Brief report

Self-construal priming modulates visual activity underlying global/local perception

Zhicheng Lin [a,b], Yan Lin [c], Shihui Han [a,b,*]

[a] Department of Psychology, Peking University, Beijing, China
[b] Learning & Cognition Lab, Capital Normal University, Beijing, China
[c] Military Psychology Institute, The Fourth Military Medical University, Xi'an, China

Abstract

Behavioral studies suggest that self-construals play a key role in modulation of cognitive processing styles, leading to context-dependent or -independent mode of processing. The current work investigated whether the neural activity in the extrastriate cortex underlying global/local perception of compound stimuli can be modulated by self-construal priming that shifts self-construal towards the Eastern interdependent or Western independent self in Chinese participants. After primed with independent or interdependent self-construals, subjects were asked to discriminate global/local letters in a compound stimulus while event-related potentials (ERPs) were recorded. We found that, while the independent self-construal priming resulted in enlarged P1 amplitude to local than global targets at lateral occipital electrodes, a reverse pattern was observed after the interdependent self-construal priming. Our findings provide electrophysiological evidence that self-construal priming modulates visual perceptual processing in the extrastriate cortex.
© 2007 Elsevier B.V. All rights reserved.

Keywords: Extrastriate cortex; Visual processing; Global/local; Self-construal

1. Introduction

Human visual perceptual processing is efficient and flexible. It is well known that visual perceptual processing can be substantially modulated by internal attentional state of observers and the affective properties of stimuli (Vuilleumier and Driver, 2007). Recent cross-cultural studies also show evidence that perceptual processes are greatly influenced by cultures (Nisbett and Miyamoto, 2005). By comparing behavioral performances from participants with different cultures, Nisbett and colleagues found that, relative to European Americans, East Asians' performance of judging the orientation of line segment in a frame showed stronger tendency to be influenced by the frame (Ji et al., 2000). In addition, Americans were better in detection of changes in focal objects whereas Japanese were better in detection of changes in the field (Masudaz and Nisbett, 2006).

Cultural influence on perceptual processes has also been demonstrated in one culture group using cultural priming procedure. While Western cultures result in independent self that is characterized as a self-contained and context-independent entity, Eastern cultures breed interdependent self that is regarded as a member in a group highlighting belonging to and dependence upon a context (Markus and Kitayama, 1991), all individuals are expected to flexibly define themselves as relatively more independent or interdependent depending upon current situations (Gardner et al., 1999). On the basis of these propositions, researchers used self-construal priming, which asks subjects to circle the independent (e.g., I, mine) or interdependent (e.g., we, ours) pronouns in an essay to switch the self towards Western independent or Eastern interdependent styles (Gardner et al., 1999), to investigate cultural influence on perceptual processes. Kühnen and Oyserman (2002) reported that subjects exposed to the independent self-construal priming responded faster to a local than global target in a Navon-type compound stimulus (Navon, 1977), whereas a reverse pattern of performance was observed in subjects exposed to the interdependent self-construal priming. We also found evidence that self-construal priming facilitated global or local perception

* Corresponding author at: Department of Psychology, Peking University, 5 Yiheyuan Road, Beijing 100871, China. Tel.: +86 10 6275 9138; fax: +86 10 6276 1081.
 E-mail address: shan@pku.edu.cn (S. Han).

in the same group of subjects who showed faster response to global targets after the interdependent-self priming but faster response to local targets after the independent-self priming (Lin and Han, submitted for publication).

While the previous research suggests interactions between cultures and perceptual processing, the conclusions were made mainly based on behavioral measurements. It remains an open issue if the neural activity in the visual cortex underlying perceptual processing is modulated by self-construal priming. The current research tested this by measuring event-related potentials (ERPs) to global and local targets in compound letters (Fig. 1). Previous ERP and brain imaging studies found that the extrastriate activity was modulated by global/local perception of compound stimuli. Specifically, a lateral occipital positive activity peaking at about 100 ms after stimulus delivery (P1) was enlarged to local than global targets (Han et al., 1997, 1999, 2000). In addition, enhanced activity in the right and left extrastriate cortex was, respectively, linked to the global and local perceptual processes (Fink et al., 1996; Han et al., 2002). These findings demonstrate that the extrastriate activity is involved to differentiate global and local perceptual processes of compound stimuli.

