Negative and Positive Priming Effects on Global-Local Processing : Chinese Participants Respond to Navon Paradigm with Chinese Characters

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Negative and Positive Priming Effects on Global-Local Processing: Chinese Participants Respond to Navon Paradigm with Chinese Characters

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Referring to hierarchical visual stimuli consisting of global and local levels, Navon figures are often used within studies of global-local processing. Although previous studies have reported negative priming effects for sequentially presented Navon figures, the results vary across cultures. Western participants exhibit negative priming effects at the local level, while East Asian participants exhibit negative priming effects at the global level. In contrast to the letters and numbers used in prior studies, the present study used Chinese characters, which possess internal structures of various local features, such as strokes and radicals, and, therefore, may further emphasize global processing. The results revealed a positive priming effect at the local level and a trend for negative priming at the global level. These results suggest that East Asians tend to process both larger contexts and the details, and, thus, only inhibit local, not global, levels of irrelevant information.
Key words: Global-Local Processing, Priming Effect, Cultural Differences, Chinese Characters

Introduction

The Navon figure is widely used as an experimental stimulus to examine global-local process in human vision processing. The component stimuli in Narvon figures are compound hierarchical visual patterns comprising global (e.g. big letters made up of smaller letters) and local (e.g. small letters making up a bigger letter) levels (Navon, 1977). Participants are required either to report only the global features regardless of the local elements, or the local elements regardless of the global ones. Two results are typically found given paradigm: *global advantage*, i.e., the recognition of global features is faster than that of local elements, and *asymmetric interference*, i.e., global information interferes with local information processing with local information exhibiting a relatively small effect on global information processing. Although Navon (1977, 1981) originally observed that this precedence towards global aspects occurred in an early, perceptual, stage of processing, later studies demonstrated that attentional, rather than perceptual factors, play a central role in the global-local processing (e.g. Miller, 1981; Paquet & Merikle, 1988).

Negative priming is often involved in selective attention studies. Priming occurs when the processing of one stimulus, the prime, activates certain cognitive operations involved in processing a related stimulus, the probe (see review, Janiszewski & Wyer, 2014). Although priming originally referred only to positive, i.e., facilitating, effects of a prior stimulus on a subsequent one, negative priming, involving a decrement in performance, has also been studied extensively. Negative priming occurs when a

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probe is the same as, or similar to, an irrelevant distractor ignored in a previously presented stimulus. It has been conventionally proposed (e.g., Tipper, 1985) that during the presence of a priming stimulus, attention is inhibited by a distracting prime and this inhibition continues to dampen attention, thus interfering with future processing of the probe stimulus. However, more recent studies also suggested that negative priming may not reflect inhibition but due to difficulties in either recognizing retrieval response tags or distinguishing relevant and irrelevant information (Tipper, 2001).

Simultaneously presented Navon figures were first used in early studies on the inhibitory mechanisms involved in global-local processing (Paquet & Merikle, 1988; Paquet, 1988). Braind (1994) was the first to study global-local processing using a negative priming paradigm. He used shapes and colors to distinguish priming from simultaneously presented probe stimuli. Although lacked of consistency, his results clearly demonstrated that inhibition is not necessary when ignoring local items; instead, it may be a basis to ignore global stimuli.

Stablum, Ricci, Pavese, & Umilita (2001) asked Italian university students to serve in a typical sequentially presenting negative priming paradigm with Navon figures. They discovered that the negative priming effect was greater when these participants followed directions to attend to the local level than when attend to the global level. Using the same paradigm with French participants, Poirel et al. (2014) observed a negative priming effect only in a local task. These results further suggest that global information has to be inhibited during the processing of local information, whereas the reverse is not true.

However, Chinese participants showed different results with the same experiment procedures. Wang & Li (2002) executed the same paradigm using Arabic numbers and Chinese university students and found that negative priming only appeared when participants attended to global features. Cai, Du, Zhang, Qiu, & Zhang (2013) used the same procedure on healthy and autistic Chinese children. Results on healthy children were the same as Wang & Li (2002), while autistic children showed no priming effect under either condition.

The observed differences in previous studies about negative priming effects, given the Navon paradigm, may be relevant to the holistic/ analytic tendencies in attention between East Asian and Western participants. Psychological process often varies depending human populations (Henrich, Heine, & Norenzayan, 2010). It is commonly believed that East Asians process information in a more holistic way and are likely to integrate context or field information over an object, while Westerners' processing is more analytic and tends to detach objects from contexts (e.g., Nisbett, Peng, Choi, & Norenzayan, 2001; Masuda & Nisbett, 2001; Nisbett & Miyamoto, 2005). Specifically, given the Navon paradigm, East Asians, as well as second generation Asian immigrants, should show a much stronger global advantage relative to Caucasians (McKone, et al., 2010).

