Attraction, Distraction, and Action: Multiple Perspectives on Attentional Capture
C. Folk and B. Gibson (Editors)

3 Inattentional Blindness and Attentional Capture: Evidence for Attention-Based Theories of Visual Salience

Bradley S. Gibson and Mary A. Peterson

For the past three decades or more, vision research has considered the possibility that certain early stages of visual processing might occur without attention (Neisser, 1967). Recently, however, there appears to be growing consensus that traditional conceptions of "pre-attentive" visual processing may be misleading in many respects (Nakayama & Joseph, 1998). One fundamental issue that has generated considerable discussion concerns the question of whether pre-attentive processing truly occurs prior to the allocation of attention or whether this stage of processing might also depend on the allocation of attention. In the present chapter, we discuss how the resolution of this issue is intertwined with theories of attentional control.

At the center of this discussion has been the visual pop out effect which is typically observed in the visual search paradigm when the target can be distinguished from the distractors on the basis of a simple feature discontinuity, as for instance, when a single red target appears in a homogenous field of blue distractors. In this "singleton search" task, the visual pop out effect is characterized by relatively fast and efficient detection of the red singleton target regardless of the number of blue distractors that are present in the visual field (Treisman, 1988; Treisman & Gelade, 1980; Wolfe, 1998). Feature singletons that lead to such fast, efficient detection within the context of singleton search tasks are often said to be "visually salient" (Yantis & Egeth, 1999), though it is important to note that visual salience is a relative, rather than an absolute, term. In the context of the example in which the target appears as the single red element among a homogenous field of blue distractors, the target would have the highest salience because it differs from every distractor in color; whereas, the distractors would all be equally low in salience because each of the homogenous distractors differs only from the target in color.

Computationally, relative salience is typically based on an analysis of feature differences and this analysis is thought to be performed by pre-attentive visual processes operating in parallel across the visual field (Cave & Wolfe, 1990). The computation of these stimulus-based, "difference signals," is important, because these signals are thought to guide (along with other, top-down, control processes) the subsequent allocation of focal attention to objects in the environment so that these objects can be consciously detected, identified, and responded to (Cave &

Wolfe, 1990; Wolfe, 1994). Thus, according to this "guided search" account, the detection of visual singletons in singleton search tasks is typically fast and efficient because salience can be computed in parallel across the visual field and focal attention is consistently allocated to the element with highest salience (the singleton target) first.

The relative ease with which visual singletons are detected in singleton search tasks such as these can be contrasted with much less efficient forms of visual search that arise when the target appears relatively non-salient, as for instance when the target cannot be distinguished from the distractors on the basis of a simple feature discontinuity (Treisman, 1988; Treisman & Gelade, 1980; Wolfe, 1998). In this situation, all of the display elements are similar and thus feature differences cannot be used to guide focal attention. As a result, focal attention will not be consistently allocated to the target first; rather, focal attention must instead be allocated to the display elements in a random fashion in this situation until the target is found. Consequently, the time to detect the target typically increases as the number of distractors increases in this search environment.

Although it has been tempting to interpret the efficient detection of feature singletons as reflecting visual processes that occur pre-attentively, some researchers have recently pointed out that this conclusion may be inappropriate. This is because such detection is typically measured under conditions in which observers are actively attending to the visual search display (Mack & Rock, 1998). Thus, the ability to process salience by simultaneously comparing feature differences across the visual field may not reflect a truly pre-attentive process. This observation in turn has led to a variety of dual-task studies that attempted to limit the amount of attention that would otherwise be available to mediate singleton detection. For instance, Mack and Rock (1998) conducted a dual-task experiment in which observers were initially led to believe that they would be performing a single line-length judgment task. Following several trials, however, an unexpected color singleton appeared in a background display of homogenous distractors along with the expected stimuli. Immediately after their response to the primary task, observers were asked if they noticed anything unusual on that trial. Relatively few observers reported any awareness of the color singleton (see pp. 44-51), and Mack and Rock termed this surprising lack of awareness "inattentional blindness."

In another series of experiments, Joseph, Chun, and Nakayama (1997) used the rapid serial visual presentation (RSVP) paradigm to determine whether observers could simultaneously perform both a primary letter identification task and a secondary singleton search task in which observers attempted to detect the presence or absence of a uniquely-oriented target element that appeared among an homogenous display of distractors. On each trial in this experiment, observers initially observed a stream of black letters presented briefly one after the other and were instructed to identify the single white letter in the stream. At various time points following this critical letter stimulus, the visual search display appeared. As expected, performance was highly accurate in the letter identification task; more importantly however, singleton detection was nearly at chance in the singleton