Here we used the self-construal priming procedure to shift the self towards the independent or interdependent styles in Chinese subjects before they performed tasks of discrimination of global/local targets. Because the early ERP components such as the P1 arise from the extrastriate cortex (Di Russo et al., 2001; Martinez et al., 2001), variation of the P1 amplitudes to global/local targets as a function of self-construal priming would provide evidence that self-construal priming modulates the perceptual processing in the extrastriate cortex. In addition, because increased scope of visual attention facilitates global processing and decreased scope of visual attention facilitates local processing (Stöffer, 1994; Han and Humphreys, 2002) and the interdependent and independent self-construal priming increases and decreases the scope of visual attention respectively (Lin and Han, submitted for publication), we

	Priming		
	Independent	Neutral	Interdependent
RTs			
Global	505.2(81.9)	499.8(75.0)	503.1(71.0)
Local	488.2(88.2)	484.0(74.8)	484.8(77.0)
Accuracy			
Global	90.0(7.5)	91.2(7.0)	91.2(7.6)
Local	88.8(13.5)	89.1(12.4)	89.0(12.9)

1.5 cm lateral to the left and right outer canthi, the vertical EOG from electrodes below and above the left eye. The impedance for all the electrodes was kept below 5 kΩ. EEG was amplified (half-amplitude band pass 0.1–70 Hz) and digitized at a sampling rate of 250 Hz. The ERPs in each stimulus condition were averaged separately off-line with averaging epochs beginning 200 ms prior to and ending 1000 ms after the onset of the stimulus. Trials contaminated by eye blinks (VEOG exceeding ± 50 μV relative to 200 ms pre-stimulus baseline), horizontal eye movements (HEOG exceeding ± 50 μV relative to baseline), other artifacts (a voltage exceeding ± 50 μV at any electrode location relative to baseline), or followed by response errors were excluded from the average. The EEG to the stimuli was averaged separately for all combinations of target level (global and local) and self-construal priming type (independence, interdependence and neutral), resulting in six ERP waveforms for each participant and electrode site. All ERP measures were taken relative to the mean voltage of the 200 ms pre-stimulus baseline interval. The analysis of the ERP data focused exclusively on the early P1 and N1 components, with mean amplitude measured 70–130 ms after stimulus onset. Repeated measure analysis (ANOVA) was performed on mean ERP amplitudes at O1, O2, PO3, PO4, PO5, PO6, PO7, PO8, P3, P4, P5, P6 with Target level (global vs. local), self-construal priming type (control, independent vs. interdependent), and hemisphere (electrodes over the left or right hemisphere) as independent variables. When appropriate, a Greenhouse-Geisser adjustment to the degrees of freedom for non-sphericity was applied. For the behavioral data, repeated measures ANOVAs were performed on RTs and responses accuracy with Target level and Self-construal priming type as independent variables.

3. Results

3.1. Behavioral data

Table 1 shows the mean RTs and response accuracies in each stimulus condition. ANOVAs performed on RTs showed only a main effect of Target level ($F(1, 29) = 8.546$, $p < 0.01$): responses to local letters (485.7 ms) were faster than those to global letters (502.7 ms). Neither the main effect of Priming ($F(2, 38) = 0.196$, $p = 0.82$) nor the interaction of Priming × Target level ($F(2, 38) = 0.160$, $p = 0.85$) was significant. ANOVAs performed on response accuracies did not show any significant effect (Target level: $F(1, 19) = 0.53$, $p = 0.48$; Priming: $F(2, 38) = 0.536$, $p = 0.59$; Interaction of Target level × Priming: $F(2, 38) = 0.57$, $p = 0.57$), suggesting that there was no trade-off between speed and accuracy in these conditions.

