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The discrimination of facial expressions by typically developing infants and toddlers and those experiencing early institutional care

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Abstract

Early experience likely plays an important role in the development of the ability to discriminate facial expressions of emotion. We posited that compared to children reared with their biological families ($n = 72$), abandoned children being reared in institutions ($n = 39$) should demonstrate impairments in this ability. The visual paired comparison procedure was utilized to assess the abilities of 13- to 30-month-old children to discriminate among multiple pairs of photographs of facial expressions. Both groups exhibited a normative profile of discrimination, with no group differences evident. Such findings suggest that early institutionalization does not affect the ability of 1- to 3-year-olds to discriminate facial expressions of emotion, at least as inferred by the Visual Paired Comparison Procedure.

Keywords: Early experience; Institutional rearing; Emotion recognition; Development; Visual discrimination

The ability to recognize facial expressions of emotion is a fundamental ability in the preverbal child, and matures rapidly over the first years of life. For example, Field, Cohen, Garcia, and Collins (1983), Field, Woodson, Greenberg, and Cohen (1982) have shown that infants as young as 36 h are able to discriminate happy, sad and surprise expressions from one another when posed by a live model. And, studies with older infants reveal that by 3 months infants can discriminate happy from surprise faces (Young-Browne, Rosenfeld, & Horowitz, 1977) and smiling faces from frowning faces (Barrera & Maurer, 1981); however, they cannot consistently discriminate sad faces from surprised faces and show no evidence of discriminating sad faces from happy faces (Young-Browne et al., 1977). By 4 months of age, infants look longer at joyful expressions than angry or neutral ones (LaBarbera, Izard, Vietze, & Parisi, 1976) and look longer at happy faces with toothy smiles than sad faces (Oster & Ewy, 1980) but look equally long at angry and neutral expressions (LaBarbera et al., 1976) or happy faces with closed mouths when paired with sad faces (Oster & Ewy, 1980). At 5 months infants can discriminate between sad and fearful faces; they can also discriminate both of

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these expressions and an interest expression from angry, but only if they are first habituated to angry and then tested with fear, sad or interest, and not if they are shown the expressions in the opposite order (for discussion, see de Haan and Nelson (1998)). At the same age infants show no evidence of discriminating joy from anger or interest (Schwartz, Izard, & Ansul, 1985), and at 6 months they show no evidence of discriminating surprised from fearful expressions (Nelson & Horowitz, 1980). Finally, by 7 months infants look longer at fearful than happy faces (Nelson & Dolgin, 1985) and can discriminate happy from fearful faces, but only if first habituated to happy and not if first habituated to fear (Nelson, Morse, & Leavitt, 1979). Finally, it is around this age that infants begin to show evidence of categorizing facial expressions; thus, infants are able to generalize their discrimination of happy faces across multiple exemplars of happy, and then discriminate happy from fear; however, they are unable to generalize their discrimination of fear faces across multiple exemplars and discriminate fear from happy. This last finding has been frequently replicated, and points to constraints on infants' knowledge of facial expressions.

The ability to discriminate between facial expressions of emotion likely aids the infant in identifying another individual's emotional state and frequently provides cues on how to respond and behave in social situations. In the current study we examined the role of early experience in shaping the ability to recognize static, prototypical facial expressions. Based on the assumption that emotion recognition is an experience-expectant and activity-dependent process (see Nelson, 2001), we posited that children reared in deprived environments, specifically those being reared in institutions would exhibit impairments in emotion recognition. As we elaborate below, the basis for this prediction is that such care is characterized by exposure to atypical social visual experience.

Children reared in institutional care (particularly common in Eastern Europe, Russia, and China) experience serious disruptions of caregiver–infant interactions. In the first $1-1\frac{1}{2}$ years of life (or until infants begin to locomote independently), infants have only limited face-to-face interactions with their caregivers, thus restricting their access to emotional information. This restricted experience occurs primarily because infants spend most of their time in individual cribs and have only occasional views of their caregivers' faces (mostly during feeding and changing). Thus, the lack of experience with emotional expressions may lead to impairments in emotion recognition.

