Published in final edited form as:
Dev Sci. 2015 March ; 18(2): 298–313. doi:10.1111/desc.12217.

Effects of early institutionalization on the development of emotion processing: A case for *relative* sparing?

Margaret C. Moulson[1], **Kristin Shutts**[2], **Nathan A. Fox**[3], **Charles H. Zeanah**[4], **Elizabeth S. Spelke**[5], and **Charles A. Nelson**[6,7,8]

[1] Department of Psychology, Ryerson University [2] Department of Psychology, University of Wisconsin-Madison [3] Department of Human Development and Quantitative Methodology, University of Maryland [4] Department of Psychiatry, Tulane University [5] Department of Psychology, Harvard University [6] Department of Pediatrics, Harvard Medical School [7] Center on the Developing Child, Harvard University [8] Division of Developmental Medicine, Boston Children's Hospital

Abstract

We tested the capacity to perceive visual expressions of emotion, and to use those expressions as guides to social decisions, in three groups of 8- to 10-year-old Romanian children: children abandoned to institutions then randomly assigned to remain in "care as usual" (institutional care); children abandoned to institutions then randomly assigned to a foster care intervention; and community children who had never been institutionalized. Experiment 1 examined children's recognition of happy, sad, fearful, and angry facial expressions that varied in intensity. Children assigned to institutional care had higher thresholds for identifying happy expressions than foster care or community children, but did not differ in their thresholds for identifying the other facial expressions. Moreover, the error rates of the three groups of children were the same for all of the facial expressions. Experiment 2 examined children's ability to use facial expressions of emotion to guide social decisions about whom to befriend and whom to help. Children assigned to institutional care were less accurate than foster care or community children at deciding whom to befriend; however, the groups did not differ in their ability to decide whom to help. Overall, although there were group differences in some abilities, all three groups of children performed well across tasks. The results are discussed in the context of theoretical accounts of the development of emotion processing.

Recognizing facial expressions of emotion is a fundamental ability that guides social interactions and underlies complex social behaviors and judgments. Most adults decode facial expressions quickly and accurately, but the development of this ability is unclear. Theoretical accounts of the development of emotion processing vary. Nativist accounts posit innately specified capacities to recognize and express basic emotions (see Ekman, 1994; Izard, 1994), whereas empiricist accounts posit that these abilities are learned through extensive experience in the social world (see Russell, 1994). Other theoretical accounts fall

Direct correspondence to Margaret Moulson, Department of Psychology, Ryerson University, 350 Victoria Street, Toronto, ON, Canada, M5B 2K3, mmoulson@psych.ryerson.ca..

between these two extremes. Leppanen and Nelson (2009) proposed that the development of emotion processing reflects an experience-expectant process, in which the brain is biased from birth to attend to socially relevant stimuli (e.g., faces), but the emergence of mature emotion processing is profoundly shaped by subsequent species-typical experiences during a sensitive period of development.

It is difficult to assess the role of experience in the development of mature emotion processing because, for most children, the accumulation of rich social experiences is correlated with increasing age and brain maturation. However, there are unfortunate cases in which children are deprived of species-typical social experiences in their early rearing environments; studying the development of emotion processing in these children provides a way to test different accounts of the development of emotion processing. In the present paper, we investigated emotion processing in three groups of children: (1) institutionalized children who were randomized to remain in institutional care; (2) institutionalized children who were randomized to placement in high-quality family foster care; and (3) children who had never been institutionalized and were being raised in their biological families. Comparing emotion processing in these three groups of children can illuminate the role of early species-typical social experiences in emotion processing.

The development of emotion recognition is protracted; even in late childhood, children are not able to identify all emotions with the same accuracy and speed as adults (for a review, see Herba & Phillips, 2004). Previous research has demonstrated that impoverished or atypical experiences during development are associated with aberrant emotion processing. Many studies have documented altered emotion processing in abused compared to non-abused children, likely as a result of the negative socioemotional interactions that occur in abusive households. Physically abused children are less skilled at recognizing emotions than non-abused children (Camras, Grow, & Ribordy, 1983), and abused children pose less recognizable facial expressions than non-abused children (Camras et al., 1988). Children's processing of angry faces appears to be especially affected by abuse. Abused children show a response bias for angry faces when matching a facial expression to an emotional situation (Pollak, Cicchetti, Hornung, & Reed, 2000); recognize angry faces on the basis of less perceptual information than non-abused children (Pollak & Sinha, 2002; Pollak, Messner, Kistler, & Cohn, 2009); display different category boundaries than non-abused children for angry, but not happy, fearful, or sad facial expressions (Pollak & Kistler, 2002); and show increased allocation of attention to angry faces, but not other emotional faces, compared to non-abused children (Pollak, Klorman, Thatcher, & Cicchetti, 2001; Pollak & Tolley-Schell, 2003). That these effects were largely specific to angry facial expressions speaks to the potential specificity of early experiences on subsequent emotion processing. It is likely adaptive for abused children to show increased sensitivity and attention to angry faces, given its heightened signal value in an abusive environment.

Researchers have also investigated the link between early social experiences and emotion processing in children who have experienced a different form of early adversity—neglect. Many children around the world experience early neglect in institutions for orphaned and abandoned children. Although the quality of institutional care varies widely across institutions and countries, it is generally characterized by conditions of profound social deprivation. High child-to-caregiver ratios and high caregiver turnover (reviewed in Maclean, 2003; Gunnar, 2001; Zeanah et al., 2003) lead to a lack of quality interactions between children and caregivers and little opportunity to form close attachment relationships with adult caregivers (Smyke et al., 2007; Zeanah et al., 2003). Minimal communication, attention, and physical contact from caregivers, along with the strictly regimented life in an institution, mean that children in institutions experience little responsiveness to their individual needs (reviewed in Maclean, 2003; Gunnar, 2001). These characteristics of institutional care may lead to atypical exposure to faces and facial emotion, although such differences have not been directly quantified. For example, institutionalized children may see a different quantity of faces than family-reared children (e.g., they may see a greater number of individual faces, but fewer instances of their primary caregiver(s) face); they may see a more limited range of facial expressions, including fewer positive facial expressions and more negative facial expressions; and they may experience fewer facial expressions that are contingent on their own behavior. Overall, the neglect experienced by institutionalized children is associated with a host of physical, neurobiological, cognitive, behavioral, and socioemotional deficits (Beckett et al., 2006; Carlson & Earls, 1997; Chisholm, 1998; Chugani et al., 2001; Eluvathingal et al., 2006; Fisher, Ames, Chisholm, & Savoie, 1997; Johnson, 2000; O'Connor & Rutter, 2000; O'Connor, Rutter, Beckett, Keaveney, & Kreppner, 2000; Rutter et al., 1999; Rutter et al., 2007).

As part of the Bucharest Early Intervention Project (BEIP), a longitudinal study of the effects of early experience on brain and behavioral development, we have examined institutionalized children's ability to recognize facial expressions of emotion. The BEIP began in 2000 as a randomized controlled trial of foster care as an intervention for early institutionalization. A cohort of children (N = 136) were recruited from all six institutions for abandoned/orphaned children in Bucharest, Romania. Following a baseline assessment that occurred between 6 and 30 months of age, institutionalized children were randomly assigned either to remain in institutional care (the “Care as Usual Group”) or to be placed in high-quality foster care created and supported by the BEIP (the “Foster Care Group”). A community sample of children, who lived with their biological families and had never been institutionalized (the “Never Institutionalized Group”), was recruited for comparison purposes.

Findings from the BEIP indicate that the institutionalized children differ from the never-institutionalized children on virtually every measure of development tested, including physical growth (Johnson et al., 2010), IQ (Nelson et al., 2007), executive functioning (Bos, Fox, Zeanah, & Nelson, 2009), language (Windsor, Glaze, Koga, & the BEIP Core Group, 2007), electrophysiological indices of brain development (Marshall & Fox, 2004), attachment (Zeanah, Smyke, & Dumitrescu, 2002; Zeanah, Smyke, Koga, & Carlson, 2005), and psychiatric outcomes (Bos, Zeanah, Fox, Drury, McLaughlin, & Nelson, 2011; for review, see Nelson, Fox, and Zeanah, 2013). Children in foster care often showed significant recovery at later assessments. Additionally, sensitive periods were observed among some of the domains; outcomes among children placed before roughly 2 years of age were superior to those placed after this age (see Nelson et al., 2013).

There is one domain of development, however, where institutionalized children seem to perform comparatively well: the ability to process facial expressions of emotion. Previous findings from the BEIP suggest that emotion-processing differences between institutionalized and community children are small (Nelson, Parker, & Guthrie, 2006; Jeon, Moulson, Fox, Zeanah, & Nelson, 2010; Parker, Nelson, & BEIP Core Group, 2005; Moulson, Fox, Zeanah, & Nelson, 2009). At the baseline and 42-month-old assessments, children completed (1) a visual paired comparison procedure testing their discrimination of happy, fearful, sad, and neutral facial expressions, and (2) an event-related potential (ERP) task that examined the neural response to happy, fearful, sad, and angry facial expressions. At both assessments, there were no differences between institutionalized, foster care, and never-institutionalized children in their ability to discriminate behaviorally among the facial expressions of emotion (Nelson et al., 2006; Jeon et al., 2010). The ERP tasks at the two assessments also revealed few differences among groups. Although there were small differences between institutionalized and never-institutionalized children's ERP responses to fearful and sad facial expressions at the baseline assessment (Parker et al., 2005), at the 42-month assessment there were no group differences in ERP responses to any the facial expressions (Moulson et al., 2009). Indeed, at the 42-month assessment, all three groups of children showed a normative response pattern to happy and fearful faces—specifically, a larger amplitude and longer latency Nc component for fearful faces compared to happy faces (Moulson et al., 2009).

