The Journal *of* Developmental Processes

Journal of Developmental Processes

Submission Guidelines

Description

The goal of the *Journal of Developmental Processes* is to provide a vehicle for research and clinical studies that advance knowledge of the complexity inherent in all developmental processes. The *JDP* encourages exchange of ideas across fields including, but not limited to, animal behavior, anthropology, biology, education, linguistics, neuroscience, occupational and speech and language therapy, primatology, psychiatry, psychology, public policy, sociology, and social work.

The *Journal* is interested in both experimental and descriptive studies, including basic research, detailed case reports, ethnographic analysis, and theoretical explorations. Particularly welcome are innovative conceptual frameworks and methods that capture the complexity of developmental processes as well as assessment procedures and interventions that enable children and families to overcome mental health, developmental, social, and learning challenges.

Submissions

Send queries and submissions on clinical aspects and applications to Associate Editor Ira Glovinsky at ira1834@sbcglobal.net; all other queries and submissions, and books for potential review, should go to Editor Barbara J. King at bjking@wm.edu or Department of Anthropology, College of William and Mary, Williamsburg, VA, USA, 23187-8795.

Please submit manuscripts electronically, preferably in Microsoft Word® format. Length is negotiable with the editor, but generally should not exceed 50 manuscript pages, including references. Submit your contact information, including phone, fax, and postal mailing address. Also enclose a cover letter indicating that the article has not been published, and is not under consideration elsewhere.

Tables, figures, and photographs should be used sparingly. Please include a high gloss black-and-white copy of the image as well as an electronic file in TIFF, EPS, or JPG format. Clearly indicate where the image should appear, as well as a title and explanatory note. Line art should have a resolution of 1200 dots per inch for good print quality.

References

References should be listed in alphabetical order. Each listed reference should be cited in the text, and each text citation should be listed in the References. We follow the APA style, e.g.,

Greenspan, S. I., & Shanker, S. G. (2004). *The first idea: How symbols, language, and intelligence evolved from our primate ancestors to modern humans*. Cambridge, MA: Da Capo.

Greenspan, S. I., & Shanker, S. G. (2005). Developmental Research. In E. S. Person, A. M. Cooper, & G. O. Gabbard, *American psychiatric publishing textbook of psychoanalysis* (pp. 335–360). Washington, DC: American Psychiatric Publishing.

Greenspan, S. I., & Wieder, S. (1997). Developmental patterns and outcomes in infant and children with disorders in relating and communicating: A chart review of 200 cases of children with autistic spectrum diagnosis. *Journal of Developmental and Learning Disorders, 1,* 87–141.

THE JOURNAL OF DEVELOPMENTAL PROCESSES

CONTENTS

The Journal of Developmental Processes

Editorial: Developmental Science Matters

Barbara J. King

Children: The Bottom Line

Anyone who reads a good national newspaper or listens to public radio has a pipeline to our world's joys and sorrows. Daily, I read *The New York Times*. Some articles boost my mood. Reports of discoveries about animal intelligence or empathy, in species ranging from apes to octopi, affirm my sense of connection with other animals. Profiles of artists who embody emotion through innovative dance or theatre remind me how much there is to learn about human relationships through the arts and literature.

By contrast, taking in the world news often unleashes feelings of a different type and magnitude. For months now, I have been haunted by a front-page photograph of an Ethiopian mother and her five-month-old son. The mother sits, and the baby lies, on a hospital bed in a ward devoted to severely undernourished infants. The baby's eyes are huge. They stare straight out from a skull that emerges from a blanket; sticking out from the bottom of the blanket are legs that appear impossibly thin.

From the accompanying article, I learned that in 2005 more than 10,000 children under age five died in northern Ethiopia alone, many because they didn't have enough to eat. Thousands and thousands more survive malnutrition but become sickly or experience a kind of intelligence stunting.[1]

Two months earlier, I saw (in the same front-page position) a photograph of a young boy at work on a canoe in Ghana. Indentured to a man in the fishing industry, six-year-old Mark stares straight out with large eyes, as had the Ethiopian baby. Mark, and others like him on multiple continents, labor on boats, in plantations, or in street markets for as many as 14 hours a day, seven days a week, for three or four years. These victims of the child-slavery trade do not, obviously, attend school.[2]

Few people on any continent can fail to feel compassion or a desire to change these terrible circumstances for children. And people *do* help. They offer their time and expertise (through public-health or child advocacy work of various kinds) or money. Often it happens, though, that we get caught up in our own lives, our own struggles, and feel, however unintentionally, a sense of detachment from what is happening to children *out there in the world somewhere*.

---

1. Michael Wines, "Malnutrition is cheating its survivors, and Africa's future," with photograph by Lynsey Addario, *The New York Times,* December 28, 2006, p. A1.
2. Sharon LaFraniere, "Africa's world of Forced Labor, in a 6-year-old's eyes," with photograph by Joao Silva, *The New York Times,* October 29, 2006, p. A1.

