Hemispheric Asymmetries in Adults’ Perception of Infant Emotional Expressions*

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Accounts of emotion lateralization propose either overall right hemisphere (RH) advantage, or differential RH vs. LH involvement depending on the negative-positive valence of emotions. Perceptual studies generally show RH specialization. Yet viewer emotional responses may enhance valence effects. Because infant faces elicit heightened emotion in viewers, we assessed perceptual asymmetries with chimeric infant faces. First, we determined that chimeras must be paired with their counterparts, not their mirror-images, to tap viewers’ sensitivity to adult facial asymmetries. Next, we found an RH perceptual bias for infant cries, but bihemispheric sensitivity to asymmetries in infant smiles. This effect was not due to LH featural vs. RH holistic processing, and held for additional, intensity-matched, spontaneous expressions. Specialized RH sensitivity to infant cries may reflect an evolutionary advantage for rapid response to infant distress.

Effects of Emotional Valence and Hemiface Differences on Adult Perceptual Asymmetries for Infant Facial Expressions

Findings with both unilateral brain-damaged patients and normal adults have led to general consensus that the human cerebral hemispheres are differentially involved in emotional, as well as cognitive, processes. However, the exact pattern of hemispheric involvement in emotions remains controversial. According to the most widely-held view, the right hemisphere (RH) dominates overall in perception and expression of emotion, across both negative and positive valence (e.g., Campbell, 1978; Chaurasia & Goswami, 1975; Gainotti, 1972, 1988; Hirschman & Safer, 1982; Ladavas, Umilta & Ricci-Bitti, 1980; Ley & Bryden, 1979, 1981; Safer, 1981; Strauss & Moscovitch, 1981). For convenience, we will refer to that view as the RH hypothesis. The major counter-proposal has been that the RH predominates in negative emotions, the left (LH) in positive, a view we will call the valence hypothesis (e.g., Ahern & Schwartz, 1979; Dimond & Farrington, 1977; Natale, Gur & Gur, 1983; Reuter-Lorenz & Davidson, 1981; Reuter-Lorenz, Givis & Moscovitch, 1983; Rossi & Rosadini, 1967; Sackeim et al., 1982; Silberman & Weingartner, 1986; Terzian, 1964). Several variations on the valence hypothesis have also been offered. Some evidence suggests that while negative emotions show differential RH involvement, there may be less hemispheric asymmetry for positive emotions (e.g., Dimond, Farrington & Johnson, 1976; Ehrlichman, 1988; Sackeim & Gur, 1978, 1980); we will call this the negative-valence hypothesis. Another possibility is that differential

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hemispheric involvement in emotions may depend on the motivational qualities of approach versus avoidance, rather than valence per se (e.g., Kinsbourne, 1978). According to Davidson and colleagues, the hemispheric approach-avoidance distinction pertains only to the subject's internal feeling-state and expressions (both mediated by frontal lobes), but not to perception of emotions (parietal lobes), which show an overall RH superiority (Davidson, 1984, 1992; Davidson & Fox, 1982; Davidson, Schwartz, Sarson, Bennett, & Goleman, 1979; Fox & Davidson, 1986, 1987, 1988). We will call the latter proposal the motivational hypothesis.

This report focuses on normal adults' perceptual asymmetries for infant facial expressions. Findings on perception of adult facial expressions by neurologically-intact subjects generally favor the RH hypothesis (e.g., Brody, Goodman, Halm, Krinzman & Sebrechts, 1987; Bryden, 1982; Bryden & Ley, 1983; Campbell, 1978; Carlson & Harris, 1985; Gage & Safer, 1985; Heller & Levy, 1981; Hirschnan & Safer, 1982; Ley & Bryden, 1979, 1981; Moscovitch, 1983; Safer, 1981; Segalowitz, 1985; Strauss & Moscovitch, 1981). They have typically found a left visual field (LVF) advantage (RH superiority) for both positive and negative expressions.

A few perceptual studies have supported the other hypotheses. Favoring the valence hypothesis, adults rate tachistoscopically-presented facial expressions more negatively in the LVFRH, more positively in the right visual field (RVFRH), although the RH is better overall at differentiating emotions (Natale et al., 1983). Similarly, subjects detect which visual field contains a negative expression (vs. a contralateral neutral expression) more rapidly in the LVFRH, but detect positive expressions more rapidly in the RVFRH (Reuter-Lorenz & Davidson, 1981; Reuter-Lorenz et al., 1983). Supporting the motivational hypothesis, both adults (Davidson et al., 1979) and infants (Davidson & Fox, 1982) show greater EEG activation in frontal RH while viewing emotionally negative films, but greater LH frontal activation during positive films; parietal activation is greater in RH at both ages for both film types. Consistent with the negative-valence hypothesis, when emotionally negative films (Dimond et al., 1976) or odorants (Ehrlichman, 1988) are lateralized to a single hemisphere, subjects rate RH stimuli as more intensely negative, but fail to show asymmetries for rating positive stimuli.

Why the inconsistencies? One possibility is that studies favoring the RH hypothesis have often, though not always, assessed recognition or discrimination of facial expressions, whereas studies showing valence effects have called for judgments about stimulus emotionality. Recognition and discrimination can be carried out by so-called “cold” cognitive abilities, but emotionality judgments may encourage the viewer to tap into emotional processes. Perceptual asymmetries may be enhanced by the viewer's emotional response to the stimuli (e.g., Safer, 1981), perhaps especially to their valence properties (see Davidson, 1984; Ehrlichman, 1988). Emotional response may, in turn, be influenced by whether the expressions are spontaneous or posed. Spontaneous emotional expression is disrupted by temporal or extrapyramidal damage, posed expression by frontal or pyramidal damage (e.g., Monrad-Krohn, 1924; Remillard, Anderman, Rhi-Sauzé & Robbins, 1977; Rinn, 1984). Spontaneous vs. posed expressions likely carry information about the emitter's emotional state. Perceivers should be more likely to respond emotionally to genuine than simulated expressions. Notably, most perceptual asymmetry studies have used posed rather than spontaneous stimuli.

Therefore, we conducted a series of studies involving emotionality judgments about stimuli that are highly likely to elicit emotional responses: smiling and crying infants. Infants' expressions are more spontaneous than adults', which are influenced by social conditioning and cultural display rules (Buck, 1986; Ekman, 1972). Those factors have little or no influence on young infants, who are thought not to simulate or mask emotional expressions until the second year (e.g., Campos, Barrett, Lamb, Goldsmith & Stenberg, 1983; Oster & Ekman, 1978; Rothbart & Posner, 1985; Sroufe, 1979; but see Fox & Davidson, 1988, and our Experiment 5). Moreover, adult expressions are said to often show complex emotion mixtures, making them more difficult to “read” than infant expressions, which are thought to display simple, basic emotions (Campos et al., 1983; Izard, 1979; Izard, Huebner, Rissi, McGinnies & Dougherty, 1980; but see Oster, Hegley & Nagel, 1992). Most importantly, ethological research indicates that infant faces elicit stronger emotional responses in viewers than do those of (unknown) adults (e.g., Bowlby, 1969; Eibl-Eibesfeldt, 1975; Lorenz, 1935, 1981; Lorenz & Leyhausen, 1973). Adults' emotional responses to infant expressions are part of a mutually adapted behavior system that shapes communicative interactions, and that presumably...
evolved to promote nurturance and survival of the relatively helpless human infant. These responses are particularly strong in infants' caregivers, but are present in all humans.