There are two potential explanations for this surprising pattern of results. First, emotion processing may be a relatively spared domain of development for children who have been institutionalized. Institutionalized children are likely limited in the type and quantity of facial expressions to which they are exposed, and they certainly have impoverished social relationships (Almas et al., 2012), but the exposure they receive, although different in quality and quantity, may be sufficient to "build" facial emotion recognition neural networks. Second, emotion processing may be adversely affected by institutionalization, but previous assessments of children in the BEIP may not have used sufficiently sensitive emotion-processing tasks. The tasks used for these assessments probed only the perceptual discrimination of basic emotions and its neural correlates. It is possible that children's experience in the institution is sufficient to support these basic discriminations (e.g., discrimination between very happy and very sad faces), but not more subtle ones.

This second possibility is consistent with previous research using more demanding tasks of emotion-processing abilities, which has demonstrated that early neglect leads to emotion-processing deficits. Children who experienced neglect in their biological families had more difficulty matching facial expressions to appropriate emotional situations than physically abused and control children and more difficulty discriminating negative facial expressions of emotion than control children (Pollak et al., 2000). Children who were internationally adopted from institutions showed the same two deficits (Wismer Fries & Pollak, 2004). These findings suggest that the lack of group differences observed in previous assessments of children in the BEIP may have been due to the choice of tasks.

The goal of the current investigation was to probe emotion processing in children in the BEIP using tasks that require more sophisticated emotion recognition and reasoning skills, in order to determine whether the significant social deprivation experienced by children in our sample leads to deficits in emotion processing. To that end, we used two approaches to test emotion processing in BEIP children at a follow-up assessment that occurred when the children were 8 to 10 years of age. First, we evaluated children's fine-grained emotion perception abilities. Most previous studies of emotion recognition in children experiencing neglect, including our own findings from the BEIP, used tasks that require discrimination or identification of intense expressions of basic emotions. Although this approach has been fruitful, it is potentially even more informative to ask whether children with different caregiving histories show differences in their ability to recognize subtle expressions of emotion (e.g., Pollak & Sinha, 2002). Most often, the expressions encountered in daily life are subtle portrayals of emotion; thus, a task examining children’s recognition of less intense expressions of emotion might provide a more realistic picture of their functional emotion recognition ability. To probe for subtle deficits in children's ability to identify facial expressions of emotion, we used morphed stimuli that ranged in intensity from neutral to extreme for each of four different emotional expressions (happy, sad, fearful, and angry; Gao & Maurer, 2009). Children were asked to identify the emotion portrayed in each face, and we measured their sensitivity to and accuracy for the different emotional expressions.

Our second approach required children to use emotional faces to guide hypothetical social interactions in two social judgment tasks. In one task, children viewed pairs of faces that differed according to how happy or angry they were; children were asked to point to the person with whom they would rather play. In another task, children viewed face pairs that differed according to how happy or sad they were; children were asked to point to the person whom they would want to help. Even if socially deprived children are able to perceive facial expressions of emotion with great accuracy, they may show deficits in their ability to use emotional information from faces to guide their social interactions. To our knowledge, no previous studies of institutionalized children have required children to use emotions in a social way, so these tasks provide a novel assessment of emotion-processing abilities in children with adverse rearing histories.

Based on the opposing perspectives regarding the role of experience in the development of emotion processing and on the conflicting findings reviewed above, we test two competing hypotheses. If the capacity to recognize and use facial expressions of emotion depends only on minimal social experiences of the kind that are present in institutional environments, then institutionalized children should show few, if any, deficits on either the emotion perception or social judgment tasks compared to family-reared children. Conversely, if this capacity depends on access to rich social input in the context of complex social interactions with consistent caregivers, then institutionalized children should show deficits on both sets of tasks compared to family-reared children, and children assigned to foster care might show some recovery. The findings from the current investigation therefore have the potential to offer insight into our understanding of the role of experience in the development of emotion processing.

Experiment 1

Experiment 1 tested children's ability to recognize four facial expressions of emotion—happy, sad, fearful, and angry—that varied in intensity from neutral to extreme. We used sets of faces that had been morphed from a neutral expression to an extreme expression of the same face in increasing increments. Our goal was to simulate the reality of day-to-day interactions, where individuals generally produce and perceive a range of facial emotion, from subtle to intense.

Method

Participants

Children in the Care as Usual Group (CAUG) and Foster Care Group (FCG) were drawn from the Bucharest Early Intervention Project (BEIP). The characteristics of participants in the BEIP have been described in detail elsewhere (Nelson et al., 2007; Zeanah et al., 2003). Briefly, at the inception of the BEIP, 136 institutionalized children aged 6-30 months were randomly assigned to remain in institutional care (CAUG; N = 68) or to be placed in high-quality foster care developed and supported by the BEIP (FCG; N = 68). All CAUG and FCG children were free of major neurological diseases and disorders, and evidenced no signs of fetal alcohol syndrome.

For the present experiment, 41 CAUG children, 48 FCG children, and 67 children from the community ("Never-Institutionalized Group"; NIG) agreed to participate. Following previous research (Nelson, Westerlund, McDermott, Zeanah, & Fox, in press; McDermott, Westerlund, Zeanah, Nelson, & Fox, 2012), the data from 13 CAUG, 11 FCG, and 1 NIG participants were excluded from all analyses because they had IQs below 70, and therefore were likely to have difficulty understanding and following verbal instructions in the tasks. Thus, the final sample included 28 CAUG children (11 girls; mean age = 9.70 years, range = 8.27 to 10.85), 37 FCG children (16 girls; mean age = 9.82 years, range = 8.11 to 11.06), and 66 NIG children (37 girls; mean age = 9.78 years, range = 7.82 to 10.96). Of the 65 CAUG and FCG children, 29 had been placed in an institution at birth; the remaining children had spent varying amounts of time with their birth families before being placed in an institution (M = 4.83 months, Range: 7 days to 17 months). None of the children in the NIG had ever lived in an institution.

Between the start of the BEIP and the start of the present experiments, the living arrangements for many of the children originally assigned to the CAUG and FCG had changed (Figure 1). Despite these changes in placement, the analyses presented here use an intent-to-treat approach: groupings for analyses consider only children's original group assignment. This approach permits causal inferences about effects of foster care (because randomization is preserved), and tests the conservative view that it is early experience, not subsequent life experience, that most impacts the course of development. As mandated by Romanian law, the Commission on Child Protection provided informed consent for each of the child participants. We also obtained assent from caregivers who accompanied children to the laboratory. The Institutional Review Boards of Children's Hospital Boston, the University of Maryland, and Tulane University approved the protocol.

Materials

The stimuli used in this experiment were obtained from Gao and Maurer (2009), who used photographs of two female models portraying happy, sad, fearful, angry, and neutral facial expressions (drawn from the MacBrain Face Stimulus Set; Tottenham et al., 2010) to create sets of morphed emotional faces. Female faces were used because all institutional caregivers and foster care primary caregivers are female. Each morphed set contained a model expressing 10 levels of intensity of a particular emotion (e.g., happy), created by morphing the emotional face with the neutral face of the same model in 10% increments (Figure 2; see Gao & Maurer, 2009, for a detailed description of the morphing procedure). For each model, there were four morphed sets (happy, sad, fearful, angry), plus four identical neutral expressions, for a total of 44 stimuli per model. Each photograph was printed in color on 5 x 7-inch cardstock.

Design and Procedure

Participants were tested by a Romanian female experimenter in their native language (Romanian). Participants were seated facing five brown paper bags on a table. The bags were marked with happy, sad, fearful, angry, and neutral schematic faces and were verbally labeled by the experimenter. Next, participants were told that they would see many faces expressing different emotions, and their job was to put each face into the bag with the matching emotion. On each trial, participants were presented with one face and placed the face in the bag they thought was correct. They were given only neutral feedback on their responses. Participants first completed five practice trials presented in random order: the neutral expression and the 100% versions of each emotional expression (happy, sad, fearful, angry) portrayed by one of the two female models. This ensured that they understood the task and could recognize the extreme versions of each emotion. Participants then saw all 44 stimuli of the model not seen in the practice trials presented in random order. The model used for practice vs. test was counterbalanced across participants in each group.

Results

First, children's accuracy in the test phase on the extreme (100%) versions of each emotion were compared across the three groups. Then, to characterize children's performance across the different intensities of each emotion, we used two complementary approaches. First, we calculated the thresholds at which children reliably identified each expression as different from neutral, to assess their sensitivity to subtle portrayals of emotion. Second, we calculated the misidentification rates for each expression, to assess their accuracy at identifying emotional expressions.

Accuracy on Extreme Versions of Emotions

Figure 3 displays the mean accuracy for the 100% versions of each emotion averaged across participants in each of the three groups (CAUG, FCG, NIG). An ANOVA with group and participant gender as between-subjects factors and emotion (happy, sad, fearful, angry) as a within-subject factor revealed only a main effect of emotion ($F(3, 375) = 4.12$, $p < .05$). LSD post-hoc tests revealed that accuracy on the 100% happy faces ($M = 100\%$) was greater than accuracy on the 100% sad ($M = 91.6\%$, $p < .01$), 100% fearful ($M = 90.8\%$, $p < .01$), and 100% angry faces (M = 94.7%, $p < .01$), and that accuracy on the negative emotions did not differ. There was neither a main effect of group, nor a group x emotion interaction, indicating that children's accuracy on the extreme (100%) versions of each emotion did not differ based on their group membership. There were no effects involving participant gender.

