Faculty of Education
Department of Learning Disabilities

Edmond J. Safra Brain Research Center
For the Study of Learning Disabilities
מרכז אדמונד י. ספרא לחקר המוח בלקויות למידה
مركز إدموند ج. سفرا لبحوث الدماغ في العسر التعليمي

החוג ללקויות למידה

Israel Ministry of Science & Technology
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Israel Science Foundation

Language-universal and script-specific factors in the recognition of letters in visual crowding: The effects of lexicality, hemifield, and transitional probabilities in a right-to-left script

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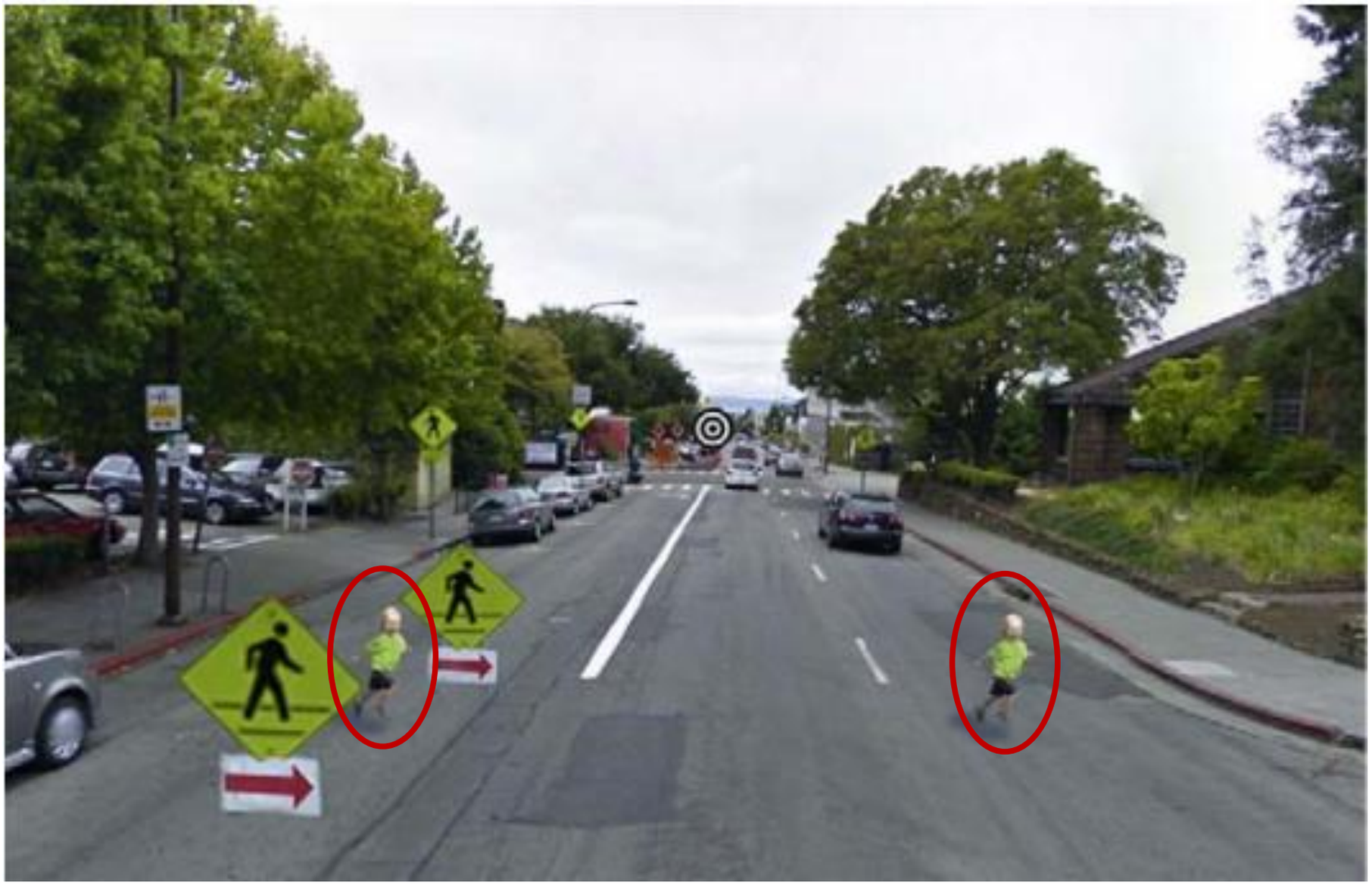
Introduction

Crowding

- Crowding refers to the failure to identify a peripheral item in clutter (Bouma, 1970).
- Mostly pronounced at the visual periphery.



Whitney & Levi, 2011

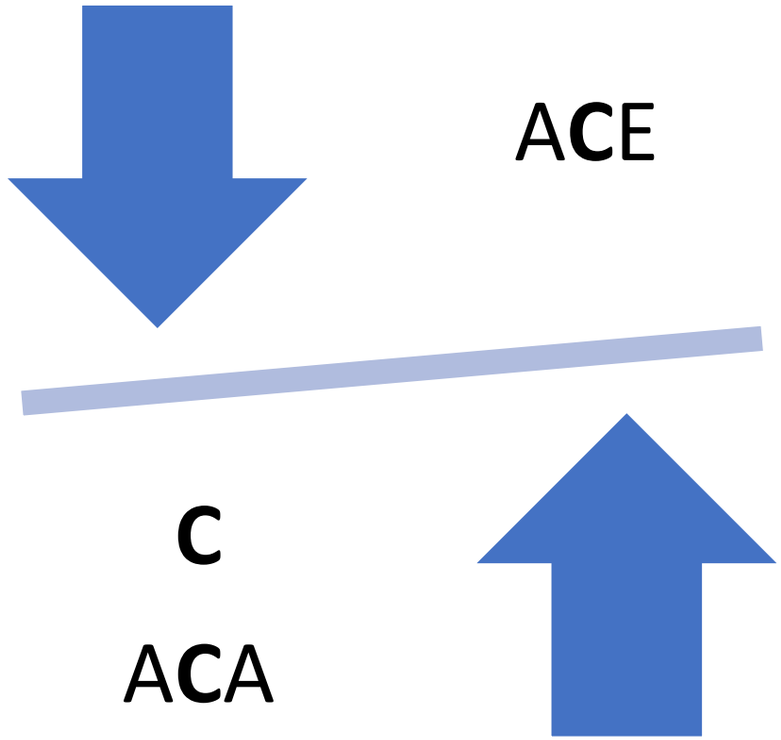
Introduction

Crowding and reading

- The visual periphery plays an important role in preprocessing upcoming words during reading (Schotteret al., 2012).
- Crowding sets significant constraints on the visual-orthographic processes involved in reading (Grainger et al., 2016).
- Whether sequential probabilities of letters influences crowding interference?
- We address this issue in the context of letter recognition.

Introduction

Central vision		Visual periphery	
Word superiority effect	**Word lexicality effect**	**Word superiority effect**	**Word lexicality effect**
☑	☑		
(e.g., McClelland & Rumelhart, 1981)			



Introduction

Central vision		Visual periphery	
Word superiority effect	**Word lexicality effect**	**Word superiority effect**	**Word lexicality effect**
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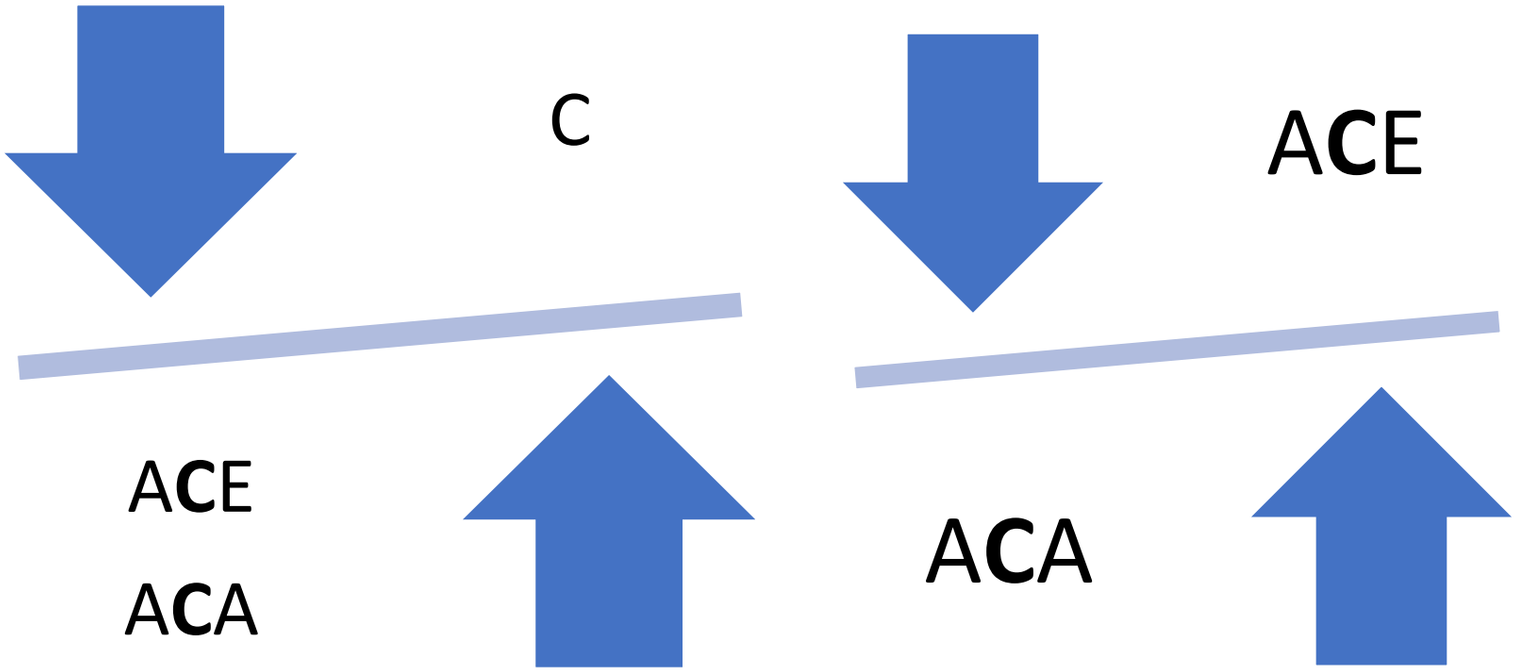
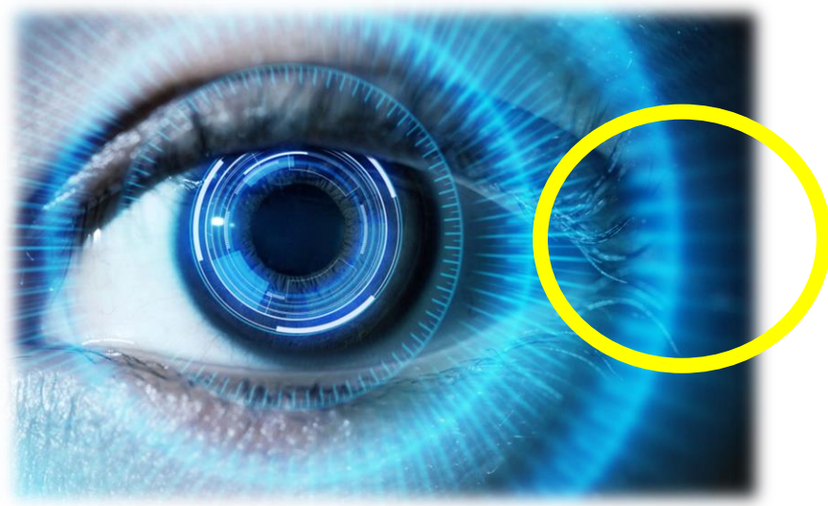
(e.g., McClelland & Rumelhart, 1981)		(e.g., Martelli et al., 2005)	

