An EEG-based Approach for Evaluating Graphic Icons from the Perspective of Semantic Distance

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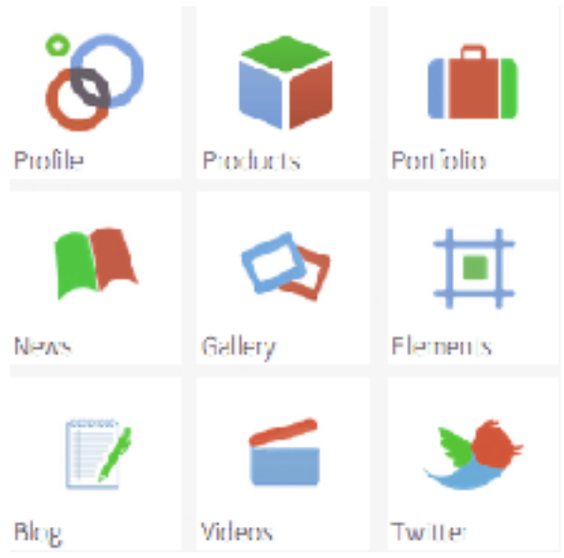
Physical

Digital

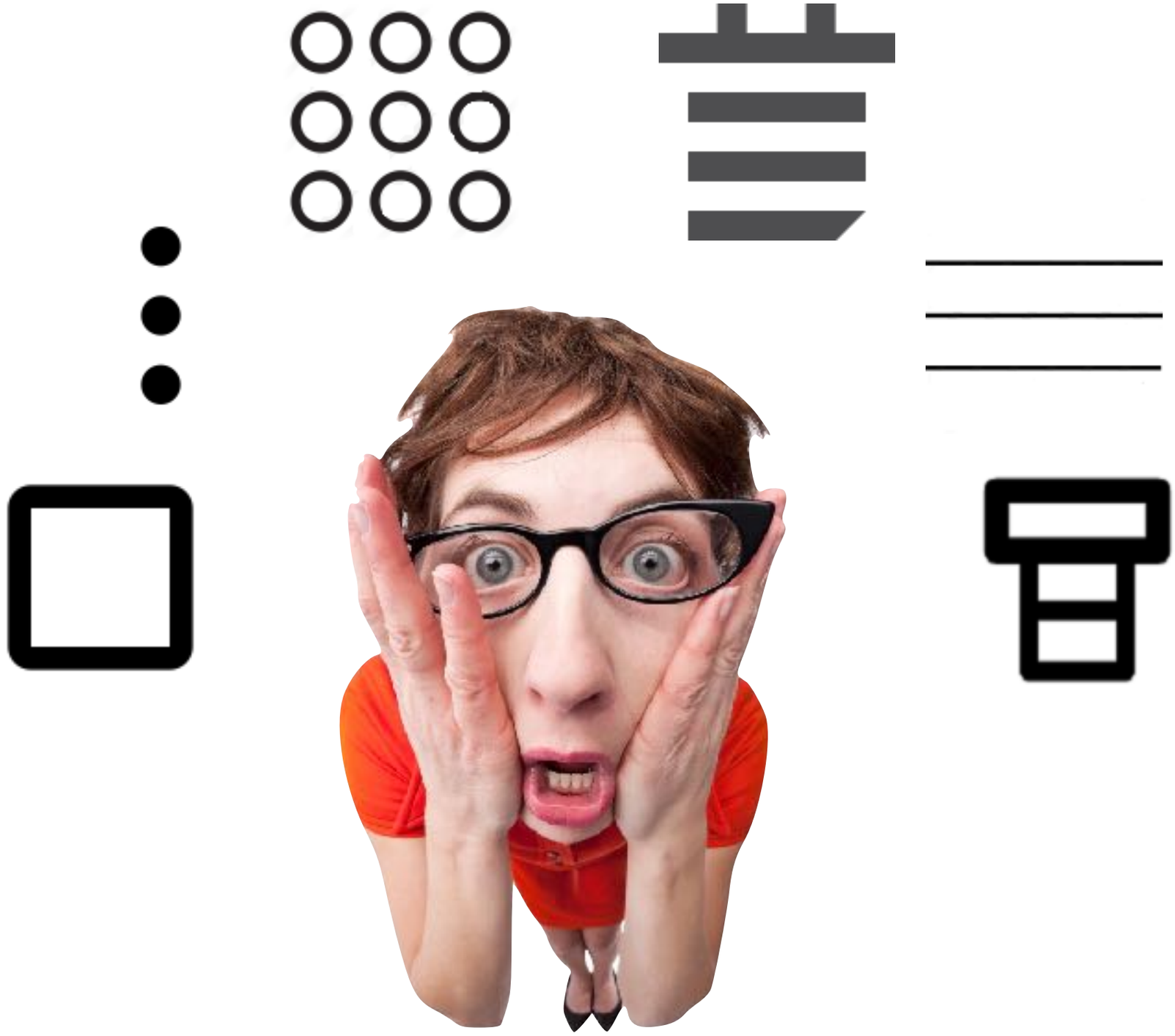
Graphic icons for interface Design

vs.



Improve Scannability

Universal



How to **evaluate** the effectiveness of icons?

Function ..... **Icon**

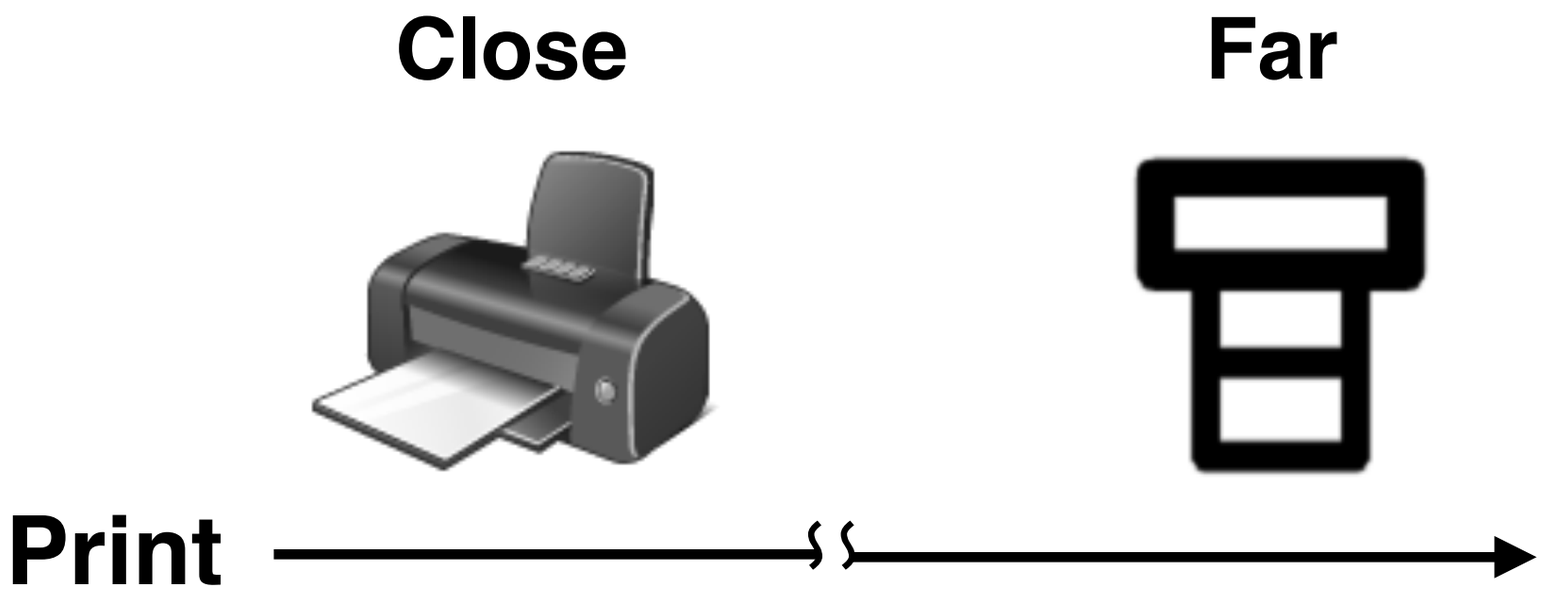
Semantic Distance

Close

Far

Print

Semantic Distance



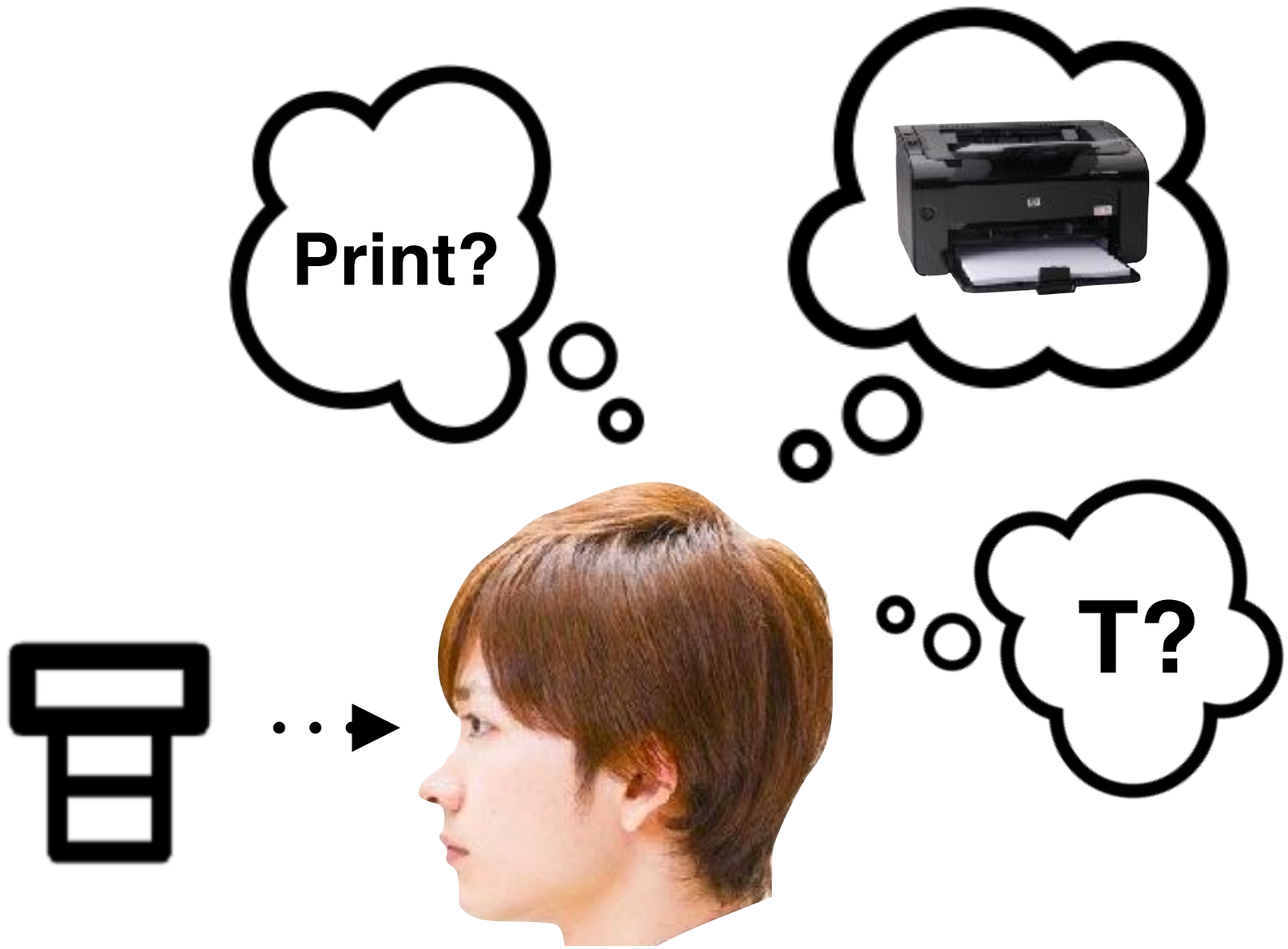
Semantic Distance

Effectiveness of **conveying information**

Key indication of good icons

Measured by **behavior** and **self-report** methods

[cf. Setlur et al., 2014; Warnock et al., 2013]



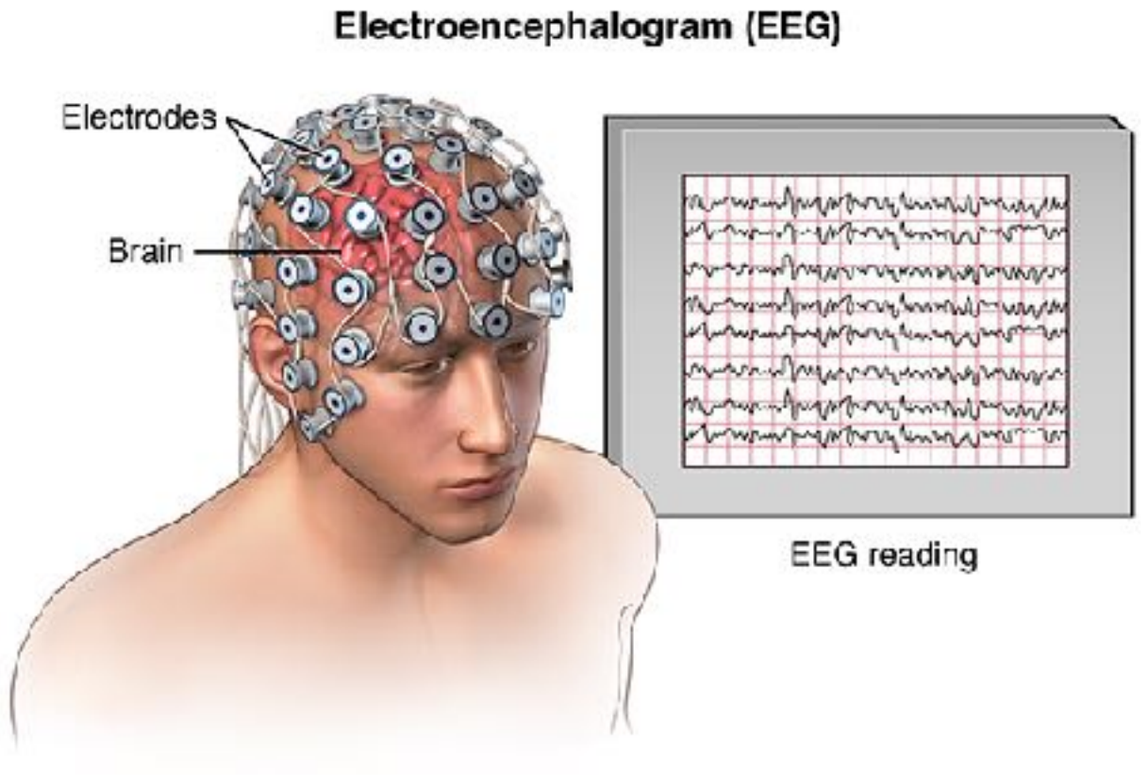
Complicated cognitive states and difficult to determine semantic distance by behavioral measures alone.

[cf. Huang et al., 2015]

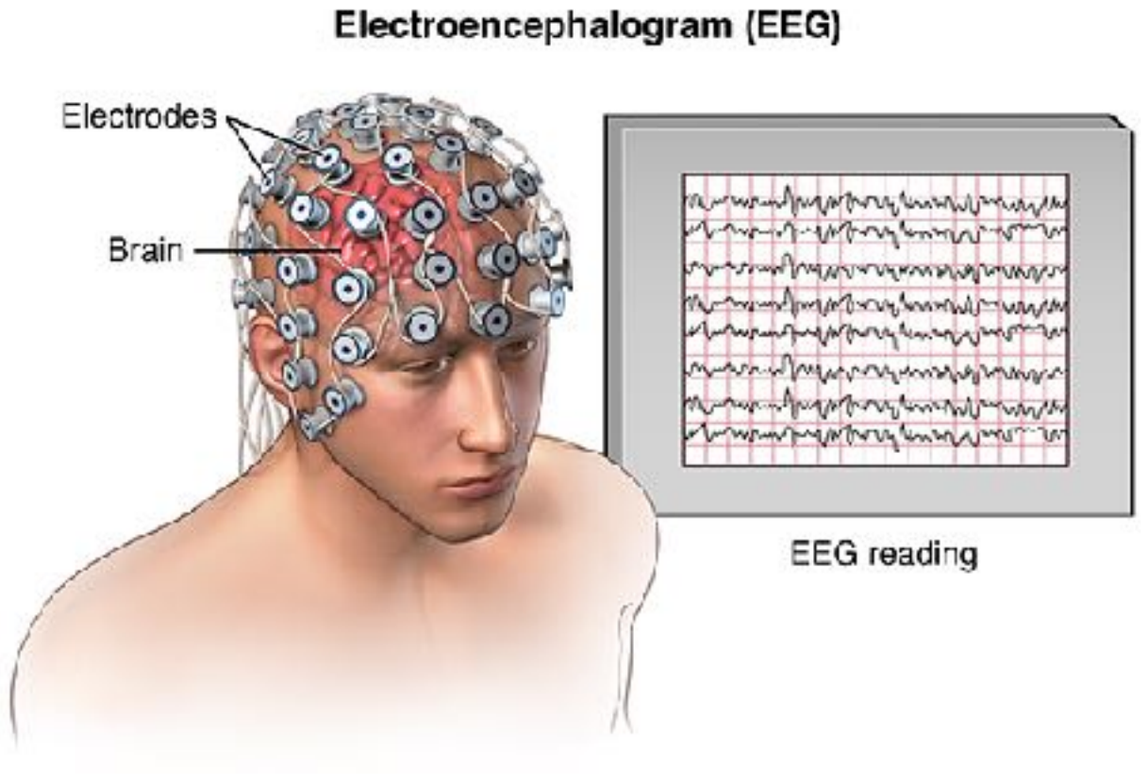
Use **physiological** indicators to measure and analyze cognitive states

Complicated cognitive states and difficult to determine semantic distance by behavioral measures alone.