But what role might perceptual asymmetries play in face-to-face interactions between adult and infant? Infant crying and smiling are of particular interest here. Both promote physical proximity between infant and caregiver, though for different reasons (e.g., Bowlby, 1969; Campos et al. 1983; Emde, Gaensbauer & Harmon, 1976). Infant smiling indicates a positive affective state and emotional approach toward the adult partner, and typically elicits corresponding positive feelings and approach from the adult. Infant crying, however, indicates negative feelings toward a noxious stimulus, and thus a withdrawal tendency. Infant crying typically evokes negative feelings of concern in adults, who usually want to approach in order to mitigate the infant's distress. This analysis leads to different predictions by the four hypotheses regarding cerebral organization for emotional processes. The RH hypothesis predicts an overall RH bias unaffected by valence. The valence hypothesis predicts a RH advantage for infant crying expressions, but a LH advantage for smiles. The negative-valence hypothesis predicts a RH advantage for cries only. The motivational hypothesis should predict a LH advantage for cries and smiles, both of which motivate approach responses in adults.

To investigate these possibilities, we tested perception of photographs of smiling and crying infants. A free-viewing procedure (Levy, Heller, Banich & Burton, 1983a) was deemed best suited to the ecological condition of interest—adults' perception of infants in natural face-to-face situations—and to future studies with infant and child viewers (see Levine & Levy, 1986). For each page of the test booklet, subjects chose which of two half-neutral/half-emotional chimeras of a given infant appeared happier (or sadder); the emotional expression was on the left in one chimera, on the right in the other, with top vs. bottom position on the page counterbalanced across items. Because binary forced-choice data avoid floor and ceiling effects, performance level corrections such as the Phi coefficient (Kuhn, 1973) or λ (Bryden & Sprott, 1981) are neither necessary nor applicable; unbiased asymmetry scores on this task are obtained via simple laterality ratios (Levine & Levy, 1986).

Visual asymmetries have often been assessed via tachistoscopic lateralization of stimulus input to a single hemisphere, under the assumption that tasks involving lateralized input provide a more precise and controlled index of hemispheric processing differences than do free-field tasks. However, theory and recent findings question this assumption. Over two decades ago, Kinsbourne (e.g., 1970, 1978) argued that task requirements and subject expectancies increase the activation of the hemisphere that the subject employs preferentially for the perceptual or cognitive functions involved. This biases attention to the spatial hemifield contralateral to the more active hemisphere, which heightens sensitivity to, and perceived intensity of, stimuli in that hemifield and results in the lateral asymmetries observed in both free-field and lateralized-input tasks. Although there were some failures to replicate certain of Kinsbourne's specific results, recent findings with brain-damaged and intact adults support the claim that activational asymmetries cause perceptual biases in tachistoscopic tasks (e.g., De Renzi, Gentillini, Faglioni & Barberi, 1989; Reuter-Lorenz, Kinsbourne & Moscovitch, 1990). In fact, tasks in which input is restricted to one hemisphere are subject to individual differences in attentional biases or hemispheric arousal asymmetries (Levy, Wagner & Luh, 1990; Mondor & Bryden, 1992). Moreover, a number of free-field tasks find the expected left spatial field (LSF) bias in tests of RH functions (e.g., Levy et al., 1983a; Luh, Rueckert & Levy, 1991) and a right spatial field (RSF) bias for LH functions (Levy & Kueck, 1986), and do so reliably (Wirsen, Klinteberg, Levander & Schalling, 1990). Indeed, subjects' free-field perceptual biases are predicted by their asymmetries on tachistoscopic tasks (Burton & Levy, 1991; Kim, Levine & Kertesz, 1990; Hellige, Bloch & Taylor, 1988; Wirsen et al., 1990). The correlation reflects individual variations in characteristic arousal differences between the hemispheres (e.g., Levy, Heller, Banich & Burton, 1983b), which are corroborated by individual differences in EEG alpha asymmetry in the parietal and temporal regions (Green, Morris, Epstein, West & Engler, 1992), which include the cortical projection area of the posterior, visuo-spatial attention system (Posner & Peterson, 1990).

On the chimeric free-field task, a LSF-RH bias for negative infant expressions would be expected according to the RH, valence, and negative-valence hypotheses; however, the motivational hypothesis predicts a RSF-LH bias. The four theoretical models differ as to whether infant smiles should yield a LSF-RH bias (RH hypothesis), a RSF-LH bias (valence and
motivational hypotheses), or no asymmetry (negative-valence hypothesis).

Moreover, the heightened perceptual sensitivity to infant expressions that is predicted by ethological theory suggests that viewers’ perceptual asymmetries should also be influenced by hemiface differences in infant emotional expressiveness. Infants, like adults, show greater emotional intensity on one hemiface, a manifestation of hemispheric differences in expression of emotions. Unlike adults, however, who show a left hemiface expressive bias, infants show a right hemiface bias (Best & Queen, 1989; Rothbart, Taylor & Tucker, 1989). Therefore, we wanted our task to detect interactions between infant hemiface biases and adult perceptual asymmetries. In their original tachistoscopic study with chimeras of smiling adults, Heller & Levy (1981) found just such an interaction between emitters’ hemiface biases and viewers’ perceptual asymmetries. However, their free-field test with the same faces (Levy et al., 1983a) failed to find a hemiface effect on perception. While the tachistoscopic measure might be more sensitive than the free-field one, differences in the construction of the chimeric choice pairs in the two studies provide another potentially important methodological factor. Each chimera in the tachistoscopic study was paired with one generated from the other halves of the same photos. The free-field task instead paired each chimera with its mirror-reversed print. Thus the pairs in the tachistoscopic task retained information about emitter hemiface asymmetries, whereas those in the free-field task did not. To determine whether the free-field task can detect emitter hemiface effects on perceptual asymmetries, we first tested two versions of the Levy et al. free-field adult face task, which differed only in how the chimeric choices were paired.

As indicated earlier, the expressive asymmetries of the smiling emitters in the Levy et al. test booklet had been previously determined tachistoscopically in Heller and Levy (1981), via viewers’ paired-comparison emotionality judgments of mixed-expression chimeras of each emitter. Because our interest was in perceived emotionality, perceptual evidence about the expressive asymmetries of the stimulus faces was deemed most appropriate for our purposes (as opposed to, e.g., taking some physical measurement of each hemiface, which may not necessarily map straightforwardly to perceived emotionality of the two hemifaces—see also footnote 1). Although not all of the emitters in the Levy et al. test booklet had shown a left hemiface bias in smiling, we used their full set of stimuli because we needed to replicate their findings for comparison against the results from free-field presentations of the pairings used in the Heller and Levy (1981) tachistoscopic study.

**EXPERIMENT 1**

**Method**

**Subjects.** The subjects were familial righthanders, who show stronger, more consistent cerebral asymmetries than non-right-handers, including emotion perception asymmetries (Chaurasia & Goswami, 1975; Heller & Levy, 1981). The handedness checklist assessed degree of hand preference on 10 unimanual activities, as well as writing hand of immediate family members. Right-handedness was defined as a “strong” to “moderate” right-hand preference for all items, with no switch during childhood, and both parents right-handed. Four subjects failed to meet these criteria. Subjects were university students with normal or corrected vision, who received $4.00 for participation. Forty-six subjects (23 male, 23 female) completed Test A (see Procedure), and 58 completed Test B (29 male, 29 female). All had participated in a related study of asymmetries in infants’ facial expressions (Best & Queen, 1989).

**Stimuli.** We used the chimeras of half-smiling, half-neutral adult faces constructed by Heller and Levy (1981) from frontal photographs of nine young men, including both right- and left-handers, whose smiles had been elicited by the photographer’s own smiling and joking. Given that the photographer was unfamiliar to the men, their smiles were most likely the socially conditioned sort rather than the truly spontaneous, genuine smiles that occur in interactions among good friends. All nine emitters displayed strong evidence of *orbicularis oculi* muscle activity, which causes cheek-raising, eye narrowing, and crinkling at the outer corners of the eyes (AU6-7 muscle involvement) and results in the appearance of “happy eyes.” AU6-7 activity has been posited to occur only with smiles that are “felt”, i.e., spontaneous and genuine expressions of heartfelt positive emotion; such “felt” smiles are claimed by some to show symmetry rather than asymmetry (Ekman & Friesen, 1982). Nevertheless, Heller and Levy (1981) found that all but one emitter had asymmetrical smiles; six were perceived to be more expressive on the left hemiface, two on the right.1 The right-handed viewers in that study...
showed a LVF (RH) perceptual bias across this set of emitters.