Thresholds

For the threshold analyses, children's responses were considered correct if they placed a face in the bag with the matching emotion, and incorrect if they placed it in any other bag. Previous papers defined the threshold as the point where a subject was more likely to accurately identify the correct emotion; that is, the 50% point (Gao & Maurer, 2009; see Supplemental Information section for details regarding the threshold calculations).

We fit marginal models for emotion and group; that is, we first examined the effect of emotion collapsed across all groups, and the effect of group collapsed across all emotions. Table 1 displays the threshold estimates and 95% confidence intervals for each emotion when collapsed across groups. Across all groups, children had a significantly lower threshold for fearful compared to all other emotions: they begin distinguishing fearful faces from neutral faces at a lower intensity level than for any other emotion (see Leppanen & Nelson, 2012). The thresholds for happy, angry, and sad faces did not differ.

Table 2 displays the threshold estimates and 95% confidence intervals for each group when collapsed across emotions. The identification threshold for the CAUG was significantly higher than for the NIG: children in the NIG begin distinguishing emotional faces from neutral faces at a lower intensity than children in the CAUG. The identification threshold for the FCG did not significantly differ from either the CAUG or NIG.

Finally, we stratified the analysis by emotion in order to examine the effect of group membership on identification threshold separately for each emotion (Figure 4). Table 3 displays the threshold estimates and 95% confidence intervals for each group and emotion combination. Notice that the confidence intervals of the three groups overlap in the fearful, sad, and angry conditions, indicating that there are no differences in identification threshold among the groups for these emotions. For the happy condition, the threshold for the CAUG is significantly higher than for the FCG and the NIG. The thresholds for the FCG and NIG just barely overlap, which is equivalent to a p-value that is marginally significant ($0.05 < p < 0.10$).

Misidentifications

Figure 5 displays the mean number of misidentifications made for each emotion in each of the three groups. A misidentification was counted whenever a child mistakenly classified one emotion as another emotion; responses of “neutral” were not considered misidentifications, because all of the faces (other than the 100% versions) contained some neutral face information. An ANOVA with group (CAUG, FCG, NIG) and participant gender as between-subjects factors and emotion (happy, sad, fearful, angry) as a within-subject factor revealed a main effect of emotion ($F(3, 375) = 21.11$, $p < .001$). Post-hoc (LSD) tests revealed that participants made the most misidentifications for sad faces (M =

1.25), then angry faces (*M* = 0.84), then fearful faces (*M* = 0.67), then happy faces (*M* = 0.17). The differences among all emotion pairs were significant (all *p*'s < .05). There was neither a main effect of group, nor a group x emotion interaction, indicating that children's accuracy at identifying even subtle portrayals of emotions did not differ based on their group membership. There were no effects involving participant gender.

We also examined the pattern of misidentifications that children made in this task and whether this differed by group. Table 4 displays the mean number of misidentifications made for each emotion, broken down by group. Generally, sad faces were most often misidentified as fearful faces and vice versa; sad and fearful faces were both misidentified as angry more often than happy. Angry faces were misidentified as sad and fearful more often than happy. Happy faces were rarely misidentified. Importantly, none of these results differed by group, suggesting that the groups did not have different identification biases.

Summary

Overall, findings from Experiment 1 revealed no group differences either in children's accuracy at identifying extreme versions of the emotions, or in the number of misidentifications children made. The threshold analyses did reveal a group difference: the identification threshold for the CAUG was higher than the threshold for the NIG when collapsed across emotions. When the thresholds were analyzed separately by emotion, however, it seemed that happy faces were driving this overall group effect: CAUG children had significantly higher thresholds than NIG children for happy faces, but there were no threshold differences among the groups for angry, fearful, or sad faces. Collapsing across groups, children had significantly lower identification thresholds for fearful faces than for the other emotions, indicating that children in all three groups needed less perceptual information to identify fearful faces correctly.

Experiment 2

Experiment 2 tested children's use of emotional expressions to guide their social decisions about whom to befriend and help. We were unable to find standardized measures in the literature for probing children's use of emotions to guide their social decisions, so we designed two new tasks. In both tasks, children saw pairs of faces in which one face was more positive (or less negative) than the other. In the “Happy-Angry” task, children saw happy and angry faces and pointed to the person with whom they would rather play. In the “Happy-Sad” task, children saw happy and sad faces and pointed to the person whom they would rather help.

Method

Participants—The participants were the same as those described in Experiment 1.

Materials—The software program FaceGen was used to generate two adult female faces (“Face A” and “Face B”). As in Experiment 1, female faces were used because all institutional and foster care primary caregivers were female. The emotion controls in FaceGen were used to create 16 versions of each female's face: four open-mouth happy faces at different levels of intensity (25%, 50%, 75%, 100%); four angry faces (25%, 50%, 75%, 100%); four closed-mouth happy faces (25%, 50%, 75%, 100%); and four sad faces (25%, 50%, 75%, 100%). The open-mouth happy and angry faces appeared in the "Happy-Angry" task, while the closed-mouth happy and sad faces appeared in the "Happy-Sad" task. Every trial in both tasks featured one version of Face A and one version of Face B. Face pairs were presented to children against a black background in PowerPoint on a laptop computer. See Figure 6 for example trials from both tasks.

Design—Approximately half of the participants in each group completed the "Happy-Angry" task before the "Happy-Sad" task, and half did the reverse. Both tasks featured 8 "mixed emotion" trials (e.g., one happy and one angry face), 6 "positive-positive" trials (i.e., two happy faces— one happier than the other), and 6 "negative-negative" trials (e.g., two sad faces—one sadder than the other). Mixed-emotion, positive-positive, and negative-negative trials were interspersed throughout each task. See Table 5 for a complete list of trial types and trial order (which was the same across participants). On half of trials, the more positive (or less negative) face was on the child's left; on remaining trials, it was on the right. On half of trials, Face A was the more positive (or less negative) face; on remaining trials, Face B was the more positive face.

Procedure—A Romanian female experimenter tested all the children in their native language (Romanian). Participants first completed two practice trials that were designed to familiarize children with the kinds of emotions they would see during the task and teach them how to indicate their responses (i.e., by pointing). These trials featured faces of real women (one very happy and one very angry, or one very happy and one very sad) accompanied by brief descriptions of their emotional states (e.g., Happy: "Do you see this person here [point]? She's really happy. Today she made a cake to share with everyone!" Angry: "Do you see this person here [point]? She's really angry. Today she took someone else's teddy bear and threw it on the ground." Sad: "Do you see this person here [point]? She's really sad. Today she lost her favorite book."). After the practice trials, participants saw 20 test trials featuring Face A and Face B. In the "Happy-Angry" task, participants were asked to point to the person with whom they would rather play. In the "Happy-Sad" task, participants were asked to point to the person they would rather help. During the test trials, the emotions were never labeled or presented with a context, and the experimenter provided only neutral feedback on children's responses (e.g., "OK").

Results

Happy-Angry Task—Children's responses were scored as "correct" if they chose the more positive (or less negative) face in the trial pair. Collapsing across all trial types (happy-happy, angry-angry, and happy-angry), children from all three groups performed significantly above chance (Chance = 50%; CAUG: M = 80%; $t(27) = 12.89$, $p < .001$; FCG: M = 89%; $t(36) = 23.13$, $p < .001$; NIG: M = 90%; $t(65) = 36.87$, $p < .001$). Nevertheless, an ANOVA with group (CAUG, FCG, NIG) and participant gender as between-subjects factors and trial type (happy-angry, angry-angry, happy-happy) as a within-subject factor revealed a main effect of group ($F(2,125) = 6.97$, $p < .01$). According to LSD post-hoc tests, FCG and NIG children did not differ from one another (p = ns), but both FCG and NIG children outperformed CAUG children ($p < .01$ and $p < .001$, respectively). Participant group did not interact with either of the other factors.

There was also a main effect of participant gender ($F(1,125) = 9.70$, $p < .01$): Girls outperformed boys (M = 91% vs. 84%, respectively). Because the gender composition of the CAUG and NIG groups differed, we conducted independent samples t-tests comparing the performance of NIG and CAUG boys and the performance of NIG and CAUG girls separately. These analyses indicated that NIG boys outperformed CAUG boys (M = 87% vs. 76%, respectively; $t(44) = 3.46$, $p < .01$), and that NIG girls tended to outperform CAUG girls (M = 92% vs. 87%, respectively; $t(46) = 1.81$, $p = .076$). Therefore, the overall difference in performance between groups (NIG > CAUG) was not driven by the differential distribution of boys and girls in the two groups.

Finally, the ANOVA revealed a main effect of trial type ($F(1.38,172.50) = 51.08$, $p < .001$, Greenhouse-Geisser Correction). Participants performed better on happy-angry and angry-angry trials than on happy-happy trials (both p's < .001; LSD post-hoc tests); performance on happy-angry and angry-angry trials did not differ (p = ns). See Figure 7a for performance by all three groups of participants on all three trial types. Trial type did not interact with participant group. As shown in Figure 7a, all three participant groups showed a similar performance profile across the different trial types: mean performance was worst for all three groups on happy-happy trials, and best for all three groups on happy-angry and angry-angry trials.

Happy-Sad Task—Children's responses were scored as “correct” if they chose the more negative (or less positive) face in the trial pair. Collapsing across all trial types (happy-happy, sad-sad, and happy-happy), children from all three groups performed significantly above chance (Chance = 50%; CAUG: M = 75%; $t(27) = 9.31$, $p < .001$; FCG: M = 78%; $t(36) = 11.63$, $p < .001$; NIG: M = 80%; $t(65) = 20.68$, $p < .001$). An ANOVA with group (CAUG, FCG, NIG) and participant gender as between-subjects factors and trial type (happy-sad, sad-sad, happy-happy) as a within-subject factor revealed only a main effect of trial type: $F(1.81,226.04) = 21.90$, $p < .001$, Greenhouse-Geisser Correction. Children performed better on happy-sad trials (M = 85%) than on happy-happy or sad-sad trials (both p's < .001); children also performed better on happy-happy trials (M = 76%) than on sad-sad trials (M = 71%; $p < .05$). There were no other main effects or interactions. As shown in Figure 7b, mean performance was best for all three groups on happy-sad trials, followed by happy-happy trials, followed by sad-sad trials.

