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## INTEGRATING AN UNDERSTANDING OF BRAIN DEVELOPMENT INTO EARLY CHILDHOOD EDUCATION

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**ABSTRACT:** This article describes the efforts to date of a five-year project undertaken by the Erikson Institute Faculty Development Project on the Brain to help ensure that early childhood education faculty and practitioners have access to information on the brain and early development. Specifically, the article presents survey and focus group findings regarding the interests and learning needs of early childhood faculty and practitioners, the content and process of the resource modules on the brain and early development designed for use as part of the undergraduate or graduate curriculum in early education, and the faculty development activities undertaken to facilitate the inclusion of this content into the ongoing curriculum. The article describes the need for integrated frameworks for practice that more fully reflect a biopsychosocial perspective, and concludes with some reflections on the challenges of including brain development as part of the preparation of early educators to work with infants and young children.

**RESUMEN:** Este artículo describe los esfuerzos hasta la fecha de un proyecto de cinco años que lleva a cabo el Instituto Erikson a través del "Proyecto para el mejoramiento del profesorado en cuanto al conocimiento del cerebro." El propósito del proyecto es asegurar que tanto el profesorado como los profesionales que se dedican a la educación sobre los primeros años de la niñez comprendan e integren el conocimiento sobre el cerebro con el conocimiento del desarrollo en los primeros años del infante. Específicamente, el artículo presenta los resultados de una encuesta y de grupos de discusión acerca de los intereses y necesidades de aprendizaje que tienen quienes enseñan y se dedican a la práctica de asuntos relacionados con los primeros años del infante. También se incluye el contenido y proceso de los módulos disponibles sobre el cerebro y el desarrollo en los primeros años, el cual fue diseñado para ser usado como parte del curriculum sobre la educación en los primeros años, tanto a nivel de la licenciatura como al nivel de maestría y doctorado. Además, se presentan las actividades para el mejoramiento del profesorado que se llevaron a cabo para facilitar la inclusión del contenido en el curriculum actual. El ensayo describe la necesidad de un marco integrado para la práctica, que refleje en su totalidad una perspectiva biosicosocial, y concluye con algunas reflexiones sobre el reto de incluir el tema del desarrollo del cerebro

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como parte de la preparación de educadores de los primeros años para que éstos trabajen con infantes y niños pequeños.

RÉSUMÉ: Cet article décrit les efforts à ce jour d'un projet de cinq ans déjà, entrepris par le Projet de Développement sur le Cerveau mené par les Professeurs de l'Institut Erikson pour aider à s'assurer que les professeurs et les praticiens en éducation de la petite enfance comprennent et intègrent la connaissance du cerveau à la connaissance du développement précoce. Pour être plus exact, cet article présente des résultats d'une enquête et d'une étude d'un groupe d'intérêt à propos des intérêts et des besoins en matière de connaissances des professeurs et des praticiens se consacrant à la petite enfance, le contenu et le processus des modules de ressource sur le cerveau et le développement précoce conçu pour être utilisés dans le cadre du programme des études en licence, en maîtrise et en doctorat sur l'éducation précoce, et les activités de développement intellectuel des professeurs entreprises pour faciliter l'inclusion de ce contenu dans le programme d'études actuel. Cet article décrit le besoin d'une structure intégrée qui reflète bien mieux la perspective biopsychosociale, et conclut avec des réflexions sur les défis que présente l'intégration du développement du cerveau dans la préparation des éducateurs qui travailleront avec les nourrissons et les petits enfants.

ZUSAMMENFASSUNG: Dieser Artikel beschreibt die Anstrengungen eines fünfjährigen Projekts, das von der Erikson Institut Fakultät: „Entwicklung des Gehirns“ gemacht wurde, um sicherzustellen, dass die Fakultätsmitglieder und die Praktiker—die für die frühe Kindheit zuständig sind—Kenntnisse des Gehirns in Verbindung mit der frühen Entwicklung verstehen und integrieren. Im Einzelnen präsentiert dieser Artikel generelle und detaillierte Gruppenergebnisse im Bezug auf die Interessen und den Lernbedarf der Fakultät und der Praktiker—die für die frühe Kindheit zuständig sind—den Inhalt und den Prozess der Erstellung der vorbereiteten Module über das Gehirn und die frühe Entwicklung, die wurden als ein Teil des Anfänger—und Fortgeschrittenenlehrplans in früher Erziehung vorbereitete wurden und die Entwicklungsanstrengungen der Fakultät, um die Einbeziehung dieser Inhalte in den gegenwärtigen Lehrplan zu erreichen. Diese Arbeit beschreibt die Notwendigkeit eines integrierten Bezugsrahmens für die Praxis, der eine biopsychosoziale Perspektive erlaubt und es schliesst mit einigen Reflexionen über die Herausforderungen, wenn man die Gehirnentwicklung als einen Teil der Vorbereitung der Frühförderer, die mit Kleinkindern arbeiten sollen, einschliesst.

