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# When Is a Face No Longer a Face? A Problematic Dichotomy in Visual Detection Research

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## Abstract

Countless studies have reported that individuals detect threatening/angry faces faster than happy/neutral faces. Two classic views have been used to explain this phenomenon—that negative valence drives the effect, or conversely, that low-level perceptual characteristics of the stimuli are responsible for their rapid detection. In the current review, I question whether dichotomous perspectives are the most parsimonious way to explain a large and inconsistent literature. Further, I argue that nondichotomous, *multicomponent* accounts for the detection of emotionally valenced stimuli might help take us beyond traditional approaches to visual detection research, and I suggest various ways in which future research can use these newer approaches to more effectively elucidate the mechanisms underlying the rapid detection of emotionally valenced stimuli.

**Keywords**
anger superiority effect, angry faces, emotional facial expressions, threat detection, visual search

## Introduction

The detection of emotionally valenced stimuli has been a widely studied topic among researchers for decades. More specifically, countless researchers who study adults' detection of various emotional stimuli have reported that threatening or angry facial expressions are detected more quickly than happy or neutral expressions (e.g., Calvo, Avero, & Lundqvist, 2006; Eastwood, Smilek, & Merikle, 2001; Esteves, 1999; Fox et al., 2000; Hansen & Hansen, 1988; LoBue, 2009; Lundqvist & Öhman, 2005; Öhman, Lundqvist, & Esteves, 2001; Schubo, Gendolla, Meinecke, & Abele, 2006; Tipples, Atkinson, & Young, 2002; Williams, Moss, Bradshaw, & Mattingley, 2005). In basic visual detection paradigms, participants are presented with photographs or schematic drawings of various facial expressions in an array, and participants respond by indicating whether all of the photographs are from one category or whether a single discrepant face is present. The majority of findings in this area report that adults detect discrepant angry or negative facial expressions more quickly than discrepant happy or neutral expressions.

This effect—which has been given many names in the emotion literature including the "Face in the Crowd" and Anger Superiority Effect (ASE)—has been widely replicated using various stimuli, different paradigms, and in various age groups, including infants and preschool children (LoBue, 2009; LoBue & DeLoache, 2011). However, despite countless studies reporting similar findings, the phenomenon is not free from controversy. The original research in this area stemmed from the hypothesis that the ability to quickly and efficiently direct attention to dangerous threats in the environment is adaptive, and such a predisposition might have evolutionary origins (e.g., Hansen & Hansen, 1988). Following this logic, stimuli that have a *negative valence* should be detected quickly, or even automatically in visual attention (e.g., Calvo & Esteves, 2005; Eastwood et al., 2001; Eastwood, Smilek, & Merikle, 2003; Lundqvist & Öhman, 2005; Öhman, Lundqvist, & Esteves, 2001). However, other researchers have shown that low-level perceptual characteristics of threatening faces—and not their negative valance—drive these findings, and when such characteristics are controlled for, the effect disappears (e.g., S. I. Becker, Horstmann, & Remington, 2011; Horstmann, 2009; Horstmann, Borgstedt, & Heumann, 2006; LoBue, 2013; LoBue, Rakison, & DeLoache, 2010). Researchers purporting the *low-level features* hypothesis often criticize the phenomenon since simple geometric shapes that happen to be common in angry faces can account for the effects.

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These opposing views have led to a dichotomy that has shaped the way many researchers have framed their empirical questions regarding the detection of emotional facial expressions. Several recent literature reviews have highlighted the controversies surrounding research in this general area (D. V. Becker, Anderson, Mortensen, Neufeld, & Neel, 2011; Frischen, Eastwood, & Smilek, 2008; LoBue & Rakison, 2013); I will not attempt to rereview the entire literature here, as these recent reviews are well written and quite thorough. Instead, my goal is to question whether the dichotomy often used to interpret studies on the detection of emotionally valenced stimuli (e.g., negative valence hypothesis vs. low-level features hypothesis) is always appropriate. First, I will very briefly review the literature on the visual detection of negative/threatening facial expressions, and its consistencies and inconsistencies. Next, I will argue that although a dichotomous approach to the interpretation of these data has had several positive effects on research in this area, it may also limit the scope of future work. Finally, I will propose a *multi-component* approach to the detection of emotionally valenced stimuli, in which multiple factors contribute simultaneously to rapid detection, and I will discuss how such an account might help take us beyond traditional approaches to research on the detection of emotional stimuli.

## Negative Valence or Low-Level Features?

Emotional facial expressions are important sources of information. While a happy face might tell you that a friendly interaction is likely to follow, a looming angry face suggests the potential for a threatening encounter (Hansen & Hansen, 1988; Öhman & Dimberg, 1978; Öhman et al., 2001; Öhman & Mineka, 2001). Hansen and Hansen (1988) used this logic to propose the "face in the crowd hypothesis," suggesting that humans who recognized and detected threatening or angry facial expressions exceptionally quickly would have been more likely to survive to reproduce, and over the course human development, the visual system may have evolved to very efficiently detect signals of threat, such as angry faces. Using a standard visual detection paradigm such as the one described above, Hansen and Hansen found evidence to support their hypothesis, demonstrating that adults detect an angry face in a crowd of happy faces more quickly than a happy face in a crowd of angry faces. Although Hansen and Hansen's (1988) methodology has been criticized for potential confounds, many researchers have replicated these results under more controlled parameters (e.g., Calvo & Esteves, 2005; Eastwood et al., 2001, 2003; Lundqvist & Öhman, 2005; Öhman, Lundqvist, et al., 2001).