Past work points to the potential effects of this limited experience on older children's social and emotional competence. One specific study examined the understanding of emotional expressions in 6- and 7-year-olds being reared in a Russian orphanage (Sloutsky, 1997). The study reported profound differences between orphanage-reared children and home-reared children in their identification of emotion states. Specifically, the orphanage-reared children identified significantly less frequently the emotions of anger, love, fear, and joy. Yet, the orphanage-reared children performed similar to the home-reared children on sadness and disgust, expressions that are presumably more common in the orphanage. In fact, the author points out that within the orphanage, displays of human emotion are deemed inappropriate for staff, thus the children may rarely witness adult emotional expressions.

Another study examined the play behavior of 4-year-olds adopted from Romania before 6 months or between 6 and 24 months of age (Kreppner, O'Connor, Dunn, Anderson-Wood, & the English and Romanian Adoptees Study Team, 1999). Both groups of adoptees exhibited lower frequencies of pretend play than the control group of children adopted from the United Kingdom. Pretend play, as assessed in this study, involved the child's ability to interact in a social way with the adult experimenter, and thus involved aspects of socio-emotional development. Facial expressions of emotion are social signals that, in part, act to dictate the social interplay between humans. The rules and skills guiding these normal social interactions are complex, but include the appreciation and understanding of other people's thoughts and intentions and, not surprisingly, the processing of affective facial expressions. Impairments in social interaction, similar to those reported in the Romanian adoptees, may include inadequate comprehension of social-emotional cues, poor use of social signals, and a lack of socio-emotional reciprocity. A number of investigators have suggested that infants are sensitive and responsive to their environments and that these experiences may be important to the child's ability to understand and discriminate emotional expressions and engage in social interactions with others (Nelson, 1987; Walker-Andrews & Lennon, 1991). Accordingly, the impairments in play behaviors observed in Romanian adoptees may primarily reflect deficits in socio-emotional development resulting from early deprivation.

In the current study we examined the impact of early experience on the discrimination of basic facial expressions of emotion in two groups of Romanian infants and toddlers. One group was reared within their families of origin in Bucharest, and the other consisted of children selected from several institutions for abandoned children within Bucharest (for details, see Zeanah et al. (2003)). Institutions characteristically retain a very high caregiver-to-child ratio (typically 12–15 children for 1 caregiver). The children who reside in these institutions, however, are typically adequately fed and clothed and receive some medical care. Thus, the employed measure was intended to capture

the effects of global deprivation, characteristic of the institutions, on the ability to discriminate facial expressions of emotion. We posited that differences in early experience with facial expressions of emotion may differentially impact the institutionalized and community groups' abilities to discriminate certain facial expressions. Specifically, because the community group is likely to have been exposed to typical rearing conditions in which positive expressions dominate (Malatesta & Haviland, 1982), this group is expected to succeed in discriminating all pairs of expressions when fear serves as the test stimulus, but will be unable to discriminate fear from other expressions when first familiarized to a fear face (based on the typical developmental pattern; see previous discussion, in which this stimulus order effects is discussed). Likewise, because the institutionalized group is likely to have been exposed to a more constrained range and intensity of facial expressions, and possibly more negative emotions, this group is expected to show impairments in the discrimination of positive emotion (i.e., happy) from negative emotion (e.g., fear, sad), but may show a better ability in discriminating sad expressions, relative to the community group (based on the assumption that sad may be a more dominant expression among institutional caregivers). Lastly, the two groups are expected to perform similarly in their ability to discriminate non-face objects. Such a finding will help to ensure that any deficits in discriminating facial expressions are not influenced by a more general perceptual impairment.

Admittedly our hypotheses are not as sharply defined as might be desirable, for several reasons. First, the vast majority of the work examining the discrimination of facial expressions has been performed in infants below 12 months of age; thus, it is difficult to predict what might happen with older children. For example, although there have been several replications of the finding that infants can discriminate happy from fear if first familiarized/habituated to happy but not if first familiarized/habituated to fear (e.g., Nelson & Dolgin, 1985; Nelson et al., 1979), this finding has typically be observed among 7 month old infants—thus, it is hard to predict whether a comparable finding will obtain in toddlers. Second, the vast majority of studies in this area have been conducted with Caucasian, middle class American children; to the best of our knowledge this is the first study to examine this ability among infants and toddlers in Eastern Europe. Finally, although a number of studies have been performed examining emotion recognition among older children with histories of neglect, we believe this is the first such study to examine this ability among young, institutionalized children.

