

# The Influence of Invisible Stimuli on Action

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## Introduction

Humans engage in various motor activities throughout the day. Most of these activities are made in response to stimuli in the external environment (e.g. visual input). Researchers in motor control are interested in trying to explain how the human brain transforms sensory input (e.g. visual input) into the appropriate motor responses. In other words, researchers are interested in how the brain is able to utilize external stimuli, such as visual information, to accurately coordinate the body's muscles and limbs in such a way that allows the individual to successfully interact with the external environment. In this study we sought to determine whether the presence of a rapidly presented visual stimulus (i.e. a prime) could influence responses made to a visual stimulus presented later in time (i.e. a mask), even when subjects were not aware that the primes had been presented. In other words, we asked if a visual cue could influence action in the absence of conscious awareness.

## Methods and Procedures

For this pilot research, right-handed participants with normal vision (or corrected to normal vision) completed a series of tasks. On all trials a prime (i.e. a small left or right arrow, or a neutral star stimulus) and mask (i.e. a larger left or right arrow) were displayed. These tasks included:

1. A **response initiation** (reaction time) task in which we looked to determine if the rapidly presented prime stimuli would influence how quickly subjects initiated a key press in response to the mask stimulus. In this task, participants (5 females and 2 males) were seated in front of a computer screen. Participants were instructed to respond to a large arrow (i.e. the mask) by pressing the corresponding key on the keyboard as quickly as possible. For example if it was a right (or left) arrow, they pressed a right (or left) key. Participants completed a number of these reaction time tasks, each with a different stimulus onset asynchrony (SOA), such that the time interval between when the prime and mask were presented was manipulated. Within each task, participants completed a total of one hundred and twenty trials.
2. A **response execution** (on-line control) task in which we looked to determine if the rapidly presented primes could take over control of the movement. The set-up was similar to the response initiation task but this time, participants (3 females and 1 male) were to move their right index finger to a center target. If a directional arrow mask appeared, participants would then update their movements and land at the corresponding left or right target box.
3. A **prime identification** task in which participants were asked to try to identify the primes that were displayed on each trial. Participants (4 females and 2 males) attempted to identify the prime displayed after completing a pointing movement or on its own (without any concurrent motor task).