抄録：この論文は、Erikson Instituteの脳の学部教授法開発プロジェクトによって、早期児童期教育の学部や実践家が、脳の知識と早期発達の知識とを理解し、統合するのを確実にするのを助けるために、現在まで5年間実施されたプロジェクトの努力を記述することである。特に論文は、早期児童期の学部と実践家の興味と学習への要望に関する調査および焦点グループの所見、学部あるいは大学院での早期教育のカリキュラムの一部として利用するためにデザインされた脳と早期発達についての学習単位の内容と課程、そしてこの内容を進行中のカリキュラムに含めるのを促進するために行われている学部教授法開発活動を、提示する。論文は、生物心理社会的視点をもっと十分に反映する実践のための統合された枠組みの必要性を記述し、乳児や幼い子どもとともに仕事をする早期教育者の準備の一部として脳の発達を含めるという難題についての考察をもって終わる。

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Early childhood educators have long advocated for a whole child approach. Whether working with infants, toddlers, or preschoolers, early childhood practitioners are challenged to view the child as an active learner and to consider each child's developmental level and individual characteristics in the context of the child's family and community (Bredenkamp & Copple, 1997). The recent explosion of information about the brain provides new insights into the biological basis of behavior and development. Most early childhood academic programs rely

on child development theory; developmental, educational, and behavioral research; and the wisdom of practice to prepare practitioners to understand and facilitate child development. Traditionally, undergraduate and graduate programs have covered social/emotional, cognitive, and language development and, to a lesser extent, health and motor development. Because early childhood educators seek a perspective that encompasses all aspects of development—the biological, psychological, and social—integrating knowledge of the brain into our picture of the developing child should bring a deeper understanding of development, and thus a greater understanding of the whole child.

The Erikson Institute, a graduate school in child development whose mission is knowledge in the service of young children, is engaged in a five-year project, the Faculty Development Project on the Brain, to examine the literature on early brain development and to identify information that is relevant to the preparation of early childhood educators. Over the past three years we have developed and piloted a set of resource modules on the brain and child development and have worked with faculty from community colleges and undergraduate and graduate programs in Chicago to integrate this knowledge into the higher education curriculum. The Project also provides an extensive faculty development program, and supports curricular change by funding interdisciplinary faculty study groups within the collaborating institutions.

This article describes the interests and learning needs of faculty and practitioners, the content and process of the resource materials developed to date, the need for integrated frameworks for practice, the activities undertaken to increase faculty knowledge about the brain and early development, and reflections on the challenges of strengthening the early childhood curriculum to more fully reflect a biopsychosocial view of development and thus enhance the early educator's capacity to understand and engage the whole child.

## WHAT DO EARLY CHILDHOOD EDUCATORS WANT TO KNOW ABOUT THE BRAIN?

### *Faculty Perspectives*

In 1997, 27 early childhood education department chairs and faculty from 13 colleges in the Chicago area were surveyed to identify their perspectives on brain development and early education (Gruber, Gilkerson, & Rosinia, 1997). The results revealed that 91% of faculty surveyed felt that it was important for educators to know about brain development. While their reasons varied, three themes emerged. First, the faculty view the brain as a “foundation for development,” and believe that if knowledge of brain development and functioning is absent from the early childhood curriculum, a critical perspective is lost. Second, faculty feel that brain research lends “credence to what we know” as educators about the importance of early development. Third, faculty feel that they “owe it to the students” to stay current, to address this topic that has received such widespread media attention and to help students put it into perspective. Interestingly, faculty did not identify practical application as a primary reason for including content on the brain in the curriculum. At the time of the survey, faculty reported that students were not requesting information about the brain; however, students were interested when information was presented, especially students who were parents or grandparents.

The faculty specified content to add to the early childhood curriculum, including the fundamentals of brain development; critical periods; prenatal development; neurological basis of learning, memory, and language development; learning style differences; learning disabilities;

impact of drug exposure, abuse, and violence on the brain; and the interface of culture with brain development. Some faculty expressed concern that a focus on the brain would encourage biological determinism in a field that values ecological and transactional models of development (Brofenbrenner, 1979; Rogoff, 1990; Sameroff & Chandler, 1975). Department chairs noted that although most faculty think that understanding the brain is important, there are wide variations among individuals and, for some faculty, teaching about the brain may be threatening.

