There Is No Naked Eye:
How Higher-Order Social Concepts Clothe Visual Perception

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Abstract

Vision researchers have investigated many sources of information that assist perception. Although basic visual properties of stimuli can alter interpretation, the following 5 studies contend that implicit, complex, social information significantly influences basic visual perception. Study 1 employed a scrambled sentence priming procedure used to activate concepts without participants' awareness. Studies 2, 4, and 5 used less contrived priming techniques that required participants to read paragraphs related to the intended prime. Study 3 utilized self-generated primes created through minimal prompting. All priming procedures resulted in an increase in the proportion of initial percepts that were related to the primed concept. These priming procedures not only demonstrate the influence of complex information on perception of ambiguous figures but of indistinct natural scenes as well.

Introduction

For decades visual cognition researchers have investigated whether object identification is purely the result of bottom-up processes, or also incorporates top-down, contextual information. Many contend that perception is driven by synthesis and analysis of basic object components (Kosslyn & Koenig, 1992; Michelon & Koenig, 2002). Specifically, these researchers propose that perception is influenced by focal areas and critical features (Long & Olszweski, 1999), fixation points (Georgiades & Harris, 1997; Loftus & Mackworth, 1978), texture (Julesz, 1978), among others. Mast and Kosslyn (2002) summarize this theoretical stance explaining "visual perception is driven by the nature of the external world" (p. 57).

Several research programs have suggested metaphors that describe how limited and basic information feeds initial perception. Posner, Snyder, & Davidson (1980) suggest that detection of a visual stimuli requires the involvement of a "limited-capacity attentional mechanism" that constrains the amount of information available as input. Similarly, Eriksen and Yeh (1985) proposed that attentional resources act as a zoom lens to constrain visual information. As a result of limited capacity, is not possible to process all the information available (Broadbent, 1982). Essentially, initial percept is the product of the limited number of basic features that are or can be attended to.

In another direction, some recent research supports the role of attentional constraints and biases on low-level visual perception. Research (Motter, 1993) on single cells within cortical visual areas of rhesus monkeys demonstrated a differential neural sensitivity when attention was directed toward a target stimulus. Additionally, Spivey and Spirn (2000) have demonstrated effects of attention on visual orientation believed to occur in the primary visual cortex.

Evidence such as this led other researchers, to suggest a union of high- and low-level systems. Specifically, they contend that that top-down processing cues are required for object perception. For example, Henderson, Pollatsek, and Rayner (1987) demonstrated visual priming influences on object perception specifically concluding that participants were faster to identify target objects when they were preceded with semantically related priming objects than when preceded with semantically unrelated priming objects.

Additionally, congruent background contexts can impact the speed with which objects embedded in that scene are identified (Boyce & Pollatsek, 1992) and the accuracy of their identification (Biederman, 1972; Biederman, Mezzanotte, and Rabinowitz, 1982). Yet, this paradigm specifically draws attention to target objects while participants are asked to identify them. It is difficult to conclude from these studies that context provides the primary source of information for object identification when the paradigm relies upon the inclusion of methods demonstrated to be effective for manipulating perception by bottom-up theorists. In addition, work by Boyce, Pollatsek, and Rayner (1989) suggests that inconsistent background contexts do not impede object identification. Instead, they contend that consistent backgrounds provoke a type of spreading activation response that prepares participants for the likely occurrence of objects commonly paired with that background environment.

In the following studies, we sought to demonstrate the impact of higher-order information on early stages of visual processing. Although there is research supporting global influences, it is relatively scarce and does not investigate conceptual information that is activated implicitly. That is, certainly top-down processing effects have been demonstrated in the field of visual perception, however, the following studies demonstrate that perception can be influenced outside of participants awareness and through the activation of complex but related higher order information. To uncover what processes determine initial perception, researchers have often used a variety of reversible and multi-stable ambiguous figures. In tow, the following

studies demonstrate that top-down priming through tasks representative of real-world activities have direct and powerful effects on the perception of artificial and naturalistic ambiguous figures.

