workspace height (74, 147, 294 mm)
x 3 aspect ratio (4:3, 16:9, 32:10)

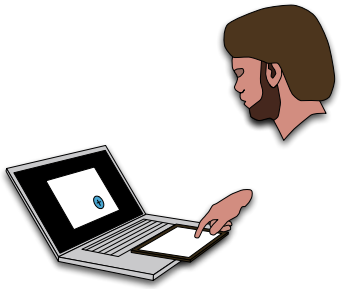
	4:3	16:9	32:10
x 0,5			
x 1			
x 2			

Design



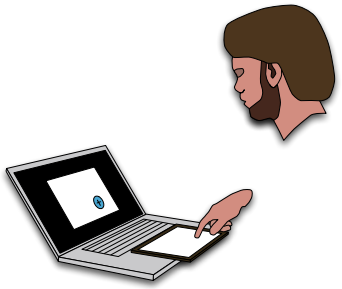
12 participants
x 3 workspace height (74, 147, 294 mm)
x 3 aspect ratio (4:3, 16:9, 32:10)
x 3 blocks

Design

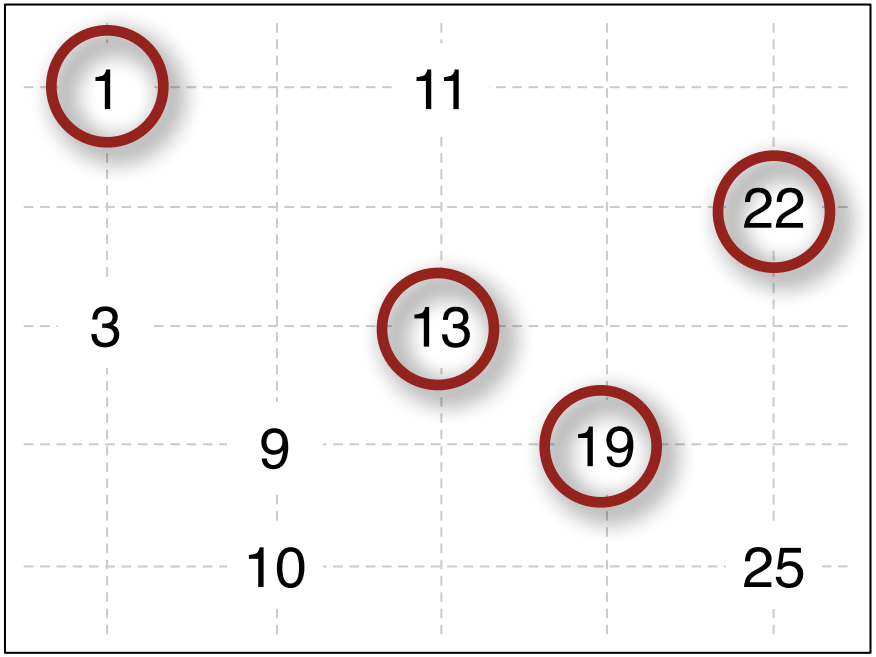


12 participants
x 3 workspace height (74, 147, 294 mm)
x 3 aspect ratio (4:3, 16:9, 32:10)
x 3 blocks
x 2 target size (20 and 40 mm)

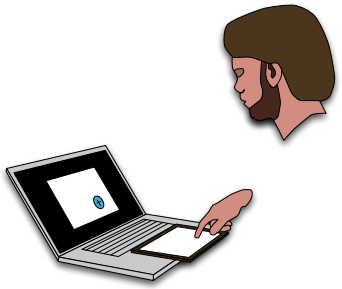
Design



12 participants
x 3 workspace height (74, 147, 294 mm)
x 3 aspect ratio (4:3, 16:9, 32:10)
x 3 blocks
x 2 target size (20 and 40 mm)
x 4 target position

