Examining the Effect of Subliminal Priming on Ambiguous Figure Perception

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Abstract ~ Figure-ground organization is a kind of perceptual organization that has been studied in Gestalt psychology. Ambiguous/reversible figures can evoke two different percepts. When we see ambiguous figures, sooner or later our perceptual system determines one side that stands out as the figure, while the other side forms the ground and becomes shapeless. Subjects were subliminally trained with the half-figures of the target

ambiguous figures and then presented with the target figures. The result demonstrated above-chance level of consistency between the prime and the choice of the figure. From this result, it was concluded that subliminal priming of the figure had effects on figure-ground organization.

Introduction

In the investigation of visual perception, Gestalt psychologists made an indispensable contribution by asserting that perceptual processes were not simply determined by separate elements in visual stimuli (Peterson, 1999; Mack, Tang, Tuma, Kahn, & Rock, 1992). Those elements are not processed separately from each other. Rather, they are organized into particular groups in the course of perceptual processing. For instance, if there is a curved line with another line branching out, and if the branching out is too abrupt, we tend not to see the second line as continuous to the first one. On the other hand, if the branching out is smooth and continuous enough to the first line, we tend to see these two lines as continuous. This is an example of the Gestalt law of good continuation (Rock, 1975). This phenomenon of perceptual organization or perceptual grouping was clearly described by Wertheimer who, besides good continuation, proposed several laws of perceptual organization such as similarity, proximity, common fate, objective set, and past experience (Rock, 1975; Mack, Tang, Tuma, Kahn, & Rock, 1992). These laws influence how we perceive the external world.

The occurrence of figure-ground organization is an aspect of perceptual organization. The mechanisms of our binocular vision enable us to translate a 2D retinal image into a 3D percept so that a part of the stimulus stands out as the figure that has a shape while other parts form the ground and appear shapeless (Peterson, 1999). For instance, in Rubin's classic vase/face figure, there are two possible interpretations: either a decorative

vase or two profiles facing each other. Alternations between two percepts occur, an amazing phenomenon considering the fact that there is only one fixed stimulus. Therefore, the occurrence of two interpretations or alternations can be attributed to our perceptual processes themselves. The assignment of the figure is not a random phenomenon; it is subject to certain rules. Surroundedness, symmetry, blackness, and convexity are among those rules (Rock, 1975; Peterson & Gibson, 1994; Vecera & O'Reilly, 1998; Vecara, Flevaris, & Filapek, 2004). The assignment of figure can be considered a resolution of a problem of choosing one of the competing sides. In this way, perceptual organization "settles" the perceptual problem. It stands on the Gestalt concept of *Prägnanz*, or a "good shape" (Rock, 1975).

The phenomenon that a single stimulus elicits two percepts or interpretations has been attributed to various possible causes. These include satiation or neural fatigue, eye movement, preference for novelty, and availability (Rock & Mitchener, 1992; Horlitz & O'Leary, 1993; Long & Olszweski, 1999). Some argue that there is an effect of instruction or the possibility of voluntary control of reversals. Rock and Mitchener (1992) reported that subjects who were not informed of the possibility of reversal failed to perceive reversals. Toppino (2003) examined the effect of intentional control over the reversal of figures and found out that it was possible for observers to intentionally control (i.e. hold one percept) the reversal to some limited extent. In this case, top-down influence may be involved in the perceptual processes.

Traditionally, it has been said that perceptual organization and figure-ground organization occured very early in the perceptual processes and are automatic. One of the reasons for this is that it has been considered a pre-attentive process (Neisser, 1967; Vecera, Flevaris, & Filapek, 2004). Peterson (1999) argued that figure-ground organization took place before object recognition.

She demonstrated the possible mediation by meaning by comparing the reactions to inverted figures and those to canonical figures. There are also other researchers who have cast doubt on the traditional early-on, bottom-up view of figure-ground organization. As such an example, an interactive view of figure-ground organization based on the Parallel Distributed Processing (PDP) model has also been proposed (Vecera & O'Reilly, 1998). PDP hypothesizes that there might be access to and feedback from object representation before the completion of figure-ground organization. Other theories assert that even if a PDP model is employed, that does not affect the convention that figure-ground organization occurs first in the perceptual processing (Peterson & Gibson, 1994). Vecera, Flavaris, and Filapek (2004) concluded from their experiments involving exogenous attention that the processes of figure-ground organization were not completely finished before the operation of focal attention.

