Chapter 9

The Effects of Early Deprivation on Brain-Behavioral Development

The Bucharest Early Intervention Project

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The effects of early experience on brain and behavioral development are most frequently examined by studying the effects of early deprivation. Indeed, using both animal models and so-called "experiments of nature" with humans, extremes of early experience provide opportunities to explore the origins of typical and atypical psychological development, along with the neurobiological underpinnings that support such development. A short list of examples from this literature include the effects of (a) monocular and binocular deprivation on visual development, (b) early auditory deprivation on auditory and linguistic development, (c) poverty on cognitive development, and (d) psychosocial deprivation on psychological, mental, and physical development (for discussion of these and related topics, see Knudsen, 2003; Nelson, Thomas, & de Haan, 2006).

In nearly all cases, deprivation exerts powerful effects on the course of development. It must be underscored, however, that the specific effects and the severity of effects will vary as a function of the dose, timing, and duration of the deprivation and, as well, individual differences in the response to the deprivation (which likely have most to do with the individual's genetic makeup and experiential history). Thus, for example, being deprived of auditory or visual input during the time the auditory or visual system is developing will lead to a different developmental outcome than if such deprivation occurs later, once these systems are online and mature. Most sensory and perceptual systems generally have

sensitive periods that occur very early in development; less is known about cognitive and social-emotional development, although both domains clearly share features with sensory and perceptual development (e.g., the importance of early cognitive stimulation or the opportunity to form an attachment).

Not surprisingly, there is a vast literature on the effects of deprivation on rodents and nonhuman primates that extends from sensory to cognitive to social development. Such work has the advantage of being able to manipulate variables in a controlled and systematic way that permits causal or semicausal inferences to be drawn. Such is not the case when it comes to the human, as one cannot randomly assign infants and children to differing degrees of deprivation at different ages. Rather, one often takes advantage of so-called experiments of nature, by which we mean situations in which a child has been deprived of a given experience by virtue of a congenital abnormality or, sadly, by sociopolitical circumstances. Children born with cataracts or born deaf represent an example of the former, whereas children abandoned at birth and placed in institutions represent an example of the latter. In this chapter we focus specifically on children being reared in institutions.

Institutional care, which was studied with small scale and often poorly controlled studies through much of the early to mid-20th century, recently has reemerged as a focus of study as tens of thousands of "postinstitutionalized" children have been adopted into the United States and Western Europe (Zeanah, Smyke, & Settles, 2005). More recent investigations have been more rigorous and have confirmed earlier findings from descriptive studies suggesting that institutional care was associated with a variety of deleterious outcomes. Contemporary research has documented many problems in young children adopted out of institutions in Eastern Europe and Russia. Although there may be wide variability in the quality of care between and even within institutions, there are certain modal features that tend to characterize institutional care: regimented daily schedule, high child/caregiver ratio, nonindividualized care, lack of psychological investment by caregivers, lack of sensory, cognitive, and linguistic stimulation, and rotating shifts, all leading to an adverse caregiving environment (for an example of such conditions in Russian orphanages, see St. Petersburg–USA Orphanage Research Team, 2005).

Not surprisingly, young children adopted out of institutions characterized by social and material deprivation have been shown to be at risk for a variety of social (Chisholm, 1998; O'Connor et al., 2003), cognitive (Hodges & Tizard, 1989; O'Connor, Rutter, Beckett, et al., 2000a), and psychiatric sequelae (e.g., Ellis, Fisher, & Zaharie, 2004). Despite the importance of their contributions, these studies have important limitations that must be acknowledged. First, most adoption studies have not been able to assess important details of the preadoptive caregiving environment (that is, what the institutional environment is like). This is important, because there is wide variability between and within settings (Smyke, Zeanah, & Koga, 2002b; Zeanah et al., 2003). Second, children are not adopted randomly

