An ERP study of visual change detection: Effects of the feature and spatial attention on the change-related posterior positivity

Motohiro KIMURA, Jun'ichi KATAYAMA, AND Harumitsu MUROHASHI

Graduate School of Education, Hokkaido University, Sapporo, Japan

m-kimura@edu.hokudai.ac.jp

INTRODUCTION

Change-related positivity (CRP): A posterior positive ERP component at around 100-200 ms elicited by the visual change stimuli in the S1-S2 matching paradigm (Kimura et al., 2005, *Psychophysiology*) or the oddball paradigm (Kimura et al., 2006, *Psychophysiology*).

Pre-attentive nature of CRP: Significant elicitation of CRP in response to changes in unattended feature (i.e., spatial frequency) at attended location (Kimura et al., 2006, *Int J Psychophysiol*) and to changes in attended feature (color) at unattended location (Kimura et al., 2005, *NeuroReport*).

Purpose of the present study: To make a comprehensive assessment of the feature and spatial attention effects on the color and spatial frequency CRPs in the S1-S2 matching paradigm. We tested the elicitation of CRP in response to (1) changes in unattended feature at attended location, (2) changes in attended feature at unattended location, and (3) changes in unattended feature at unattended location.

METHODS

Participants: 10 students (m/f = 5/5, *M* = 24.1 yrs)

Stimuli: Five types of S1-S2 trials presented in random order with equal probabilities (*p* = .20 each)

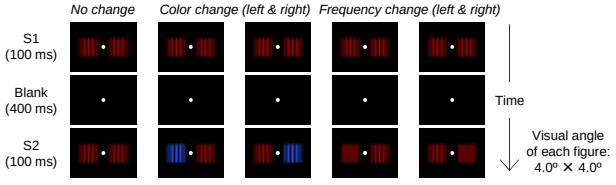

Figure 1. Examples of five S1-S2 types used in the present study.

Task: To respond to changes in a given feature (color or frequency) at a given location (left or right)

EEG recordings: 25 scalp sites (referred to the nose-tip), A/D = 250 Hz, Band-pass = 0.1-20 Hz

Data analysis: Change effects were obtained by subtracting ERPs elicited by each change S2 from those elicited by no change S2 in the corresponding task, which were then classified into four categories defined by the change type and the target change type.

Table 1. Four categories defined by the change type and the target change type

Change type	Target change type			
	Left color	Right color	Left frequency	Right frequency
Left color	(S+F+)	S–F+	S+F–	S–F–
Right color	S–F+	(S+F+)	S–F–	S+F–
Left frequency	S+F–	S–F–	(S+F+)	S–F+
Right frequency	S–F–	S+F–	S–F+	(S+F+)

S: Spatial; F: Feature; +: Attended; –: Unattended

Since there were no systematic hemispheric differences, the left and right conditions were pooled.

RESULTS

Table 2. Behavioral performance (mean & SD)

Target change type	RT (ms)	Hit (%)	FA (%)			
			S+F–	S–F+	S–F–	Nc
Color	435 (68)	89.3 (8.1)	0.8 (0.9)	0.8 (0.8)	0.3 (0.5)	0.4 (0.5)
Frequency	435 (60)	94.3 (5.0)	1.0 (1.0)	0.2 (0.3)	0.2 (0.5)	0.3 (0.5)

RT: n.s.
Hit: Color < Frequency
FA:
(Color) S+F–, S–F+ > others
(Frequency) S+F– > others

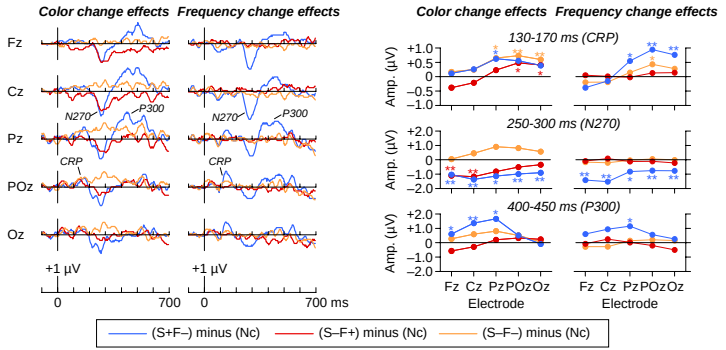

Figure 2. (Left panel) Difference waves representing the effects of the color and spatial frequency changes under the three attention conditions. (Right panel) Mean amplitudes of the difference waves. **: *p* < .05, *: *p* < .10 by one-tailed *t*-tests.

Color change		Frequency change	
(S+F–):	CRP, N270, & P300	(S+F–):	CRP, N270, & P300
(S–F+):	CRP, N270	(S–F+):	——
(S–F–):	CRP	(S–F–):	CRP

DISCUSSION

CRPs to the changes in unattended feature at unattended location: The elicitation of the CRPs in response to changes in unattended feature at unattended location for both dimensions suggests the attention-independence of CRP. Thus, these results provide further support for the pre-attentive nature of CRP.

?? No CRP to the changes in attended feature (i.e., frequency) at unattended location ??: Although the reason why CRP was not observed in response to changes in attended feature at unattended location for the spatial frequency dimension is unclear, this might be consistent with the "*competition hypothesis*" for the auditory change detection (Sussman et al., 2003, *Psychophysiology*), proposing that the pre-attentive processing of the competing changes at unattended location is strongly inhibited.

CONCLUSION

Change-related positivity (CRP) reflects the pre-attentive detection of visual stimulus changes.

The 46th Annual Meeting of the Society for Psychophysiological Research . 10/25 – 29, 2006. Vancouver, BC, CANADA.