Although the faculty felt that it was important for students to learn about the brain and readily identified content areas to be covered, they rated themselves as having only a moderate to small amount of knowledge about the neurosciences. In fact, just one faculty member reported being very knowledgeable. Faculty typically acquired their knowledge through self-study, including conferences, public media (*Newsweek/Time*), or semiscientific journals. Faculty development needs included access to knowledge in three areas: (1) a solid baseline of scientifically validated information on the brain and early development, (2) a source of continually updated information given the rapidly evolving science of brain/behavior research, and (3) implications for early childhood practice. Many respondents voiced the need for a clearinghouse or resource center on neuroscience and education.

### *Practitioner Perspectives*

Practitioner interests in brain development were identified through a focus group (Rosinia, 1997) and needs assessment surveys (Gruber & Gilkerson, 1997). The focus group included experienced early childhood educators working with infants, toddlers, and preschoolers in childcare centers, nursery schools, and early intervention programs. The group included both generalists working with typically developing children and specialists working with children with identified disabilities. All of the participants expressed a desire to gain a greater understanding of brain development, including the anatomy and physiology of the nervous system, and how this knowledge relates to their current understanding of cognitive, motor, language, and social development. Like the faculty, the practitioners expressed great interest in understanding individual learning styles, including differences in sensory processing. The generalists were most interested in specific techniques to foster a child's optimal academic readiness and strategies to manage children whose behavioral needs require a high degree of individualization—the “challenging child” in group care. The specialists were most interested in strategies to identify and intervene with children with developmental disabilities.

Needs assessment surveys were conducted with two groups of practitioners attending presentations on the brain at state and national conferences. One group was comprised primarily of early childhood educators (62) and the second group, early childhood special educators (99). The conference participants comprised a nonrandom sample of practitioners interested in the topic. As in the focus group, the surveys found that practitioners were interested in normal brain development, including information on neural communication, plasticity, and the role of genetics and the environment in brain development. Both the general and special educators wanted to know more about attention deficit hyperactive disorder, autism, and learning disabilities and about the impact of childhood trauma on the brain. The early educators were particularly interested in individual differences in children and learning styles; the special educators, in prenatal development, and prenatal substance exposure. Further, they wanted to understand the relationship between early intervention and brain development. Specifically, does early intervention promote brain development, and conversely, does the lack of early intervention harm brain development?

## INTEGRATING BRAIN DEVELOPMENT INTO THE CURRICULUM

Given the fact that information on the brain is relevant to understanding early development and that faculty and practitioners value this information, the questions become what to teach and how to integrate it effectively into the existing curriculum. Should brain development be covered in the basic science courses rather than in the early childhood curriculum? If it is considered appropriate for the early childhood curriculum, should it be treated as a special topic, covered in a guest lecture by an outside expert? Or should an understanding of the brain be integrated into the curriculum, much like multiculturalism or inclusion, and covered by early childhood faculty or early childhood faculty in partnership with interdisciplinary colleagues and/or guest lecturers? Based on Erikson Institute's commitment to a biopsychosocial view of development and on the recommendation of the chairs and faculty surveyed, we adopted the later approach of curricular integration.

### *Resource Module Development*

A critical component of the Brain Project is to identify relevant, accurate information on the brain and link it in understandable and engaging ways to developmental and educational content that is already a part of or can be added to the existing curriculum. To make this overwhelming task more manageable, we decided to develop resource modules for faculty on topics of major interest. These modules are a start at distilling and organizing key information about the brain, and serve as a catalyst for the longer term processes of curricular revision and faculty development.

To develop teaching resources on the brain and early development, a team of educators works closely with expert consultants in neurobiology, neuropsychology, developmental psychobiology, developmental psychology, and occupational therapy. Faculty from community college, undergraduate, and graduate programs pilot the modules and provide feedback from faculty and student perspectives. Through this interactive process, we are continually learning what faculty are comfortable teaching and what students can absorb.

Five resource modules have been developed and piloted thus far: Prenatal Development (Klein & Gilkerson, 2000); Building the Brain; (Wills, Gilkerson, & Scott, 2000); Brain Basics (Wills, 2000); Brain Imaging (Davis, 2000); and Stress, Coping, and Caregiving (Davis & Gunnar, 2000). Two additional modules are in preparation: Affect: Biology of Emotion (Munro, 2000) and Sensory Processing (Rosinia, 2000). Additional modules are planned focusing on cognition, learning, and memory; language development; early relationships and the developing brain, prenatal substance exposure, and integrated frameworks for practice. Each resource module includes lecture notes, overhead transparencies or Powerpoint slides, learning activities, readings, student handouts, glossary, and optional quizzes for pre and postassessment of student learning.