According to Hansen and Hansen's (1988) original hypothesis, threatening or *negative valence* is what drives the rapid detection of angry faces, and one potential mechanism to account for the effect is a fear module that automatically detects signals of threat in the environment (Öhman & Mineka, 2001). In support of this view, several researchers have produced evidence that *threat-relevance* is indeed the effective stimulus driving the rapid detection of angry faces. For example, many studies have shown that other categories of threat-relevant stimuli such as snakes and spiders are also identified very quickly in visual detection tasks (Flykt, 2005, 2006; Hayakawa, Kawai, & Masataka, 2011; Lipp, 2006; Lipp & Derakshan, 2005; Lipp, Derakshan, Waters, & Logies, 2004; Lipp & Waters, 2007; LoBue, 2010; LoBue & DeLoache, 2008, 2011; Masataka & Shibasaki, 2012; Öhman, Flykt, & Esteves, 2001; Purkis & Lipp, 2007; Soares, Esteves, Lundqvist, & Öhman, 2012; Tipples, Young, Quinlan, Broks, & Ellis, 2002). Further, there is evidence that perceived threat relevance is related to speed of detection; in other words, the more aversive or negatively participants judge threatening stimuli, the more quickly they detect them (Beaver, Mogg, & Bradley, 2005; Lundqvist & Öhman, 2005). Finally, researchers have shown that the context of facial stimuli matters for rapid detection: There is no search advantage for threatening faces when simple characteristics of the faces are scrambled, or when they are presented in a non-face-like context (Fenske & Eastwood, 2003; Schubo et al., 2006; Tipples, Atkinson, et al., 2002). Further, a few studies have suggested that the advantage for angry faces is only evident when faces are presented upright; when faces are inverted (which generally impairs face processing) the effect disappears (Eastwood et al., 2001; Fox et al., 2000).

Despite evidence that valence or threat relevance drives the rapid detection of angry faces, other researchers have reported findings that tell a completely different story; their data instead suggest that low-level perceptual characteristics that are highly represented in angry faces are what drive their rapid detection (S. I. Becker et al., 2011; Horstmann, 2009; Horstmann, Borgstedt, et al., 2006; LoBue, 2013; LoBue et al., 2010). For example, specific geometric shapes, such as the V-shaped brow characteristic of angry faces are sufficient in eliciting rapid detection (Larson, Aronoff, & Stearns, 2007; LoBue & Larson, 2010), and presenting faces without the V-shape brow often eliminates the effect (see S. I. Becker et al., 2011). Further, contrary to the results presented before, other researchers have reported that presenting participants with specific characteristics of angry faces in non-face-like configurations maintains the advantage (Coelho, Cloete, & Wallis, 2011; Horstmann, Borgstedt, et al., 2006), while manipulating these important characteristics eliminates it (S. I. Becker et al., 2011). Based on these data, researchers supporting the *low-level features hypothesis* argue that rapid detection of angry faces has nothing to do with threat relevance per se, and instead, that low-level perceptual characteristics common to these facial expressions drive the results of these studies.

In summary, there is little agreement about the origins of the rapid detection of threatening facial expressions, and researchers generally fall on one of two sides of the argument. On one side are proponents of the negative valence hypothesis, who argue that it is the threatening valence of an angry face that drives their rapid detection. On the other side are proponents of the low-level features hypothesis who argue that simple perceptual characteristics of angry faces can account for the effect.

## Parallel or Serial Search?

The issue of negative valence versus low-level features remains controversial in the literature, and as the brief previous review suggests, data supporting each side of the dichotomy are mixed. To further complicate matters, there is a second contentious issue wrapped within the negative valence versus low-level features controversy that also receives attention in the literature. More specifically, some researchers assert that the processing of angry faces (or threat-relevant stimuli in general) occurs automatically, or via *parallel search*. This is generally contrasted with *serial search*, or search that is guided by focused attention. In order to test whether detection of threatening stimuli evokes automatic processes, detection of threatening targets should not be affected by variations in the number of distracters present in an array (Treisman & Gelade, 1980). In other words, if search occurs automatically or in parallel, speed of detection should remain constant (or have a very shallow slope) when the number of distracters increases from three (as in $2 \times 2$ matrices) to eight (as in $3 \times 3$ matrices).

Accordingly, matrix size is often varied in experimental designs so that researchers can examine whether there is an advantage for threat-relevant stimuli in general, and further, whether there is evidence for automatic processing of threat stimuli. Several researchers have indeed reported that when participants are asked to detect targets in both $2 \times 2$ and $3 \times 3$ matrices, performance does not vary as a function of the number of distracters (three or eight) when the targets are threat-relevant (angry faces, snakes, spiders). However, when the targets are nonthreatening (e.g., happy or neutral faces, flowers, mushrooms), participants are significantly slower when more distracters are present in a matrix (Eastwood & Smilek, 2005; Fox et al., 2000; Öhman, Flykt, & Esteves, 2001).

Despite studies reporting an effect of set size on the detection of angry faces, other researchers have criticized these findings for a number of reasons. Some have argued that the detection latencies in these studies are too slow (slopes > 10 ms) to represent parallel search (D. V. Becker et al., 2011; Horstmann & Bauland, 2006; Treisman & Gelade, 1980). Others have presented evidence against automatic search by failing to demonstrate that threat-relevant stimuli are unaffected by the number of distracters present in an array (for a review, see D. V. Becker et al., 2011; Horstmann & Bauland, 2006). Some have reported an advantage for negatively valenced stimuli in visual detection tasks, but suggest that this advantage does not necessarily constitute automatic processing (e.g., Horstmann, 2009). Most importantly, in an analysis of 2,500 visual detection experiments, Wolfe (1998) reported that visual search cannot be accounted for by either serial or parallel processes alone, and that search slopes across studies vary systematically based on a variety of factors.