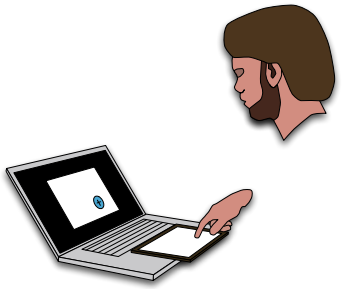


Design



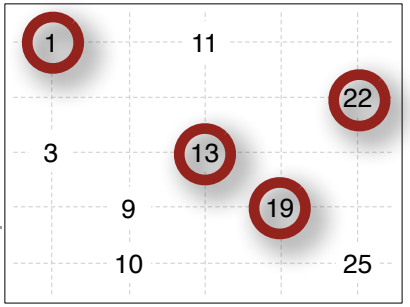
12 participants
x 3 workspace height (74, 147, 294 mm)
x 3 aspect ratio (4:3, 16:9, 32:10)
x 3 blocks
x 2 target size (20 and 40 mm)
x 4 target position
x 3 repetitions

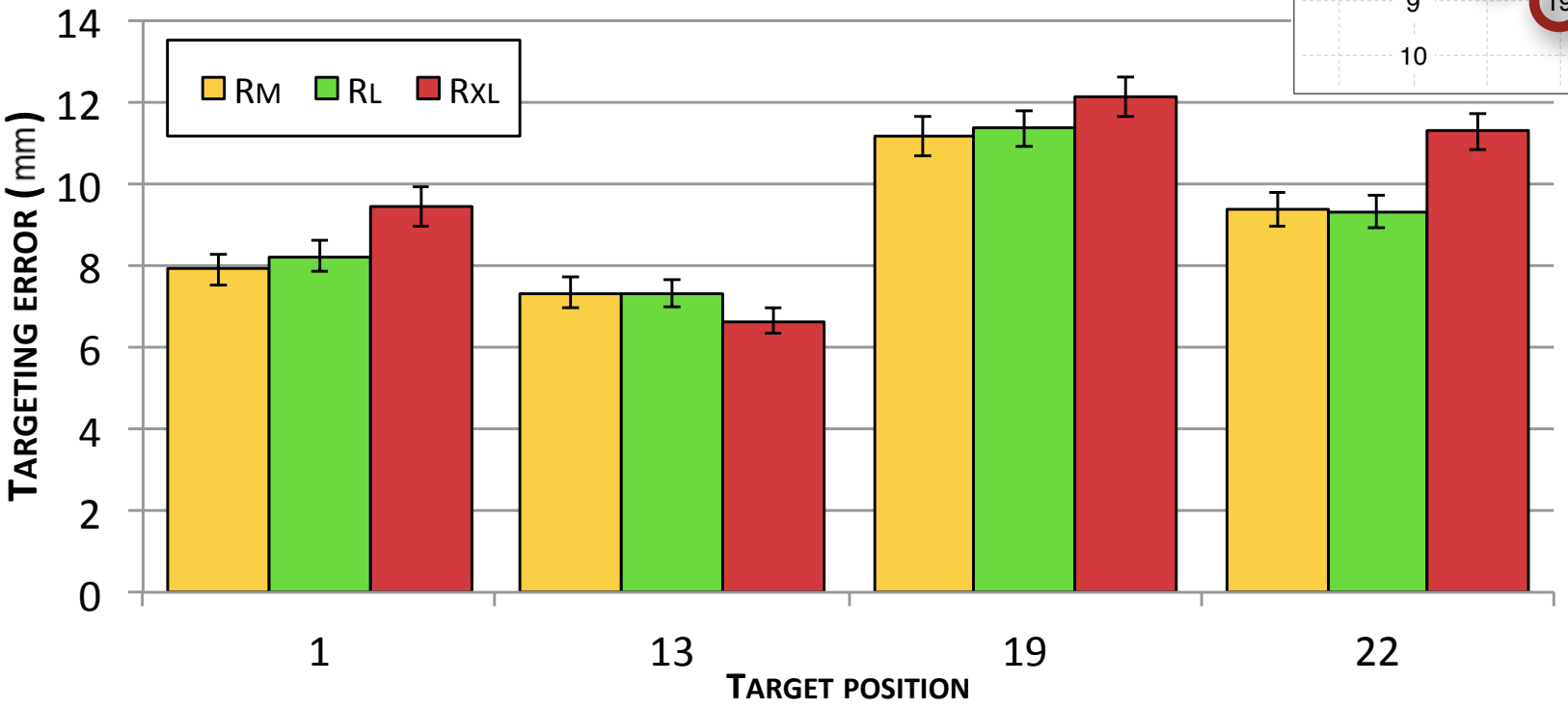
Design



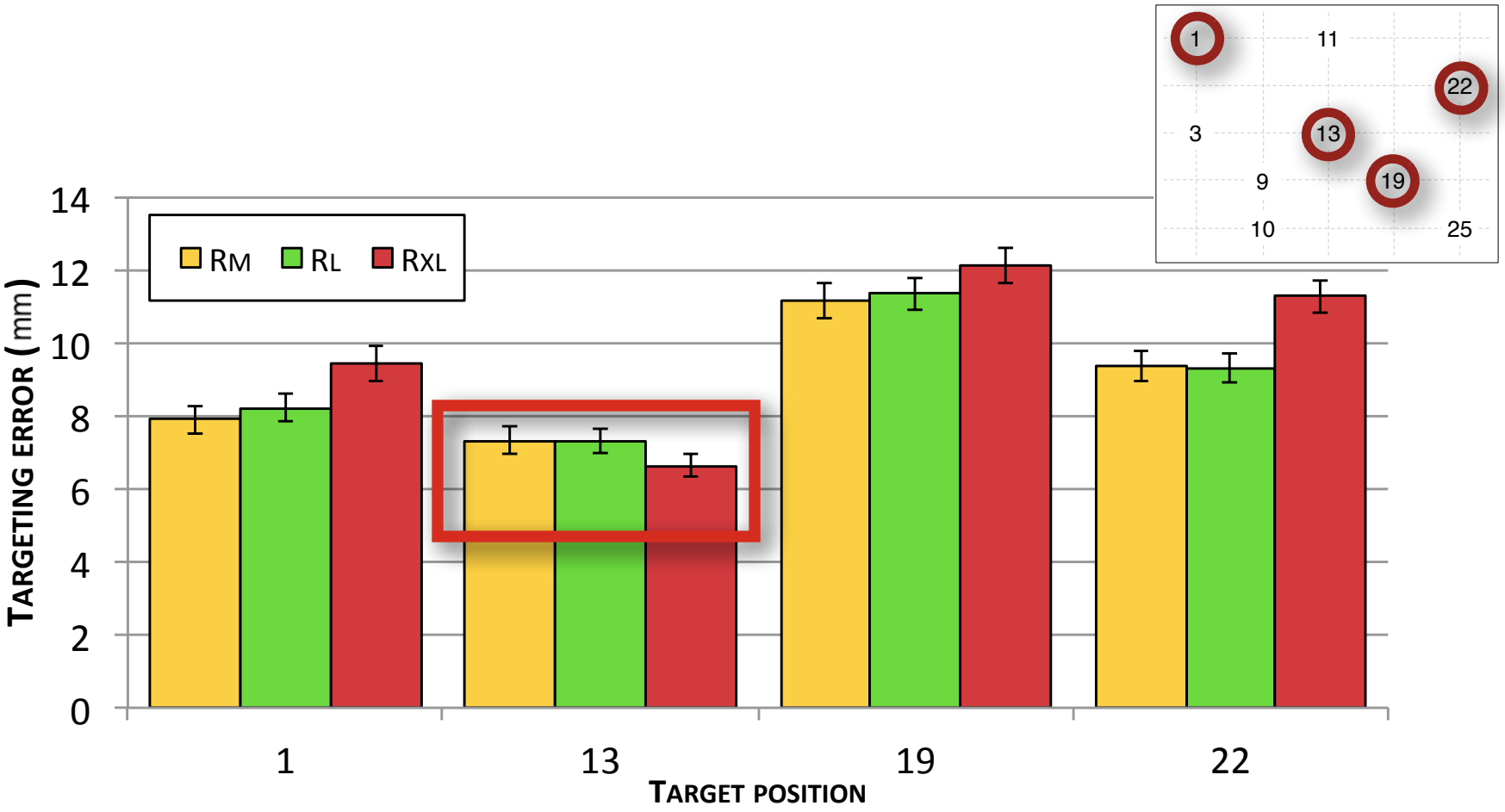
12 participants
x 3 workspace height (74, 147, 294 mm)
x 3 aspect ratio (4:3, 16:9, 32:10)
x 3 blocks
x 2 target size (20 and 40 mm)
x 4 target position
x 3 repetitions
= 7,776 total trials