The faculty survey revealed that the early childhood curriculum is predominately preschool oriented and education focused. Developmental research, infancy, special needs, and parenting tend to receive less coverage. The resource modules offer an opportunity to expand the discussion of these issues as well as to explore the links between the brain, behavior, and development. The content and approach for the modules developed thus far is presented below.

*Prenatal Development.* We learned early in the course of developing the modules that beginning with *the Brain* was too overwhelming for students and for faculty. We needed to find a way to start where the students are focused—on the child—and where faculty had experience

teaching. For students and faculty, the remarkable accomplishments of the baby during the prenatal period provided a perfect entry to the developing brain and nervous system. Most early childhood textbooks cover the physical growth of the fetus, but not sensory system or behavioral development. This module, developed by Klein and Gilkerson (2000), begins by exploring with students their images of intrauterine life and what the sounds and sensations might be like for the baby. Next, we briefly review physical development and then move to the sequence of sensory system development in utero (tactile, vestibular, chemical [taste and smell], hearing, and vision), and the emergence of fetal movements and behavioral states. Students are truly amazed that babies can smell, taste, detect light, suck, swallow, “breathe,” and respond to the external world before birth. The module introduces the link between prenatal behaviors and the developing brain, including areas of the sensory, motor, auditory and visual cortex. We explore the role that the fetus plays in his/her development (e.g., fetal movement prevents joint contractures, fetal swallowing helps to develop the intestinal tract), and consider the premise that the nervous system becomes, in part, a history of its own use (Lickliter & Bahrnick, 2000). The link between prenatal experience and postnatal perceptual preferences challenges students to reassess their view of innateness. The overriding theme is that the dynamic interaction between biology, behavior, and the environment begins in the prenatal period and continues throughout development.

The module ends with discussion of two video clips that illustrate the continuity of development between prenatal and postnatal development. The first shows prenatal development from fertilization through each trimester, ending with the birth of a baby, and the second shows many of the same behaviors in the newborn. Once again, students are captivated by what babies can do and by the idea that the only truly new newborn behavior is the birth cry.

*Building the Brain.* Once students are intrigued with very early development and aware of the ties between the brain and behavior, they can move to the “harder science” of developmental neurobiology in this module developed by Wills, Gilkerson, and Scott (2000). To avoid what faculty teaching the modules have come to compassionately call “the Glaze”—that distant look in a student’s eyes when too much unfamiliar, biological information is presented, we learned not to begin this module at the cellular level—neurons and glial cells. But rather, the module starts with the development of the neural tube, a process that can be more easily linked to child development. Students learn how the neural tube forms in the first 28 days of life, and what happens when the tube fails to close. We discuss the occurrence of neural tube defects, focusing on the abilities and needs of children with spina bifida.

With this as background, the module moves to the cellular level and briefly explains the structures and functions of neurons and glial cells. Where possible, we offer metaphors to make scientific terms more meaningful. For example, glial cells are described as the “nurturing cells”; they provide structural support, form the blood brain barrier, provide nutrition, clean up waste, and make myelin.

The module presents the four stages of brain development: cell birth (proliferation), cell migration, cell identity (differentiation), and cell connections (synapse formation, pruning, and myelination). Students are fascinated with the cortical layers and columns and with the precise mapping of the body onto the somatosensory cortex (e.g., the area of the cortex that responds to sensory signals from the fingers is next to the set of columns that respond to the thumb). The longer term processes of synapse formation, pruning, and myelination are then introduced. Communication within the neuron by electrical current and across neurons by release of neurotransmitters is covered. Synapse plasticity is presented as a life-long-process, continuing throughout development.

To return the focus to the child, we then introduce developmental disorders that can originate during the four different phases of brain development (e.g., cell birth: microcephaly; dysmigration syndrome: fetal alcohol syndrome). For many students, seeing the unfamiliar processes of neurobiology linked to the very real developmental disabilities of children whom they might teach is very compelling.