East Asians are also more likely to be influenced by previous contextual information in a subsequent task. One study demonstrated that only for East Asians was the recognition performance of previously seen objects better in their original backgrounds than in new backgrounds (Masuda & Nisbett, 2001). Amer, Ngo, & Hasher (2016) used Stroop stimuli and line-drawings with distractor words/nonsense words, and suggested that unlike Western participants, East Asians extend their processing to task-irrelevant background information without interfering with current task performance and actually benefit from such corresponding irrelevant features. In this case, irrelevant words become relevant on a subsequent task, thus leading to a positive priming effect.

When attending to the local level in a Navon task, global information becomes a distractor for both East Asian and Western participants. Although Westerners have to inhibit irrelevant global feature processing as they respond to local features (Briand, 1994; Poirel et al., 2014), we hypothesize that East Asians are able to keep global features activated and accessible, since East Asians are able to process irrelevant background information without costs and make use of this information in the upcoming task (Amer et al., 2016). Consequently, East Asian participants may experience less inhibition at the global level in a prime stimulus and even benefit from automatically activated global features when presented as the local feature in a probe stimulus. This hypothesis explains why negative priming at the local level was only

observed with Westerner participants (Stablum et al.,2000; Poirel et al., 2014) but not with Chinese participants (Wang & Li, 2002; Cai et al., 2013) in previous studies. If this is the case, then we can expect East Asian participants to have a positive rather than negative priming effect at the local level when the global advantage is emphasized.

On the other hand, when attending to the global level of a Navon figure, Chinese participants showed negative priming in previous studies (Wang & Li, 2002; Cai et al., 2013). By contrast, Westerners showed either no (Poirel et al., 2014) or a relatively smaller (Stablum et al., 2000) negative priming effect. Although it remains unclear, we hypothesize that since Chinese individuals tend to process objects within contexts, they may direct extra attention to local features even when instructed to focus only on global features. Unlike global information that can be processed automatically, this local processing requires attention and therefore might engender a negative priming effect in the subsequent response. If it is true that Chinese participants process task irrelevant local information on the basis of context, then we may reduce such processing of local elements in prime stimuli and lower the negative priming effect by emphasizing global processing.

To assess these hypotheses, we used Chinese characters as stimuli and Chinese students as participants in the current study. Compared to the typical materials used in Navon paradigm, such as Latin alphabets, Arabic numbers or geometrical shapes, Chinese characters (or "Kanji" in Japanese) are rather complex. Contrast to alphabetic languages, Chinese characters are composed of strokes and radicals, and become meaningful only when such components are combined under certain rules (Peng, Li, & Yang, 1997). Similar to Navon figure, a Chinese character consists of both global (i.e. the character) and local (i.e. strokes and radicals) features. Structural factors (i.e., spatial relationship of strokes and radicals) are extremely important in the recognition of Chinese characters (Huang, & Wang, 1992). Therefore, although radicals might be semantically meaningful respectively, a Chinese character must be processed as an entire stimulus regardless of separate local features. When Chinese characters are applied in Navon figures, we would expect global processing to be further heightened.

Chinese characters offer a greater global advantage in several aspects. It is suggested that while Latin letters are semantically processed after visual and phonological processing (Posner, 1973), the semantic processing of Chinese characters happens in parallel with visual processing (Wang, 1988), immediately after morphological processing (Kaiho, 1975). Hemispheric differences might also contribute to the global advantage of Chinese characters, as these characters are recognized better in the left visual field. This suggests that the right hemisphere plays a more important part in processing (Hatta, 1978; Nagae, 1994). In visual attention research it is commonly believed that the right hemisphere is superior in global processing and the left dominates the local processing (Heinze, Hinrichs, Scholz, Burchert, & Mangun, 1998; Hübner, 1997).

In the present study, we examined whether the cultural background of participants and the integrality of stimuli affect selective attention during global-local processing. We used Chinese participants and characters in a combined paradigm of negative priming and a Navon task. We hypothesized that, compared to Westerners, East Asians are more likely to integrate the compound stimuli and process irrelevant context information. Additionally, Chinese characters feature greater integration across components within characters, and this element should emphasize global processing. Accordingly, we predict that: a) When attention is directed to the local level, to-be-ignored global features are processed automatically and remain active until the next trial, which may lead to no priming or a positive priming effect; and b) When attention is directed to global level, local features receive little attention, which results in a relatively smaller negative priming or no priming effect.