## Issues with Dichotomies

Dichotomies in the interpretation of research on the detection of emotionally valenced stimuli such as the ones discussed here have split researchers. Proponents of the negative valence hypothesis generally support the idea that the threatening message portrayed by angry faces is the effective stimulus in driving their detection (e.g., Öhman, Lundqvist, et al., 2001). Proponents of the low-level features hypothesis suggest that particular characteristics of angry faces are the effective stimulus in their rapid detection, and some researchers even suggest that when the experimental stimuli are very tightly controlled there is evidence of a *happy superiority effect* instead of an angry superiority effect (e.g., D. V. Becker et al., 2011).

This controversy has had several consequences for how research on the detection of emotional facial expressions is conducted. One positive result of this debate is that researchers have worked hard to rigorously address several of the methodological issues that might have led to inconsistent findings. For example, Purcell, Stewart, and Skov (1996) identified an important confound in Hansen and Hansen's (1988) original study and many studies that followed, in which a dark spot appeared at the base of the angry face stimuli and may have been responsible for driving some of the reported results. Two recent articles have even outlined specific experimental guidelines for determining whether an advantage for angry faces is present, and whether researchers can determine if angry faces are detected automatically. These criteria include varying the set size of the displays, controlling for all possible low-level perceptual characteristics of the stimuli, and using distracter stimuli that contain some variability but remain constant across target conditions (D. V. Becker et al., 2011; Frischen et al., 2008).

Although these dichotomous perspectives have enriched the field in many other ways as well—by inspiring new and innovative studies, by pushing the field to pay careful attention to experimental control and thus, by encouraging researchers to make very careful conclusions based on their experimental designs—these dichotomies also have several limitations. First, dichotomous perspectives often fail to explain the large body of work on the detection of emotional facial expressions and the seemingly contradictory findings that continue to plague the field. As discussed before, while some researchers find no search advantage for angry faces when their characteristics are presented outside of the context of a face (Eastwood et al., 2001; Fenske & Eastwood, 2003; Fox et al., 2000; Schubo et al., 2006; Tipples, Atkinson, et al., 2002), others report exactly the opposite (S. I. Becker et al., 2011; Coelho et al., 2011; Horstmann, Borgstedt, et al., 2006).

Further, specific recommendations or guidelines about strict control of the perceptual characteristics of face stimuli have led to the common use of schematic instead of realistic facial expressions in visual detection studies to control for any potential confounding factors like the dark spots in Hansen and Hansen's (1988) real-face stimuli. However, Horstmann and Bauland (2006) recently challenged the ecological validity of using schematic faces in studies examining the detection of angry faces. Ultimately, the problem with tight control of facial stimuli is the fact that facial expressions are *naturally confounded* with their perceptual characteristics. Indeed, Ekman and colleagues have established a long line of seminal work identifying the stereotypical characteristics of various emotional facial expressions, and have even developed a validated system for coding for them (Ekman & Friesen, 1976). The very premise of the Facial Action Coding System (FACS) is the notion that faces can be reliably defined by their characteristics. In fact, in research where the V-shaped brow is removed from angry faces, the faces no longer look unambiguously angry and participants often identify them as sad (e.g., Fox, Russo, Bowles, & Dutton, 2001). Thus, while it is possible to generate faces that are generally positive or negatively valenced while controlling for specific perceptual characteristics, it is nearly impossible to separate discrete emotional expressions (e.g., angry, fearful, sad) from their characteristics without sacrificing ecological validity in some way. Indeed, if a defining characteristic of an angry face is the shape of its brow, how can we study the detection of angry faces in an ecologically meaningful way by removing this important attribute?

## Multicomponent Approaches

Not all researchers sit neatly on one side of the negative valence versus low-level features argument. Recently, a handful of investigators have proposed alternative, *multicomponent* approaches to explain the seemingly disparate results that continue to appear in the visual detection literature. Horstman and Bauland (2006), for example, propose a *sensory bias* perspective, in which facial signals evolved to exploit the visual system's tendency to quickly respond to certain types of perceptual stimuli. According to this view, the possibility that perceptual characteristics contribute to a general search advantage for threat is not at all in conflict with the idea that threatening or negative valence in facial expressions can be detected very rapidly. Further, this view purports that the advantage for threat need not necessarily be automatic to be evolved. In fact, they present evidence *against* automatic search for angry faces, arguing that, a general search advantage for negative over neutral or positive stimuli is sufficient in supporting its main tenants.

Frischen et al. (2008) have also come to the conclusion that a multicomponent perspective should be applied to research on the detection of emotional facial expressions. First, they suggest that it is nearly impossible to distinguish between whether automatic or controlled processes are responsible for the detection of threatening faces (the same conclusion reached by Wolfe, 1998), and that visual detection usually recruits *both* top-down and bottom-up processes. Further, unlike the *sensory bias* perspective, Frischen et al. (2008) argue that abstract representations like negative or threatening facial expressions can indeed guide preattentive search and that evidence to support automatic processing can be elicited under very carefully controlled experimental conditions. Thus, according to this view, the detection of emotional stimuli is driven by both featural parts of the stimuli as well as the valence of the stimulus as a whole. In other words, individual perceptual characteristics of emotional facial expressions can drive an advantage in visual detection, and so can their valence. Further, even the *emotional state of the participant* can affect visual detection for emotional expressions, as evidenced by countless studies showing a clear relationship between attentional biases for angry faces and clinical anxiety (see Bar-Haim, Lamy, Pergamin, Bakersman-Kranenburg, & van Ijzendoorn, 2007, for a review).

