

Intelligent User Interfaces

Xiaojun Bi

Stony Brook University

Xiaojun@cs.stonybrook.edu

11/19/2019

Definition:

- Intelligent user interfaces are human-machine interfaces that aim to improve the efficiency, effectiveness, and naturalness of human-machine interaction by representing, reasoning, and acting on models of the user, domain, task, discourse, and media.

IUI range of approaches:

- Personalized, proactive interfaces
 - Personalization
 - User modeling/user profiling
 - Adaptive interfaces (machine learning)
 - Recommender systems
 - Software agents
 - ...
- Interfaces to mimic human-to-human interaction
 - Conversational interfaces, natural language techniques in interfaces
 - Interface that plan and reason

Main conference: annual IUI conference

Intelligence in commercial applications

- Recommendation systems are ubiquitous
- Typo & grammar correction
- Spam filters
- More, better speech interfaces
- ...

Intelligent User Interfaces

Print

Printer

Name Canon Photo

Status: Idle

Type: Ink jet

Where: Printer room

☐ Print to File

☐ Manual Duplex

Page range

☒ All

☐ Current Page

☐ Pages

Copies

Number of copies 1

Print Content

Print what Document

Print All pages in range

Zoom

Scale to paper size

Ok Cancel

Print

Printer

Name

Canon Photo

Epson Stylus

HP Deskjet

Lexmark Inkjet

Xerox Phaser

Status: Idle

Type: Ink jet

Where: Printer room

☐ Print to File

☐ Manual Duplex

Page range

All

Current Page

Pages

Copies

Number of copies

1

2

3

4

5

6

7

8

9

10

☐ Collate

Print Content

Print what

Document

Document properties

Document showing markup

List of markup

Styles

AutoText entries

Key assignments

Print

☒ All pages in range

☐ Odd pages

☐ Event pages

Zoom

Print what

1 page

2 pages

4 pages

6 pages

8 pages

16 pages

Scale to paper size

No Scaling

Letter

Legal

Executive

A4

Ok Cancel

Supple

[Gajos et al]

User Preference Elicitation

The image shows a window titled "Factored Cost Query" with a question: "In general, how do you prefer Disc to be displayed?". Below the question are two panels, "Option A" and "Option B".

Option A: Contains a vertical list box labeled "Disc" with values 1, 2, 3, 4, and 5. The value "1" is selected and highlighted in blue.

Option B: Contains a text input field labeled "Disc" with the value "1" and a dropdown arrow button.

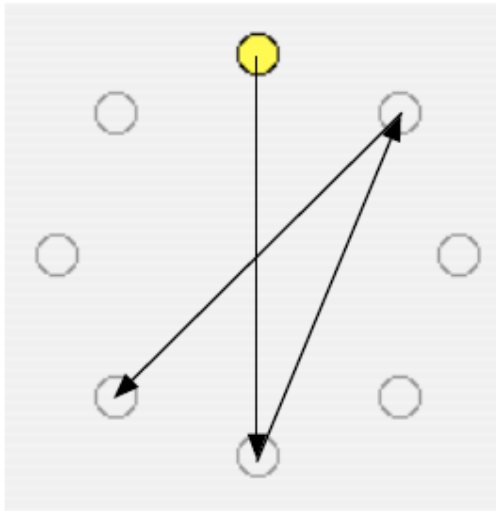
Below the two panels is a section labeled "Your choice:" with three buttons: "Option A", "Neither", and "Option B". The "Neither" button is highlighted in blue.

At the bottom of the window is a large "Submit" button.

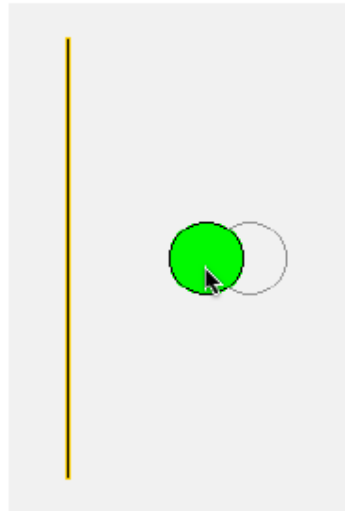
(a) An example of a query used during the active elicitation part of the preference elicitation.

Model Motor Abilities

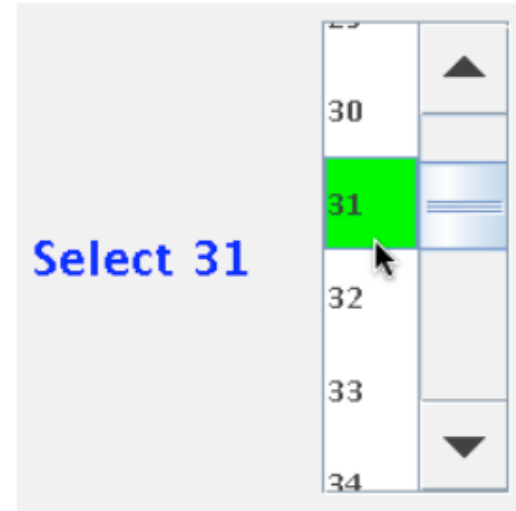
Pointing



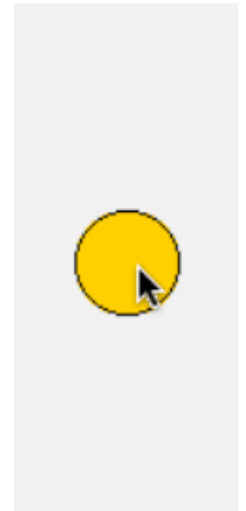
Dragging



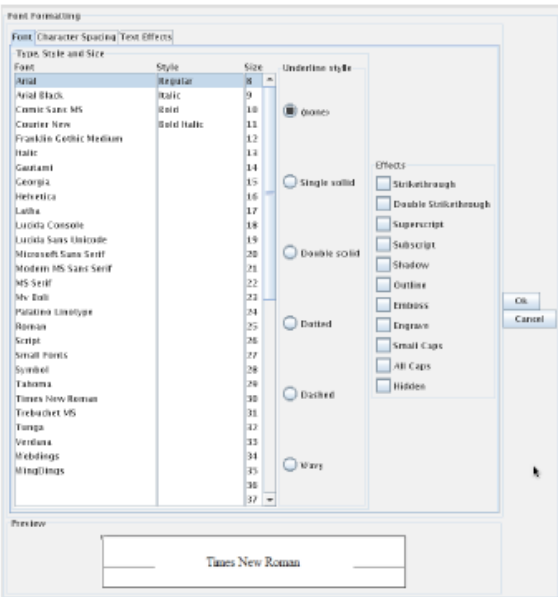
List Selection



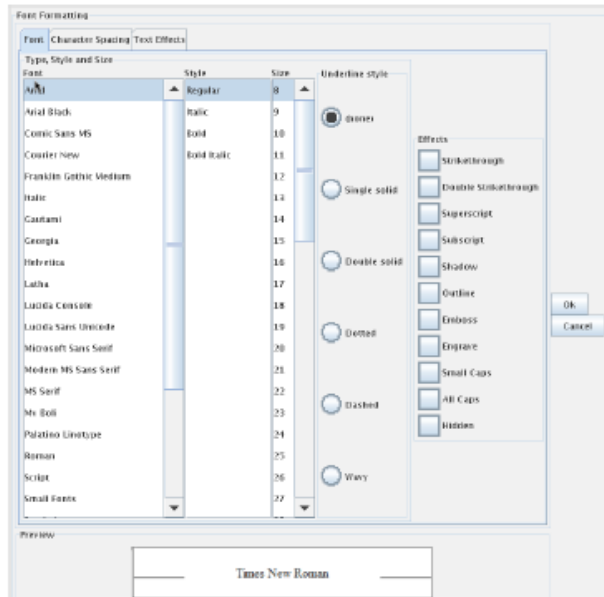
Clicking



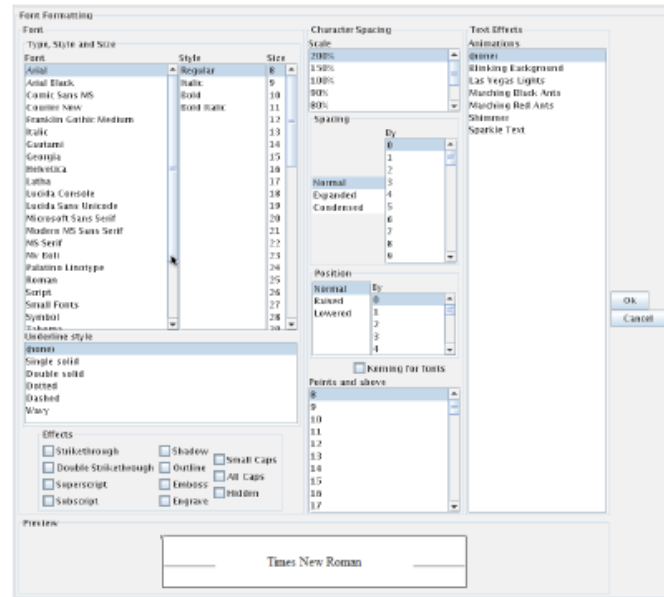
(b) Four task types used to measure participants' motor capabilities