There has been an argument that figure-ground organization is mediated by unconscious processes (Epstein & De Shazo, 1961; Rock, 1975). This view proposes that the perceptual system oscillates between two interpretations of the figure and only one of them enters the consciousness when the choice is made. As Peterson (1999) argued, the observer might be able to connect the presented figure and the object representation in his/her mind guided by familiarity. For instance, when we walk in front of trees and a building, we are able to successfully distinguish the trees from the building because we have the prior knowledge of their distinctiveness by walking around. Likewise, various kinds of past experience can influence our perceptual processes, contributing also to the perception of figure-ground organization.

In 1957, Rock and Kremen (1957) conducted an experiment to examine the effect of past experience on ambiguous figure perception. They prepared 18 ambiguous square figures, each of which had a black and white side. Observers were trained with

the half-figures of the above-mentioned composite figures (the primes) for 2 seconds for each half-figure and were instructed to make great efforts to telepathically send the image to another person. Then there was an intermission with a distracting task, followed by the presentation of test figures. Each test figure was presented for 1 second and observers were asked to tell which side of the stimulus appeared as the figure. The result turned out to be not significant, refuting the effect of past experience.

What constitutes past experience can be controversial. Does it refer to supraliminal or subliminal experience? What duration is enough to constitute past experience? How about the types of attention, focal or divided? In Rock and Kremen (1957)'s experiment, the figures were not only presented supraliminally for 2 seconds but also observers made great effort to telepathically send the image to another person. On the other hand, as Rock (1975) speculated, the whole process of figure-ground organization may involve unconscious processes. While conscious perception of the prime may affect the subsequent perceptual process one way, subliminal perception of the prime may also affect the subsequent perception in one way or another. Subliminal priming might be influential enough to affect the subsequent perceptual processes, thus, account for a kind of past experience.

Cheesman and Merikle (1984) dealt with the issue of perception without awareness using the Stroop procedure. They found no evidence for the perception of materials presented below threshold. On the other hand, Epstein and Rock (1960) tested the effect of expectancy in relation to frequency and recency of the primes by manipulating the frequency and the order of the primes. Their finding showed no effect of expectancy but there was an effect of recency. In this study, the primes were presented supraliminally. Following this study, Epstein and De Shazo (1961) demonstrated that there were oscillations between two possible percepts as

Rock (1975) later suggested. They considered that the deter-mined figure entered the perceptual processes only after the oscillations stopped.

There is a dearth of studies that deal with subliminal perception as past experience. Most studies examine the effect of the primes presented supraliminally, despite the argument that there are a considerable amount of activities going on outside the perceptu-al processes. In this study, the author will examine the effect of priming below threshold as past experience that may influence the perception of figure-ground organization.

Method

Participants
Sixteen undergraduate and graduate students at New School University participated in the experiment. There were 5 male participants and 11 female participants. They all had normal or corrected-to-normal vision. Participants were placed in one of the four experimental groups. Four experimental groups were determined by the order of the presentations of the primes and the test figures.

Apparatus and stimuli
Prior to the experiment, two ambiguous figures were prepared (Figures 1 and 2). They resembled those used in Rock and Kremen's (1957) study, each of which was a square with a curvy line running down in the middle to divide the square into two parts. Each part was painted either black or white. Each figure had two versions in terms of color combinations; one version with the black part on the left side and the white part on the right side (B/W), and the other version with the white part on the left and the black part on the right (W/B). These figures were placed on the gray background. The gray half-figures, both the left sides and the right sides, were also prepared and used as the primes (Figure 3).
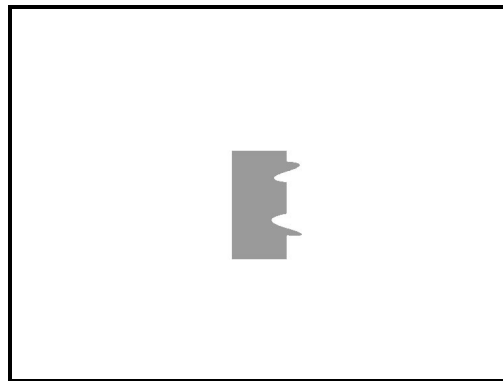
Figure 1