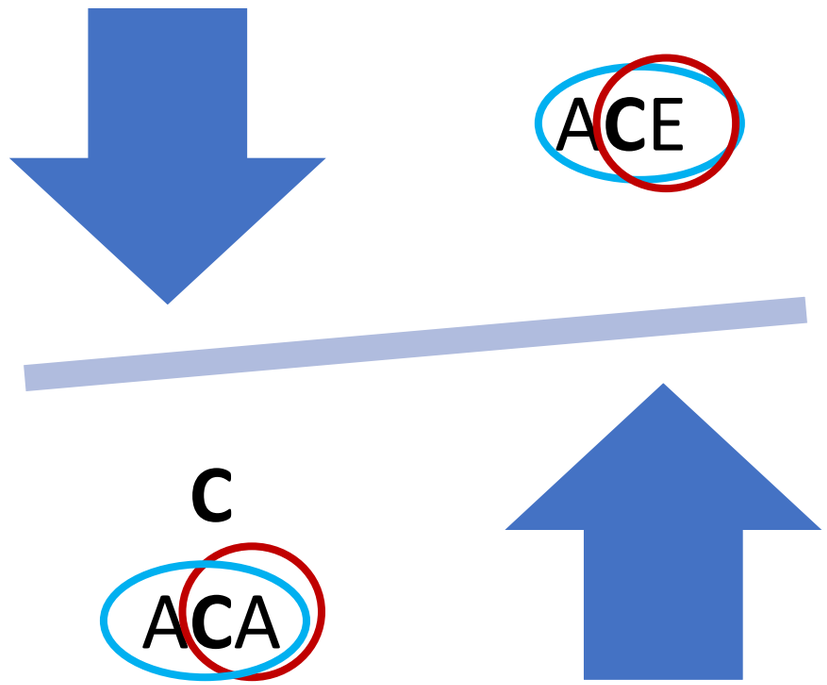




Introduction

Sub-lexical information and letter identification

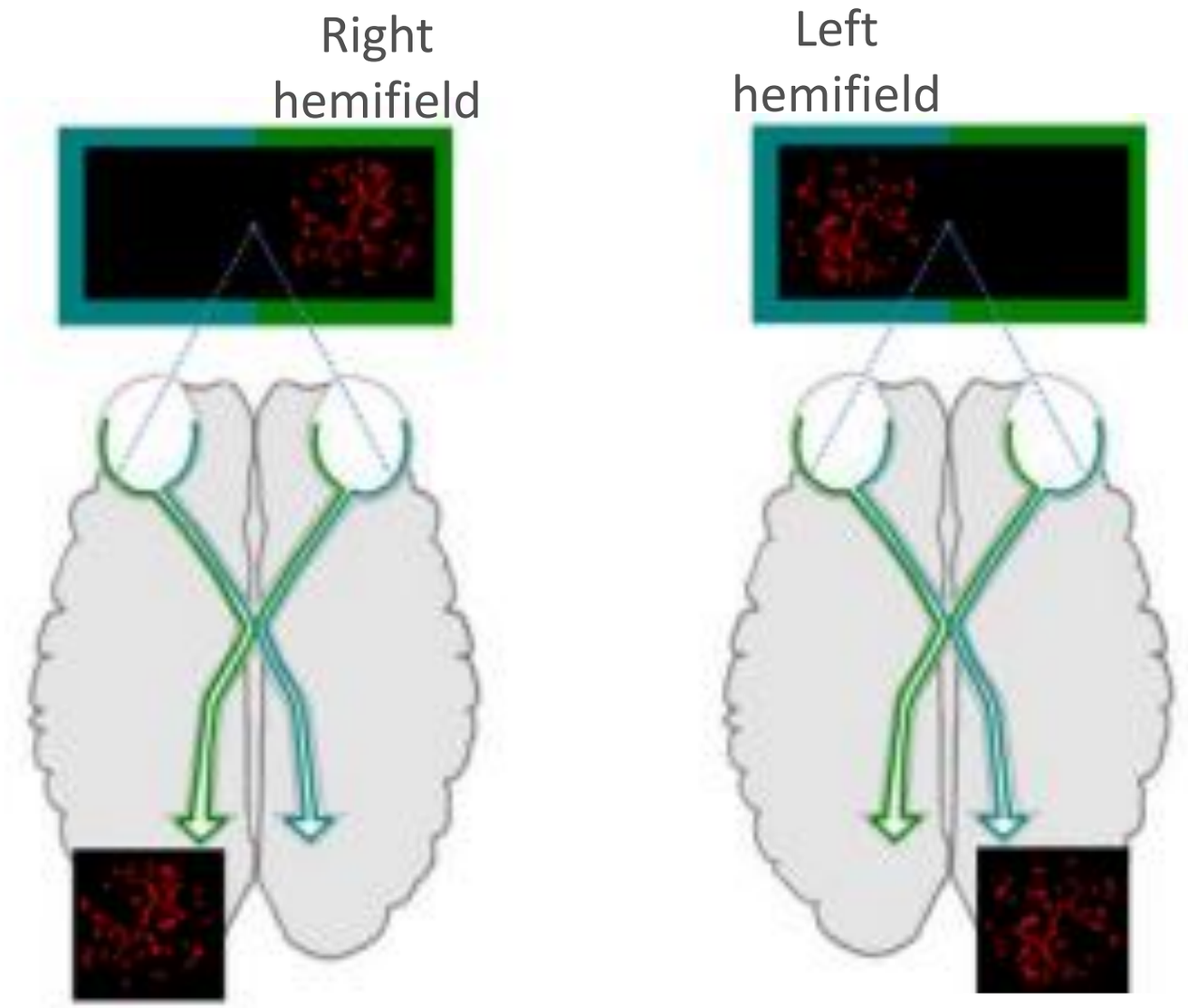
- Words and pseudowords differ in their probabilities of the word-internal sequence of letters.
- Certain bigrams and trigrams have higher probabilities than others.
- No studies have yet directly investigated the influence of transitional probability on letter recognition in print.



Introduction

Lateralization effect and letter identification

- A domain-specific neural mechanism for reading located in the left hemisphere (Dehaene, 2005; Ossowski & Behrmann, 2015)
- The neuronal recycling hypothesis: left hemisphere advantage.
- Right hemifield > Left hemifield



Wright et al., 2017

The current study

Language universal effects

Language specific factor

Lateralization effect

Lexicality effect

Sublexical transitional probabilities

Right hemifield > Left hemifield

Left bigram ≠ Right bigram

Uncrowded > crowded familiar word > crowded unfamiliar word

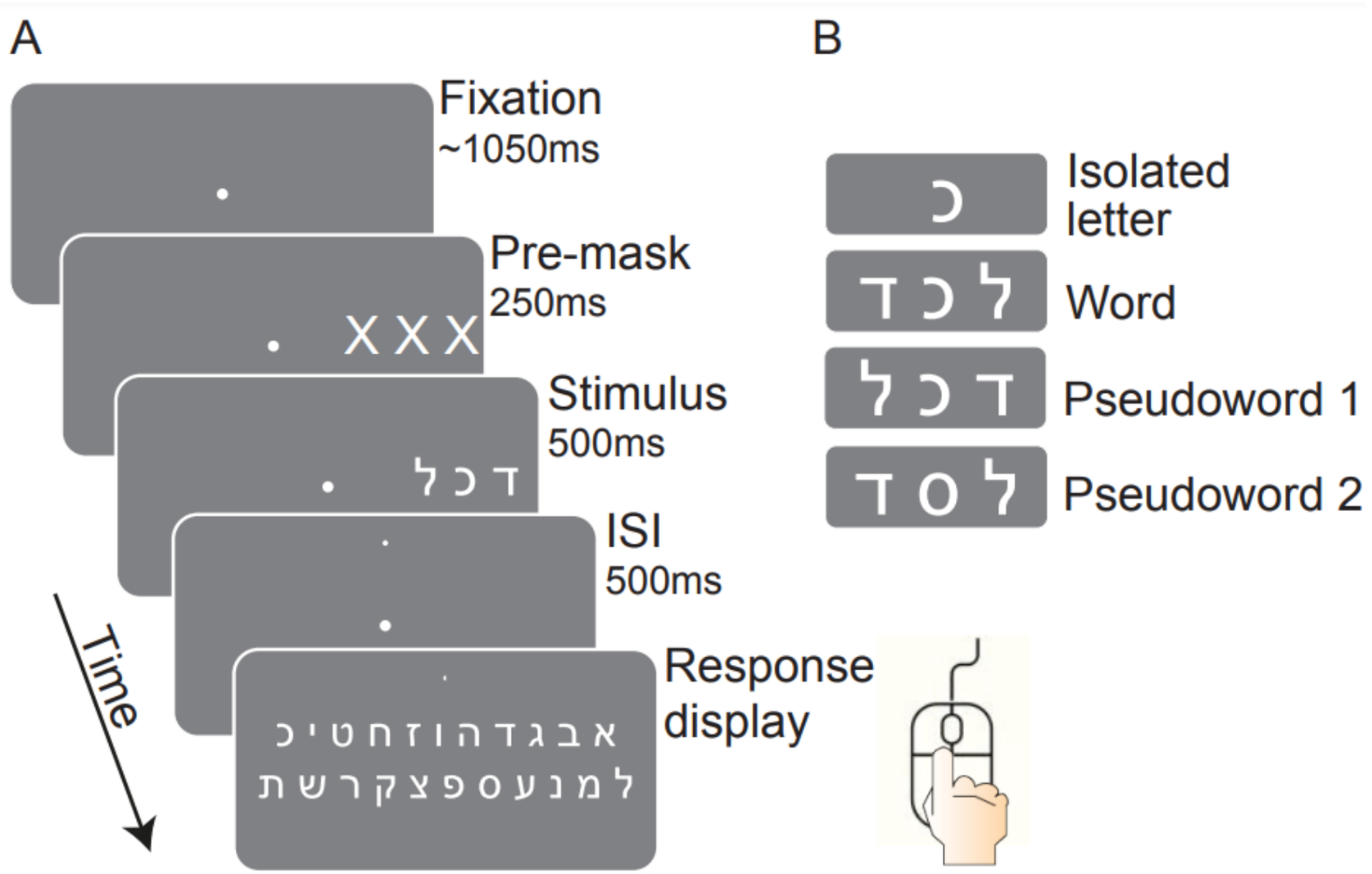
General method

Experiment 1
(n = 14)