Indeed, most of the *JDP*'s readers come, at present, from North America and Europe. (As I noted in issue 1's editorial, the *JDP* is at work to invite an increasingly international authorship and readership). Why, then, do my two examples come from Africa? In part, this is because I lived and worked in Gabon and Kenya, and I am drawn to articles about that region. In part, too, the media tends to focus on what may be billed as "developing-world disasters": the African child, the child from any poor country, in crisis.

A report issued by UNICEF in February shocks us out of that perspective.[3] Researchers analyzed children's well-being in 21 economically developed nations. Six dimensions (broken down into 40 separate indicators) were rated: material well-being; health and safety; education; peer and family relationships; behaviors and risks; and children's subjective sense of well-being. The Netherlands ranked #1, at the top; Canada, at #12, mid-pack. The U.S. came in at #20, followed only by Britain. Further, Poland and the Czech Republic far outranked the U.S. and Britain, and Greece tied with Canada. This is notable because Poland, the Czech Republic, and Greece are, in economic terms, comparatively far poorer nations.

Let's stop thinking in numbers, and imagine instead the lives of real kids. What do these findings mean for the children in the communities and neighborhoods we live in? Think of the infant—in Africa, America, Anywhere—with a broken bone whose parent explains away her bruises; the kindergartner too hungry to pay attention to her reading teacher; the middle-schooler who is overweight and bullied mercilessly; the teenage boys who are afraid to visit the library because of gun violence in their neighborhood; and the teenage girls who decide as a group to engage in shoplifting and risky sex, or to self-injure, to blunt their emotional pain. Children's suffering is all around us.

Clearly, a robust economy is not the whole answer. What's done with funds earmarked for children is key: What percentage of a nation's budget is targeted for children's well-being? How effectively are those monies managed?

And here's the point for scientists who focus on developmental processes. In the face of children's immediate suffering, our doing good, holistic developmental science *matters*. Let me amend that statement: *especially* in the face of children's immediate suffering, our doing good, holistic developmental science matters. When we "think systems," it matters. Solutions for improving the well-being of children must be informed by research that both embraces the webs of factors that impact development, and refuses to treat as noise the individual differences that emerge as children mature.

Individual variation *is* the point here: Some scientists may wish to engage directly with policy-makers, others may not. Further, there can be no assumption of homogeneity in the developmental science community about what might constitute good, effective policy for children. Nonetheless, I believe that, together with other systems-thinking scientists who focus on developmental processes, the scientists who support the *JDP* (that is, its authors, editorial board members, and readers) are uniquely placed to make a difference by doing and disseminating research that honors the complexity of children's lives.

---

3. See http://www.unicef.org/media/files/ChildPovertyReport.pdf.

This Issue

Academic or clinical findings on children's development in a single report often come from the researcher's home country, based on a relatively homogenous population. Yet developmental scientists must take care not to make sweeping conclusions about children, human infancy, or human behavior based on single-population studies. Anthropologist Sara Harkness and colleagues lead off the *JDP's* second issue with comparative research on maternal practices in five countries: Italy, Korea, the Netherlands, Spain, and the U.S.

Using both quantitative and qualitative evidence, Harkness et al. identify distinct developmental agendas of mothers in these countries. These differences were found to be in place even with infants, that is, at earlier developmental time periods than previously reported. One major finding is the extent to which mothers' models of care diverge around the desirability of high-arousal versus calm states in the children. Harkness et al. frame their results in terms of "shared cultural models" of infant development.

Comparative on a different scale, the article by Charles Snowdon and Toni Ziegler focuses on callithricid family patterns. Callithricids, the tamarin and marmoset monkeys of South America, are of great interest to developmental scientists because they rear infants cooperatively in extended families. In a wide-ranging review of the data, a good deal of it from Snowdon's own lab, these authors highlight aspects of family relationships, including those between breeding partners and between siblings and parents. Owing to our own lengthy periods of infancy and childhood, humans too are cooperative child-raisers. Snowdon and Zeigler contrast and compare the human and callithricid cooperative rearing systems.

Emotional regulation in infancy is at the core of Marc Lewis and Margaret Lloy Cook's article. They tested 12 human infants using sensorimotor tasks and a frustration-induction procedure. At two specific periods in the first year, infants' competence at sensorimotor tasks increased. At the same periods, the strength of the tendency to maintain attention on the mother decreased in certain non-distressed contexts. Lewis and Cook explore the implications for these cognitive-developmental changes, and their relationship to each other, in an explicitly dynamic-systems analysis.