Study 1 begins an investigation into socially motivated priming effects on visual perception. This study uses the traditional scrambled-sentence priming technique and a simple dual-interpretation ambiguous figure. Study 2 uses the same figure but calls upon a more natural procedure for activating higher order concepts. Study 3 attempts to demonstrate the same top-down processing effects without the labored priming strategies. Instead, participants in study 3 generate their own primes with minimal prompting. Study 4 employs a more complex yet still artificial ambiguous figure that combines pictorial and orthographic elements. Finally, study 5 leaves behind the artistic images and calls upon naturally occurring ambiguity. Study 5 relies upon a photograph with 2 interpretations of the focal element. Each of the successive demonstrations reveals that social, higher-order information of a more naturalistic nature may come to influence both simple and complex, natural visual information.

Study 1

Method

Forty-eight Cornell psychology and human development undergraduates completed 1 of 3 scrambled sentence tasks (female, music, or control) adapted from Srull & Wyer (1979). In this priming task, participants constructed grammatically correct 4-word sentences out of sets of 5 words presented in a scrambled order by eliminating a single word (e.g. *the dry was wet field*).

For those in the non-control conditions, embedded within 15 of the 27 trials were words related to women (e.g. *waitress*, *mother*) in the female condition or words related to music (e.g. *gig*, *jazz*) in the music condition. It is important to note that in neither priming condition were participants exposed to words that directly described the figure (e.g. *face, saxophone*). Those in the control condition were exposed to neutral words with respect to music or women in all trials (e.g. *lectures, pencil*). Participants then completed a second, supposedly unrelated object identification task in which they were shown the sax player/face ambiguous figure for 1 to 2 seconds (Figure 1) and were asked in an open-ended question to indicate their initial percept. Additionally, participants were asked if they had seen the figure before and if they knew what the hypotheses of the study were.

Figure 1: Sax player/face ambiguous figure.

We expected that the female prime would increase the percentage of participants who reported seeing a face compared to the base rate as determined by the neutral condition. However, we expected that the music prime would increase the percentage of participants who saw the saxophone player as compared to the base rate.

Results and Discussion

These studies intended to demonstrate the effects of conceptual priming on basic visual perception as opposed to memory for previously viewed images. As a result, data from participants who indicated that this figure was not novel were removed from the analyses (N = 19).

As predicted, a greater percentage of music-primed participants saw the saxophone player (40%) compared to the control condition (20%), $\chi^2(1) = 4.01$, $p < .05$. However, the female prime made little impact on perceptions of the face. In the control condition, 80% of participants saw the face, but this percentage was not influenced by the female prime as 80% of participants in this condition reported seeing a face as well, $\chi^2(1) = 0.0$, $p = 1.0$. We interpret this result as indicating there is a ceiling effect for initial percept of a face, a favoritism that could not be overcome with the scrambled sentence priming technique.

Study 2

Study 2 intended to replicate the conceptual priming effects of the previous study. Although study 1 provided an initial demonstration of implicit top-down processing effects due to complex information, study 2 modified the priming procedure in order to better capture how concepts are activated outside the laboratory. Additionally, study 2 sought to demonstrate priming effects even in the face of percept favoritism.

Method

Participants were 108 Cornell University undergraduates. They read 1 of 2 sets of paragraphs: one set was composed of discussions on the music file sharing controversy surrounding Napster while the other asserted pro- and anti-pornography arguments. Again, participants were not exposed to words that directly described any component of the figure. Then, participants were given an ostensibly unrelated object identification task. Participants were shown

the sax player/face ambiguous figure (figure 1) for 1.5 seconds. Immediately after, participants indicated their initial percept, asked if they had seen this figure before, and probed for suspicion of the hypotheses.