Difficulty Analyses—Reasoning that any group differences might be magnified on trials that children found particularly difficult, we compared the performance of the three groups on the five most difficult trials and 10 most difficult trials for each task. To determine which trials were the most difficult, we calculated mean performance on each trial across all three groups of children (see Table 5). For each participant for each task, we then averaged performance on the trials that had been identified as the five most difficult and 10 most difficult for the full sample. ANOVAs with group (CAUG, FCG, NIG) as a between-subjects factor were conducted on these scores. For the Happy-Angry task, when examining performance on the 10 most difficult trials, there was a main effect of group ($F(2,128)$ =

6.48, $p < .01$). Mimicking the results when all trials were included, LSD post-hoc tests revealed that FCG and NIG children did not differ from one another (p = ns), but both FCG and NIG children outperformed CAUG children ($p < .05$ and $p < .001$, respectively). Similarly, when examining performance on the five most difficult trials, there was a main effect of group ($F(2,128) = 5.89$, $p < .01$). LSD post-hoc tests revealed that FCG and NIG children did not differ from one another (p = ns), but NIG children outperformed CAUG children ($p = .001$). FCG and CAUG children were marginally significantly different ($p = .087$). For the Happy-Sad task, there was no effect of group for either the five most difficult trials ($F(2,128) = 0.52$, p = ns) or the 10 most difficult trials ($F(2,128) = 0.21$, p = ns). Thus, performance on both tasks was largely the same when only performance on the more difficult trials was examined.

Comparison and Summary—To compare participants' performance in the Happy-Angry and Happy-Sad tasks, we collapsed across trial type (since it did not interact with any other factors in previous analyses), and conducted an ANOVA with task as a within-subjects factor and participant group as a between-subjects factor. This analysis revealed main effects of task ($F(1,128) = 50.37$, $p < .001$) and participant group ($F(2,128) = 5.42$, $p < .01$), but no interaction between the two factors (p = ns). Participants performed better in the Happy-Angry Task than they did in the Happy-Sad Task (M = 88% vs. 78%, respectively). Additionally, LSD post-hoc tests showed that FCG and NIG children outperformed CAUG children ($p < .05$ and $p < .01$, respectively), and that FCG and NIG children's performance did not differ (p = ns). Taken together, the findings from the two tasks show that CAUG children had greater difficulty using emotional expressions to guide their social decisions compared with FCG and NIG children. Nevertheless, CAUG children performed well above chance on all trial types in both tasks (Figures 7a and 7b), and their performance patterns resembled those of the other groups.

Supplemental Analyses

Overall, the results from Experiments 1 and 2 reveal relatively subtle differences among groups, which is somewhat surprising given the concurrent large deficits that institutionalized children display in multiple domains of development. However, it is possible that this apparent "sparing" is an artifact of the intent-to-treat design that we used. Thus far, children's performance on our tasks has been analyzed based on their randomized group assignments. In reality, however, the majority of children who were initially randomized to the CAUG were no longer living in the institution at the time of this assessment (Figure 1). It is possible that children who spent more time in an institution would show greater deficits in emotion processing. In the Supplemental Information section, we present additional regression analyses that reveal no associations between the percentage of time spent in the institution and performance on our tasks of emotion processing. Thus, the relatively good performance of children in the CAUG on these tasks is not simply the result of many children in the CAUG no longer living in the institution by the time of the 8-year assessment.

General Discussion

The goal of the current research was to investigate whether experiencing rich social interactions early in life is necessary for the development of the capacity to perceive emotions. In Experiment 1, we examined children's ability to recognize facial expressions of emotion that varied in intensity from neutral to extreme. In Experiment 2, we examined children's ability to use facial expressions of emotion to guide social decisions about whom to befriend and help. Consistent with the possibility that early rich social interactions are necessary for the typical development of emotion processing, we found group differences in both experiments. In Experiment 1, our findings revealed a difference in processing happy faces, where institutionalized children had higher thresholds for identifying happy faces than never- institutionalized children. This finding suggests that institutionalized children needed more perceptual information to distinguish happy faces from neutral faces; that is, they were less sensitive to happy faces than their family-reared counterparts. In contrast, children in the three groups did not differ in their thresholds for distinguishing sad, fearful, and angry faces from neutral faces, indicating that perceptual sensitivity to the negative emotions may not have been adversely affected by early social deprivation.

The threshold difference for happy faces but not negative emotions might reflect a difference in exposure to particular facial expressions in the institution versus a family home. It is plausible that the biggest difference in experience between institutionalized and family-reared children would be in their exposure to happy faces. Although we do not have independent data to support this assumption, it seems likely that children reared in typical family settings see more happy faces than children reared in an institution. This purported lack of exposure to happy faces in an institution might conceivably result in the decreased perceptual sensitivity to happy faces seen in institutionalized children in our study. Additionally, it is possible that happy faces—a signal of social reward in typical interactions —may not be as tightly linked to social reward in an institutional context (i.e., happy faces are less likely to be directed at the child and contingent on his/her behavior in an institution compared to a family setting). This decreased signal value of happy faces in an institutional context could also result in decreased perceptual sensitivity to happy faces amongst institutionalized children, just as the increased signal value of angry faces in an abusive context results in increased perceptual sensitivity to angry faces amongst abused children (Pollak & Sinha, 2002). The decreased perceptual sensitivity to happy faces in institutionalized children is consistent with earlier measures of emotional expressivity in this sample of children. At the baseline and 42-month assessments, institutionalized children displayed less positive affect in two tasks from the Laboratory Temperament Assessment Battery (LabTAB) designed to elicit emotion (Smyke et al., 2007; Ghera et al., 2009). There was also an intervention effect; foster-care children showed a significant increase in positive affect by the 42-month assessment (Ghera et al., 2009). Taken together, these findings suggest that the recognition and production of positive facial expressions in particular is adversely affected by early social deprivation, but that this effect can be remediated by placement in foster care.

On the Happy-Angry task in Experiment 2, we also found a group difference: family-reared and foster-care children outperformed institutionalized children (90% and 89% accuracy vs.

80% accuracy, respectively). This finding suggests that institutionalized children are less able to use emotional faces to guide their decisions about whom to befriend. In contrast, there were no group differences on the Happy-Sad task in Experiment 2, although when performance on the two tasks was compared, there was an overall deficit in performance among institutionalized children compared to children in the other groups. It is not clear why group differences were more apparent on the Happy-Angry task. Institutionalized children may have learned it is necessary to be less discriminating in their choice of friends or caregivers in the institution, and so may not be as concerned with fine-grained differences in how happy or angry someone is when seeking social partners. Whatever the reason, the findings from Experiment 2 suggest that social deprivation affects children's tendency to use emotional information when making social decisions, especially decisions about whom to befriend. Since the tasks we used to investigate children's ability to use facial emotions to guide their social decision-making were of our own design, it will be useful to collect more data with these tasks in future studies of children with adverse rearing histories.

The tasks used to assess emotion processing in this study offered significant benefits. The morphing procedure used in Experiment 1 provided a high degree of control over the amount of emotional information available in the stimulus faces in order to examine group differences in accuracy for more subtle portrayals of emotion. The level of control offered by morphing procedures has made them increasingly common in the study of face processing (e.g., Gao & Maurer, 2009; Short, Hatry, & Mondloch, 2011; Vingilis-Jaremko & Maurer, 2013); however, the use of morphing may result in faces that are not representative of the faces and facial expressions encountered in everyday life. Similarly, the synthetic faces used in Experiment 2 allowed us to manipulate the intensity of the facial expressions, but may not have been representative of real faces. Because children in all groups experienced the same stimuli and procedures, the group differences we found remain meaningful.

Although institutionalized children showed deficits in emotion processing, it is noteworthy that the performance of foster-care children did not differ from that of family-reared children on any measure of emotion processing in either experiment. Thus, the adverse effects of early institutionalization on emotion processing seem to be remediated by placement in a high-quality foster care family. This finding is consistent with the majority of previous research with this sample of children demonstrating the positive effects of the foster care intervention across multiple domains of development.

Our findings that institutionalized children showed deficits in emotion processing are consistent with previous research examining deficits in emotion processing in other samples of neglected and institutionalized children (Pollak et al., 2000; Sloutsky, 1997; Wismer Fries & Pollak, 2004). Our findings are also consistent with findings from an ERP task of emotion processing completed by children in the BEIP as part of the current assessment: In this task, children were required to press a button when they saw an angry face and inhibit button presses to fearful and neutral faces while ERPs were recorded. The three groups did not differ in their accuracy for angry faces, but institutionalized children were less likely to inhibit button presses successfully in response to fearful and neutral faces (Nelson et al., in press). Institutionalized children also showed a smaller P1 response to angry faces relative to family-reared children, and showed no differences in N170 latency in response to fearful compared to neutral faces (Nelson et al., in press).

Although institutionalized children showed deficits in emotion processing, their performance was remarkably good overall and in many cases did not differ from the performance of children in the other groups. In Experiment 1, there were no group differences in the number of misidentifications children made across all levels of emotion intensity. Additionally, children in the three groups did not differ in their thresholds for distinguishing sad, fearful, and angry faces from neutral faces, indicating that perceptual sensitivity to the negative emotions may not have been adversely affected by institutionalization. In Experiment 2, children in all three groups performed well above chance on both the Happy-Angry and the Happy-Sad task.