[cf. Huang et al., 2015]



Electroencephalography (EEG) based method

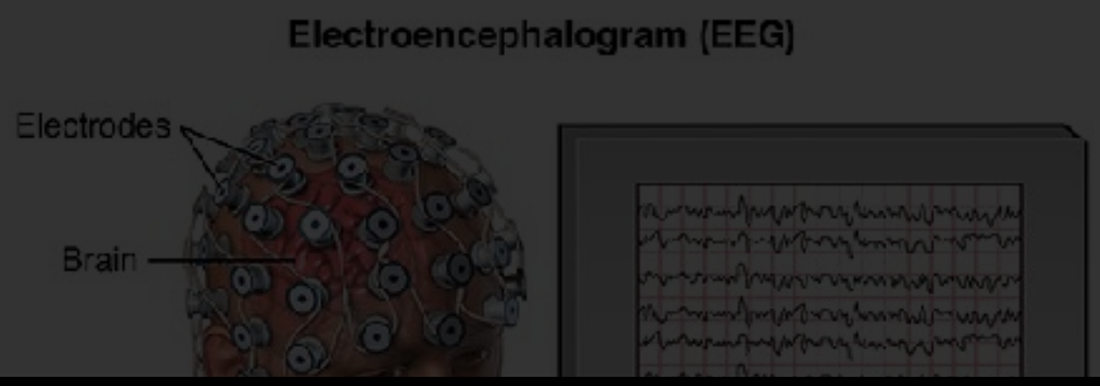


Electroencephalography (EEG) based method

Directly related to cognitive events and states

Used in evaluation and usability testing.

[cf. Chi et al., 2014; Lee et al., 2014]



EEG-based method is a potentially powerful tool for evaluating icons.

Directly related to cognitive events and states

Used in evaluation and usability testing.

[cf. Chi et al., 2014; Lee et al., 2014]

Research Goal

Propose **EEG**-based method to evaluate human **perception of icons**, focus on how users perceive semantic distance of icons.

Research Question #1

How users perceive **semantic distance** between icon and function?

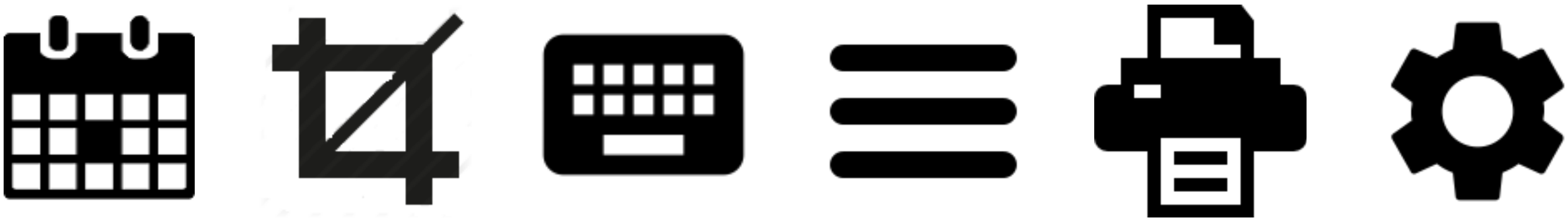
Research Question #2

How do semantic distance of icons affect users in **different scenarios**?

Collection of Icons

6 functions: Calendar, Crop, Keyboard, Menu, Print, Setting

70 icons in gray tone



[cf. ICONFINDER; FLATICON; Google Images]

Classify Semantic Distance

Not Closely Related ○ ○ ● ○ ○ Very Strongly Related

[cf. Isherwood et al., 2007; Mcdougall et al., 1999]

50 participants (24 females)

Close icons

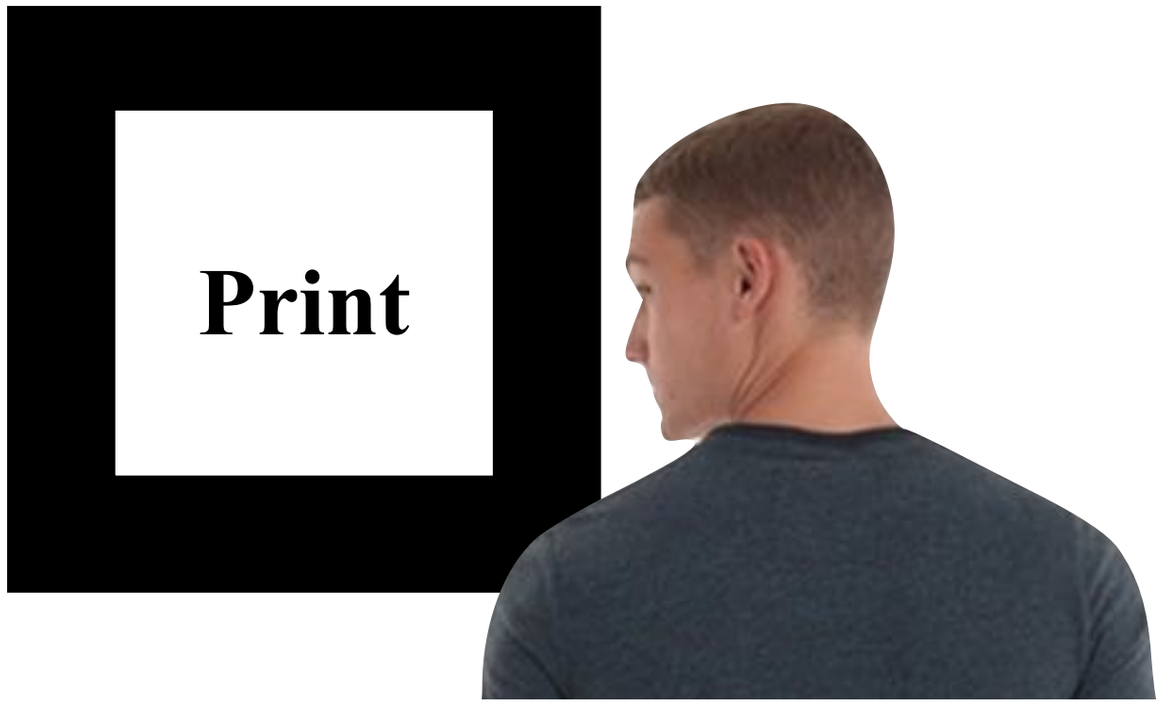
Far icons

Experiment 1

Function-icon matching

19 participants (11 males), mean age: 21.11

Function Name



Experiment 1 I Design

Icon

Match/Mismatch?

Experiment 1 I Design

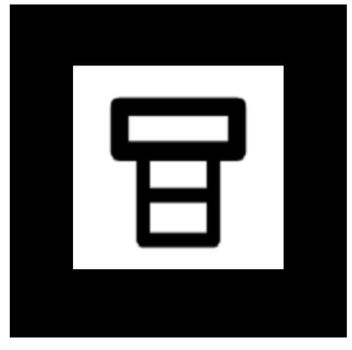
Icon

Match/Mismatch?

Factors:

Mismatch

Match



Close Far

Semantic Distance

Experiment 1 I Design

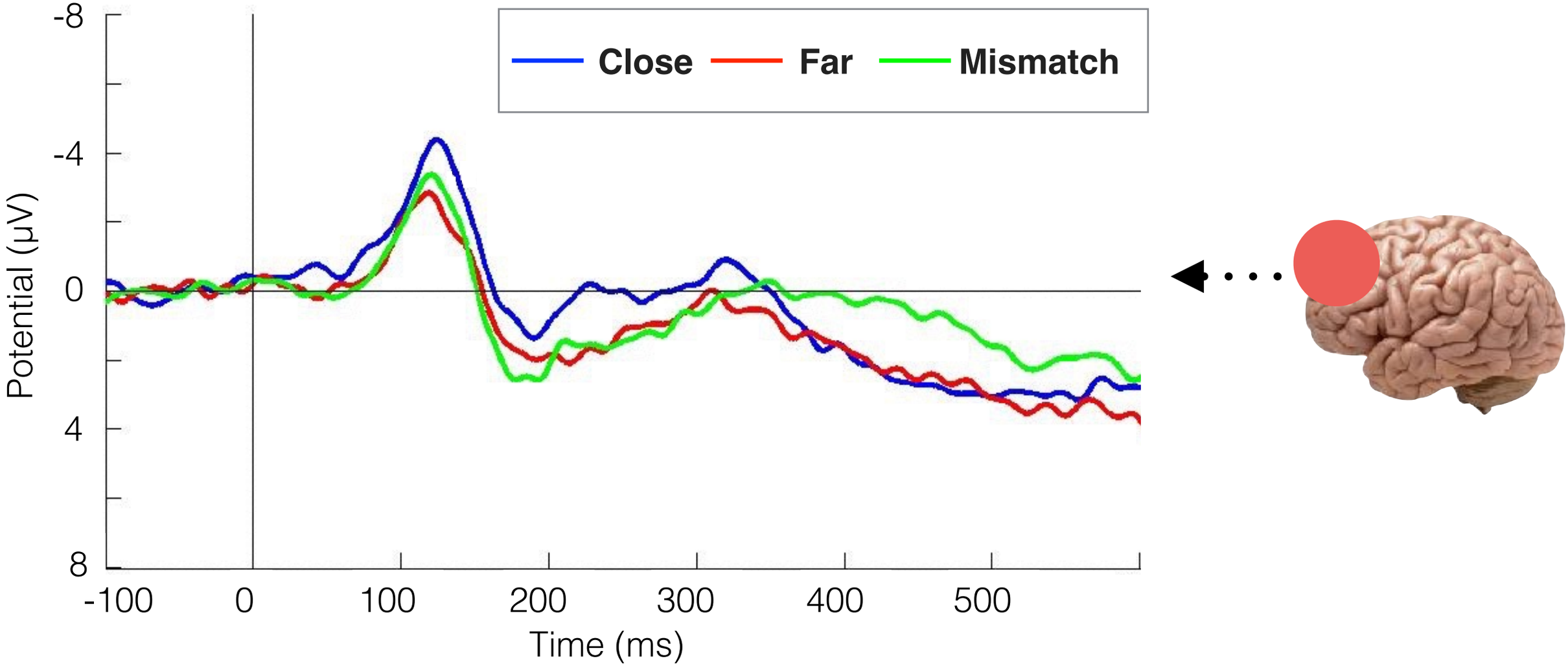
Measures:

Reaction time

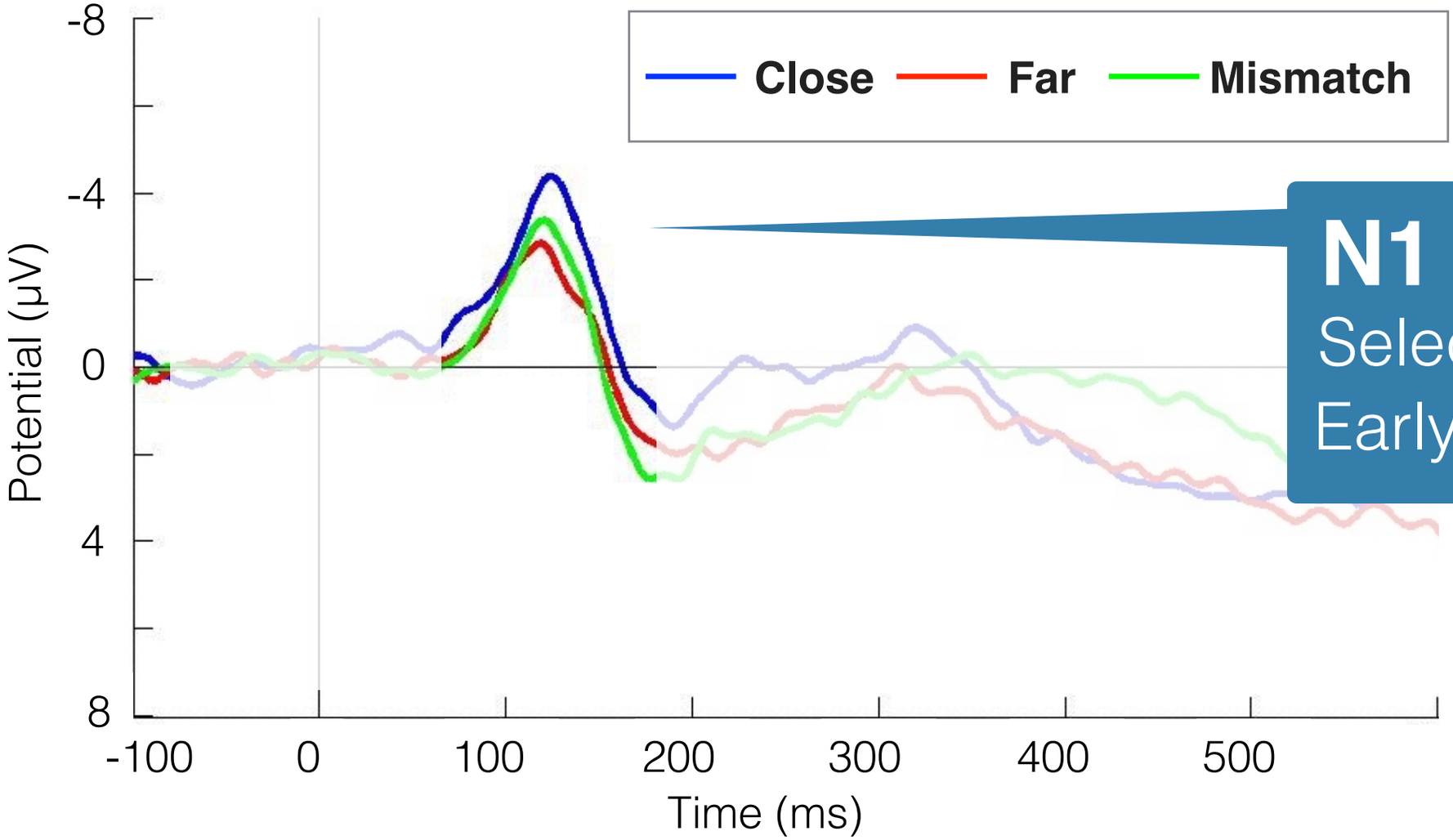
Error Rate

EEG Signal

Experiment 1 I Result

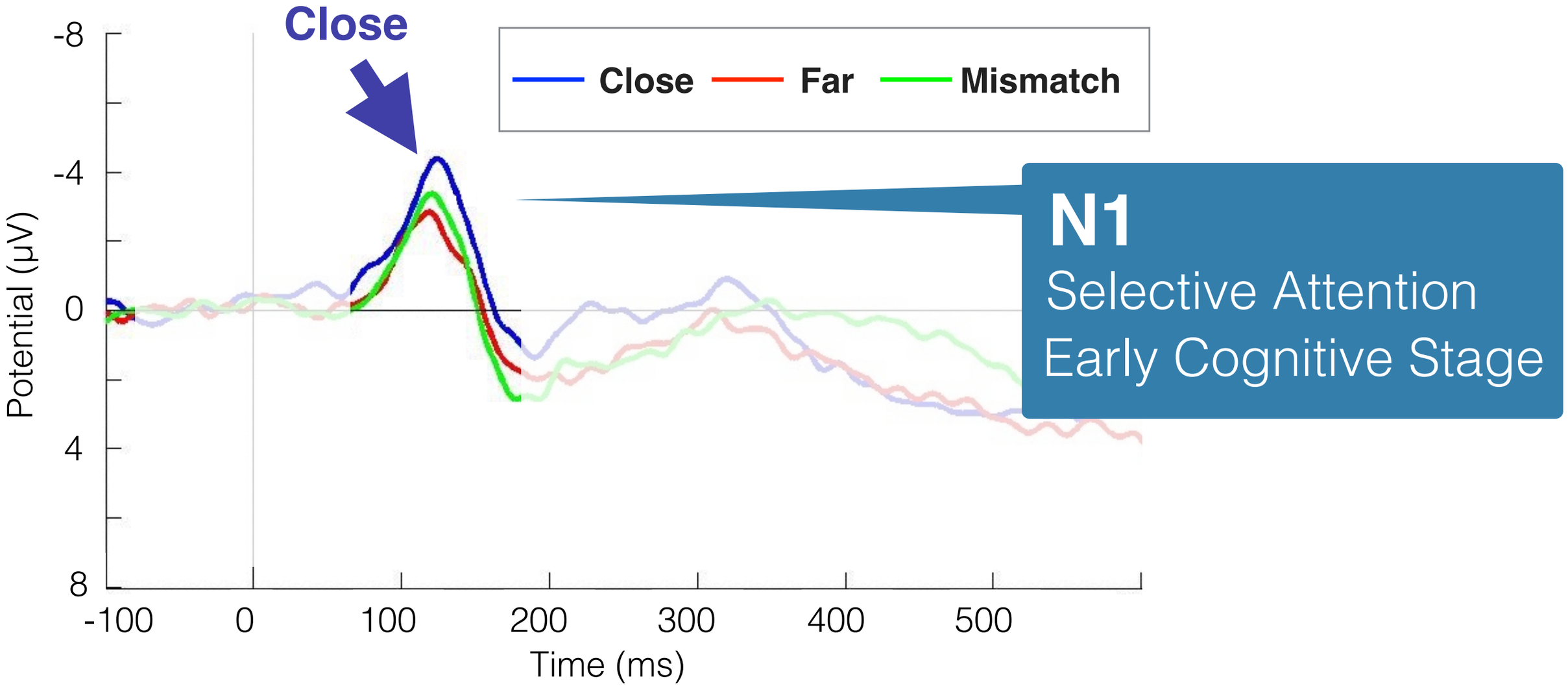


Experiment 1 I Result



N1
Selective Attention
Early Cognitive Stage

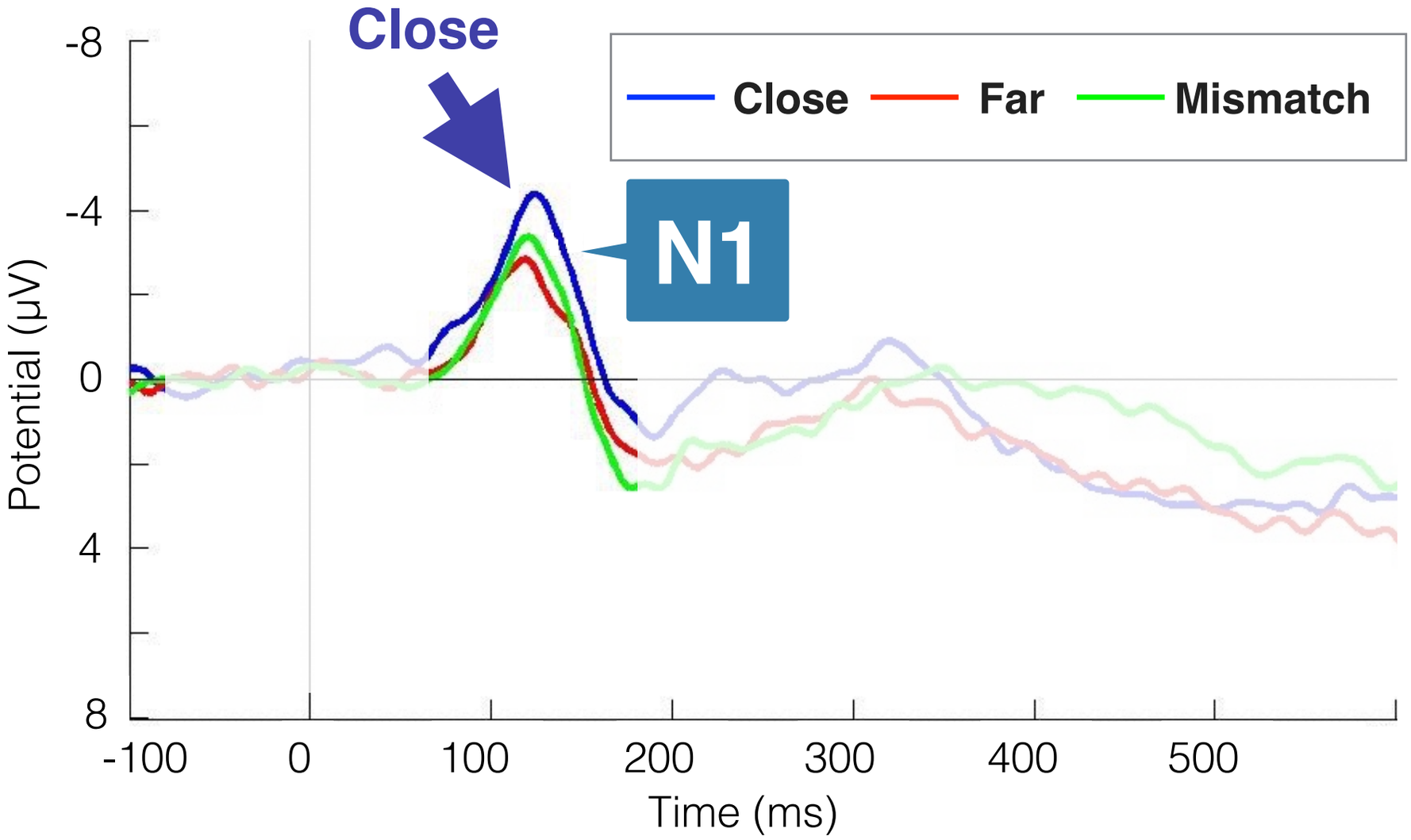
Experiment 1 I Result

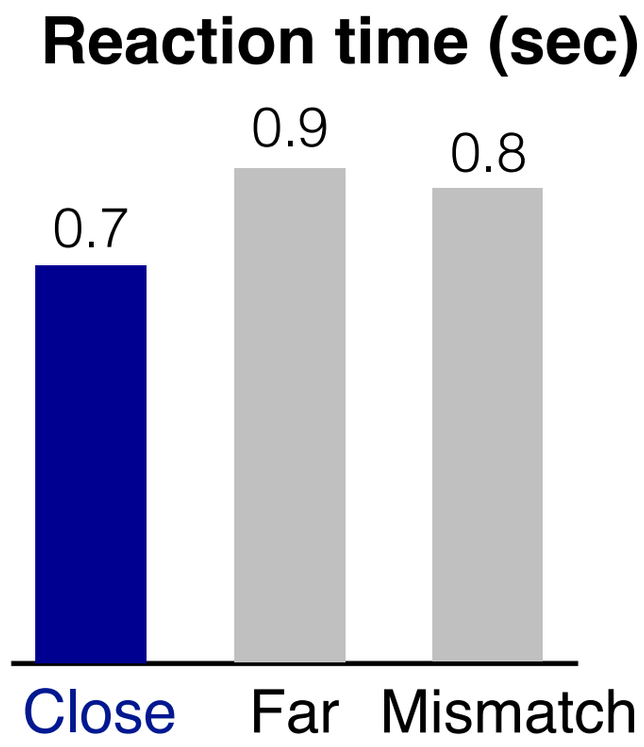


N1
Selective Attention
Early Cognitive Stage

Close Icons attract **more attention** than far icons in early cognitive stage.

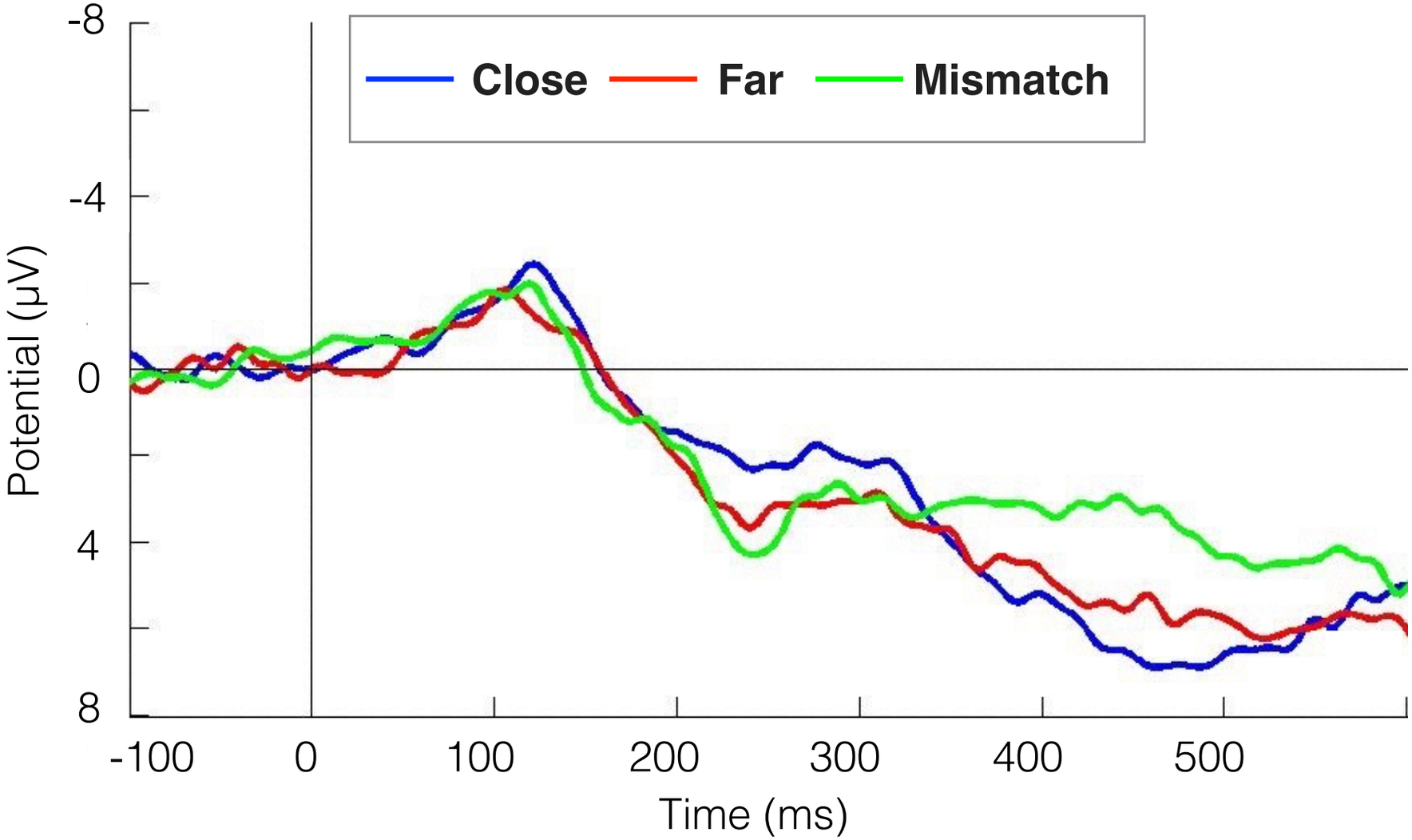
Experiment 1 I Result

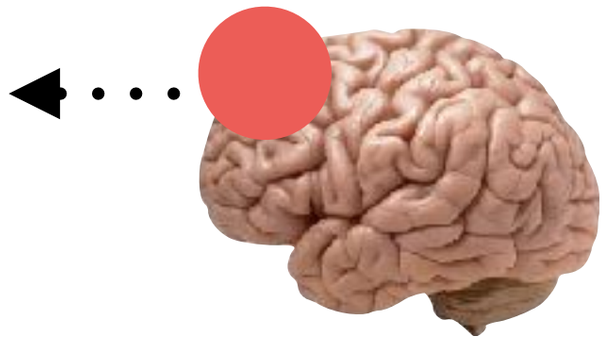




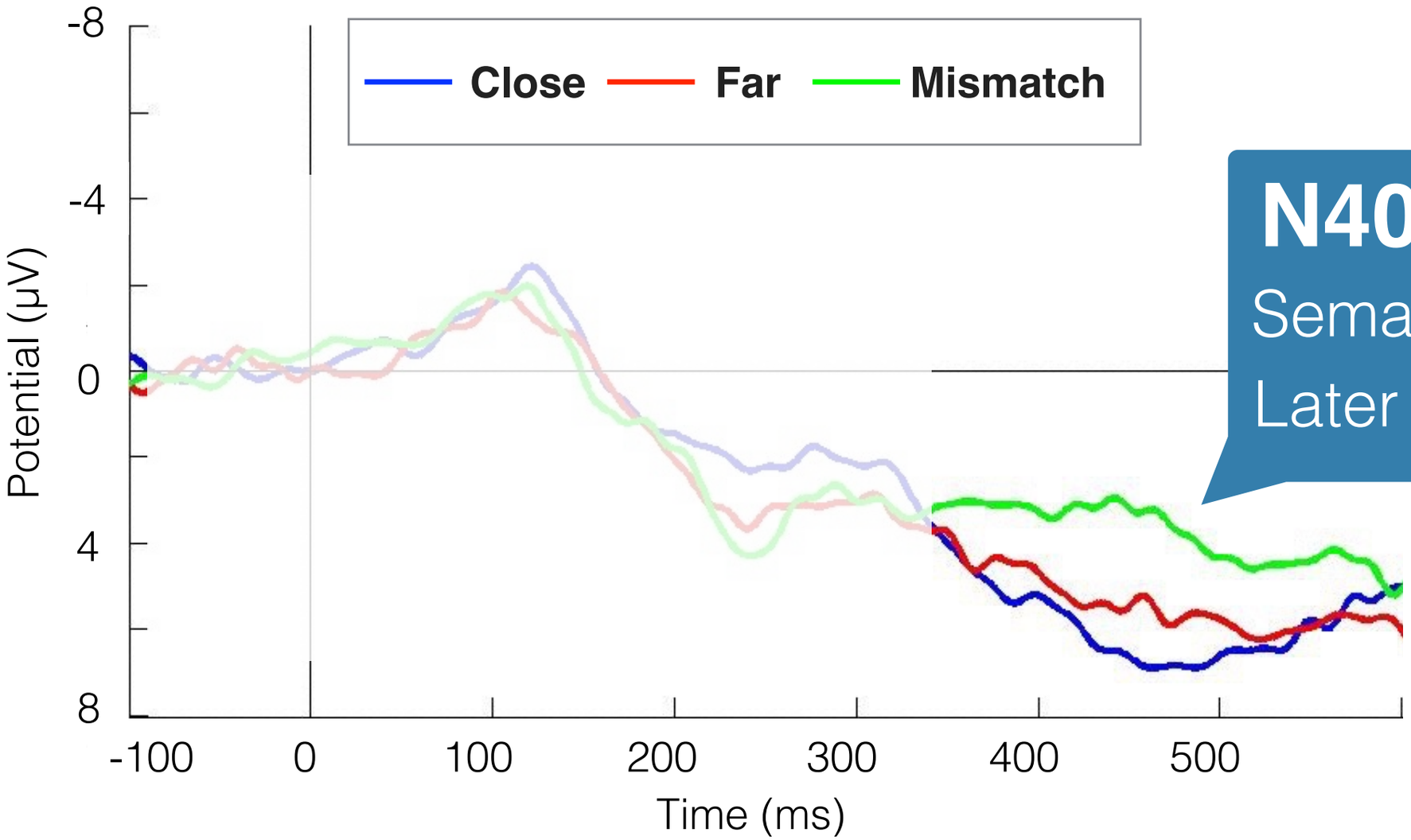
Close icon can attract more **attention**, thereby shortening **reaction time**.