Figure 2

Figure 3

A Macintosh iMac computer and Super Lab Version 1.4 were used to present the stimuli. Observers were asked to sit in front of the computer and look at the center of the screen. First, observers were shown a figure that resembled the actual test figures and received a brief explanation on figure-ground organization and their task. On the computer screen, a fixation point appeared, and the prime was presented 5 times subliminally, with the duration of 10.5 milliseconds (ms) for each presentation. Each subliminal presentation was followed by a mask with random gray-toned patterns. The test figure was presented immediately after the termination of the last subliminal presentation and the mask, and observers were asked to tell which side, left or right, stood out as a figure or press the corresponding keys, L or

R, on the keyboard. The same sequence was repeated for the other figure. If observers remained indecisive about the response, they were encouraged to report what came into their mind first.

Results

All 16 participants saw two test figures, which summed up to 32 responses. Out of those 32 figures, the black sides and white sides were equally primed. Twenty-two responses were consistent to the prime, regardless of the color of the primed side, and 10 responses were inconsistent to the prime. Out of those 22 responses that were consistent to the prime, 11 chose the black side as the figure, and 11 chose the white side as the figure. In other words, there were no differences observed related to the color of the primed side. In the responses that were inconsistent to the prime, 6 chose the black side as the figure, while 4 chose the white side as the figure.

A chi square analysis comparing responses made to the primed and unprimed sides of the test figures yielded a significant effect, X^2 (1, N = 16) = 4.5, p < .05. This demonstrated that subliminal priming of the figure has the effect as past experience on figure-ground organization.

Discussion

In this experiment subjects had an opportunity to be subliminally trained with the half-figures of ambiguous figures prior to figure-ground discrimination trials. The aim of this training was to provide past experience of the figure. The overall result demonstrated that the primes presented below threshold indeed had effects on figure-ground organization. In conjunction with the laws of figure-ground organization mentioned before, there were some characteristic responses observed in the experiment. First,

responses that were consistent to the prime (22 responses) were unrelated to the color (black or white). This may suggest that the effect of priming is stronger than the effect of color. Second, out of 10 responses that were not consistent to the prime, 6 chose the black side as the figure and 4 chose the white side as the figure. This seems to be consistent with the law of figure-ground organization of blackness. Among the 4 subjects who were presented with Figure 2 with the black side primed (see Figure 2), 3 subjects chose the white side that was not primed. This appears to be because of another law of figure-ground organization, namely convexity in Figure 2 (Rock, 1975; Peterson & Gibson, 1994; Vecera, Flevaris, & Filapek, 2004). In this case, the convexity effect might be strong enough to override the effect of the priming of the black side. Altogether, the result showed both the effect of past experience and perceptual laws.

Four participants pointed out the inconsistency between the actual key positions of R and L on the computer keyboard and the physical direction of right and left. Although the study was not concerning reaction time, this inconsistency might have had an affect on their responses. In this study, observers were given as much time as necessary before providing the response. Nonetheless, when observers remained indecisive about the response, they were encouraged to report their first impression. Taking time to respond might suggest that some of them were not directly reaching one percept but instead experienced moments of oscillations between the two.

This bears resemblance to Rock's (1975) hypothesis that the figure enters consciousness after the unconscious oscillations are resolved and the decision of the figure is made. Following this, Esptein and De Shazo (1961) claimed that there were indeed unconscious oscillations occurring during the perceptual processes of figure-ground organization. It is unreasonable to conclude that such oscillations occur only unconsciously. Just as the case

of reversible figures (Long & Orszweski, 1999), oscillations can occur consciously and unconsciously. Observers might be aware of fluctuations between two percepts both consciously and unconsciously.

One possible cause for this occurrence of oscillations might be that once observers take time to give the response and start to trace the contour, the search initiates a reversal of figure (Hochberg, 1981). Or, observers may simply change their mind after perceiving the first image. If the assignment of the figure is analogous to identification between the perceived figure and internal object representation then; if there is a match the figure might be chosen, or; if there is no match, the other side might be chosen (Vecera & O'Reilly, 1998). This process might be justified by the match-seeking tendency of figure-ground organization (Peterson, Harvey, & Weidenbacker, 1992) and if there is no match between the perceived image and the memory trace, the unprimed side is chosen because of our tendency to prefer novelty. Preference for novelty seems to be so fundamental in human perceptual processes that related phenomena of habituation and attention are observed as early as in infancy (Horlitz & O'Reilly, 1993).

