

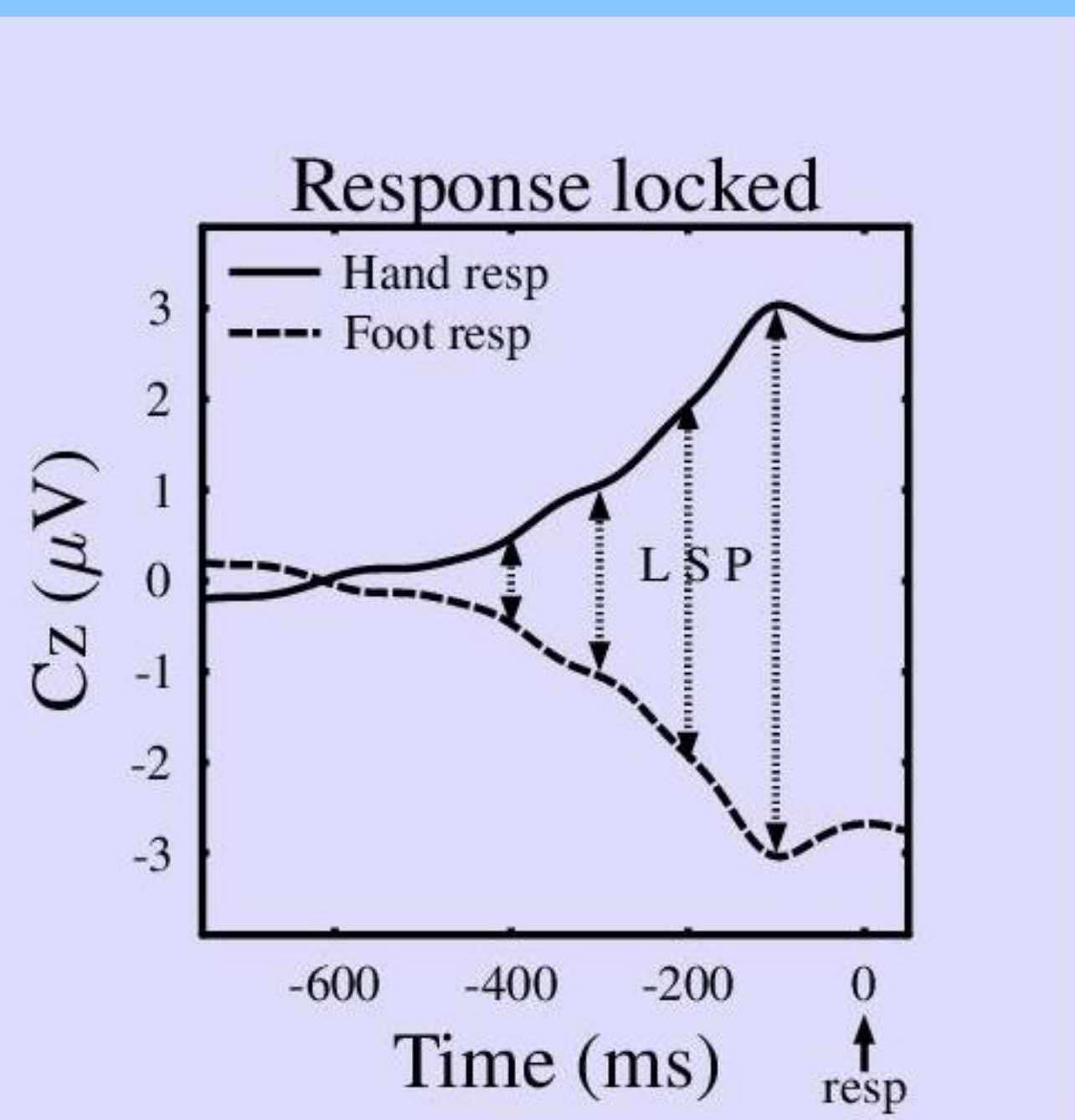
Spatial congruence (Simon) effects on the duration of motor processing?

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A New Event-related Potential (ERP): The Limb Selection Potential (LSP)

Recent comparisons of motor ERPs for hand versus foot responses have identified a promising new ERP component called the “limb selection potential” (LSP; Miller, 2012). As is illustrated in the figure below, hand responses produce more positivity than foot responses, and the LSP is defined as the hand/foot difference. Conveniently, LSP amplitude is larger and provides a better S/N ratio than is obtained with the lateralized readiness potential (LRP), the most widely used previous measure of motor activity.