The current findings are consistent with previous results in this sample of children. At the baseline and 42-month assessments, we found no differences among the three groups of children in their ability to discriminate happy, sad, fearful, and neutral facial expressions (Nelson et al., 2006; Jeon et al., 2010). There were also few differences among the groups in their ERP responses to happy, sad, fearful, and angry facial expressions (Parker & Nelson, 2005; Moulson et al., 2009). Thus, our findings across the baseline, 42-month, and current assessments paint a fairly consistent picture of emotion processing in children who experienced early institutionalization. The relatively good performance of institutionalized children on tasks of emotion processing is in stark contrast to the significant deficits seen across multiple domains of development in this sample of children. At the 8-year assessment, institutionalized children showed significant deficits in IQ (Fox, Almas, Degnan, Nelson, & Zeanah, 2011), social skills (Almas et al., 2012; Almas et al., submitted), and inhibitory control and attention (McDermott et al., 2012). They also displayed structural brain changes: their grey matter and white matter volume were significantly reduced compared to family-reared children (Sheridan, Fox, Zeanah, McLaughlin, & Nelson, 2012).

Our findings demonstrate that children who are deprived of rich social interactions early in life show some deficits in emotion processing and that these deficits are remediated by placement in high-quality foster care. They also reveal that on some measures of emotion processing institutionalized children show comparable performance to family-reared children, and considerably better performance than one might have expected based on their concurrent deficits in many other domains of development. From an evolutionary perspective, it is plausible that the neural system subserving emotion processing might be relatively robust to significant variations in experience, given how critical this system is for successful social functioning and therefore for survival. Nevertheless, the institutionalized children in our sample likely received some typical exposure to facial emotions through early experiences in their birth families before placement in an institution and through their interactions with peers in the institution and in the school system. These more normative experiences may have compensated somewhat for the atypical experiences children received with caregivers in the institution, thereby supporting the development of the emotion-processing system.

Future studies of children who have experienced early social deprivation are needed to shed light on remaining questions surrounding the role that experience plays in shaping the development of emotion processing, including how much experience is necessary, what kind of experience is necessary, and when that experience must occur to result in typical development of the emotion-processing system. Future research should also address whether and how emotion processing influences more sophisticated socioemotional abilities in children who have experienced early social deprivation. For example, previous studies with this sample of children at 8 years of age have demonstrated that institutionalized children show significant deficits in social skills as rated by teachers (Almas et al., 2012) and in interactions with unfamiliar peers (Almas et al., submitted). It is possible that better performance on basic tasks of emotion processing—perhaps especially those tasks that involve social judgments—is related to better performance on other social skills.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

Acknowledgements

This work was generously supported by the John D. and Catherine T. MacArthur Foundation (Research Network on *Early Experience and Brain Development*), the Binder Family Foundation, the Richard David Scott Chair and the NIMH (**MH091363**) to Nelson; and a Jacobs Foundation Young Scholars Research Grant to Shutts. The authors wish to thank our dedicated Bucharest-based lab members, Elizabeth Furtado for US-based administrative support, Matt Gregas and Christine Powell for statistical support, Xiaoqing Gao and Daphne Maurer for generously sharing their stimulus set with us, and the many families and children who participated in this project.

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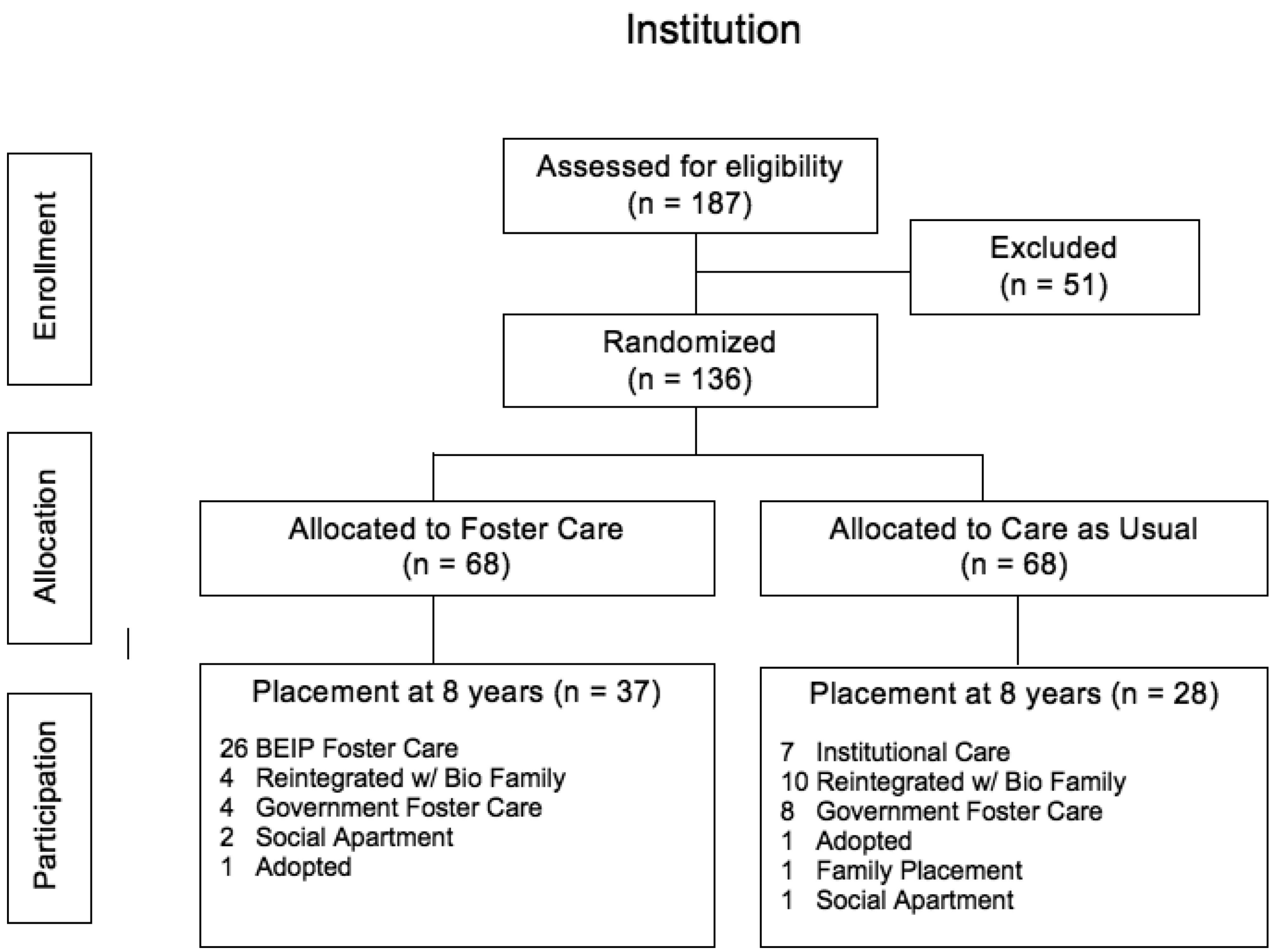


Figure 1.

Placement status at 8 years of age for children in the Care as Usual Group (CAUG) and Foster Care Group (FCG). Placement at 8 years is reported for the children who were included in the current study (CAUG: N = 28; FCG: N = 37).

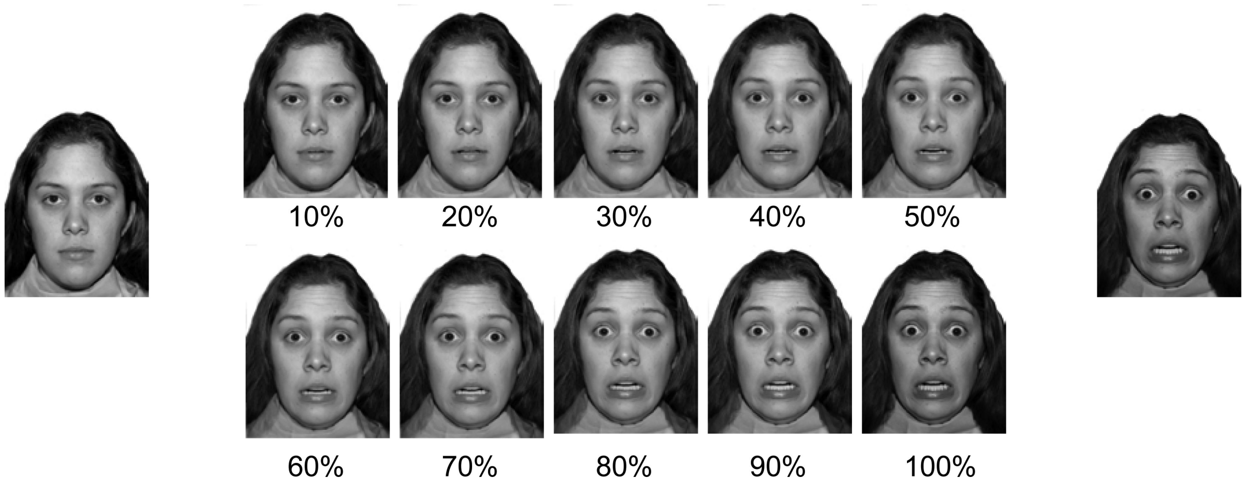


Figure 2.

Example of a morphed set of stimuli used in Experiment 1. The face on the left is the neutral face; the face on the right is the extreme fearful face. The 10 faces in between are morphs of the neutral and extreme fearful face in 10% increments.

