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

**Emily Balcetis (eeb29@cornell.edu)**
**Rick Dale (rad28@cornell.edu)**
Department of Psychology, Uris Hall, Cornell University
Ithaca, NY 14853 USA

**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 complex, social information significantly influences 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. These 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 stimuli that approximate visually rich, natural scenes as well.

## Introduction

Human sensory systems are constantly exposed to ambiguous stimuli and must decode information that lacks richness. Even in the face of this handicap, sensory systems are able to interpret and impose meaning on degraded stimuli quickly and without awareness of possible alternative interpretations. It remains crucial to investigate the influences on the sensory systems' task of deciphering ambiguous information.

Vision researchers have investigated the general instability of perception and specifically the influences on interpretation of visual stimuli. For decades, it has been debated whether object identification is purely the result of bottom-up processes, or also incorporates top-down, contextual information. Many contend that object identification is driven by a synthesis and analysis of basic components of the object (Kosslyn & Koenig, 1992; Michelon & Koenig, 2002). Additionally, the visual system relies upon focal areas, critical features (Long & Olszweski, 1999), fixation points (Georgiades & Harris, 1997; Loftus & Mackworth, 1978), and texture (Julesz, 1978) as cues to assist in identifying target object. Mast and Kosslyn (2002) summarize this theoretical stance explaining "visual perception is driven by the nature of the external world" (p. 57). Essentially, this system has evolved to process quickly and efficiently visual information in the immediate environment (Cutting & Massironi, 1998; Gibson, 1950, 1979).

Several research programs have suggested metaphors that describe how basic external 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, recent work supports the role of attentional constraints and biases on low-level visual perception. Research on single cells within cortical visual areas of rhesus monkeys demonstrated a differential neural sensitivity when attention was directed toward a target stimulus (Motter, 1993). 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). 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.

Yet, these paradigms specifically draw attention to target objects while participants identify them by "wiggling" or rocking the target object back and forth within the scene. By "wiggling" the object, visual attention is directed specifically to the target object leaving the peripheral visual

field to capture the contextual information. Although the results suggest the visual system is sensitive to and relies upon context to improve performance on object identification tasks, this paradigm does not investigate top-down influences on the disambiguation of objects that are not easily identifiable because of the possibility for multiple interpretations.

In the following studies, we sought to demonstrate the impact of higher-order information on object identification. There is indeed research supporting global influences, yet it is relatively scarce and overlooks conceptual information that is activated implicitly. Though top-down processing effects have been demonstrated in visual perception, the following studies demonstrate that perception can be influenced outside of participants' awareness and through the activation of complex but relevant 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 figures with multiple interpretations.

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. Opponents to this research (Cutting & Massironi, 1998; Gibson, 1950, 1979) may argue that the type of results expected in studies 1-4 would be an artifact of the visual stimuli used. They would argue that the visual system has not evolved to process simple line drawings but rich visual scenes. To begin to address this argument, study 5 leaves behind the artistic images and calls upon a more naturally occurring ambiguity that approximates a rich visual display. Study 5 relies upon a photograph of an external environment 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 complex visual information.

## Study 1

### Method

Sixty-seven 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 (e.g. *the dry was wet field*) by eliminating a single word.

For those in experimental conditions, embedded within 15 of the 27 trials were words related to women in the female condition (e.g. *waitress*, *mother*) or words related to music in the music condition (e.g. *gig, jazz*). In all trials, those in the control condition were exposed to words considered neutral with respect to music or women (e.g. *lectures, pencil*). It is important to note that in all conditions participants were not exposed to words that directly described the figure (e.g. *face, saxophone*). 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 an open-ended question to indicate their initial percept. Additionally, participants were asked if they had seen the figure before and if they were aware of the purpose of the study.

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 object recognition as opposed to memory for previously viewed images. As a result, data from participants who indicated that this figure was not novel were removed (N = 19) leaving data from 48 participants for analyses. As expected, participants were not aware of the true purpose of the study. No participant indicated that the scrambled sentence task may have influenced their responses in the object identification task.