3.2. Electrophysiological data

The early ERP components recorded at occipital electrodes were characterized with a positive wave (P1) peaking at 90 ms followed by a negative wave (N1) peaking at 150 ms (Fig. 2). To examine whether the P1 to global and local targets was modulated by self-construal priming, the P1 mean amplitudes (70–130 ms) recorded over the lateral occipital electrodes were subjected to ANOVAs. The main effects of Target level, Priming, and Hemisphere were not significant (all $p > 0.05$). However, the interaction of Target level × Priming was significant at O1–O2 ($F(2, 38) = 4.22$, $p = 0.022$), PO7–PO8 ($F(2, 38) = 3.975$, $p = 0.027$), and marginally significant at PO5–PO6 ($F(2, 38) = 2.898$, $p = 0.067$), suggesting that the P1 was of larger amplitudes to local than global targets after the independent self-construal priming whereas a reverse pattern was true after the interdependent self-construal priming. The interaction of Target level × Priming did not differ between electrodes over the left and right hemispheres ($F(2, 38) = 0.006$–2.789, $p > 0.05$). The P1 amplitudes to global targets were subtracted from those to local targets to index the local enhancement effect (LEE) as illustrated in Fig. 3b. Post hoc paired t-test confirmed larger LEE after the independent than the interdependent priming (O1–O2: $t(19) = 2.622$, $p = 0.017$; PO7–PO8: $t(19) = 2.687$, $p = 0.015$). The difference in the LEE was marginally significant between the independent and the control priming conditions (O1–O2: $t(19) = 2.01$, $p = 0.059$). The LEE did not differ between the interdependent
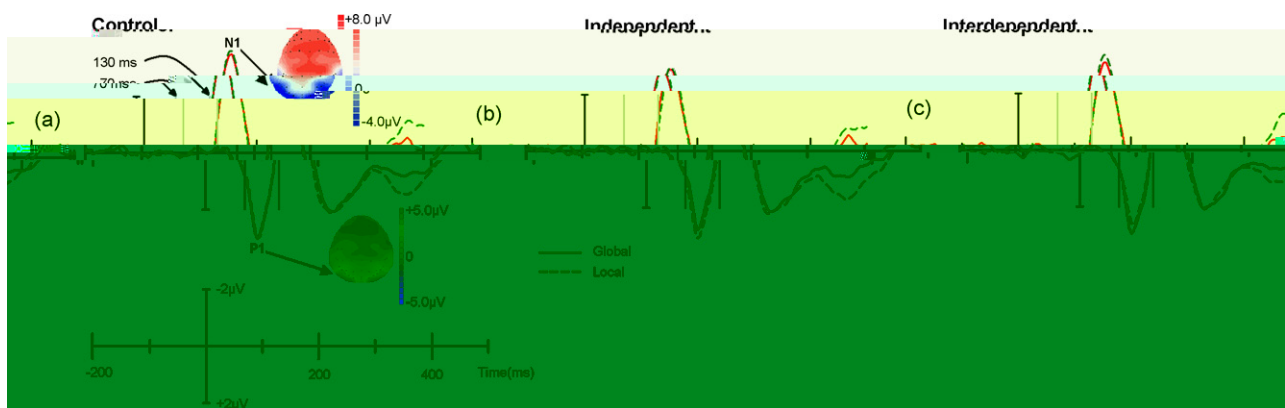