## Stimulus Display

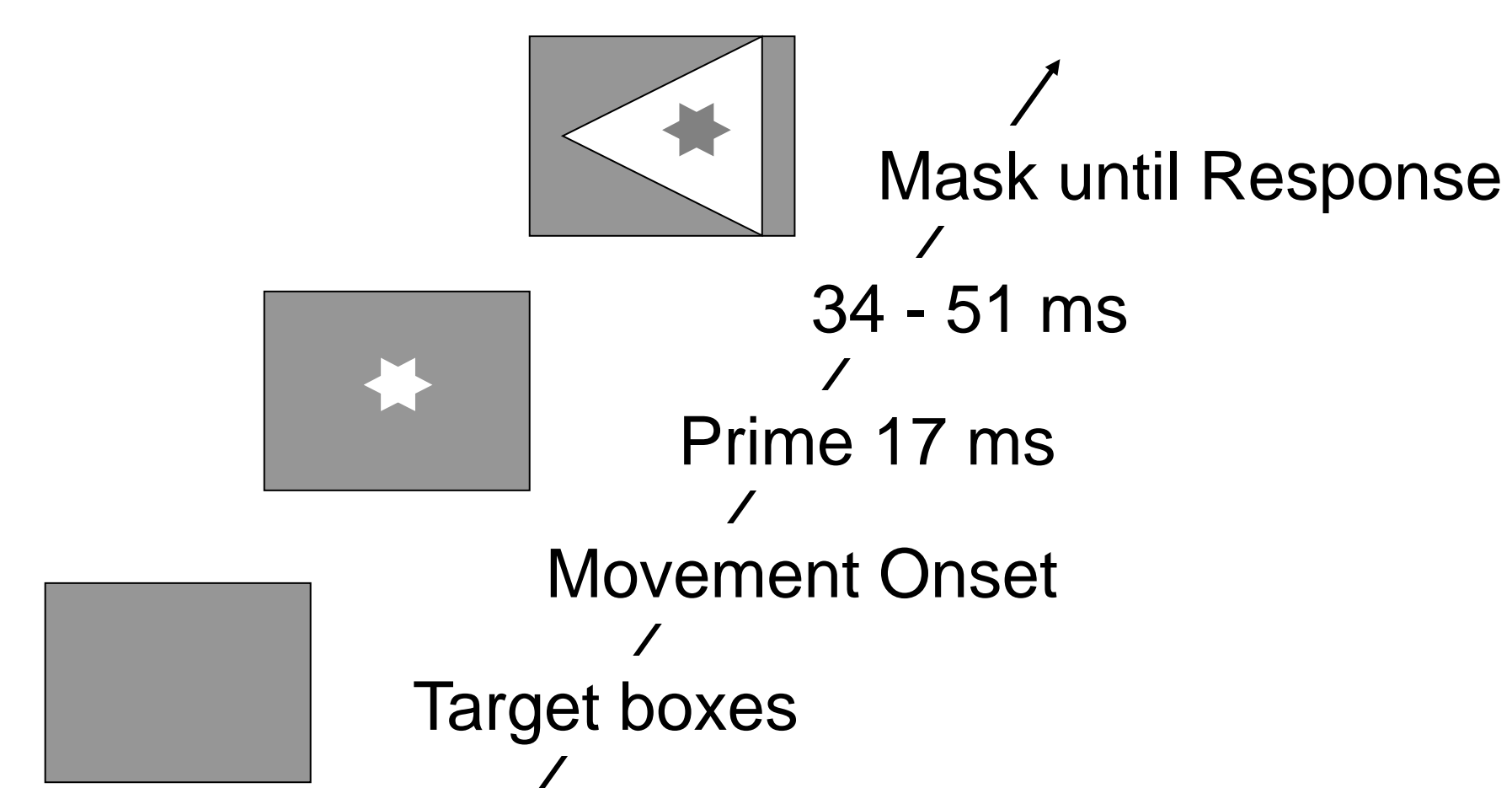


Figure 1: Sequence of visual events.

## Results

The primes influenced motor performance, both response initiation and response execution processes, in the absence of conscious awareness. In particular, response initiation was faster on trials in which a prime and mask pointing in the same direction were presented (congruent trials) and slower on trials in which an incongruent prime-mask sequence was displayed (incongruent trials). As well, in the response execution tasks, the primes took over control of the movement, such that reaches were initiated in the direction indicated by the prime before correcting to the target specified by the mask.