Similarly, in the *perceptual bias perspective*, LoBue and colleagues (LoBue, 2013; LoBue & Rakison, 2013; LoBue et al., 2010) argue that low-level perceptual characteristics guide visual biases for threatening stimuli early in development, but these initial biases can be heightened or dampened by experience and learning. This account is ambivalent about the origins of such biases (i.e., whether they were driven by evolutionary pressures or whether they are just an artifact of the human visual system), and whether emotional stimuli can be detected automatically. Instead, the perceptual bias account stresses the role of development in shaping perceptual biases over time, suggesting that a bias for some of the low-level characteristics of threatening stimuli is evident early in development, but that this bias is then likely to be augmented by knowledge, experience, emotional traits (e.g., temperament), and emotional state of the individual.

Evidence for the perceptual bias perspective comes from developmental work demonstrating that 9 to 12-month-old infants show a detection advantage for threat-relevant stimuli such as snakes and angry faces in the absence of any explicit knowledge of the stimuli's valence (LoBue & Deloache, 2009). Further, research has shown that adults can *learn* to detect threatening stimuli particularly quickly through negative experience (Cave & Batty, 2006). For example, when conditioned to associate a loud noise with pictures of neutral faces, participants detected those neutral faces significantly faster than before conditioning (Milders, Sahraie, Logan, & Donnellon, 2006). Similarly, learning to associate a particular stimulus with a reward leads to a sustained attentional bias for that stimulus (e.g., Anderson, Laurent, & Yantis, 2011; Anderson & Yantis, 2013). Together, this work shows that attentional biases can be learned through both positive and negative experience, and may not necessarily be unique to evolutionary threats like angry faces. Research on the detection of modern threats also supports this notion: Several studies have reported that humans quickly detect both evolutionary (e.g., snakes, spiders) and modern threats (e.g., guns, knives) more quickly than neutral stimuli (Blanchette, 2006; Brosch & Sharma, 2005).

While these newer multicomponent accounts differ on the origins of visual biases for the detection of emotionally valenced stimuli and on whether such stimuli can be processed automatically, they all suggest that various factors—including both negative valence and low-level perceptual characteristics—can all account for the rapid detection of threatening or negative facial expressions. Further, it is possible that multiple characteristics of emotionally valenced stimuli interact to play an *additive role* in facilitating visual detection. As mentioned above, the V-shaped brow (characteristic of angry faces) is a low-level perceptual characteristic that leads to an advantage in visual detection. Further, despite the controversy surrounding whether there is an advantage for the detection of angry faces in particular, there is wider agreement that stimuli that are negatively valenced in general are detected more quickly than stimuli that are neutral or positively valenced. The combination of having both the V-shaped perceptual characteristic that is so easy to detect *and* a negative valence might enhance the ease of detection more than the perceptual characteristic or negative valence alone. Thus, if multiple factors lead to an advantage in detection, when presented together, these factors might combine to create a greater advantage than that produced by one single factor.

Recent research has provided support for this perspective, and has suggested that multiple factors can indeed lead to rapid detection in visual detection tasks. In one recent study, researchers attempted to examine the unique and potentially interacting roles of low-level perceptual characteristics, cognitive factors, and emotional state on rapid visual detection of threat (LoBue, 2014). Across studies, adult participants were asked to detect low-level perceptual characteristics of a commonly studied threat-relevant stimulus—snakes. In Experiment 1, participants were asked to detect simple curvilinear (snake-like) versus equally simple rectilinear shapes in a visual detection task in the absence of any threat-relevant cues. In Experiment 2, the same procedure was used, except that threat-relevant or non-threat-relevant *labels*—calling the simple shapes "snakes" or "caterpillars"—were applied to the curvilinear and rectilinear stimuli in order to examine the added role of cognition (or knowing the identity of a stimulus) in detection. Finally in Experiment 3, a fearful or neutral emotional induction was administered before participants completed the visual detection task with curvilinear and rectilinear targets to examine the added role that an individual's emotional state might play in rapid detection. Across all three studies, adults detected simple curvilinear shapes more quickly than simple rectilinear shapes in the absence of any threat-relevant cues, suggesting a perceptual bias for curvilinearity. Further, threat-relevant labels and a fearful emotional induction facilitated detection even further, potentially playing an additive role in rapid detection.

Another recent study using eye-tracking technology further supports this perspective, demonstrating that the advantage for threat-relevant stimuli in visual detection tasks cannot be accounted for by either bottom-up or top-down processing biases alone. In the study, researchers replicated a classic threat-detection paradigm (Öhman, Flykt, et al., 2001) with threat-relevant (snakes and spiders) versus non-threat-relevant (flowers and mushrooms) stimuli using an eye-tracker. The results replicated previous work, demonstrating that adults detected discrepant snakes and spiders more quickly than discrepant flowers and mushrooms. Most importantly, the fixation data suggested that a single mechanism was not solely responsible for the results. First, there was an advantage for threat-relevant stimuli in perception, and participants were faster to first fixate threat-relevant versus non-threat-relevant targets, suggesting (consistent with previously literature) that bottom-up processes lead to a search advantage. However, there was also an advantage for threat-relevant stimuli in behavioral responding—participants were faster to indicate that discrepant threat-relevant stimuli were present after first fixating them—demonstrating that there is also a top-down advantage for threatening stimuli in detection tasks (LoBue, Matthews, Harvey, & Stark, 2014).