Before describing our methods, three potential limitations of this study should be acknowledged. Because our project was essentially taking advantage of a tragic "natural experiment," there were a number of variables we could not control for or information to which we did not have access. For example, although we screened our study groups for obvious pre- and perinatal complications, it is possible that such variables could still have played a role in our findings (e.g., iron deficiency, prematurity). Second, there may also have been maternal conditions that existed prenatally that could potentially influence infant/child outcome, such as maternal psychopathology. In both cases, of course, these factors would tend to exaggerate group differences. Finally, although it may have been desirable to include a clinical group that did not experience the profound deprivation inherent in institutional care (e.g., those experiencing child abuse; those diagnosed with Fetal Alcohol Syndrome), it proved impossible to do so for the simple reason that there has been no history of child development research in Romania. As a result, recruitment of such a sample proved impossible.

1. Method

1.1. Participants

1.1.1. Institutional group

Children ranging in age from 5 to 31 months were initially recruited from six institutions for young children in Bucharest, Romania. All had spent more than half of their lives in institutional care. Screening for inclusion in the study consisted of a pediatric (including neurological) examination, growth measurements, and an assessment of any physical abnormalities (including those of genetic origin). Participants selected for inclusion fell within 2.5 S.D. from the mean for occipitofrontal circumference, using standards from Tanner (1973).

A group of 125 institutionalized children was enrolled in the study. Of these, 36 were tested but excluded because of fussiness, technical problems, or if the child was 12 months or younger.[2] The final sample of participants in the

[2] There were only a small number of infants 12 months or younger and for statistical purposes it was decided to delete these infants' data in order to constrain the age range.

institutional group consisted of 89 children. Participants ranged in age from 13.0 to 32.0 months ($M = 23.7$, S.D. = 4.8; 53 boys) and had spent an average of 91.1% of their lives in institutional care.

1.1.2. Community comparison group

A group of 72 children, who had never been institutionalized, were recruited using birth records from the same maternity hospitals where the institutionalized group was born. The children's parents were approached by personnel from the Institute for Maternal and Child Health (directly or through their family physician) at the children's routine clinic visits and invited to participate. They were matched to the other group by age and gender. The screening included a pediatric examination, physical growth measurements, and a psychosocial interview with the family. Although the exclusion criteria were the same for the community and institutionalized group, all participants in the community group fell within 2 S.D. from the mean for physical growth (weight, length, occipitofrontal circumference).

The final sample of participants in the community comparison group consisted of 39 children. Participants ranged in age from 13.0 to 29.0 months ($M = 22.4$, S.D. = 4.7; 22 boys). An additional 27 children were tested but were excluded because of fussiness, technical problems, or if the child was 12 months or younger.

Although not relevant to the current report, following baseline testing approximately half of the institutionalized children were randomly assigned to foster care to satisfy the purposes of the larger study for which these children were recruited (for details see Zeanah et al. (2003) and Zeanah et al. (in press)). Since these follow up data are still being collected, they are not reported herein.

1.2. Stimuli

The stimuli were static, color images taken from the NimStim-MacBrain Face Stimulus Set.[3] The stimuli (8-bit color, 800 × 600 pixel resolution) depicted eight American females unknown to the children and posing the facial expressions of happy, sad, neutral, and fear. The images were taken against a gray background while the women wore a gray scarf around their necks to conceal any clothing.

To ensure that any deficits we observed were due to deficits in processing facial emotion and not to more broadly based perceptual deficits, we also tested children's discrimination of non-face objects. Images of objects (spoon, shoe, mug, key) were used in object discrimination problem sets. These images were also taken against a gray background. The objects were chosen to represent familiar, but not emotionally salient, objects for both participant groups. Bitmaps of the objects were captured using an Olympus C-3030 digital camera and converted to 8-bit color using Adobe Photoshop.

1.3. Procedure

For all participants enrolled in the study, informed consent was obtained from biological parents and/or the Commission for Child Protection. Video recorded consent was also obtained from all caregivers.

The participants' discrimination abilities were assessed using the visual paired comparison (VPC), a non-verbal behavioral measure. Each child was tested individually while seated on his/her caregiver's lap, facing two computer monitors approximately 40 cm away. The computer monitors were surrounded by black panels that blocked the child's view of the room behind the screen and to his/her sides and the lights were turned off (unless the child had a known fear of the dark). The caregiver was instructed not to comment on the stimuli during testing but to soothe the child if he/she became fussy or upset. If the child looked away from the monitor during stimulus presentation, the observer behind the computer monitors tapped the monitors or rattled a toy behind it to attract the child's attention back to the screen.