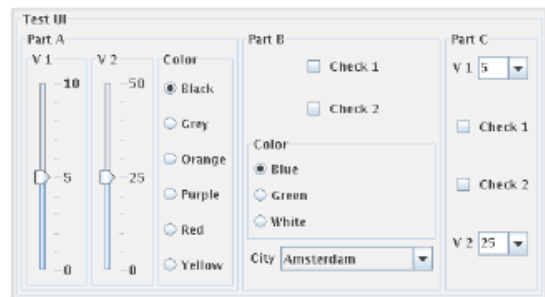
AB02



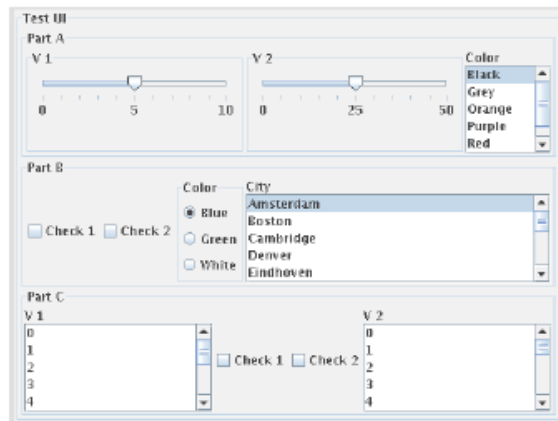
MI02



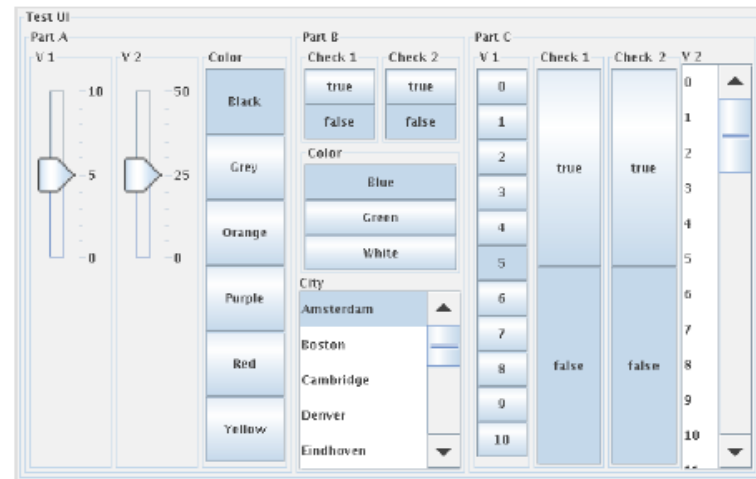
MI04



baseline

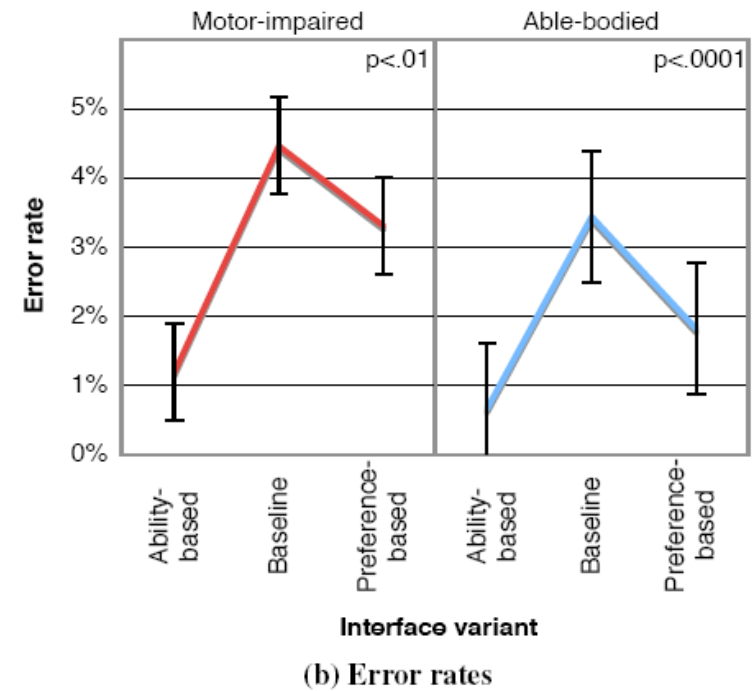
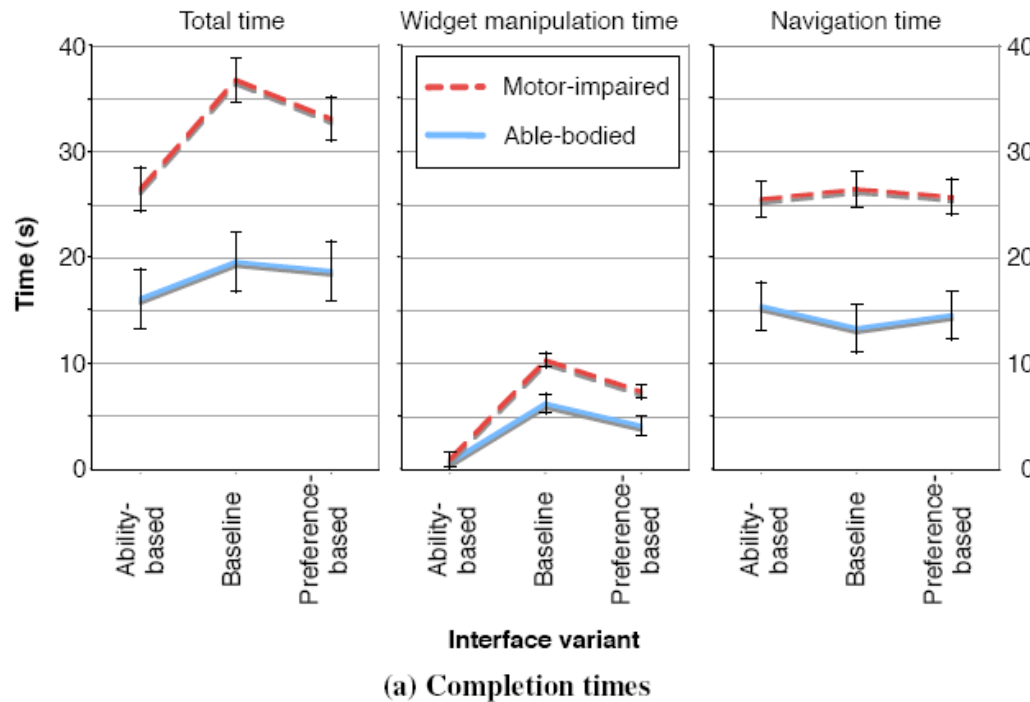


AB03



MI09

Evaluation



Sikuli - GUI Screenshots for Search and Automation

Sikuli Search

Capture Screenshot



Search Documentations

PC Magazine Windows XP
Solutions, page 33



Microsoft Windows XP
Step by Step, page 116



Save Custom Annotations



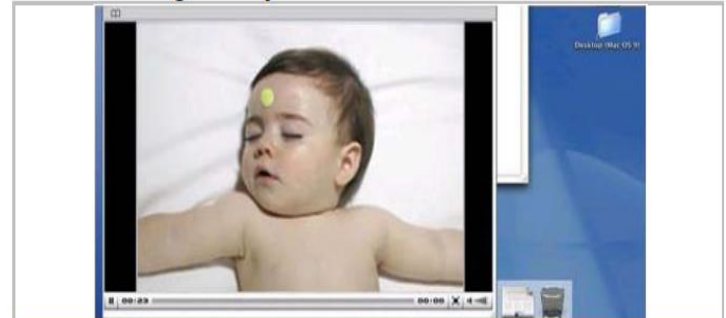
This is where you can change the wallpaper
on the desktop. Click "Browse" to


Download free wallpapers from <http://...>

Sikuli Script

```
pdfs = find() doubleClick() dragDrop(, )
```

6. Monitoring a Baby



```
1: while find().similar(0.7):  
2:   sleep(60)  
3:   popup("Check the baby!")
```



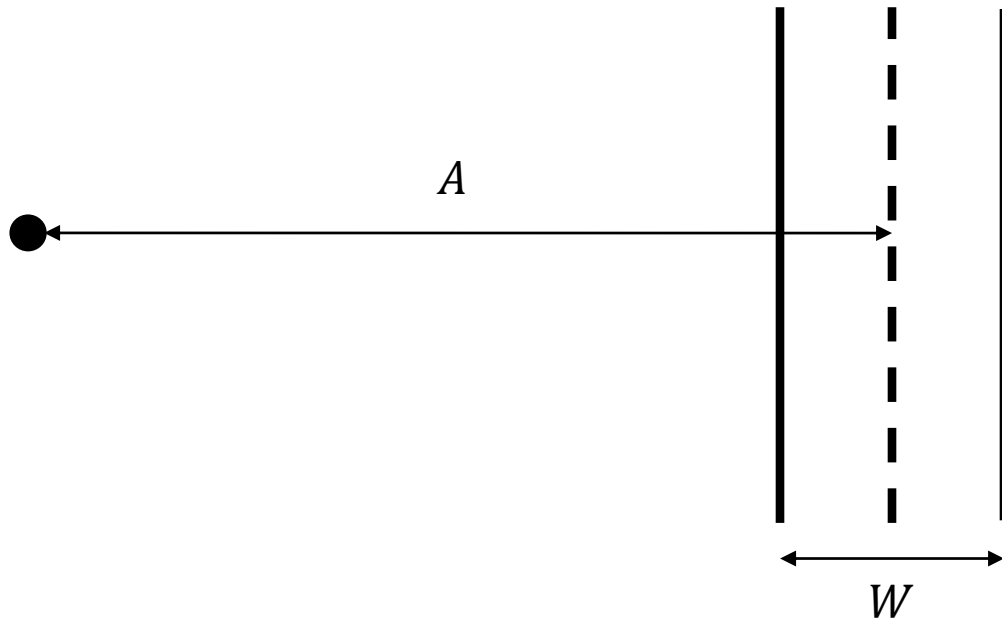
Inferring Identity using Accelerometers in Television Remote Controls



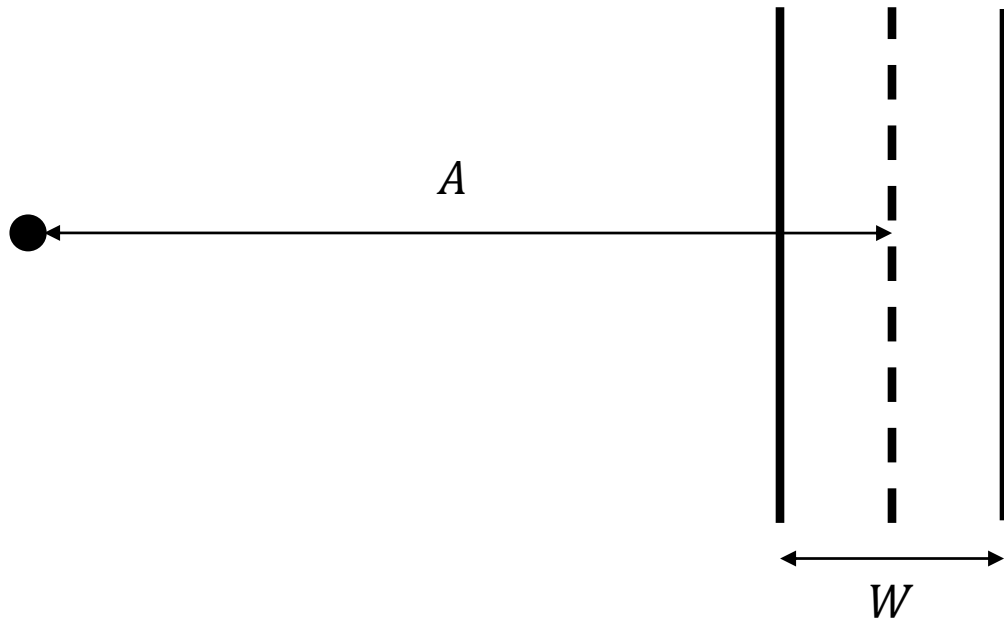
Fig. 1: Snapshots of different hand motion patterns as captured in our plausibility study. In comparison to (a), the participant in (b) holds the remote with different orientation, and the participant in (c) leans his arm on the sofa, which stabilizes his movements.