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from institutions, and selection bias may limit our ability to understand developmental differences associated with institutionalization because more impaired children are less likely to be studied. Third, measures of important constructs have often been limited. For example, in the area of psychiatric symptomatology, most studies have relied on behavior problem checklists rather than structured psychiatric interviews (Fisher et al., 1997; Hoksbergen et al., 2003; Kreppner, O'Connor, & Rutter, 2001; Marcovitch et al., 1997; Roy, Rutter, & Pickles, 2000). Fourth, in the context of social development, attachment and indiscriminate sociability[1] have been studied (Chisholm, 1998; O'Connor et al., 2003; Smyke et al., 2002a; Vorria et al., 2003; Zeanah et al., 2005), but many other developmental processes vital to social adaptation have not been examined, especially social cognition. Fifth, more within-country studies of the effects of institutionalization are needed so that effects resulting from the experience of adoption into another culture (and often into a different language environment) can be disentangled from the effects of institutionalization itself. Sixth, other than a study of PET scans in 10 children adopted out of institutions (Chugani et al., 2001) and our preliminary work (Marshall, Fox, & the BEIP Core Group, 2004; Parker & Nelson, 2005; Parker, Nelson, & the BEIP Core Group, 2005), there have been no studies of brain functioning, and we know far too little about functional differences in brain development in children raised in institutions. Ultimately, behavioral plasticity and recovery from early abnormalities must involve neurobiological processes, but formidable challenges remain before we determine which ones.

The Bucharest Early Intervention Project (BEIP) was designed to address these limitations. The project itself was an outgrowth of a broader initiative aimed at understanding the role of experience in influencing brain and behavioral development. This initiative was embedded in the work of a MacArthur Foundation research network entitled Early Experience and Brain Development (www.macbrain.org). The premise of this group of researchers was to systematically examine how experience influences brain development and behavioral development across species; indeed, the BEIP has a nonhuman primate counterpart (to it) designed to examine the effects of early social bond disruption in rhesus monkeys (for a summary of this and related work in the context of developmental psychopathology, see Nelson et al., 2002). In so doing, we hope to take advantage of this comparative approach by modeling in the nonhuman primate the "experiment of nature" we are studying in Romania.

necessary?

Bucharest Early Intervention Project

The Bucharest Early Intervention Project (BEIP) is a randomized controlled trial comparing the effects of foster care as an alternative to institutional care for young children abandoned at birth and placed in institutions (Zeanah et al., 2003). The

study was collectively designed by members of the Early Experience and Brain Development network and implemented by the three authors of this chapter. This study, which is still ongoing, comprehensively assessed 136 children between the ages of 6 and 31 months who were institutionalized in all 6 of the institutions for young children in Bucharest, Romania, and followed them systematically though 54 months of age. The details of this assessment are described in the next section.

Study Design

Assessing children at baseline—that is, prior to randomization—increased our confidence that outcome differences would reflect true effects of the intervention and not, for example, differences in sample makeup. As discussed in Zeanah et al. (2003), randomization prior to intervention addressed the concerns about previous studies of adopted children that have the potential of selection bias with regard to who is adopted and therefore included in studies. In addition, randomization prior to intervention increased the chance that prenatal risk factors would be evenly distributed across the intervention and control groups. The inclusion of a community sample of Romanian never-institutionalized children permitted us to ascertain whether our measures would yield the same findings in a Romanian comparison sample as in a U.S. sample and to reveal potential ethnic differences. Moreover, because we predicted that foster care would serve to redress the sequelae associated with institutional care, it was imperative that we be able to compare our intervention group with an in-country comparison group.

Our study design permitted us to juxtapose both length of time in the institution with months of intervention, and in so doing permitted us to assess the effects of timing of intervention on remediation.

Participants

INSTITUTIONAL GROUP. We initially screened 187 children (51% boys, 49% girls) who resided in any of the 6 institutions in Bucharest, and who at the age of screening were 31 months of age or less. An additional eligibility criterion was that these children needed to have spent at least half of their lives living in an institution. The screening consisted of a pediatric/neurologic exam, growth measurements, an auditory assessment, and assessment of any physical abnormalities, and took place in February 2000. Of those screened, we excluded 51 children for medical reasons, including genetic syndromes; frank signs of fetal alcohol syndrome, based in large part on facial dysmorphology; and microcephaly using standards from Tanner (1973), which then resulted in 136 children in our institutionalized group (prior to randomization to foster care).

NEVER-INSTITUTIONALIZED GROUP (NIG). These children were drawn from the same maternity hospitals as our IG, and matched on age and gender to them.[2]

Eighty children were initially recommended by their pediatricians, and after screening 72 were enrolled.

Each assessment consists of up to 14 procedures (depending on the age of the child). These assessments are divided into 3 lab assessments and 1 home/institutional observation. Additionally, physical growth measures of all children in the institutional and foster care groups are obtained monthly.

Measures

The measures we employ include a range of structured and unstructured procedures in laboratory and naturalistic settings, as well as elicited and observed behaviors in the child. Cognitive functioning, social communication and social relatedness, and attachment (Ames, 1997; Chisholm, 1998; Johnson, 2000; O'Connor et al., 2003; O'Connor et al., 2000a; O'Connor et al., 2000b; Zeanah, 2000) were all included as central measures due to the fact that these domains are all known to be compromised among previously institutionalized children. Note that although we list all the dimensions we assessed, not all of these findings will be discussed in this chapter.