The two normal orientation chimeras of each emitter had been made by joining the left half of the smiling photo with the right half of the neutral photo, and conversely, the right half of the smile with the left half of the neutral. Mirror-reversed chimeras were constructed from reverse prints of the photos.

Procedure. The Test A booklets were those developed by Levy et al. (1983). Each normal orientation chimera (9 emitters × 2 chimeras) was paired with its mirror-reversed counterpart. Each pair was presented one below the other on 8-1/2 × 11" pages, and appeared twice in the randomized 36-page test booklet, once with the normal orientation chimera at the top, once at the bottom. For the 36-page Test B booklets we re-paired the chimeras as in Heller and Levy (1981), such that each normal orientation chimera was presented with its normal orientation counterpart, and each mirror-reversed chimera was likewise presented with its mirror-reversed counterpart. Thus each choice pair in Test B retained evidence of hemiface differences between each emitter's two half-smiles, but those hemiface biases were missing from each Test A pair.

Subjects were run in small groups in a quiet windowless room, with Test A and Test B conducted as separate experiments. Each subject had a separate copy of the booklet. Their task was to write on their answer sheet which of the two items appeared happier for each page of their booklet. Test completion was self-paced, but subjects were told to follow their initial reaction rather than deliberating over their choices. They were told there were no correct answers, and that they should do the pages in order without comparing or changing answers.

Results

The data were converted to laterality ratios via the formula (R-L)/(R+L), in which R = percent of choices with the emotional expression on the right side of the chimera (i.e., RSF preference), L = percent choices with it on the left (LSF preference), and R+L = 100%. The laterality ratios thus range from -1.0 (LSF bias) to +1.0 (RSF bias). The Test A data were entered into 2 × 2 analysis of variance (ANOVA) for the factors of subject sex and emitter hemiface (i.e., whether the half-smile of the mirror-imaged chimera pairs was from the right or left hemiface of the emitter). Test B data were entered into a separate 2 × 2 ANOVA, for the factors of subject sex and chimera orientation (i.e., normal or mirror-reversed pairs).

To determine whether specific laterality ratios showed significant asymmetry (i.e., deviation from 0), two-tailed t-tests were conducted, with alpha level correction for multiple t-tests set at p < .0125 for Test A and p < .007 for Test B.

In the Test A analysis, only the grand mean was significant, F(1, 44) = 15.62, p < .0003, indicating a significant LSF-bias (Mlat ratio = -.302) in perceived intensity of the chimeric half-smiles. Neither sex nor hemiface nor their interaction was significant. The LSF effect was significant both when the emitter's left hemiface provided the smile (Mlat ratio = -.294), t(45) = -3.73, p < .0005, and when the right hemiface did, (Mlat ratio = -.309), t(45) = -3.75, p < .0005, and for both male viewers(Mlat ratio = -.23), t(22) = -2.84, p < .01, and female viewers (Mlat ratio = -.374), t(22) = -4.53, p < .0005.

In the Test B analysis the grand mean effect, F(1, 56) = 19.19, p < .0001, was also LSF-biased (Mlat ratio = -.155). Note, however, that it was only half the magnitude of that for Test A. Moreover, both the orientation effect, F(1, 56) = 248.94, p < .0001, and the sex effect, F(1, 56) = 18.72, p < .0001, were significant. The orientation effect indicated that the LSF bias occurred only for the mirror-reversed chimera pairs (Mlat ratio = -.529), t(57) = 12.51, p < .0001; normal-oriented chimeras showed a significant RSF bias (Mlat ratio = +.218), t(57) = -4.25, p < .0001. Males showed an overall LSF bias (Mlat ratio = -.308), t(28) = -8.19, p < .0001, while females showed no overall asymmetry (Mlat ratio = -.002). While the sex × orientation effect was not significant, male viewers' striking LSF bias for mirror-reversed chimeras (Mlat ratio = -.651), t(28) = -19.06, p < .0001, was met by a lack of significant asymmetry for normal-oriented chimeras (Mlat ratio = +.034), but females' LSF bias for mirror-reversed chimeras (Mlat ratio = -.406), t(28) = -9.23, p < .0001 was opposed by an equally large RSF bias for normal-oriented chimeras (Mlat ratio = +.402), t(28) = 8.09, p < .0001 (see Figure 1). That is, while both sexes were sensitive to emitter expressive asymmetries, this interacted with spatial hemifield asymmetries in male viewers, but instead it overpowered hemifield asymmetries in females. Emitter asymmetries enhanced or attenuated male viewers' perceptual bias, dependent on whether the more intense half-smile appeared in the more attentionally-biased hemifield, but stimulus asymmetry was apparently the sole determinant of female performance on Test B.
DISCUSSION

The overall LSF bias found with the mirror-image pairings of Test A replicates the Levy et al. (1983) findings with the same booklet, and supports the RH hypothesis for perception of adult smiling faces. This result runs counter to the other three theoretical hypotheses, except possibly the motivational hypothesis, which assumes RH parietal involvement in simple perception of both negative and positive expressions.

However, the Test B results complicate this interpretation. When the chimera choices retain emitter hemiface differences, those expressive asymmetries significantly affect the viewers' perceptual asymmetries in this free-field task, just as in a tachistoscopic test (Heller & Levy, 1981). For normal orientation chimera pairs, the emitter's left-hemiface (LF) smile (the more expressive hemiface, on average) falls in the viewer's less sensitive RSF, but for mirror-reversed chimeras the more expressive LF smile falls in viewer's more sensitive LSF. Male viewers showed a trading relation between their basic LSF attentional asymmetry (tapped in Test A) and the emitters' LF expressive asymmetries. Cooperation between the two asymmetries in the case of mirror-reversed chimera pairs enhanced the magnitude of LSF bias in viewers' choices. But the two asymmetries were in conflict in the case of normal orientation pairs and thus cancelled each other's effects.

Female viewers, however, did not show this trading relation. Instead, their choices for normal vs. mirror-reversed chimera pairs showed equal-magnitude but directionally opposite biases, i.e., they depended exclusively on emitter expressive asymmetries. That their laterality ratios were not at the extremes of the possible range (-1.0 and +1.0) may reflect individual differences in the direction and degree of expressive asymmetry in the emitters, two of whom were reported to have RF expressive biases, another a complete lack of expressive asymmetry (Heller & Levy, 1981). The crucial point is that when expressive asymmetries were evident in the paired choices of Test B, for female viewers those expressive asymmetries apparently overpowered the effect of the basic attentional asymmetry that was evident in females on Test A. Thus, the two asymmetry factors interact in male judgments about stimulus emotionality, but stimulus asymmetry takes primacy over spatial hemifield biases in female judgments. Another possibility, though not mutually exclusive, is that the differential impact of emitter asymmetries may reflect sex differences in perceiving the smiles of young men.