Fig. 2. Illustration of ERPs elicited by global and local targets in (a) neutral, (b) independent, and (c) interdependent self-construal priming conditions. The ERPs shown collapsed those recorded at posterior electrodes (O1–O2). Vertical gray bars indicate the time windows for P1 measurement (70–130 ms). Voltage topographies illustrated the scalp distribution of the P1 and N1 waves to global targets in the control priming condition.
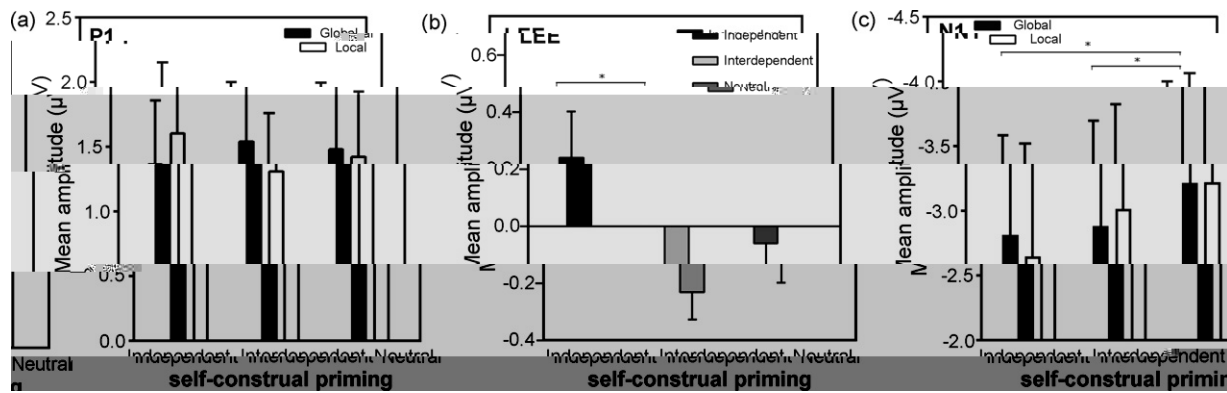
Fig. 3. (a) The mean amplitudes of the P1 wave measured at 70–130 ms in different priming conditions. (b) The local enhancement effect (LEE) was obtained by subtracting the P1 amplitudes to global targets from those to local targets. (c) The mean amplitudes of the N1 wave measured at 130–180 ms in different priming conditions. Error bars indicate standard deviation of the mean. The asterisks indicated significant differences.

and control priming conditions (O1–O2: $t(19) = -1.057$, $p = 0.304$; PO7–PO8: $t(19) = -1.626$, $p = 0.12$).

ANOVAs of the N1 mean amplitudes at 130–180 showed significant main effect of Priming (PO3–PO4: $F(2, 38) = 4.637$, $p = 0.016$; PO7–PO8: $F(2, 38) = 4.225$, $p = 0.022$; P3–P4: $F(2, 38) = 4.095$, $p = 0.025$; P5–P6: $F(2, 38) = 4.857$, $p = 0.013$), suggesting that the N1 amplitudes tended to be larger in the control priming condition than the interdependent self-construal priming condition, which in turn tended to be larger than in the independent self-construal priming condition. However, there was no significant interaction between Target level and Priming at any electrodes ($F(2, 38) = 0.007$–2.434, $p > 0.05$). Post hoc paired t-test confirmed smaller N1 amplitude after the independent priming (PO7–PO8: $t(19) = -2.497$, $p = 0.022$; PO3–PO4: $t(19) = -2.614$, $p = 0.017$; P3–P4: $t(19) = -2.137$, $p = 0.046$; P5–P6: $t(19) = -2.580$, $p = 0.018$) and the inter-dependent priming (PO7–PO8: $t(19) = -2.17$, $p = 0.043$; PO3–PO4: $t(19) = -2.764$, $p = 0.012$; P3–P4: $t(19) = -2.84$, $p = 0.010$; P5–P6: $t(19) = -2.727$, $p = 0.013$), relative to the control priming condition. The N1 amplitude did not differ between the independent and interdependent priming conditions (PO7–PO8: $t(19) = -1.232$, $p = 0.233$; PO3–PO4: $t(19) = -0.626$, $p = 0.539$; P3–P4: $t(19) = -0.073$, $p = 0.943$; P5–P6: $t(19) = -0.704$, $p = 0.490$).

4. Discussion

The present study investigated if the extrastriate activity underlying perceptual processes of global/local targets in compound stimuli can be modulated by categorical types of self-induced by self-construal priming. We found that, while the P1 amplitude did not differ between global and local targets in the control priming condition, the independent self-construal priming generated larger P1 amplitudes to the local than global targets whereas the interdependent self-construal priming tended to result in smaller P1 to local than global targets. There has been convincing evidence that the P1 elicited by visual stimuli is generated in the lateral ventral extrastriate cortex and the P1 amplitude is modulated by spatial attention (Di Russo et al., 2001, 2003; Martinez et al., 1999, 2001; Heinze et al., 1994). In line with these findings, the ERP results

in the current work and our previous studies (Han et al., 1997, 1999, 2000) suggest that attention to the global and local level of compound stimuli also modulates the P1 wave. Because the compound stimuli and procedures were identical for the global/local discrimination tasks in different priming conditions, the variation of the P1 amplitudes observed in our study reflected per se the modulation of the extrastriate activity by self-construal priming.