CAREGIVING ENVIRONMENT. We used the Observational Record of the Caregiving Environment (ORCE) to assess qualitative and quantitative differences in caregiving environments in the institution, foster care homes, and homes of the never-institutionalized children.

PHYSICAL GROWTH. Physical growth is assessed (monthly, permitting us to construct growth curves) using standard measures of weight, length/height, occipitofrontal circumference, mid-arm circumference, triceps skin-fold, and height.

COGNITIVE FUNCTION. The Bayley Scales of Infant Development (BSID-II) are used to assess developmental level through 42 months of age, whereas the Weschler Preschool Primary Scales of Intelligence (WPPSI) is used for the 54-month assessment.

LANGUAGE. Language development is assessed with the Receptive-Expressive Emergent Language (REEL) scales (Bzoch & League, 1972) and the Reynell Developmental Language Scales III (Edwards, Garman, Hughes, Letts, & Sinka, 1997), as well as by quantitative assessments during social interaction.

SOCIAL COMMUNICATION. The Early Social Communication Scales (ESCS; Mundy, P., Delgado, C., Block, J., Venezia, M., Hogan, A., & Seibert, J. (2003) assess the child's initiation of joint attention, response to joint attention, and behavior regulation.

EMOTIONAL REACTIVITY. We selected two tasks from a standard laboratory battery for the assessment of temperament (LAB-TAB, Goldsmith, & Rothbart, 1999) to assess positive affect reactivity: the peek-a-boo and the puppet interview tasks. For peek-a-boo, the child's caregiver/mother participated and for the puppet task, a female experimenter performed the task.

INTERACTIONAL BEHAVIOR. The Crowell Procedure (Crowell & Feldman, 1988) was used to observe a variety of structured episodes of parent-child interaction, including free play, clean up, blowing bubbles, a series of teaching tasks, and a separation and reunion between the child and a caregiver who knew the child well.

ATTACHMENT. In order to assess attachment in the institutional setting, we use three different methods. First, we use classifications of the Strange Situation Procedure (Ainsworth, Blehar, Waters, & Wall, 1978), observing the child with his/her "favorite" caregiver. Second, we developed a continuous rating of the degree to which a child has formed an attachment to a parent/caregiver based on behavior in the Strange Situation. Finally, we use the Disturbances of Attachment Interview (Smyke & Zeanah, 1999) to assess attachment disorder symptomatology. This interview has been validated preliminarily in a sample of institutionalized Romanian children (Smyke et al., 2002a; Zeanah, Smyke, & Dumitrescu, 2002).

EMOTION RECOGNITION. Based on the assumption that face recognition is an experience-expectant and activity-dependent process (see Nelson, 2001), we posited that institutional care would lead to impairments in emotion recognition, possibly due to delays in the development of the amygdala and surrounding circuitry purported to be involved in this process (for review, see Nelson, 2001; Nelson & de Haan, 1996). We employed two tasks designed to examine the discrimination and recognition of facial expressions. The first involves the visual paired comparison procedure (VPC), in which infants are first presented with pairs of identical faces (e.g., the same model posing the same expression; "happy") and then tested by presenting the familiar stimulus alongside a stimulus in which the facial expression has changed ("happy" vs. "fear"). Looking time is recorded, and longer looking at the novel stimulus permits the inference that the infant has discriminated the two emotions. In our second paradigm, we record event-related potentials (ERPs) while infants are presented with happy, fear, anger, and sad faces (25% probability each). Here, the goal is to examine whether the neural correlates of emotion recognition differ across our samples. Collectively, we hope to be able to specify some of the areas of neural functioning underlying social relatedness that are impacted by early social deprivation.

ELECTROPHYSIOLOGY. Conventional neuroimaging tools such as MRI and fMRI exist in only a limited fashion in Bucharest. As well, we first studied the children

when they were infants or toddlers. As a result, we focused our efforts on the recording of the brain's electrical activity, including both the resting electroencephalogram (EEG) and the event-related potential (ERP). Both measure provide detailed information about the transmission of electrical information throughout the brain (i.e., mental chronometry), and in the case of the ERP, ~~also provide~~ some information about the neural and mental operations the brain performs when engaged in a cognitive task. To this end we used the EEG as our metric of overall brain development and brain health and the ERP to probe the child's knowledge of facial identity and facial expressions. Each of these is described below.