In any event, the Test B approach is better suited to assessing how adult attentional asymmetries when viewing infant faces may interact with the infants' expressive asymmetries. Would infant expressions, like adults', elicit an overall LSF bias even for smiles, supporting the RH hypothesis? Or would the increased emotional response to infant faces result in a valence effect on attentional asymmetry? These questions were examined with emotional/neutral chimeras of smiling and crying infants, presented in a free-field task. To assess any interaction between infant expressive asymmetries and attentional asymmetries, we retained information about hemiface asymmetries in each chimeric choice pair as in Test B. Recall that our previous study of infant expressive asymmetries had found a right hemiface (RF) bias in infant cries and smiles (Best & Queen, 1989; also Rothbart et al., 1989), contrary to the LF bias found in adults' expressions. Thus, whereas in normal face-to-face interactions most adults' more expressive LH appears in the viewer's less sensitive RSF, most infants' more expressive RF appears in the viewer's more sensitive LSF. That is, the RH hypothesis predicts that for normal orientation chimeras the infant's expressive asymmetry and the viewer's attentional asymmetry will usually coincide, enhancing the LSF perceptual bias regardless of the emotional valence depicted. According to variants of the valence hypothesis, however, the pattern of asymmetries may differ for crying vs. smiling expressions, due to heightened emotional responses toward in-
fants. Specifically, the valence and negative-valence hypotheses predict the same LSF pattern for cries as does the RH hypothesis. For smiles, however, the valence hypothesis predicts an RSF bias that is stronger for mirror-reversed than normal orientation, while the negative-valence hypothesis predicts an orientation-dependent shift in perceptual asymmetry concordant with the spatial position of the more expressive RF. Finally, the motivational hypothesis should predict an RSF bias for both the smiles and cries of infants, stronger for mirror-reversed than normal orientation chimeras; as argued earlier, both expressions should elicit an approach tendency from the viewer.

**EXPERIMENT 2**

**Method**

*Subjects.* The 46 subjects who took Test A in Experiment 1 also participated in this study.

*Stimuli.* The stimulus materials were generated from photographs of facial expressions by 10 normal, full-term 7- to 13-month-old infants, originally taken by a portrait photographer for a series of infant attractiveness studies (Hildebrandt & Fitzgerald, 1978, 1979, 1981). The same original photographs were used in Best and Queen (1989). In that study, viewers made paired-comparison judgments of mirror-image composites of each infant's left versus right hemiface. Their data indicated that the infants' showed more intense emotional expressions on the right hemiface than on the left; this was true for both smiling and crying expressions.

For the present study, each of those infants provided a neutral expression and either a clear-cut negative (crying) or a clear-cut positive (smiling) expression, according to ratings obtained in an independent study (Hildebrandt, 1983). Four infants had crying expressions; six had smiling expressions. Only two of the smiling infants displayed AU6-7 eye "crinkling" activity; these were the two youngest infants photographed. All photographs were full-frontal facial views.

Chimeras were constructed as in Experiment 1 (see Heller & Levy, 1981). Each print was cut exactly down facial midline, defined by a line extending through the point midway between the internal canthi of the eyes and the point in the center of the philtrum just above the upper lip. For each chimera, the hemifaces were aligned at the eyes and nose (mouths often could not be exactly aligned because of differing degrees of opening; see also Heller & Levy, 1981).

Each chimera was then centered behind an oval-shaped mattboard opening the size of the average photographed face, to screen out variations among infants in hair and facial outline. Copies were made with a high-quality Kodak photocopier, using a gray-scale photo correction template. Each infant was represented on four pages, as in Test B of Experiment 1. Thus, there were 40 pages of paired chimeras. The pages were ordered pseudo-randomly, with no more than three consecutive smiling or crying infants, and no consecutive presentations of the same emitter. The question "Which infant looks happier?" (for smiling chimeras) or "Which infant looks sadder?" (for crying chimeras) was printed at top of each page.

*Procedure.* Testing was as in Experiment 1, except for the question valence difference.

**Results**

Laterality ratios were entered into a $2 \times 2 \times 2$ analysis of variance (ANOVA) for the factors of emotion (cry, smile), orientation (normal, mirror-reversed), and sex. As before, $t$-tests were used to test significance of laterality ratios; the alpha adjustment was set to $p < .0065$.

There was a significant though modest LSF bias overall ($M_{\text{lat ratio}} = -.13, t(45) = -4.78, p < .0001$). However, a significant emotion effect, $F(1,45) = 10.09, p < .003$, indicated that valence influenced the asymmetry of the adults' judgments about the intensity of infant expressions. Specifically, the LSF bias was significant for crying infants ($M_{\text{lat ratio}} = -.19, t(45) = -4.84, p < .0001$, but not for smiling infants ($M_{\text{lat ratio}} = -.07$). In addition, the orientation effect, $F(1,45) = 366.68, p < .0001$, revealed that adult viewers' perceptual biases were sensitive to asymmetries in the infants' expressions themselves. Normal orientation chimeras, in which the infants' more expressive RH (Best & Queen, 1989) appeared in the LSF, yielded a significant LSF bias ($M_{\text{lat ratio}} = -.57, t(45) = -17.84, p < .0001$), whereas mirror-reversed chimeras, in which the infant RH appeared in the RSF, yielded a smaller but significant RSF bias ($M_{\text{lat ratio}} = -.31, t(45) = 8.02, p < .0001$). Finally, the significant emotion $\times$ orientation interaction, $F(1,45) = 66.80, p < .0001$, found that laterality ratios for smiles reversed from a strong LSF bias for normal orientation chimeras ($M_{\text{lat ratio}} = -.72, t(45) = -22.07, p < .0001$, to a strong RSF bias for mirror-reversed chimeras ($M_{\text{lat ratio}} = -.59, t(45) = 15.22, p < .0001$ (see Figure 2). Perceptual asymmetries were less strongly influenced by orientation of the crying chimeras, with a moderate LSF bias for normal orientation.
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Infant Emotion

Discussion

The main effect of emotion is consistent with our suggestion that valence effects may be optimized in perception of infant faces, perhaps due to increased emotional responsiveness to infants of the sort posited by ethological theory. Indeed, many subjects smiled or showed other positive emotional responses to the smiling infant faces, but none had done so while judging adult smiles in Experiment 1; conversely, crying infant faces often evoked sympathetic frowns or other emotional responses. Viewers showed a significant LSF bias in perception of negative infant expressions but no asymmetry for positive expressions. This pattern is most compatible with the negative-valence hypothesis of cerebral organization for emotional processes (e.g., Ehrlichman, 1988). The valence hypothesis (e.g., Silberman & Weingartner, 1986; Tucker, 1981) failed to find support for its prediction of a RSF-LH bias for positive expressions. Nor did the motivational hypothesis (e.g., Davidson, 1984) find support for the prediction that infant cries and smiles should yield a RSF-LH advantage because both infant expressions should elicit approach responses from adult viewers. The results also stand in contrast to the RH hypothesis’ prediction that smiles should show the same overall LSF bias as cries.

In addition, the orientation effect shows a significant influence of infants’ expressive asymmetries on adult perceptual field biases. Viewers showed a strong LSF bias for normal orientation chimeras, when infants’ more expressive RF appeared on the left. But this shifted to a smaller yet significant RSF bias for mirror-reversed pairs, when infants’ RF fell on the right.

Importantly, however, the significant interaction between emotion and orientation reveals that the relation between viewers’ attentional biases and infant expressive asymmetries differed between judgments of negative and positive expressions. Although orientation (right/left position of infants’ more expressive RF) influenced perception of both expressions, it did so differently for smiles and cries. The interaction pattern is reminiscent of the sex differences found for Test B in Experiment 1, and meets the negative-valence hypothesis’ predictions of strong LSF bias for normal orientation cries, little or no bias for mirror-reversed cries, and an orientation-dependent shift in perceptual asymmetry concordant with the spatial hemifield containing the infants’ more expressive RF. The obtained pattern was inconsistent with the predictions of each of the other three hypotheses.

Specifically, there was a trading relation between viewer attentional asymmetries and emitter expressive asymmetries in judgments of infant crying expressions, analogous to that for males’ responses to smiling young men in Test B. Because the adult emitters’ mean hemiface asymmetry was LF-biased while the infants’ was RF-biased, however, viewer left hemifield attentional bias and emitter hemiface bias were concordant for normal orientation infant chimeras (as in face-to-face interactions) but discordant for mirror-reversed adult chimeras. Thus, the LSF bias was significant for normal-oriented infant cries, where attentional asymmetry and emitter asymmetry cooperate, but the two biases conflicted for mirror-reversed chimeras, resulting in a lack of perceptual asymmetry. In contrast, infant emitter asymmetries essentially overshadowed the impact of viewer attentional biases, analogous to the findings for females viewing smiling men in Test B. That is, judgments about intensity of infant smiles depended on which spatial hemifield
contained the more expressive infant RH; they were influenced very little by viewers' attentional asymmetry. A strong LSF bias was found for normal-oriented infant smiles, but a strong RSF bias for mirror-reversed smiles. Recall that there were no sex effects in Experiment 2. Both male and female viewers showed this orientation by emotion interaction with infant faces, unlike the sex effect for adult faces in Test B.