Hypothetical ERPs illustrating the limb selection potential

(LSP): In a choice reaction time (RT) task, the ERP at Cz is more positive in trials with a hand response than in trials with a foot response. The LSP is the difference between the ERPs for trials with these two different responses.

Goals

This study explored the possibility of using the LSP to decide whether an experimental manipulation influences the final motor processes involved in response execution, or whether it instead influences premotor processes (i.e., perception and decision). Specifically, we examined the manipulation of spatial congruence between stimulus and response.

Spatial congruence (Simon) effects

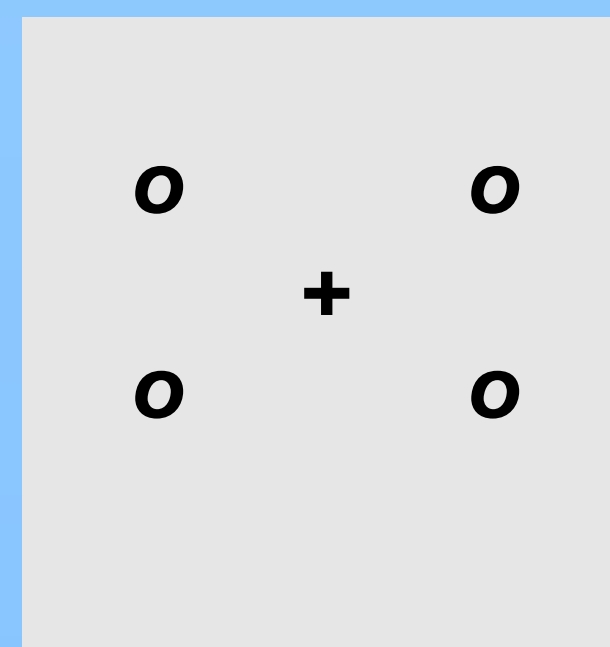
People respond faster when stimuli appear in locations congruent with the required responses (e.g., responding with the left hand to a stimulus on the left of fixation) than when stimuli appear in incongruent locations (e.g., responding with the left hand to a stimulus on the right). This congruence effect is found even when the spatial location of the stimulus is task-irrelevant (e.g., responses are based on stimulus color or shape).

Does spatial congruence affect motor processes?

There is debate about which RT processes are influenced by spatial congruence, and different researchers have argued for effects of congruence primarily on perceptual, decision, or motor processes (e.g., Hasbroucq & Guiard, 1991). This study used the LSP to find out whether congruence influences the final motor processes involved in response execution, or whether it instead influences premotor processes (i.e., perception and decision). The LSP is more appropriate for this purpose than the LRP, because the LRP—but not the LSP—is contaminated by stimulus artifacts when the stimuli are lateralized (e.g., Leuthold, 2011; Praamstra, 2007).

Method

Task: In each trial, a single stimulus digit 1, 2, 3, or 4 was presented in any of four display locations above/below and left/right of a central fixation cross (see figure below). Each digit was assigned to one of four responses (left hand, right hand, left foot, or right foot; assignments counterbalanced). The digit's location was task-irrelevant.



Stimulus display: Central fixation cross (+) and possible stimulus locations (o's). In each trial, a single digit was presented at one of the four possible locations (e.g., lower left), and the other locations were blank.