## Response Initiation Task

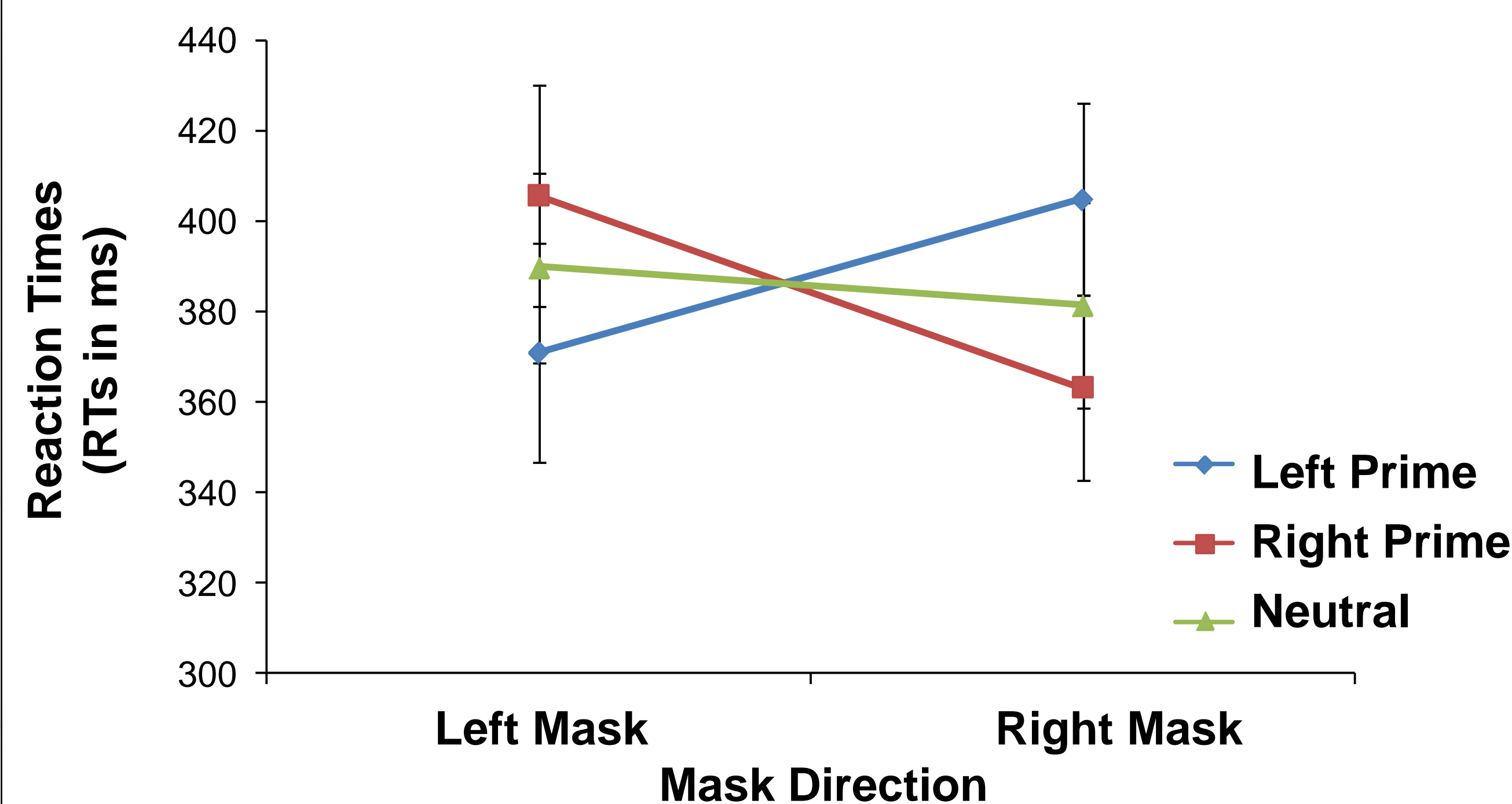


Figure 2: Mean reaction times (in ms) for trials completed with the largest stimulus onset asynchrony (SOA = 51 ms). Error bars reflect SE.