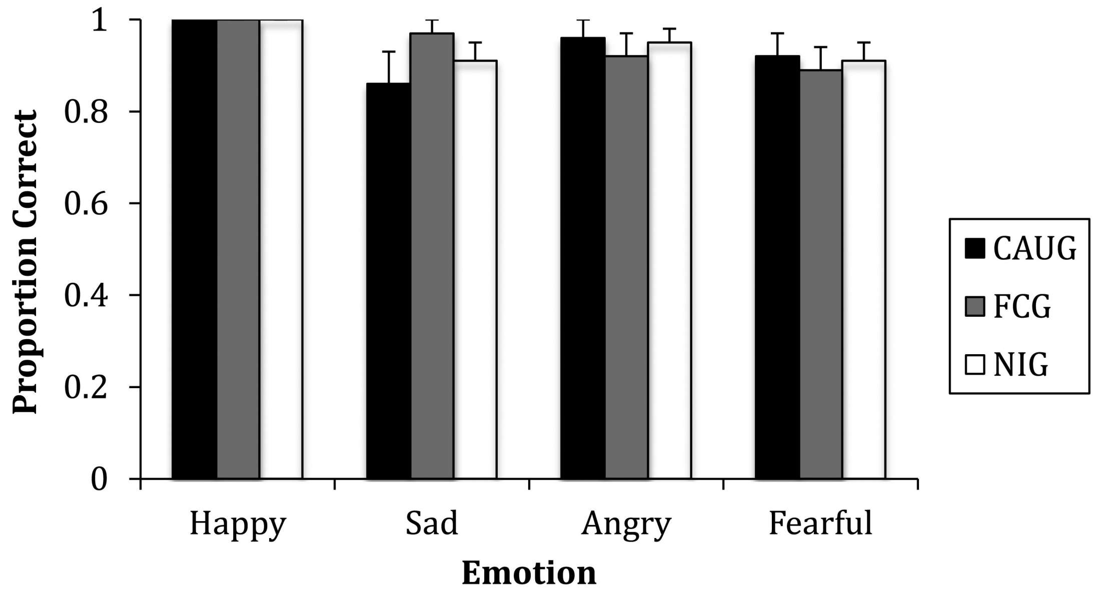
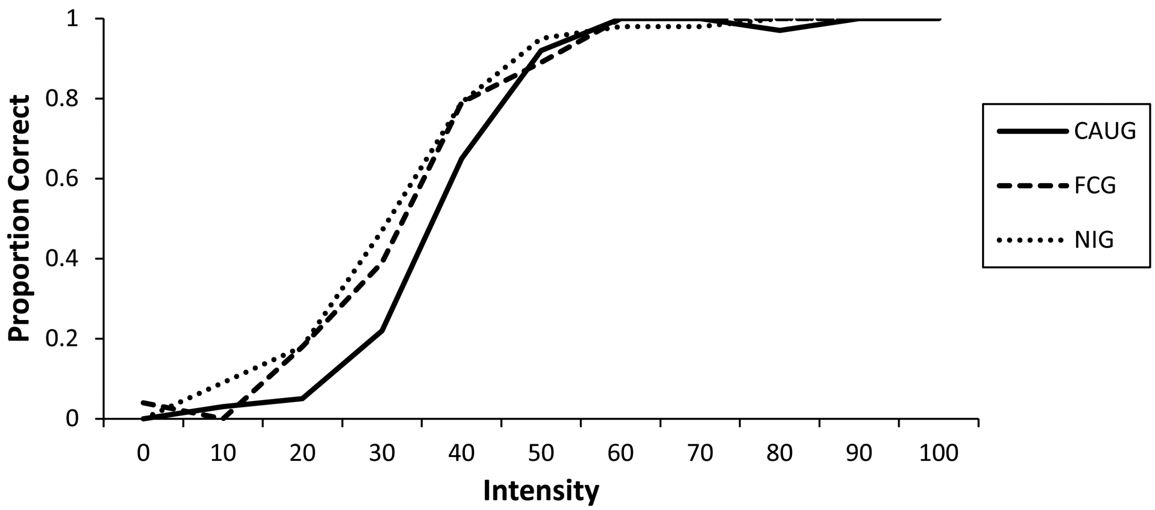
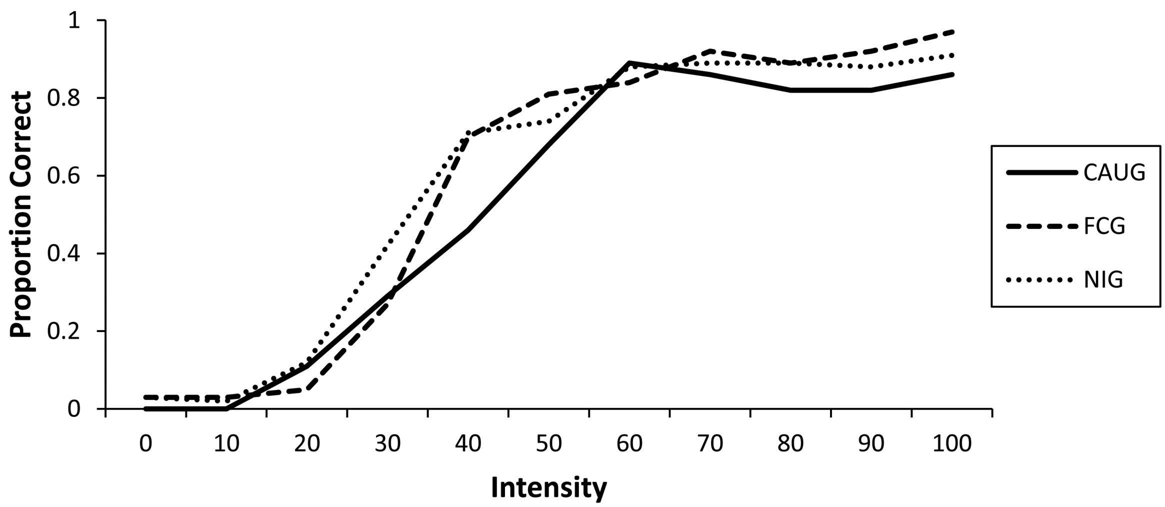


Figure 3.
Performance on 100% versions of each emotion. Error bars represent standard error. CAUG = "Care as Usual Group;" FCG = "Foster Care Group;" NIG = "Never Institutionalized Group."

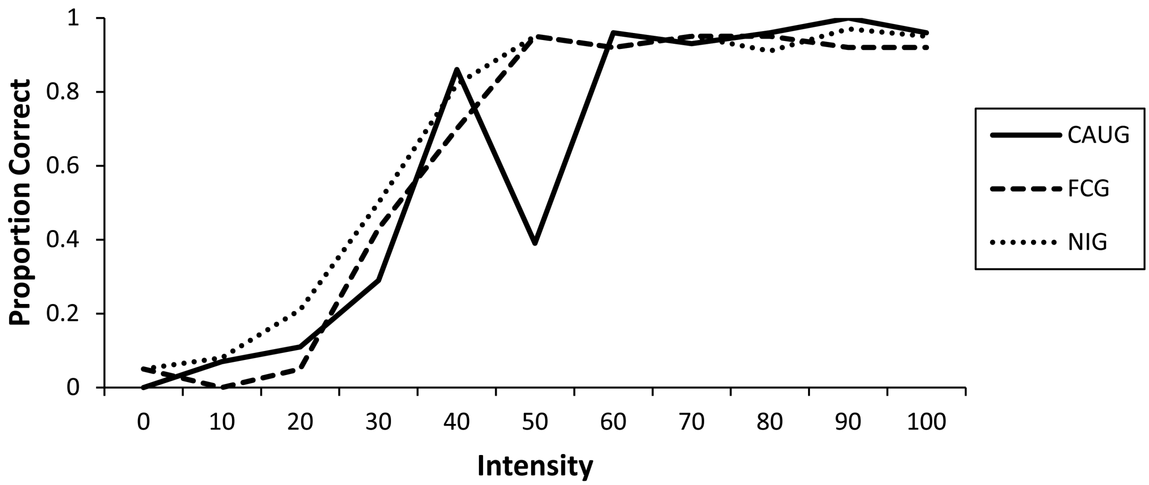
a) Happy Faces



b) Sad Faces



c) Angry Faces



d) Fearful Faces

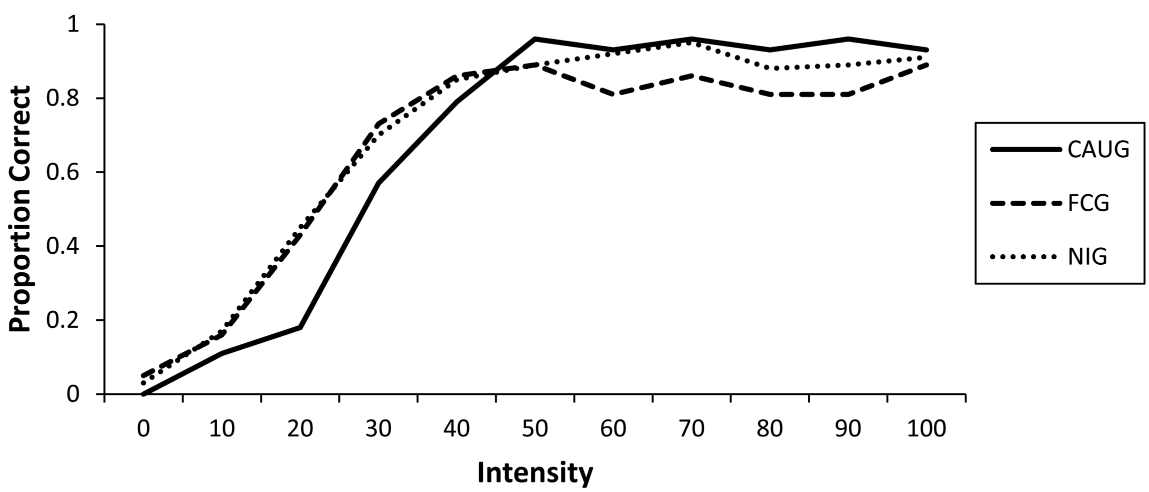


Figure 4.