As predicted, a greater percentage of music-primed participants saw the saxophone player (40%, N = 7) compared to the control condition (20%, N = 3), $\chi^2(1) = 4.01$, $p < .05$. However, the female prime made little impact on perceptions of the face. In the control condition, 80% (N = 12) of participants saw the face, but this percentage was not influenced by the female prime as 80% (N = 12) 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, and 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 of complex information, study 2 modified the priming procedure in order to better capture how such information is activated outside the laboratory. Additionally, study 2 sought to demonstrate priming effects even in the face of percept favoritism.

### Method

Cornell University undergraduates (N = 108) 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.

We expected that a greater percentage of participants would report seeing a saxophone player after reading about Napster than after reading about pornography.

### Results and Discussion

Within this sample, a large number of participants wrote down a 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% (N = 8) of those in the Napster condition did. Again, these effects occur outside participants' awareness as no one recognized the intended connection between the priming and object recognition tasks.

## Study 3

Although studies 1 and 2 demonstrate the effects of complex information on object identification, both used very controlled priming techniques that did not allow much variability in what information was activated. The purpose of study 3, then, 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 greater variance within the activated information, the effects on object identification are strong.

### Method

Sixty-three Cornell undergraduates were asked to assist in the creation of the text and illustrations 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 prime 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 inclusion in the children's book (figure judgment task). 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 after creating a sea animal story than after 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 figure judgment 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% (N = 8) of those in the sea creature condition reported seeing a seal.

## Study 4

Study 4 used a more complex figure that involved orthographic and pictorial interpretations. Additionally, by varying the rotation at which the figure was viewed, we differentially modulate the favoritism in object identification. With this study, we intended to demonstrate that conceptual priming could override this favoritism and still result in an interpretation in line with specific types of activated information.

### Method

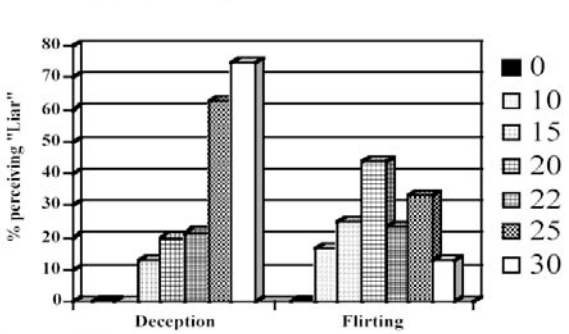
One hundred forty-four Cornell undergraduates read a 2-page transcript of a couple on a first date. Participants in the flirting condition were asked to seek out examples of flirting by underlining phrases and providing a brief explanation about how those lines exemplify flirting. Because flirting is not directly related to one particular interpretation of the ambiguous figure, this condition served as a control for a deception condition. As was instructed in the control condition, those in the deception condition read the transcript, underlined examples of the couple deceiving one another, and justified their choices. The transcripts were nearly identical except for minor alterations that made flirting or deception more salient depending upon condition.

Following this, participants completed an ostensibly unrelated object identification task. As a between-subjects variable, participants viewed the liar/face ambiguous (Figure 3) at 1 of 7 degrees of rotation (0, 10, 15, 20, 22, 25, or 30 degrees) for 1 to 2 seconds. The figure was rotated counterclockwise between 0 and 30 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 of the static image of the figure. In addition, participants were asked if the figure was novel to them and probed for suspicion. We expected that in the deception condition, increasing rotation would result in increased reports of the word "Liar" in script. However, it was expected that those in the flirting condition would not be influenced by rotation and would be just as likely to report seeing the face regardless of degree of rotation.

Figure 3: Liar/face ambiguous figure at 0 degrees rotation on left and 35 degrees rotation on right.

### 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 an artifact of the significant increasing linear trend for reports of "Liar" with increasing rotation in the deception condition, $t(\text{inf}) = 5.62$, $p < .0005$, and not in the control condition. There was not a significant linear trend as rotation increased in the flirting condition, $t(\text{inf}) = 1.61$ $p > .05$. To summarize, as the figure was rotated, participants were more likely to identify in the figure the word "Liar" after having sought our deception but not after having sought out examples of flirting.