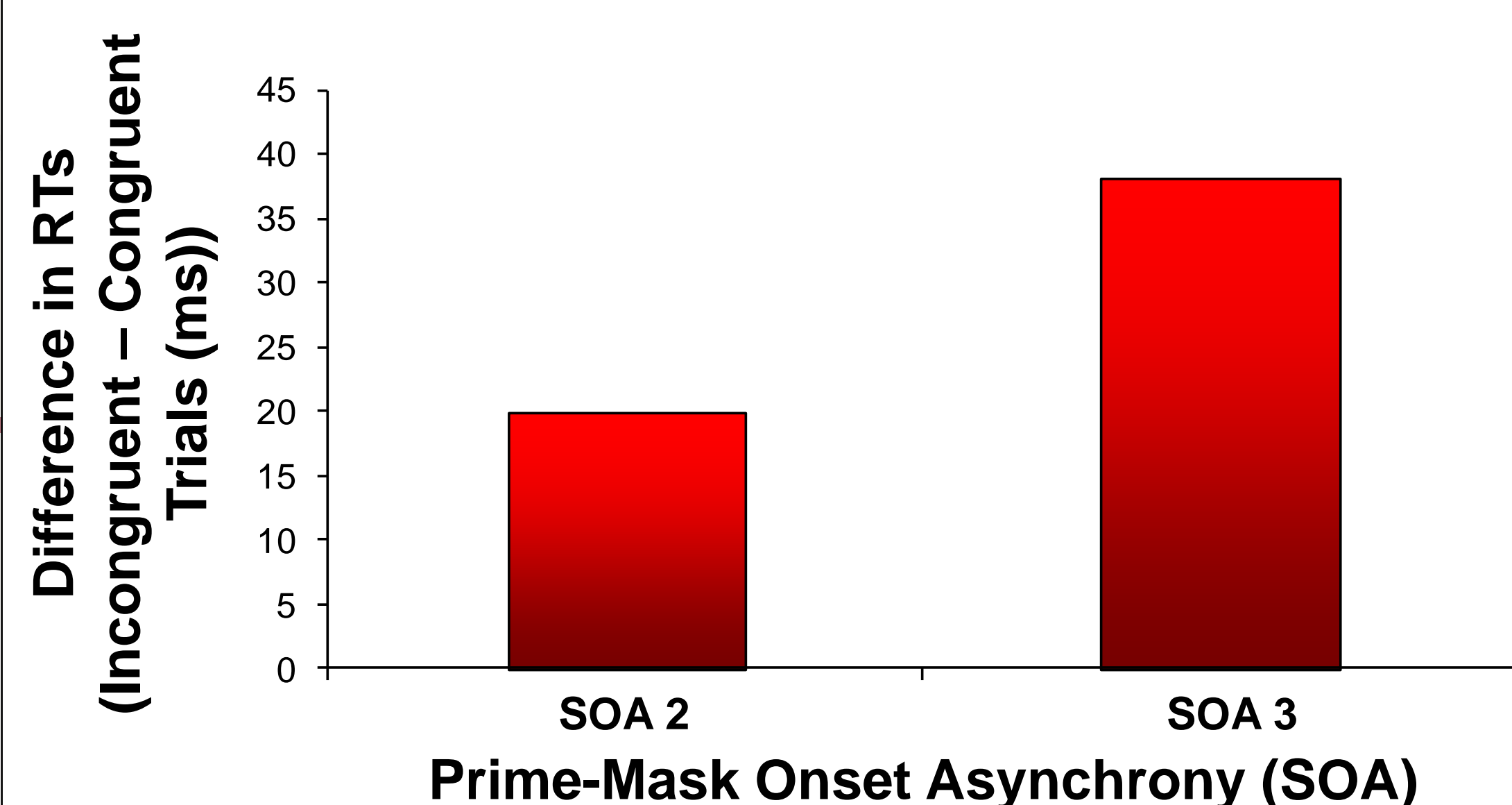


Figure 3: Mean reaction times (in ms) at a SOA of 34 ms and 51 ms. Larger time intervals between the disappearance of the prime and the onset of the mask during incongruent trials resulted in slower reaction times.

