PSYCHOLOGY

Amygdala Response to Happy Faces as a Function of Extraversion

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Cognitive neuroscience aims to delineate principles of brain-behavior relations by characterizing both common mechanisms across, and individual differences among, individuals. Both approaches are relevant for the study of the amygdala, a critical structure for the processing of emotional signals (*1*). Consistent activation to fearful facial expressions (*2–4*) may reflect a shared neural mechanism, whereas inconsistent activation to happy facial expressions (*2–4*) may reflect individual differences in the personality trait of extraversion (*5*), given that amygdala activation to positive emotional scenes varies as a function of this trait (*6*).

We used functional magnetic resonance imaging (fMRI) to examine whether amygdala activation to fearful expressions is independent of extraversion and whether amygdala activation to happy expressions varies with extraversion (*7*). Significant amygdala activation across participants was found only for fearful expressions (Fig. 1, left). Amygdala activation for happy expressions correlated positively and significantly with the degree of extraversion (Fig. 1, middle and right). The center of the correlation cluster was located in the amygdala but extended into regions of the uncus and hippocampus. The specificity of the relation between extraversion and amygdala activation to happy expressions was supported in three ways: (i) Extraversion did not correlate significantly with activation to other emotional (angry, fearful, and sad) expressions; (ii) neuroticism did not correlate significantly with activation to any expression; and (iii) this correlation was the largest of all possible correlations among the "big 5" major personality traits factors (extraversion, neuroticism, openness, agreeableness, and conscientiousness) and all four facial expressions.

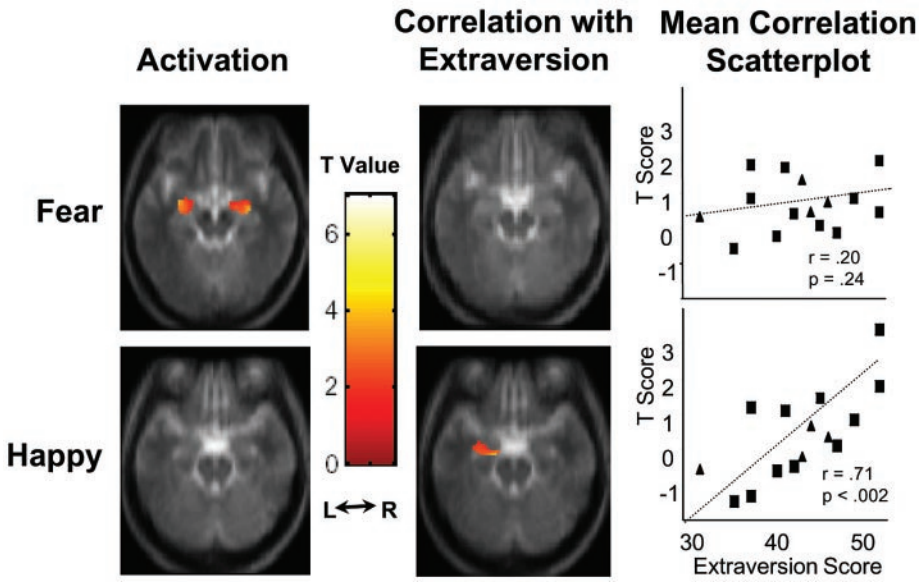

Fig. 1. Amygdala response to emotional faces. (**Left**) Significant amygdala activation to fearful, but not happy, faces (left: −23, −6, −18; right: +24, −7, −17). (**Middle**) Extraversion correlated with left amygdala activation (−22, −9, −20) to happy, but not fearful, faces. (**Right**) Participants' mean activations (in T scores) as a function of extraversion, from voxels surviving small volume correction. For fearful-neutral, no voxels survived at $P < 0.05$ threshold, which was therefore reduced to $P < 0.25$. Black squares represent females, and black triangles represent males.

The findings suggest two processes in the amygdaloid region. The first is engaged consistently across people in response to fearful expressions and may reflect the importance of detecting cues to potentially dangerous situations. The second process is engaged variably across people, as a function of extraversion, in response to happy expressions. This activation was left-lateralized, i.e., located within the hemisphere associated with positive emotions and with approach-related behavior (*8*), and may thus contribute to behavior consistent with the sociable interactive style of extraverts. The variability associated with this second process may explain why prior studies, which did not control for personality, reported various outcomes (*2–4*). Limited spatial resolution precludes determination of whether these processes are differentially localized among the subnuclei of the amygdala or adjacent regions involved in processing facial expressions (*4*). Nevertheless, the present results demonstrate that personality traits influence some, but not other, brain responses to emotionally salient perceptions.

References and Notes

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7. Fifteen participants (11F) with no psychiatric history, assessed for extraversion and neuroticism (*9*), categorized blocked presentations of emotional (angry, fearful, happy, and sad) or neutral faces as male or female. Functional whole-brain images were acquired in a 3T GE scanner with a gradient echo T2*-weighted spiral scan (repetition time = 3 s, echo time = 30 ms, flip angle = 83°, field of view = 24 cm), smoothed (8 mm full width at half-maximum), and normalized (gray-matter SPM99 template). Analyses were restricted to the amygdala and based on contrasts between each of the four emotional and neutral face categories, using random-effects models in SPM99 with gender as a covariate. Functional analyses were based on the average activation of voxels after small volume correction (height: $P < 0.05$, corrected; extent: 5 voxels).
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