Thus, Experiment 2 indicated a negative-valence effect on adult perceptual asymmetries for infant emotional expressions. However, it did not elucidate the perceptual processes underlying the phenomenon. One possibility is that negative expressions may be perceived as a configuration of the whole face (i.e., a gestalt of the combined features within the "frame" of face outline and hair), whereas perception of positive expressions may instead focus on the mouth as a singular distinguishing feature (Moscovitch, 1983). The holistic approach should call more heavily upon RH skills, while the feature-oriented approach should be better suited to LH analytic abilities (e.g., Levy, 1974; Bradshaw & Nettleton, 1981; Bryden, 1982; but see Trope, Rozin, Kemler Nelson & Gur, 1992). If the valence effect is attributable to such differences in perceptual approach to crying and smiling expressions, then the negative-valence effect—indeed the overall LSF bias—should become attenuated as the viewers' attention is focused on facial subcomponents or specific features within the "frame." This manipulation may lead subjects to use a more feature-oriented, analytic approach, and thus to rely more heavily on LH information processing strategies. Alternatively, the viewers' actual emotional responses to crying and smiling infants, rather than the information processing strategy, may be responsible for the valence effect. If so, the negative-valence effect should appear even when the viewer's attention is focused on facial-expression subcomponents or specific features within the remaining central facial features. To restrict the viewers' attention to the details of the central features of eyes/brows, mouth and nose, we deleted the unwanted peripheral "frame" information (i.e., face outline, ears, chin, cheeks, hair) by image-editing of optically-digitized versions of the original photographs, leaving only the facial features against a uniform white background. A new group of subjects made choices between pairs of the mixed-expression chimeras generated from these computer-edited expressions.

**Method**

**Subjects.** Ninety-six right-handed university and high school students (51 female, 45 male) participated.

**Stimuli.** High-quality photocopies of the original photographs from Experiment 2 were computer-digitized and edited, using an Apple Macintosh computer (see Best & Queen, 1989, for details). The cheeks, ears, chin, hair, and face outline were digitally erased from the digitized pictures, and the resulting images of the de-contextualized facial features were printed in normal and mirror-reversed orientation on white paper. Again obtaining judgments of mirror-image composites of each emitter's hemifaces, Best and Queen (1989) had found that these digitally-edited faces showed a strong right hemiface bias in expressiveness. These digitally-edited faces were used to generate mixed-expression chimeras (Figure 3), which were assembled into a 40-page test booklet as before.

**Procedure.** Subjects completed the test booklet as in Experiment 2.

**Results**

Laterality ratios were analyzed as before. Significance for t-tests was again set at $p < .007$. There was a significant overall LSF bias ($M_{\text{lat ratio}} = -.11$), $t(95) = -5.33 < 0.001$, the magnitude of which did not differ significantly from that in Experiment 2 according to t-test. The emotion effect was significant, $F(1,95) = 7.76, p < .007$, again indicating a stronger LSF bias for crying ($M_{\text{lat ratio}} = -.15$), $t(95) = -5.62, p < .0001$, than smiling expressions ($M_{\text{lat ratio}} = -.07$), $t(95) = -3.10, p < .003$. The magnitude of the emotion difference in hemifield biases did not differ significantly from those in Experiment 2.

The orientation effect was significant, $F(1,95) = 432.01, p < .0001$, indicating that infant expressive asymmetries affected viewers' judgments.
There was a significant LSF bias when the infants' more expressive RF was on the left in the normal orientation chimeras ($M_{lat}$ ratio = -.49), $t(95) = -19.13$, $p < .0001$, but a RSF bias when it was on the right in mirror-reversed chimeras ($M_{lat}$ ratio = +.26), $t(95) = 8.83$, $p < .0001$. The emotion × orientation interaction was also significant, $F(1,95) < 63.64$, $p < .0001$, repeating the pattern found in Experiment 2 (see Figure 4a). For smiling infants, normal orientation chimeras showed a strong LSF bias ($M_{lat}$ ratio = -.56), $t(95) = -19.66$, $p < .0001$, and mirror-reversed chimeras showed an equivalent, strong RSF bias ($M_{lat}$ ratio = +.42), $t(95) = 12.34$, $p < .0001$. The crying infants yielded a strong LSF bias for normal orientation chimeras ($M_{lat}$ ratio = -.41), $t(95) = -11.08$, $p < .0001$, but a smaller RSF bias for mirror-reversed chimeras ($M_{lat}$ ratio = +.11), $t(95) = 2.94$, $p < .005$. 

Figure 3. Examples of digitized mixed-expression chimeras of a smiling and a crying infant, with the emotional expressions on the left versus right side of the chimera, Experiment 3.
Simple effect tests found the orientation effect to be significant for both crying, $F(1,95) = 13.23, p < .0005$, and smiling, $F(1,95) = 65.76, p < .0001$, and the emotion effect to be significant for both normal, $F(1,95) = 559.26, p < .0001$, and mirror-reversed chimeras, $F(1,95) = 104.62, p < .0001$.

**EXPERIMENT 4**

Restricting the view of infant faces to the mouth or eye/brow region alone should bias viewers' perceptual approach toward the analytic, feature-oriented abilities ascribed to the LH. If information processing differences between smiles and cries were responsible for the negative-valence effect as reasoned in Experiment 3, then this manipulation should either eliminate the valence effect or shift it to a strong RSF bias for smiles but a weak or nonexistent LSF bias for cries. However, if the negative-valence effect arises from emotional rather than cognitive factors, it should be impervious to this manipulation.

We focused on the expressive patterning of the mouth versus the eyes because our previous report (Best & Queen, 1989) had found that the infants' RF expressive bias was specific to the mouth, and was not present in the eye region; this eye/mouth asymmetry held for both smiles and cries. Viewers nonetheless were able to reliably judge relative happiness/sadness for either facial region. Each of these regions carries distinctive information in smiles and cries due to differential actions of the zygomaticus, mentalis, levator palpebralis, orbicularis oculi, and other facial muscles (Ekman, 1979; Oster & Ekman, 1978). Given that cortical input to the mouth region is contralateral, whereas input to the eye region is bilateral, our earlier results had suggested that lateralized cortical specializations rather than more peripheral factors are responsible for the RF bias in infant expressions. Thus, a second purpose of the present experiment was to test whether adults' perceptual asymmetries are influenced by the difference in asymmetrical patterning between the eye and the mouth regions of the infants' expressions. For Experiment 4, a new group of judges was perceived of the full-face chimeric photographs in the previous study had focused on the central facial features rather than their holistic relation to the contextual “frame” of facial outline, etc. It also suggests that the negative-valence effect may be due to some factor other than differential involvement of RH holistic and LH feature-analytic approaches to negative vs. positive expressions, respectively.

Perhaps, however, the stimulus manipulations of Experiment 3 failed to disrupt the facial gestalt sufficiently to interfere with a holistic RH response to crying expressions. The next experiment investigated this possibility by narrowing viewers' focus to specific facial features.

**DISCUSSION**

The results of this experiment replicated those of Experiment 2, even though the gestalt of the whole faces had been modified by removing the facial outline and other peripheral details, leaving only the central facial features. In fact, the magnitude of the effects failed to differ significantly from Experiment 2, suggesting that viewers' perception of the full-face chimeric photographs in

![Figure 4](image_url) Interaction of infant emotion × chimera orientation in (a) Experiment 3 and (b) Experiment 4.
presented with an “upper face” test and a “lower face” test employing further modifications of the digitized, edited infant expressions.