## Response Execution Task

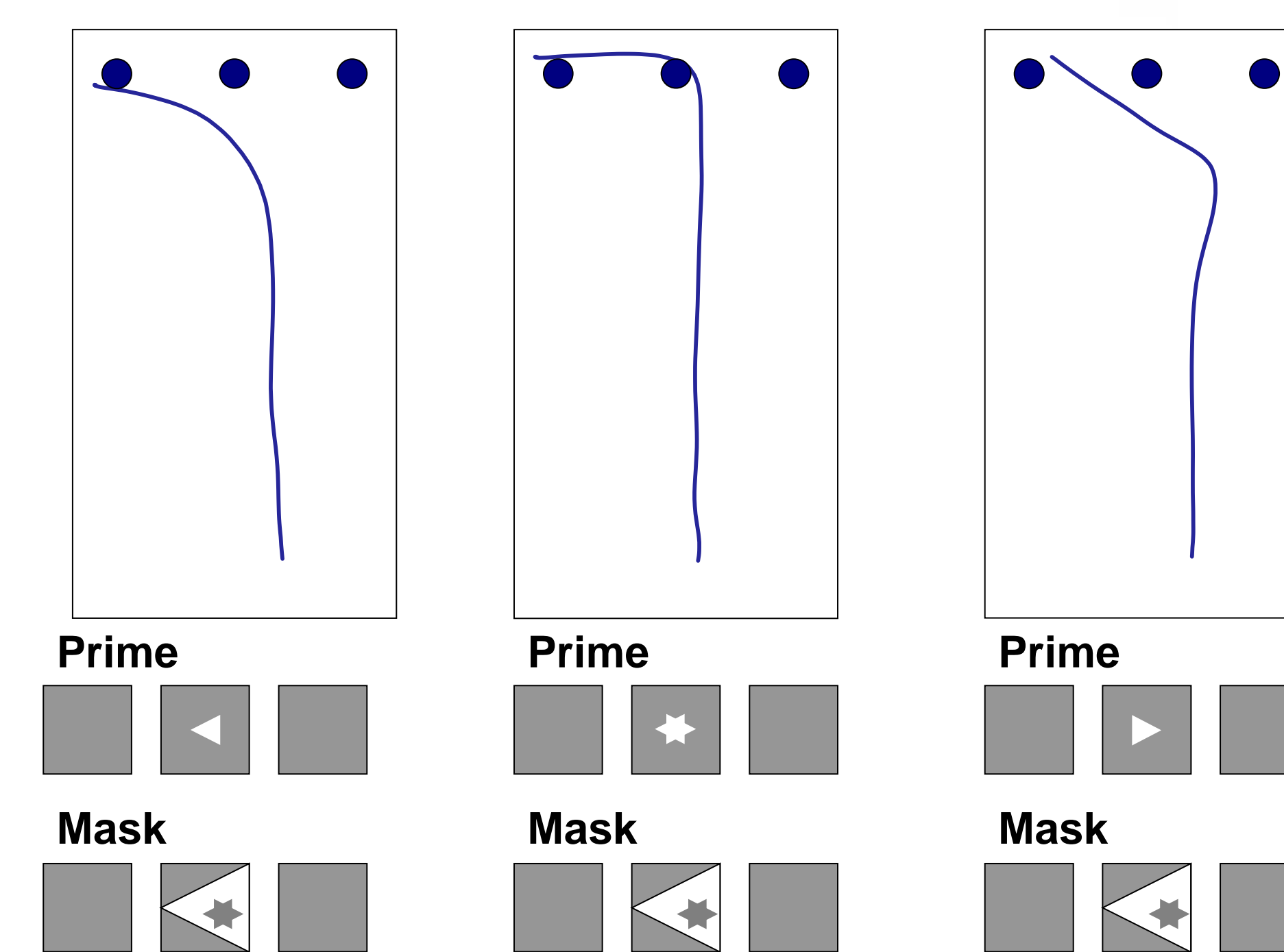


Figure 4: Movement trajectories from three response execution trials. Deviation patterns resulting from a left prime (A), neutral prime (B), and right prime (C) being presented prior to the left mask. All reaches were completed correctly (to the left target).

## Discussion

Results in the motor tasks indicated that the primes influenced action. Furthermore, results from the response selection tasks indicated that increasing the stimulus onset interval between the prime and mask resulted in the prime having a greater influence on movement. Specifically, slower RTs were observed on incongruent prime-mask trials, with the slowest RTs observed on trials with the largest SOA. This increased influence of the primes on movement is likely due to the fact that the longer it takes for the mask to appear, the greater the opportunity for the prime to influence movement without interference from other visual stimuli.

In the prime identification tasks (with and without the movement task) participants were unable to identify the primes. It was hypothesized that by having participants move and then perform a perceptual task, the brain would have increased difficulty identifying the prime. Moreover, identifying the prime without engaging in the pointing task would decrease the difficulty of identifying the correct prime as the brain would have fewer demands placed on it. However, in contrast to our hypothesis, findings revealed no difference in participants' ability to identify the primes.

In conclusion, our results support Milner and Goodale's (1995) proposal of a dissociation between how visual stimuli are processed for perception and action. In particular, we show that motor areas of the cortex can process a stimulus, such that it influences action, in the absence of conscious awareness.

## Future Directions

Additional research is currently being conducted to determine the extent to which an invisible prime stimulus can influence action and if participants ever become aware of the resultant deviations in their movements.

## Reference

Milner, A. D., & Goodale, M. A. (1995). The visual brain in action. Oxford: Oxford University Press.



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