Our findings that the independent self-construal priming resulted in facilitation of local processing by increasing the extrastriate activity is in agreement with the behavioral measurements in cross-cultural studies. The independent self-construal priming shifted the self-construal towards the Western self-styles, which has been shown to cultivate a context-independent style of cognitive processes and to facilitate focused attention to salient object and ignore the field (Nisbett and Miyamoto, 2005; Kühnen and Oyserman, 2002; Lin and Han, submitted for publication). Our ERP results suggest that the temporal self-construal priming influences the style of perceptual processes in the same way as the long-term cultural effect does (e.g., the independent self-construal priming increased the visual activity to local targets) and the neural activity in the visual cortex in association with perceptual processes can vary as a function of social variables such as self-construals. However, it is unclear at this stage which neutral structures function to modulate the extrastriate activity when self-styles are temporarily changed. A possible candidate is a fronto-parietal circuit that has been shown to engage in processing of self-personal traits (Kelley et al., 2002; Lou et al., 2004; Zhu et al., 2007). However, this needs to be confirmed in future research.

We also observed influence of the N1 amplitudes by self-construal priming procedures. Relative to the control priming condition, the N1 amplitude was decreased after the independent and interdependent self-construal priming. However, the N1 modulation was different from that of the P1 amplitudes in that the N1 modulation by self-construal priming was not self-style specific. Previous work suggests that the N1 also originates from the lateral extrastriate cortex (Di Russo et al., 2001) but in the higher extrastriate areas within occipito-parietal cortex (Vogel and Luck, 2000). Thus it appears that

self-construal priming produced self-style specific modulation of the early ventral extrastriate activity, whereas resulted in general influence on the dorsal extrastriate activity at a later time window. The priming effect on the N1 amplitude suggests that exposure of 'I' and 'We' may induce similar neural mechanisms serving to weaken the long-latency extrastriate activity.

One may notice that the behavioral data in the current research did not show influence of self-construal priming on behavioral responses to global and local targets, unlike our previous behavioral research (Lin and Han, submitted for publication). A key difference between the previous and current studies is that there were more trials in the current ERP study (360 trials) than in the previous behavioral study (80 trials) after each priming condition, because ERP research required more trials during the average analysis to increase signal to noise ratio. This, however, might in turn produce significant effect of perceptual learning and thus weakened the effect of self-construal priming on behavioral responses.

In sum, our ERP results reinforce the previous behavioral studies by providing neuroscience evidence that self-construal priming modulates visual perceptual processes in the extrastriate cortex. The effect of self-construal priming on the extrastriate activity is consistent with the results of cross-cultural behavioral research, showing self-style-specific modulation of the P1 amplitudes. Self-construal priming also produced general influence on the late extrastirate activity (i.e., N1). Future research may identify whether modulation of the extrastriate activity by attention, emotion, and self-construal priming share common top-down neural mechanisms.

Acknowledgement

References

Di Russo, F., Martinez, A., Sereno, M.I., Pitzalis, S., Hillyard, S.A., 2001. Cortical sources of the early components of the visual evoked potential. Human Brain Mapping 15, 95–111.

Di Russo, F., Martinez, A., Hillyard, S.A., 2003. Source analysis of event-related cortical activity during visuo-spatial attention. Cerebral Cortex 13, 486–499.

Fink, G.R., Halligan, P.W., Marshall, J.C., Frith, C.D., Frackowiak, R.S.J., Dolan, R.J., 1996. Where in the brain does visual attention select the forest and the trees? Nature 382, 626–628.

Gardner, W.L., Gabriel, S., Lee, A.Y., 1999. I'' value freedom, but ''we'' value relationships: Self-construal priming mirrors cultural differences in judgment. Psychological Science 10, 321–326.