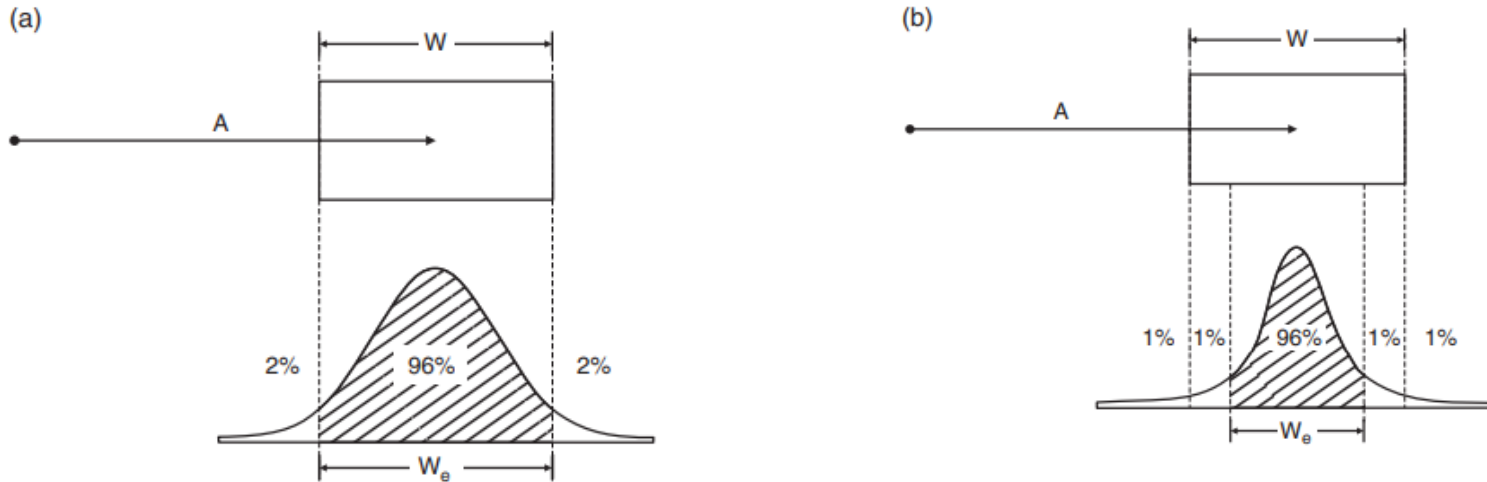
Fitts' Law: $T = a + b \log_2 \left(\frac{A}{W} + 1 \right)$



Fitts' Law: $T = a + b \log_2 \left(\frac{A}{W} + 1 \right)$



Effective Width of Fitts' Law



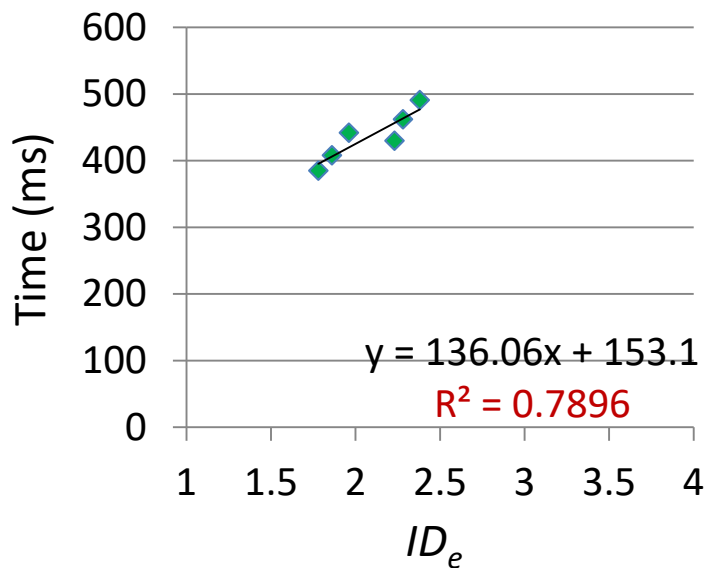
$$T = a + b \log_2 \left(\frac{A}{W_e} + 1 \right)$$

$$W_e = \sqrt{2\pi e} \sigma$$

Fitts' Law for Finger Touch



Fitts' Law for Finger Touch



FFitts Law

$$T = a + b \log_2 \left(\frac{A}{\sqrt{2\pi e(\sigma^2 - \sigma_a^2)}} + 1 \right)$$

Xiaojun Bi, Yang Li, Shumin Zhai (2013) "FFitts Law: Modeling Finger Touch with Fitts' Law". In *Proceedings of CHI 2013 - the SIGCHI Conference on Human Factors in Computing Systems*. 1363-1372

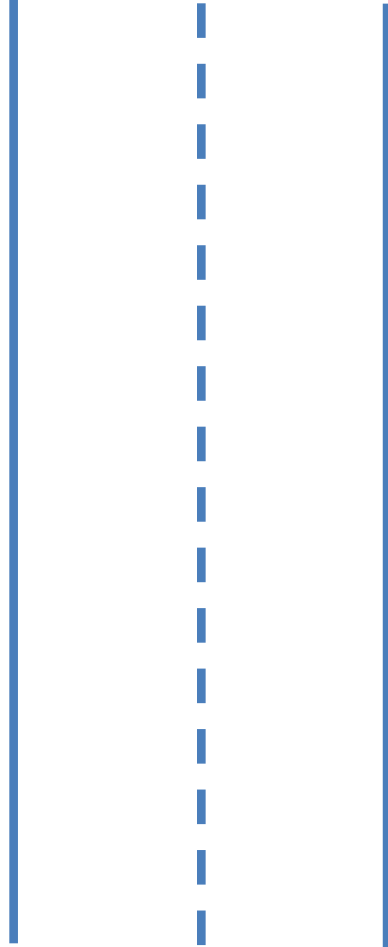
FFitts Law

$$T = a + b \log_2 \left(\frac{A}{\sqrt{2\pi e(\sigma^2 - \sigma_a^2)}} + 1 \right)$$