Method

Subjects. Participants were 54 right-handed university students (27 female, 27 male).

Stimuli. The digitized, edited faces from Experiment 3 were revised to produce an “upper face” test, for which all facial features other than the eyes, brows and bridge of the nose were removed, and a “lower face” test, for which all features other than the mouth and the tip of the nose were eliminated. Mixed-expression chimeras were generated separately for the eyes/brows and for the mouth (see examples in Figure 5, which uses the same infant emitters as in Figure 3). The eye and mouth regions were not separated from one another until after the midline had been traced as in Experiment 2. Two 40-page booklets were constructed as before, one for the “lower face” test and one the “upper face” test.

Figures 5. Examples of digitized mixed-expression chimeras of the eye and mouth regions of a smiling and crying infant, with the emotional expressions on the left versus the right side of the chimera, Experiment 4.
Procedure. The subjects were tested as before. Each completed the “lower face” test first and the “upper face” test second. Pilot testing had suggested that judgments about the eyes/brows might be more difficult than judgments about the mouth; this test order thus allowed more practice before the more difficult test.

Results

The data were handled as before, except that the ANOVA included a fourth factor: face part (mouth vs. eyes). Significance for multiple t-tests was set at \( p < .002 \).

Once again, there was an overall LSF bias (\( M_{lat} \) ratio = -.08), \( t(53) = 4.44, p < .0001 \), which did not differ significantly from the two preceding experiments. The emotion effect was again significant, \( F(1,53) = 13.96, p < .0005 \). The overall regions from cries elicited a significant LSF bias (\( M_{lat} \) ratio = -.14, \( t(53) = 5.14, p < .0001 \), but those from smiles yielded no significant bias (\( M_{lat} \) ratio = -.02). The magnitude of this valence effect again failed to differ significantly from the earlier experiments. As before, there was also a significant orientation effect, \( F(1,53) = 39.70, p < .0001 \). The LSF bias held only for normal orientation, when the infants' RF was on the left side of the chimeras (\( M_{lat} \) ratio = -.19), \( t(53) = 8.47, p < .0001 \). The mirror-reversed chimeras elicited no significant bias (\( M_{lat} \) ratio = +.03). The emotion \( \times \) orientation interaction was significant as well, \( F(1,53) = 8.97, p < .004 \) (see Figure 4b). As before, orientation had a smaller effect on perception of crying than smiling expressions. There was a LSF bias for normal orientation cries (\( M_{lat} \) ratio = -.20, \( t(53) = 5.62, p < .0001 \), but not for mirror-reversed cries (\( M_{lat} \) ratio = -.08). In contrast, normal orientation smiles evoked a LSF bias (\( M_{lat} \) ratio = -.17), \( t(53) = 6.99, p < .0001 \), but mirror-reversed smiles produced a significant RSF bias (\( M_{lat} \) ratio = +.14), \( t(53) = 4.79 p < .0001 \). Simple effects tests found the orientation effect to be significant for both crying, \( F(1,53) = 5.13, p = .02 \), and smiling, \( F(1,53) = 76.97, p < .0001 \). However, the emotion difference was significant only for mirror-reversed chimeras, \( F(1,53) = 21.28, p < .0000 \).

The face part factor also entered into two significant interactions. The face part \( \times \) orientation interaction, \( F(1,53) = 101.86, p < .0001 \), showed that infant expressive asymmetries had a greater influence on perception of the mouth than the eyes. Normal orientation mouth chimeras yielded a LSF perceptual bias (\( M_{lat} \) ratio = -.35), \( t(53) = 10.31, p < .0001 \), while mirror-reversed mouths yielded a RSF bias (\( M_{lat} \) ratio = +.20), \( t(53) = 4.93, p < .0001 \). In contrast, the eyes produced a smaller but significant LSF bias in mirror-reversed orientation (\( M_{lat} \) ratio = -.14), \( t(53) = 3.98, p < .0002 \), which became nonsignificant for normal orientation (\( M_{lat} \) ratio = -.03). Simple effects tests found that the face part difference was significant for both normal orientation, \( F(1,53) = 62.39, p < .0001 \), and mirror-reversed items, \( F(1,53) = 44.88, p < .0001 \). Moreover, the orientation effect was significant both for the mouth, \( F(1,53) = 119.58, p < .0001 \), and for the eyes, \( F(1,53) = 6.68, p < .01 \).

The face part \( \times \) orientation \( \times \) emotion interaction was also significant, \( F(1,53) = 165.97, p < .0001 \). As with the full-face studies, smiling mouths produced a large LSF bias for normal orientation (\( M_{lat} \) ratio = -.57), \( t(53) = 17.31, p < .0001 \), and a large RSF bias for mirror-reversed items (\( M_{lat} \) ratio = +.52), \( t(53) = 11.92, p < .0001 \). Crying mouths showed nonsignificant LSF biases for normal orientation (\( M_{lat} \) ratio = -.13), and mirror-reversed chimeras (\( M_{lat} \) ratio = -.11). Crying eyes yielded a significant LSF bias for normal orientation chimeras (\( M_{lat} \) ratio = -.28, \( t(53) = 6.23, p < .0001 \), but no bias for mirror-reversed ones (\( M_{lat} \) ratio = -.05), consistent with previous full-face results. Smiling eyes, however, elicited a modest RSF bias for normal orientation (\( M_{lat} \) ratio = +.23), \( t(53) = 5.67 p < .0001 \), and an equal LSF bias for mirror-reversed chimeras (\( M_{lat} \) ratio = -.24), \( t(53) = 4.95, p < .0001 \). The direction of this orientation effect for smiling eyes was opposite that of the emotion \( \times \) orientation interactions found in Experiments 2 and 3, where the normal orientation was associated with LSF bias and the mirror-reversed with RSF bias.

Overall, then, orientation again had a greater effect on perceptual responses toward the smiling expressions than toward the crying expressions. According to simple effects tests, the orientation effect was significant for crying eyes, \( F(1,53) = 53.48, p < .0006 \), for smiling mouths, \( F(1,53) = 457.26, p < .0001 \), and for smiling eyes, \( F(1,53) = 11.06, p < .002 \), but not for crying mouths. The emotion effect was significant for eyes in both normal, \( F(1,53) = 56.96, p < .0001 \), and mirror-reversed orientation, \( F(1,53) = 9.72, p < .003 \), as well as for mouths in both normal, \( F(1,53) = 58.74, p < .0001 \), and mirror-reversed orientation, \( F(1,53) = 90.83, p < .0001 \).

DISCUSSION

The emotion main effect was not diminished relative to the two other infant face tests, in spite
of restricting the viewers' attention to isolated facial features. This finding suggests that the negative-valence effect on perceptual asymmetries for infant emotional expressions derives from emotional processes rather than information processing factors. The emotion \times orientation interaction again indicated that, overall, there was a weaker hemiface effect, or greater effect of attentional asymmetry, on perception of crying than smiling expressions. Moreover, differences in perception of the eye and mouth regions suggest that the viewers were sensitive to differences in the expressive asymmetries displayed by those facial regions. Consistent with the Best & Queen (1989) finding of a significant overall RF bias only for the mouth region, the viewers in the present study were more affected overall by orientation of the mouth than of the eyes. We should note, however, that this face part interaction differed for smiles versus cries. For smiles, both face regions showed dominance of the orientation factor, as before, but the direction of this influence was reversed for the eyes relative to the mouth and to the previous studies. That is, viewers apparently detected greater intensity of expression on the left hemiface for smiling eyes, but on the right for the mouth. For crying expressions, there was a greater perceptual effect of orientation on eyes than mouth. The pattern of higher-order face part effects are curious, given the Best and Queen finding (1989) that only mouths showed significant RF expressive asymmetry. Although a complete explanation cannot be offered at this time, this interaction nonetheless indicates that adults are quite sensitive to emotional information in the eye region of infant expressions.