Experiment 1 I Result





Experiment 1 I Result

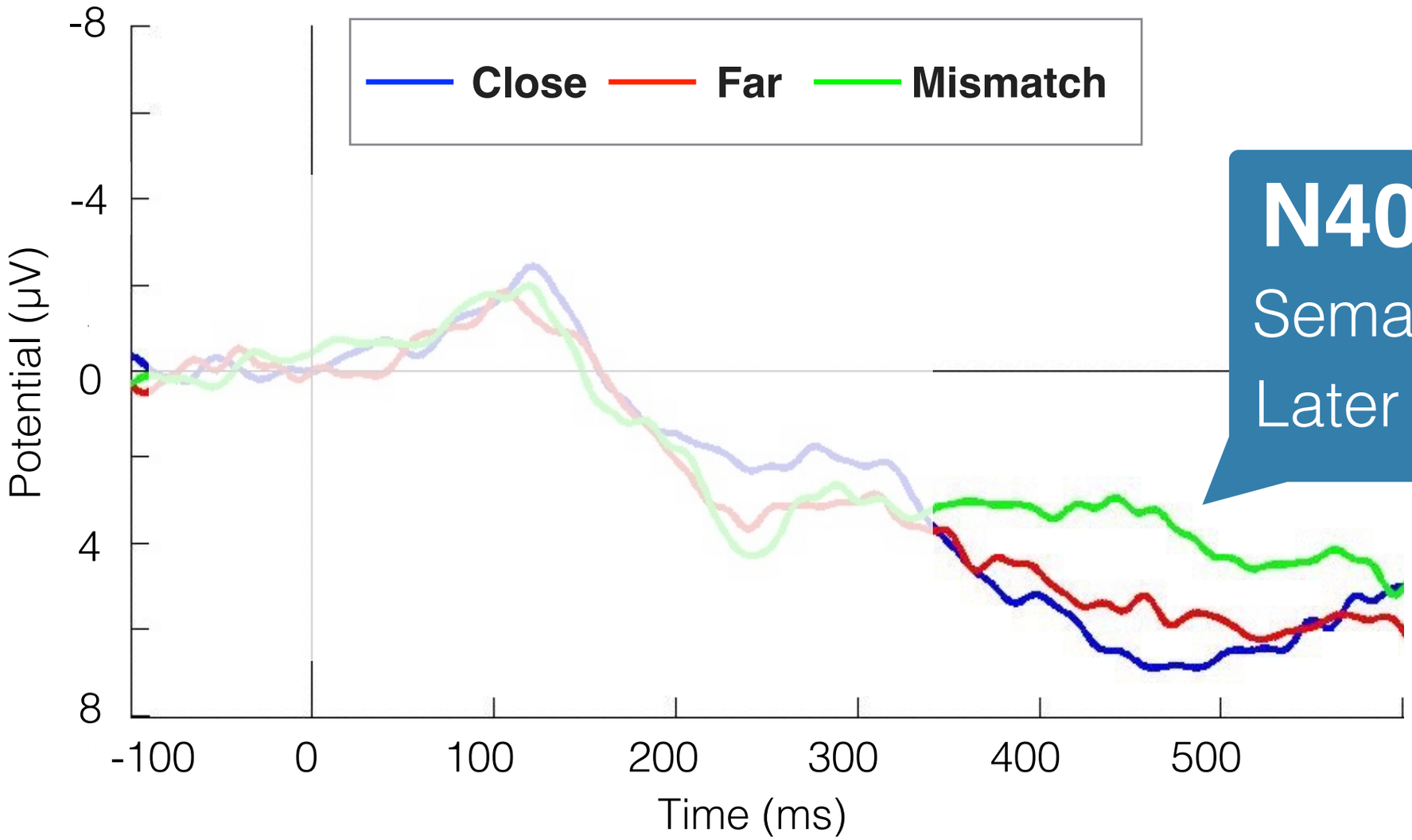


N400

Semantic Incongruence

Later Cognitive Stage

Experiment 1 I Result



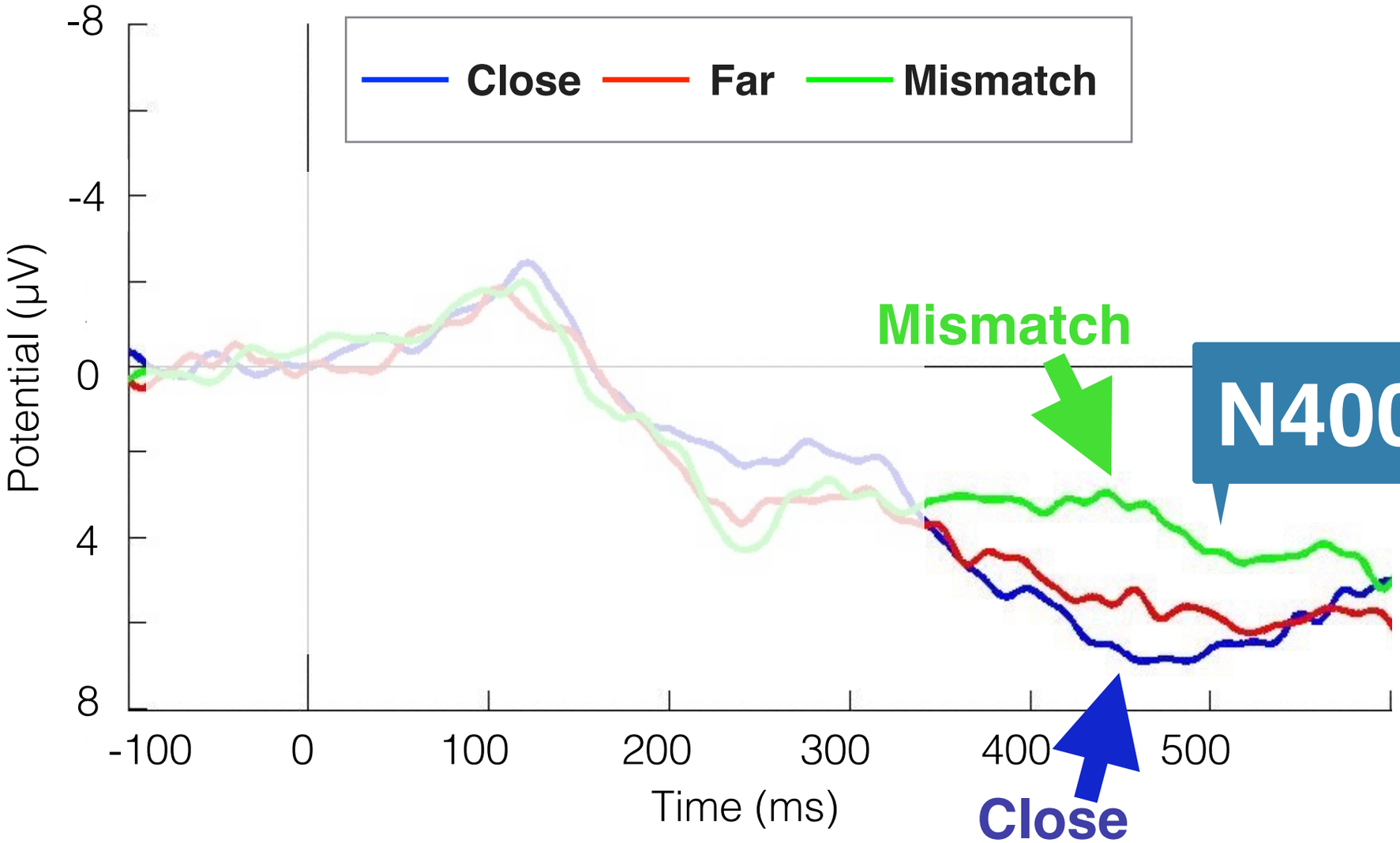
N400

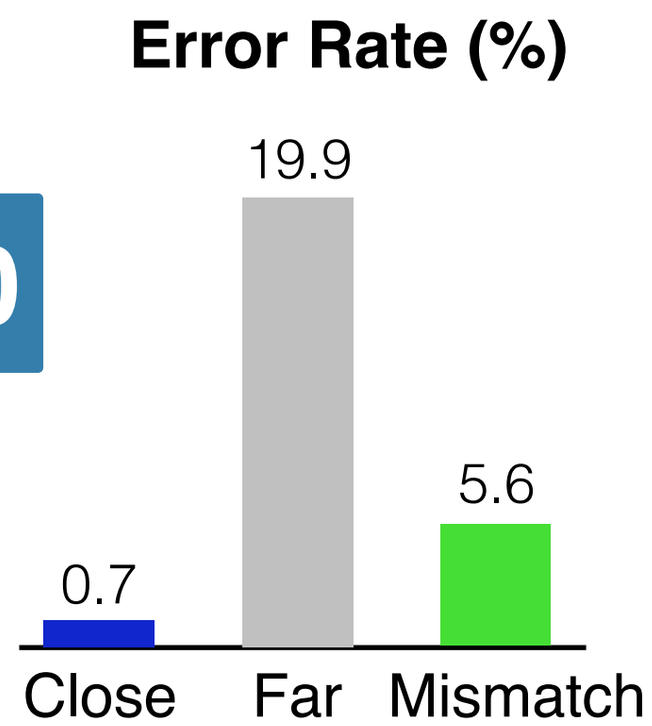
Semantic Incongruence

Later Cognitive Stage

Semantic distance level is **distinguished** in later cognitive stage.

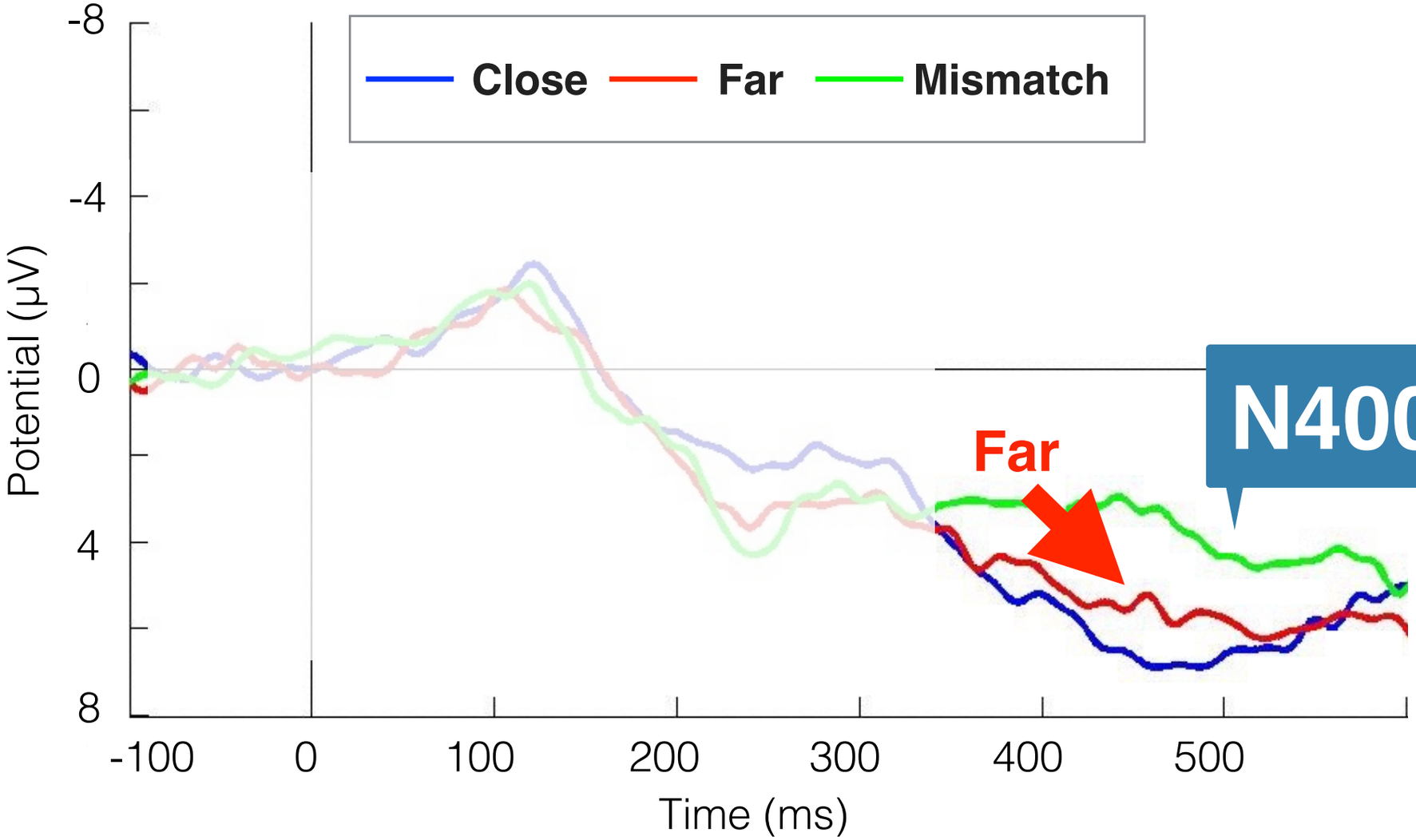
Experiment 1 I Result

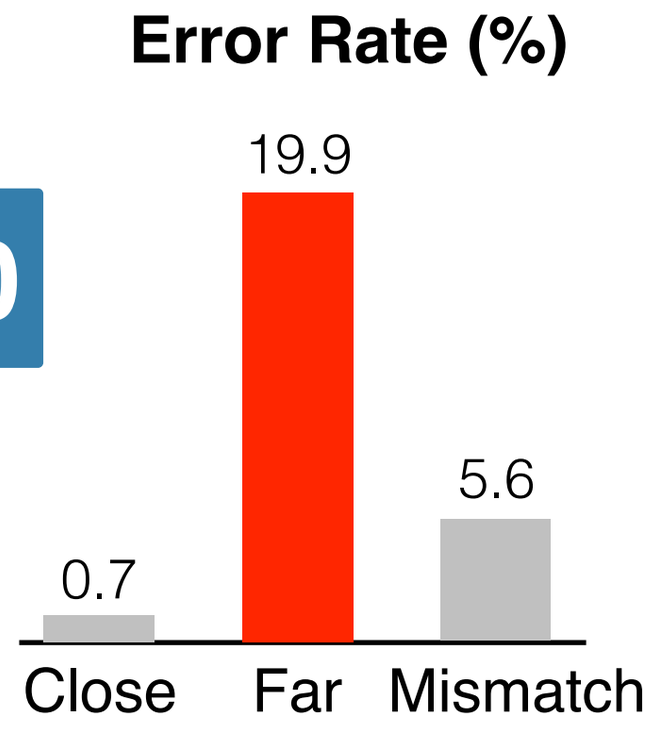




Opposite groups of semantic incongruence reduce error rate.

Experiment 1 I Result





Vague semantic incongruence increases error rate.

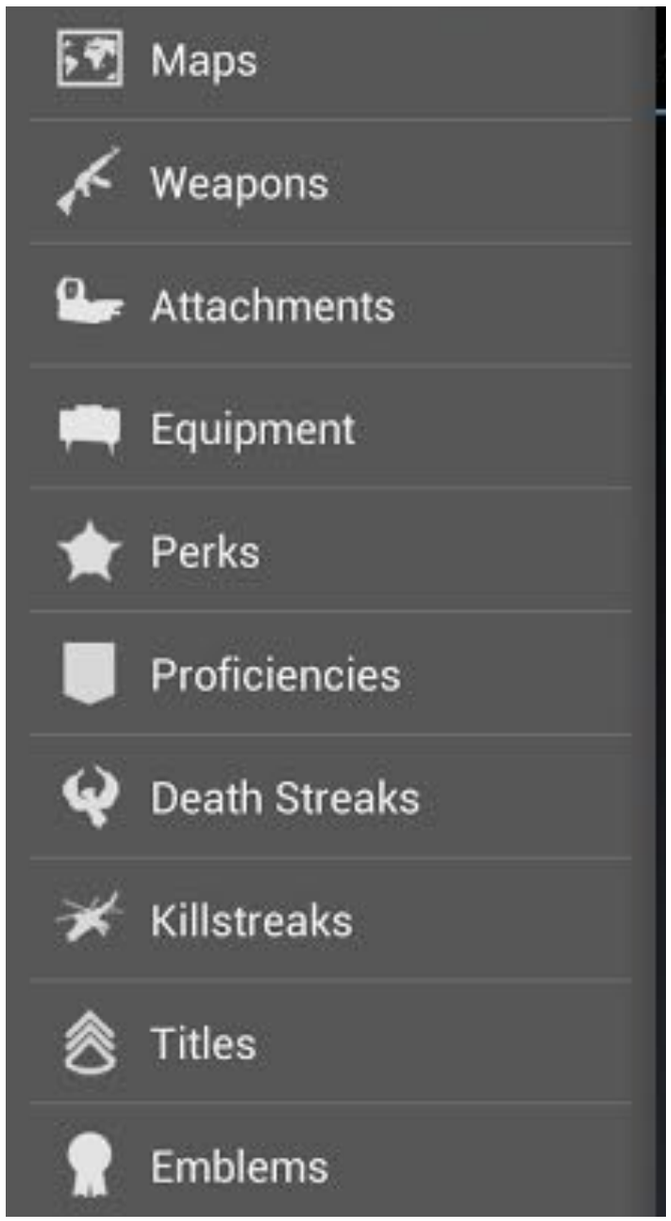
Participants' behaviors provided basic findings, **EEG** results revealed **causes** of behaviors and performance in **different cognitive stages.**