Two final studies also present evidence for the role of multiple factors in the detection of emotionally valenced stimuli. In order to control for the low-level perceptual characteristics of their target stimuli, Gerritsen, Frischen, Blake, Smilek, and Eastwood (2008), for example, avoided comparing the detection of angry to neutral faces by training adults to associate various neutral faces with positive and negative adjectives ("hostile" vs. "peaceful"), thereby inducing valence. After the training, participants detected "hostile" faces more quickly than "peaceful" ones, supporting the role of negative valence in driving rapid detection. However, after performing a meta-analysis on a series of their experiments, the researchers found that the effect of negative valence explained only a small portion of the variance in their studies, suggesting that some other factor (e.g., perceptual) likely accounted for the majority of the differences in detection. Likewise, a very recent study examining the detection of snakes versus frogs also reported that although valence of the snake stimuli elicited some advantage in detection, perceptual similarity between the target and distracter stimuli accounted for a much larger proportion of variability in participants' detection latencies (Gao, LoBue, Harvey, & Irving, 2015). Together, these studies suggest that negative valence and perceptual characteristics of the target and distracter stimuli can drive the rapid detection of threat, and might perhaps interact to facilitate visual detection (Gao et al., 2015; Gerritsen et al., 2008).

## Future Research

In summary, multicomponent perspectives for the rapid detection of emotionally valenced stimuli provide a more parsimonious explanation for the varied findings in the literature than classic dichotomous views. Evidence from empirical data presented here and in other reviews suggests that both low-level perceptual characteristics and negative or threatening valence can create an advantage in visual detection. Thus, perspectives that acknowledge that there are multiple, potentially interacting factors simultaneously at play in visual detection tasks might better inform us about how the visual system processes threat than perspectives that only consider one single factor. However, to date, empirical work that directly examines multicomponent perspectives is limited, as previous research has focused on testing the classic dichotomy. Future research that lays out clear research objectives and allows for the contribution of multiple interacting factors on the rapid detection of emotionally valenced stimuli can help move us forward in elucidating the mechanisms that drive our biases in visual attention.

One of the fundamental problems with existing studies on the detection of emotionally valenced stimuli is that often researchers are interested in slightly different questions. Thus, one recommendation for future research is for investigators to be very clear about their research objectives. For example, while some investigators are interested in whether angry or threatening faces are detected more quickly than positive or neutral ones, others are interested in how negative valence or emotional stimuli are processed more generally. Likewise, while some researchers are interested in examining whether emotional, angry, or negative stimuli are processed automatically, others are simply looking for evidence that *some* level of automatic processing is involved in visual detection (but do not discount the possibility that conscious processes are also at play), and others still are simply asking whether there is a general advantage for threatening stimuli in detection (and not necessarily an efficient one). It is difficult to compare findings across studies when researchers are not explicit about their goals and predictions, so in moving forward, clarity in these areas might help to reconcile potentially contrasting perspectives. Further, clarity in research objectives might also help prevent criticism among different camps from being directed inappropriately to researchers asking fundamentally different questions.

Following from this point, besides making recommendations for careful control of experimental stimuli, specific research questions should be considered when choosing appropriate emotional stimuli. As mentioned before, early work on the detection of emotionally valenced stimuli was based on the hypothesis that the human visual system evolved to detect threat very efficiently. Thus, researchers approaching the detection of threatening stimuli from this perspective are generally interested in studying the presence of an adaptive behavior that occurs naturally in the real world. In this case, removing all real-world elements of emotional facial expressions renders the hypothesis moot, as the stimuli should represent faces that occur naturally in the real world. For these studies, using schematic or computer-generated facial expressions is not necessarily appropriate, as they strip the study of ecological validity.

In contrast, if a researcher's goal is to examine the way the visual system operates, or to examine how the visual system functions in certain contexts, it is clearly important to control for all of the low-level perceptual characteristics of target stimuli. Further, for general questions about the visual system, the issue of ecological validity in real-world detection of emotional facial expressions is not as relevant, and using schematic or computer-generated images is appropriate. Similarly, if a researcher's goal is to examine automaticity of detection, guidelines for strict stimulus control such as those listed by D. V. Becker et al. (2011) and Frischen et al. (2008) should indeed be followed. However, such guidelines are not as relevant if researchers are not interested in automaticity, or are again interested in how humans detect emotional facial expressions in the real world.

Another potential pitfall to avoid in future work is circular arguments that lead to dichotomous debates such as the ones presented here. For example, evolutionary arguments such as those that guide the negative valence hypothesis suggest that the human visual system evolved to quickly detect threatening stimuli. Others can argue, in contrast, that facial expressions evolved to take advantage of the fact that certain low-level perceptual characteristics happen to be easy to detect. Others still can propose that the human visual system evolved to quickly detect certain low-level perceptual cues for reasons that are completely unknown, and the fact that an advantage for these cues makes angry faces easier to detect is purely accidental. As D. V. Becker et al. (2011) points out, arguments like these border on unfalsifiable, and a visual detection experiment might never be able to distinguish between them.

In quoting a reviewer, D. V. Becker et al. (2011) say that,

> "the literature on visual detection using face stimuli is a morass where the bold should fear to tread. Instead, the allure of faces, emotion, and evolutionary psychology continues to attract researchers like moths to the proverbial flame." We could not agree more. (p. 657)

I couldn't either. Although evolutionary arguments are compelling and worth speculation (I too have been guilty of falling prey to their allure in much of my earlier work), they often become problematic when they are used to direct empirical questions that they cannot answer. One way to avoid these circular arguments is to direct future research toward *mechanism*. Indeed, evolutionary arguments can give us a compelling story about why the visual system might function the way it does, but they do not tell us *how* it works. With eye-tracking technologies becoming more and more available to many labs, future research can be directed at examining the exact search strategies that individuals use to detect emotional stimuli, how fixation latencies are affected by different parameters, and how these fixation patterns change over the course of development.