For each problem set, participants were familiarized to a pair of identical stimuli for a cumulative, age-dependent, familiarization time. The familiarization trial was followed immediately by two counterbalanced (left/right positions

[3] The MacBrain Stimulus Set is a compilation of color images of male and female adult actors, representing a range of ethnicities, posing various facial expressions. The pictures were originally taken using a Nikon F3 35-mm camera and then scanned and transformed into computer images (8-bit color, 800 × 600 pixel resolution). Development of the NimStim-MacBrain Face Stimulus Set was overseen by Nim Tottenham and supported by the John D. and Catherine T. MacArthur Foundation Research Network on Early Experience and Brain Development. For further details, see http://www.macbrain.org/faces/index.htm.

reversed) test trials, in which the familiar stimulus was paired with a novel stimulus. This manipulation (familiar stimulus followed by two test trials) constituted one problem set. For the facial emotion discrimination task, participants were tested using four different facial expression pairs: sad versus fear, fear versus neutral, happy versus sad, and fear versus happy. The task was administered in a between-subjects design, such that one stimulus order group of participants was familiarized to sad, fear, happy, and fear, and tested on, respectively, fear, neutral, sad, and happy. The second stimulus order group of participants received the opposite order. Each emotion comparison was presented three consecutive times, depicting a different model in each comparison. Using multiple problem sets for each emotion comparison decreased the possibility of preference effects resulting from facial identify. In addition, participants were tested with two additional problem sets testing object discrimination. Here participants were familiarized to an image of a shoe and tested on an image of a spoon (or the reverse) and familiarized to an image of a key and tested on an image of a mug (or the reverse). The object and emotion expression comparisons made up a total of 14 problem sets.[4]

As mentioned, the timing parameters of stimulus presentation were age dependent, such that familiarization and testing times varied by age (Rose, Feldman, & Jankowski, 2001). The younger group of participants (12–23 months) was familiarized for 10 s and tested for two 5-s, continuous periods. The older group (24–32 months) was familiarized for 7 s and tested for two 3-s periods. Such timing parameters were intended to allow for proper familiarization, yet were short enough to not severely limit the number of problem sets that could be presented at one session.

The procedure was recorded by a digital camcorder that also projected the image of the child's face on a monitor in another testing room. This set-up enabled the experimenter to observe and record by mouse-click the direction and duration of each look. The recordings were conducted by observers, who were trained until their observations were deemed reliable by the second author, who has extensive experience using this procedure. Due to a lack of provisions to record from two observers,[5] reliability scores were not compiled, a noticeable shortcoming of this work. However, such observations are widely acknowledged to be highly reliable, thus the lack of formal reliability scores was not thought to be problematic. The computer recorded the direction and duration of each look for later analysis. Longer looking to the novel stimulus, relative to the familiar stimulus, during test trials is taken as evidence that the child has discriminated between the two emotions (Fagan, 1970; Fantz, 1964).

1.4. Data analysis

Data were first converted to percentages by dividing the length of time spent looking at the target (novel) stimulus by the total length of time looking at either stimulus; since all of our stimuli occurred in pairs, the total for the pair was 100%. Data were interpreted using a $2 \times 2 \times 2$ analysis of covariance (ANCOVA), care group $\times$ familiarization presentation group $\times$ gender, with age used as a continuous covariate; for the two object comparisons there was only one trial per subject, for the four emotion comparisons there were three trials each per subject treated statistically as repeated measures. Significance tests and adjusted means and standard errors were computed using the likelihood-based program SAS PROC MIXED. Since this approach yielded six ANCOVAs, each of which had eight *F*-tests of between-subjects effects, we chose to use $p < .01$ as indicating statistical significance. Some children were not able to complete every test; hence samples sizes vary slightly from task to task.

2. Results

Fig. 1 shows the adjusted mean estimates, and twice their standard errors (i.e., 95% confidence interval) of the percentage of time spent looking at the novel stimulus in each pair. Each pair of bars represents the two groups as defined by familiarization order. These means suffice to capture the major findings of the study, which were

[4] Because of the logistics of launching this study, the emotion discrimination task was implemented several days before the object discrimination task. In addition, once the task was implemented, we administered the emotion task before the object task, which led to a small number of subjects not completing the object task. The overall result of these two events was that 14 more children were tested and/or gave good data in the emotion task versus the object task.