*Brain Basics.* The formal introduction of the brain and nervous system comes in the third module. Developed by Wills (2000), this module begins by asking students about their images of the brain. What color is it? How much does it weigh? What metaphors do they have for how the brain works: is it a computer? Students learn the basic geography of the brain, first very simply by identifying the front, back (identified by looking for the cerebellum or “little brain”), and brain stem in various pictures and on a brain model. Next comes a closer look at the locations and functions of the brain stem, limbic system (amygdala, hippocampus, hypothalamus, cingulate gyrus), thalamus, cerebral cortex, cerebellum, and basal ganglia. To the extent possible, we take a developmental perspective by introducing the areas of the brain as they come “on-line” in development. Students are very interested in the impact of brain injury and in the potential for recovery of functioning.

Students enjoy learning about the autonomic nervous system: the sympathetic, energy-expending “go” system, and the parasympathetic, energy-conserving “slow” system. We describe the dynamic balance between these two systems during everyday functioning and during the extremes of “fight or flight” and “rest and digest.” An awareness of the dynamic balance of the nervous system during the day offers caregivers and teachers a new window into their own functioning as well as the functioning of the children. For example, the concepts of sympathetic and parasympathetic bias helped one student understand her struggle with the beginning of the school day, a time when the children were talkative and active and she was in a much lower state. To give herself time to warm up and shift to a higher level of arousal, she arranged for her team teacher to handle the larger group while she took early morning bathroom duty with just a few children at a time. Students are introduced to the idea that the sympathetic and parasympathetic systems continue to develop after birth, and may be influenced by the nature of the caregiving relationships (Schore, 1996). Students relate easily to the idea that activation comes before inhibition, and that much of maturation of the nervous system, perhaps maturation in general, is the development of inhibitory controls.

The concepts and visuals about the central and peripheral nervous systems are introduced here and reviewed in later modules on stress and sensory processing. Because of the specific questions students ask about the brain, this is the hardest module for early childhood faculty to teach. It is also the hardest for students to grasp. We suggest that faculty either have a guest lecturer or coteach this module with a clinical expert such as a pediatric neuropsychologist or an occupational therapist or a knowledgeable colleague in biology, neuroscience, or psychology.

*Brain Imaging: How Technology Helps Us Understand the Brain.* This module by Davis (2000) describes the strengths and limitations of five brain imaging techniques: EEG, ERP, PET, MRI, and fMRI. Again, putting the child first, the module begins by explaining the clinical use for each tool in pediatric medical care (e.g., EEG for detection of tumors, seizure disorders, sleep disorders) and what the procedure requires of the child (e.g., for EEG, child can sit on parents’ lap, on the floor or in a chair while scalp is cleaned and sensors are placed on cleaned areas). The technology is described (e.g., EEG records the electrical activity that is naturally occurring in the brain) and research studies related to child development are presented. The EEG work of Fox (1991) demonstrating the association of different patterns of brain activity

with different emotions provides a background for students to understand the findings of Dawson, Frey, Panagiotides, Osterling, and Hessel (1997) on differences in EEG activity in infants of depressed mothers compared to those of nondepressed mothers. The goal is for students to begin to understand what these techniques can and cannot tell us about the brain and behavior, and to help them become more informed and critical consumers of research presented in the popular media and professional literature. The module offers related information on seizure disorders in children, how sleep patterns change with development, the impact of maternal depression on child development, and technology for hearing and vision assessment in early infancy.

*Stress, Coping, and Caregiving.* This module, developed by Davis and Gunnar (2000), is a comprehensive presentation of the physiology of stress, its impact on child behavior and development, and the role caregiving plays in buffering stress. The module covers the definition of stress, distinguishing stress from challenge, and reviews the changes in the body that occur under stress: the future-oriented growth and repair processes (e.g., digestion, physical growth, immune system function, sleep, and exploration/play) that are inhibited by the stress system and the threat management processes (heart rate, energy availability, increased memory for and attention on the threat, and decrease in pain perception) that are accelerated. Students gain an appreciation for the healthy functioning of the stress system, a system that turns on in response to threat, turns off after threat, and replenishes future-oriented systems.

The module presents both branches of the stress system: the autonomic nervous system, with which students are already familiar, and the new piece, the HPA axis (Hypothalamic–Pituitary–Adrenocortical system) that stimulates the production of the stress hormone cortisol. The functioning of these branches under three conditions—nonstress, stress, and chronic stress—is emphasized. Controllability, predictability/familiarity, and social support, referred to as stress’s Big Three, are introduced, and the role of early experience (good and bad) on the HPA stress system is presented. Because much of the research on early experience is with animals, the relevance of animal research findings to humans is considered.

Next, the relationship between attachment security and cortisol response to a threatening event is presented. Children with an insecure attachment are more likely to show cortisol elevations in challenging situations, i.e., seeing a scary toy or getting a shot (Nachmias, Gunnar, Mangelsdorf, Parritz, & Buss, 1996; Spangler & Schieche, 1998), while children who have a secure attachment have caregivers who will help them control and predict threat or protect them when they cannot protect themselves. These children can be upset by challenges without turning on their stress system.

