

# Embodied time: how the abstract concept of time arises from sensorimotor experience

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INTRODUCTION

MENTAL TIMELINE

MAIN RESULTS

CONCLUSIONS

HYPOTHESES

METHODS

MOVEMENTS FOR RESPONSES

How do people *grasp* the abstract concept of time?

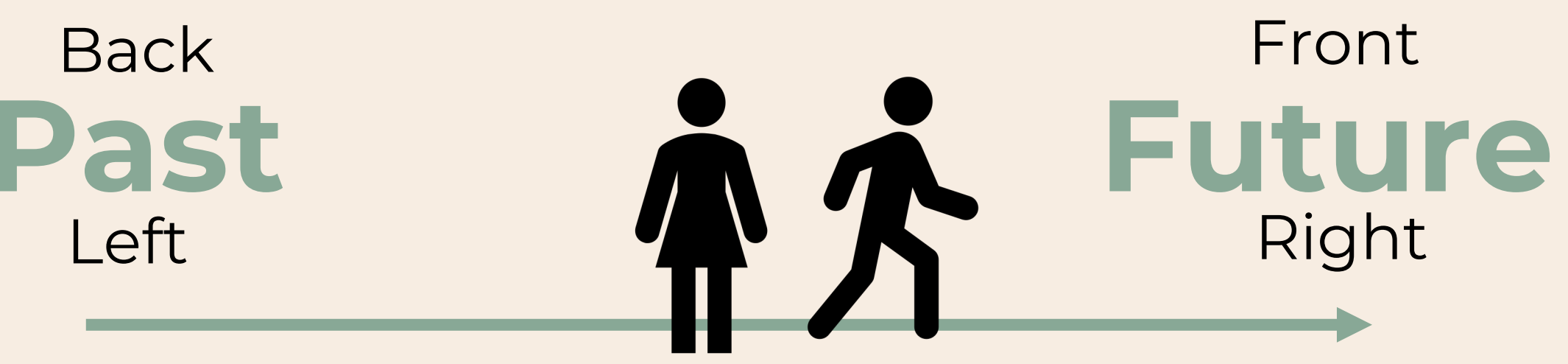
If the role involvement of sensorimotor systems in the processing of concrete words is now established, their role in the representation and the processing of abstract concepts is at the heart of a lively debate [1][2]. Based of theoretical proposal such as neural reuse [3] and correlational learning [4] we examined the way in which abstract temporal concepts could be grounded.

**Time is a highly abstract concept.** Data suggest that humans represent abstract temporal concepts in two spatial axes, flowing linearly from one position in space to another, called a “mental timeline” [5][6] (see fig. below).