Method

Design

The experiment used a 2×2 repeated measures design crossed two levels of attention (global, local) with two types of priming-probe relations (conflicting, controlled).

Each trial consisted of a sequence of two stimuli: a prime stimulus and a probe stimulus. In controlled

trials, the global and local features of a probe stimulus differed from those in its prime stimulus. In conflicting trials, the attended level of the probe stimulus was the same as the unattended level of the priming stimulus. Ignored features of the prime stimulus became targets of probe stimulus in the same trial and therefore could serve as interference for probe stimulus. The size of priming effect is measured by the RT differences between conflicting and controlled trials.

Participants

Thirty university students (20 females and 10 males) from Beijing Normal University and Beijing University of Posts and Telecommunications volunteered to take part in this experiment. Participants were aged 17~21. All participants were right-handed, with normal or corrected to normal visual acuity, and had never participated in similar experiments.

Materials

The stimuli were large Chinese characters representing numbers composed of smaller Chinese characters representing numbers. We used particular numbers to enable participants to respond upon a keyboard. In order to avoid shape similarity, Chinese character numbers "一", "二" and "三" (1, 2, 3) were excluded, and only "四", "五", "六", "七", "八", "九" (4, 5, 6, 7, 8, 9) were used in this experiment. The ratio of large characters to smaller ones was 12: 1.

Each compound stimulus has two different levels of features: local (small characters) and global (large character). The global and local features of a compound stimulus were always different. Participants were instructed to respond only to either local or global features. When participants were asked to attend to global features, the large characters were probe stimuli and the small characters were interference, and vice versa. Sample stimuli are showed in Figure 1.

Procedure

Each participant took part in both attention conditions. In the global attention condition, participants had to report the large characters and disregard the smaller characters. In the local attention condition, participants were instructed to report the smaller characters and disregard the large characters.

In each trial, a red central fixation point appeared at first. After 300 milliseconds, the fixation point disappeared and the priming stimulus was presented. After a participant reported the stimulus by pressing corresponding numbers on the keyboard, the stimulus disappeared and a 500-millisecond blank screen appeared. Next, the probe stimulus was presented. After the participants responded to the stimulus, there was an interval of 1000 milliseconds before the next trial began. The procedure in each trial is shown as Figure 2.

The experiment was divided into two blocks corresponding, respectively, to the two different

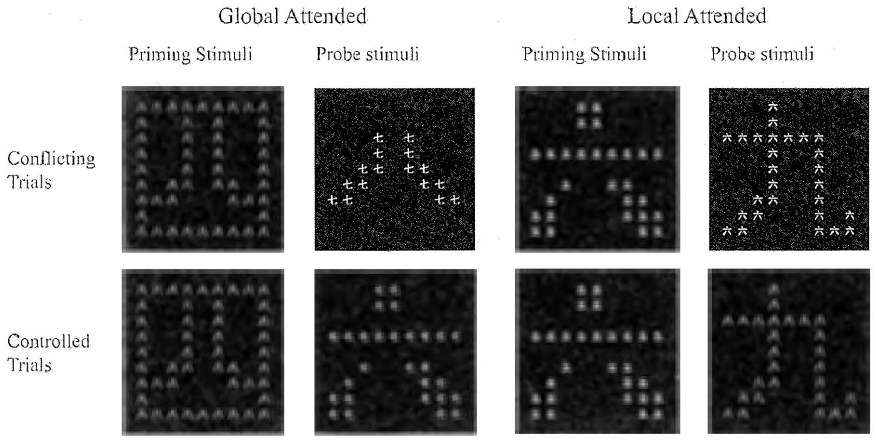

Figure 1. Samples of Stimuli Used in The Experiment

attention conditions. The order of the two attention conditions was counterbalanced. There were 20 trials in each block, with conflicting and controlled trial s randomly presented. Participants were asked to complete a training session before each block to make sure they understood the instruction.

The whole experiment took approximately 10 minutes for each participant to accomplish.

Results

Proportion Correct

Proportion correct results under different conditions are shown in Figure 3. It should be noted that the mean accuracy rate of all participants was 97.06%, which was high enough to suggest the existence of ceiling effects.