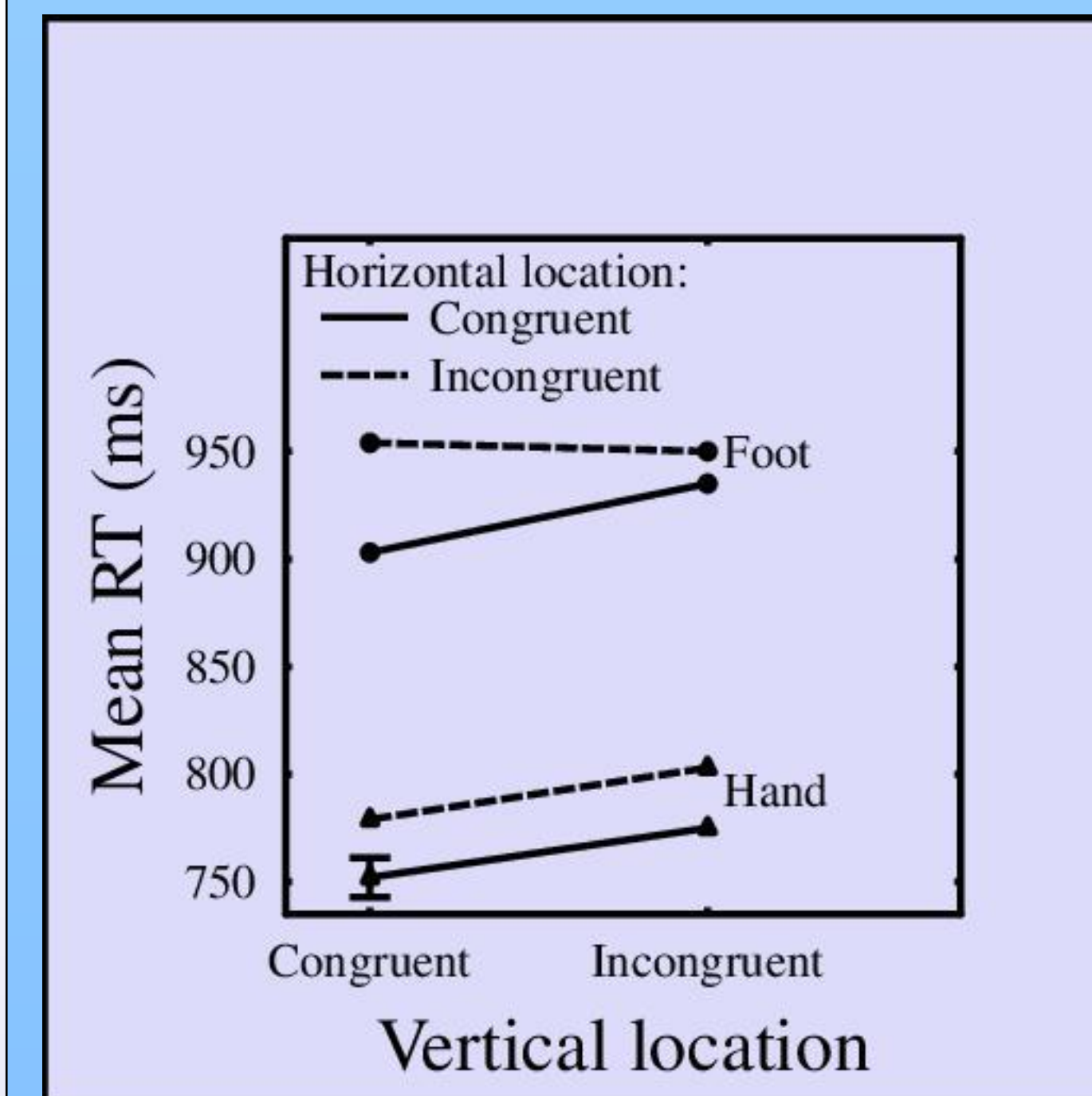
Congruence conditions: As shown in the table below, the conditions were defined by the congruence or incongruence of the stimulus location with the required response, separately for both the horizontal and vertical dimensions. Stimulus locations on the left and right sides of the display were congruent with limbs on the left and right sides of the body, respectively. Stimulus locations in the upper and lower halves of the display were congruent with hand and foot responses, respectively.

Table 1: Spatial Congruence Conditions				
Stimulus Location:	Response:			
	Left Hand	Right Hand	Left Foot	Right Foot
	<u>Horizontal congruence:</u>			
Left	<i>Congruent</i>	<i>Incongruent</i>	<i>Congruent</i>	<i>Incongruent</i>
Right	<i>Incongruent</i>	<i>Congruent</i>	<i>Incongruent</i>	<i>Congruent</i>
	<u>Vertical congruence:</u>			
Upper	<i>Congruent</i>	<i>Congruent</i>	<i>Incongruent</i>	<i>Incongruent</i>
Lower	<i>Incongruent</i>	<i>Incongruent</i>	<i>Congruent</i>	<i>Congruent</i>