The effect of past experience is not what has usually been reported. Epstein and De Shazo (1961) asserted that figure-ground organization was not determined by expectation but by memory trace. On the other hand, Rock and Kremen (1957) did not find a significant effect of supraliminal priming on figure-ground organization. Contrary to their finding, this study found an effect of subliminal priming on figure-ground organization. Is there anything about subliminal priming rather than supraliminal priming that potentiates priming of the figure? To say the least, it is possible to argue that supraliminal priming allows observers to consciously think about the figure, and consequently, it allows more possibilities for them to choose the unprimed side out of

preference of novelty (Rock & Mitchener, 1992; Long & Olszweski, 1999). By consciously perceiving the figure, observers may have more control over the decision they make. However, in the case of subliminal priming, there might not be room for such control over choice. For example, it is possible to "hold" on a percept for a while (Toppino, 2003). If the image provided subliminally is registered in observers, they may respond consistently or inconsistently to the representation. Just as the case of supraliminal priming, observers may choose the primed side as the figure because it looks familiar, or they choose the unprimed side as the figure because it looks novel. What is noteworthy about subliminal priming is that this kind of match between the perceived test image and internal representation is totally beyond observers' awareness.

According to the convention, figure-ground organization occurs prior to object recognition (Peterson & Gibson, 1994; Peterson, Harvey, & Weidenbacker, 1992; Peterson, 1999). If subliminal priming has an effect on figure-ground perception, at what point within the perceptual processes does it occur? Does it interact with the perceived image, or is it considered to be part of past experience? In the case of supraliminal priming, a match between the consciously perceived image and the past experience or memory trace is made while the latter is possibly evoked consciously. But in the case of subliminal priming, the past experience or memory trace can be accessed only unconsciously, thus, a match is made between that unconscious image and the perceived image. These two processes appear to be different ones.

As for perception of subjective contours, memory seems to serve as the source of familiarity that gives rise to the shapes (Wallace & Slaughter, 1988). Familiarity plays an important role in perceptual processes. The question here is whether subliminal priming is robust enough to provide such familiarity. The result of this study seems to confirm this robustness. Familiarity or mean-

ingfulness is one important factor to determine figure-ground organization. One question is whether figure-ground organization just serves as an input to later object recognition (Vecera & O'Reilly, 1998). Although subliminal priming may provide some kind of familiarity to observers' internal processes, there is no doubt that that familiarity remains unknown to observers. In other words, observers are unaware of any familiar figures in the test stimuli and are simply responding according to the primed figures. The capacity of perceptual system may be greater than what consciousness can grasp or process. As Neisser (1967) suggested, most of our perceptual experiences in daily life are unconscious. Nonetheless, we have few difficulties in conducting daily life and remembering things. Below-threshold stimuli are not consciously perceivable, nonetheless they still influence later perceptual processes.

There have been controversies over the effect of instructions and expectations, and the procedure of explaining the task of choosing the figure may in fact evoke some expectations in observers. Nonetheless, in the study, most observers simply chose the one consistent with the subliminally presented prime. Again, subliminal presentation does not allow any room for usual sense of expectation, for observers have no control over taking in such information.

This study suggests that subliminal priming of figure-ground organization could be effective. There are several questions that can be posed to advance this line of investigation. First, this study allowed virtually unlimited time for observers to respond to the test figure. What happens if the response is more pressed, that is to say, for instance, time-limited or under the condition of measuring reaction time? Second, what happens if there is a sufficient interval between the prime and the test figure? For instance, when there is a sufficient interval between the priming and the trial and the observers think that they are independent

perceptual events, do they still respond according to the prime? It is necessary to find out where in the perceptual processes this kind of priming occurs. Are they interactive processes or more traditional, serial bottom-up processes? If we call them unconscious, is the unconscious part based on priming, about oscillations between two percepts, about both of them, or about processes beyond them? In the process of choosing the figure, how is the primed image evoked and processed? Further investigations would expand our still limited knowledge on perceptual organization and perceptual processes.

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