To summarize, the perceptual findings with infant smiles and cries in Experiments 2-4 provided fairly strong support for the negative-valence hypothesis over the other three hypotheses. However, those results were based on the same set of six smiling and four crying infants. Therefore, it was important to extend our investigation to a new set of infant photographs.

EXPERIMENT 5

In the three preceding studies the smiling and crying expressions had come from different infants. Although the mean rated intensities (Hildebrandt, 1983) of the two types of expression were roughly equivalent, they were not absolutely matched. These factors left open the (unlikely, we thought) possibility that individual differences in infant expressiveness and/or differences in the mean intensity of the two expression types might account for the main effects of emotion found in Experiments 2 and 3, or for the pattern of the emotion by orientation interactions.

We wished to insure that the infants' expressions of happiness and distress were spontaneous and genuine. Although the laboratory photographs of infants from Hildebrandt and Fitzgerald (1978, 1979, 1981) seemed appropriate for our purposes, based on reports that infants do not mask or simulate emotions until their second year (Campos et al., 1983; Oster & Ekman, 1978; Rothbart & Posner, 1985; Sroufe, 1979), a recent study suggests that infants do produce smiles like those of adults simulating happiness they don't feel or covering up negative emotions. Ekman & Friesen (1982) termed such adult expressions "unfelt smiles," as described earlier. Those authors claim that whereas felt smiles are virtually symmetrical, unfelt smiles tend to show asymmetries favoring the LF (recall, however, the difficulties presented to this position by the asymmetrical adult smiles in the Levy et al. stimuli used in Experiment 1). Fox and Davidson (1988) videotaped infants responding to mother versus a stranger in an unfamiliar laboratory setting, and found evidence of unfelt smiles, i.e., lacking \textit{orbicularis oculi} activity, toward strangers but not toward mother. Moreover, EEG asymmetry patterns over the infants' frontal lobes differed between felt (LH activation) and unfelt smiles (RH activation). The facial expressions we used in Experiments 2-4 had been obtained by a portrait photographer (i.e., a stranger) in a university laboratory (i.e., unfamiliar setting). Both factors raise the likelihood of unfelt smiles, and the possibility that the RF bias we had found in those smiles might not occur in genuine, felt smiles. Indeed, as mentioned earlier, only two of those six smiling expressions showed evidence of \textit{orbicularis oculi} activity.

For these reasons, one of us (JSW) photographed infants enrolled in high-quality daycare, a familiar and comfortable setting to the infants. During a two-month period JSW visited the daycare centers 2-3 days per week to interact with the infants. Before she began to photograph the infants at a given center, she spent at least three weeks there, playing with the infants, interacting with their caregivers, and participating in daily caregiving (e.g., feeding, diaper-changing). Thus, she was not a stranger but had become a familiar caregiver. After she had become familiar to the infants, she took multiple...
photographs of each infants’ expressions, taking care to “catch them in the act” of spontaneous social smiles and distress cries, as well as of neutral expressions. We selected for this study only those emitters for whom a smile and a cry photo were matched in emotional intensity, according to a preliminary rating study. These photographs were then used to assess infants’ expressive asymmetries for spontaneous smiles and cries, as well as to extend the investigation of perceptual asymmetry. This study was modeled after Experiment 2, using photographs rather than digitally-edited images. There had been remarkable consistency in the major findings of the preceding studies, indicating that the primary effects had not been influenced substantially by the progressive restriction of facial features available for judgments. Therefore, we used the full facial configurations of the actual photographs in the present study.

Method

Subjects. Forty-four right-handed university students (22 male, 22 female) participated. Five more failed the handedness criteria (n=3) or filled out their answer sheets incorrectly (n=2).

Stimuli. The spontaneous neutral, crying, and smiling expressions of 17 infants (range = 5-14 mo.) were photographed at their daycare, using black and white print film in a Minolta XG-1 camera fitted with a zoom lens. All were printed, placed behind an oval template as in Experiment 2 to screen out peripheral and background details, and photocopied via a Xerox 1012 machine with a grayscale setting. The first 12 infants provided 68 photos, which were compiled randomly into a pre-test intensity rating booklet. Twelve university students rated each expression between -3 (very sad) to +3 (very happy), with 0 as neutral. Nine infants had at least one smile and one cry that were rated equally intense (e.g., +2 and -2, respectively), along with one clearly neutral expression (rated 0). Therefore, five additional infants were photographed and their expressions submitted to 12 new raters; the latter infants all met the equal-intensity criterion. Of the final 14 infants, 12 showed clear orbicularis occuli activity (AU6-7), suggesting “felt” smiles.

Mixed-expression chimeras were constructed for the 14 infants with matched intensity and paired as before, for the first 56 pages of a new test booklet. Mirror-image composites of each hemiface for each infant’s smile and cry were also constructed, as in Best and Queen (1989), to test for expressive asymmetries in the booklet’s last 28 pages. Top-bottom position of right vs. left composites was counterbalanced over infants and expressions.

Procedure. For the first part of the test, subjects judged mixed-expression chimeras. For the second part, they judged left vs. right mirror-composites of each expression for each infant.

Results

Mirror-image composites. Because the interpretation of orientation effects on judgments of mixed-expression chimeras depends on the expressive asymmetries observed in the emitters, we begin by reporting on the test for hemiface biases in infant smiles and cries. Laterality ratios were computed on choices of the left vs. right hemiface mirror-composites and analyzed in a 2 x 2 ANOVA (sex of viewers x infant emotion). Alpha level for t-tests was set at p < .025.

Only the main effect of emotion was significant, F(1,42) = 34.931, p < .0001, reflecting a right hemiface bias in intensity of crying expressions (Mlat rat = .263), t(43) = 8.736, p < .0001, but a nonsignificant left-side bias in smiles (Mlat rat = -.013). That is, these spontaneous smiles failed to show the rightward bias found in previous reports (Best & Queen, 1989; Rothbart et al., 1989) and in the smiling expressions used in Experiments 2-4, although crying expressions replicated the earlier-found right hemiface bias. Thus, the new set of mixed-expression chimeras were expected to yield the same orientation effect for crying chimeras as found before, but there should be no orientation difference for smiling chimeras, unlike Experiments 2-4.

Mixed-expression chimeras. Laterality ratios were entered into a 2 x 2 x 2 ANOVA (sex x emotion x orientation). The alpha criterion for multiple t-tests was set at p < .00625.

There was a significant LSF bias overall (Mlat rat = -.312), t(43) = 6.92, p < .0001. However, the significant effect of emotion, F(1,42) = 32.16, p < .0009, indicates that the LSF bias for smiles (Mlat rat = -.44), t(43) = -7.78, p < .0001, was larger than that for cries (Mlat rat = -.18), although cries were significantly LSF-biased, t(43) = -3.84, p < .0004. The emotion x orientation interaction was also significant, F(1,42) = 6.754, p < .0129 (see Figure 6). Simple effect tests found significant orientation effects for both cries, F(1,42) = 17.188, p < .001, and smiles, F(1,42) = 23.347, p < .001. The difference between expressions was significant for normal, F(1,42) = 80.152, p < .0001, but not mirror-reversed orientation. An LSF bias appeared for smiles in normal (Mlat rat = -.31), t(43) = -4.69, p < .0001, and mirror-reversed orientation (Mlat rat = -.57), t(43) = -9.61, p <
.0001, and for cries in normal orientation \(M_{\text{lat rat}} = -.28\), \(t(43) = -7.78, p < .0001\). As in Experiments 2-4, perceptual asymmetry was lacking for mirror-reversed cries \(M_{\text{lat rat}} = -.08\).

As in Experiments 2-4, perceptual asymmetry was lacking for mirror-reversed cries \(M_{\text{lat rat}} = -.08\). Figure 6. Interaction of infant emotion \(\times\) chimera orientation on the mixed-expression chimera trials in Experiment 5.