Proportion correct across intensity levels displayed separately for each emotion. CAUG = "Care as Usual Group;" FCG = "Foster Care Group;" NIG = "Never Institutionalized Group." A) Happy Faces; B) Sad Faces; C) Angry Faces; D) Fearful Faces.

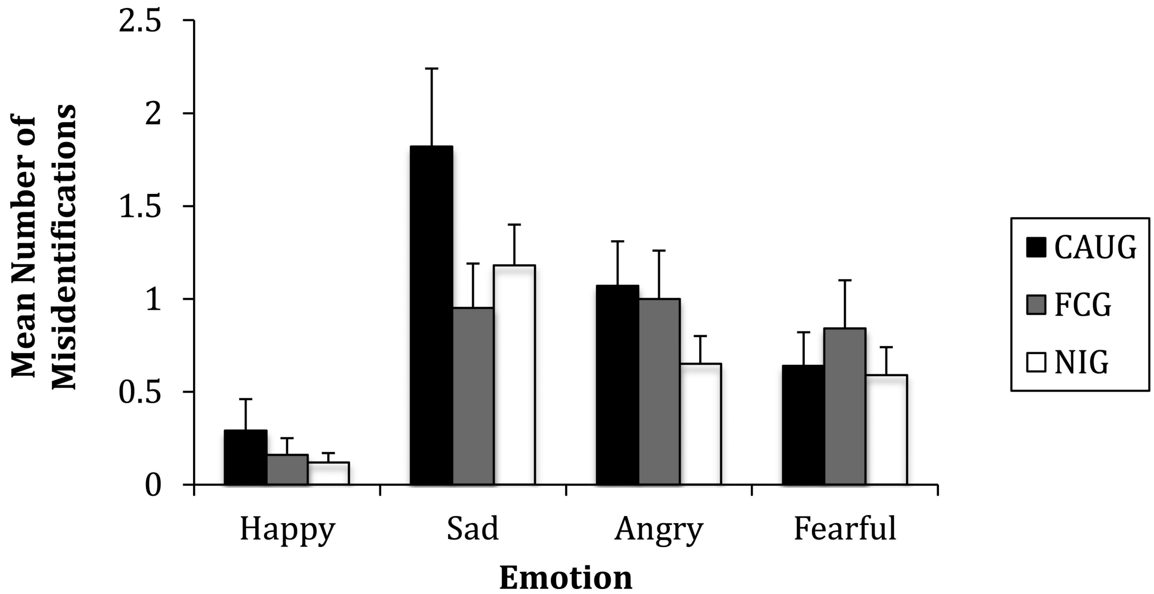


Figure 5.

Mean number of misidentifications made for each emotion. Error bars represent standard error. CAUG = “Care as Usual Group;” FCG = “Foster Care Group;” NIG = “Never Institutionalized Group.”

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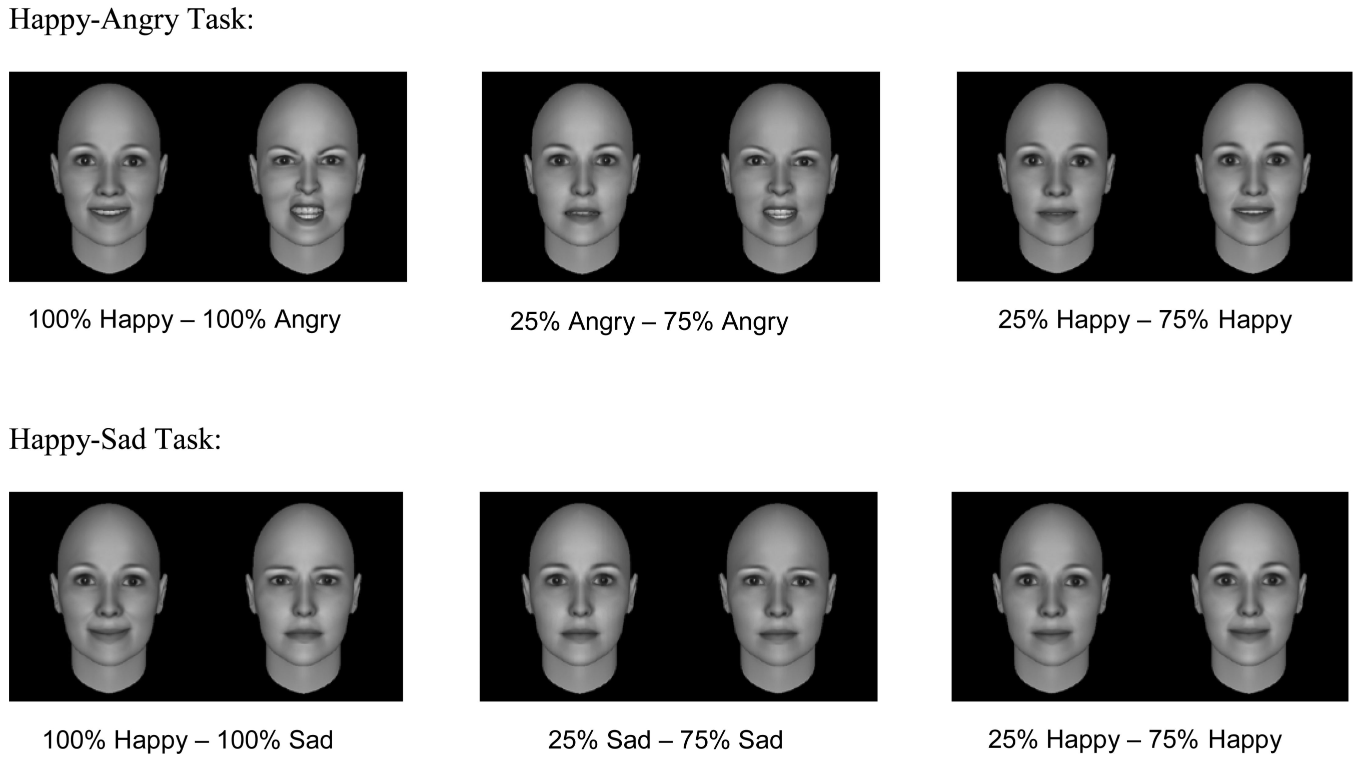
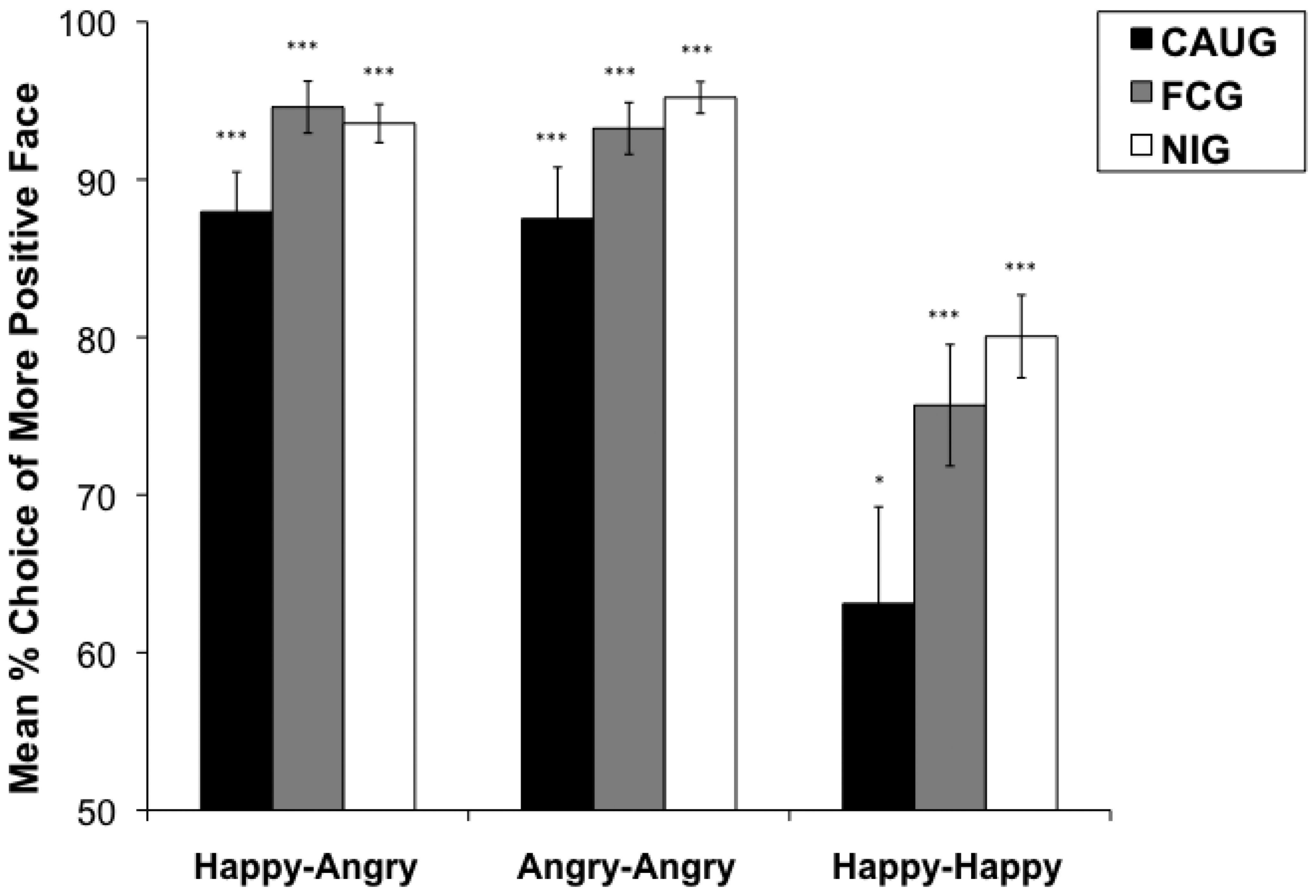


Figure 6.

