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Female advantage in threat avoidance manifests in threat reaction but not threat detection

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Abstract

Threat avoidance involves both detection of a threatening stimulus and reaction to it. We demonstrate with empirically validated stimuli (that are threatening, nonthreatening-negative, neutral, or positive) that threat detection is more pronounced among males, whereas threat reactivity is more pronounced among females. Why women are less efficient detectors of threat challenges Benenson et al.'s conceptual analysis.

Benenson et al. suggest that females have a stronger self-protective capacity to avoid survival threats than do males. A more general threat-superiority literature suggests that humans inherited a neural architecture that preferentially processes and responds to immediate survival threats (of phylogenetic or ontogenetic origin; Blanchette, 2006; March, Gaertner, & Olson, 2018a, 2018b; LeDoux, 2012; Öhman & Mineka, 2001). Such threat-superiority manifests as earlier detection and stronger responses to threatening than non-threatening stimuli. For example, March, Gaertner, and Olson (2017) empirically validated four categories of stimulus images – threatening (e.g., snarling predators, gunmen), nonthreatening-negative (herein "negative," e.g., bugs, wounded animals), positive (e.g., puppies, babies), and neutral (e.g., doorknobs, mugs) – and found that the threatening stimuli were identified faster, more frequent targets of initial eye-gaze, and elicited stronger startle-eyeblinks. Conceptually similar patterns occur when threat superiority is isolated from the opposing effect of conscious attention by presenting stimuli outside conscious perception (i.e., by using masked presentations at 14–21 ms; March, Gaertner, & Olson, 2022). Not considered by the threat-superiority literature, however, is the possibility of a sex difference favoring females.

Benenson et al. focused primarily on reaction to, rather than the detection of, threat. Accordingly, we reanalyzed data from four of our studies: two that assessed stimulus detection and two that assessed stimulus reaction. As a caveat, we powered our studies to test within-subject effects of the stimuli not between-subject effects such as sex. Moreover, sex imbalances among our college-student samples compromise inferential tests of sex differences. Consequently, we focus on the effect size of the sex difference (Table 1).

The stimulus detection studies in the top half of Table 1 used visual search and eye-tracking tasks. Each trial of visual-search presented a 3×3 matrix containing a central "X" surrounded by eight stimuli. On congruent trials, stimuli were all threatening, all negative, all neutral, or all positive. On the critical incongruent trials, either one threatening or negative stimulus was embedded among seven positive or seven neutral stimuli. Participants pressed one of two keys to indicate whether the stimuli were all the same or not. Males were faster than females to detect the incongruent threatening stimulus and the incongruent negative stimulus. Each trial of the eye-tracking task presented a pair of stimuli from different categories (e.g., threat and negative) and assessed at which stimulus the participant first gazed. Males were more likely than females to first gaze at a threatening than negative or neutral stimulus, and to first gaze at a negative than positive stimulus, with negligible differences on the remaining

Table 1 (March and Gaertner). Sex differences in stimulus detection and reaction

Source	Task	F_n	M_n	Stimulus	*d*
Stimulus detection					
Study 1[a]	Visual search	35	55	Thr	−0.59
				Neg	−0.54
Study 2[a]	Eye tracking	29	34	Thr vs. Neg	−0.18
				Thr vs. Neu	−0.16
				Thr vs. Pos	−0.03
				Neg vs. Pos	−0.15
				Neg vs. Neu	−0.09
				Pos vs. Neu	0.08
Stimulus reaction					
Study 3[a]	Startle eyeblink	94	28	Thr	0.35
				Neg	−0.20
				Neu	−0.18
				Pos	0.08
Study 2[b]	Startle eyeblink	70	30	Thr	0.40
				Neg	0.27
				Neu	−0.17
				Pos	−0.38

Note. F_n = female sample size; M_n = male sample size; Thr = threat; Neg = negative; Neu = neutral; Pos = positive. Effect size *d* is scored so positive values reflect a stronger female than male response and is the difference of the female mean minus the male mean divided by their pooled standard deviation with the exception of the eye-tracking data for which we converted the odds ratio of the sex difference in the tendency to first gaze at the stimulus listed first vs. second to *d* as ln(OR)/1.65 (Sánchez-Meca, Chacón-Moscoso, & Marín-Martínez, 2003). Sample size discrepancies from the source are because of currently excluding participants who did not specify their sex and the reversed labeling of sex frequencies in study 1 of March et al. (2017).
[a]March et al. (2017).
[b]March et al. (2022).

pairings. These data suggest that males have an advantage over females in the detection of threatening stimuli.

The stimulus reaction studies in the bottom half of Table 1 assessed startle eyeblink – a reflexive response measured by electromyography of the orbicularis oculi muscle (Blumenthal et al., 2005). Each trial presented an image from one of the four stimulus categories for 6,000 ms (in the first study) or 21 ms (in the second). On critical trials, a 100 dB noise blast was presented via headphones 2,000–4,000 ms after stimulus image onset to trigger a startle-eyeblink. Females responded with a larger startle-eyeblink than did males when the noise blast was paired with threatening stimuli in the first and second studies and with negative stimuli in the second study. Alternatively, males responded with a larger startle-eyeblink than did females when the noise blast was paired with neutral stimuli in the first and second studies, with negative stimuli in the first study, and with positive stimuli in the second study. The only consistent pattern across studies favoring females was in response to threat, which supports Benenson et al.'s argument. That a consistently stronger female response did not occur to other stimuli rules out the alternative of an invariantly stronger female response. The stronger female response appears cued to immediate survival threats.

Our data support Benenson et al.'s argument in regard to reaction to threat but not in regard to threat detection. The only evidence Benenson et al. considered that could be construed as threat detection was their section on pain tolerance. A sex difference in self-reported pain, however, could be compromised by gender role expectations that differentially influence male versus female reports (Robinson, Gagnon, Riley, & Price, 2003). Of course, Benenson et al. did not buttress their argument solely with self-report. Nonetheless, gender expectations could compromise much of the self-report data they used (e.g., such as emotions, sleep disruption, and picture aversion; Grossman & Wood, 1993; Wong, Pituch, & Rochlen, 2006). Fortunately, the threat detection and reaction tasks that we employed are not easily compromised by gender role expectations. Reanalysis of our data reveals a stronger female self-protective capacity to avoid survival threats in regard to stimulus reaction but not stimulus detection. Why males are more efficient than females at detecting immediate survival threats requires further consideration by Benenson et al.

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