A 2x2 repeated measures ANOVA revealed a significant main effect of attention condition, F (1, 29) = 12.369, p = .001, η^2 = .299. Local characters were recognized more accurately than global characters. The main effect of prime-probe relatedness was not significant, F (1, 29) = 1.445, p = .239, η^2 = .047. And the interaction between attention direction and relatedness was not significant, F (1, 29) = 2.278, p = .142, η^2 = .073.

Reaction Time

Reaction times of incorrect responses were removed; only reaction time of correct responses were analyzed. Mean reaction times are shown in Figure 4.

A 2x2 repeated measures ANOVA was conducted. The main effect of attention condition was not significant, F (1, 29) = 1.74, p = .197, η^2 = .057, and nor was the main effect of relatedness, F (1, 29)

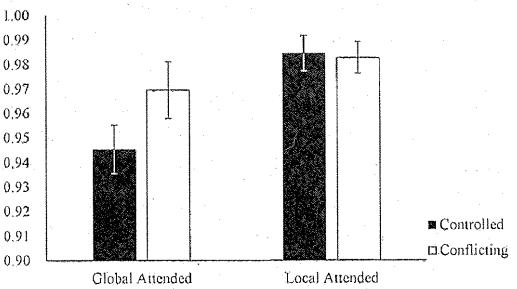

Figure 3. Mean Proportion Correct (Vertical bars represent standard errors)

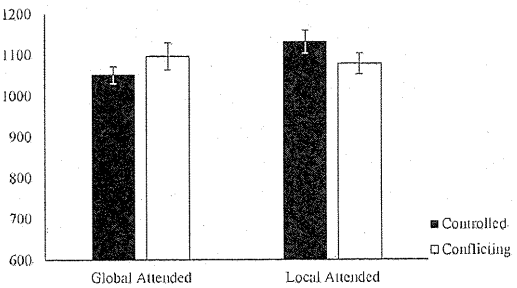

Figure 4. Mean Reaction Times (Vertical bars represent standard errors)

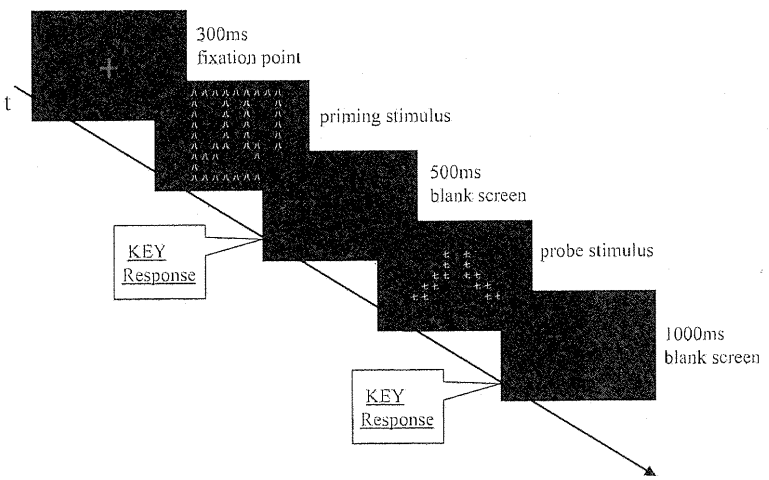

Figure 2. The Procedure in Each Trial

= .087, p = .770, η^2 = .003. However, there was a significant interaction between attention condition and relatedness, F (1, 29) = 7.67, p = .01, η^2 = .209.

Post-hoc t-tests assessed RT differences due to relatedness within each attention condition. As shown in Table 1, significant positive priming emerged when participants attended to local features: the prime stimuli speed responding to probes on conflicting trials, by 53.9ms, t = 2.678, p = .012, d = .371. While attending to global features, there was a slight trend indicating the possibility of a negative priming effect, t = 1.710, p =.098, d = .295. The size of priming effects between global and local attention level were significantly different, t (1,29) = 2.77, p = .010, d = .771.

Discussion

The main purpose of the present study was to ascertain if population and type of stimuli influence the inhibition in global-local processing. We hypothesized that East Asians tend to process current task irrelevant information on a contextual basis. For these participants, such irrelevant information is more likely to be processed automatically at a global level than at a local level. Presenting Chinese characters emphasized the processing at the global level. A positive priming effect occurred on local level, whereas a borderline significant negative priming effect emerged when attention was directed to global level. The results are consistent with our hypotheses.