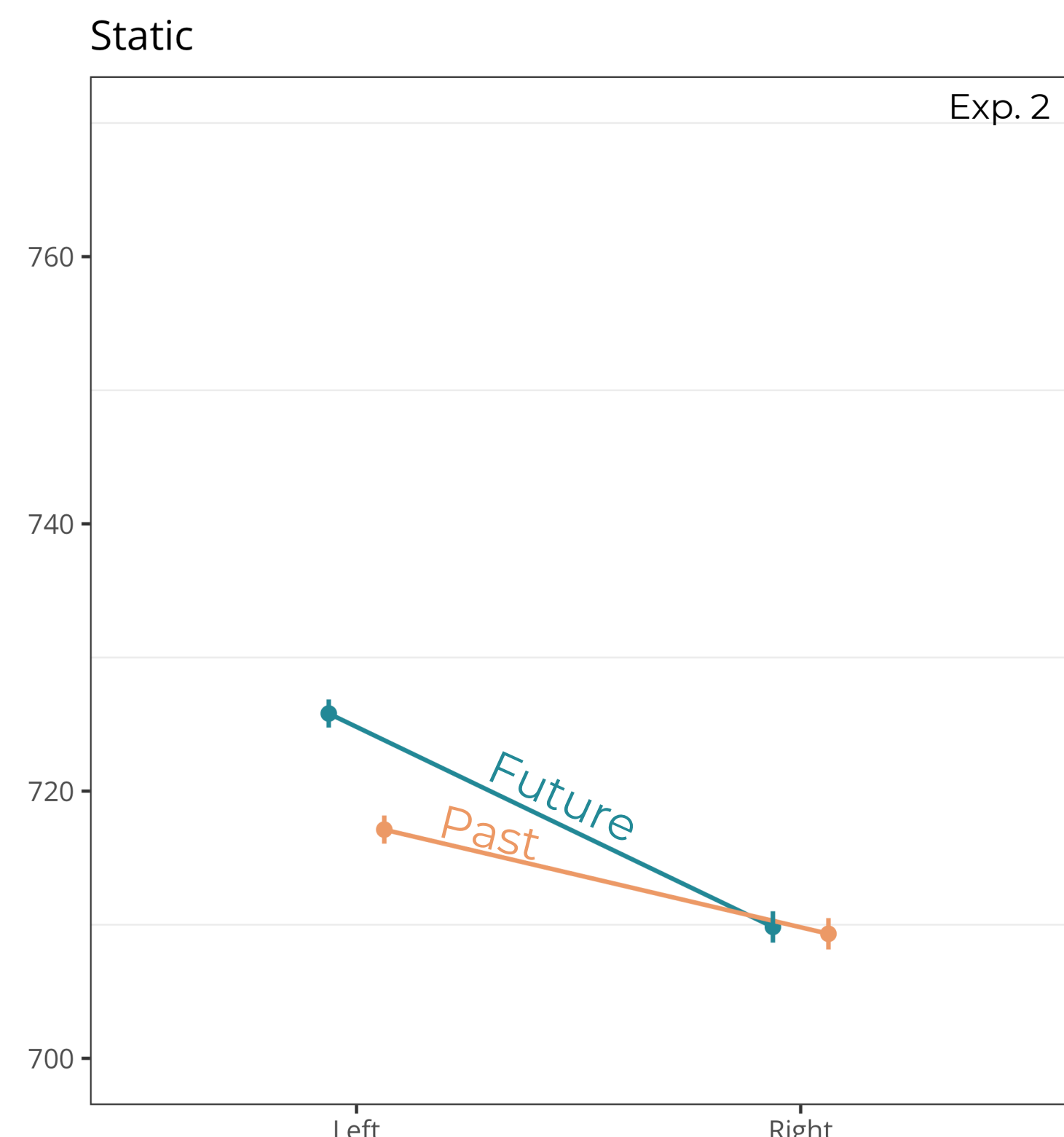
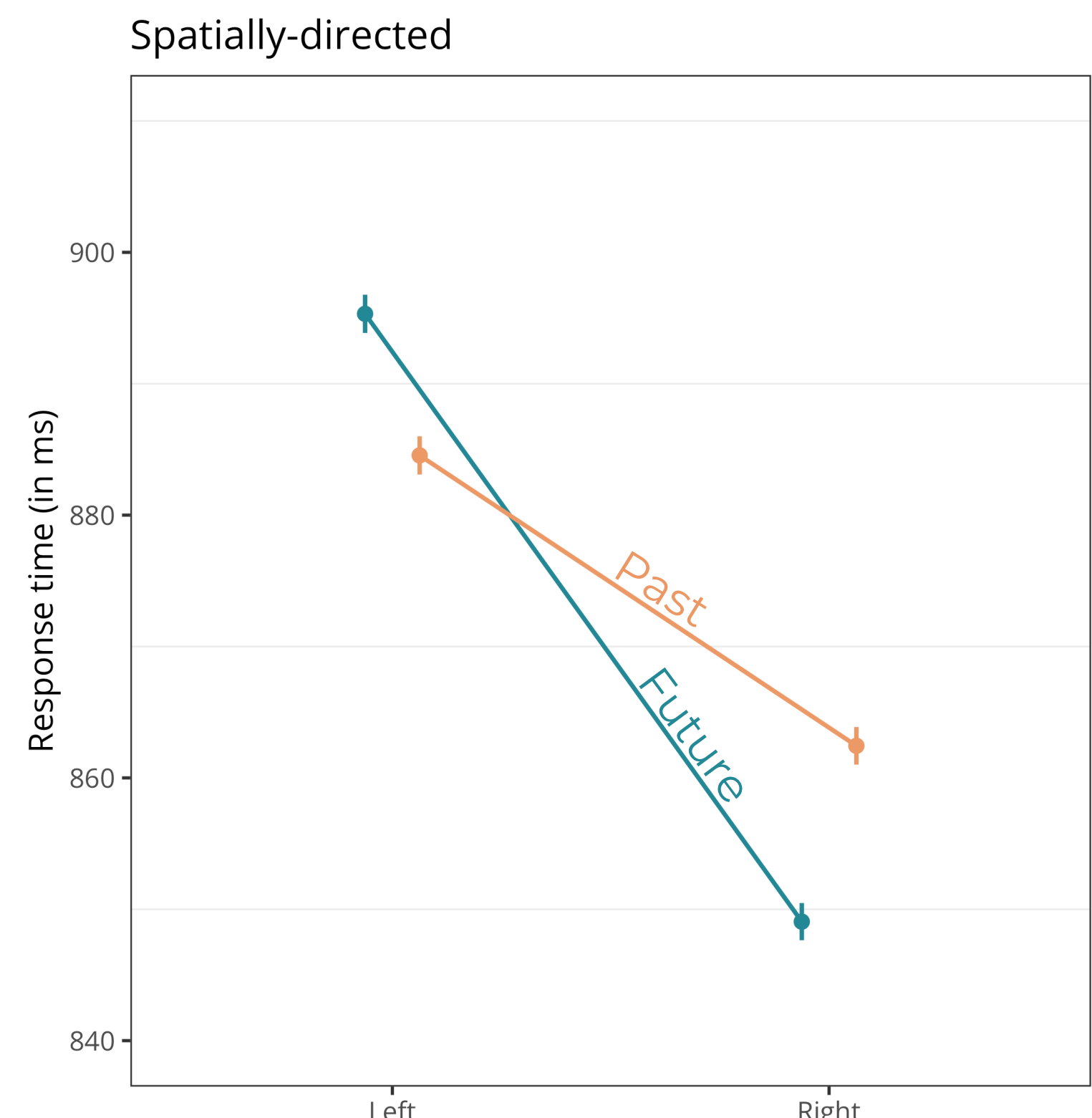
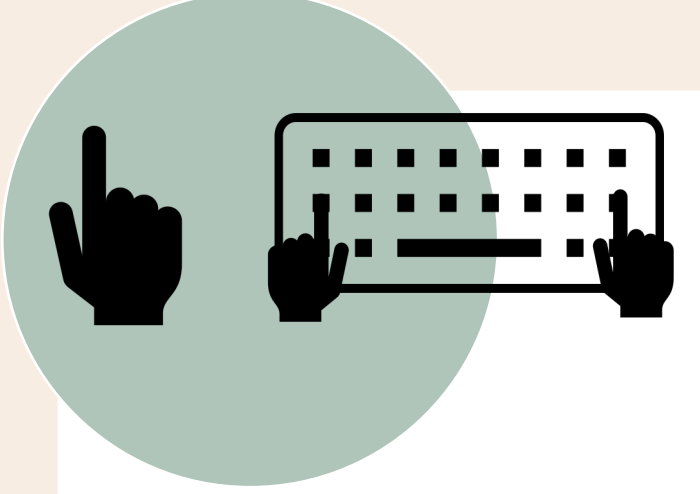