Experiment 2
(n = 14)

Experiment 1
Method

Procedure:



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Method

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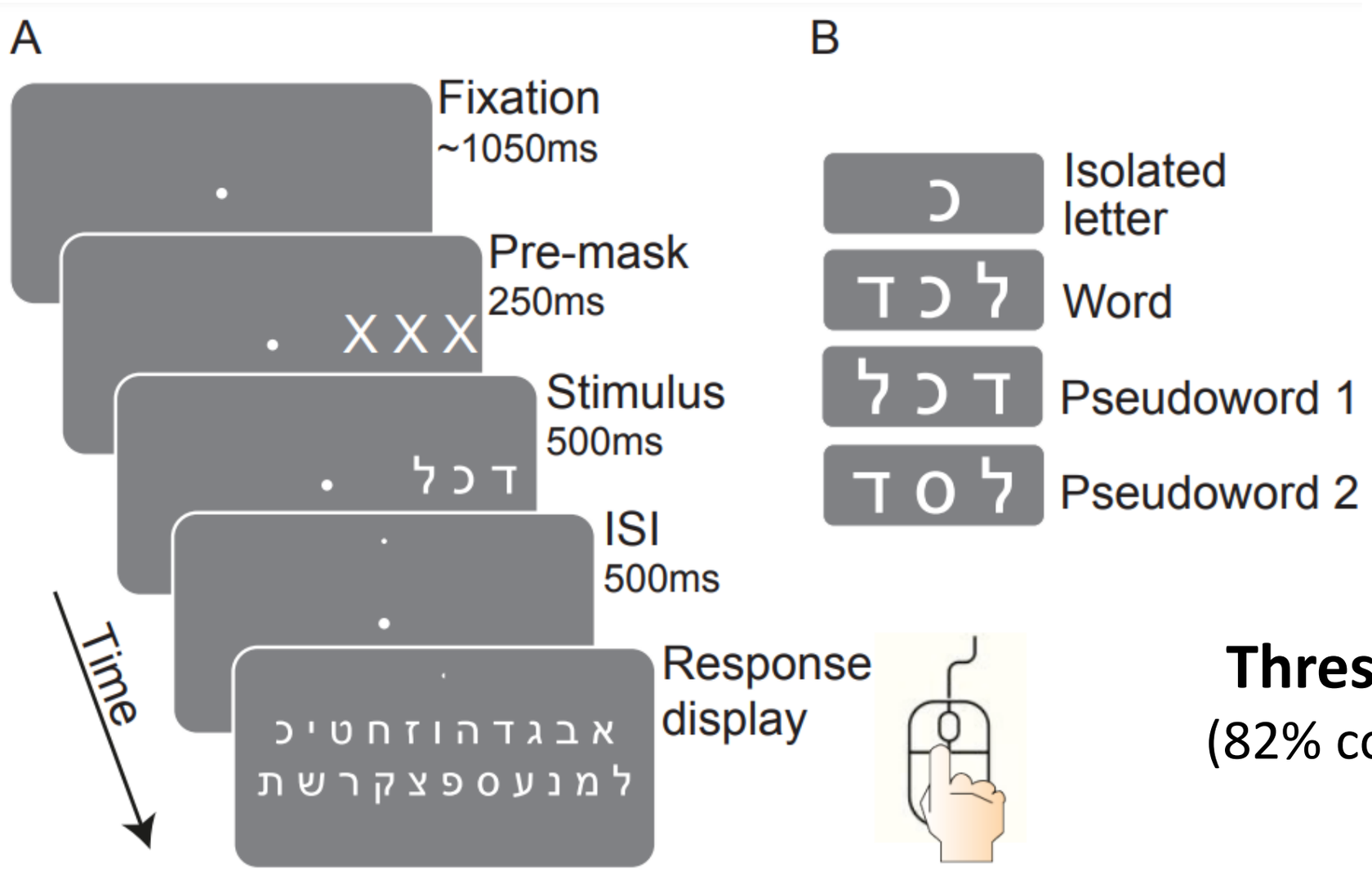


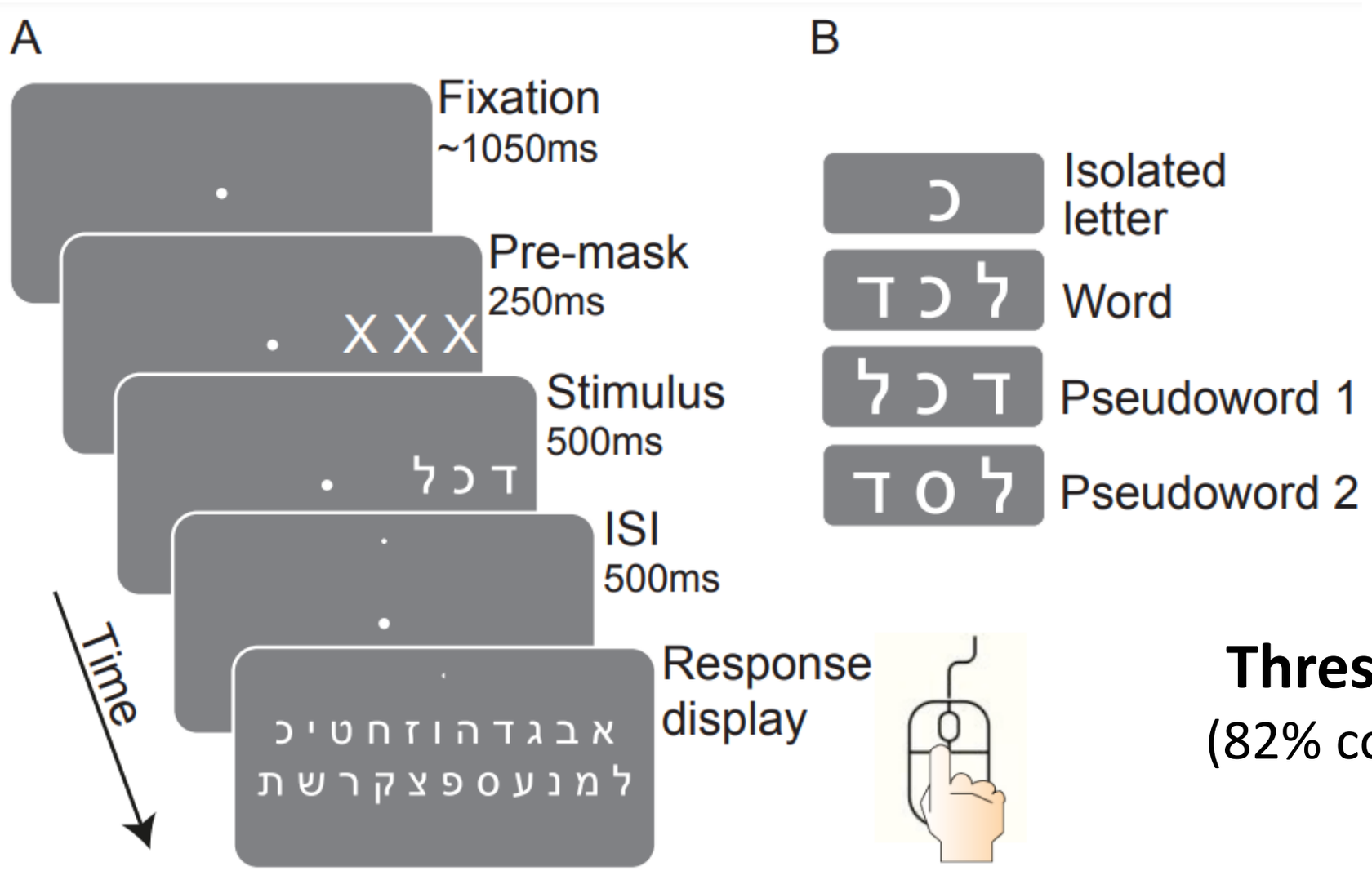
Threshold
(82% correct)

דכל

QUEST (Watson & Pelli, 1983)

Experiment 1
Method

Procedure:



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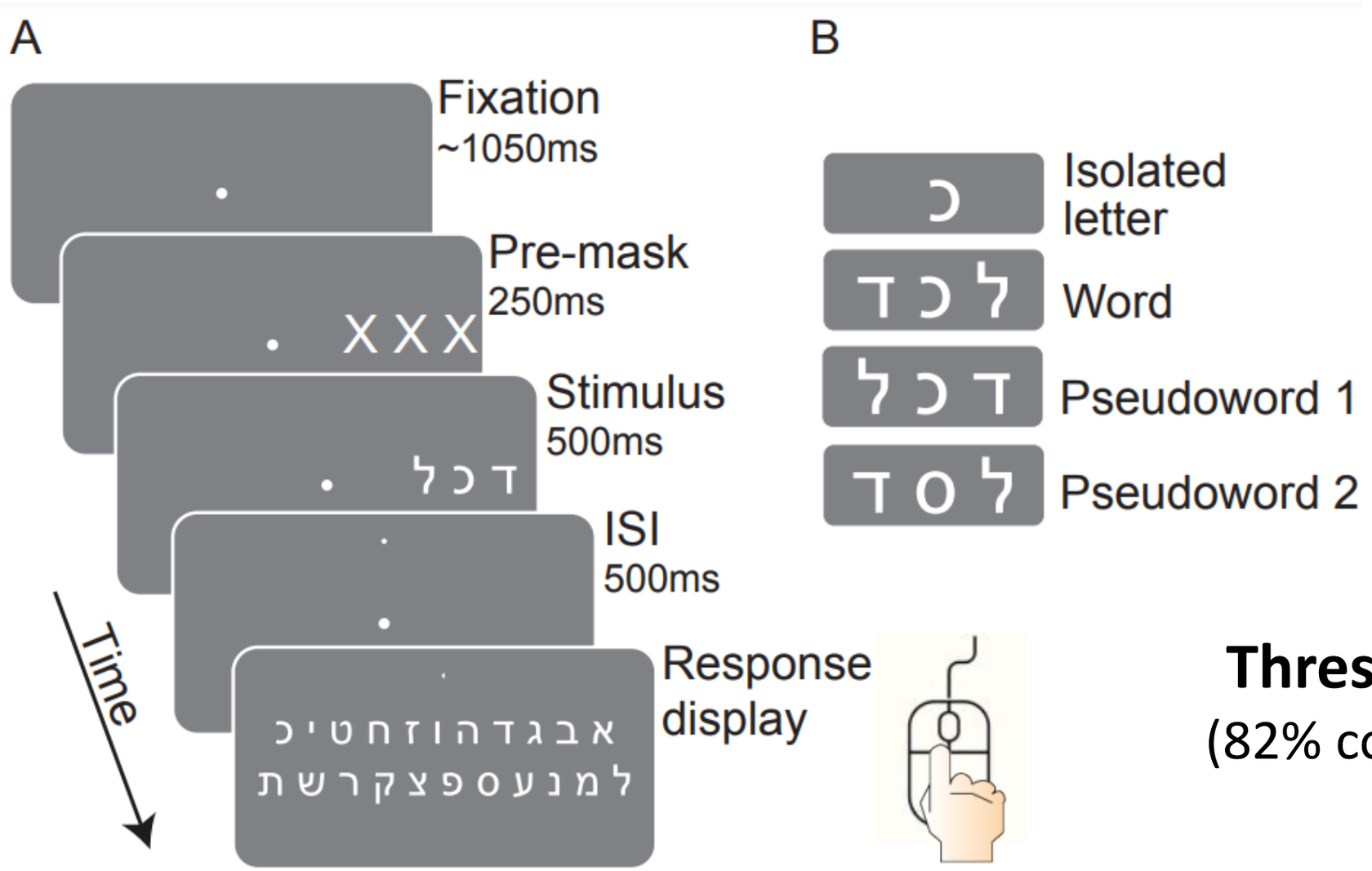

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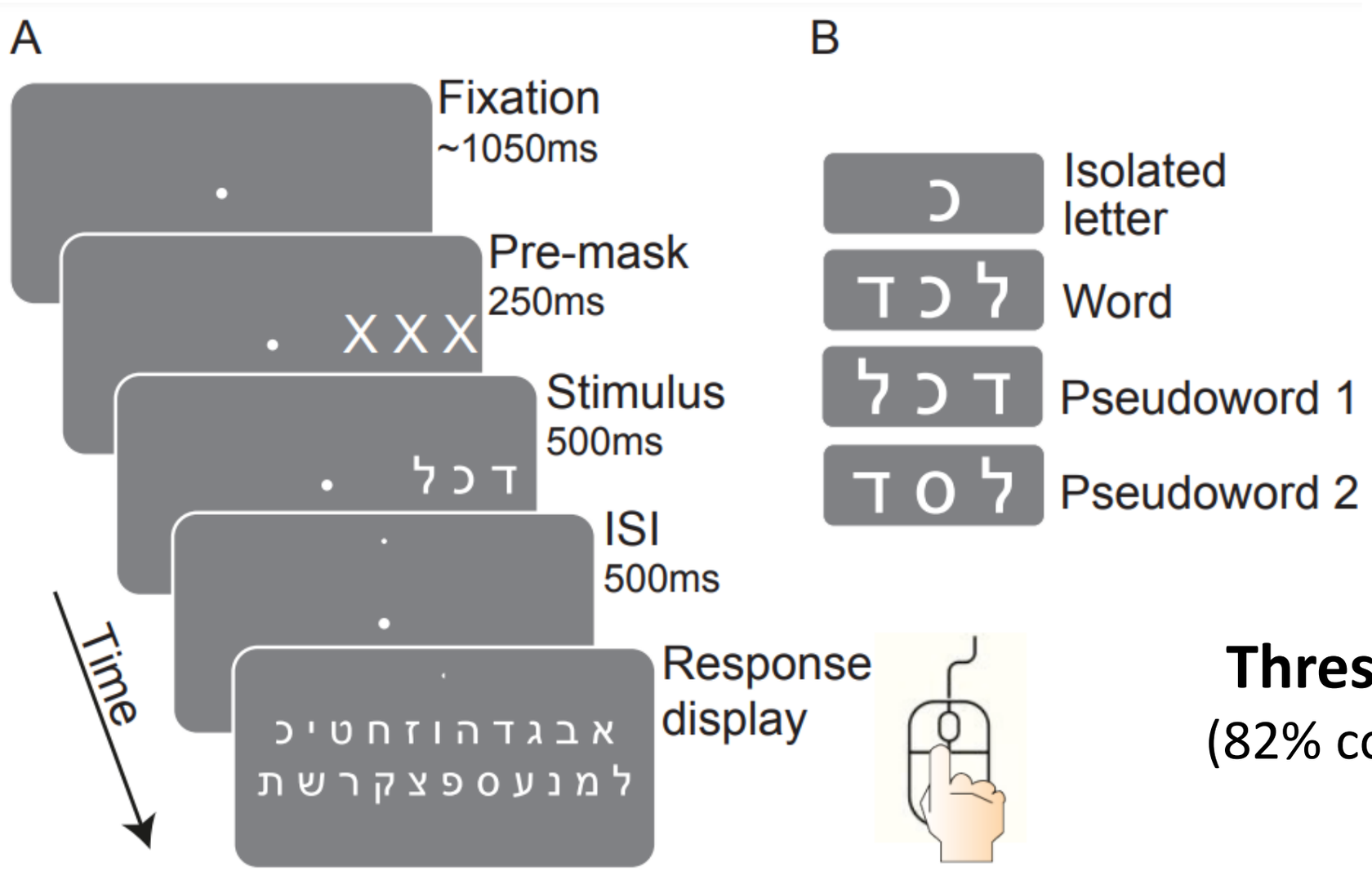

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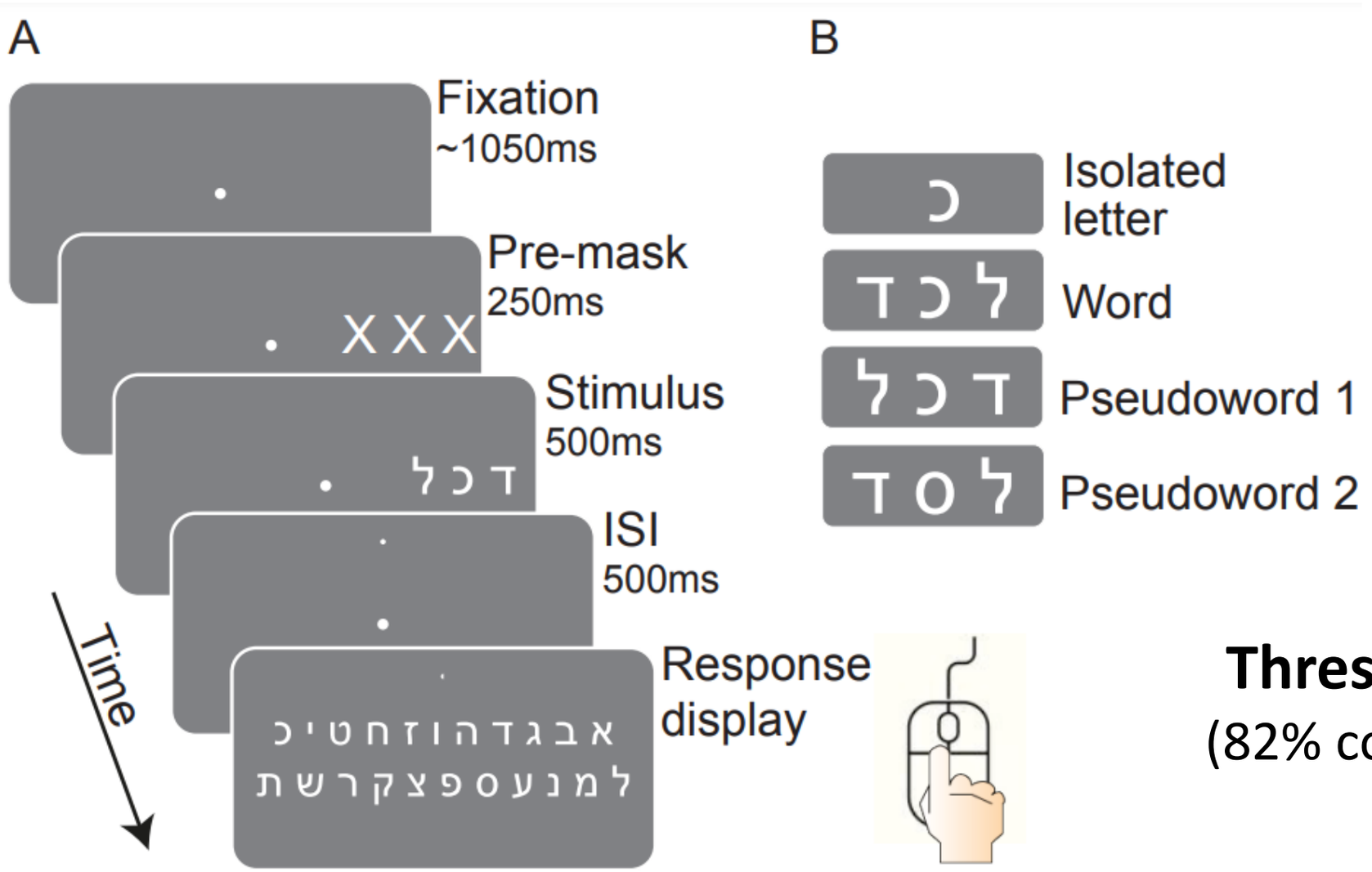

