Varieties of Emotional Experience during Voluntary Emotional Facial Expressions

JAMES A. COAN AND JOHN J. B. ALLEN

Department of Psychology, University of Arizona, Tucson, Arizona 85721-0068, USA

KEYWORDS: EEG asymmetry; emotional experience; facial expression

Emotion theorists have argued that emotions are patterns of responses that imply coherence between behavioral, physiological, and phenomenological systems,[1] including coherence between physiology and emotional expression[2] and the modulation of emotional expression and subjective experience by trait physiological dispositions.[3] A physiological measure sensitive to emotion—frontal EEG asymmetry—has been hypothesized to reflect approach and withdrawal propensities,[4] with relatively greater left frontal activity indexing a propensity for approach-related behavior, and relatively less left frontal activity indexing a propensity for withdrawal-related behavior. By this scheme, disgust, fear, and sadness—all thought to be withdrawal-related emotions—should show relatively less left frontal activity; while the putative approach-related emotions of anger and joy should show relatively greater left frontal activity.[5]

Using voluntary posed emotional facial expressions depicting anger, disgust, fear, joy and sadness, this study examined: (1) the coherence between physiological change and subjective reports of emotional experience, and (2) the modulation of subjective reports of emotional experience by resting physiology. The modulation hypothesis states that individuals with relatively greater left frontal activity at rest will be more likely to report approach emotions during this task and less likely to report withdrawal emotions during this task. This hypothesis states that trait levels of CNS activity will be related to

Present address and address for correspondence: James A. Coan, W.M. Keck Center for Functional Brain Imaging and Behavior, Waisman Center, University of Wisconsin, Madison, WI 53705. Voice: 608-265-6602.
jacoan@wisc.edu
John J.B. Allen, Department of Psychology, University of Arizona, Tucson, AZ 85721-0068. Voice: 520-621-4992; fax: 520-621-9306.
jallen@u.arizona.edu

Ann. N.Y. Acad. Sci. 1000: 375–379 (2003).
doi: 10.1196/annals.1280.034

state changes in emotional experience. The coherence hypothesis states that individuals who are more left frontally active during anger and joy should be more likely to report those emotions, while individuals who are more right frontally active during disgust, fear, and sadness will be more likely to experience those emotions. According to this hypothesis, state levels of CNS activity will be related to state levels of emotional experience. Individual differences in reported dimensions of emotional experience were also examined.

METHOD

Eight minutes of resting EEG was recorded from 30 participants prior to the state emotion task. EEG was additionally recorded while 31 participants performed voluntary facial expressions in a directed facial action (DFA) task: anger (4+5+7+23/24), disgust (9+15), fear (1+2+4+5+15+20), joy (6+12+25) and sadness (1+6+15+17). Faces were held for two one-minute segments. Particular facial movements are here noted using the Facial Action Coding System.[6] EEG alpha asymmetry was calculated using ln(right)–ln(left) alpha (8–13 Hz) at homologous sites, with higher scores indicating greater relative left activity.

Immediately following each two-minute facial expression sequence, participants were asked: (1) While making that face, did you experience any thoughts? (2) While making that face, did you experience any emotions? (3) While making that face, did you experience any sensations? (4) While making that face, did you feel like taking any kind of action, like doing anything? Participants were then asked to rate the intensity of their reported experiences on a scale from 1 (very slight experience) to 7 (extremely intense experience).

RESULTS

Resting EEG Asymmetry and Emotional Experience

Relatively greater left frontal activity at rest predicted an increased likelihood of reporting an experience of anger, joy, disgust, and the average of all five emotions (trait EEG asymmetry by emotion interaction, $F[4,865] = 3.53$, $P < 0.01$), independently of reference scheme (average and linked mastoid) or specific frontal region (F7/8, F3/4, and FTC1/2). Similarly, trait frontal EEG asymmetry differentially predicted emotional intensity ratings (interaction $F[4,865] = 2.38$, $P = 0.05$) as depicted panel A of FIGURE 1, again independently of reference scheme (average and linked mastoid) or specific frontal region (F7/8, F3/4 and FTC1/2).

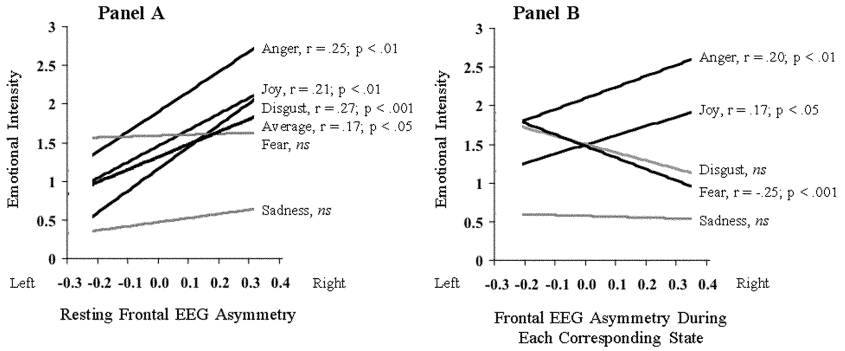

FIGURE 1. Regression lines depicting the relationship between frontal EEG asymmetry and emotional intensity ratings recorded following emotional facial expressions. **Panel A** depicts this relationship for resting frontal EEG asymmetry. **Panel B** depicts this relationship for concomitant-state frontal EEG asymmetry.