Targeting error and aspect ratio





Targeting error and aspect ratio



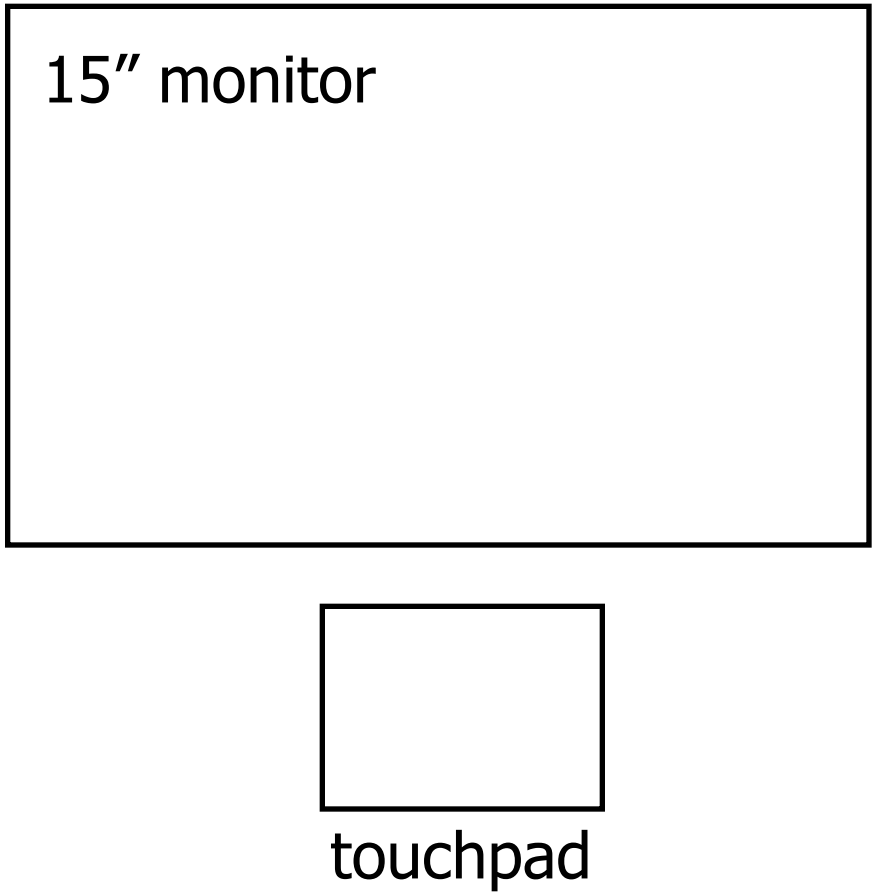
Targeting error and scale

WM	WORKSPACE HEIGHT		HS	HM	HL
	ASPECT RATIO	RM	20×20	10×10	5×5
		RL	15×20	17.5×10	3.7×5
		RXL	8.3×20	4.2×10	2.1×5
WL	WORKSPACE HEIGHT		HS	HM	HL
	ASPECT RATIO	RM	40×40	20×20	10×10
		RL	30×40	15×20	7.5×10
		RXL	16.7×40	8.3×20	4.2×10