Example trials from Experiment 2.

a) Happy-Angry Task



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b) Happy-Sad Task

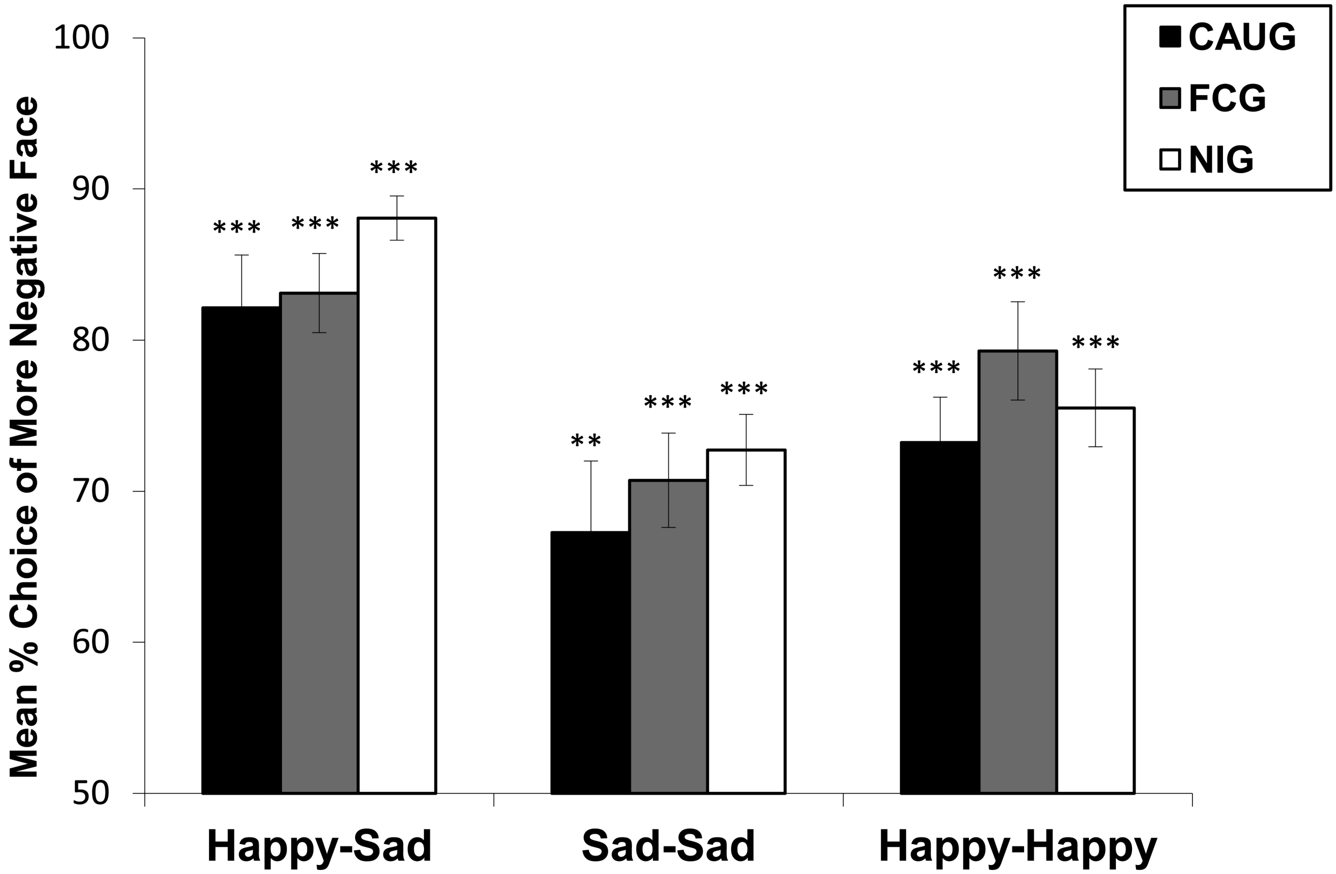

Figure 7.

Performance in Experiment 2. Error bars represent standard error. Asterisks indicate cases where performance differed from chance (50%) according to one-sample t tests (*$p < .05$; **$p < .01$; ***$p < .001$). CAUG = "Care as Usual Group"; FCG = "Foster Care Group"; NIG = "Never Institutionalized Group." A) Happy-Angry Task; B) Happy-Sad Task.

Table 1

Identification thresholds for the four emotions collapsed across groups.

Emotion	Estimate	95% Confidence Interval
Happy	33.24	(29.79, 36.69)
Sad	37.60	(34.16, 41.04)
Fearful	25.20	(21.73, 28.67)
Angry	33.23	(29.77, 36.67)

Table 2

Identification thresholds for the three groups collapsed across emotions.

Group	Estimate	95% Confidence Interval
CAUG	34.61	(32.21, 37.01)
FCG	33.10	(30.70, 35.49)
NIG	29.61	(27.21, 32.00)

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Table 3

Identification thresholds broken down by emotion and group.

Emotion	Group	Estimate	95% Confidence Interval
Happy	CAUG	36.66	(35.70, 37.62)
	FCG	32.23	(31.27, 33.19)
	NIG	30.66	(29.69, 31.61)
Sad	CAUG	41.83	(37.63, 46.03)
	FCG	37.31	(33.10, 41.50)
	NIG	35.23	(31.03, 39.43)
Fearful	CAUG	29.16	(25.19, 33.11)
	FCG	23.04	(19.08, 27.00)
	NIG	23.06	(19.10, 27.02)
Angry	CAUG	37.18	(32.26, 42.10)
	FCG	33.66	(28.73, 38.57)
	NIG	29.64	(24.72, 34.56)

Table 4

Mean number of misidentifications broken down by emotion and group.

Happy							**Sad**
Misidentified as:	Sad	Angry	Fearful		Happy	Angry	Fearful
CAUG	0.12	0.05	0.07		0.20	0.71	1.15
FCG	0.06	0	0.08		0.02	0.21	0.94
NIG	0.04	0.03	0.04		0.03	0.18	1.01
Angry				**Fearful**			
Misidentified as:	**Happy**	**Sad**	**Fearful**		**Happy**	**Sad**	**Angry**
CAUG	0.05	0.71	0.76		0.12	0.44	0.24
FCG	0	0.58	0.48		0	0.79	0.27
NIG	0.03	0.34	0.31		0.04	0.42	0.13

Table 5

Trial types and trial orders for Experiment 2.

Happy-Angry Task			
	More Positive Face	**Less Positive Face**	**Mean Performance**
Trial 1	100% Happy	100% Angry	0.99
Trial 2	75% Happy	75% Angry	0.99
Trial 3	50% Happy	50% Angry	0.95
Trial 4	25% Happy	25% Angry	0.82
Trial 5	100% Happy	25% Happy	0.86
Trial 6	25% Angry	100% Angry	0.98
Trial 7	25% Happy	25% Angry	0.79
Trial 8	50% Angry	100% Angry	1.00
Trial 9	100% Happy	50% Happy	0.82
Trial 10	75% Happy	25% Happy	0.81
Trial 11	50% Happy	50% Angry	0.89
Trial 12	25% Angry	75% Angry	0.95
Trial 13	75% Angry	100% Angry	0.95
Trial 14	75% Happy	75% Angry	0.99
Trial 15	100% Happy	75% Happy	0.66
Trial 16	75% Happy	50% Happy	0.71
Trial 17	50% Angry	75% Angry	0.93
Trial 18	100% Happy	100% Angry	0.97
Trial 19	25% Angry	50% Angry	0.76
Trial 20	50% Happy	25% Happy	0.64

Happy-Sad Task			
	More Positive Face	**Less Positive Face**	**Mean Performance**
Trial 1	100% Happy	100% Sad	0.98
Trial 2	75% Happy	75% Sad	0.92
Trial 3	50% Happy	50% Sad	0.91
Trial 4	25% Happy	25% Sad	0.67
Trial 5	100% Happy	25% Happy	0.88
Trial 6	25% Sad	100% Sad	0.82
Trial 7	25% Happy	25% Sad	0.64
Trial 8	50% Sad	100% Sad	0.77
Trial 9	100% Happy	50% Happy	0.87
Trial 10	75% Happy	25% Happy	0.73
Trial 11	50% Happy	50% Sad	0.85
Trial 12	25% Sad	75% Sad	0.62
Trial 13	75% Sad	100% Sad	0.76

Happy-Sad Task			
	More Positive Face	**Less Positive Face**	**Mean Performance**
Trial 14	75% Happy	75% Sad	0.93
Trial 15	100% Happy	75% Happy	0.81
Trial 16	75% Happy	50% Happy	0.55
Trial 17	50% Sad	75% Sad	0.72
Trial 18	100% Happy	100% Sad	0.92
Trial 19	25% Sad	50% Sad	0.56
Trial 20	50% Happy	25% Happy	0.73