[5] While state of the art in many ways, the laboratory constructed in Bucharest was lacking in multiple capabilities during collection of the current data. At the start of the study, the hardware of the visual paired comparison set-up did not allow for multiple observers during the same test session. Moreover, following the resolution of this issue, scheduling two observers for test sessions proved very difficult due to staff limitations.

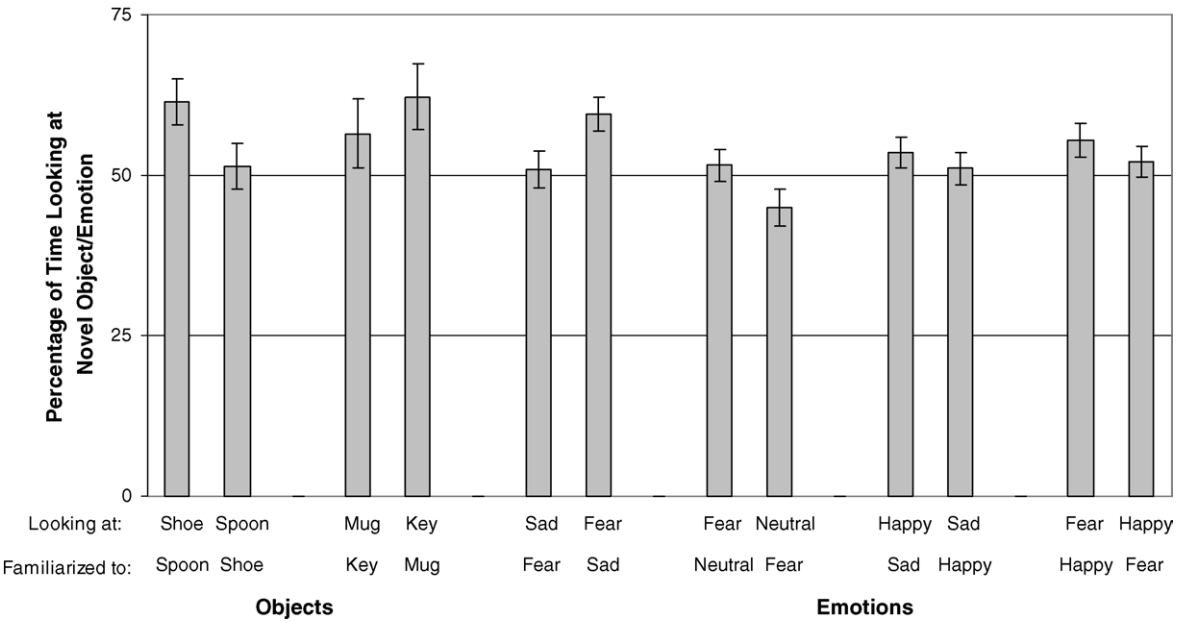

Fig. 1. Estimated percent of time infants spent looking at novel objects or faces. Sample sizes are reported in Table 1; bars represent 95% confidence intervals.

that: (a) children's object discrimination was intact (with the exception that they were unable to discriminate spoon from shoe when first familiarized to shoe; see below for elaboration) and (b) children in both groups showed intact discrimination of most expression pairs, except when first familiarized to fear (again, see below for elaboration). Table 1 provides *F*-statistics, *p*-values and estimated effect sizes for the main effects of care group, familiarization group and gender. Five of the six ANCOVAs (all except neutral-fear) yielded significant main effects of familiarization group, yet only two of the other 42 inter-subject main effects and their interactions were significant, and those only at $p < .05$. Since neither of these effects was hypothesized in advance, and since they were not supported by other similar effects, we would minimize their importance to our findings. The repeated measures effect deriving from the three trials of the emotion comparisons did not approach significant, nor did its interactions with the inter-subject effects.

2.1. Object comparisons

Both the Spoon-Shoe and Key-Mug dyads showed a highly significant effect between care group and familiarization group. As may be seen in Fig. 1, when first familiarized to the spoon, the percentage of time spent looking at the shoe (the novel stimulus) was greater than that spent looking at the spoon (the familiar stimulus; Shoe = 61% versus Spoon = 39%), but neither of the objects dominated after familiarization to the shoe (Spoon = 51% versus Shoe = 49%). Familiarization to either the key or the mug produced significant novelty preference, although it was somewhat stronger after familiarization to the mug ($p < .0001$). These findings were consistent across the two groups of children. There was no significant interaction between group and familiarization. In the Spoon-Shoe trial, there was a suggestion of a main effect of gender ($p = .02$); girls looked at the shoe more often than did boys (58% versus 52%). There were no other significant main effects or interactions involving group or gender. Age, the covariate, was not a significant effect, although the means we report in Fig. 1 are adjusted for age.