We are investigating four elements of our EEG data: (1) the patterning of EEG power in different frequency bands across the scalp (a metric of the brain's general level of functioning across different domains; thus, the alpha band reflects sensory processing, the beta band reflects cognitive processing, etc.), (2) the development of EEG power spectra (a metric of the general amount of electrical activity generated by the brain), (3) intrahemispheric EEG coherence (a metric of the brain's ability to communicate from one region to another), and (4) frontal EEG asymmetry (a metric of differential activity recorded over the frontal lobe and thought to reflect individual differences in temperament or emotion). In addition to collecting EEG data during different stimulus conditions, we acquire EEG time locked to the presentation of auditory and visual stimuli. We are interested in the infants' and young children's physiological responses to novelty in the auditory modality. Inspection of ERP waveforms allows us to investigate electrophysiological reactivity to auditory novelty.

FACE RECOGNITION. Face recognition plays an important role in caregiver-infant interactions prior to the onset of language. In this context we are evaluating the child's ability to recognize his/her caregiver's face and discriminate this from the face of a stranger. Children are presented with digitized images of their primary caregiver's face and the face of a stranger while ERPs are recorded. From this project we intend to evaluate not only whether children show ERP evidence of discriminating caregiver from stranger, but as well, whether the neural processes involved in such discrimination are the same across groups.

Experimental Design

The BEIP began with comprehensive assessments of children and their caregiving environments prior to randomization, and then assessed their development serially at 9, 18, 30, 42, and 54 months. Because participants were 6–30 months of age at the beginning of the study, *all* children were seen for follow-up assessments at 30, 42, and 54 months.

DESCRIPTION OF FOSTER PARENTS. Before describing our findings, some mention should be made of our foster care intervention. A challenge entering the study

was that foster care did not exist in Bucharest prior to our arrival, and for this reason we needed to develop our own system. Because of the extreme deprivation our institutionalized children experienced, we thought it essential to develop a foster care system that was high quality, but also one that was realistically replicable. To this end we actively recruited and then screened potential foster care parents. After screening, we were able to identify 56 foster care families who met our rigorous criteria, and 69 institutionalized children were randomly assigned to be placed in foster care (leaving 67 children to be randomly assigned to remain in the institutions). Of 56 foster families eventually recruited to participate, 46% were single-parent families. All foster mothers had at least a high school education, with an additional 63% having completed vocational training, possessed specialized skills, or completed college. In addition, 27% were retired, and 5% had never been employed before.

All foster care parents received a monthly stipend, and we provided essential supplies for the children (e.g., diapers, toys) and a 24-hour, on-call pediatrician for all children. Moreover, our team of social workers visited the families on a regular basis, and if the child or family required clinical services, the social workers either provided those services directly or made necessary referrals. Crucial to this model was clinical supervision provided on a weekly basis to the social workers in Bucharest by American psychologists.

In the discussion that follows, we highlight just a few of the major findings at baseline and when possible, follow-up. It is important to underscore that many of these findings are preliminary because data collection continues, but the pattern of findings is fairly clear. First, institutional environments were less adequate based on quantitative and qualitative ratings when compared to family settings at all points in time. Further, children in institutions had more developmental delays and deviance in almost every domain assessed. Foster care appears to be leading to amelioration of some of these delays and deviances, but in no domain did children in foster care catch up to children who had never been institutionalized (insofar as we have been able to look at our data thus far).

Findings

After briefly describing some general findings, we will focus most on just a few domains of functioning that we consider most germane to this volume.

GENERAL OBSERVATIONS ABOUT CAREGIVING. In the BEIP study, caregivers of never-institutionalized children were both more available and interacted more frequently with their children than did caregivers in institutional settings. Further, within the institutionalized group, quality of caregiving at baseline was strongly associated with cognitive development and with child competence. Care was assessed based on ratings of 2-hour videotaped observations. They were coded with the Observational Record of the Caregiving Environment (ORCE), which is de-

scribed in Zeanah et al. (2003) and Smyke et al. (2006), explaining variance over and above what was accounted for by large between-group (institutionalized vs. never-institutionalized) differences (Smyke et al., 2004). Among institutionalized children, quality of caregiving was related to signs of attachment disorder and to a more fully developed attachment to the caregiver. Quality of caregiving also was the only significant factor associated with an institutionalized child having an organized (as opposed to disorganized or unclassifiable) attachment.[3]

At follow-up, infants and toddlers randomized into foster care were observed to use speechlike vocalizations and to exhibit more positive interactions with caregivers significantly more frequently than children who had been randomized to continued institutional care (Smyke et al., 2004). This pattern of findings, both in the NICHD child care studies (see NICHD Early Child Care Research Network, 1996, 2003, 2005) and in the findings from the infant and toddler BEIP, suggest that quality of the caregiving environment, as measured by the ORCE, is an important construct in understanding child outcome. Examples of inadequate caregiving include being less available to the child or interacting less with the child.