Results and Discussion

Within this sample, a large number of participants wrote down an generic description of the figure (N = 20) that did not clearly indicate whether they saw the saxophone player or the face (e.g. *person*). These responses were included in the analyses as a separate response category. All data was analyzed using a 2 (prime: Napster, porn) X 3 (response: saxophone player, face, generic) chi-square to control for these vague responses. Results indicate that there was a significant difference in the percentage of participants who saw the saxophone player depending upon prime type, $\chi^2(2) = 8.99$, $p = .01$. Of those in the porn prime condition, 0% reported seeing a sax player but 18% of those in the Napster condition did.

Study 3

The purpose of study 3 was to allow participants to self-generate conceptual primes with minimal prompting. We intended to demonstrate the effects of study 1 and 2 without the heavy-handed influence of experimenter-created primes and that even with great variance within the prime, the effects on visual perception are strong.

Method

Sixty-three Cornell undergraduates were asked to assist in the creation of the text and pictures of a children's book. Participants completed 1 of 2 types of self-generated priming packets. In the farm prime condition, participants were asked to choose a farm animal as the main character of a children's story, list peripheral animal characters, and write an introductory paragraph that incorporates all of the characters. Participants in the sea condition received the same prompts but created a tale surrounding a sea creature. In a second task, participants were asked to judge the appropriateness of a figure that was intended for the children's book. For 1 to 2 seconds, participants viewed the horse/seal ambiguous figure (Figure 2). Immediately after, participants indicated their initial percept, asked if they had seen this figure before, and probed for suspicion.

Figure 2: Horse/seal ambiguous figure.

We expected that the distribution of percepts would vary as a function of prime type. Specifically, we expected that a greater proportion of participants would report a seal when primed with a self-generated sea animal story than when primed with a farm animal story.

Results and Discussion

Again, data from participants who gave vague responses (N = 10) or had seen the image before (N = 3) were removed. Additionally, data from those participants who could blatantly describe the purpose of the study and link the prime to the object identification task were removed (N = 7) as advised by Bargh and Chartrand (2000) due to concerns of reactance towards the prime. For those who are aware of the purpose of the prime, measures of the effects of implicit priming techniques are not valid as contrast or at times demand effects may occur. This left data from 43 participants for analyses. Results indicated that the distribution of reported percepts significantly differed depending upon prime type, $\chi^2(1) = 7.15$, $p = .008$. Of those in the farm prime condition, 0% reported seeing a seal. However, 26% of those in the sea creature condition reported seeing a seal.

Study 4

Study 4 used the least contrived prime of all 4 studies. The figure chosen for this study was more complex because it involved orthographic and pictorial interpretations. Additionally, by varying the rotation at which the figure was viewed, we created favoritism in object identification. We intended to demonstrate that conceptual priming could override this favoritism and still result in an interpretation in line with the primed concept.

Method

One hundred forty-four Cornell undergraduates read a 2-page transcript of a couple on a first date. Participants in a flirting condition were asked to seek out examples of flirting in the script by underlining phrases and providing a brief explanation as to why those parts exemplify flirting. Because flirting is not directly related to interpretation of the ambiguous figure used in this study, this condition served as a control for a deception condition, in which subjects were instructed to actively seek deception. The transcripts were nearly identical except for minor alterations that made flirting or deception more prominent depending upon prime condition.

Following this, participants completed an ostensibly unrelated object identification task. Participants viewed the liar/face ambiguous (figure 3) at 1 of 7 degrees of rotation for 1 to 2 seconds. The figure was rotated counterclockwise between 0 and 35 degrees making the cursive word "Liar" increasingly parallel to the bottom of the page and usual in its orientation. Participants were asked for their initial percept. In addition, participants were asked if the figure was novel to them and probed for suspicion. We expected that as rotation increased, those in the deception condition

would be more likely to report seeing the word "Liar." However, it was also expected that those in the control condition would not be influenced by rotation and would report seeing the face regardless of degree of rotation.

Figure 3: Liar/face ambiguous figure.

