

Sex differences in the emotional brain

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In this issue, Schienle *et al.* use brain imaging to examine emotion-related activation differences between men and women. Are those differences related to the way the sexes feel emotions? Are they hardwired? In this commentary, we briefly review sex differences

in feeling, perception of emotionally evocative cues, and expression of emotions, and we discuss how they may be related to sex differences in the emotional brain. *NeuroReport* 16:85–87 © 2005 Lippincott Williams & Wilkins.

INTRODUCTION

Since the times of the Greek philosophers, and probably before, humankind has been fascinated by perceived differences between men and women. Why should it be otherwise? Perhaps understanding our differences will lead us to utopian matrimonial harmony and a deeper acceptance of our closest counterparts in life. In a parable from his "Symposium," Plato suggested that our differences are complementary: man and woman were once two halves of the same creature, split by the gods and destined to search for their lost counterpart. Although this story promotes a benign, egalitarian complementarity, gender characteristics have been too-often used as a weapon in a battle to maintain social hierarchies. This too has ancient roots, as Plato's successor Aristotle described women as inferior beings incapable by nature of autonomy [1]. It is the great potential for both use and misuse of the concept of gender that makes sex differences an important and emotionally charged topic.

In this issue, Schienle and colleagues take a new look at gender differences in a way their historical predecessors could never have imagined: by examining patterns of brain activation in women and men viewing emotionally arousing photographs. They observed that men showed greater responses to scenes of violence and aggression in both amygdalae and the left occipito-temporal cortex. This difference was specific to viewing aggressive scenes; brain activation to disgusting photos did not differ between groups. Surprisingly, women did not show greater activation than men anywhere in the brain. The study's large sample size ($n=90$) combined with focused region-of-interest analyses means that they had a better chance than most studies at finding differences, should they exist, and limiting identification of false activations.

By way of explanation, the authors suggest that whereas disgust responses may have similar survival value for males and females, men are more tuned to aggression due to their role as protector and the need to compete for mates throughout evolutionary history. Thus, males may show greater responses in neural systems that encode aggression-related affective and perceptual features of stimuli, func-

tions often associated with the amygdala and temporal cortex, respectively.

At first, these findings may seem to suggest that greater amygdala responsivity to violent images in males reflects a hardwired difference in the way the brains of men and women have evolved to process emotional stimuli. However, measurements of brain function measure the end products not only of distant evolutionary history, but of the personal development and enculturation that shape the way we think and feel. Gender-specific emotional responses are subject to shaping by culture and family environment [2,3]. In the domain of aggression, girls are taught to internalize aggressive responses, which manifests in increased cardiovascular response to anger [4,5]. A rich tradition of research in psychology has identified a number of ways in which men and women differ in their processing of emotional events, including differences in feeling, attention to, and expression of emotions. Which of these might be the most likely phenomenological complement to Schienle *et al.*'s neural dissociations?

DIFFERENCES IN FEELING OR PERCEPTION?

It could be that men show a greater emotional response to aggressive scenes, which then elicits a greater response in the amygdala. However, the authors' finding that women reported that the scenes were both more arousing and more distressing belies this interpretation, and supports the idea that amygdala activation in humans may often reflect something other than felt emotions.

An alternative is that amygdala activity reflects an emotionally cued orienting or vigilance response [6,7] that primes attentional systems for the encoding of affectively charged inputs. Amygdala responses in the human neuroimaging literature appear to be most reliably elicited by viewing facial expressions of fear in others [8,9] and may be affected by the ambiguity of the perceived implications of the expression [10,11]. Patients with amygdala lesions appear to provide normal self-reports of emotion, though they may fail to show enhanced memory for or attention to

arousing events [12,13]. Thus, the differences between men and women in amygdala and occipitotemporal cortex activation may be related to the way men attend to violent scenes. Paradoxically, although women might find the scenes more distressing, for men they may provide more behaviorally relevant cues, which elicit a more potent orienting response [14].

For both genetic and developmental reasons, differential attention to and memory for specific emotional cues may differ for men and women. Such differences may emerge early in life, as infant girls will make more eye contact with caregivers than will baby boys [15], and be propagated through culture [16,17]. These differences may be related to use of different encoding and emotional appraisal strategies that guide attention to different aspects of a scene, as suggested by gender differences in lateralization of amygdala correlates (more left for women, right for men) of subsequent memory for arousing stimuli [18,19].

DIFFERENCES IN RESPONSE OR REGULATION OF EXPRESSION?

Another possibility is that men may generate stronger emotional responses to aggressive scenes, but because of self-presentation biases, simply under-report their feelings in comparison to women. Alternatively, women may tend to over-report the intensity of their feelings in comparison to men. Women often tend to report stronger emotional experiences, and in some situations they have also shown stronger physiological responses to emotional cues [3,5], although these findings are not consistent across studies [20]. Women possess more differentiated emotion knowledge [21,22] and their affective judgments may be more influenced by highly accessible beliefs about emotion, including cultural stereotypes (i.e. women are more emotional) that may lead them to report more intense feelings. For example, gender differences in retrospective reports of emotion intensity and frequency (which are more likely to be shaded by beliefs and stereotypes) disappear when these reports are taken moment-to-moment in the context of everyday life [23].

THE BIG PICTURE

It is difficult to tell which measures (self-report, physiology, behavior, or specific brain activations) are the best measure of emotion in different situations. For emotion researchers, dependent measures of experience, physiology, and behavior reflect different aspects of an individual's response to an event, and may each be influenced by different factors. Interestingly, these measures often fail to correlate strongly in behavioral and neuropsychological studies, which highlights the need for studies of gender influences on emotion to be clear about which component of a response is being influenced, in what context, and why [23].

As evidence on gender differences accumulates, it is important to keep in mind that many real differences between men and women may not be detectable using current brain-imaging technology and tasks. For example, some that could be important may occur in brain regions that are difficult to image (particularly with fMRI) due to their small size and proximity to fluid spaces in the brain that distort the MR signal. A recent meta-analysis reported more female than male activations in thalamus and

brainstem [24], although this effect was not replicated in this study, perhaps due in part to the fact that Schienle *et al.* did not perform more powerful region-of-interest analyses in these areas.

That being said, Schienle *et al.*'s results underscore the remarkable similarities between men and women in neural, experiential, behavioral, and physiological correlates of emotion. These similarities far outnumber the differences [24]. Indeed, we may be more like two halves of a whole, as in Plato's parable, than we are creatures from Mars or Venus. This sentiment was eloquently expressed by the poet Maya Angelou, who wrote, "I note the obvious differences/between each sort and type,/but we are more alike, my friends,/than we are unlike" [25].

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