## Study 5

Study 5 sought to explore the bounds of the type of figure used in the object identification portion of the experiments. As mentioned earlier, some would argue against the use of mere drawings for our purposes (Cutting & Massironi, 1998; Gibson, 1950, 1979). To begin to address this concern, study 5 cast aside the artistic and artificial figures calling upon naturally occurring ambiguity in a figure.

### Method

Forty-five Cornell undergraduates completed an evaluation of the text and pictures of 1 of 2 fictitious children's books. Participants in the sign condition read about Henry Ford, the beginnings of the Cadillac Company, and the need for regulation of automobiles on the road. 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, asked to describe what they saw, and make judgments about the photo. Again, participants were probed for suspicion.

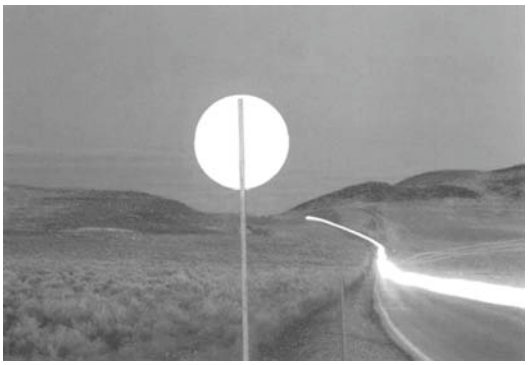


Figure 5: Sign/moon illusion[1].

Of interest was the description participants provided of the light circle in the center of the photo. We expected that a greater proportion of participants would report seeing the back of 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 after reading about space travel.

### 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, $\chi^2(2) = 11.88$, $p = .003$.

Because we made specific predictions regarding the influence of each prime on initial percept, we applied planned comparisons on the proportion of expected percepts excluding the data from those participants who gave generic responses. 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, $\chi^2(1) = 10.49$, $p = .001$. Of those in the who read the Henry Ford story, 50% (N = 10) reported seeing a sign. However, only 8% (N = 2) of participants who read the space story reported a sign.

## Conclusion

These 5 studies suggest an instability of perception by demonstrating the effects of activated higher-order concepts on visual processing and specifically object identification. Additionally, they advocate for continued study of the integration of cognition and perception. The studies indicate 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 even the decoding of ambiguities present in natural contexts that begin to approximate rich visual environments. Although vision is based on bottom-up processes, these studies demonstrate the significant contribution of top-down influences.

These data contribute to the current debate on the nature of perceptual mechanisms and have implications for the broader integration that may occur across information levels in a highly interactive cognitive system. Research on the interaction of visual and linguistic information provides further evidence for this (e.g., Spivey, Tanenhaus, Eberhard, & Sedivy, 2002, argue for this perspective). As mentioned above, future research should 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 4 New York Police officers which hit and killed Amidou Diallo, an unarmed 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.

This type of 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. Additionally, in a behavioral follow-up to this study (Correll, Park, Judd, & Wittenbrink, 2002), not only were participants more likely to misperceive tools as guns upon activation of complex, social information, but participants were more likely to react with aggression in response to this misperception. These results suggest that 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

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

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.

## Acknowledgments

We would like to thank Richard Eibach, Michael Spivey, Dave Dunning, and Stephanie Hankin for helpful comments and suggestions.

## References

Bargh, J. A. & Chartrand, T. L. (2000). The mind in the middle: A practical guide to priming and automaticity research. In H. T. Reis & C. M. Judd (Eds.), *Handbook of research methods in social and personality psychology*. New York: Cambridge University Press.

Biederman, I. (1972). Perceiving real-world scenes. *Science, 177,* 77-80.

Biderman, I., Mezzanotte, R. J., & Rabinowitz, J. C. (1982). Scene perception: Detecting and judging objects undergoing relational violations. *Cognitive Psychology*, 14, 143-177.

Boyce, S. J. & Pollatsek, A. (1992). Identification of objects in scenes: The role of scene background in object naming. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, 18, 531-543.

Boyce, S. J., Pollatsek, A., & Rayner, K. (1989). Effect of background information on object identification. *Journal of Experimental Psychology: Human Perception and Performance, 15,* 556-566.