Results

Because data were binomial and distributed unequally across cells, planned linear contrasts with harmonic n and arcsine transformations were used. As can be seen in Figure 4, there was a significant interaction between prime type and rotation conditions, $t(\text{inf}) = 2.84$, $p < .005$. This was influenced by a significant increasing linear trend for reporting of "Liar" as rotation increased in the deception condition, $t(\text{inf}) = 5.62$, $p < .0005$. However, there was not a significant linear trend as rotation increased in the flirting condition, $t(\text{inf}) = 1.61$ $p > .05$.

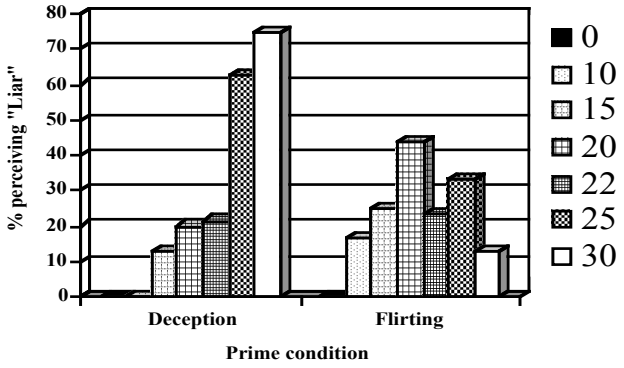

Figure 4: The percentage interpreted as "Liar" across greater angles of rotation.

Study 5

As was the purpose of study 4, study 5 sought to explore the bounds of the type of figural used in the object identification portion of the sessions. Study 5 cast aside the artistic and artificial figures calling upon naturally occurring ambiguity in the figure.

Method

Forty-five Cornell undergraduates completed an evaluation of the text and pictures of 1 of 2 fictitious children's books. Those in the sign condition read about Henry Ford, the beginnings of the Cadillac Company, and the need for regulation of automobiles on the roads. Those in the space condition read about various astronauts, space shuttle missions, and space exploration. As in earlier studies, participants were not exposed to words that directly described the focal figure. Then, participants in both conditions were asked to judge the appropriateness of a few photos for inclusion in the children's book they were just acquainted with. Participants were shown the photo in Figure 5 for 1 second and asked to describe what they saw and make judgments about the photo. After completing the same procedure for 3 photos unrelated to this study but meant to uphold the cover story, participants were probed for suspicion.

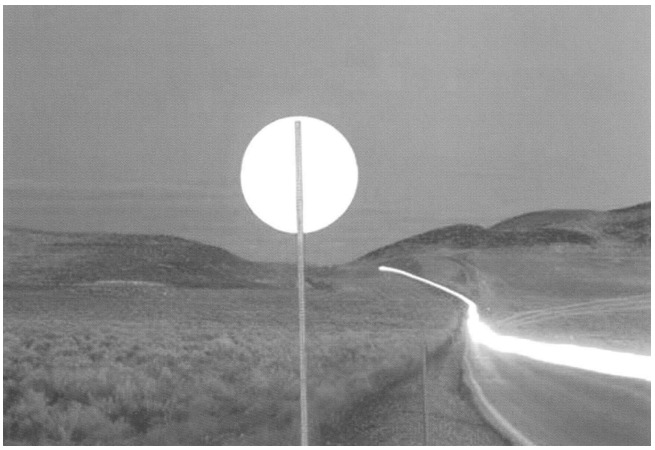

Figure 5: Sign/moon illusion[1].

We expected that a greater proportion of participants would report seeing a road sign after reading about Henry Ford than after reading about space. However, it was expected that a greater proportion of participants would describe the photo as a view of the sun or moon perhaps obstructed by a rod.

Results

As was the case in study 2, a large number of participants wrote down a generic description of the figure (N = 14) that did not clearly indicate their interpretation of the ambiguous object (e.g. *desert scene*). These responses were included in the analyses as a separate response category. All data were analyzed using a 2 (prime type: sign, space) X 3 (response type: sign, sun/moon, generic) chi-square to control for these vague responses. Results indicate that there was a significant difference in the distribution of responses depending upon prime type, $\chi^2(2) = 11.88$, $p = .003$.