To illustrate differences in our institutionalized versus never-institutionalized children, we will sample five different domains, including attachment, cognitive development (i.e., Bayley scores), EEG power, ERPs to facial recognition of emotion, and psychiatric disorders. Note that because both data collection and data analysis is ongoing, only an overview of these findings will be discussed (here the reader is encouraged to consult our existing published data).

Mental age: At baseline, there were substantial differences in the institutionalized group and the never-institutionalized group. Mean scores on the Bayley Mental Development Index (MDI) were 103 in the never-institutionalized group (virtually identical to the population mean of the US of 100) and 65 in the institutionalized group (Smyke et al., 2003). The latter score was inflated because the lowest score assigned on the Bayley is < 50. All children who received this score were assigned a score of 49. Following randomization, children in foster care demonstrated more significant gains in MDI scores than children in the institution group, although they did not attain levels of the never-institutionalized group at any follow-up point (Smyke et al., 2004).

To examine the effects of foster care on developmental status, we compared the data from our IG to our FCG at 42 months of age. As can be seen in figure 9-1, the Developmental Quotient (roughly comparable to full scale IQ) of the Bayley improved significantly for those placed in foster care, but only modestly for those who remained in the institution.

Attachment: At baseline, institutionalized children had substantially more disorganized (including nonattached) attachment than children raised with their parents (78% vs. 22%; for discussion, see Zeanah et al., 2005). Furthermore, 100% of never-institutionalized children were coded blindly as having fully developed attachments to their mothers, whereas only 3% of institutionalized children were

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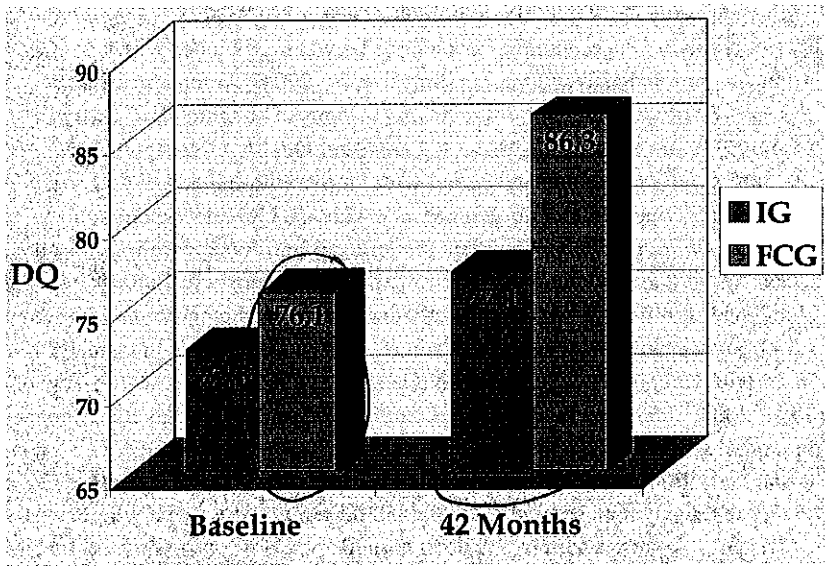

Figure 9-1 Change in developmental quotient from the Bayley exam at 42 months, IG versus FCG. Note the 10 point improvement in DQ among those placed in foster care compared to 5 points among those remaining in the institution.

coded as having fully developed attachments to their caregivers. In addition, caregivers reported significantly more signs of both emotionally withdrawn/inhibited reactive attachment disorder (RAD)[4] and indiscriminately social/disinhibited RAD in institutionalized compared to never-institutionalized children. At follow-up, signs of emotionally withdrawn/inhibited RAD were significantly lower in the foster care group than the institutionalized group, and indistinguishable from the never-institutionalized group. Indiscriminate sociability/disinhibited RAD, on the other hand, was significantly lower at follow-up in the foster care group than in the institutional group, but was still significantly higher than in the never-institutionalized group (Zeanah et al, 2005).