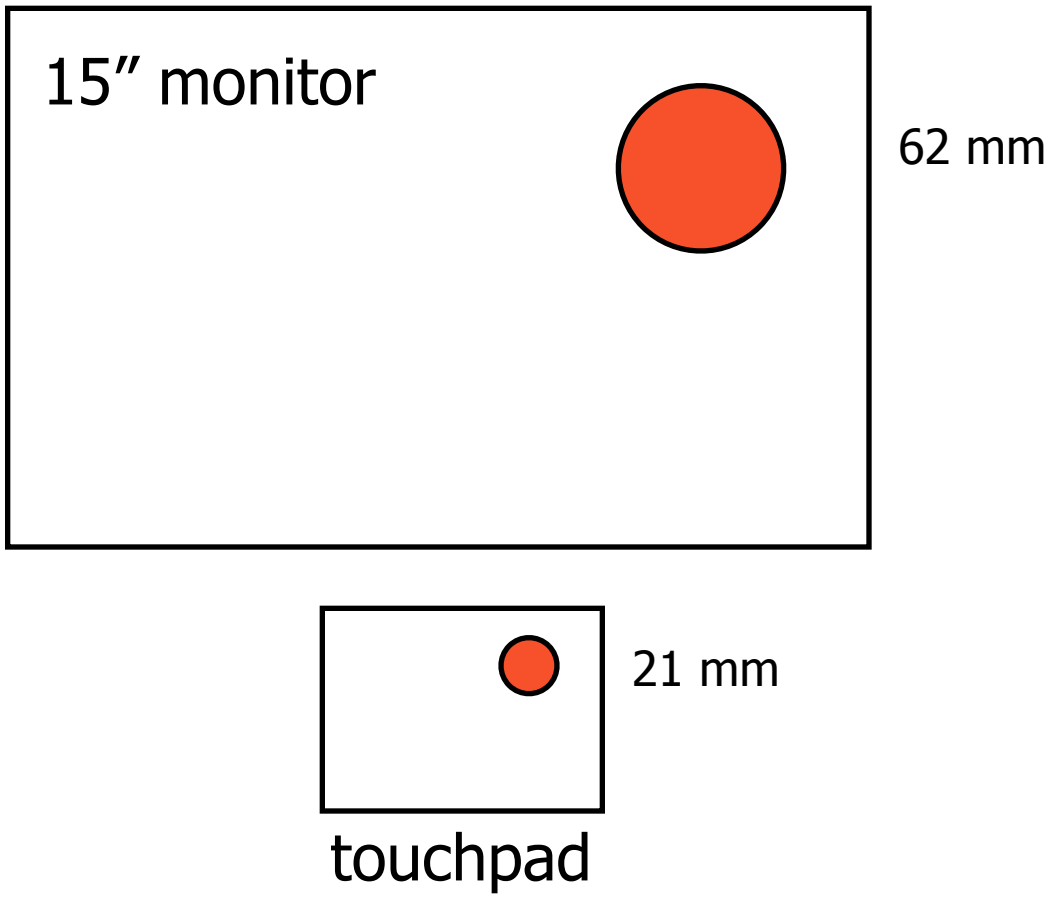
Targeting error and scale

WM	WORKSPACE HEIGHT		HS	HM	HL
	ASPECT RATIO	RM	20×20	10×10	5×5
		RL	15	29.9 mm	3.7×5
		RXL	8.3×20	4.2×10	2.1×5
WL	WORKSPACE HEIGHT		HS	HM	HL
	ASPECT RATIO	RM	40×40	20×20	10×10
		RL	30×40	31.2 mm	
		RXL	16.7×40	8.3×20	4.2×10