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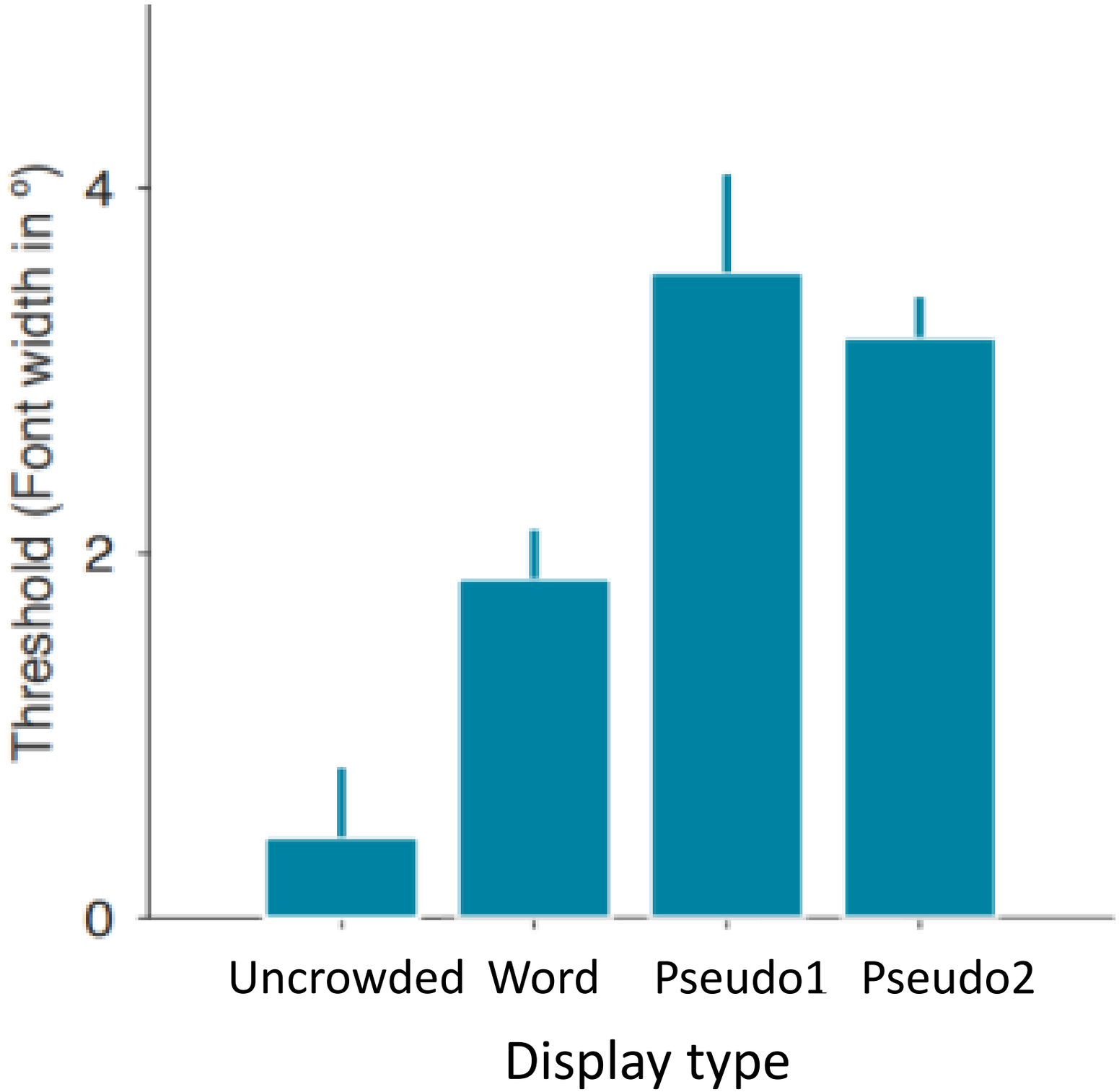
QUEST (Watson & Pelli, 1983)

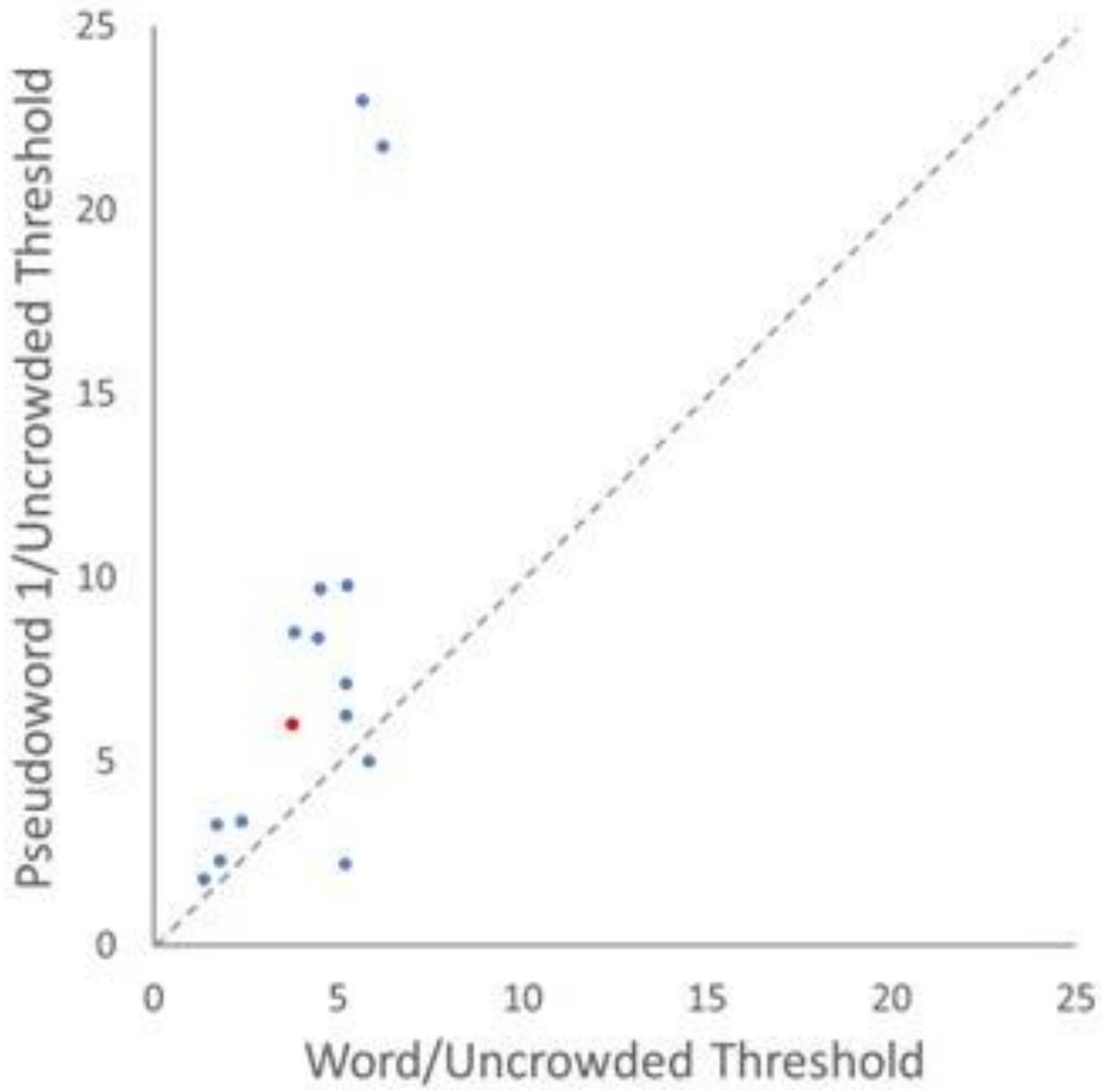
Experiment 1
Results

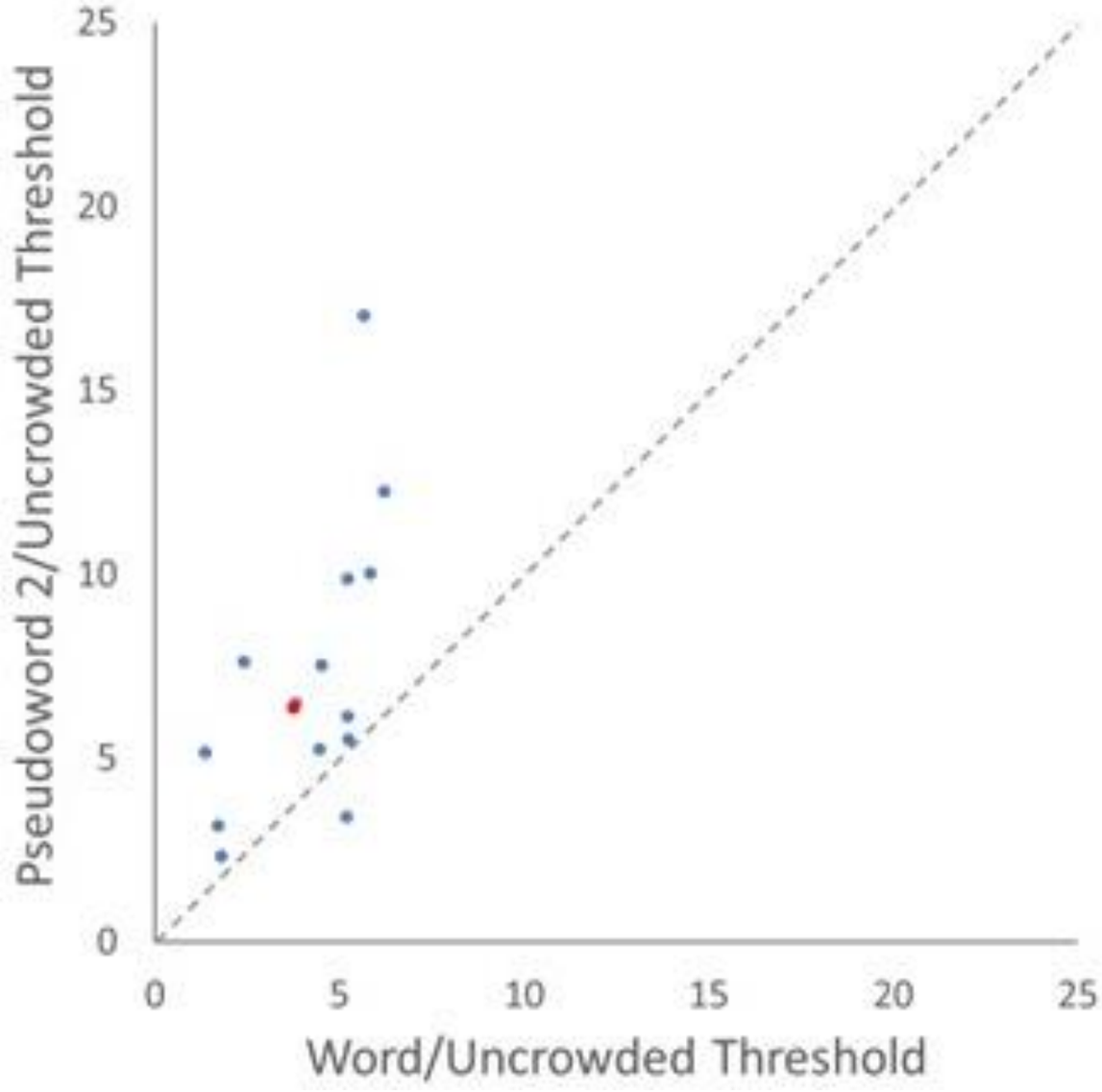
(n = 14)