Event-Related Potentials: Event-related potentials (ERPs) in response to four facial expressions—fear, angry, happy, and sad—were collected from institutionalized children and never-institutionalized children ranging in age from 7 to 32 months. The ERP findings are complicated by the fact that we observed several components over several regions of the scalp; moreover, previous research has revealed rather dramatic developmental changes in the ERP across this age range. As a result, we have subdivided our sample in to those younger or older than 23 months of age, and have focused on one specific component, the P400. The P400 component reflects the brain's obligatory and specific response to faces and, as such, pro-

vides a metric of whether face processing has been perturbed by early institutionalization (which we expect it to be). In previous studies (e.g., de Haan & Nelson, 1997), it was reported that the latency to peak for the P400 is faster to faces than to objects, and faster in the right hemisphere than left (reflecting an adult configuration). Focusing first on the baseline data, comparing IG to NIG, we find a faster P400 for NIG compared to IG, reflecting the typical developmental pattern we would expect. At follow-up (figure 9-2), our latency effects is replaced by an amplitude effect.[5] Specifically, now we find that amplitude of the P400 is greatest among the NIG, smallest among the IG, and in-between among the FCG. Reframing these findings, the data from the FCG appears to be moving in the direction of the NIG, that is, is beginning to normalize. (Note that this same pattern of findings can be observed for the P100 component, also evident in figure 9-2. The P100 is thought to reflect the early sensory processing of a visual stimulus.)

EEG Power: At each assessment in the original BEIP study, the EEG was recorded from 15 electrode sites during an episode designed to elicit quiet attention in infants and young children. Power in three frequency bands (3–5 Hz as theta, 6–9 Hz as alpha, 10–18 Hz as beta) was computed at each electrode site using both the absolute and relative power metrics. At the baseline assessment, the institutionalized group (IG) showed a higher level of relative theta power and a reduction in alpha and beta relative power compared with a group of never-institutionalized children (NIG; see Marshall, Fox, & the BEIP Core Group, 2004).

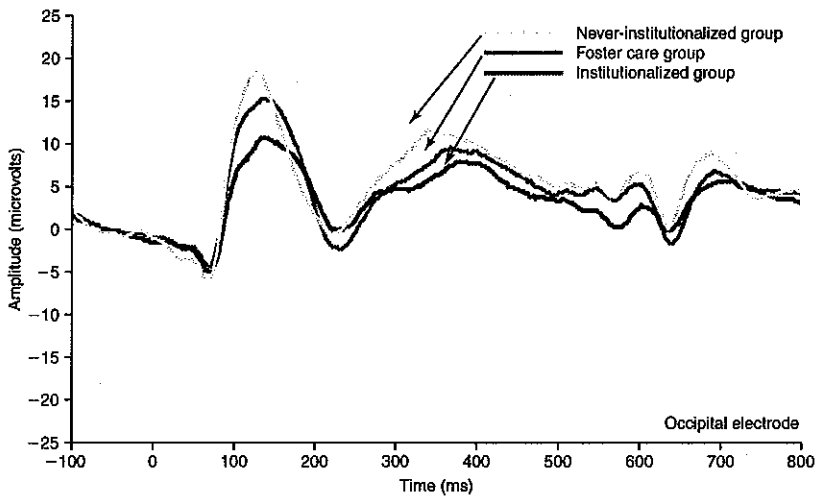

Figure 9-2 Event-related potentials (ERPs) invoked by pictures of facial expressions (collapsed to reveal a main effect of amplitude). The data illustrate the P400 component of the ERP, with the largest amplitude obtained by the NIG (n = 13), the smallest by the IG (n = 29), and the FCG (n = 33) in between IG and NIG. See color insert.

Recent preliminary analyses of the 42-month EEG data suggest that, surprisingly, foster care is exerting little effect on the EEG—in other words, the EEG among the FCG is essentially identical to the IG. There is some hint, however, that among the FCG children who have spent the most time in foster care, the EEG is, in fact, beginning to resemble the NIG. This is encouraging, and may reflect a general principle through much of our project: that there is a dose × response × domain interaction, with some domains of function recovering with less intervention (foster care) than others.

Psychopathology

The Preschool Age Psychiatric Assessment (PAPA) is being administered to children at 54 months of age. The PAPA is a structured interview of the caregiver that covers psychiatric symptomatology and disorders, stressful life events, and impairment in functioning associated with the symptoms (see Egger & Angold, 2004; Egger, Ascher, & Angold, 1999; Egger, Erkanli, Keeler, Potts, Walter, & Angold, 2005). It permits us to examine psychiatric symptoms and disorders, specifically emotional disorders (e.g., depression, anxiety, and posttraumatic stress disorder), and behavior disorders (e.g., oppositional defiant disorder, conduct disorder, and attention deficit/hyperactivity disorder).