Standard deviation
of touch points

Absolute precision
of input finger

Target



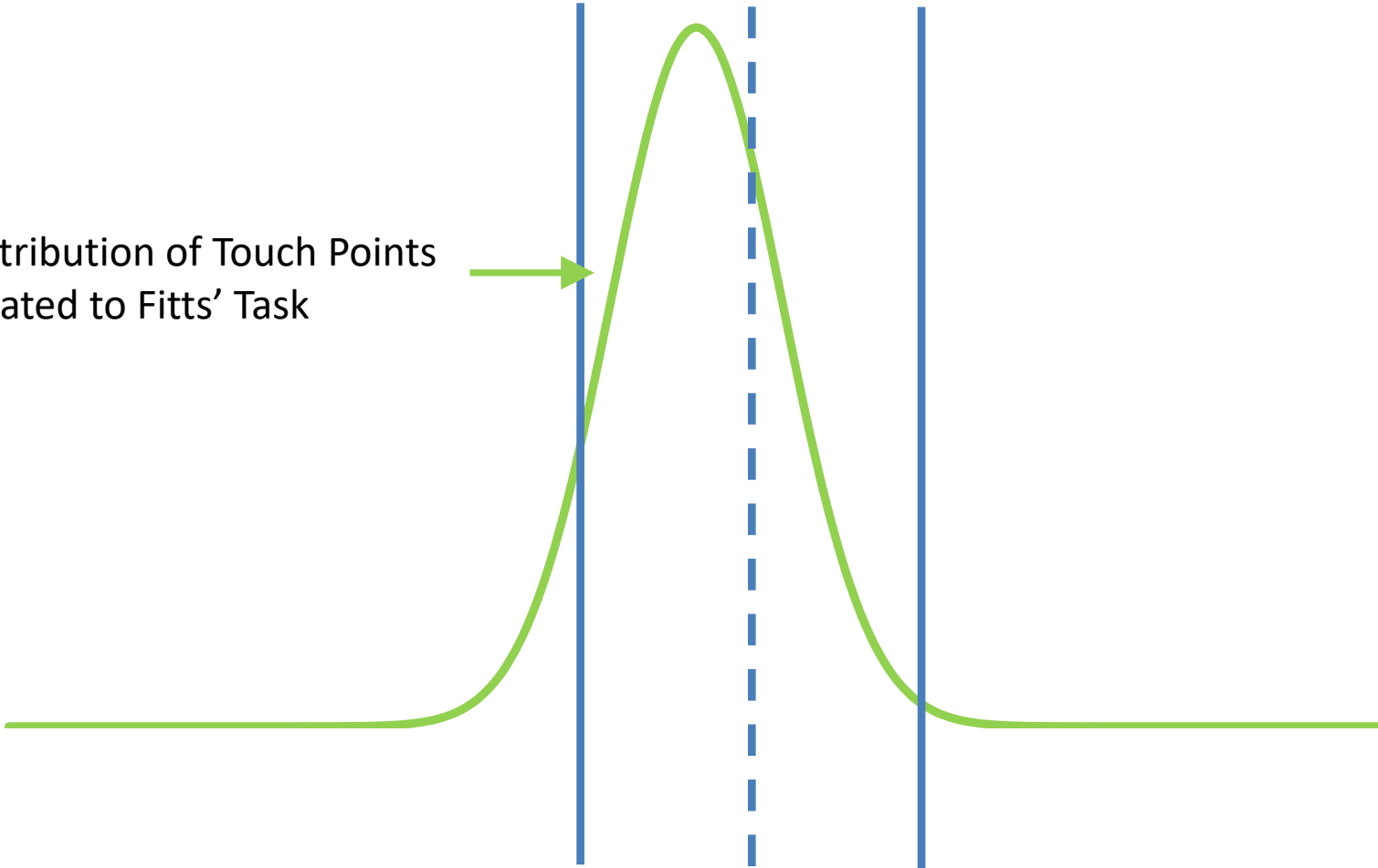
$$X_r \sim N(\mu_r, \sigma_r^2)$$

—

Target



Distribution of Touch Points
Related to Fitts' Task



$$X_r \sim N(\mu_r, \sigma_r^2)$$

$$X_a \sim N(\mu_a, \sigma_a^2)$$

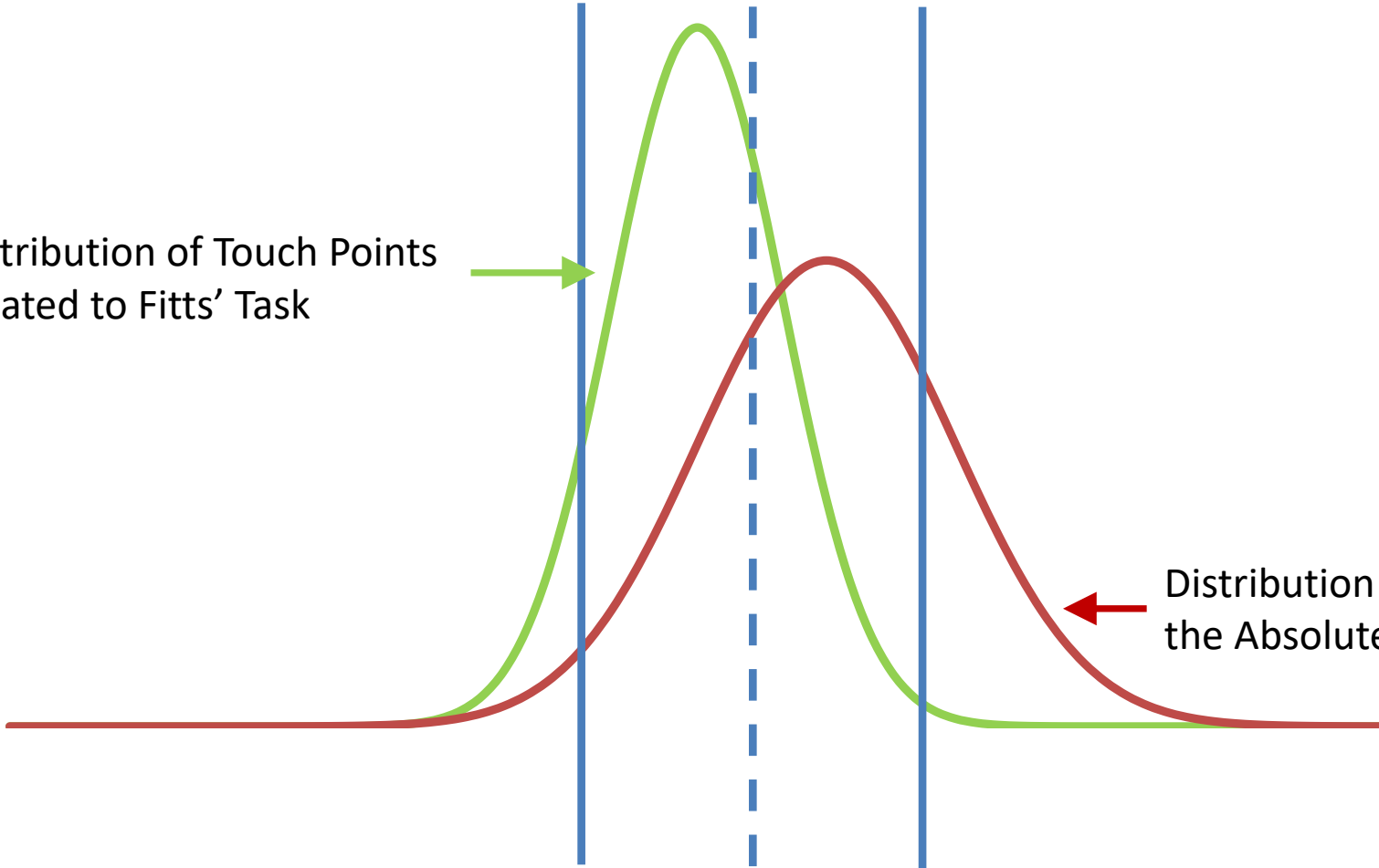


Target



Distribution of Touch Points
Related to Fitts' Task

Distribution Reflecting
the Absolute Finger Precision



$$X_r \sim N(\mu_r, \sigma_r^2)$$

$$X_a \sim N(\mu_a, \sigma_a^2)$$

$$X \sim N(\mu, \sigma^2)$$



Target

$$X = X_r + X_a$$

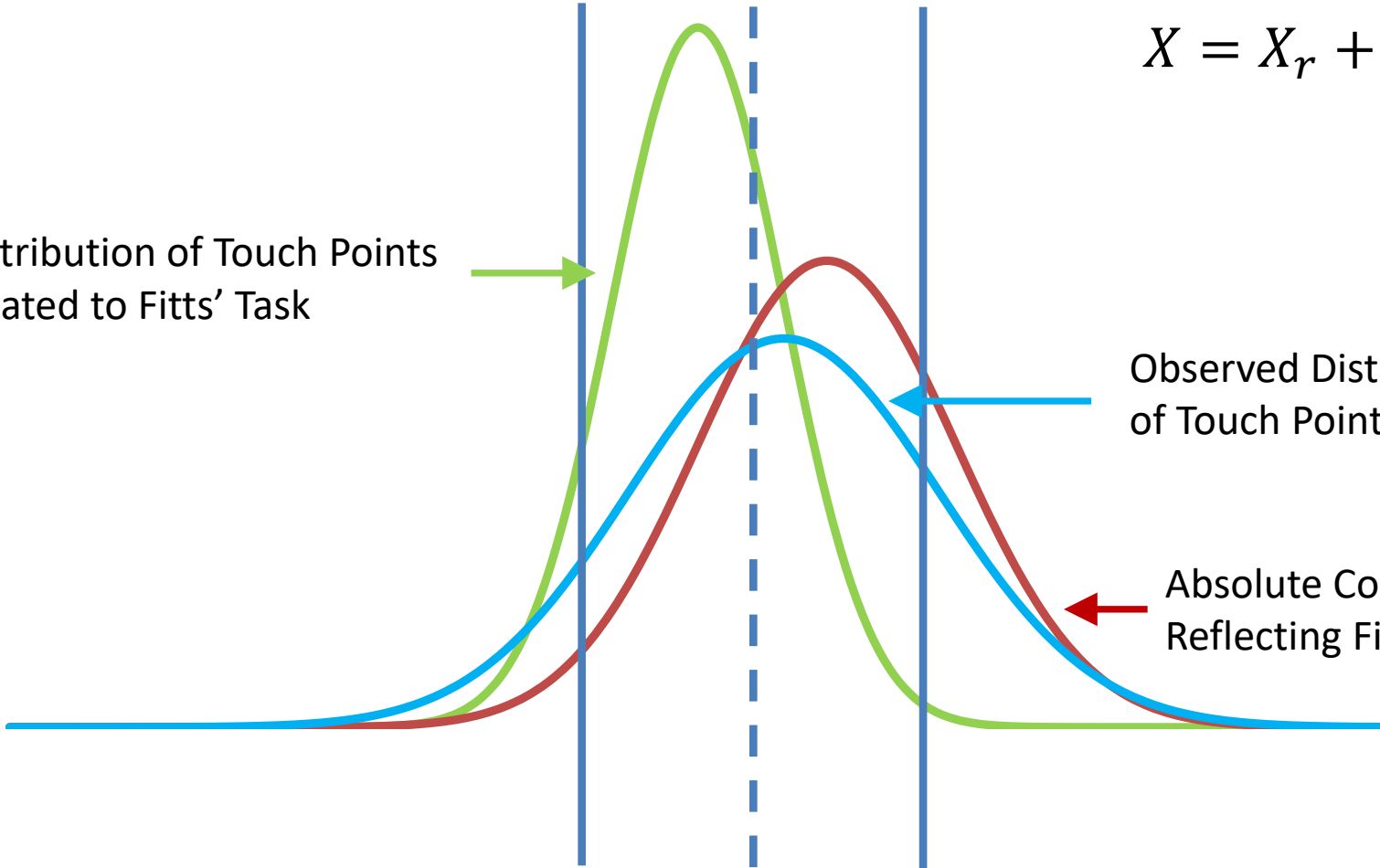
Distribution of Touch Points
Related to Fitts' Task



Observed Distribution
of Touch Points



Absolute Component
Reflecting Finger Precision



$$X_r \sim N(\mu_r, \sigma_r^2)$$

$$X_a \sim N(\mu_a, \sigma_a^2)$$

$$X \sim N(\mu, \sigma^2)$$



Target

$$X = X_r + X_a$$

$$\mu = \mu_r + \mu_a$$

$$\sigma^2 = \sigma_r^2 + \sigma_a^2$$

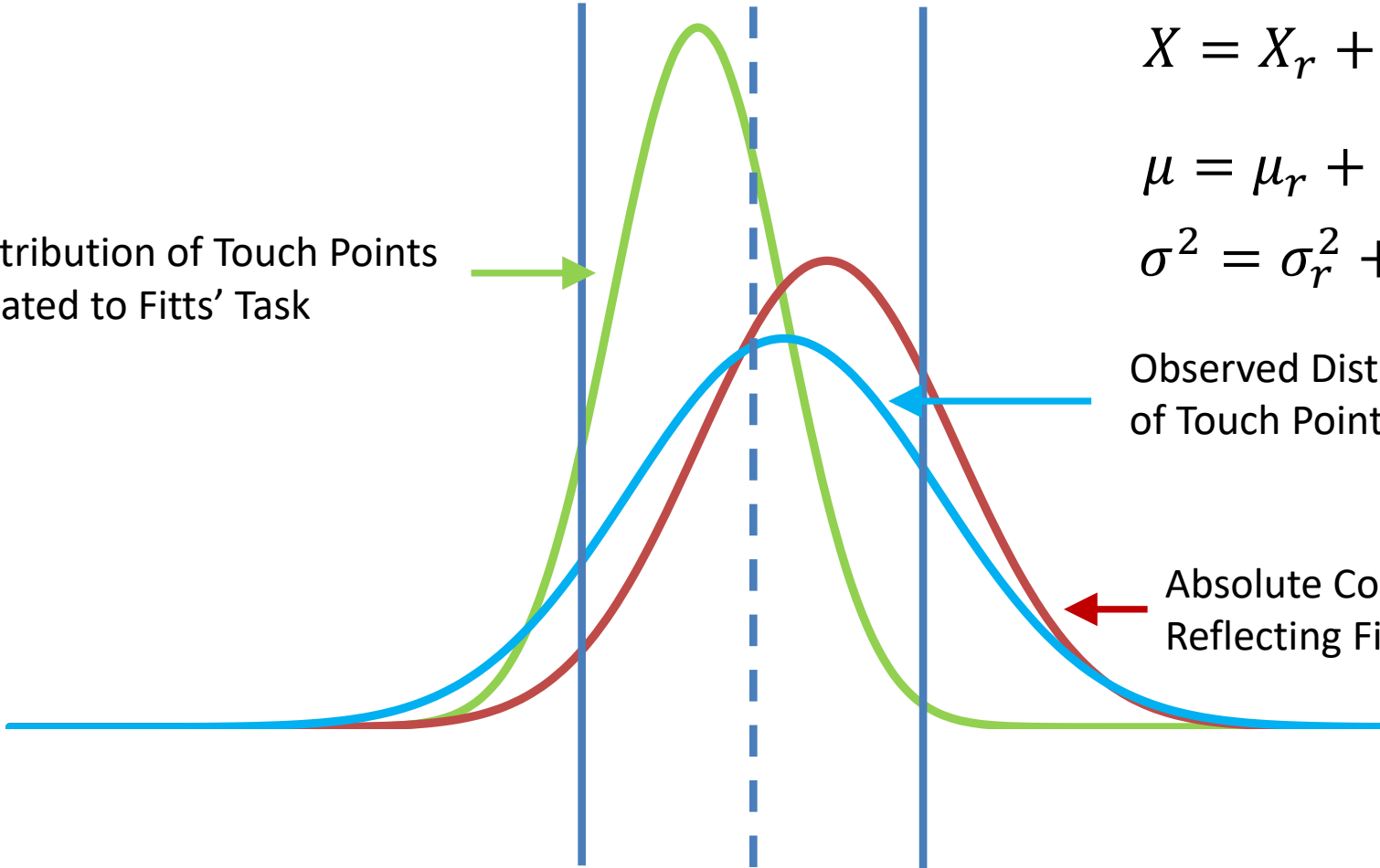
Distribution of Touch Points
Related to Fitts' Task