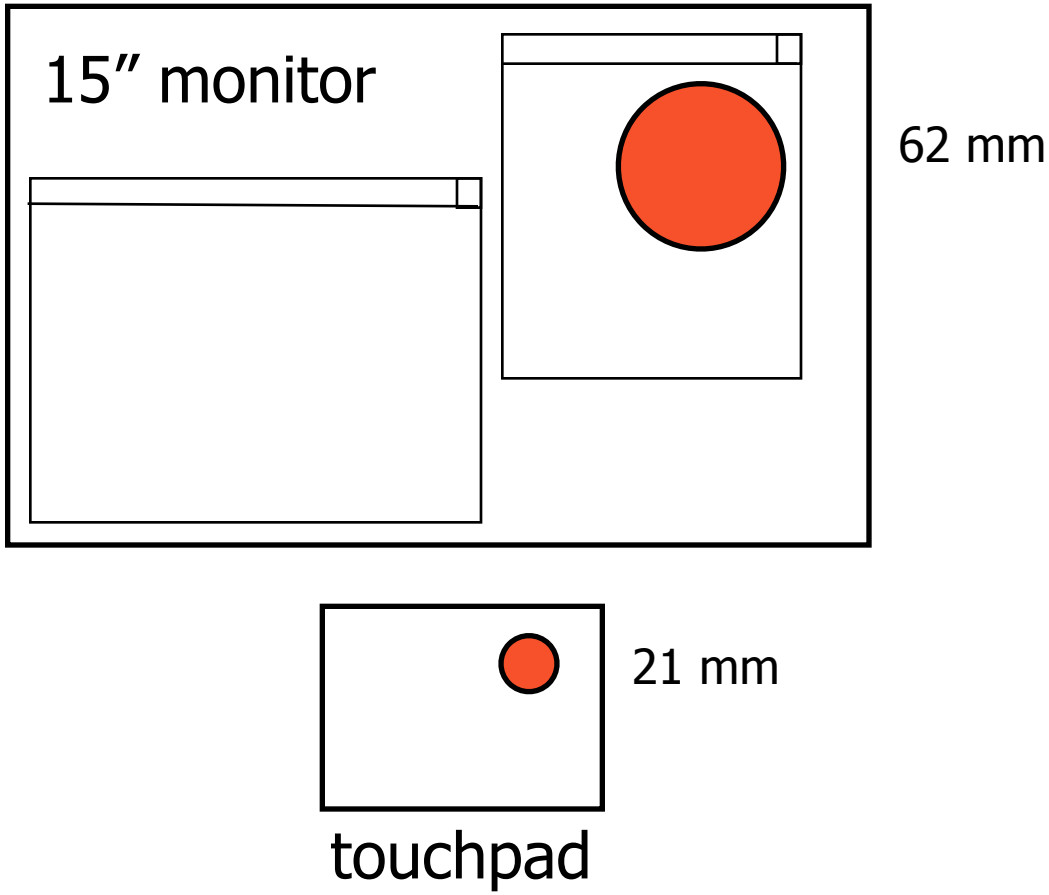
Example applications



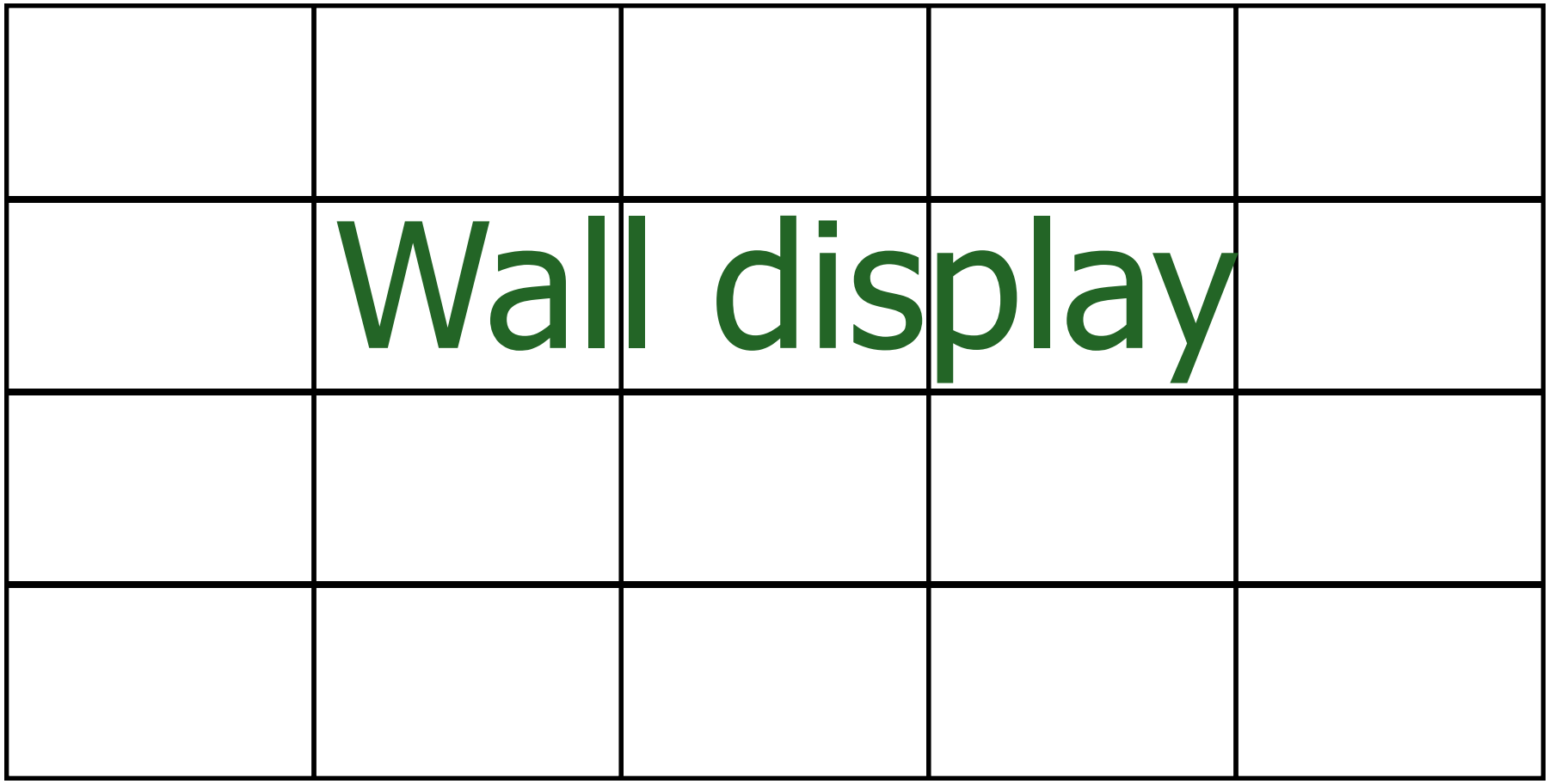
Example applications



Example applications



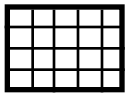
Example applications



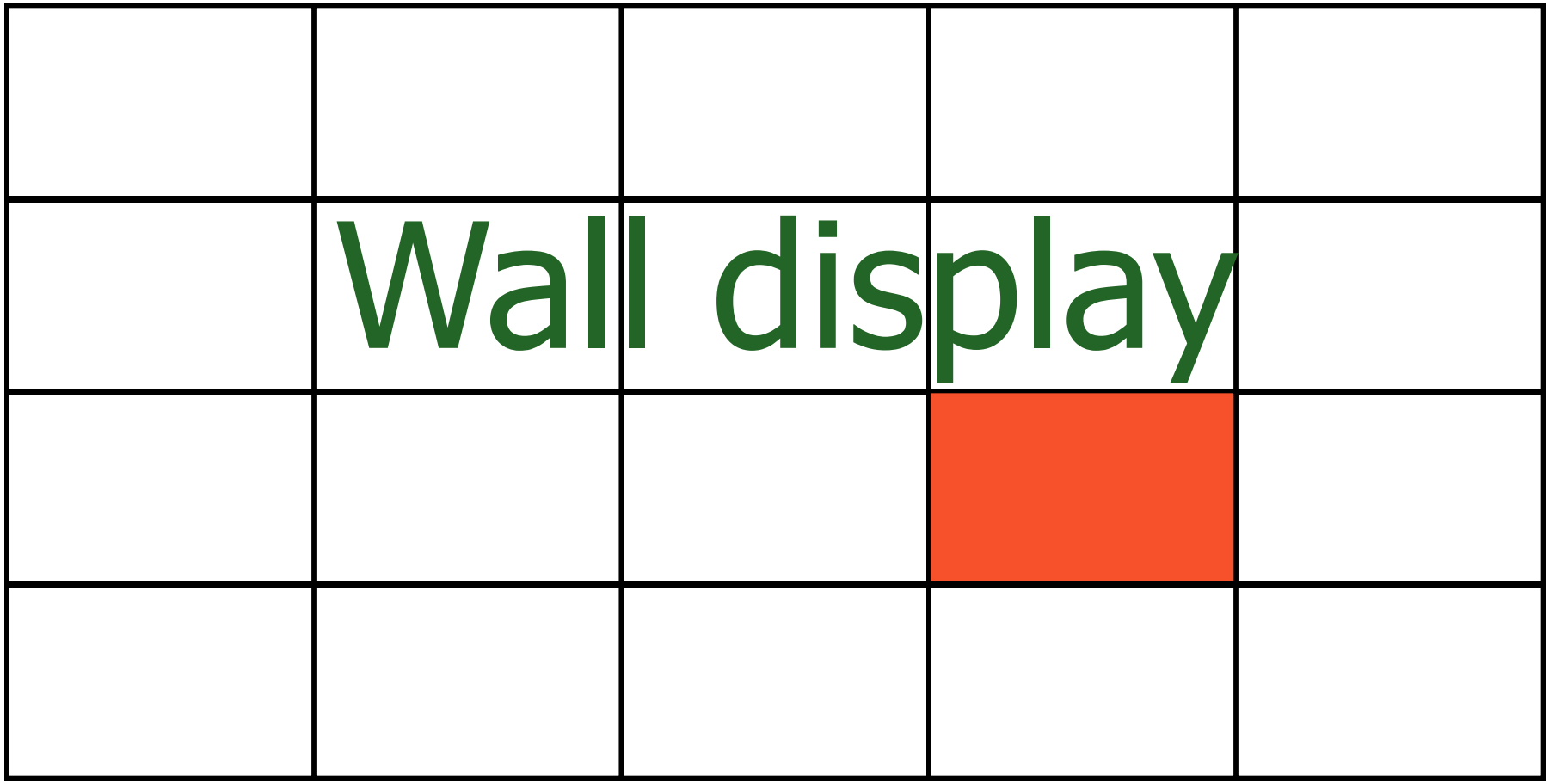
touchpad 

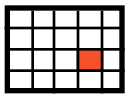
Example applications

Wall display

touchpad 

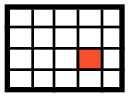
Example applications