The last section of the module considers the research on a topic of great interest to early educators—the question of how child care affects children’s stress physiology. The work of Gunnar and her colleagues (Tout, deHaan, Campbell, & Gunnar, 1998) demonstrates that children’s cortisol rhythms are different in child care, even high quality child care, than at home. Instead of decreasing, which is the normal daily pattern, the levels of children in daycare rise over the course of the day. The module addresses two factors that might contribute to this rise: level of quality of care and children’s own skill in social relationships. The authors take great care to help the students put this research, which was conducted in fairly good to high quality centers in perspective. The cortisol level changes were low, not at the level to produce the kinds of risks to health and functioning usually attributed to cortisol. They also raise the point that data is not presently available on cortisol rhythms of children in poor quality settings. The module helps students understand the current state of knowledge of stress research in child care, and stimulates their thinking about questions yet to be answered.

To accompany this module, Nepstad (2000) is generating practice implications that will address topics such as: What is quality care? How is it measured? What situations are stressful for children? How do individual children cope with these stresses? How do caregivers respond to children's coping efforts? What are ways that we can build controllability, predictability, and social support into our caregiving environments? And how do we identify and address caregiver stress? Further, additional content on prenatal stress and the brain and the impact of institutional care on children in Romania has been developed and will be integrated into this module.

### *Exploring Integrated Frameworks for Practice*

As developmental theory grows to incorporate psychobiology, frameworks for practice must also expand. Early childhood practitioners understand that developmental domains are highly interdependent; however, they have not been prepared to explicitly consider the nervous system when observing or interacting with children. Many of the most challenging issues faced in the early care and education of infants, toddlers, and preschoolers relate to the ability of children to manage emotions and control their behavior. These capacities are associated with the maturation and functioning of the nervous system, and clearly embody the interplay of brain, behavior, and caregiving. As we move into the next phase of the Project, our efforts will turn toward identifying theory, research, and clinical approaches that will help practitioners integrate neurobehavioral considerations into their everyday work with infants, toddlers, and preschoolers and with their families.

The Synactive Theory of Development (Als, 1982) provides one approach that we have found helps practitioners understand the interaction of the nervous system with more familiar areas of child development. The synactive theory explicitly includes observation of the physiological cues of the autonomic nervous system (breathing, color changes, body temperature, stability of digestion, and elimination) along with motor behavior, quality of state or attention, and capacity for social interaction. The theory guides practitioners in recognizing how all of these systems mutually influence one another, even though in the normally developing child the smooth integration of subsystem functioning is taken for granted. A robust five-month-old reaches with smooth, coordinated movements to grasp a rattle, brings it to her mouth, then with great pleasure bangs it on the table, enjoying the sounds of the rattle and the laughter of her twin brother.

When development or functioning in any system is hampered, we see more readily how difficulty with an effort in one area spills over into others. A premature infant with respiratory complications reaches for a rattle, but finds herself hampered by unsteady movements. The exertion in her motor system takes a toll on her other systems. Her breathing becomes labored, she turns pale, and then loses tone in her face. Her gaze becomes unfocused, and she puts her head down, no longer seeing the rattle or noticing her mother who has come over to see how she can help. Compared to the hardier full-term infant, this child pays a higher price, putting greater effort into the same goal with less return.

While the overflow between subsystems is most visible when there are developmental challenges, we can also see greater disorganization in neurobehavioral functioning in typically developing children when a demand exceeds their capacity to respond. Autonomic cues such as fluctuations in skin color, breathing patterns, sweating, hiccupping, yawning, or the need to go to the bathroom can be cues to the burden a current demand places on a particular child. Similarly, observation of the quality of motor behavior and attention offers insight into how the child experiences the complexity of the task and what supports he needs.

For example, one preschool teacher struggled to handle a child who either left the group or pushed the child next to him when it was his turn to stand and sing his name during circle time. At first, the teacher thought that the child was disrupting the group to get attention. On closer observation, she noticed that as his turn got closer, he was no longer following what was being said. He looked more distracted and his face was flushed. With attention gone, he began to wiggle his legs and then rock a bit, using his motor system to help keep him regulated. Finally, as his turn reached him, he opted for a response that placed much less demand on him. He either got up and wandered away or pushed the child next to him. While circle time is developmentally appropriate for most five year olds, the signs of autonomic stress, motor system overflow, and state disorganization are a clue that for this individual child, the task was overwhelming. The teacher needed to modulate the demands placed on him, rather than increase the intensity by disciplining him or insisting that he comply. Perhaps he could sit by her and hand her the materials she needed, rather than waiting for his turn to sing. To build his capacity to wait for a turn, the teacher might begin by helping him with reciprocal turn-taking with one other child during free play. After he becomes more adept in one-to-one interactions, the next step might be to play with a small group of children. For this child, watching and waiting for his turn in a group of 15 is a goal to be reached over time, rather than a competency to be assumed.