Experiment 1
Results

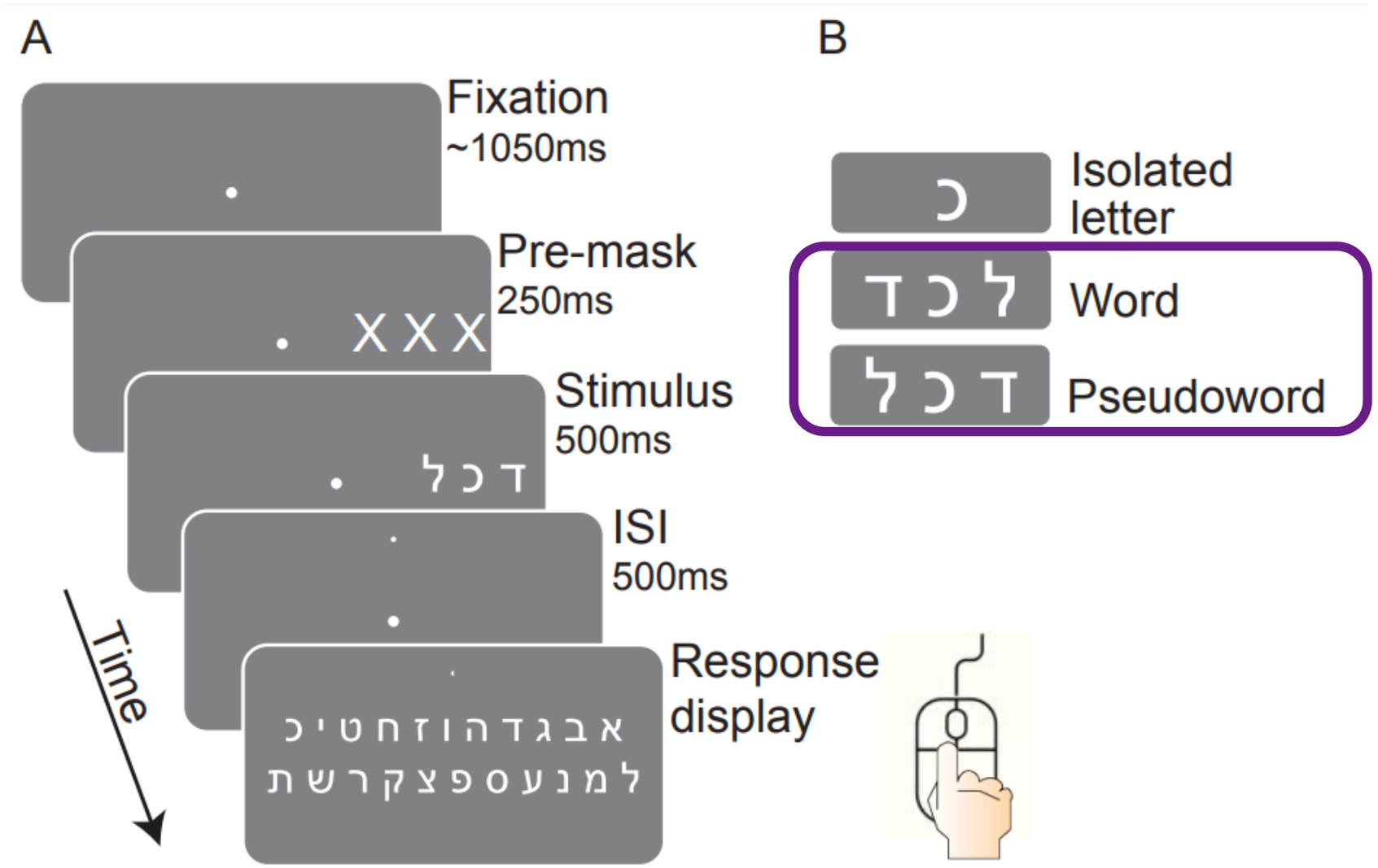
(n = 14)





Experiment 2
Method

Procedure:



Phase 1: Threshold

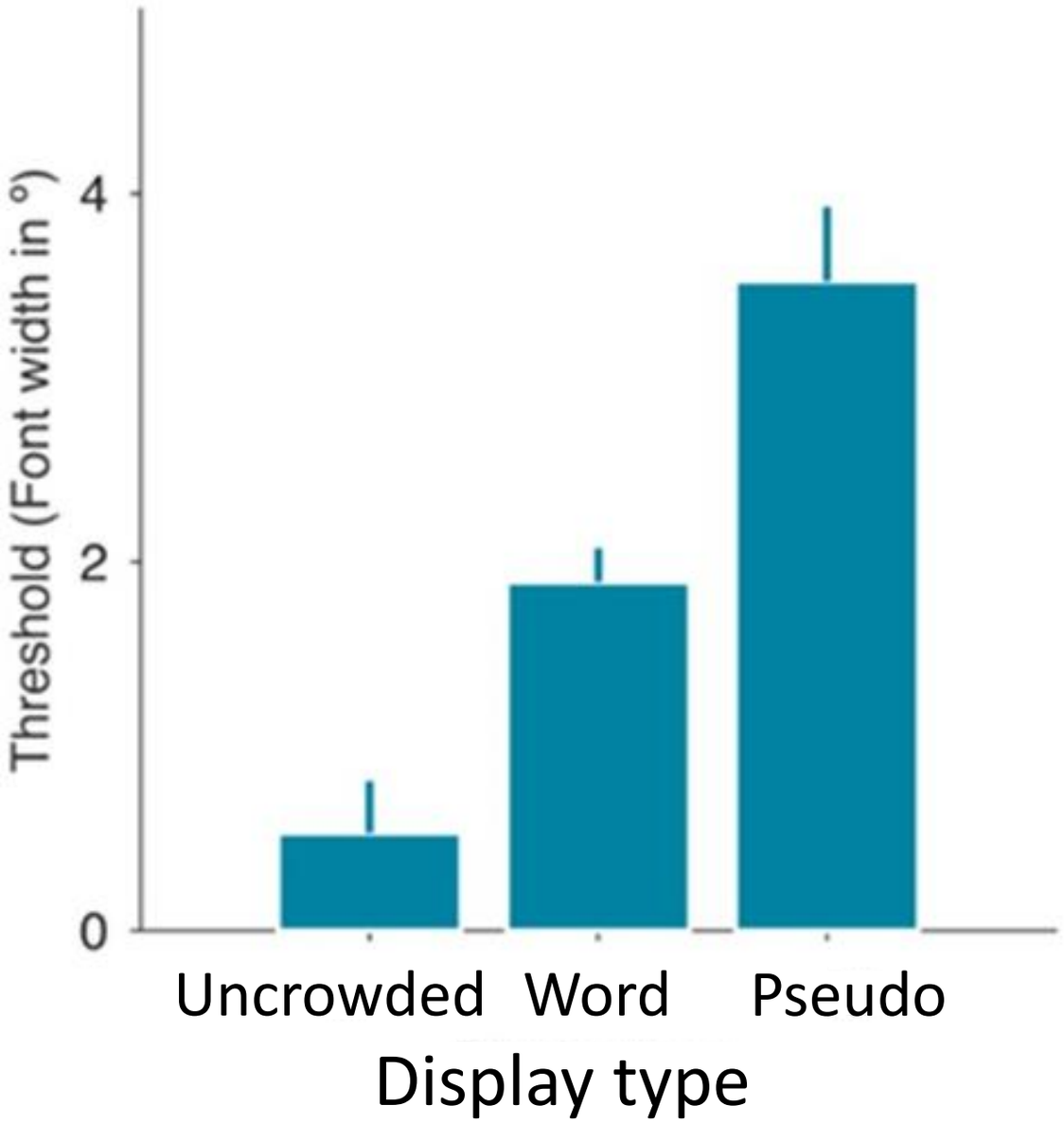
Phase 2: Accuracy

Experiment 2
Results

Threshold phase.

(n = 14)