Observed Distribution
of Touch Points



Absolute Component
Reflecting Finger Precision



$$X_r \sim N(\mu_r, \sigma_r^2)$$

$$X_a \sim N(\mu_a, \sigma_a^2)$$

$$X \sim N(\mu, \sigma^2)$$



Target

$$X = X_r + X_a$$

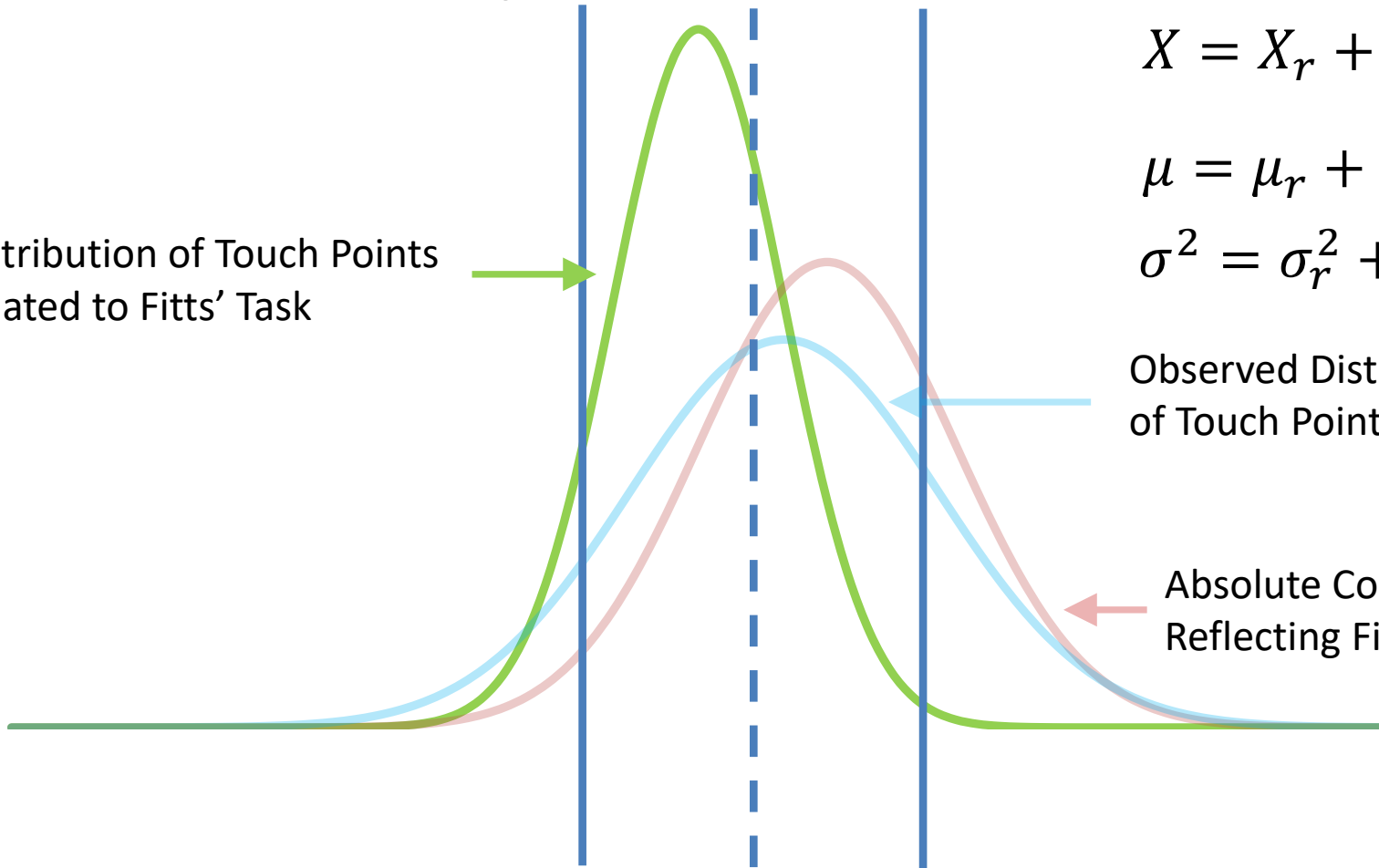
$$\mu = \mu_r + \mu_a$$

$$\sigma^2 = \sigma_r^2 + \sigma_a^2$$

Observed Distribution
of Touch Points

Absolute Component
Reflecting Finger Precision

Distribution of Touch Points
Related to Fitts' Task



Deriving FFitts Law

Deriving FFitts Law

$$T = a + b \log_2 \left(\frac{A}{\sqrt{2\pi e} \sigma_r} + 1 \right) \quad \text{Eq. 1}$$

Deriving FFitts Law

$$T = a + b \log_2 \left(\frac{A}{\sqrt{2\pi e} \sigma_r} + 1 \right) \quad \text{Eq. 1}$$

$$\sigma^2 = \sigma_r^2 + \sigma_a^2 \quad \text{Eq. 2}$$

Deriving FFitts Law

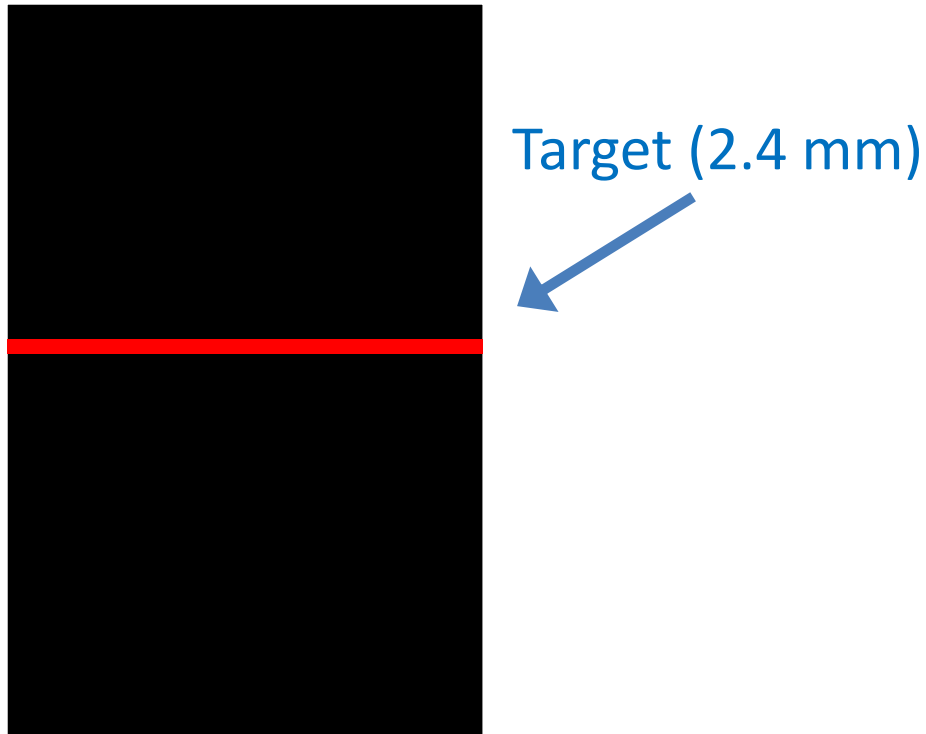
$$T = a + b \log_2 \left(\frac{A}{\sqrt{2\pi e} \sigma_r} + 1 \right) \quad \text{Eq. 1}$$

$$\sigma^2 = \sigma_r^2 + \sigma_a^2 \quad \text{Eq. 2}$$

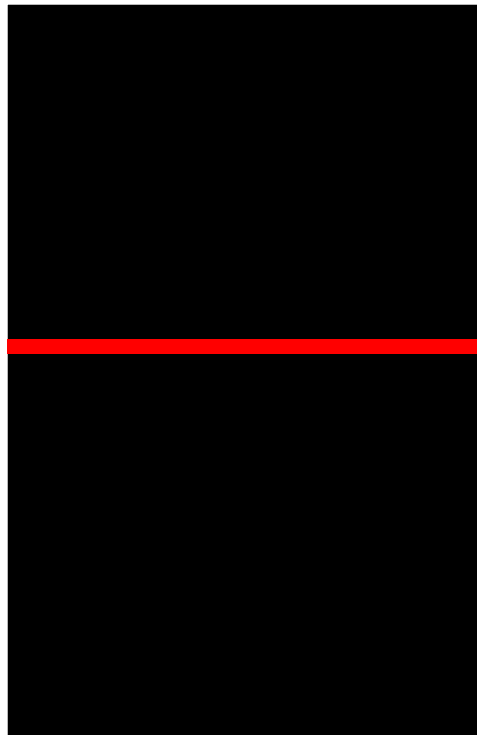


$$T = a + b \log_2 \left(\frac{A}{\sqrt{2\pi e (\sigma^2 - \sigma_a^2)}} + 1 \right)$$

Computing σ_a via Calibration Expt.