Preliminary findings on about two-thirds of the sample demonstrate several important preliminary trends (Egger, 2005). First, we found a substantial increase in the incidence of psychiatric disorders in institutionalized and foster care children compared to never-institutionalized children; indeed, the overall base rate of endorsing *any* disorder is approximately 50% for the IG children. Second, the incidence of disorders among our community sample of never-institutionalized children (NIG) is virtually identical to a sample of 2- to 5-year-old children recruited from pediatric clinics in Durham, North Carolina. This is reassuring, as it suggests that our metric of psychopathology (the PAPA) is performing in Romania as it does in the United States; it also suggests that the general incidence of child psychopathology is comparable across countries. Third, foster care appears to be very effective in ameliorating both depression and anxiety; however, foster care does not appear to have any effect on externalizing symptoms such as ADHD and disruptive behavior disorders (i.e., oppositional defiant disorder and conduct disorder) in these two groups.

The efficacy of foster care in preventing some disorders but not others is intriguing. This may have to do with the issue of sensitive periods; for example, perhaps whatever the environment is contributing to the expression of ADHD does so very early in life, before our children are placed in foster care, and thus, our intervention comes too late. Or perhaps genetics plays a role here; indeed, this would account for why foster care is having little effect on previously institutionalized children, as perhaps the genetic loading for the disorder is overwhelming whatever effect the environment might have on ADHD symptoms. However, in-

attention/hyperactivity is well known to be increased in formerly institutionalized children (Kreppner, O'Connor, & Rutter, 2001; Roy, Rutter, & Pickles, 2004). The fact that roughly one quarter of both the FCG and the IG meet diagnostic criteria for ADHD, and the fact that most children in the study were placed at or near birth (before ADHD symptomatology would manifest), mean that it is unlikely that differential placement of genetically vulnerable children could account for the finding. A third interpretation may be that ADHD may be expressing itself in two distinct contexts for different reasons. In the case of institutionalized children, for example, perhaps children possess poor attentional control because (a) there is no environmental support to teach them how to acquire such skills and/or (b) the environment is so lacking in stimulation that children engage in self-stimulatory activities (an observation confirmed by the far higher incidence of stereotypies among our IG vs. NIG children) and thus, inattention/hyperactivity results. Children in foster care, however, may show this same pattern of poor attentional control because the environment is *so* stimulating and they are having a difficult time regulating their behavior in the face of such new challenges. We are hopeful that as our study progresses we will be able to address these and other hypotheses.

Conclusions

On the whole, it is clear that institutionalization is associated with profoundly negative effects on child and brain development. As we have reported in our recently published papers and summarized in this chapter, virtually all domains of development are compromised by institutional rearing. Thus, physical, brain, cognitive, linguistic, and social-emotional development are all deleteriously affected. Moreover, nearly half of institutionalized children appear to suffer from one or more forms of psychopathology. The good news is that foster care appears to be effective in diminishing some forms of psychopathology and normalizing other domains of development; the bad news is that it is not affecting all domains of development, nor has full recovery occurred in most domains assessed to date. Of course, this picture may change as our study progresses and children spend more time in foster care, especially because we already have determined that some domains demonstrate recovery only for those children who have been in foster care the longest. Unfortunately, we are only now beginning to examine our foster care data in this light, and thus, it would be premature to comment further on the related issues of how length of time in the institution or length of time in foster care relate to long-term outcome.

Of the many questions we hope to address in the coming years, one pressing issue concerns the processes or mechanisms that underlie the success or failure of foster care in ameliorating the sequelae of early institutionalization. Thus, what is it about our foster care program (e.g., what components) that makes possible the

recovery we are seeing in so many domains? A second issue we hope to shed light on pertains to sensitive periods of development. Thus, is there a point after which a child placed in foster care will *not* recover because he/she was placed too late? We sincerely hope this is not the case, although from a neuroscience perspective we should anticipate a point of diminishing returns in some domains: thus, the longer the child lives in such a deprived environment, the harder it will be to set that child back on a typical developmental course. We might predict fuller recovery in physical growth and cognitive competence, for example, but attachment behavior and linguistic function may be harder to remediate if children are reared for too long in institutions.[6]