Another recommendation for future research is to pay careful attention to the distracter stimuli used in visual detection tasks. Many researchers have repeatedly pointed out that visual detection is highly sensitive to context, so the distracters play an important part in driving results (Frischen et al., 2008; Horstmann, Lipp, & Becker, 2012). Indeed, using threatening stimuli as distracters slows the detection of nonthreatening targets (Byrne & Eysenck, 1995; Fenske & Eastwood, 2003; Fox, Russo, & Dutton, 2002; Gilboa-Schechtman, Foa, & Amir, 1999; Horstmann, Scharlau, & Ansorge, 2006; Lipp & Waters, 2007). Fenske and Eastwood (2003), for example, presented participants with three images of schematic faces and on each successive trial they were told to identify the center image while ignoring the other two. Participants were slower to detect the center image when the distracter images were negative faces. Additional studies have shown that participants are slower to detect happy faces when angry faces are used as the distracters (Horstmann, Scharlau, et al., 2006) and slower to detect pictures of cats or rabbits when snakes and spiders are the distracters (Forbes, Purkis, & Lipp, 2011; Lipp & Waters, 2007). Thus, when designing visual detection studies and interpreting the results of these experiments, researchers should always consider the role of the distracter stimuli in driving their results and the results of others.

For many of us that are interested in threat detection in real-world contexts, another potentially fruitful area of future research is to examine the detection of negative or threatening facial expressions with more realistic stimuli and in more realistic contexts that exist outside of the lab (Frischen et al., 2008). Perhaps something that is somewhat problematic in terms of real-world threat detection is that the rapid detection of angry faces is found most consistently with schematic faces, and although rapid detection of angry faces has been found using real-face stimuli as well, the results are less consistent (Calvo & Marrero, 2009; Öhman, 2009). Thus, future research in real-world contexts is clearly needed. As D. V. Becker et al. (2011) put it, "of course, in the real world, the visceral reaction is to more than just a static display of anger: Enraged strangers growl, they bare teeth, and they approach—all things that do grab attention," (p. 658). Indeed, emotions consist of more than just facial expressions, and research on the detection of other signals of emotion, such as emotional movement, is quite limited. One study has found that threatening or angry biological motion is also detected more quickly than positive or neutral acts (Chouchourelou, Matsuka, Harber, & Shiffrar, 2006), but it is the only study to date examining emotional displays of biological movement.

## Conclusion

The detection of emotionally valenced stimuli is clearly a topic that interests a large number of psychologists, as evidenced by the massive literature and widely disparate theories about why emotional stimuli might be privileged in visual attention. The predominant and classic interpretation of many of the findings in this literature has been that either negative valence drives the rapid detection of threatening facial expressions, or that low-level characteristics of the faces are responsible. Here we propose that in moving forward, researchers should consider a multicomponent perspective to how and why emotional stimuli are detected very quickly. A multicomponent perspective opens the door to considering the interaction of multiple pathways for rapid detection of emotionally valenced stimuli, and provides a more parsimonious explanation for a large literature filled with seemingly disparate results. In the future, careful consideration of the goals of this research should be made more explicit, and researchers should strive to include the possibility that there are multiple pathways that might lead to an advantage for threat in visual attention.

### Declaration of Conflicting Interests

None declared.

### References

Anderson, B. A., Laurent, P A., & Yantis, S. (2011). Value-driven attentional capture. *Proceedings of the National Academy of Sciences*, *108*, 10367–10371.

Anderson, B. A., & Yantis, S. (2013). Persistence of value-driven attentional capture. *Journal of Experimental Psychology: Human Perception and Performance*, *39*, 6–9.

Bar-Haim, Y., Lamy, D., Pergamin, L., Bakersman-Kranenburg, M. J., & van Ijzendoorn, M. H. (2007). Threat-related attentional bias in anxious and nonanxious individuals: A meta-analytic study. *Psychological Bulletin*, *133*, 1–24.

Beaver, J. D., Mogg, K., & Bradley, B. P. (2005). Emotional conditioning to masked stimuli and modulation of visuospatial attention. *Emotion*, *5*, 67–79.

Becker, D. V., Anderson, U. S., Mortensen, C. R., Neufeld, S. L., & Neel, R. (2011). The face in the crowd effect unfounded: Happy faces, not angry faces, are more efficiently detected in single- and multiple-target visual search tasks. *Journal of Experimental Psychology: General*, *140*, 637–659.

Becker, S. I., Horstmann, G., & Remington, R. W. (2011). Perceptual grouping, not emotion, accounts for search asymmetries with schematic faces. *Journal of Experimental Psychology, Human Perception and Performance*, *37*, 1739–1757.

Blanchette, I. (2006). Snakes, spiders, guns, and syringes: How specific are evolutionary constraints on the detection of threatening stimuli? *The Quarterly Journal of Experimental Psychology*, *59*, 1484–1504.

Brosch, T., & Sharma, D. (2005). The role of fear-relevant stimuli in visual search: A comparison of phylogenetic and ontogenetic stimuli. *Emotion*, *5*, 360–364.

Byrne, A., & Eysenck, M. (1995). Trait anxiety, anxious mood, and threat detection. *Cognition and Emotion*, *9*, 549–562.