Computing σ_a via Calibration Expt.

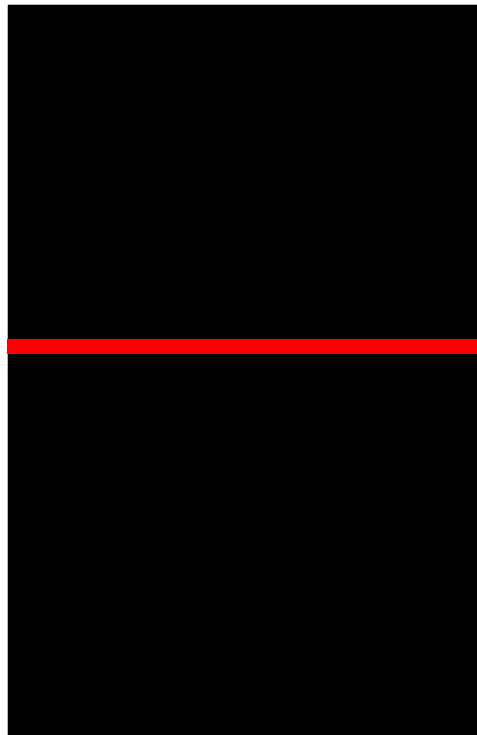


Target (2.4 mm)



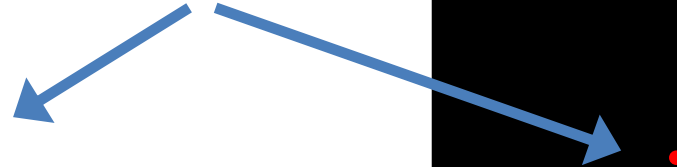
$\sigma_a = 0.94$ mm (1D)

Computing σ_a via Calibration Expt.



$\sigma_a = 0.94$ mm (1D)

Target (2.4 mm)



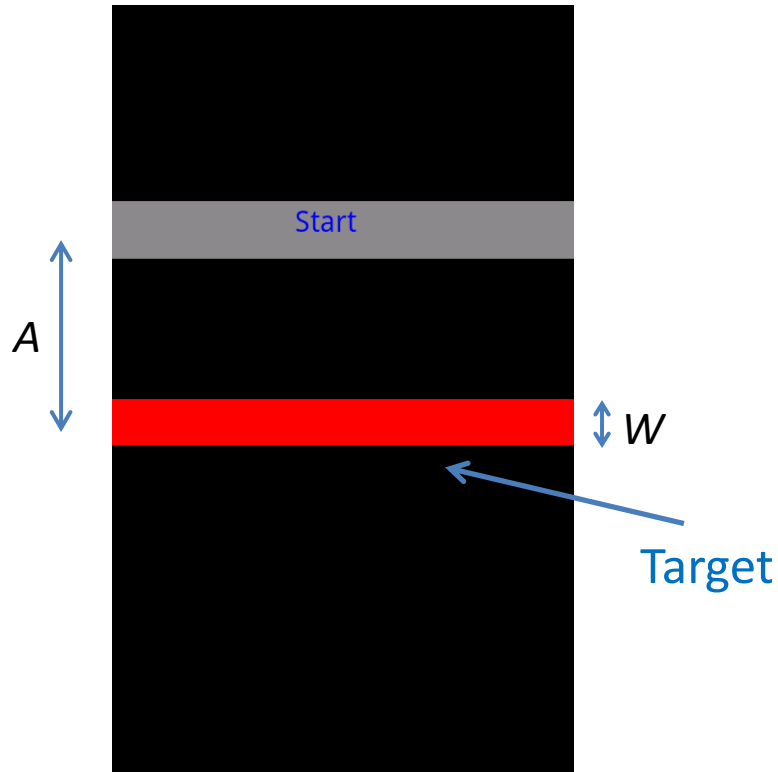
$\sigma_a = 1.5$ mm (2D)

FFitts Law

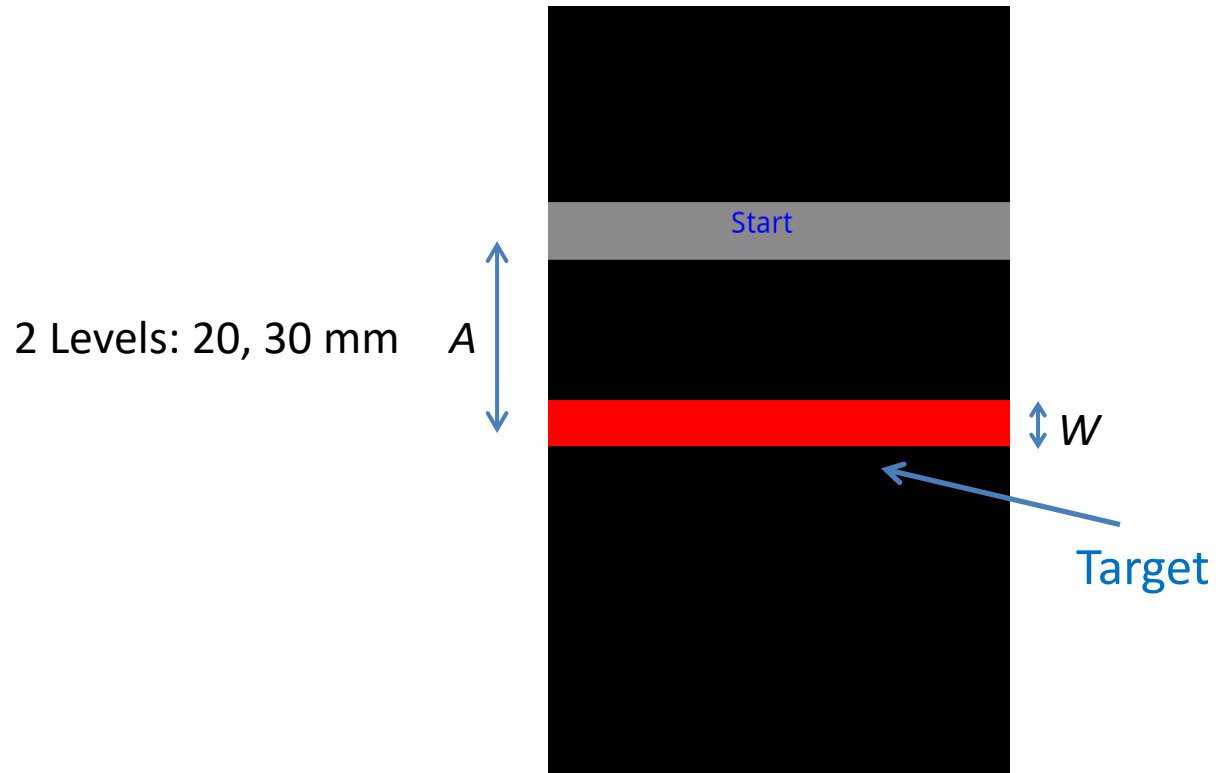
$$T = a + b \log_2 \left(\frac{A}{\sqrt{2\pi e(\sigma^2 - \sigma_a^2)}} + 1 \right)$$

Index Finger: $\sigma_a = 0.94$ mm (1D) , $\sigma_a = 1.5$ mm (2D)