2.2. Emotion comparisons

The Fear-Sad, Happy-Sad, and Happy-Fear dyads all showed significant effects of familiarization. As may be seen in Fig. 1, familiarization to Sad in the Sad-Fear dyad elicited a novelty response to Fear (the novel stimulus; 59% versus 41%), but familiarization to Fear did not produce a difference in response (Fear = 49% versus Sad = 51%); these

Table 1
Significance tests of main effects in ANCOVAs

	Care group	Stimulus order	Gender
Shoe-Spoon ($N = 128$; d.f. = 1,119)			
n	89, 39	65, 63	60, 68
F	.32	23.84	5.54
p	.57	<.001	.02
d	.11	.95	.46
Key-Mug ($N = 127$; d.f. = 1,118)			
n	89, 38	65, 62	59, 68
F	.28	24.36	3.00
p	.60	<.001	.09
d	.10	.97	.34
Fear-Sad ($N = 142$; d.f. = 1,133)			
n	100, 42	72, 70	67, 75
F	.17	27.88	2.33
p	.16	<.001	.13
d	.17	.62	.18
Neutral-Fear ($N = 142$; d.f. = 1,133)			
n	100, 42	72, 70	67, 75
F	1.22	3.72	.04
p	.27	.06	.84
d	.18	.21	.02
Happy-Sad ($N = 142$; d.f. = 1,133)			
n	100, 42	72, 70	67, 75
F	1.23	7.08	3.17
p	.27	.009	.08
d	.12	.29	.19
Happy-Fear ($N = 142$; d.f. = 1,133)			
n	100, 42	72, 70	67, 75
F	1.27	16.70	.17
p	.26	<.001	.68
d	.11	.40	.04

Notes. (1) Computations done with maximum likelihood estimation (see text). (2) *d* = effect size = (difference between means)/(standard deviation). (3) All means estimated after adjusting for age, although age is not statistically significant in any of the ANCOVAS, $p > .25$ for all six analyses.

responses were significant ($p < .0001$). There was a modest ($p = .018$) three factor interaction, possibly arising from a smaller difference between boys and girls familiarized to Sad in the Institutionalized group than between boys and girls familiarized to Sad in the Community group.

In the Happy-Sad condition there was significantly smaller percentage of looking directed toward the familiar stimulus for Sad than for Happy (46% versus 49%, $p = .009$).

In the Happy-Fear comparison there was a greater novelty reaction to fear among those familiarized to Happy than among those familiarized to Fear (55% versus 52%, $p < .0001$). No other main effects or interactions were found to be significant.

2.3. Comment on results

The absence of significant differences between institutional children and community controls must be interpreted with reference to statistical power, that is, whether our study had enough subjects to detect an effect if it were truly present. Given our sample sizes of 89 and 39, respectively, we should have been able to detect (with power = .80) an effect size of about .53 standard deviations on each main-effect test. This effect would represent two nearly overlapping populations with very little to distinguish them. We therefore feel that it is quite likely that the institutional and community children are very similar in their responses on these measures.

3. Discussion

As expected, both the institutionalized and community groups displayed an appropriate ability to discriminate objects, in that both groups displayed longer looking to the novel object than to the object to which they had been familiarized. The lack of a deficit in this ability indicates that the general perceptual abilities of both groups are intact. Of course, it must be acknowledged that our choice of objects leaves something to be desired, given the stimulus order effect we observed; specifically, given the fact that (a) only infants familiarized to the spoon discriminated the spoon from the shoe, and (b) infants familiarized to the shoe failed to show a novelty preference for the spoon, infants appear to have a looking preference towards the spoon. The fact that this preference was observed across both groups points to the robustness of the effect, even if no ready interpretation of why infants/toddlers might prefer to look at a spoon versus a shoe is apparent.

In the emotion comparisons, the two groups displayed similar looking patterns to the test stimuli. Specifically, both groups discriminated fear from sad when first familiarized to sad but not when first familiarized to fear. Here it is worth noting that there was a modest three-way interaction, in which there was a smaller difference between boys and girls familiarized to sad in the Institutionalized group than between boys and girls familiarized to sad in the Community group. However, the magnitude of this interaction coupled with its isolated nature precludes interpretation.