**DISCUSSION**

The mirror-image composites revealed a significant RF expressive bias for infant crying, consistent with previous reports (Best & Queen, 1989; Rothbart et al., 1989). However, these spontaneous smiles showed no asymmetry. Thus, spontaneous infant smiles and cries show expressive asymmetries that, like the perceptual results of Experiments 2-4, support the negative-valence hypothesis. That these smiles were symmetrical, while RF bias is reported for smiles obtained under conditions that may foster "unfelt" or socially conditioned expressions (see Fox & Davidson, 1988), is also compatible with claims (Ekman & Friesen, 1979) that truly spontaneous, genuine smiles fail to show significant asymmetry.

Given the replicated RF bias for cries, the same interaction of emitter hemiface bias and viewer attentional bias on perception of mixed-expression crying chimeras should occur as in Experiments 2-4. This was exactly the result obtained. As before, an LSF bias in perception occurred for normal-orientation cries, where the more expressive infant RF fell in the viewer's left spatial hemifield, but disappeared for mirror-reversed cries, where the RF fell in the less sensitive hemifield. However, the near-symmetry of spontaneous smiles in this experiment substantially changed the perceptual pattern found for smiles in Experiments 2-4, which was essentially determined by which hemifield contained the infants' more expressive RF. Specifically, this time both chimera orientations yielded an LSF bias for infant smiles. That is, when the hemiface bias of the smiles is extremely weak, it no longer dominates the viewer's perceptual asymmetry. Instead, an underlying leftward attentional bias appears, as was found for adult smiles in Test A of Experiment 1, where hemiface biases were eliminated by the pairing of chimeras. Nonetheless, the present finding for spontaneous infant smiles still differed in an important way from the Test A pattern. Remarkably, these very weakly asymmetrical infant smiles still produced a significant orientation effect on degree of LSF bias. The tiny, nonsignificant LF bias in spontaneous infant smiles produced a significantly larger viewer LSF bias when the infant LF appeared in the more sensitive left hemifield for mirror-reversed pairs than when it appeared in the less sensitive right hemifield for normal orientation pairs.

**GENERAL DISCUSSION**

Taken together, the results indicate that the relative contributions of viewer attentional bias and emitter expressive bias on adult judgments of infant emotional expressions differ for crying and smiling. The perceptual asymmetries as well as hemiface biases in infants' spontaneous expressions (Experiment 5) both support the negative-valence model of emotional asymmetries (e.g., Dimond, et al., 1976; Ehrlichman, 1988; Sackeim & Gur, 1978, 1980). At least when viewing static infant faces, adults show a RH bias for negative emotion, which interacts with asymmetries in the infants' faces. But adults' perception of positive emotion in infants is dominated by asymmetry in the expressions, which overpowers adults' attentional bias toward the LSF unless the expressive asymmetry is very weak, as in spontaneous smiles.

The other three models of emotional asymmetry did not fare as well. The RH model predicts the same perceptual pattern for negative and positive emotions, yet there were significant differences. The valence hypothesis posits RH specialization for negative emotion and LH specialization for positive emotion; however, perception of infant smiles failed to show an overall RSF-LH bias, and their spontaneous smiles showed no expressive asymmetry. As for the motivational hypothesis, an RSF/LH bias should result from approach responses to infant smiles, as we argued for cries also, yet neither showed that perceptual bias.
should be noted, however, that a more stringent test of the motivational hypothesis would require direct assessment of viewers’ motivational tendencies toward the infant emitters.

Given that the majority of findings on perceptual asymmetries for adult facial expressions have supported the RH hypothesis, the present infant face findings suggest that valence effects on perceptual asymmetries may depend on viewers’ emotional responses. Although this and other tasks supporting valence effects have called for emotionality judgments, that alone may not suffice to produce a negative-valence effect on perception. Levy et al. (1983) and Experiment 1 required emotionality judgments about adult chimeras, yet those studies found a significant LSF-RH bias for smiles. Infant smiles, which should increase viewers’ emotional responses, instead yielded no overall perceptual asymmetry (Experiments 2, 4, 5) or at best a small LSF bias (Experiment 3). A separate study from our lab provided additional corroboration of perceptual differences for infant versus adult expressions. Chaiken (1988) employed two chimeric choice tasks with 7-15 year old children and adults, using both adult and infant expressions, and found a valence effect only for infant expressions. However, viewer emotional responses will need to be assessed directly in future studies to test whether this factor is indeed crucial to a valence effect on perception. Such information may be especially critical for more comprehensive test of the motivational model than provided in the studies reported here.

Experiments 3 and 4 suggest that the negative-valence effect on perception was not due to basic information processing differences between the hemispheres for negative versus positive expressions. Manipulations designed to restrict viewers’ attention to progressively narrower features of the infant expressions should have shifted perception toward the analytical, feature-oriented approach of the LH, yet did not influence overall perceptual asymmetry. Nor, more importantly, did they change the valence effect. Thus, the negative-valence effect for infant expressions seems to reflect an aspect of hemispheric specialization that is largely independent of information processing asymmetries.

As noted earlier, adult’s LSF-RH bias in perception of infants’ crying expressions is compatible with the greater intensity of expressions on the infant’s RF (Best & Queen, 1989; Rothbart, Taylor & Tucker, 1989). In face-to-face interactions, the infant’s more expressive hemiface appears in the adult’s more sensitive LSF, presumably enhancing the adult’s emotional response. This compatibility does not hold in the case of adult face-to-face interactions, given that adults show a LF expressive bias, which falls in the viewer’s less sensitive RSF. Generally enhanced sensitivity and responsiveness to infant expressions is consistent with ethological theory. But why should the interaction between infant expressive asymmetry and adult attentional bias differ between crying and smiling expressions? Perhaps it can be related to differences in the imperativeness of adult responses to infant distress and pleasure states. Presumably, infant distress indicates a possible danger to the infant, or some health or survival need, which would impel caregivers or other adults to take action on the infant’s behalf. In contrast, an infant’s smile does not signal this sort of urgency. Therefore, the evolutionary pressure for specialized responsiveness toward infant crying expressions may have been greater than, or at least qualitatively different from, that toward infant smiles. Specialized responsiveness to infant cries may be optimized by the interaction between infant expressive asymmetries and the viewer’s LSF attentional bias, which may provide for the most direct, immediate activation of the RH motivational and/or action systems that are specialized for rapid responses to potentially threatening situations. The notion that the right hemisphere is specialized for response to affectively negative situations that mobilize fleeing behavior (rapid withdrawal) was proposed by Kinsbourne (1978) and further developed by Davidson (1984). Supportive evidence has been found in infants’ EEG asymmetries during facial expressions of distress in response to stranger approach and maternal separation, as well as during newborns’ facial disgust responses to noxious gustatory stimuli (Fox & Davidson, 1986, 1987, 1989). Moreover, an evolutionary foundation for this bias is suggested by two recent studies of monkeys. In one, rhesus monkeys displayed earlier-appearing and more intense negative emotional expressions on the left (RH) than the right hemiface (Hauser, 1993). In the other report, which is particularly germane to the present argument, rhesus mothers consistently picked up their infants with the left hand when frightened by the approach of a human (Haida & Koichi, 1991), but used either hand in neutral situations.
REFERENCES


Perceptual Asymmetries for Infant Facial Expressions


**FOOTNOTES**

1. Also Wesleyan University.
2. Wesleyan University.
3. Thus, these observations call into question the assumptions that AU6-7 activity is an unequivocal marker of spontaneous or genuine smiles, and/or that felt smiles are symmetrical in expressiveness. Eye crinkling apparently can also occur with socially-conditioned, elicited smiles, and these smiles do show perceived expressive asymmetries. This illustrates some of the difficulties inherent in relying solely on physical measures to assess the emotionality of expressions and the motivations behind them.

2. The smiling infant in the figure is one of the two posers who showed AU6-7 activity around the eyes. The other four smiling infants showed none of the AU6-7 activity that is thought to reflect "felt" smiles even in infants (e.g. Fox & Davidson, 1988).

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