When considering challenging behavior, Weider (personal communication, December 3, 1999) urges practitioners to ask themselves: what problem is the child's behavior a solution to? Child development specialists and early childhood educators seek to understand the child's inner experience. What does it *feel* like to be this child at this moment faced with this particular demand? Observing and responding to autonomic cues, signs of motor organization or disorganization, and the quality of a child's attention offers practitioners more ways to understand how a child experiences the complexity of a task, what his efforts are to respond, and what he needs from those who care for him to help him function at his best.

Greenspan and Weider (1998) propose that the capacity to attend, regulate, and experience pleasure in interactions with others is the foundation for all communication and learning. In their view, a child's capacity to engage is shaped in part by his individual sensory profile. For example, a child with a low sensory threshold whose nervous system is easily activated responds quickly to low-level input and requires more support to reorganize than a child with a higher threshold who easily handles multiple sights and sounds. All too often, in the press of everyday work with children, it is easy to forget the impact that basic attentional, sensory, and regulatory capacities have on their behavior and development. Observation of neurobehavioral functioning can alert caregivers to signs of disorganization *before* the child experiences failure. Infant caregivers and preschool teachers know when a child is struggling, and intuitively try to adjust their expectations and interactions in response to the child's physical and behavioral cues. Our goal is to provide practitioners with access to more formalized methods of observing and to theories that may increase their effectiveness with individual children by explicitly addressing all aspects of development, including sensory and neurobehavioral functioning. The approaches of Als (1982) and Greenspan and Weider (1998) offer a starting place from which we will explore integrated frameworks for practice, and develop ways to include them in the early childhood curriculum.

### ***Faculty Development***

Changing curriculum is always challenging. In this case, the challenge is multiplied by the degree of previous knowledge that most faculty have about the brain, the rapidly evol-

ing field of brain science, and a lack of consensus about the implications of brain research to educational practice. Therefore, as part of the Brain Project, we have found it essential to provide a support structure for faculty development. Two major professional development opportunities are offered: a Lecture Series for early childhood faculty and practitioners and Faculty Study Groups. The Lecture Series brings nationally recognized neuroscience and child development experts to present at half-day sessions on topics of special interest to educators. Thus far, the series consists of 11 lectures addressing normal brain development, plasticity, stress and caregiving, psychobiology of early relationships, impact of trauma on the brain, and the relevance of brain research to developmentally appropriate practice. Four of these sessions, sponsored jointly with the University of Chicago's Early Childhood Initiative, present perspectives informed by cognitive neuroscience on early language, reading, and mathematical development in young children, and on sex differences and early learning. The Lecture Series has attracted over 2,250 attendees and repeat attendees, including faculty from early childhood departments in 22 Chicago area colleges. Each lecture is followed by a Faculty Institute to facilitate dialogue between early childhood faculty and speakers.

The Faculty Study Groups are held monthly during the academic year for 28 faculty from community college, undergraduate, and graduate level institutions. The gatherings are lively and intense sessions where faculty both learn new information through lectures and discussions with Project staff and expert consultants, and contribute to the Project by pilot testing the materials in their teaching. They receive an honorarium to cover the time they spend critiquing the modules. These sessions provide an opportunity for peer support, encouragement, and, at times, commiseration. It is not easy for experienced faculty to teach new material, as they are learning it, especially about the brain. Thus far, most faculty chose to participate the groups for at least two years. This endeavor has revealed that we are *all* on a learning curve, including the Project's expert consultants, and that faculty need continuing opportunities to increase their mastery of the material and to weave it into the fabric of what they are already teaching.