A

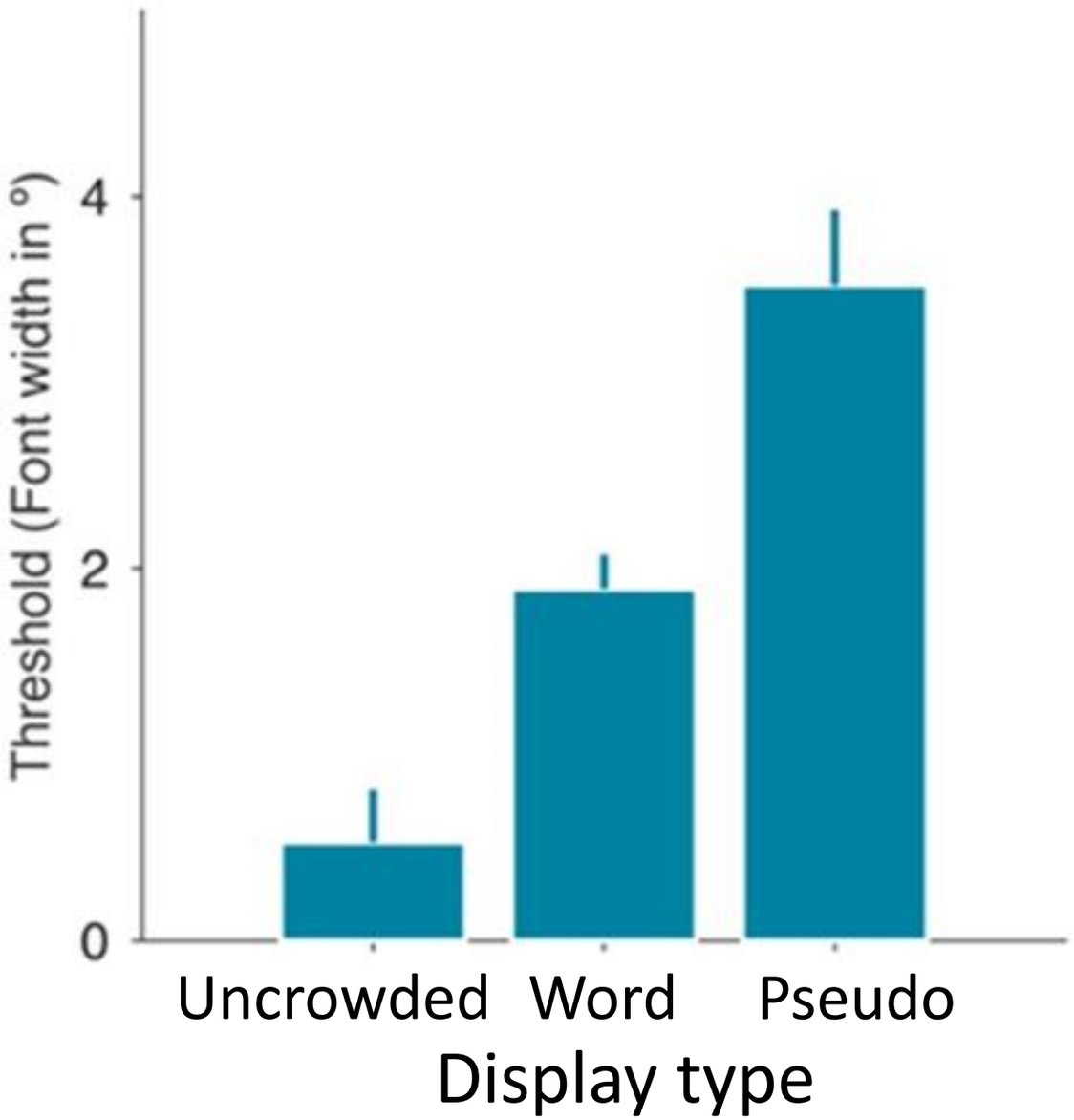


Experiment 2
Results

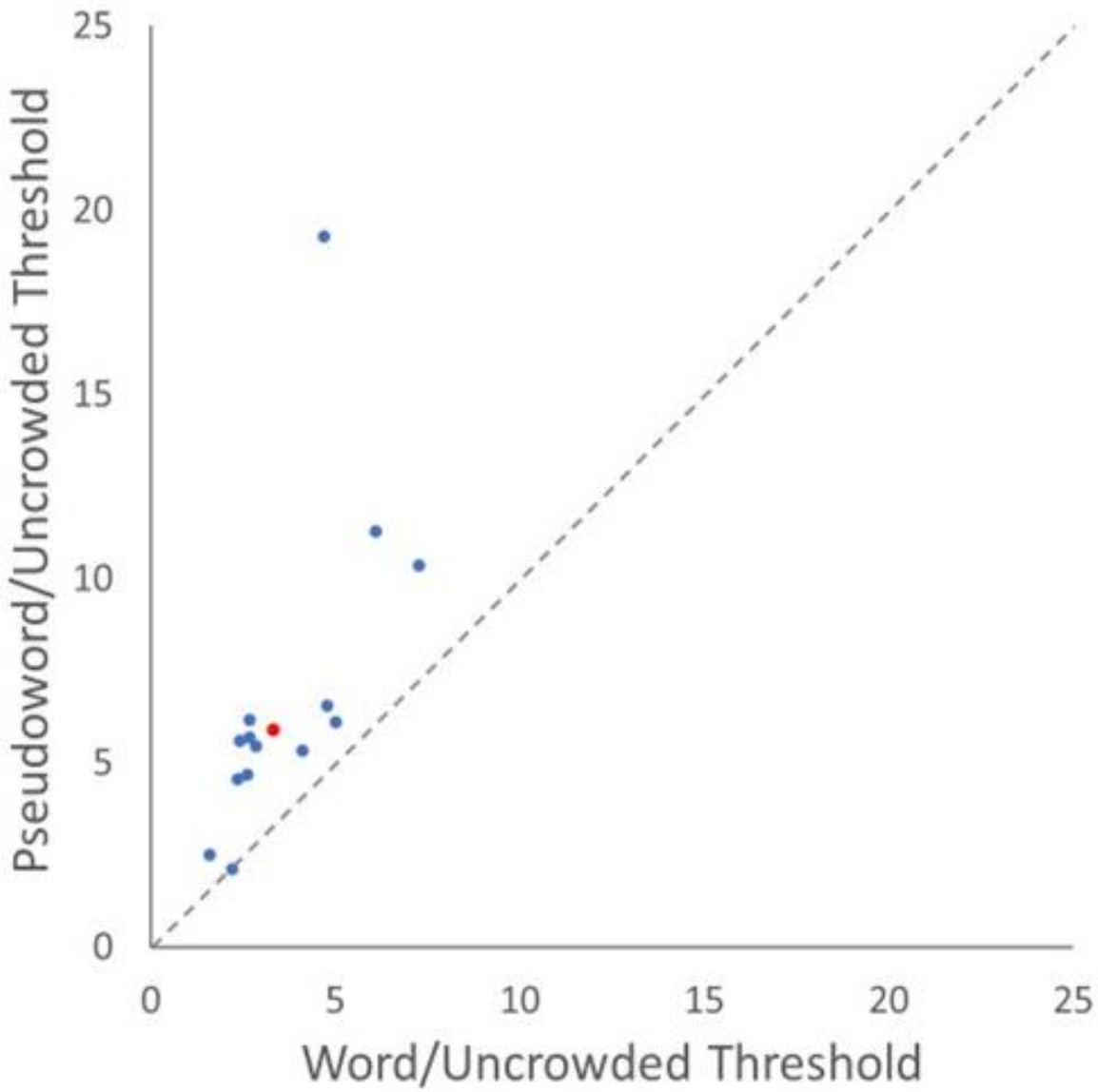
Threshold phase.

(n = 14)

A



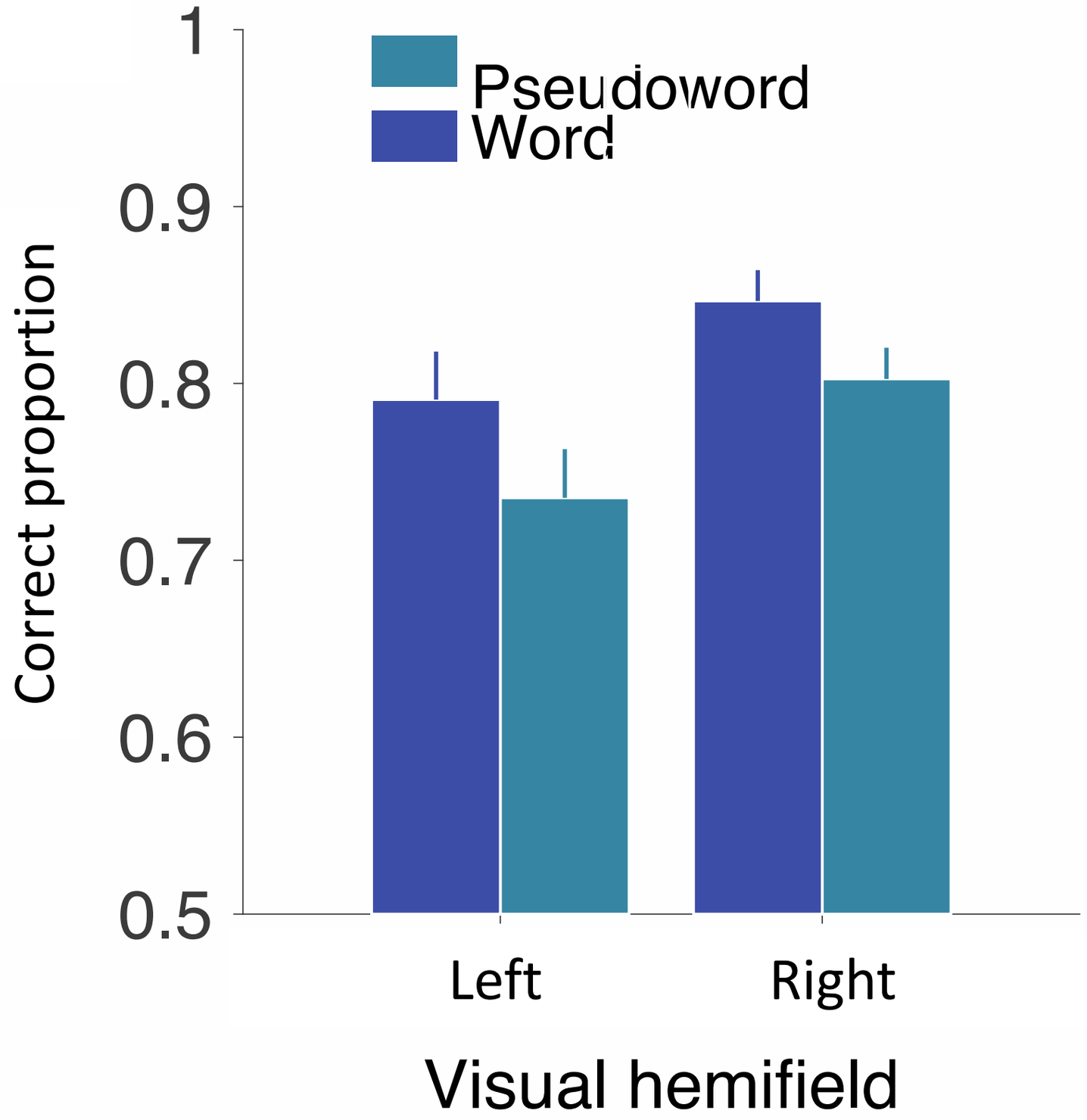
B



Experiment 2
Results

Accuracy phase.