Han, S., Fan, S., Chen, L., Zhuo, Y., 1997. On the different processing of wholes and parts: a psychophysiological study. Journal of Cognitive Neuroscience 9, 686–697.

Han, S., Fan, S., Chen, L., Zhuo, Y., 1999. Modulation of brain activities by hierarchical processing: a high-density ERP study. Brain Topography 11, 171–183.

Han, S., Liu, W., Yund, E.W., Woods, D.L., 2000. Interactions between spatial attention and global/local feature selection: an ERP study. Neuroreport 11, 2753–2758.

Han, S., Weaver, J., Murray, S., Yund, E.W., Woods, D.L., 2002. Hemispheric asymmetry in global/local processing: effects of stimulus position and spatial frequency. NeuroImage 17, 1290–1299.

Han, S., Humphreys, G.W., 2002. Segmentation and selection contribute to local processing in hierarchical analysis. Quarterly Journal of Experimental Psychology A 55, 5–21.

Heinze, H.J., Mangun, G.R., Burchert, W., Hinrichs, H., Scholz, M., Münte, F., Gös, A., Scherg, M., Johannes, S., Hundeshagen, H., 1994. Combined spatial and temporal imaging of brain activity during visual selective attention in humans. Nature 372, 543–546.

Ji, L., Peng, K., Nisbett, R.E., 2000. Culture, control, and perception of relationships in the environment. Journal of Personality and Social Psychology 78, 943–955.

Kelley, W.M., Macrae, C.N., Wyland, C.L., Caglar, S., Inati, S., Heatherton, T.F., 2002. Finding the self? An event-related fMRI Study. Journal of Cognitive Neuroscience 14, 785–794.

Kühnen, U., Oyserman, D., 2002. Thinking about the self influences thinking in general: cognitive consequences of salient self-concept. Journal of Experimental Social Psychology 38, 492–499.

Lin, Z., Han, S., submitted for publication. Self-construal priming modulates the scope of visual attention.

Lou, H.C., Luber, B., Crupain, M., Keenan, J.P., Nwak, M., Kjaer, T.W., Sackeim, H.A., Lisanby, S.H., 2004. Parietal cortex and representation of the mental self. Proceeding of National Academy of Sciences United States of America 101, 6827–6832.

Markus, H.R., Kitayama, S., 1991. Culture and the self: implications for cognition, emotion, and motivation. Psychological Review 98, 224–253.

Martinez, A., Anllo-Vento, L., Sereno, M.I., Frank, L.R., Buxton, R.B., Dubowitz, D.J., Wong, E.C., Hinrichs, H., Heinze, H.J., Hillyard, S.A., 1999. Involvement of striate and extrastriate visual cortical areas in spatial attention. Nature Neuroscience 2, 364–369.

Martinez, A., DiRusso, F., Anllo-Vento, L., Sereno, M.I., Buxton, R.B., Hillyard, S.A., 2001. Putting spatial attention on the map: timing and localization of stimulus selection processes in striate and extrastriate visual areas. Vision Research 41, 1437–1457.

Masudaz, T., Nisbett, R.E., 2006. Culture and change blindness. Cognitive Science 30, 381–399.

Navon, D., 1977. Forest before trees: the precedence of global features in visual perception. Cognitive Psychology 9, 353–383.

Nisbett, R.E., Miyamoto, Y., 2005. The influence of culture: holistic versus analytic perception. Trends in Cognitive Sciences 9, 467–473.

Stöffer, T.H., 1994. Attentional zooming and the global-dominance phenomenon: effects of level-specific cueing and abrupt visual onset. Psychological Research 56, 83–98.

Vogel, E.K., Luck, S.J., 2000. The visual N1 component as an index of a discrimination process. Psychophysiology 37, 190–203.

Vuilleumier, P., Driver, J., 2007. Modulation of visual processing by attention and emotion: windows on causal interactions between human brain regions. Philosophical Transactions of Royal Society, Biological Sciences 362, 837–855.

Zhu, Y., Zhang, L., Fan, J., Han, S., 2007. Neural basis of cultural influence on self representation. Neuroimage 34, 1310–1317.