http://www.userzoom.com/wp-content/uploads/2015/04/usability-lab.jpg

Experiment 2

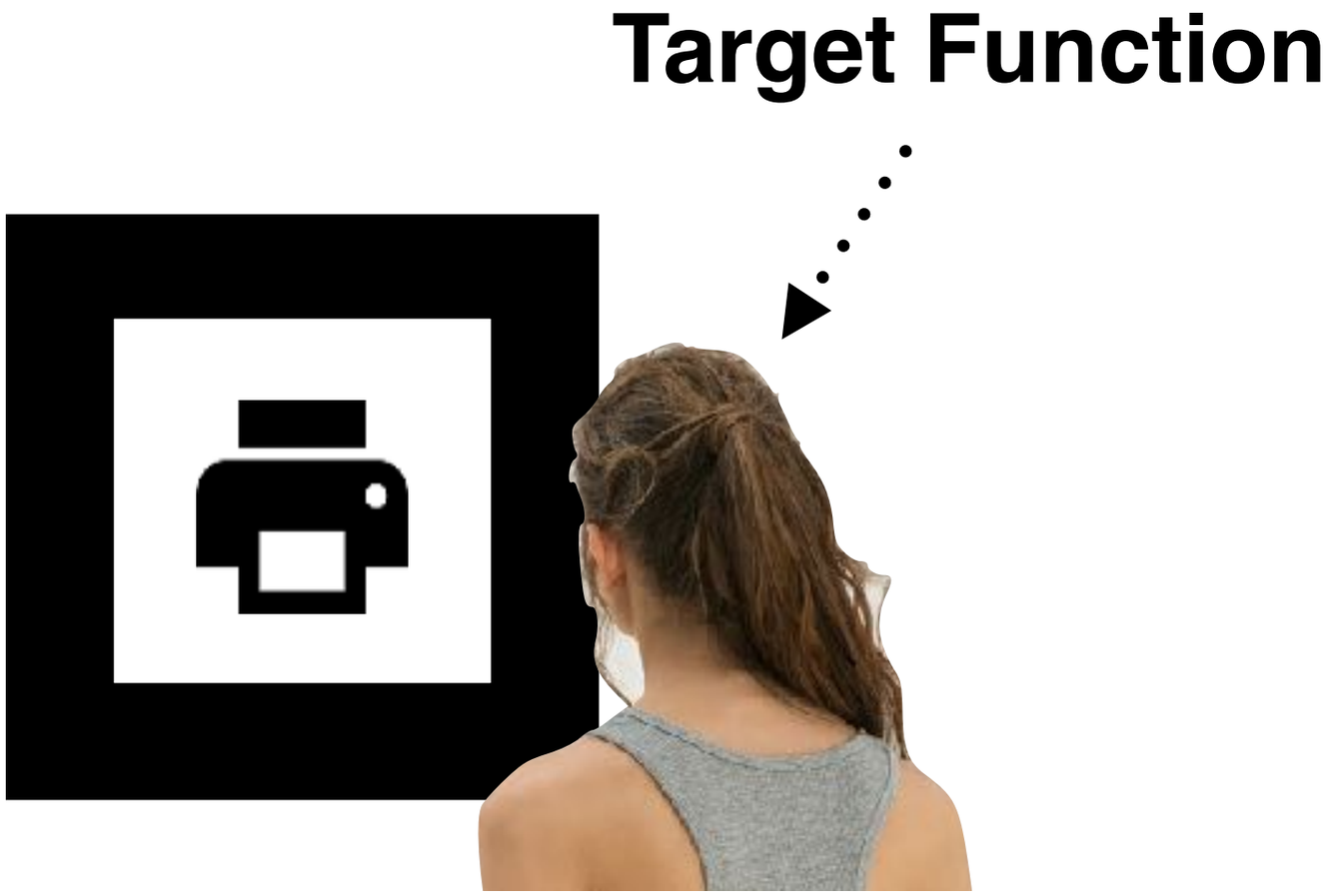
Icon Selection Under Sliding

Experiment 2 I Scenario

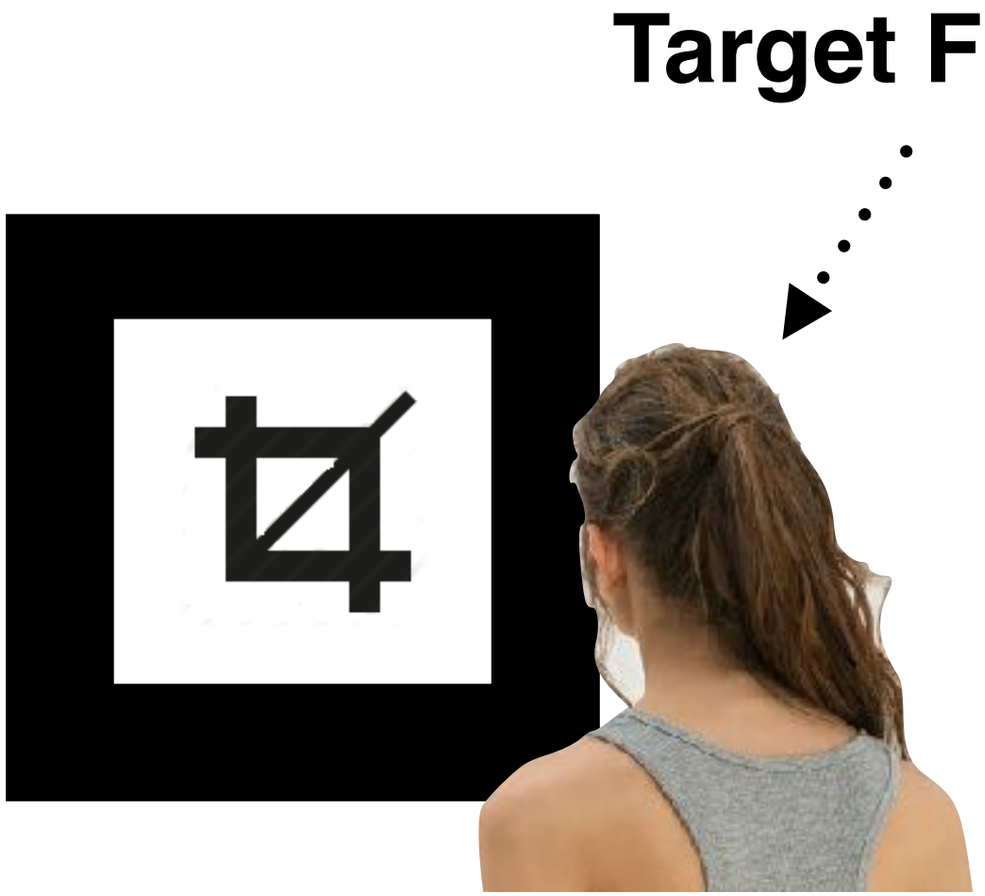


Selecting icon from sliding menu

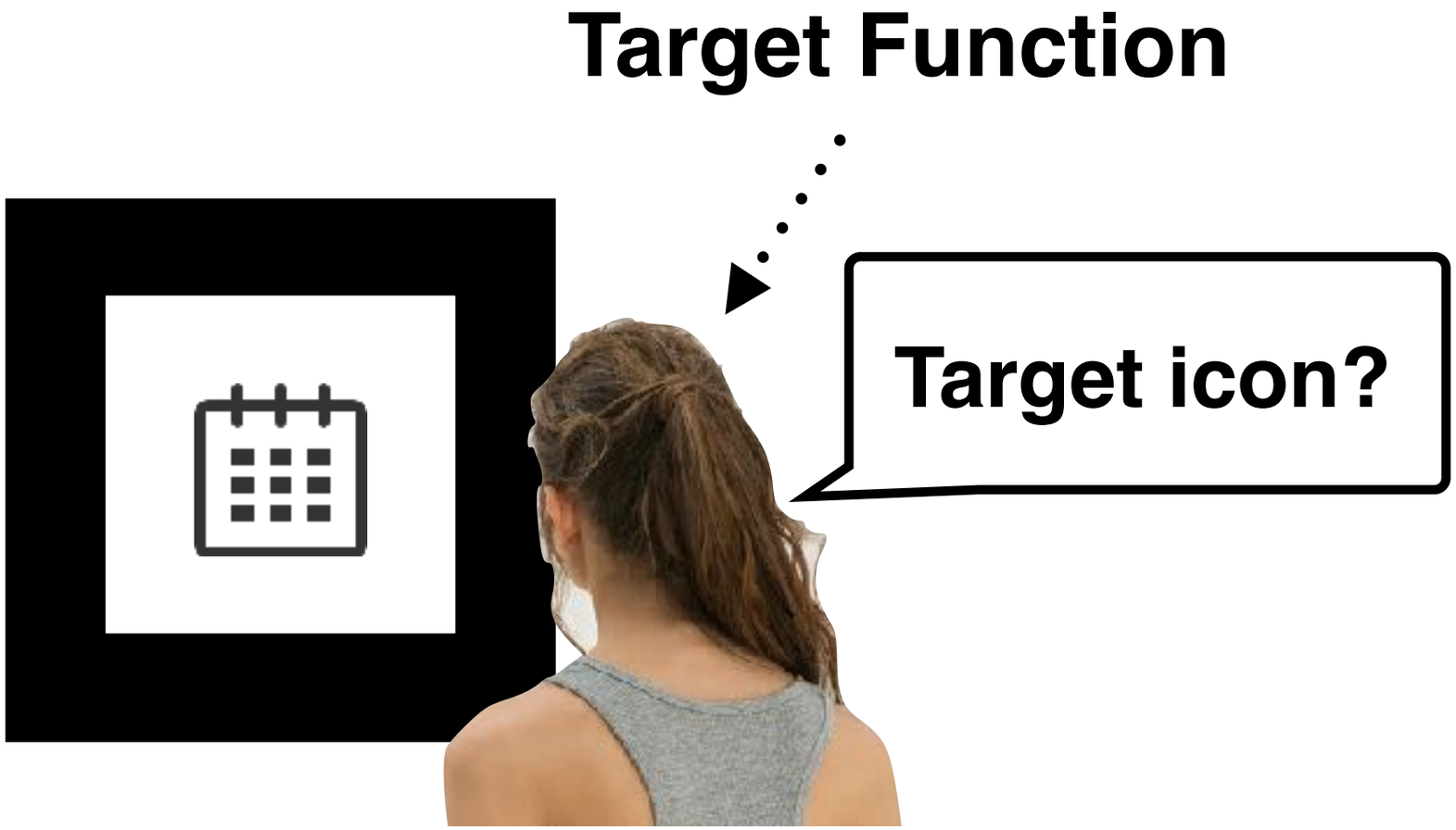
Experiment 2 I Design



Experiment 2 I Design



Experiment 2 I Design



Experiment 2 I Design

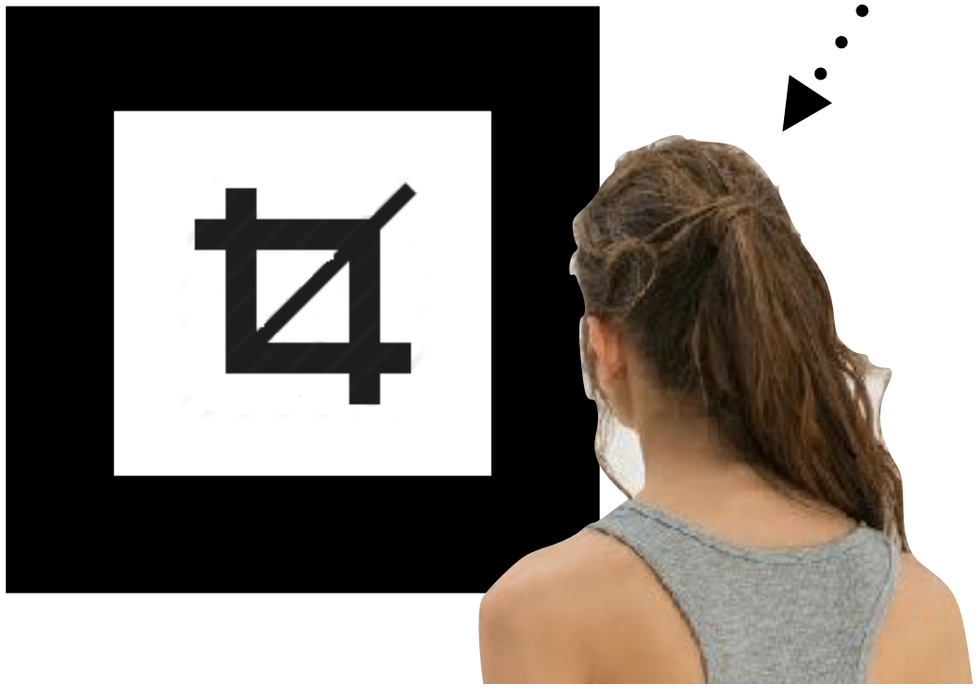
Target Function : Calendar

Non-Target

Experiment 2 I Design

Target Function : Calendar

Non-Target



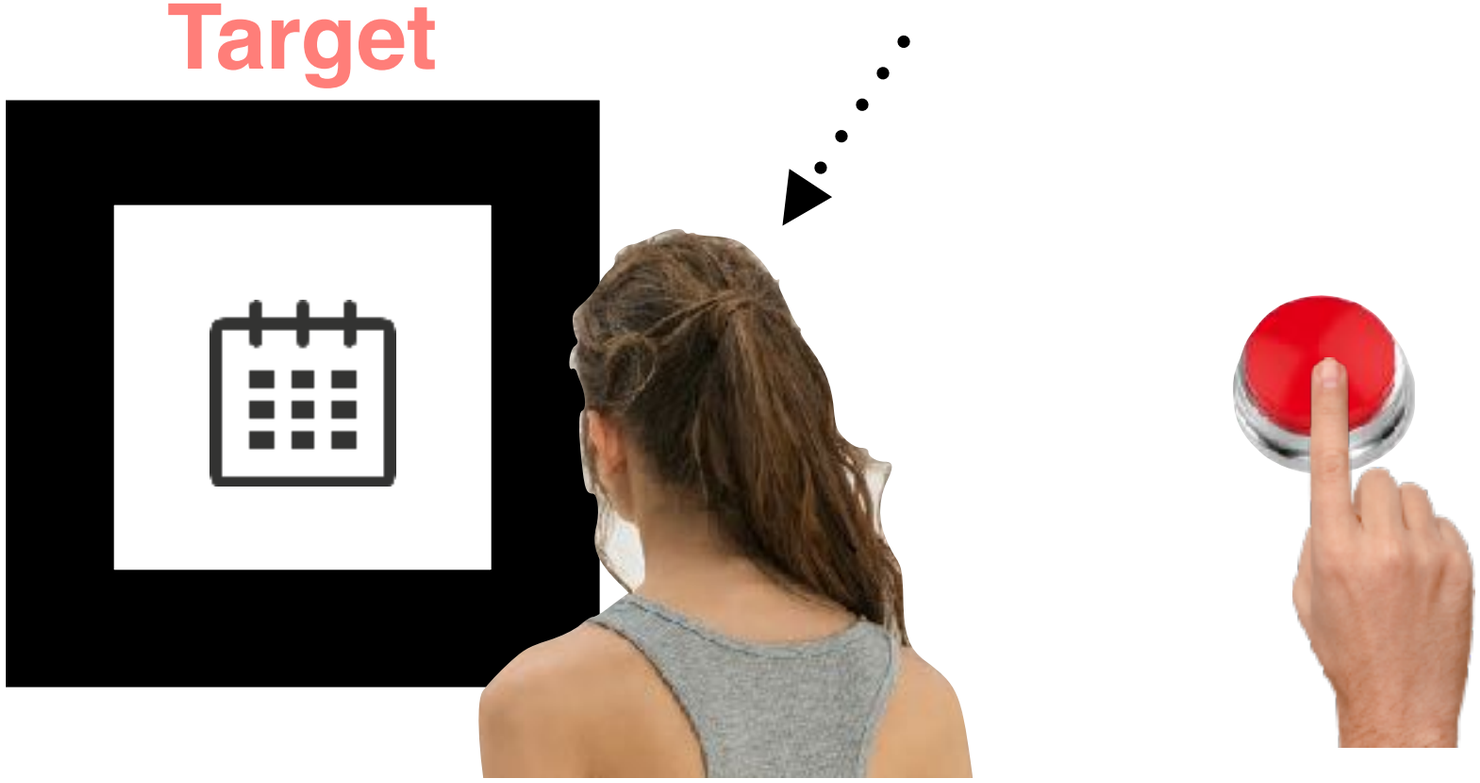
Experiment 2 I Design

Target Function : Calendar

Target

Experiment 2 I Design

Target Function : Calendar



Factors:

Target icon *Close, Far*

Presenting Speed *Slow, Fast*

Experiment 2 I Design

Target Function : Calendar

Target

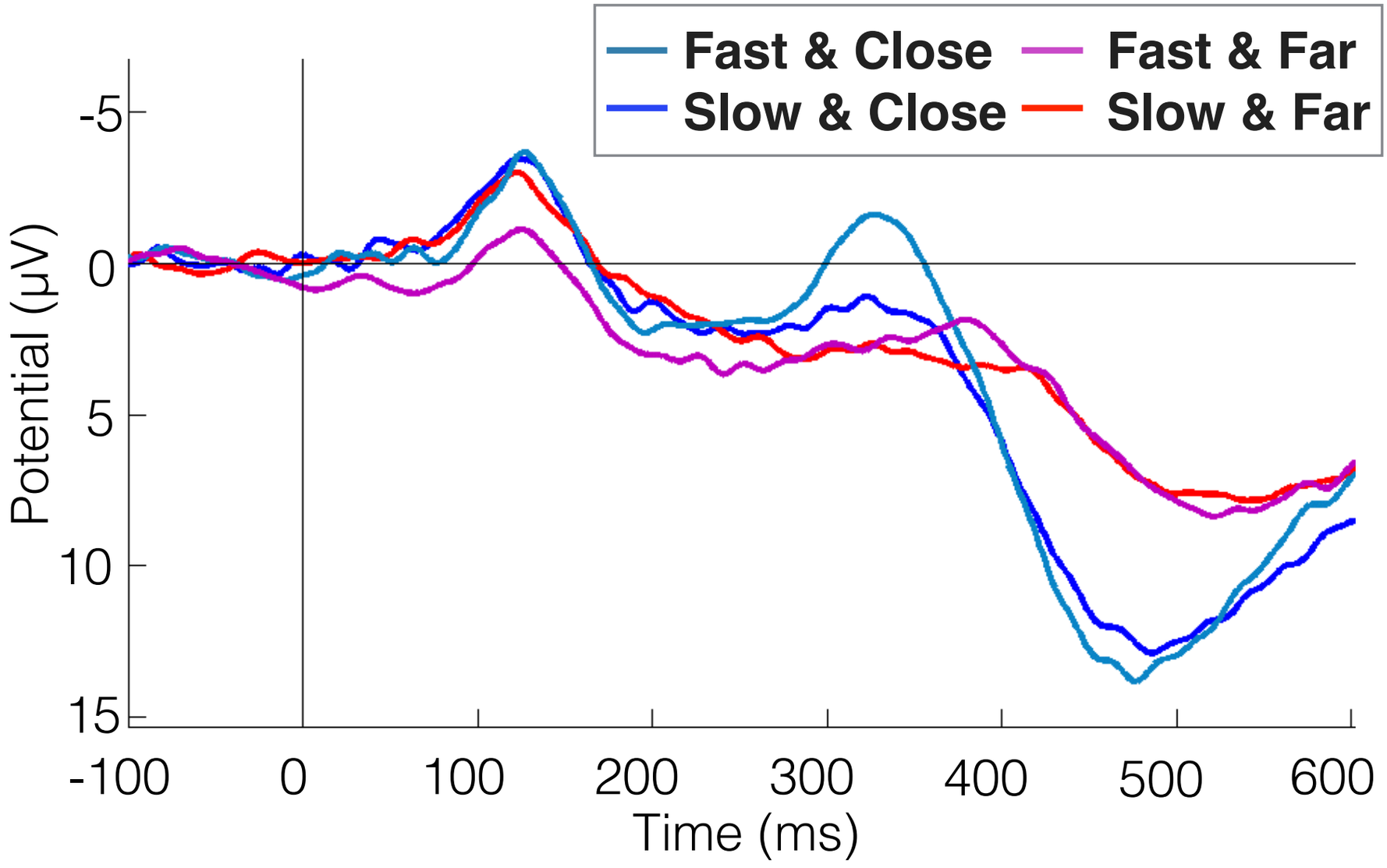
Measures:

Reaction time

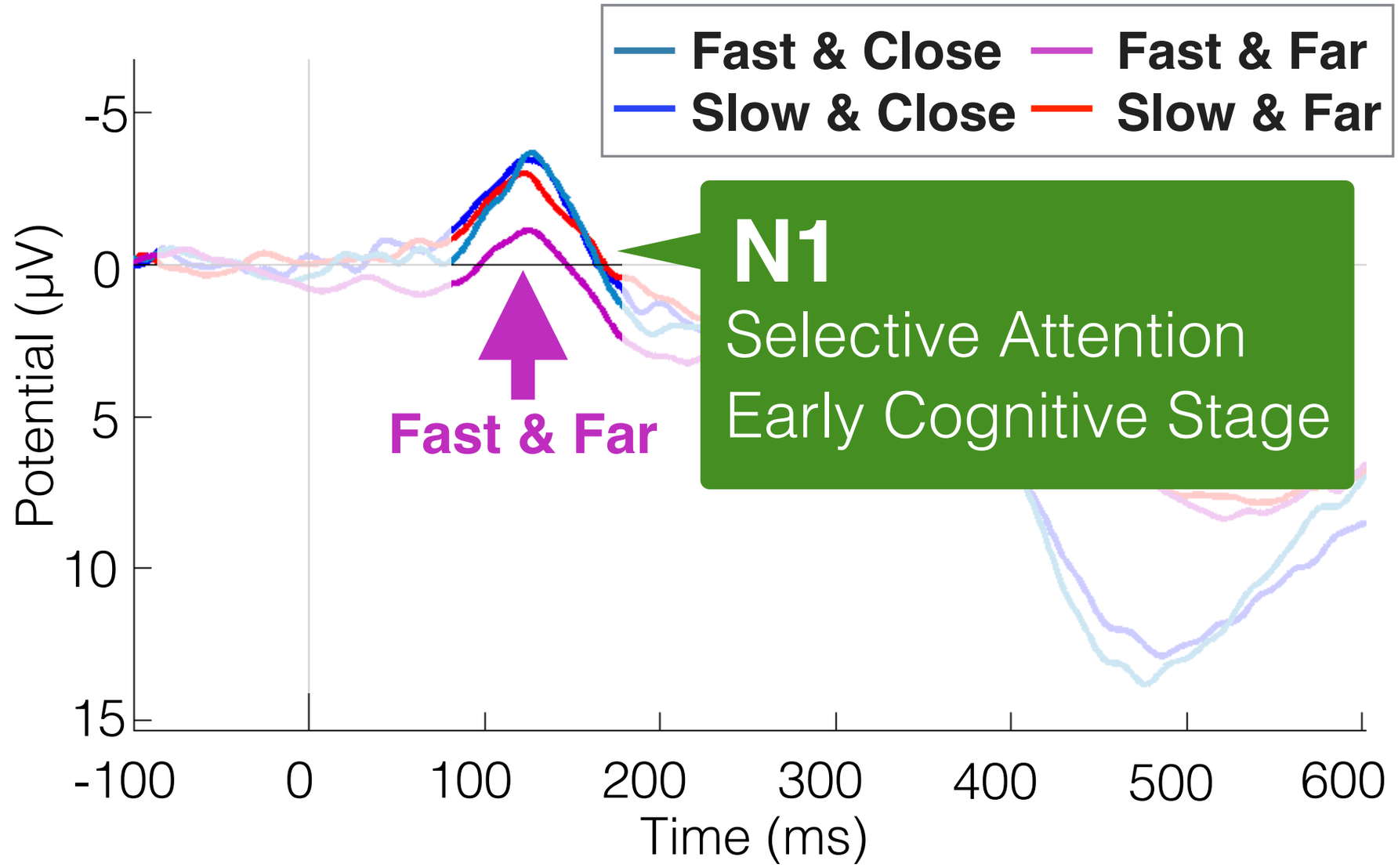
Hit Rate

EEG Signal

Experiment 2 I Result

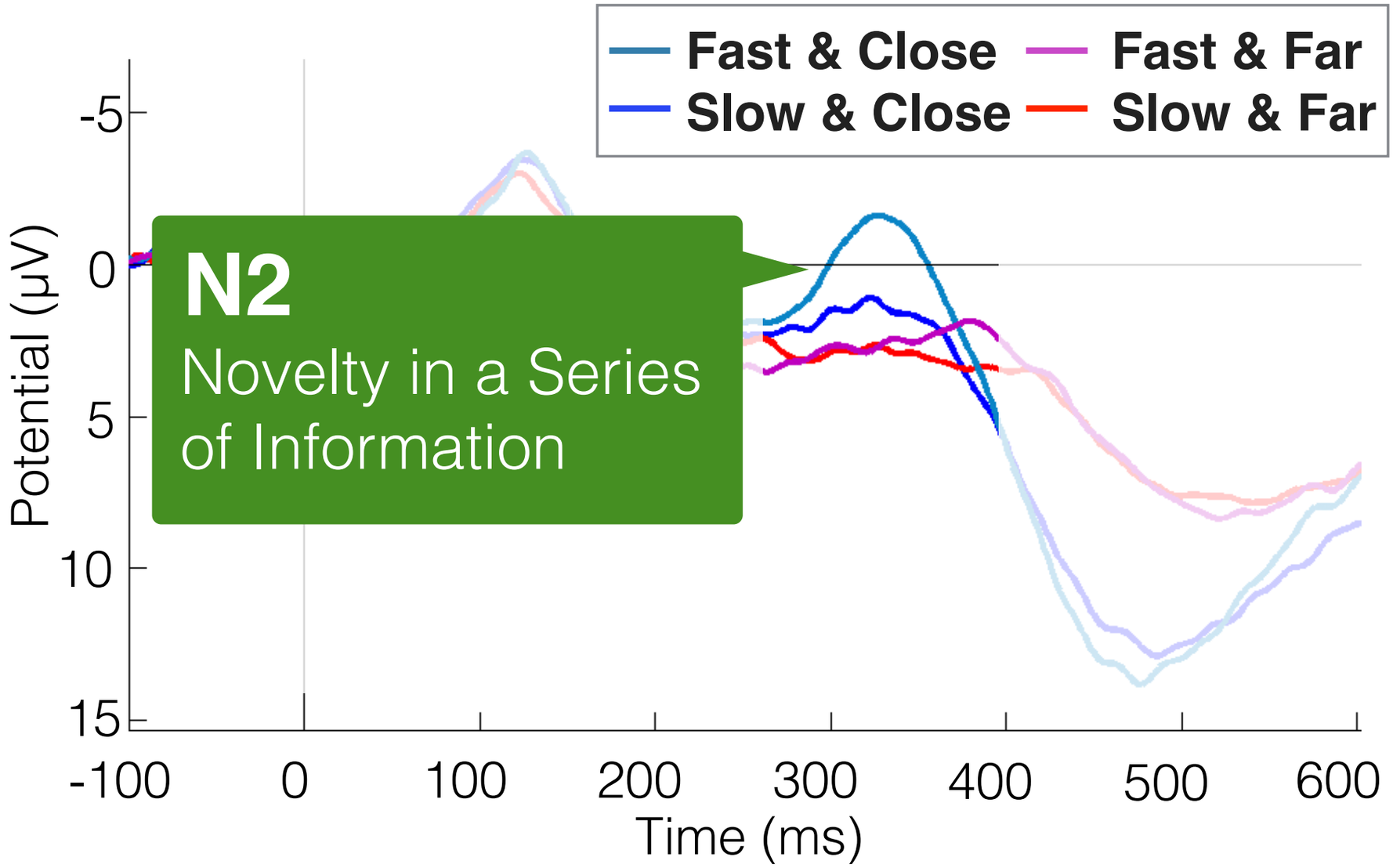


Experiment 2 I Result

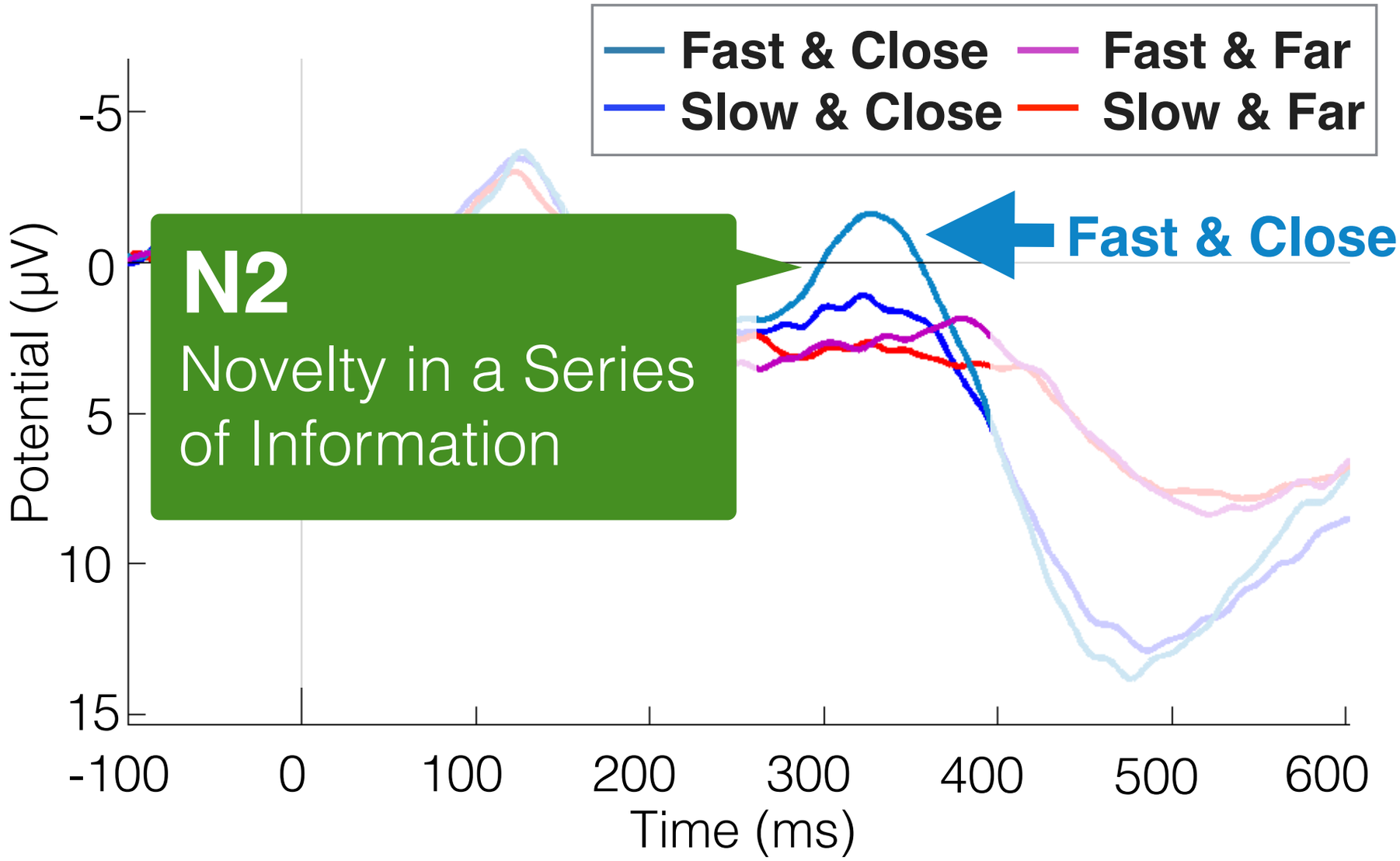


Far target icons are easily **ignored** in fast speed.

Experiment 2 I Result

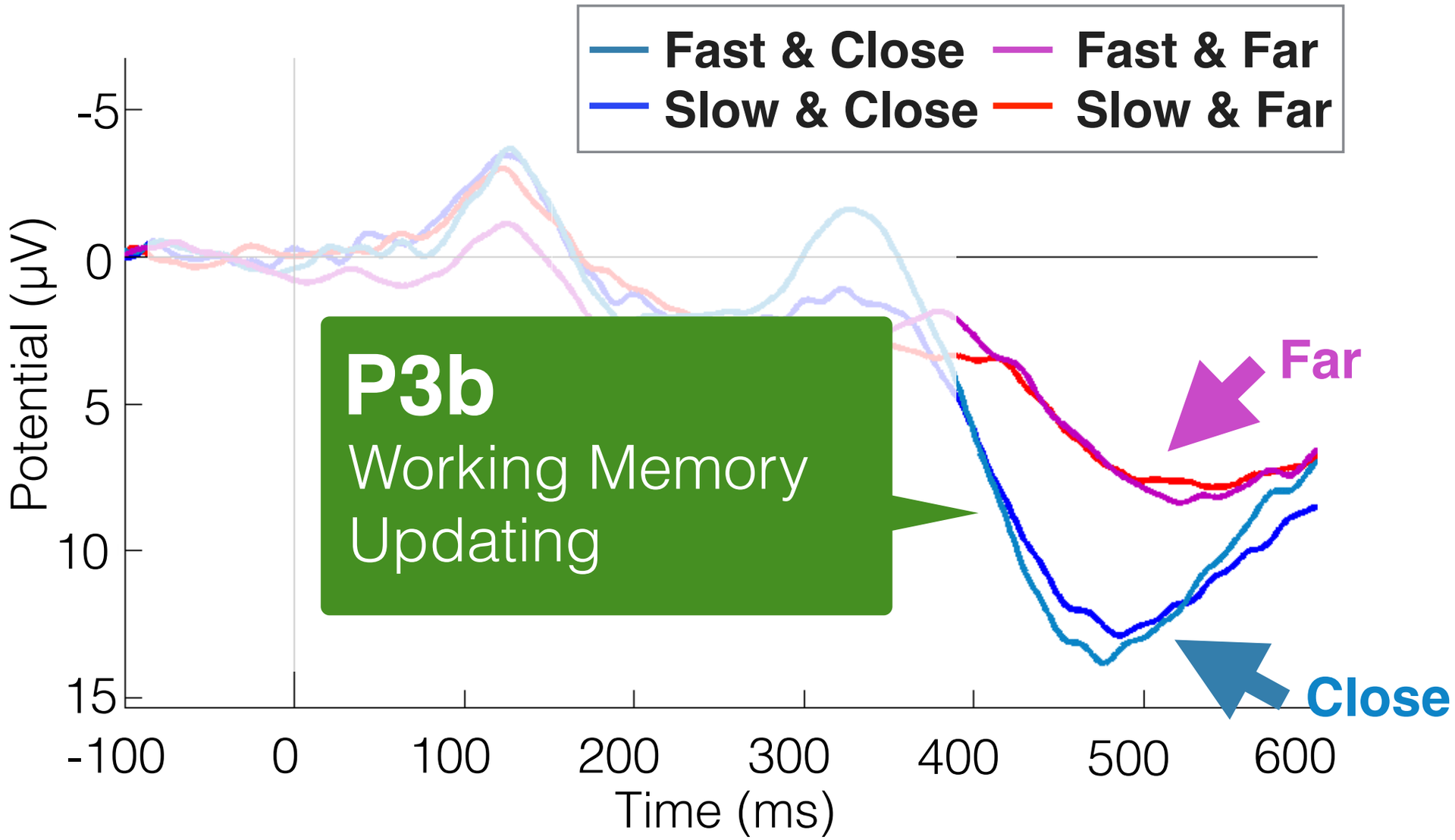


Experiment 2 I Result



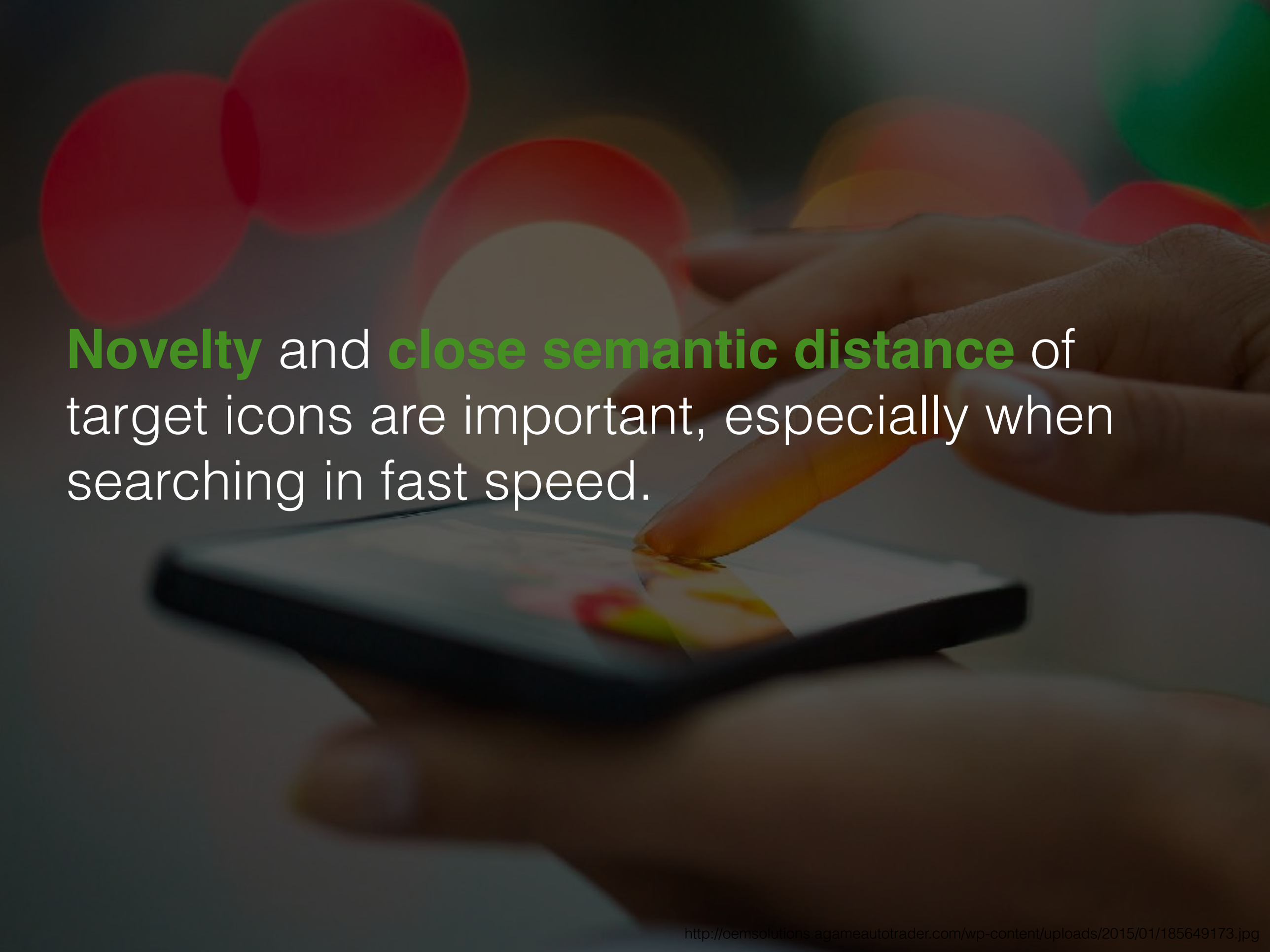
Close target icons are easily **recognized** in fast speed.

Experiment 2 I Result



Close target icons are easily updated to **working memory.**

Novelty and **close semantic distance** of target icons are important, especially when searching in fast speed.