[1] Photo by Jerry Downs (Seckel, 2002)

Because we made specific predictions regarding the influence of each prime on initial percept, we applied planned comparisons on the proportion of expected percepts. Specifically, we expected that a greater percentage of participants would report seeing a road sign after reading about Henry Ford than after reading about space. The data support this expectation ($Z = 2.38$, $p = .009$, two-tailed). Of those in the who read the Henry Ford story, 37.5% reported seeing a sign. However, only 9.5% of participants who read the space story reported a sign.

Likewise, we expected that a greater percentage of participants would report seeing the sun or the moon after reading about space than would those who read about Henry Ford. Again, the data support this expectation ($Z = 3.10$, $p = .001$). Of those in the space prime condition, 71.4% reported seeing the sun or the moon. However, only 20.8% of participants in the sign prime condition reported the same.

Conclusion

These 5 studies demonstrate that the priming of higher-order concepts directly effects lower-level visual processing. The studies suggest that the modulation of basic visual processing may be mediated through both simple lexical influences, and even complex social information that may set the occasion for an interpretation of ambiguous visual information. Additionally, it is not only the interpretation of simple ambiguous figures that is modulated, but perhaps even ambiguities present in natural visual contexts are subject to subtle environmental influences. Although it is well established that bottom-up processes contribute to visual perception, these studies demonstrate the significant impact of top-down influences, despite the seemingly negative results of Boyce, Pollatsek, and Rayner (1989). These data contribute to the current debate on the nature of perceptual mechanisms, and have implications for the broader integration of information that may occur across information levels in a highly interactive cognitive system. The studies here suggest that Mast and Kosslyn's (2002) claim that visual perception is driven by basic processes may need updating – it seems that at least the perception of ambiguous figures is driven by *both* higher-order and basic processes. Indeed, research on the interaction of visual and linguistic information provides further evidence for this (Spivey, Tanenhaus, Eberhard, & Sedivy, 2002, argue for this perspective). Future direction for this research would demonstrate that *dynamic* visual information ("optic flow," Gibson, 1979) can also be strongly modulated by higher-order social information.

If perception has direct, non-conscious effects on behavior, it is necessary to investigate the stability of perception. We must understand how even basic perception is manipulated. The effects of this inconsistent visual and interpretive faculty loom large when considering the ramifications in complex social situations—ones, perhaps, that require immediate reactions but which are unclear. Particular recent events may provide anecdotal evidence for this effect.

For example, in February 1999, 41 bullets were fired by four White New York Police officers which hit and killed Amidou Diallo, an unarmed Black immigrant from West Africa (McFadden & Roane, 1999). Although charged, the officers were acquitted as the shooting was judged to be justified. When police officers ordered Diallo to stop, he moved, producing an object that later turned out to be a wallet. The police defendants maintained that in this situation, they acted on the information available to protect themselves from danger (Fritsch, 2000). Although racial profiling explanations for this incident abound, certainly context effects and the activation of complex, social information played a role in the interpretation of a supposedly ambiguous object—however wrong that interpretation may have been.

A less extreme version of this misinterpretation of ambiguous stimuli is not a rare event. Payne (2001) produced a similar pattern of results in the lab. In one experiment where they were asked to respond as quickly as possible, participants misidentified tools as guns when primed with Black compared with White faces. These results suggest that racial primes and stereotypical information serve to bias the perception of weapons through relatively automatic, uncontrollable processes.

The realms of social cognition and visual perception therefore pose invaluable theoretical and practical questions. In fact, it may be through the study of sensory-cognitive interaction and social cognition that the domains of cognitive science, social psychology, and applied psychology will overlap. A joint effort by all the "tribes of psychology" (Gilbert, 2002) may offer a hitherto unequaled pursuit towards understanding the perceptual and social world.

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