For both groups, there was again a stimulus order effect, in which no looking preferences were observed for sad when first familiarized to happy, whereas for infants familiarized to sad, there was a modest preference for the novel stimulus (happy), 53.6%, S.E. = 1.3%. Finally, in the happy-fear comparison, both groups performed similarly: specifically, when familiarized to happy a novelty preference for fear was observed, whereas when familiarized to fear no such preference was observed to happy. These findings are consistent with past work showing that infants are typically able to discriminate happy from fearful faces, but only if they are first familiarized to happy and not if they first familiarized to fear (Nelson & Dolgin, 1985; Nelson et al., 1979). Past research with young infants has reported a consistent preference for fear expressions compared to happy expressions (Kotsoni, de Haan, & Johnson, 2001; Nelson & Dolgin, 1985; Nelson et al., 1979). Unfortunately, the development of the ability to discriminate facial expressions in children beyond 10 months of age has yet to be examined. Thus, while the current findings are consistent with those studies conducted with younger infants, similar studies of children more comparable in age to the current sample have not yet been conducted.

Finally, no significant effects were observed in the neutral-fear comparison. Recent work indicates that young children may not have acquired an understanding of the neutrality represented in a neutral expression (Thomas et al., 2001). Instead, a neutral expression may be an ambiguous signal requiring increased vigilance, similar to the fear expression. Thus, when presented with neutral and fear expressions, the neutral expression may evoke, relative to other expressions, greater looking time. This ambiguity of the neutral expression may have somehow affected the difference in overall looking time found in the neutral/fear comparison.

In summary, both groups appear to demonstrate a similar ability to discriminate facial expressions of emotion, potentially indicating that the institutionalized group received an adequate amount of experience to drive or maintain the development of this ability.[6]

The failure to observe deficits in emotion discrimination among our institutionalized sample was surprising, given the suggestion from past research that the development of the amygdala (a structure believed to play a prominent role in discriminating some facial expressions, particularly fear; see Adolphs, Tranel, Damasio, and Damasio (1994)), may be compromised by deprived rearing conditions (Chugani et al., 2001). We predicted that early institutionalization would compromise the development of this structure due to restrictions in the type and range of visual information available to the infant. This altered visual experience would, in turn, lead to deficits in recognizing facial expressions of emotion (Adolphs et al., 1994). The current findings, however, indicate that such behaviors were spared (although our data do not speak to whether other functions subserved by the amygdala might also be spared and whether the

[6] It must be kept in mind that an obvious limitation of the current study, one not specific to the VPC procedure, is the challenge of interpreting null findings—in this case, the failure to observe differences between the two groups. However, given that the order effects observed herein are consistent with the literature and were consistent across group, somewhat greater credence can be placed on the negative findings obtained. Moreover, given the possibility that our institutionalized group experienced various pre- or perinatal complications not experienced by our control (never institutionalized) group (such as prematurity or Intrauterine growth restriction), the failure to observe substantial group effects supports our contention that our findings are not due to Type II error.

normative effects we observed herein will be observed as we follow our group of participants into the preschool-age period).

However, it is worth noting is that the visual paired comparison procedure is a relatively gross scale of emotional discrimination and understanding. Indeed, in a separate study examining this same group of infants, we (Parker, Nelson, and the Bucharest Early Intervention Core Group, 2005) report that early components of the event-related potential do, in fact, differ among institutionalized versus non-institutionalized infants/toddlers in response to facial expressions of emotion. Importantly, however, the late components, which presumably reflect more cognitive processing, do not differ (a finding, perhaps, consistent with our current looking time data). Thus, these electrophysiological data suggest that there are, in fact, processing deficits among institutionalized children, deficits not detected using looking time measures. Consequently, further research is needed to elucidate how or whether such deficits influence more "upstream" processing of facial (or other) emotion. An additional area of future research includes the role of early experience in the development of the understanding of the social significance of different expressions (cf. Sloutsky, 1997) and, accordingly, how to utilize the information conveyed in this social signal to guide their behaviors. For example, while the institutionalized group appears to have some understanding of the need for increased vigilance in response to a fear expression, whether they are able to translate this understanding into an appropriate behavioral response is unknown. This is a topic to which we hope to turn our attention as our study progresses.

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