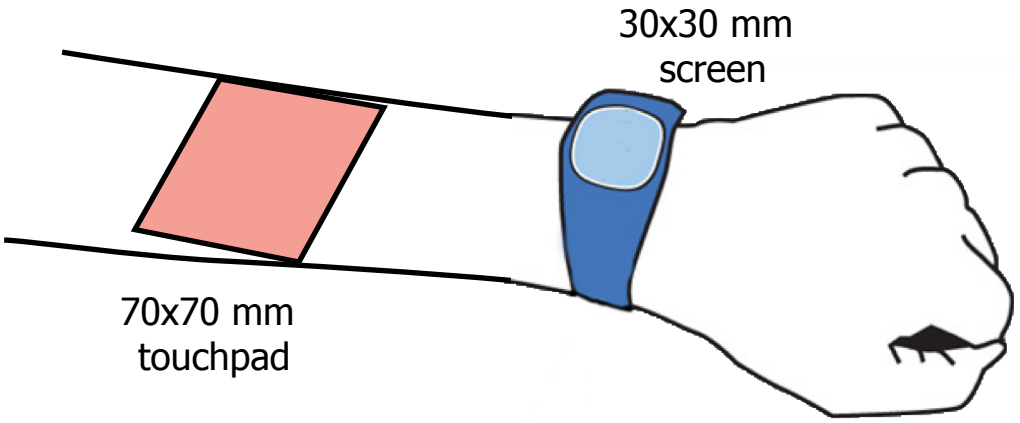
touchpad 

Example applications

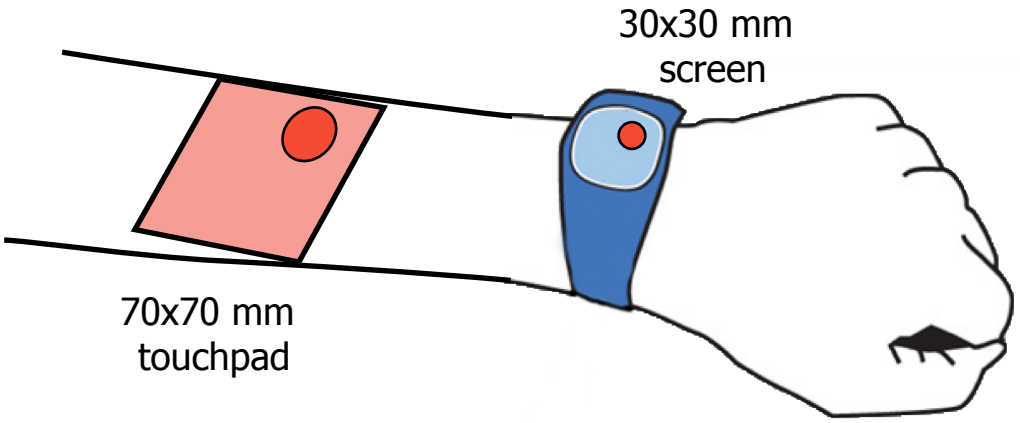
Wall display

touchpad 

Example applications



Example applications



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   even if nothing is displayed on it helps
   => the boundaries of the surface should be clearly distinguishable

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1. Looking at the input surface,
   even if nothing is displayed on it helps
   => the boundaries of the surface should be clearly distinguishable

2. Designers should take the **handedness** of the users into account for all absolute indirect-touch pointing tasks.

3. The display scale does not matter, but **input and output aspect ratios do**.

4. Pay attention to the minimum target size in motor space and use it to check whether the on-screen interactors can be reliably acquired.