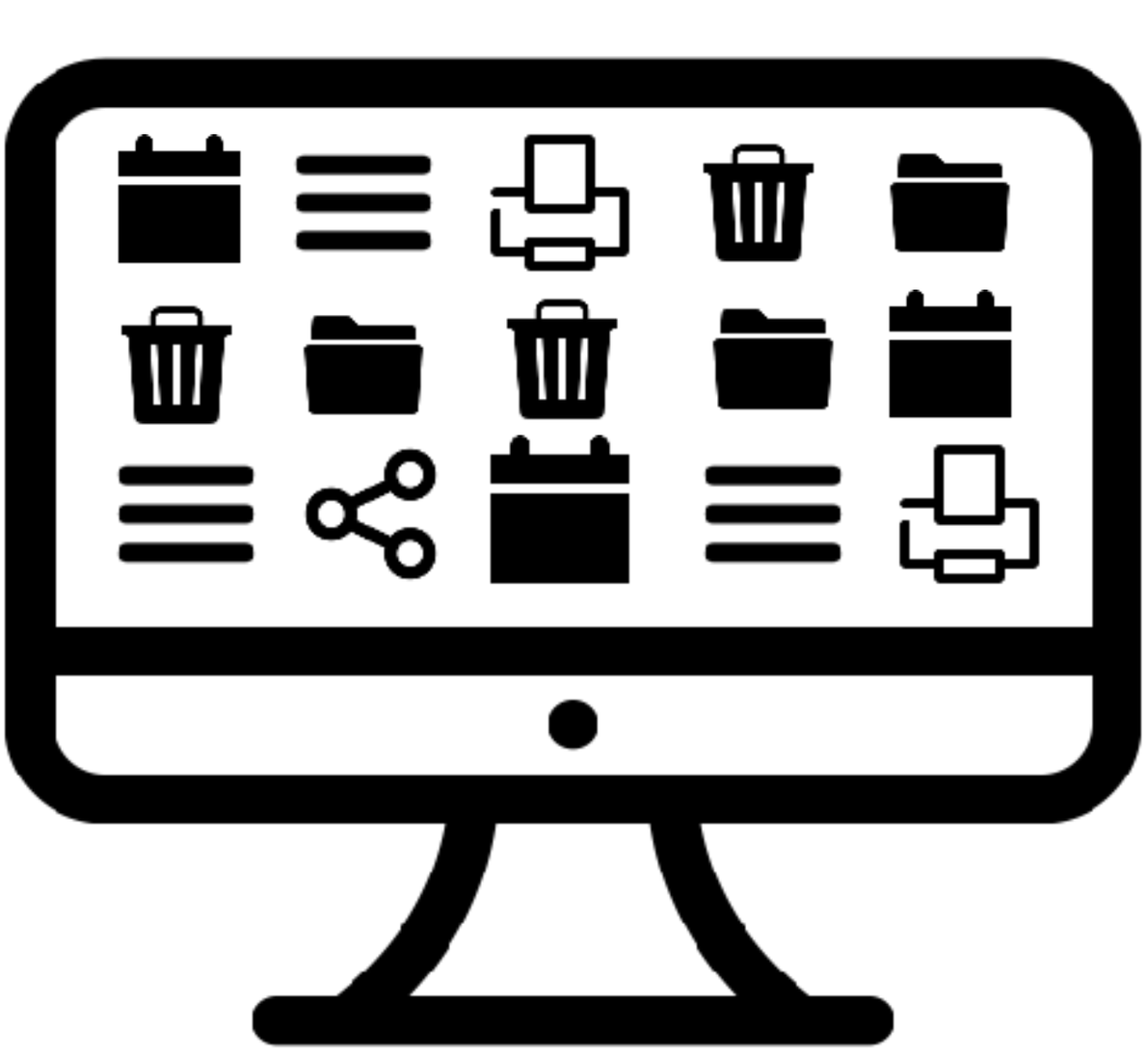


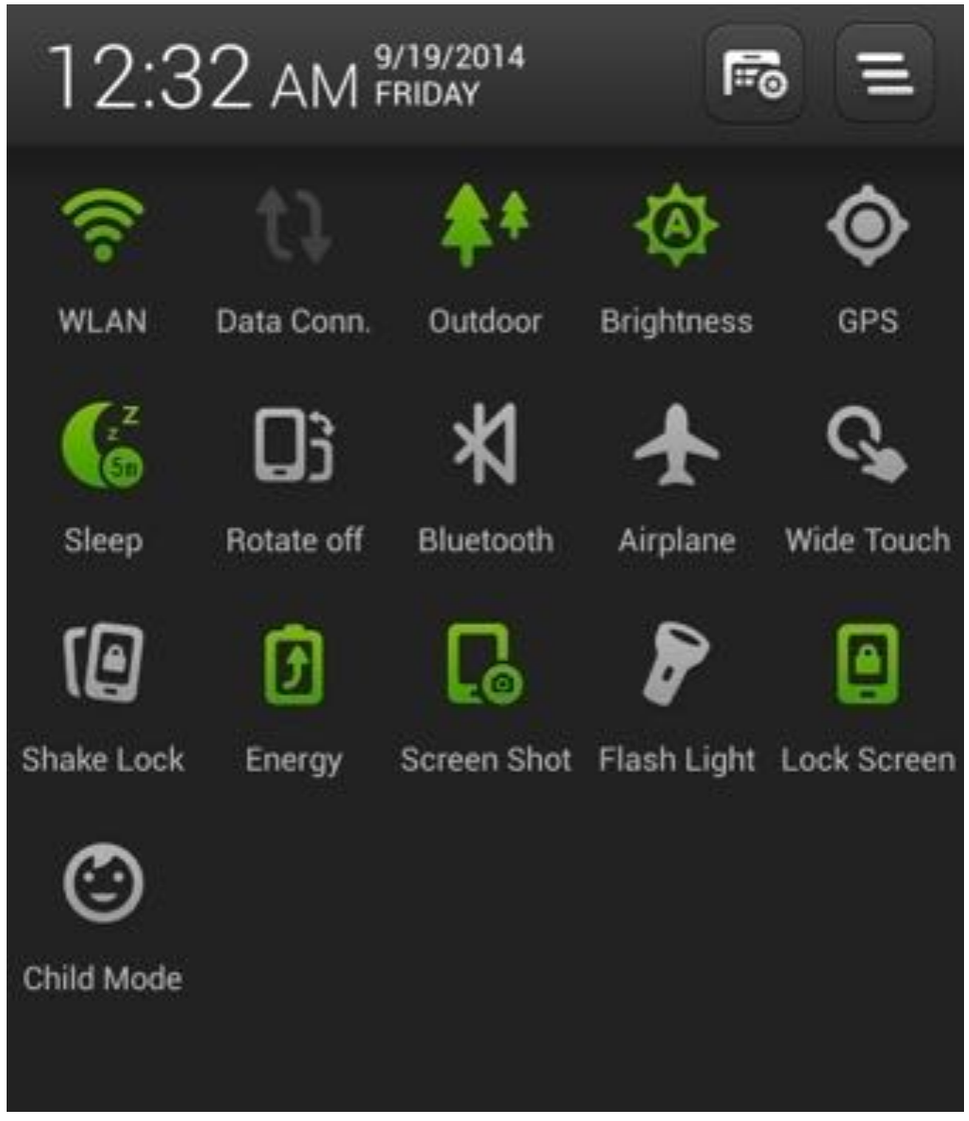
http://oemsolutions.agameautotrader.com/wp-content/uploads/2015/01/185649173.jpg