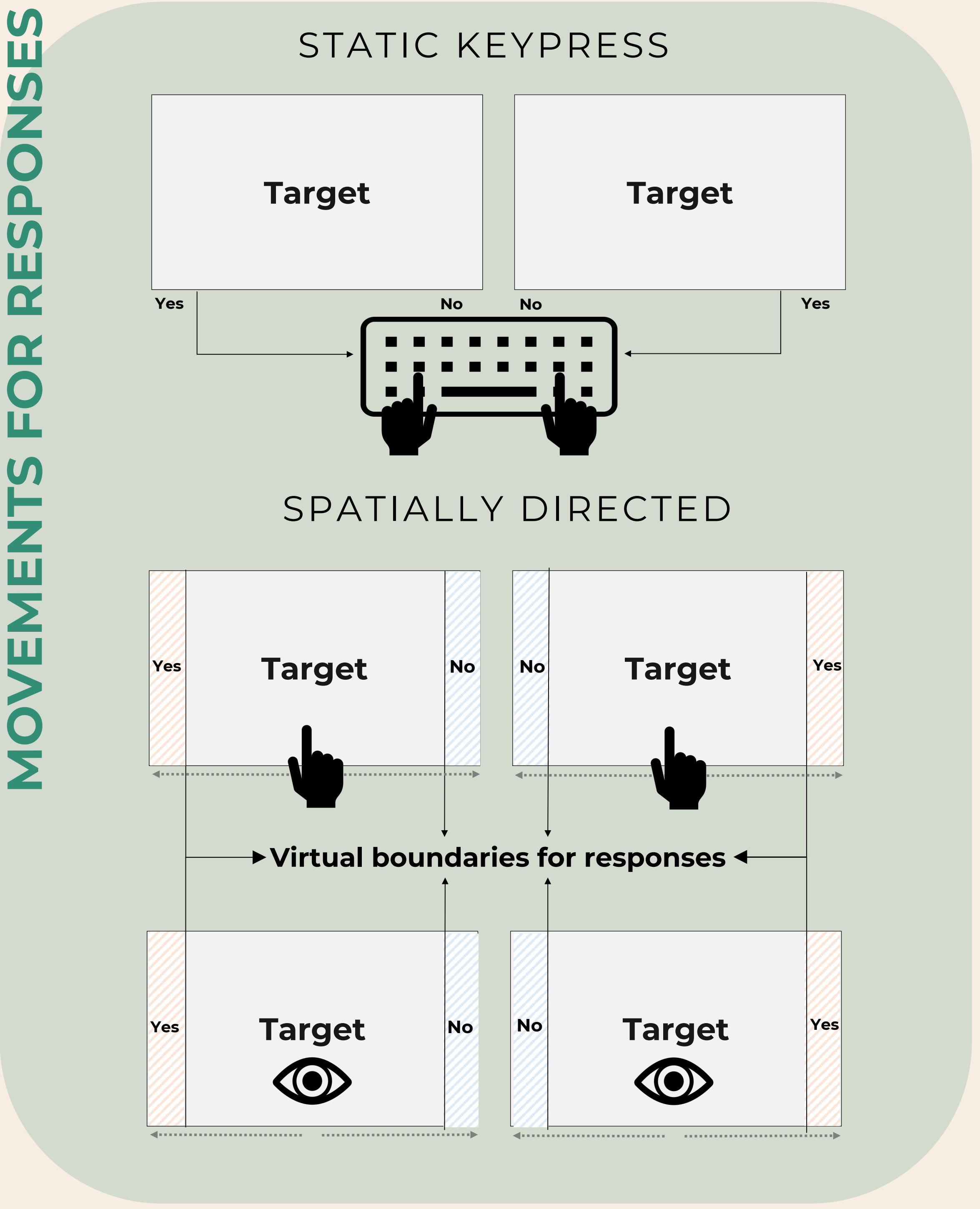
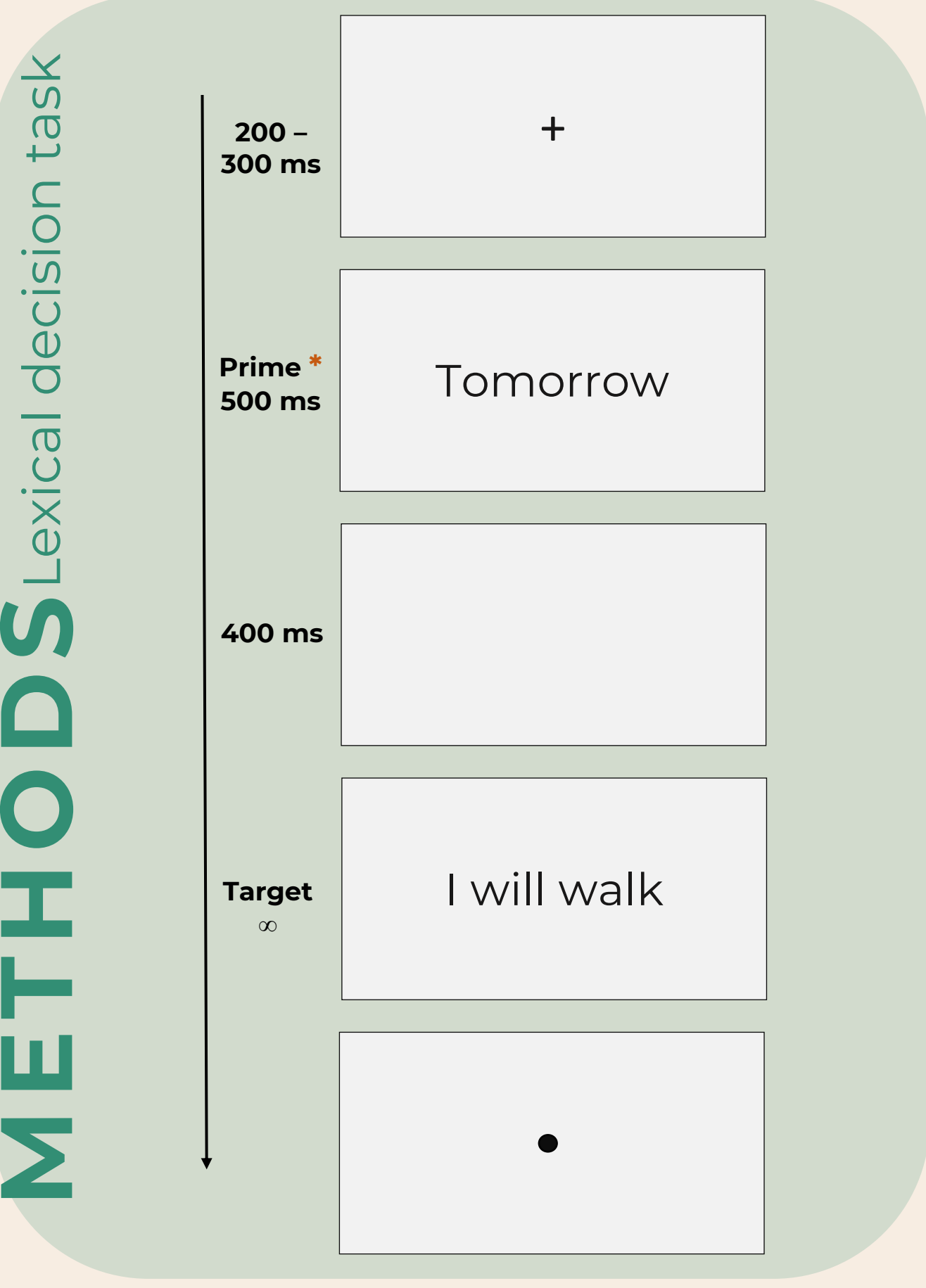
Empirical evidence of the **left-to-right mental timeline** is supported **by space-time congruency effects** in tasks where past and future stimuli are presented at different spatial locations [5][7]. Thus, temporal cognition is thought to reuse neural structures devoted to spatial cognition.