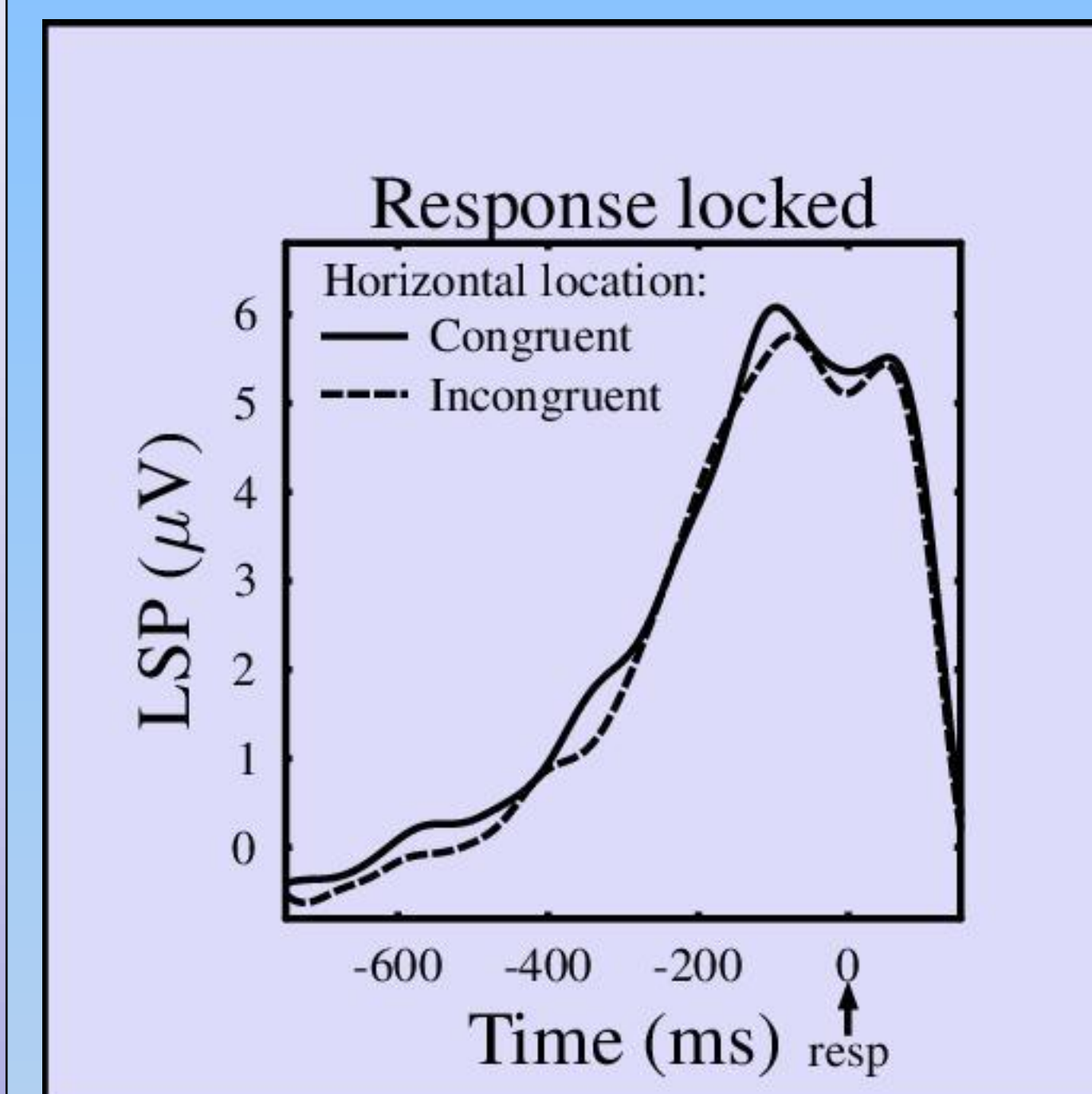
References

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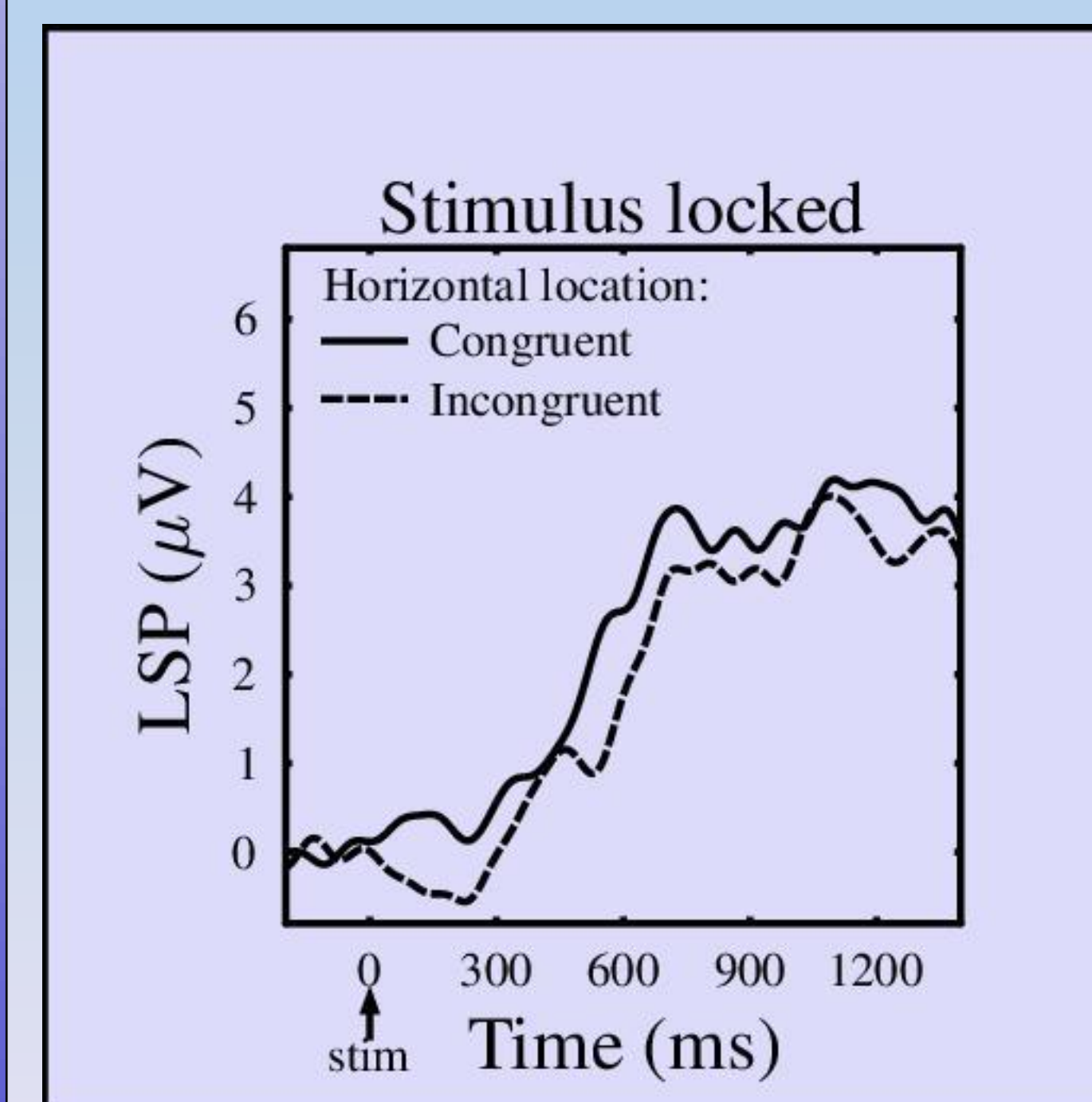
Results



Congruence affected RT: Responses were slower when stimuli appeared in incongruent rather than congruent locations along both the horizontal ($p < .001$) and vertical ($p < .025$) dimensions. Also, foot responses were slower than hand responses ($p < .001$). Interactions involving horizontal and vertical congruence and hand/foot were not significant, nor were they significant in a larger group of RT-only participants.



Congruence did *not* affect response-locked LSP: The LSP followed a virtually identical time-course leading up to the response for horizontally congruent versus incongruent trials. Thus, this type of congruence did not have any effect on the final motor processes differentiating between hand and foot responses, at least as measurable at Cz.



Congruence did affect stimulus-locked LSP: The LSP started earlier following stimulus onset for horizontally congruent than incongruent trials ($p < .05$, jackknifing test, Miller, Patterson & Ulrich, 1998). This indicates that congruence affected the durations of perceptual and/or decision processes (i.e., processes preceding the motor processes differentiating between hand and foot responses).

Conclusions

- The LSP is a promising measure for deciding whether experimental manipulations influence motor or pre-motor processes.
- Horizontal spatial congruence does not affect motor processes.

Poster # 4006 presented at the 54th annual meeting of the Psychonomics Society, Toronto, Nov 2013. Contact: miller@psy.otago.ac.nz. This poster is available at <http://www.psy.otago.ac.nz/miller/posters/miller2013psp.pdf>