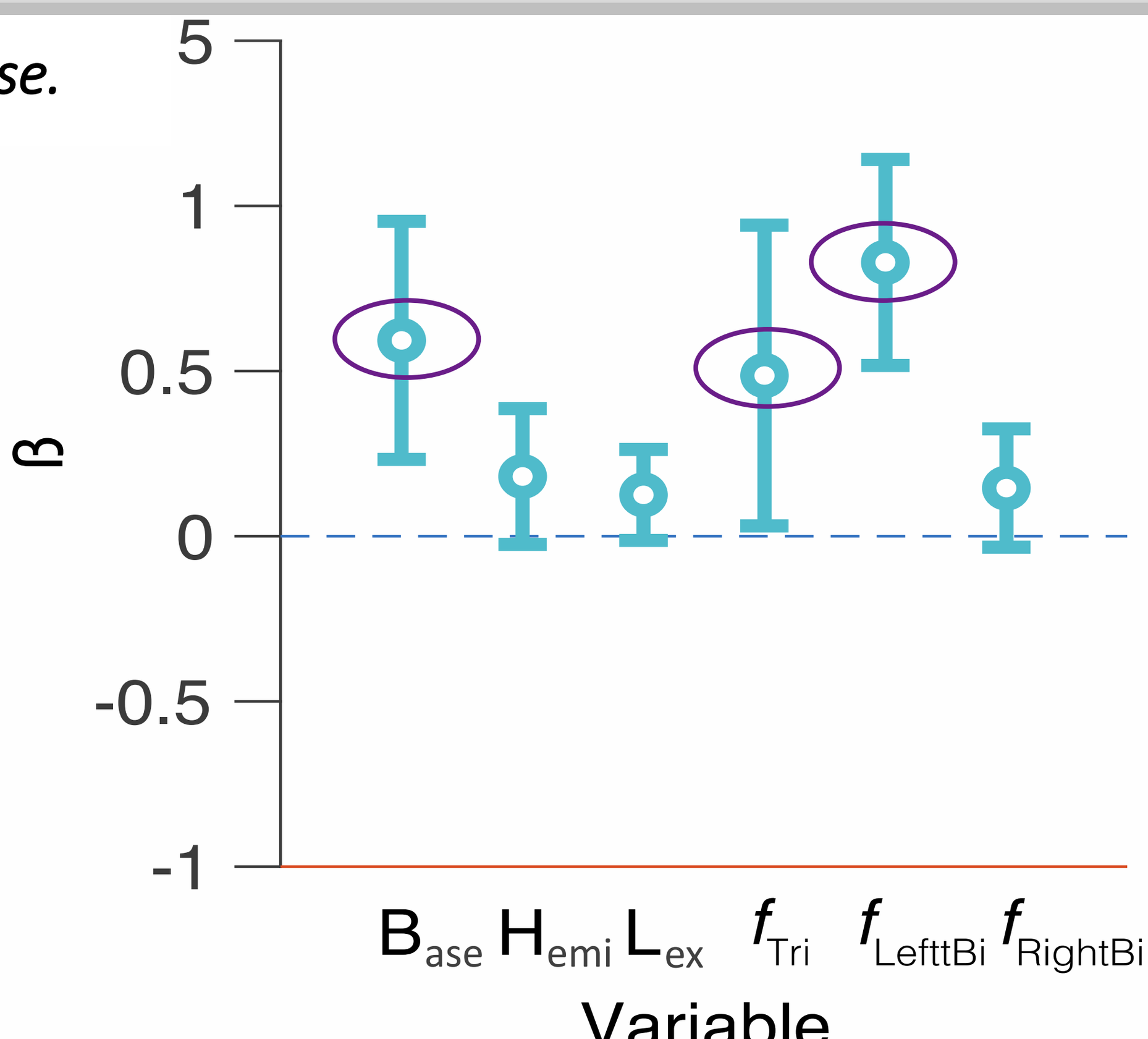
(n = 14)



Experiment 2
Results

Accuracy phase.

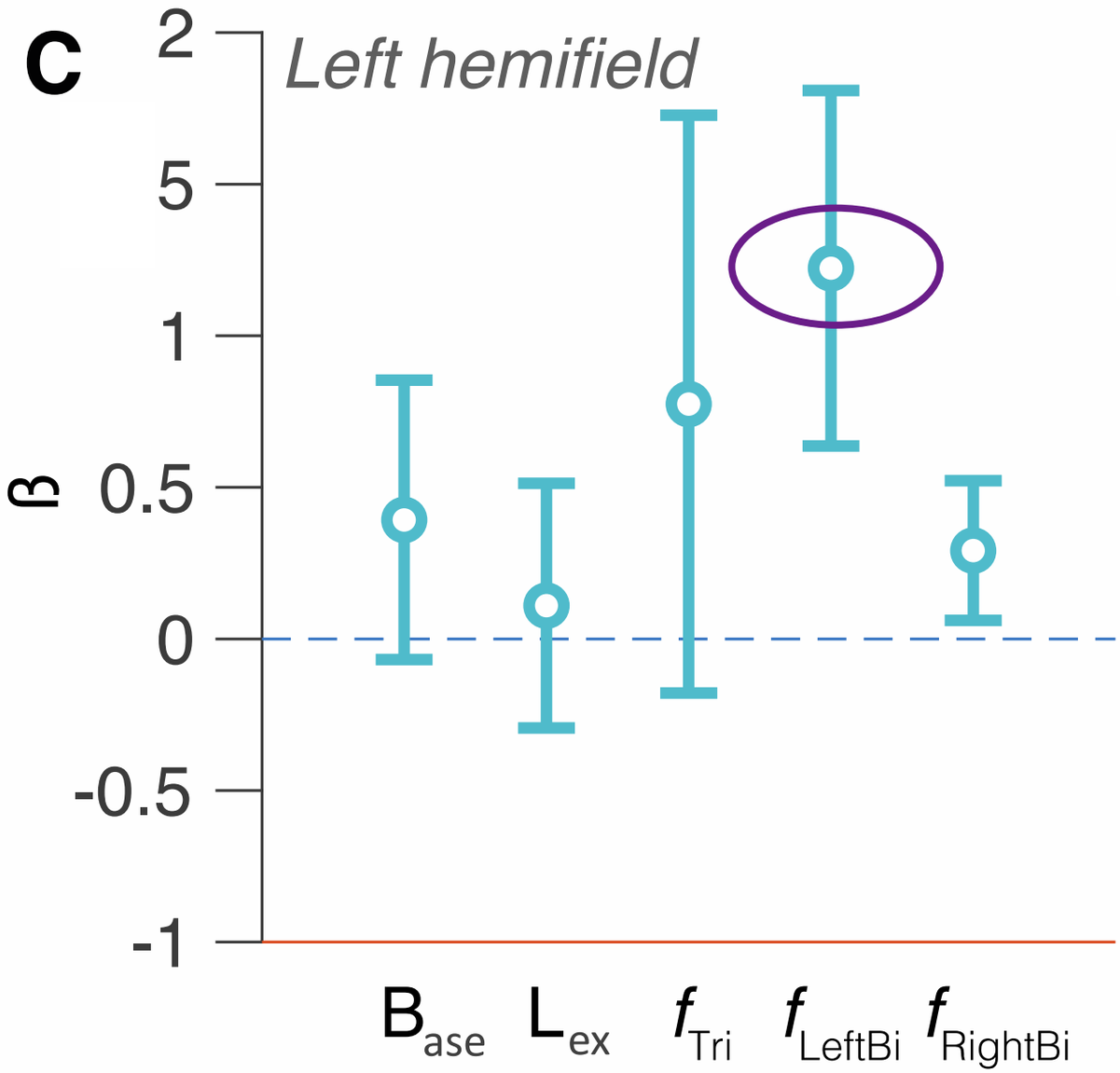
(n = 13)

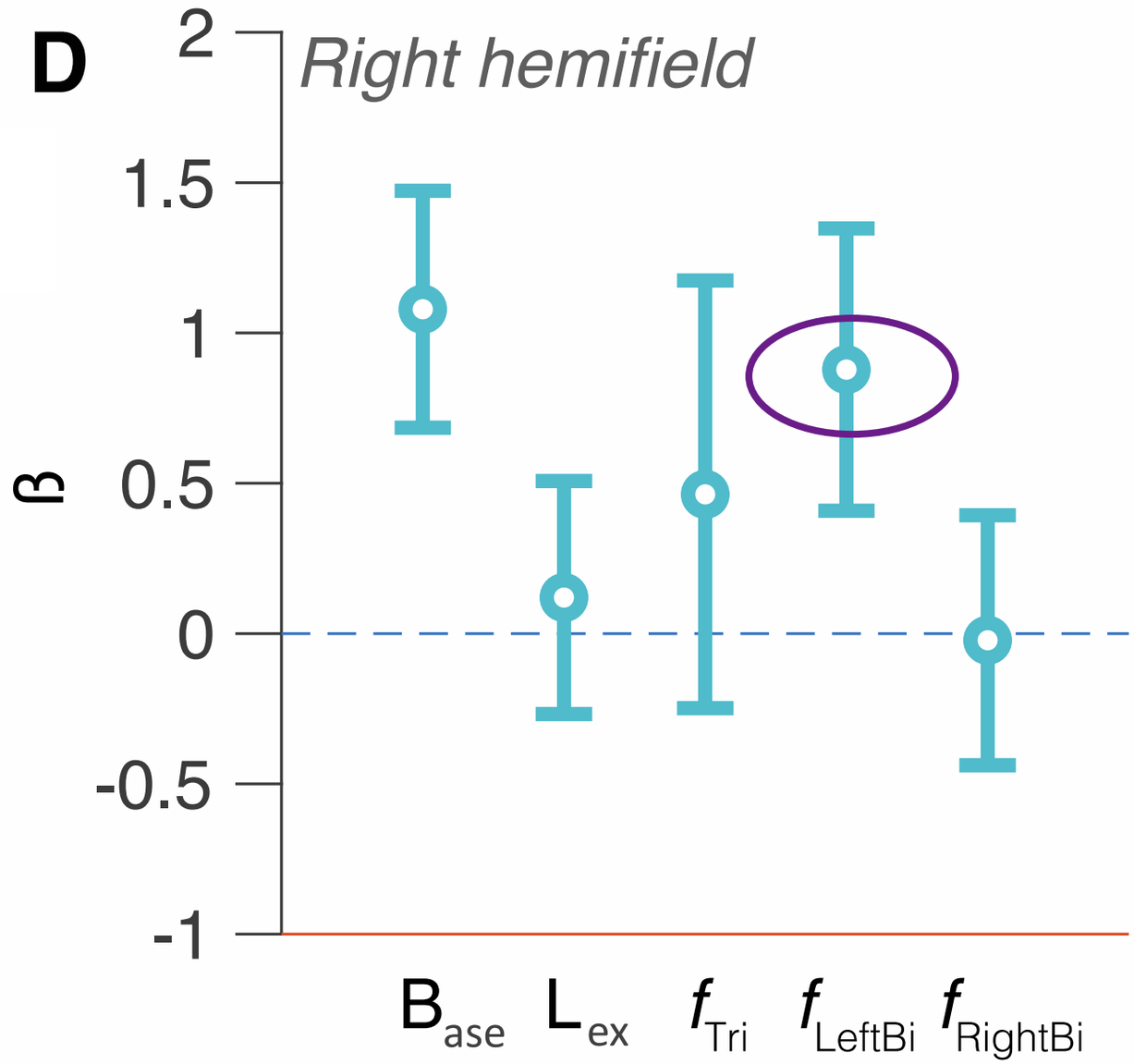


Experiment 2
Results

Accuracy phase.

(n = 13)





Summary

Language universal effects ☑

Language specific factor ☑

Lateralization effect

Lexicality effect

Sublexical transitional probabilities

Right hemifield > Left hemifield ☑

Left bigram > Right bigram ☑

Uncrowded > crowded familiar word > crowded unfamiliar word ☑

Conclusions

- Crowding is more detrimental when the crowded letter is presented in the left hemifield, regardless of script-specific factors such as reading direction.
- Lexical context supports the recognition of crowded letters in any orthography and writing system.
- In Hebrew, sub-lexical probabilities explain performance better than lexicality.
- Our findings reveal the critical role of transitional probabilities in parafoveal letter recognition.
- Bigram frequencies, more than lexicality, predict performance.
- Our results highlight the importance of integrating bigram frequencies into models of visual word recognition in the parafovea.

Funding

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Thank you!