Broadbent, D. E. (1982). Task discrimination and selective intake of information. *Acta Psychologica, 50,* 253-290.

Correll, J., Park, B., Judd, C. M., & Wittenbrink, B. (2002). The police officer's dilemma: Using ethnicity to disambiguate potentially threatening individuals. *Journal of Personality and Social Psychology, 83,* 1314 – 1329. Eriksen, C. W. & Yeh, Y. (1985). Allocation of attention in the visual fields. *Journal of Experimental Psychology: Human Perception and Performance, 21,* 628-634.

Cutting, J. E. & Massironi, M. (1998). Pictures and their special status in perceptual and cognitive inquiry. In J. Hochberg (Ed.), *Handbook of perception and cognition*. San Diego, CA: Academic Press.

Fritsch, J. (2000, February 26). The Diallo verdict: The overview; 4 officers in Diallo shooting are acquitted of all charges. *The New York Times*, A1.

Georgiades, M. S. & Harris, J. P. (1997). Biasing effects in ambiguous figures: Removal or fixation of critical features can affect perception. *Visual-Cognition, 4,* 383-408.

Gibson, J. J. (1950). *The perception of the visual world*. Oxford: Houghton Mifflin.

Gibson, J. J. (1979). *The ecological approach to visual perception*. Boston, MA: Houghton Mifflin Company.

Gilbert, D. (2002). Are psychology's tribes ready to form a nation? *Trends in Cognitive Sciences*, 6, 3.

Henderson, J. M., Pollatsek, A., & Rayner, K. (1987). Effects of foveal priming and extrafoveal preview on object identification. *Journal of Experimental Psychology: Human Perception and Performance, 13,* 449-463.

Julesz, B. (1978). Visual texture discrimination using random-dot patterns: Comment. *Journal of the Optical Society of America, 68,* 268-270.

Kosslyn, S. M. & Koenig, O. (1992). *Wet mind: The new cognitive neuroscience*. New York, NY, US: Free Press.

Loftus, G. R. & Mackworth, N. H. (1978). Cognitive determinants of fixation location during picture viewing. *Journal of Experimental Psychology: Human Perception and Performance, 4,* 565-572.

Long, G. M. & Olszweski, A. D. (1999). To reverse or not to reverse: When is an ambiguous figure not ambiguous? *American Journal of Psychology, 112,* 41-71.

Mast, F. W. & Kosslyn, S. M. (2002). Visual mental images can be ambiguous: Insights from individual differences in spatial transformation abilities. *Cognition, 86,* 57-70.

McFadden, R. D. & Roane, K. R. (1999, February 6). U.S. examining killing of man in police volley. *The New York Times,* A1.

Michelon, P. & Koenig, O. (2002). On the relationship between visual imagery and visual perception: Evidence from priming studies. *European Journal of Cognitive Psychology, 14,* 161-184.

Motter, B. C. (1993). Focal attention produces spatially selective processing in visual cortical areas V1, V2, and V4 in the presence of competing stimuli. *Journal of Neurophysiology, 70,* 909-919.

Payne, B. K. (2001). Prejudice and perception: The role of automatic and controlled processes in misperceiving a weapon. *Journal of Personality and Social Psychology, 81,* 181-192.

Posner, M. I., Snyder, C. R. R., & Davidson, B. J. (1980). Attention and the detection of signals. *Journal of Experimental Psychology: General, 109,* 160-174.

Seckel, A. (2002). *The great book of optical illusions*. Firefly Books: Toronto, Ontario.

Spivey, M. J. & Spirn, M. J. (2000). Selective visual attention modulates the direct tilt aftereffect. *Perception and Psychophysics, 62,* 1525-1533.

Spivey, M. J., Tanenhaus, M. K., Eberhard, K. M., & Sedivy, J. C. (2002). Eye movements and spoken language comprehension: Effects of visual context on syntactic ambiguity resolution. *Cognitive Psychology, 45,* 447-481.

Srull, T. & Wyer, R. S. (1979). The role of category accessibility in the interpretation of information about persons: Some determinants and implications. *Journal of Personality and Social Psychology, 37,* 1660-1672.