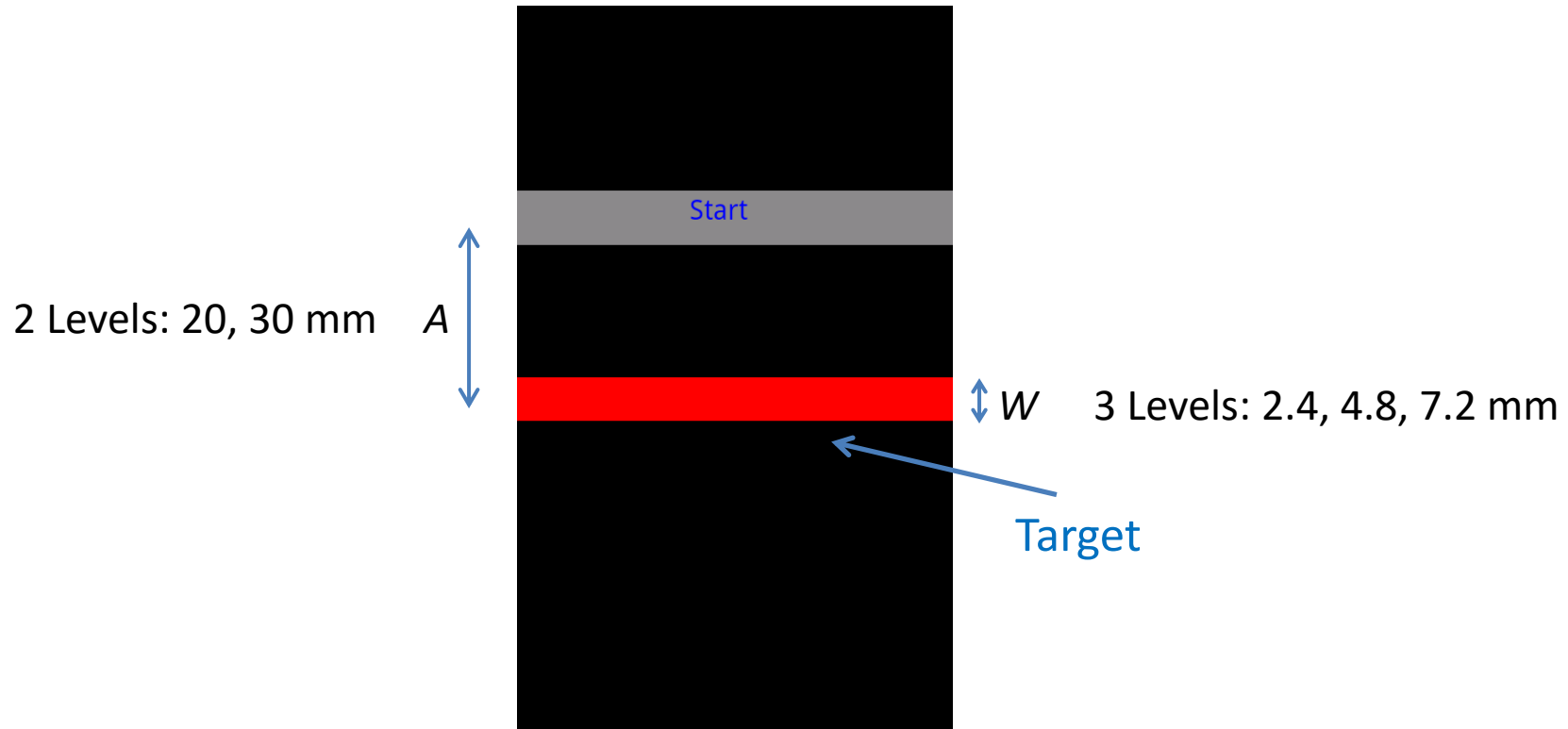
Expt 1. 1D Fitts' Tasks



Expt 1. 1D Fitts' Tasks

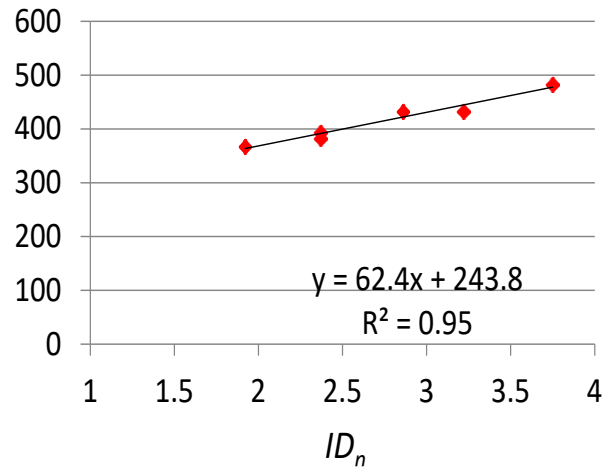


Expt 1. 1D Fitts' Tasks

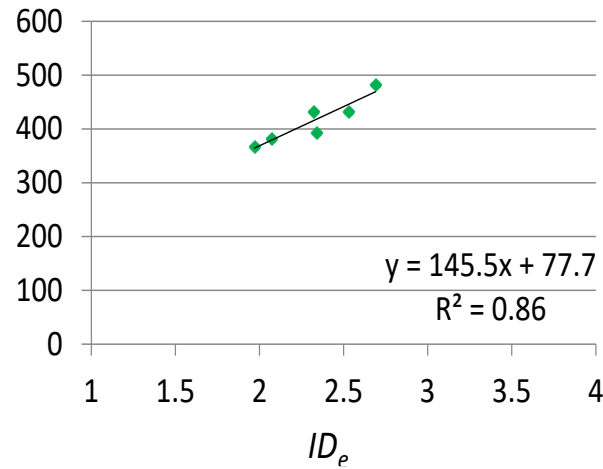


Expt 1. 1D Fitts' Tasks

Mean Completion Time (ms)



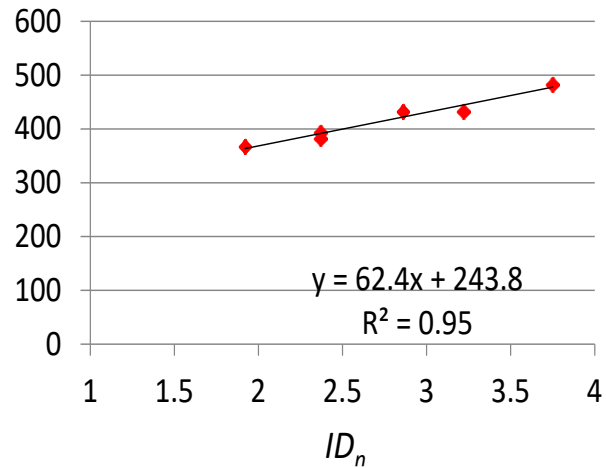
$$ID_n = \log_2 \left(\frac{A}{W} + 1 \right)$$



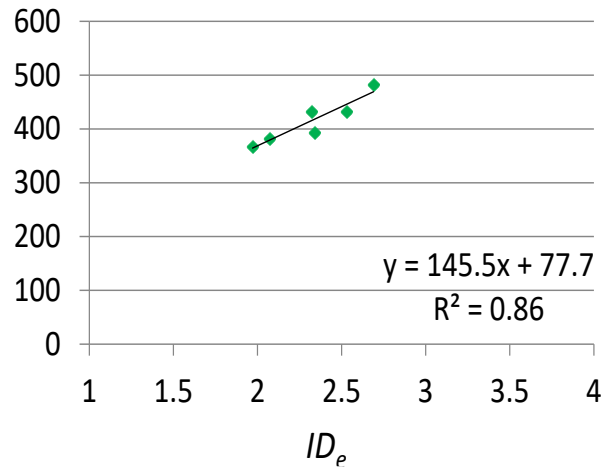
$$ID_e = \log_2 \left(\frac{A}{\sqrt{2\pi e} \sigma} + 1 \right)$$

Expt 1. 1D Fitts' Tasks

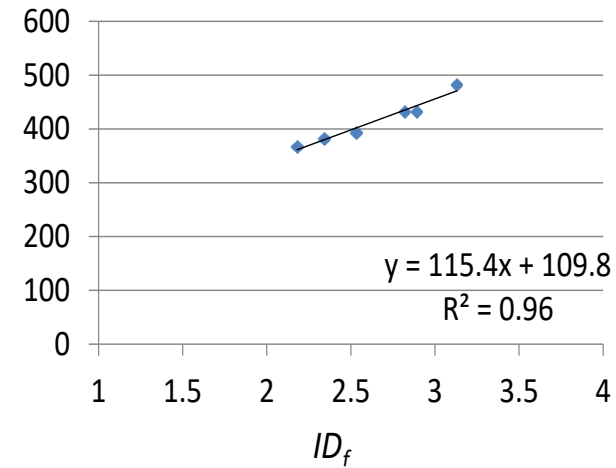
Mean Completion Time (ms)



$$ID_n = \log_2 \left(\frac{A}{W} + 1 \right)$$

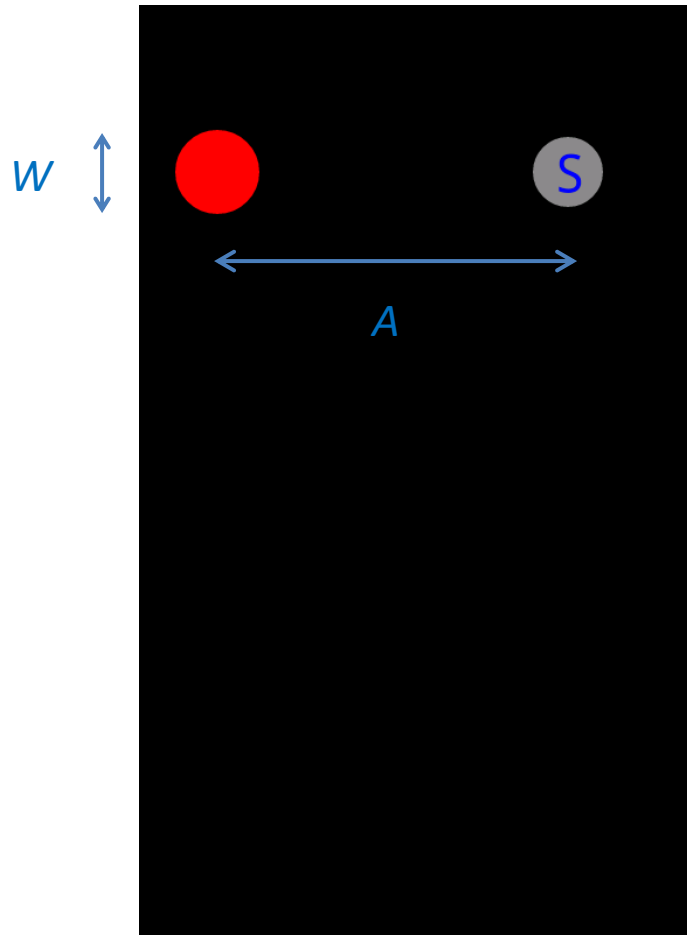


$$ID_e = \log_2 \left(\frac{A}{\sqrt{2\pi e} \sigma} + 1 \right)$$



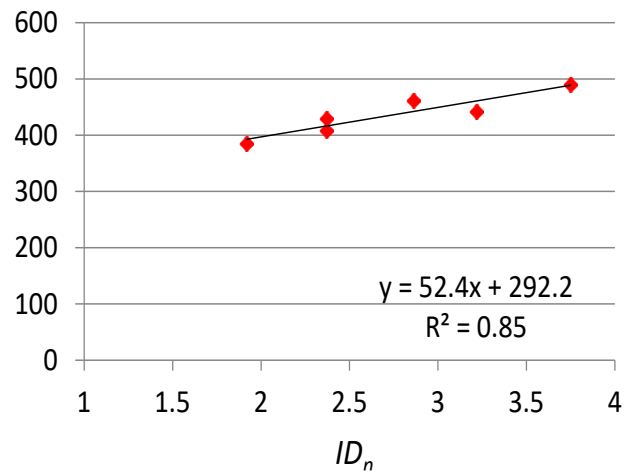
$$ID_f = \log_2 \left(\frac{A}{\sqrt{2\pi e}(\sigma^2 - \sigma_a^2)} + 1 \right)$$

Expt 2. 2D Fitts' Law

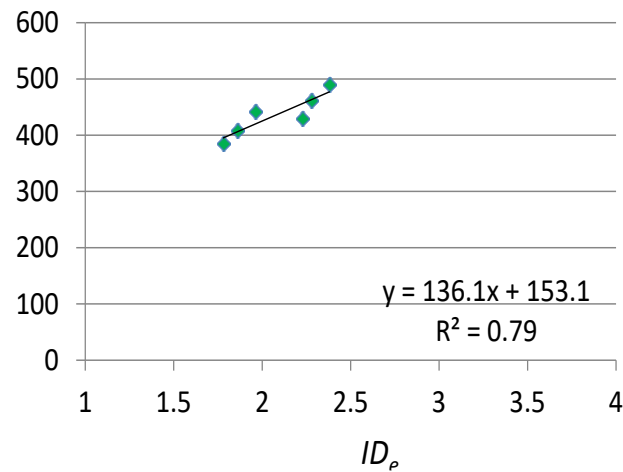


Expt 2. 2D Fitts' Law

Mean Completion Time (ms)