Experiment 3

Icon Selection From Grid

Experiment 2 I Scenario

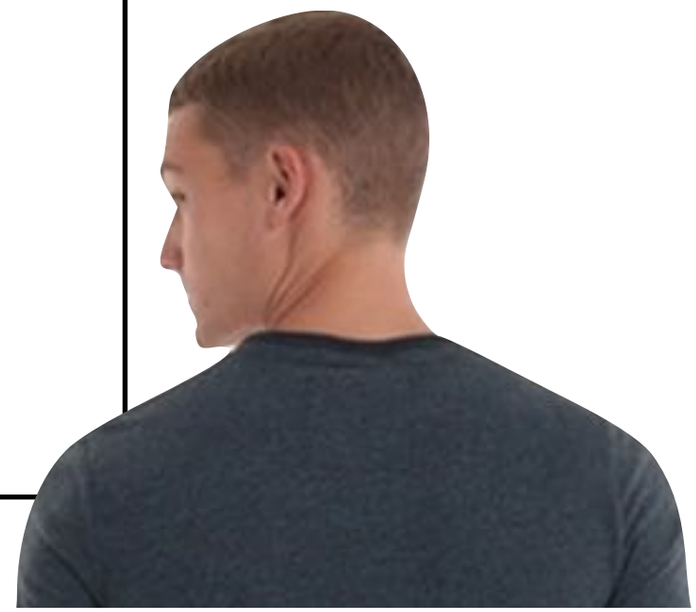




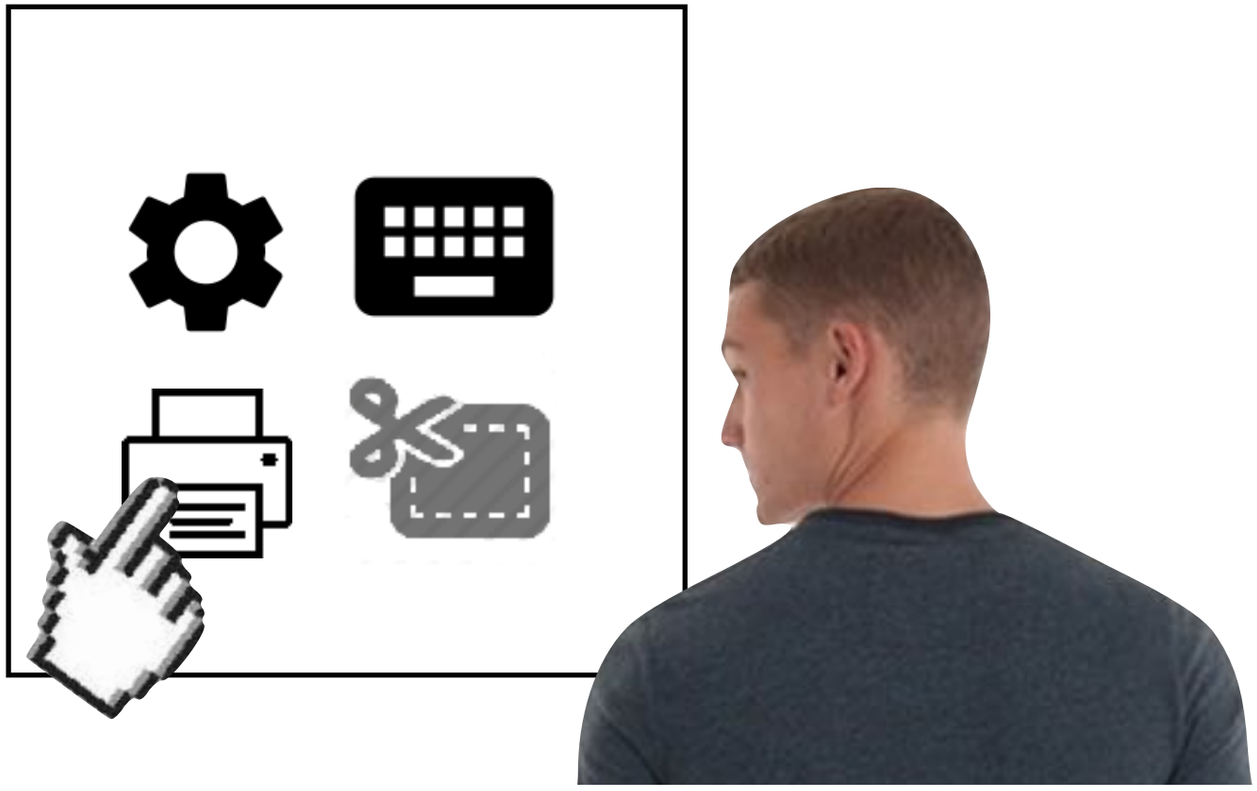
Selecting icon from icon gird

Experiment 3 I Design

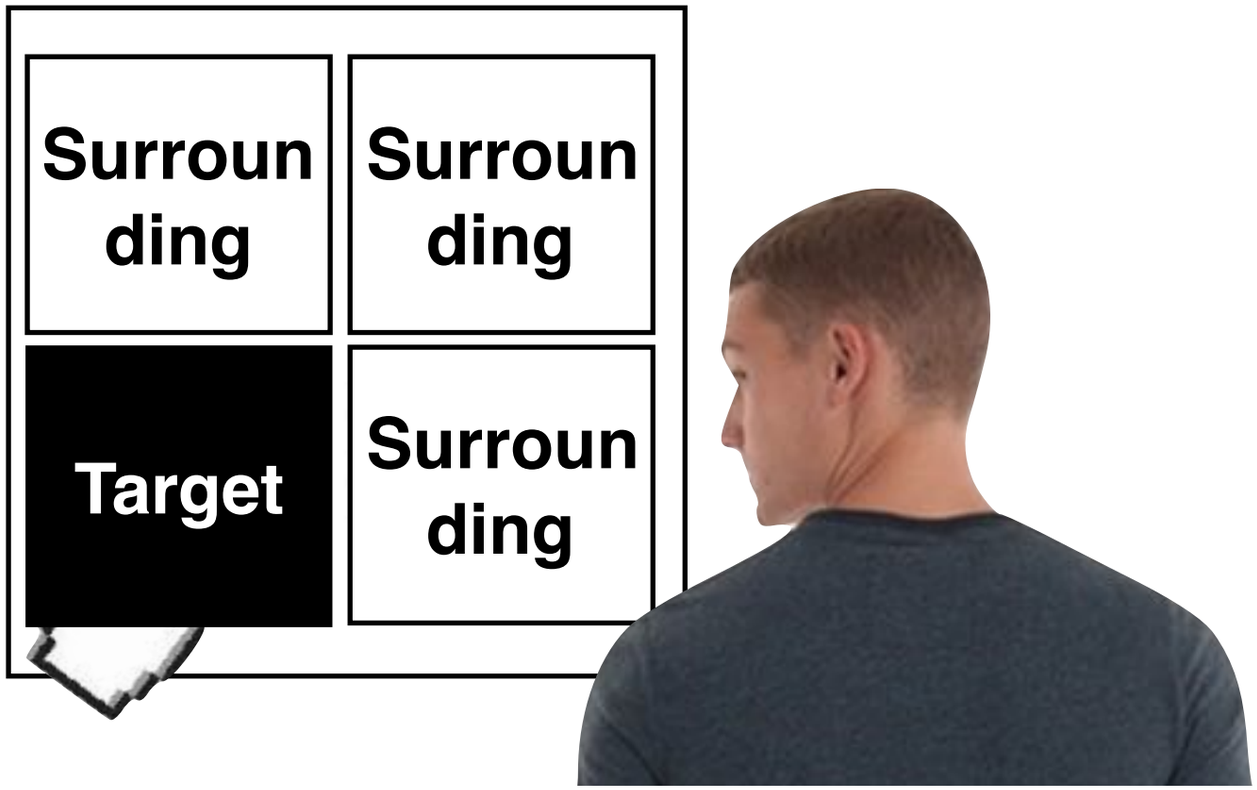
Print



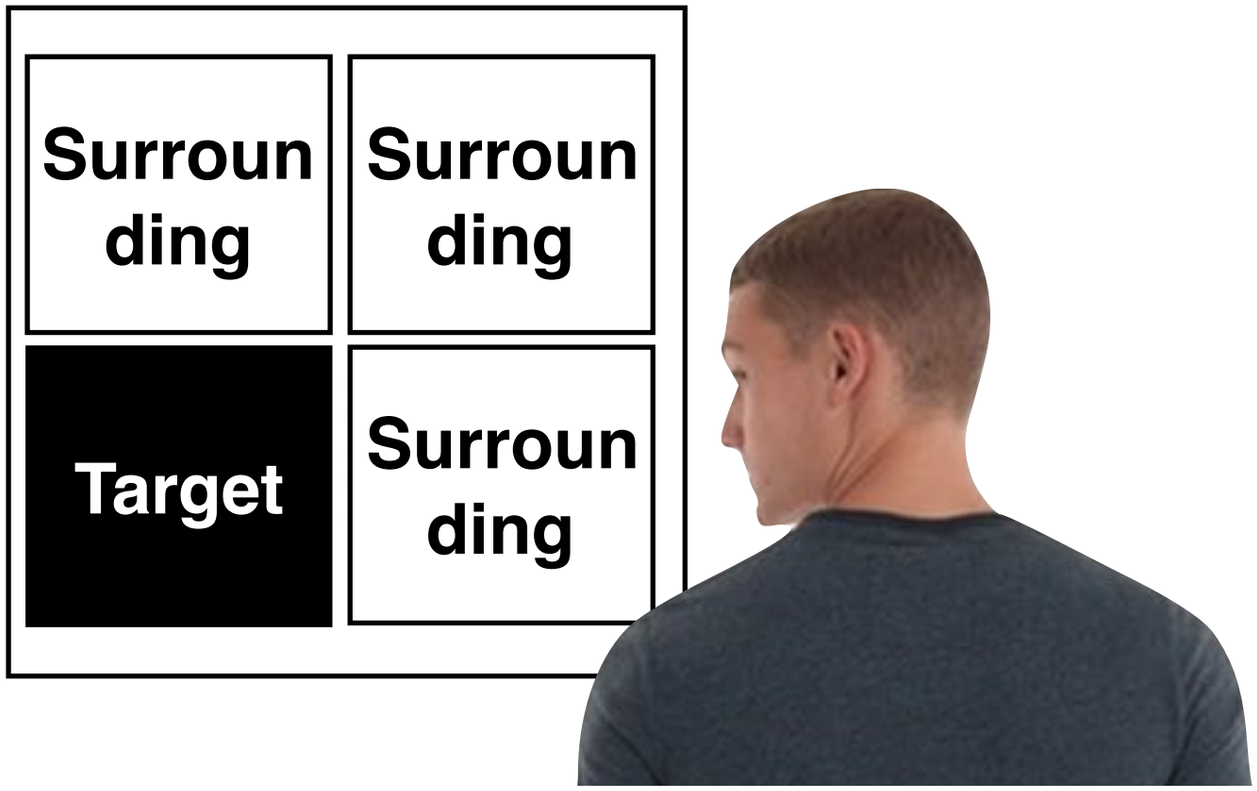
Find and Click ‘Print’ icon



Find and Click ‘Print’ icon



Find and Click ‘Print’ icon

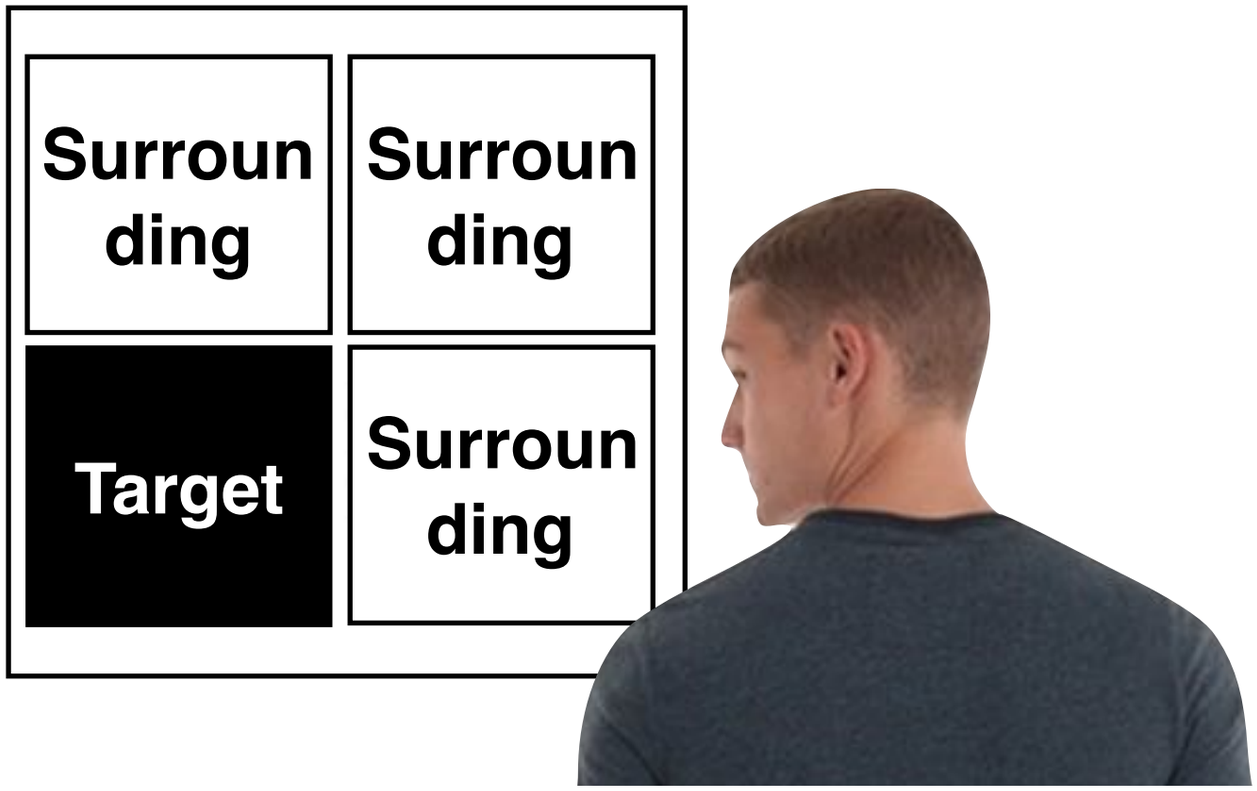


Factors:

Target icon *Close, Far*
Surrounding icon

Grid Size *2x2, 3x3, 4x4*

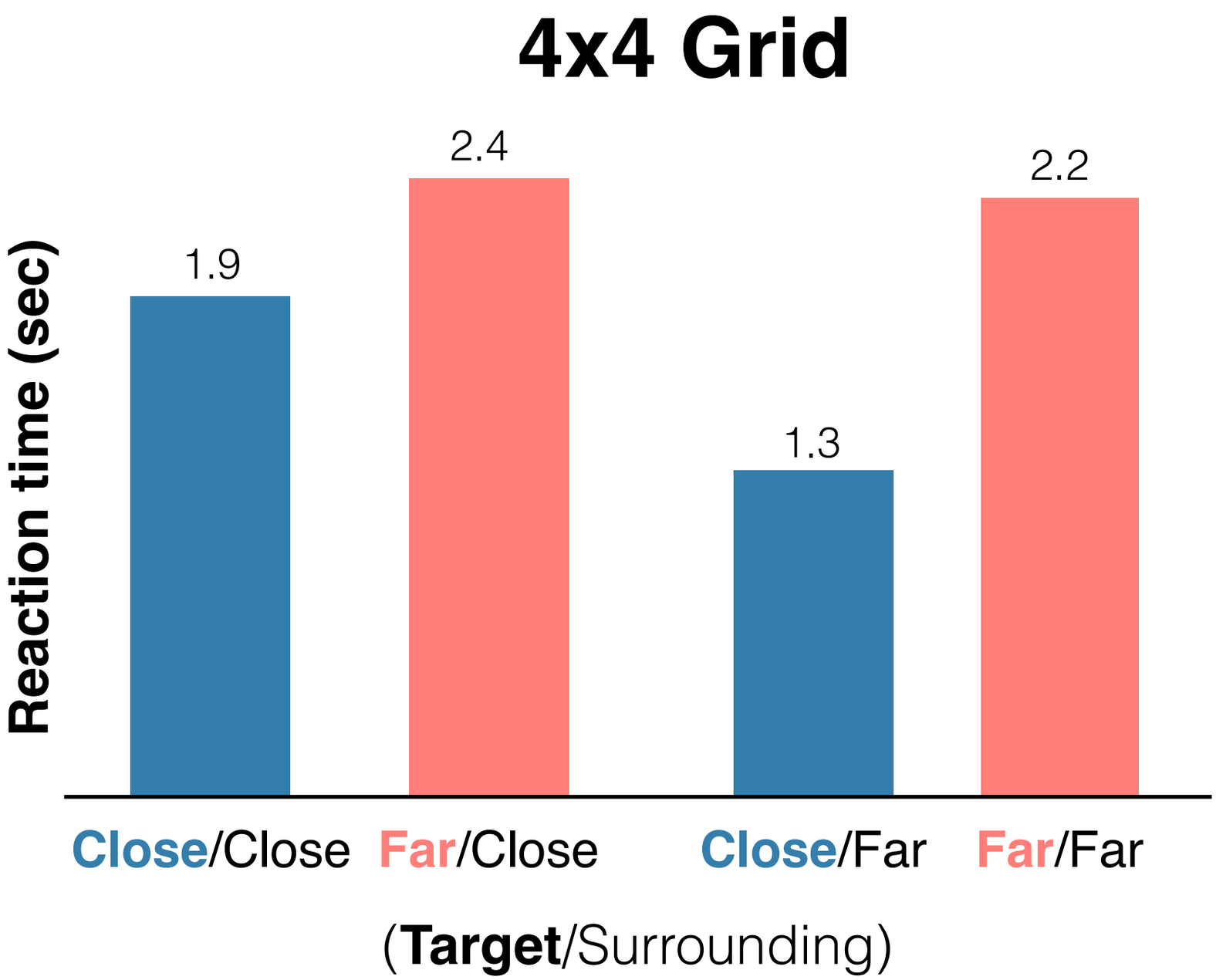
Find and Click ‘Print’ icon



Measures:

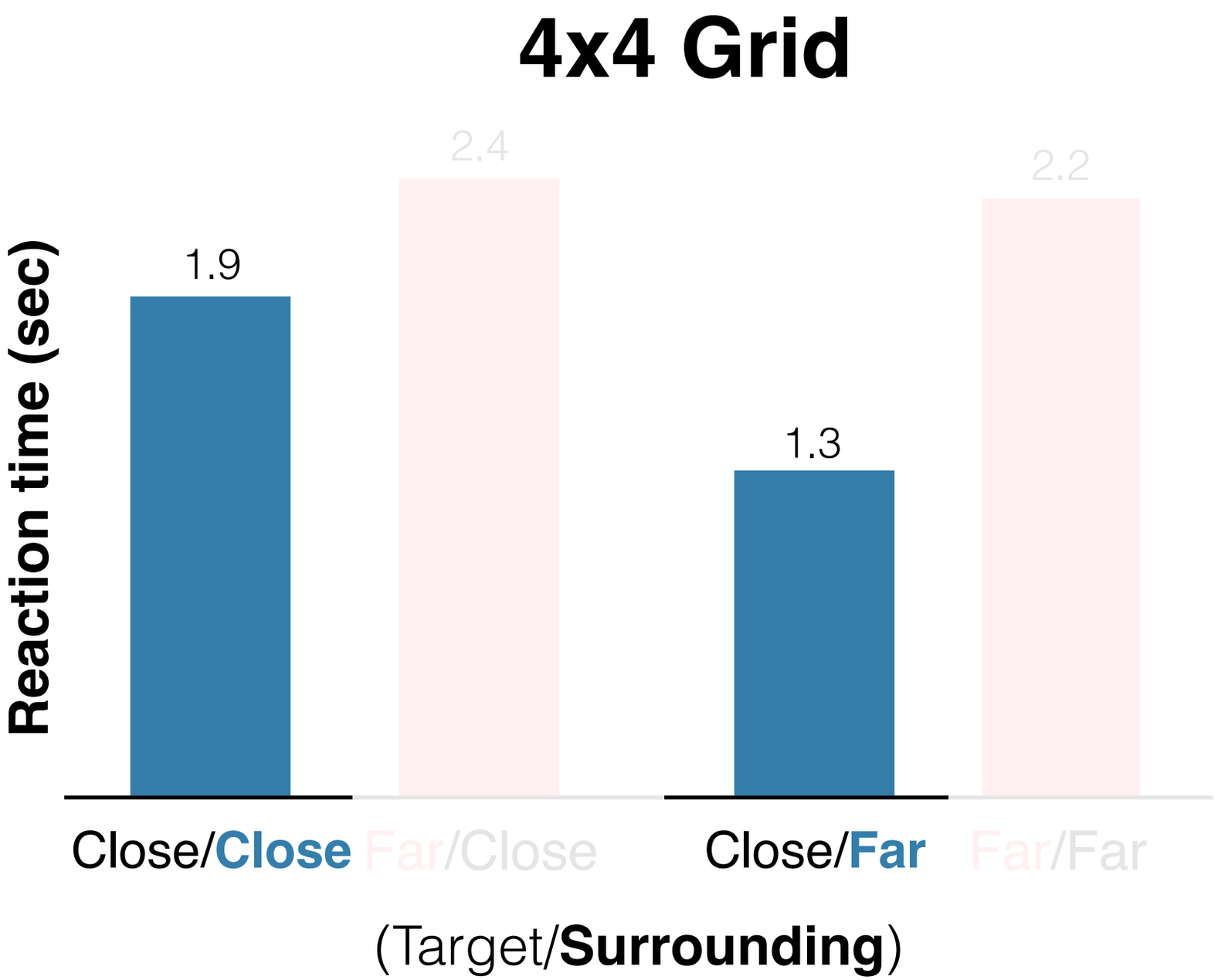
Reaction time

Error Rate



Close icons are good **target** icons.

Experiment 3 I Result

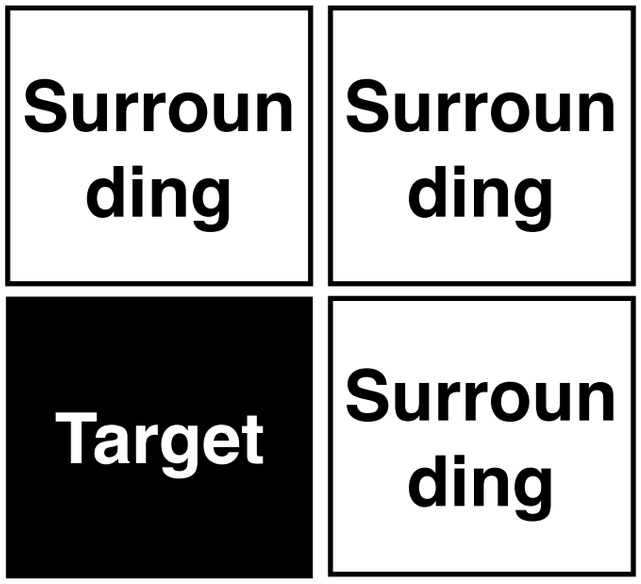


As **surrounding** icons, close icons **distract** participants.

Experiment 3 I Result

Far icons always increase **error rate.**

Experiment 3 I Result



2x2

3x3

Effect of surrounding icons with **grid sizes**.

http://www.smartwatchandroid.com/wp-content/uploads/2013/10/sony-smartwatch-1.jpg

Small Gird Size

Surroundings: Close

Make **trade-offs** between reaction time and error rate based on **screen size** of applications.

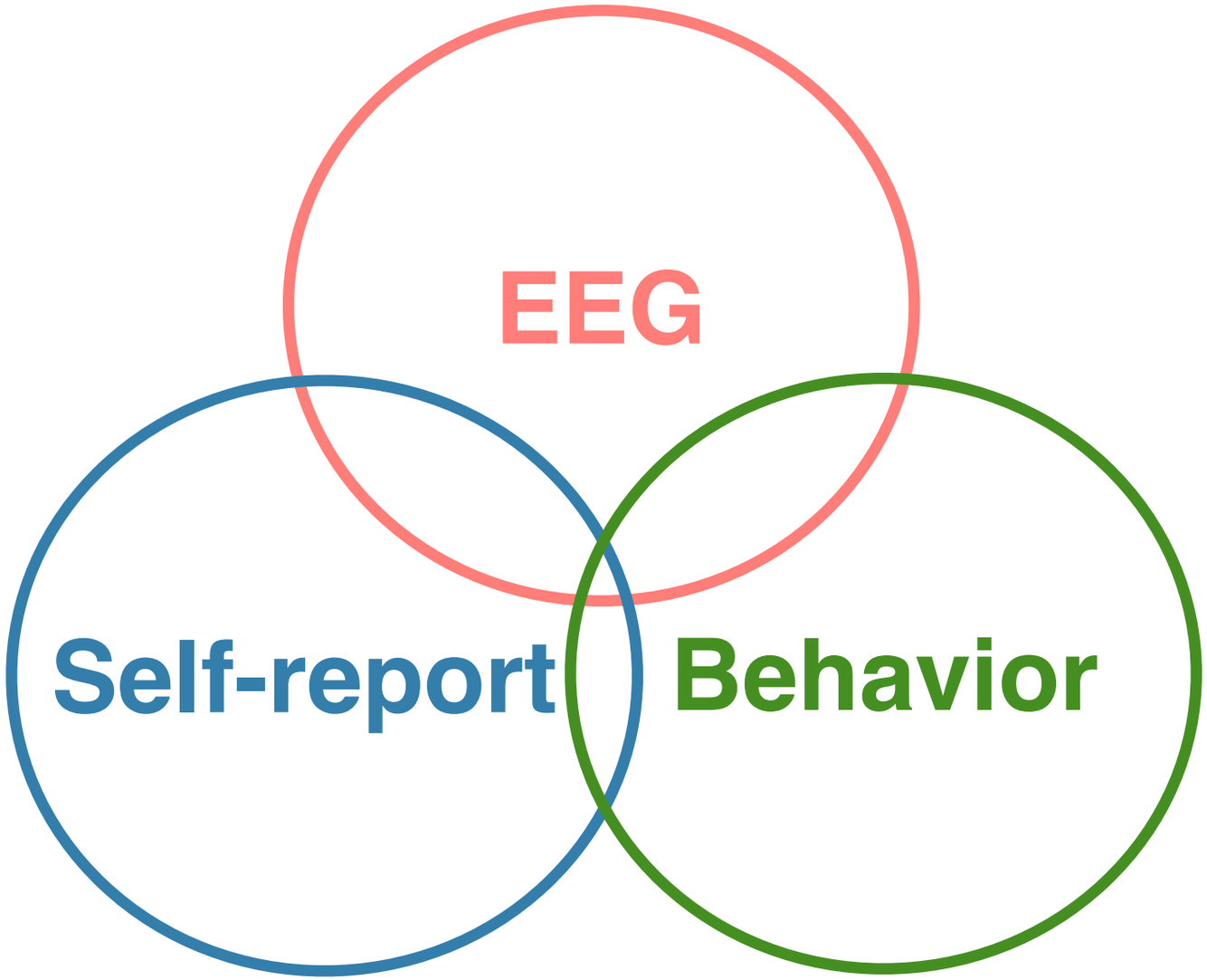
Big Gird Size

Surroundings: Far

http://files.technol... ...pad.jp

Summary

Summary



EEG-based evaluation complements behavioral measures and self-reports.

Summary

EEG-based method is feasible and powerful tool for evaluating icons.

Acknowledgement

Anonymous Reviewers

For insightful comments

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104-2628-E-009-001- MY3, 102-2221-E-009-082-MY3, and 103-2911-I-009-101-.

Questions?

An EEG-based Approach for Evaluating Graphic Icons from the Perspective of Semantic Distance

- Identify perceptual effects of icons
- Provide more refined method for evaluating icons
- Demonstrate how findings from EEG enrich icon usability testing.

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