State EEG Asymmetry and Emotional Experience

Anger and, marginally, joy were more likely to be reported if their concomitant-state EEG asymmetries involved greater left activity; and fear was more likely to be reported if its concomitant-state EEG asymmetry involved greater right activity (state EEG asymmetry by emotion interaction, $F[4,895] = 8.17$, $P < 0.001$), with results independent of reference scheme or specific frontal region. Similarly, state EEG predicted intensity of subjective emotional experience (interaction $F[4,895] = 6.30$, $P < 0.001$), independent of reference scheme or specific frontal region. As depicted in panel B of FIGURE 1, anger and joy were more intense if their concomitant-state EEG asymmetries involved greater left activity, and fear was more intense if its concomitant-state EEG asymmetry involved greater right activity.

Individual Differences

Bodily sensations played a more prominent role in the experience of fear than in other emotions (emotion by dimension interaction, $\varepsilon = .67$; $F(12,396) = 2.51$, $P < 0.05$, followed up with simple effects). Anger was more likely to be labeled as a specific emotion than disgust ($P < 0.01$), fear ($P < 0.001$), sadness ($P < 0.01$) and, marginally, joy ($P < 0.10$).

Individuals who were high in trait behavioral activation[7] were more likely to report experiencing emotion in terms of action tendencies ($r = .36$; $P < 0.05$), but not other dimensions. Individuals who were high in trait-negative

affectivity[8] were more likely to experience emotion in terms of bodily sensations ($r = .32$; $P < 0.07$) and assigned greater intensity ratings to their experiences of fear ($r = .39$; $P < 0.05$) and bodily sensations ($r = .49$; $P < 0.01$).

DISCUSSION

The Modulation Hypothesis

While a form of the modulation hypothesis was clearly supported, results only partially supported the predictions of the approach/withdrawal model of motivation and emotion. Trait-relative left-frontal EEG activity predicted an increased likelihood of any emotional experience, and increased intensity in anger, disgust, and joy. Although consistent with the model's predictions for anger and joy, the approach/withdrawal model would predict that disgust, fear, and sadness should have shown the opposite relationship.

The Coherence Hypothesis

Relatively greater state left frontal EEG activity corresponded with a greater likelihood of reporting approach (anger and joy) emotions, and greater emotional intensity associated with those emotions. Relatively greater state right activity during fear, a withdrawal emotion, corresponded with a greater likelihood of reporting fear experiences, as well as with higher reports of emotional intensity associated with fear. While the same was not true of disgust and sadness, it is striking that both of these withdrawal emotions were correlated with experience and intensity reports in the expected direction. Thus, the evidence for coherence is generally consistent with the approach/withdrawal model of frontal EEG asymmetry and emotion.

Individual Differences

Dimensions of experience (i.e., thoughts, action tendencies, bodily sensations, and emotion-labeling behaviors) vary as a function of specific emotions and individual differences. Fear was more likely than any other emotion except for anger to be experienced normatively in terms of bodily sensations. Individuals high in trait-negative affectivity were more likely to report fear, and reported their experiences of bodily sensations to be more intense, regardless of specific emotion—findings that hold implications for links between emotion and perceptions of physical sensations in mental and physical illness. Finally, those reporting the highest behavioral activation tended to experience all emotions in terms of action tendencies, suggesting they may be most likely to find emotions as motivations to action.

REFERENCES

1. ROSENBERG, E. & P. EKMAN. 1994. Coherence between expressive and experiential systems in emotion. Cognit. Emotion **8:** 201–229.
2. EKMAN, P., R.J. DAVIDSON, & W.V. FRIESEN. 1990. The Duchenne smile: emotional expression and brain physiology II. J. Pers. Soc. Psychol. **58:** 342–353.
3. WHEELER, R.E., R.J. DAVIDSON & A.J. TOMARKEN. 1993. Frontal brain asymmetry and emotional reactivity: a biological substrate of affective style. Psychophysiology **30:** 82–89.
4. DAVIDSON, R.J. 1998. Affective style and affective disorders: perspectives from affective neuroscience. Cognit. Emotion **12:** 307–330.
5. COAN, J.A., J J.B. ALLEN & E. HARMON-JONES. 2001. Voluntary facial expression and hemispheric asymmetry over the frontal cortex. Psychophysiology **38:** 912–925.
6. EKMAN, P. & W.V. FRIESEN. 1978. The Facial Action Coding System. Consulting Psychological Press. Palo Alto, CA.
7. CARVER, C.S. & T.L. WHITE. 1994. Behavioral inhibition, behavioral activation, and affective responses to impending reward and punishment: the BIS/BAS scales. J. Pers. Soc. Psychol. **67:** 319–333.
8. WATSON, D., L.A. CLARK & A. TELLEGEN. 1988. Development and validation of brief measures of positive and negative affect: the PANAS scales. J. Pers. Soc. Psychol. **54:** 1063–1070.