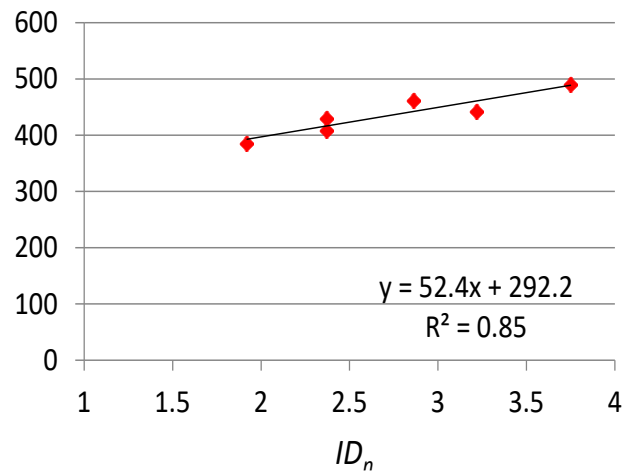
$$ID_n = \log_2 \left(\frac{A}{W} + 1 \right)$$



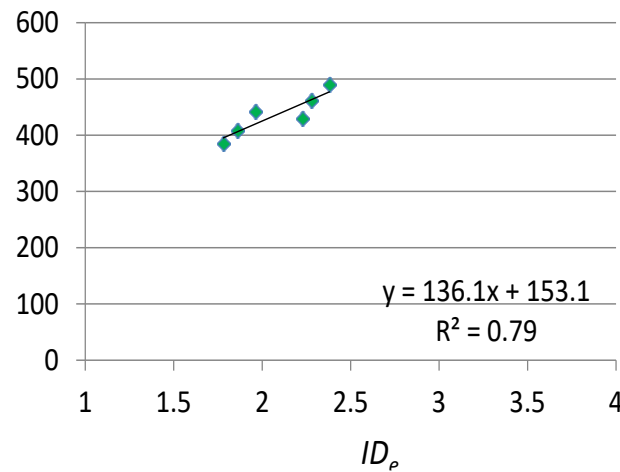
$$ID_e = \log_2 \left(\frac{A}{\sqrt{2\pi e} \sigma} + 1 \right)$$

Expt 2. 2D Fitts' Law

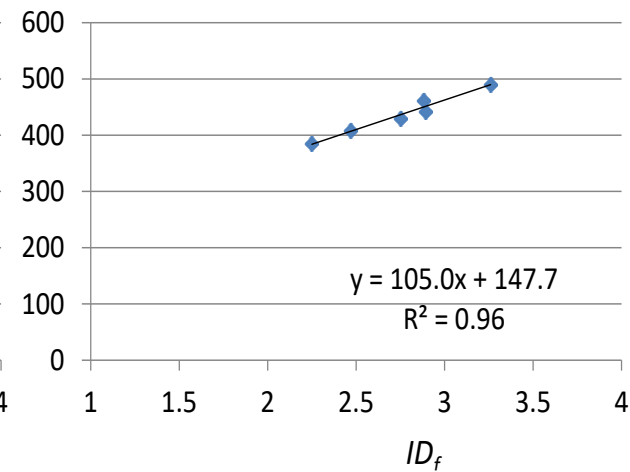
Mean Completion Time (ms)



$$ID_n = \log_2 \left(\frac{A}{W} + 1 \right)$$

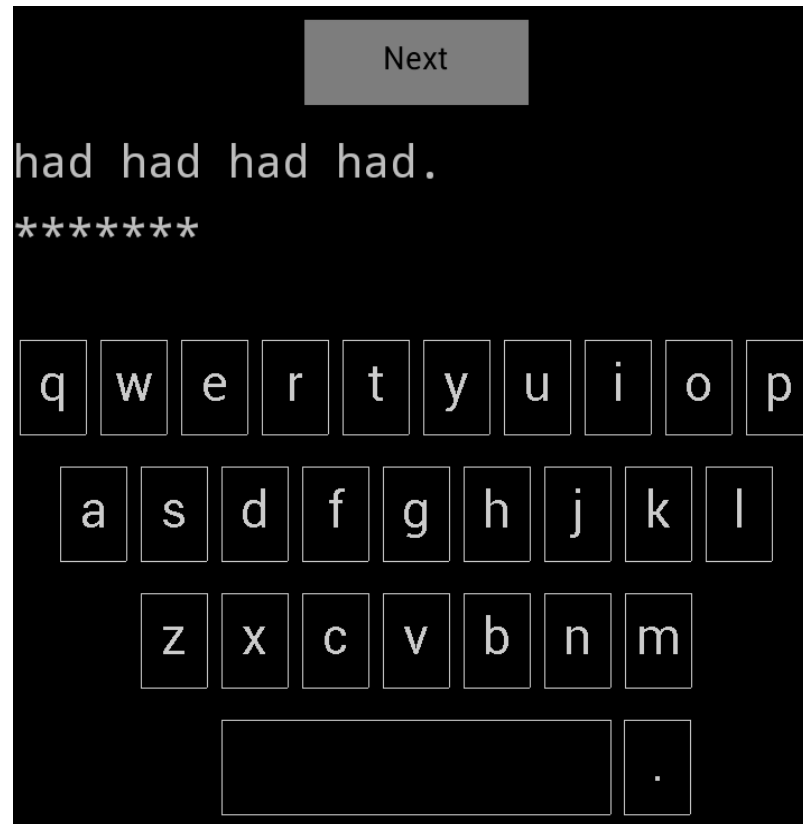


$$ID_e = \log_2 \left(\frac{A}{\sqrt{2\pi e} \sigma} + 1 \right)$$



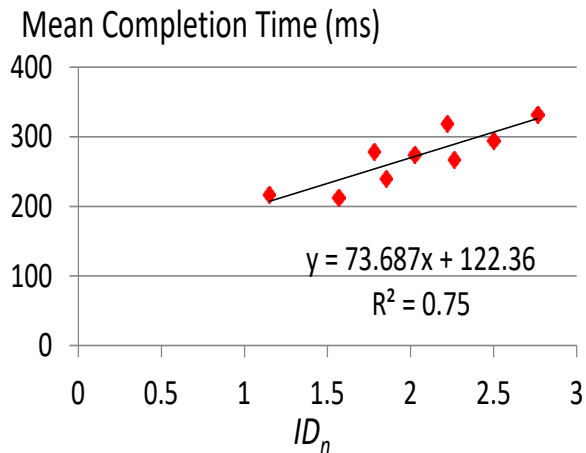
$$ID_f = \log_2 \left(\frac{A}{\sqrt{2\pi e}(\sigma^2 - \sigma_a^2)} + 1 \right)$$

Expt 3. FFitts Model in Text Input

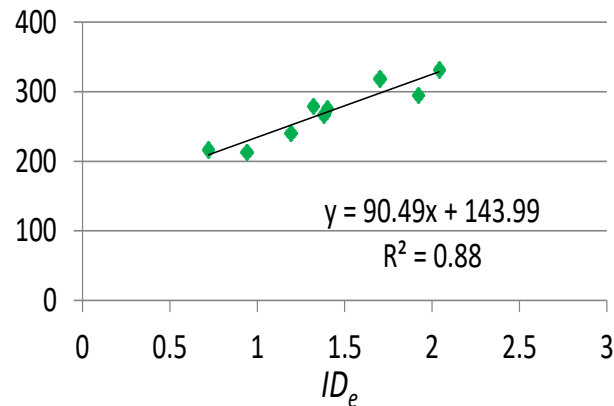


Expt 3. Text Entry Study

Text Entry Study



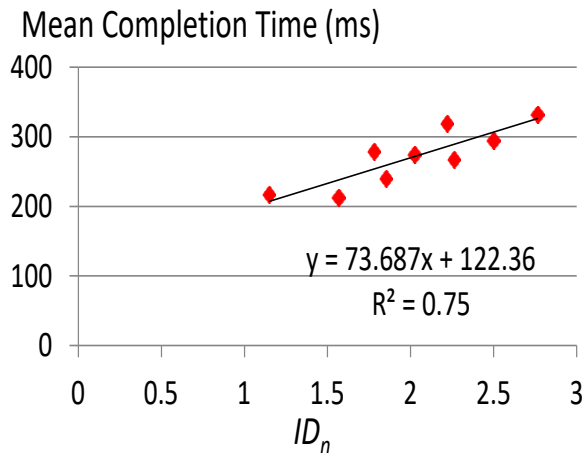
$$ID_n = \log_2 \left(\frac{A}{W} + 1 \right)$$



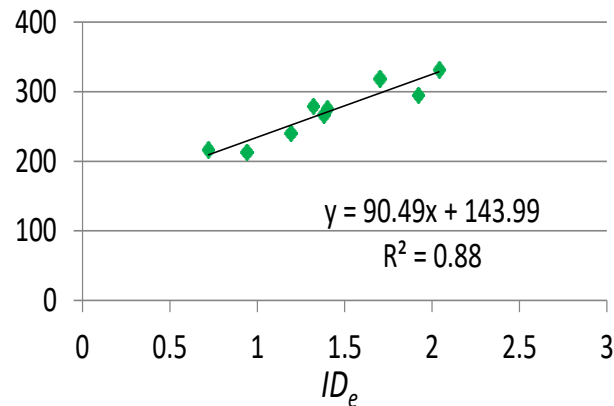
$$ID_e = \log_2 \left(\frac{A}{\sqrt{2\pi e \sigma}} + 1 \right)$$

Expt 3. Text Entry Study

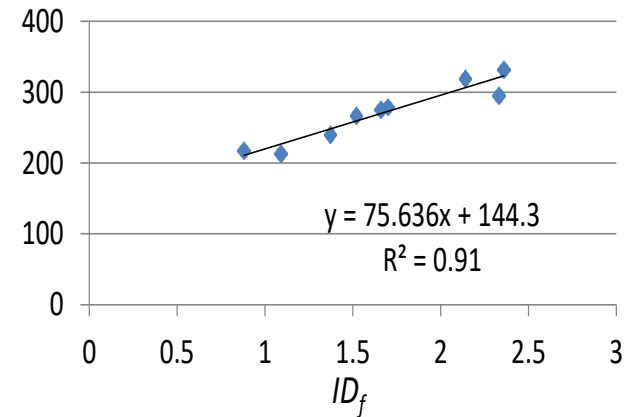
Text Entry Study



$$ID_n = \log_2 \left(\frac{A}{W} + 1 \right)$$



$$ID_e = \log_2 \left(\frac{A}{\sqrt{2\pi e} \sigma} + 1 \right)$$



$$ID_f = \log_2 \left(\frac{A}{\sqrt{2\pi e}(\sigma^2 - \sigma_a^2)} + 1 \right)$$

FFitts Law

$$T = a + b \log_2 \left(\frac{A}{\sqrt{2\pi e(\sigma^2 - \sigma_a^2)}} + 1 \right)$$

σ : the standard deviation of touch points

σ_a : the absolute precision of the input finger

Index Finger: $\sigma_a = 0.94$ mm (1D), $\sigma_a = 1.5$ mm (2D)