Calvo, M. G., Avero, P., & Lundqvist, D. (2006). Facilitated detection of angry faces: Initial orienting and processing efficiency. *Cognition and Emotion*, *20*, 785–811.

Calvo, M. G., & Esteves, F. (2005). Detection of emotional faces: Low perceptual threshold and wide attentional span. *Visual Cognition*, *12*, 13–27.

Calvo, M. G., & Marrero, H. (2009). Visual search of emotional faces: The role of affective content and featural distinctiveness. *Cognition & Emotion*, *23*, 782–806.

Cave, K. R., & Batty, M. J. (2006). From searching for features to searching for threat: Drawing the boundary between preattentive and attentive vision. *Visual Cognition*, *14*, 629–646.

Chouchourelou, A., Matsuka, T., Harber, K., & Shiffrar, M. (2006). The visual analysis of emotional actions. *Social Neuroscience*, *1*, 63–74.

Coelho, C. M., Cloete, S., & Wallis, G. (2011). The face-in-the-crowd effect: When angry faces are just cross(es). *Journal of Vision*, *10*, 1–14.

Eastwood, J. D., & Smilek, D. (2005). Functional consequences of perceiving facial expressions of emotion without awareness. *Consciousness and Cognition*, *14*, 565–584.

Eastwood, J. D., Smilek, D., & Merikle, P. M. (2001). Differential attentional guidance by unattended faces expressing positive and negative emotion. *Perception and Psychophysics*, *63*, 1004–1013.

Eastwood, J. D., Smilek, D., & Merikle, P. M. (2003). Negative facial expression captures attention and disrupts performance. *Perception & Psychophysics*, *65*, 352–358.

Ekman, P., & Friesen, W. V. (1976). *Pictures of facial affect*. Palo Alto, CA: Consulting Psychologists' Press.

Esteves, F. (1999). Attentional bias to emotional facial expressions. *European Review of Applied Psychology*, *49*, 91–97.

Fenske, M. J., & Eastwood, J. D. (2003). Modulation of focused attention by faces expressing emotion: Evidence from flanker tasks. *Emotion*, *3*, 327–343.

Flykt, A. (2005). Visual search with biological threat stimuli: Accuracy, reaction times, and heart rate changes. *Emotion*, *5*, 349–353.

Flykt, A. (2006). Preparedness for action: Responding to the snake in the grass. *The American Journal of Psychology*, *119*, 29–43.

Forbes, S. J., Purkis, H. M., & Lipp, O. V. (2011). Better safe than sorry: Simplistic fear-relevant stimuli capture attention. *Cognition & Emotion*, *25*, 794–804.

Fox, E., Lester, V., Russo, R., Bowles, R., Pichler, A., & Dutton, K. (2000). Facial expressions of emotion: Are angry faces detected more efficiently? *Cognition and Emotion*, *14*, 61–92.

Fox, E., Russo, R., Bowles, R., & Dutton, K. (2001). Do threatening stimuli draw or hold visual attention in subclinical anxiety? *Journal of Experimental Psychology: General*, *130*, 681–700.

Fox, E., Russo, R., & Dutton, K. (2002). Attentional bias for threat: Evidence for delayed disengagement from emotional faces. *Cognition and Emotion*, *16*, 355–379.

Frischen, A., Eastwood, J. D., & Smilek, D. (2008). Visual search for faces with emotional expressions. *Psychological Bulletin*, *134*, 662–676.

Gao, X., LoBue, V., Harvey, T., & Irving, J. (2015). *The effect of spatial frequency information and perceptual similarity in threat detection*. Manuscript under review.

Gerritsen, C., Frischen, A., Blake, A., Smilek, D., & Eastwood, J. D. (2008). Visual search is not blind to emotion. *Perception & Psychophysics*, *70*, 1047–1059.

Gilboa-Schechtman, E., Foa, E. B., & Amir, N. (1999). Attentional biases for facial expressions in social phobia: The face-in-the-crowd paradigm. *Cognition and Emotion*, *13*, 305–318.

Hansen, C. H., & Hansen, R. D. (1988). Finding the face in the crowd: An anger superiority effect. *Journal of Personality and Social Psychology*, *54*, 917–924.

Hayakawa, S., Kawai, N., & Masataka, N. (2011). The influence of color on snake detection in visual search in human children. *Scientific Reports*, *1*, 1–4.

Horstmann, G. (2009). Visual search for schematic affective faces: Stability and variability of search slopes with different instances. *Cognition and Emotion*, *23*, 355–379.

Horstmann, G., & Bauland, A. (2006). Search asymmetries with real faces: Testing the anger-superiority effect. *Emotion*, *6*, 193–207.

Horstmann, G., Borgstedt, K., & Heumann, M. (2006). Flanker effects with faces may depend on perceptual as well as emotional differences. *Emotion*, *6*, 28–39.

Horstmann, G., Lipp, O. V., & Becker, S. I. (2012). On toothy grins and angry snarls—Open mouth displays contribute to efficiency gains in search for emotional faces. *Journal of Vision*, *12*, 1–15.

Horstmann, G., Scharlau, I., & Ansorge, U. (2006). More efficient rejection of happy than of angry face distractors in visual search. *Psychonomic Bulletin & Review*, *13*, 1067–1073.

Larson, C. L., Aronoff, J., & Stearns, J. J. (2007). The shape of threat: Simple geometric forms evoke rapid and sustained capture of attention. *Emotion*, *7*, 526–534.

Lipp, O. V. (2006). Of snakes and flowers: Does preferential detection of pictures of fear-relevant animals in visual search reflect on fear-relevance? *Emotion*, *6*, 296–308.