### ***Higher Education Mini-Grant Program***

To further support faculty development and to stimulate curricular change within colleges and universities, faculty in the Study Groups can apply for mini-grant funds to initiate interdisciplinary study groups on the brain on their own campus. At present, seven mini-grants have been awarded to the departments of early childhood education at Chicago State University, Columbia College, Elmhurst College, Governor's State University, National-Lewis University, Roosevelt University, and St. Xavier University. Collectively, these institutions enroll over 1,350 early childhood undergraduate and graduate students annually. The grantees have initiated collaborations with faculty from a wide range of other fields including the biological sciences, health and allied health, the social sciences, and other education and education-related fields. Each faculty study group is required to have at least one member with a background in biology or neuroscience. The project modules serve as a catalyst for the study groups to consider, teach, and evaluate new content. Other activities are tailored to the needs of the individual institution. Elmhurst College is sponsoring a campus-wide Faculty/Student Colloquium on a Lifespan Perspective on the Brain; Columbia College early education and biology faculty are designing a new course on the brain that satisfies the health and development course requirement for early childhood teacher certification; and National-Lewis University is focusing on ways to integrate knowledge from the child neuropsychology courses into the child development sequence.

## REFLECTIONS

### *Crowded Curriculum*

The early childhood curriculum is faced with multiple demands. Programs that prepare early childhood educators for teacher certification are packed with requirements related to state learning standards and teacher certification. In addition, two other changes in the field are competing for faculty attention and curricular space: inclusion of children with special needs, and the use of educational technology to facilitate children's learning. Interestingly, the brain modules support both these goals by expanding the students' understanding of disability and increasing their knowledge of the role that one form of technology—brain imaging—can play in understanding child development and learning. However, efforts to integrate new information about the brain must respect the already “crowded curriculum” and the limits on faculty capacity and time to learn new content. Further, curriculum revision initiatives must wrestle with the very real question of how much biology do early educators need to know to work effectively with young children.

### *Interdisciplinary Exchange*

Teaching and learning about the brain and early development can be intimidating. Education faculty are not trained in the neurosciences; hence, faculty are acutely and appropriately aware of the limits of their knowledge about the brain. This is evident in the anxiety that faculty feel in teaching the modules for the first time and the ever present feeling of “not knowing enough.” The participation of expert consultants in the activities of the project has been crucial in identifying and interpreting research and, most importantly, answering faculty questions. Further, the experts have gained from their interaction with early childhood faculty. The mini-grant requirement that each study group include a colleague from the biological sciences was a potent and needed stimulus for interdepartmental and interdisciplinary exchange. Because there are relatively few professionals who are truly dually trained in child development and the neurosciences, our experience confirms that interdisciplinary exchange around early brain development is a two-way process, mutually beneficial to each discipline involved.

### *Encouraging Critical Thinking*

Our goal in undertaking this Project is to help early childhood faculty and students become more knowledgeable and, therefore, more effective developmentalists. Because the brain is a “hot topic,” and controversy exists about the relationship of brain science to early education, teaching about the brain provides faculty with a unique opportunity to build the capacity of students for critical thinking. To support faculty in this endeavor, we are initiating a “Hot Topics” series with faculty and with a neuroscience advisory board to examine controversial issues and to build a framework for evaluating current research and the continuing cascade of new findings about the brain in relationship to what we know about child development and early education.

### *Integrating Multiple Perspectives*

Schore (1998) asserts that in the future there will no longer be purely biological or purely psychological theories of development. Whether we are interested in infant mental health,

language, or cognition, the science of early development is moving toward a union of biological and behavioral understanding. The challenge for early educators is to hold and integrate multiple perspectives: to value and rely upon the traditional knowledge base of our field while staying open to new perspectives from within early childhood and from other disciplines. Integrating an understanding of the brain and nervous system into our picture of child development both affirms long-held beliefs about developmentally appropriate practice and empowers early childhood professionals with new insights into child behavior and development and into their vital roles with young children. This promise for integrated practice is captured in the words of an experienced infant and toddler teacher who truly holds a biopsychosocial perspective.

Understanding not only how biology influences behavior, but also how behavior and experiences influence biology, especially in early development, was extremely helpful to me in my work with infants and toddlers. One of the greatest challenges in group care is reducing stress and developing secure relationships with each child, but I knew that had to be the first priority. I made every effort to ensure that each child got lots of physical contact, social interaction, and experience with language. Understanding the autonomic nervous system was actually very useful in achieving arousal regulation with infants and in facilitating learning. I also worked to make sure the classroom environment was interesting and engaging. I set the stage and then followed their lead, because I knew that providing stimulation was not quite enough. Young children need to be actively engaged in their experiences for learning to take place and for brain development to be enhanced, and the activities need to be suited to their developmental level, their individual learning style, and their bio-behavioral state at the moment. I really do not think I would have been quite as creative or as effective without an understanding of brain development and an appreciation for the impact I was having on children's growth and well-being. (Rebecca Klein, personal communication, August 29, 2000)

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