As noted in the introduction, previous results with the same paradigm have varied considerably across studies. For instance, according to the literature, a significant negative priming occurs under both attention conditions (Stablum et al., 2000), or it can occur only when attending to local level (Poirel et.al, 2014), or only when attention is directed to global level (Wang, & Li, 2002; Cai et al., 2013). On the basis of the present study as well as previous research, one explanation of this variability across studies appeals to be population and type of stimuli. Results of previous studies as well as the present study are summarized in Table 2. Differences among results from these studies can be explained in terms of cultural backgrounds. In particular, participants in different studies can be gauged by their holistic/analytic cognition patterns due to cultural background. Thus, when attending to the global level of the Navon figure, Westerners show smaller or no negative priming because the ignored local elements provided relatively limited interference at the global level. By contrast, Chinese participants tended to process local elements as context backgrounds, hence they demonstrated distinct negative priming. When attending to local level information in a compound stimulus, however, Westerners must inhibit the priority global information; in turn, this inhibition slows identification of the same letter presented at the local level in probe stimulus (Poirel et.al, 2014). However, East Asians extend their attention to background information automatically although they are instructed to ignore this information; thus they can maintain irrelevant information until subsequent tasks where such it becomes relevant (Amer et.al, 2016). Therefore, the robust negative priming effect at the local level of this paradigm was not found in the present study, nor in several other studies involving Chinese participants (Wang & Li, 2002; Cai et al., 2013).

When highly integrated materials, such as Chinese characters, are applied in this paradigm, the global

Table 1
Mean reaction times (ms) for attention conditions: SD in parenthesis

	Local Attended	Global Attended
Controlled Trials	1132.239 (150.670)	1051.483 (114.156)
Conflicting Trials	1078.310 (139.583)	1096.475 (182.804)
Priming Effect	53.929 (110.281)	−44.992 (144.139)
t	2.678	−1.710
p	.012	.098
Cohen's d	.371	.295

advantage may be further heightened in that processing of irrelevant local elements is reduced and processing of irrelevant global information is accelerated in prime stimuli. This may promote, rather than interfere with, performance at a different attention level. By comparing our results with those of previous studies, we conclude that the global-local processing is influenced by both the cultural background of the participants and the type of material applied in the compound stimuli.

Our results confirmed that a global advantage of East Asians over Westerners exists for this type of processing. Traditionally, research in analytic versus holistic differences has focused on voluntary thoughts and behaviors, however, these differences also exist in basic cognitive and perceptual processes. Therefore, we would like to emphasize that it should be necessary to take popularion differences into account even in basic cognitive studies. Currently, most of the psychology studies published in the world's top journals are based on samples from Western, Educated, Industrialized, Rich and Democratic (WEIRD) societies. Researchers are often interested in universal principles of human behaviors despite of their narrow samples, however, we should be especially careful when generalizing results for Western participants to other cultures (Henrich et al., 2010).

However, it should be noted that our conclusion is based on just one experiment and its comparison of previous studies conducted with the same paradigm. Although previous literature exists on the priming effect using the Navon paradigm in both East Asian and Western countries, these studies might differ from the present study in many experimental parameters and stimulus properties (e.g., stimulus clarity, space between local features, number and relative size of elements, visual angle, retinal location, exposure duration, eccentricity and masking). The evidence presented in the current study is not sufficient to compare the size of the global advantage of different stimuli types across races and cultures. In other words, it is necessary to replicate this experiment with different cultural groups in the future.

In conclusion, in contrast to previous studies, this study demonstrates a positive priming effect when attending to local elements and little negative priming effect when attending to global features with East Asian participants using East Asian specific stimuli. We believe that unlike Westerners, East Asian participants can process currently task irrelevant information, and that previous global information may enhance their recognition of the same character in probe stimuli.

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Table 2
Comparisons of Previous Studies with Same Paradigm

Research	Participants	Stimuli	Priming effect results in function of attention condition	
			Global attended	Local attended
Stablum et al., 2001	Italian university students	Roman Letters	Negative	Negative
Poirel et al., 2014	French university students	Roman Letters	n.s.	Negative
Wang & Li, 2002	Chinese university students	Arabic numbers	Negative	n.s.
Cai et al., 2013	Healthy Chinese children (aged 7 or 11)	Arabic numbers	Negative	n.s
Present Study	Chinese university students	Chinese character numbers	Trend in Negative	Positive

Cai, Y., Du, X., Zhang, W., Qiu, T., & Zhang, L. (2013). Negative Priming under the Global-Local Paradigm in Children with Autism. *Chinese Journal of Special Education, 9*, 40-45 (In Chinese with English abstract)

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