Lipp, O. V., & Derakshan, N. (2005). Attentional bias to pictures of fear-relevant animals in a dot probe task. *Emotion*, *5*, 365–369.

Lipp, O. V., Derakshan, N., Waters, A. M., & Logies, S. (2004). Snakes and cats in the flower bed: Fast detection is not specific to pictures of fear-relevant animals. *Emotion*, *4*, 233–250.

Lipp, O. V., & Waters, A. M. (2007). When danger lurks in the background: Attentional capture by animal fear-relevant distractors is specific and selectively enhanced by animal fear. *Emotion*, *7*, 192–200.

LoBue, V. (2009). More than just a face in the crowd: Detection of emotional facial expressions in young children and adults. *Developmental Science*, *12*, 305–313.

LoBue, V. (2010). And along came a spider: Superior detection of spiders in children and adults. *Journal of Experimental Child Psychology*, *107*, 59–66.

LoBue, V. (2013). What are we so afraid of? How early attention shapes our most common fears. *Child Development Perspectives*, *7*, 38–42.

LoBue, V. (2014). Deconstructing the snake: The relative roles of perception, cognition, and emotion on threat detection. *Emotion*, *14*, 701–711.

LoBue, V., & DeLoache, J. S. (2008). Detecting the snake in the grass: Attention to fear-relevant stimuli by adults and young children. *Psychological Science*, *19*, 284–289.

LoBue, V., & DeLoache, J. S. (2009). Superior detection of threat-relevant stimuli in infancy. *Developmental Science*, *13*, 221–228.

LoBue, V., & DeLoache, J. S. (2011). What's so special about slithering serpents? Children and adults rapidly detect snakes based on their simple features. *Visual Cognition*, *19*, 129–143.

LoBue, V., & Larson, C. L. (2010). What makes angry faces look so… angry? Examining visual attention to the shape of threat in children and adults. *Visual Cognition*, *18*, 1165–1178.

LoBue, V., Matthews, K., Harvey, T., & Stark, S. L. (2014). What accounts for the rapid detection of threat? Evidence for an advantage in perceptual and behavioral responding from eye movements. *Emotion*, *14*, 816–823.

LoBue, V., & Rakison, D. (2013). What we fear most: A developmental advantage for threat-relevant stimuli. *Developmental Review*, *33*, 285–303.

LoBue, V., Rakison, D., & DeLoache, J. S. (2010). Threat perception across the lifespan: Evidence for multiple converging pathways. *Current Directions in Psychological Science*, *19*, 375–379.

Lundqvist, D., & Öhman, A. (2005). Emotion regulates attention: The relation between facial configurations, facial emotion, and visual attention. *Visual Cognition*, *12*, 51–84.

Masataka, N., & Shibasaki, M. (2012). Premenstrual enhancement of snake detection in visual search in healthy women. *Scientific Reports*, *2*, 1–4.

Milders, M., Sahraie, A., Logan, S., & Donnellon, N. (2006). Awareness of faces is modulated by their emotional meaning. *Emotion*, *6*(1), 10–17.

Öhman, A. (2009). Of snakes and faces: An evolutionary perspective on the psychology of fear. *Scandinavian Journal of Psychology*, *50*, 543–552.

Öhman, A., & Dimberg, U. (1978). Facial expressions as conditioned stimuli for electrodermal responses: A case of "preparedness"? *Journal of Personality and Social Psychology*, *36*, 1251–1258.

Öhman, A., Flykt, A., & Esteves, F. (2001). Emotion drives attention: Detecting the snake in the grass. *Journal of Experimental Psychology: General*, *13*, 466–478.

Öhman, A., Lundqvist, D., & Esteves, F. (2001). The face in the crowd revisited: An anger superiority effect with schematic faces. *Journal of Personality and Social Psychology*, *80*, 381–396.

Öhman, A., & Mineka, S. (2001). Fears, phobias, and preparedness: Toward and evolved module of fear and fear learning. *Psychological Review*, *108*, 483–522.

Purcell, D. G., Stewart, A. L., & Skov, R. B. (1996). It takes a confounded face to pop out of a crowd. *Perception*, *25*, 1091–1108.

Purkis, H. M., & Lipp, O. V. (2007). Automatic attention does not equal automatic fear: Preferential attention without implicit valence. *Emotion*, *7*, 314–323.

Schubo, A., Gendolla, G., Meinecke, C., & Abele, A. E. (2006). Detecting emotional faces and features in a visual search task paradigm: Are faces special? *Emotion*, *6*, 246–256.

Soares, S. C., Esteves, F., Lundqvist, D., & Öhman, A. (2012). Some animal specific fears are more specific than others: Evidence from attention and emotion measures. *Behaviour Research and Therapy*, *47*, 1032–1042.

Tipples, J., Atkinson, A. P., & Young, A. W. (2002). The eyebrow frown: A salient social signal. *Emotion*, *2*, 288–296.

Tipples, J., Young, A. W., Quinlan, P., Broks, P., & Ellis, A. W. (2002). Searching for threat. *The Quarterly Journal of Experimental Psychology*, *55A*, 1007–1026.

Treisman, A. M., & Gelade, G. (1980). A feature-integration theory of attention. *Cognitive Psychology*, *12*, 97–136.

Williams, M. A., Moss, S. A., Bradshaw, J. L., & Mattingley, J. B. (2005). Look at me, I'm smiling: Visual search for threatening and nonthreatening facial expressions. *Visual Cognition*, *12*, 29–50.

Wolfe, J. M. (1998). What can 1 million trials tell us about visual search? *Psychological Science*, *9*, 33–39.