Despite the preliminary nature of our follow-up findings, it is worth speculating about the neural bases underlying recovery, or lack of recovery. Of particular relevance is the seeming lack of recovery of a normative EEG pattern. Interestingly, although we observing a rapid improvement in both height and weight among our FCG children, there is no discernable effect on head circumference, a finding that may be relevant to our EEG findings. Specifically, it may be the case that the failure to observe dramatic changes in head circumference or EEG could be due to an error in apoptosis (programmed cell death), which in turn will lead to too few neurons and thus a smaller, underpowered brain (which will account for smaller heads and underpowered EEG). It may therefore require a number of compensatory, plastic mechanisms to become engaged in order to redirect the brain onto a typical developmental trajectory. Thus, particularly for children who have spent the longest amount of time in the institution, the overt changes in brain function may take some time to accrue. Our behavioral data clearly suggest that such change is occurring, but it is occurring on a smaller scale and perhaps slower time frame than we had expected. This argues for the important need to study these children when they are older.

A second finding we wish to comment on concerns changes in DQ. First, as can be inferred from figure 9-1, the DQ among our currently institutionalized children has gone up about 5 points from baseline to 42 months. We attribute this to the inadvertent changes that likely took place in the institutions, once we began our intervention (e.g., a more favorable child-to-caregiver ratio). Second, there is quite a dramatic increase in DQ among those placed in foster care. This is encouraging, as it suggests that as a group (i.e., with regard to *age* at placement in foster care) children's "IQ" is benefiting from the more enriched environment of foster care.

It is difficult to say how our IG and FCG will fare as adolescents. Although the oldest children in our cohort are only now turning 7 years old, it will not be long before these children will face the challenges and opportunities that await them as adolescents. We hope to be able to track their development at that time, and to glean from our current study what preventive efforts can be implemented to minimize maladaptation these children may experience. For the moment, however, we

feel it prudent to shy away from pronouncements about the implications of our findings for prevention science; still, our PAPA findings are encouraging in suggesting that at least in the domains of depression and anxiety, foster care can have a powerful effect on reducing the burden of suffering. Of course, this same intervention, implemented at the same age, appears to be having little effect on externalizing symptoms such as ADHD and oppositional deviant disorder. From the perspective of adolescent development, this is discouraging, as it suggests that even when such a powerful intervention is implemented very early in life, it is difficult to prevent such disorders from developing. On the other hand, the life circumstances our children find themselves in are hopefully far worse than the typical adolescent.

On the whole, the ideal situation would be to improve the means by which we identify adolescents at greatest risk for developing mental health problems and to intervene as early as possible. In the current context, teens who spend their early months and years living in acutely and/or chronically deprived environments would receive most attention. Here, getting these teens into solid family environments would likely prove beneficial. Of course, our success in doing so depends as much on changing public policy as it does on conducting sound scientific studies.

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Notes

1. The term *indiscriminate sociability* is typically construed to refer to a child who interacts with adults in an indiscriminate way—for example, failing to distinguish between caregivers and complete strangers. Thus, such a child is as likely to hold the hand and walk off with a stranger as they might with a caregiver.
2. By drawing on the same maternity hospitals as we drew on for our IG children, we were attempting to control for differences in SES.
3. *Organized* refers to secure, avoidant and resistant classifications and is contrasted with *not organized*, which includes both disorganized and unclassifiable (insufficient attachment behaviors evident; Zeanah et al., 2005).
4. Reactive attachment disorder is used to describe children who have experienced adverse caregiving environments (e.g., maltreatment or institutional rearing) and who develop aberrant social behaviors as a result, including absence or disturbances of attachment behaviors. Two patterns are defined: (1) an emotionally withdrawn/inhibited pattern, in which the child is minimally responsive, shows limited positive affect, expresses no

preference for any adult caregiver, and has difficulties with emotion regulation, and (2) an indiscriminately social/disinhibited pattern, in which the child fails to check back with a caregiver in unfamiliar settings, lacks reticence around strangers, and is willing to "go off" with a stranger. In the first instance, the child's social behavior is inhibited, and in the second, the social behavior is disinhibited.

5. Whereas latency to peak reflects the rate of information transmission through the brain, amplitude is typically taken to reflect the summation of synchronous neuronal activity; as such, larger amplitudes are taken to reflect a more normative response.

6. It should be noted that at the outset of our project, it was decided that any child living in an institution would be moved to state-run foster care or reunited with his/her biological family should the opportunity present itself. Indeed, as of December 2005, only 17 of our original IG children still reside in an institution.

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