However, results are mitigated, space-time congruency effects not always occur when manipulate spatial condition of the task. Another possibility is that time and space are closely linked because they are experienced together in daily movement [8].

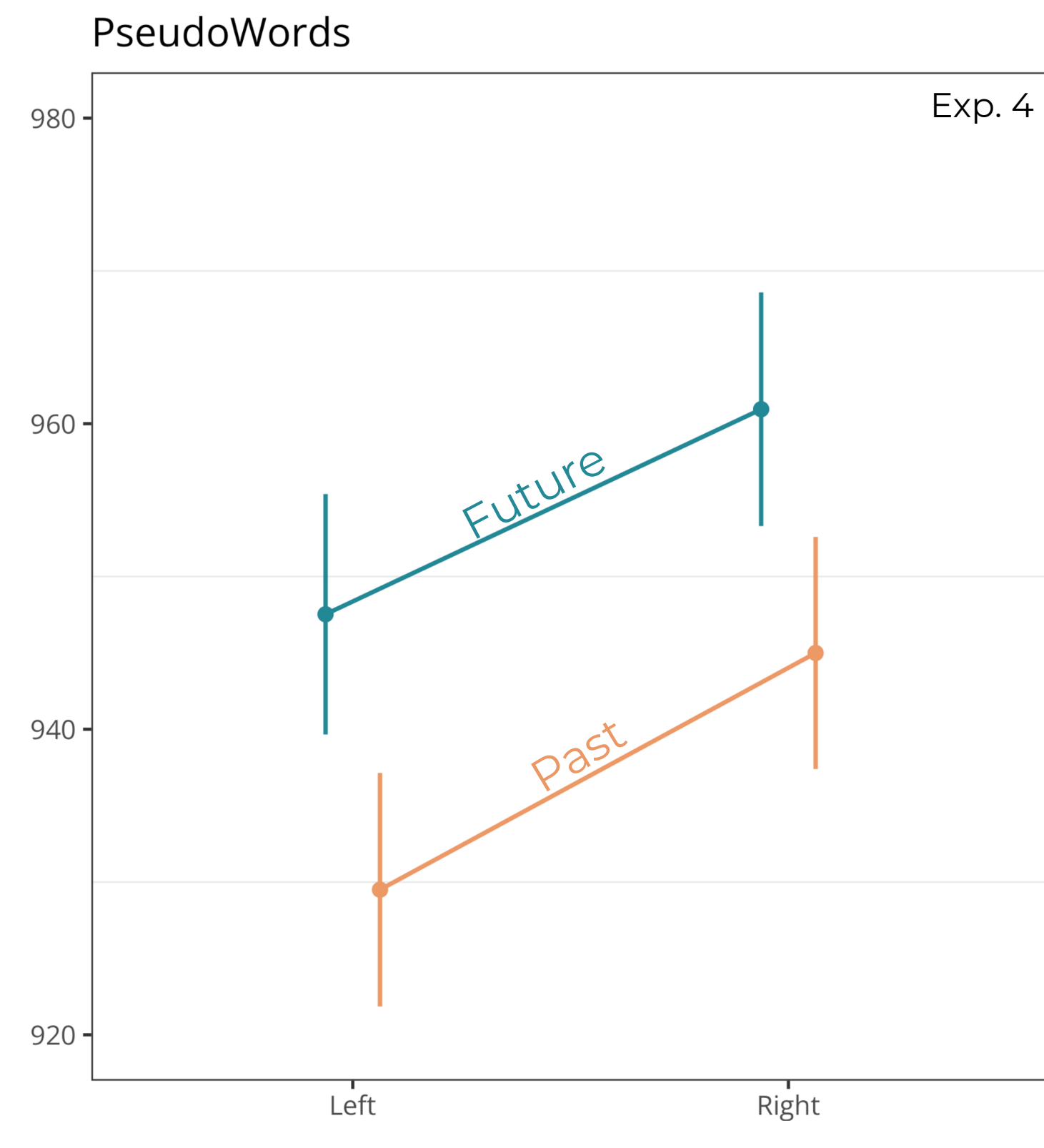
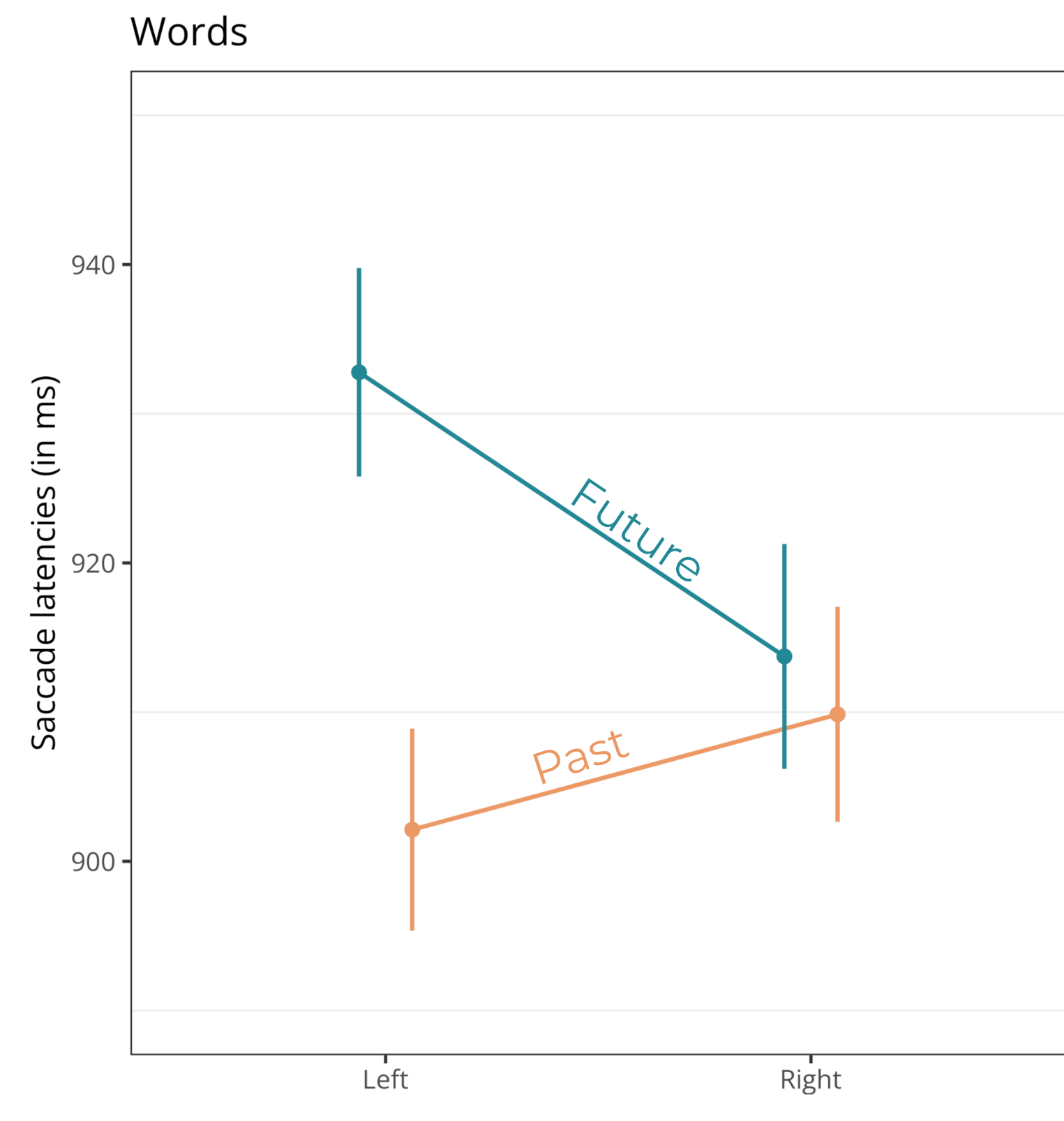
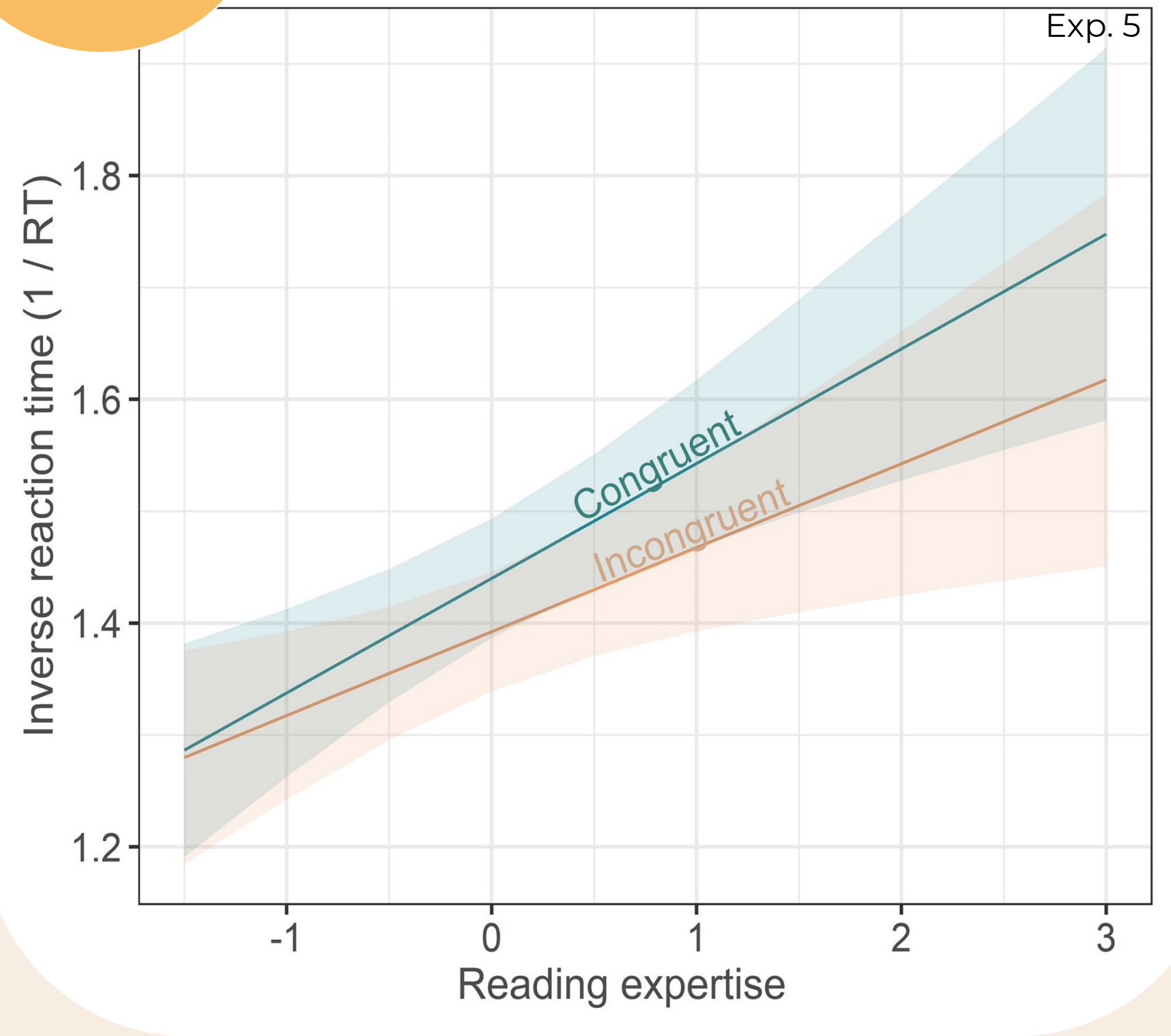
In a series of experiments, we investigated the **role of movement** in the emergence of space-time congruency effects during the visual processing of past- and future related words [7][9][10].



- Temporal concepts could be grounded in the temporal properties of spatially-directed movements.
- Reading and writing **movements** would constitute the repeated sensorimotor experience through which space and time are integrated in a left-to-right mental timeline.



Level of reading expertise interacted significantly with congruency effect: the more expert the participants were in reading, the stronger the congruency effect was.



Processing of temporal abstracts concepts rely on both motor and spatial systems.

Time and space could overlap because they are experienced together during movement.

The representation – and processing – of abstract temporal concepts relies on (and is affected by) the motor system.

Basic functions and systems, such as those of the sensorimotor system, can underlie more complex functions, such as word processing and conceptual understanding.

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