Robert Pasnak and colleagues ask whether understanding the oddity principle, seriation, and conservation are really important in the development of children's thought. Their answer is yes. Evidence from the 143 kindergartners studied shows that interactive play processes, designed to stimulate children's grasp of these abstractions, produce measurable payoffs in learning skills related to both numeracy and literacy. Pasnak et al. discuss the utility of this kind of intervention, based in guided play and learning sets, for youngsters who lag behind their peers in school.

Clinical practitioners as well as educators continually seek new and effective intervention strategies to help children. Noah Kempler describes a technique called Narration, in which an adult, using a specific type of neutral language, wonders aloud with a child about her inner feeling state. Therapists or parents, in other words, engage children verbally in ways that help them link their internal states to their behaviors, while validating the children's subjective experience. Kempler describes the positive results that may accrue from using Narration as a mode of relating.

What happens when children choose to spend more hours relating to technology than to nature? This question motivates the first *JDP Forum*. The *Forum* is meant to showcase examples of developmental research that take up questions of children and society, and couples them with responses from distinguished scholars. Here, Patricia Zaradic and Oliver Pergams explore the consequences of videophilia (sedentary interaction with electronic media) on children's well-being. Videophilia, they suggest, is displacing children's direct encounters with nature in potentially quite negative ways. In her response, Ellen Dissanayake connects her work on the arts in human evolution to children's need for creativity and human interactivity.

Finally, Ljiljana Radenovic reviews a book by Alice Boardman Smuts, *Science in the Service of Children: 1893–1935*.

In closing, I urge readers to take a look at the work being done on developmental processes at the *JDP*'s three sponsoring institutions, to which I remain most grateful.

Council of Human Development at http://www.councilhd.ca

Milton and Ethel Harris Research Initiative at http://www.mehri.ca/

Interdisciplinary Council on Developmental and Learning Disorders at
     http://www.icdl.com/staging/

Cultural Models and Developmental Agendas: Implications for Arousal and Self-regulation in Early Infancy

Sara Harkness (Corresponding author)
Departments of Human Development
   and Family Studies, Pediatrics,
   and Anthropology
University of Connecticut
Sara.Harkness@UConn.edu

Charles M. Super
Departments of Human Development
   and Family Studies, and Pediatrics
University of Connecticut

Ughetta Moscardino
Department of Developmental
   and Social Psychology
University of Padua
Padua, Italy

Jong-Hay Rha
Department of Child Development
   and Guidance
Hannam University
Daejeon, Korea

Marjolijn Blom
Department of Educational Sciences
University of Amsterdam
Amsterdam, The Netherlands

Blanca Huitrón
Department of Educational
   and Developmental Psychology
University of Seville
Seville, Spain

Caroline Johnston
Department of Human Development
   and Family Studies
University of Connecticut

Mary A. Sutherland
Department of Human Development
   and Family Studies
University of Connecticut

On-Kang Hyun
Department of Consumer, Child,
   and Family Studies
Inha University
Incheon, Korea

Giovanna Axia
Department of Developmental
   and Social Psychology
University of Padua
Padua, Italy

Jesús Palacios
Department of Educational
   and Developmental Psychology
University of Seville
Seville, Spain

Abstract: *Parental ethnotheories—the shared, abstract, and often unconscious mental schema for understanding children, families, and the self as parent—organize parental behaviors. This paper focuses on parental ethnotheories and developmental agendas concerning the regulation of infant states of arousal, as expressed in interviews by 96 mothers in five cultural communities (in Italy, Korea, the Netherlands, Spain, and the United States). Transcriptions of the hour-long home interviews were coded for nine themes of child development and 34 related caretaking practices. A Salience Index was derived for each theme to reflect both the frequency of its occurrence in the interview and the number of practices associated with it. Statistical analysis of these indices demonstrates clear differences among the groups in how aspects of infant state are framed and which themes constitute culturally defined developmental agenda. Qualitative analysis elaborates the unique cultural frameworks used by these mothers. Each framework is fully adequate for managing the arousal states of infants and leading them to a more mature pattern of self-regulation, building a platform for their future engagement in the social, emotional, and educational life of their developmental niches.*

Cultural Models and Developmental Agendas

From a developmental perspective, early infancy is a busy time for babies. Beyond surviving the biological vulnerability that comes with transition to life outside the womb, they must learn within the course of a few months how to feed, consolidate patterns of activity and rest in coordination with their caretakers, establish life-sustaining relationships with them, form mental representations for objects and experiences, and regulate their own responses to the sensory experiences generated by their environments of care. All of these developmental agendas are supported by maturational changes in the organization of states of arousal, a dimension of functioning that is often seen more as background than as "development" itself.

Although the field of developmental psychology has given relatively little attention to state of arousal, or organizational state, its importance for understanding the behavior of newborns was established in the 1950s by Wolff (1959) and subsequently Prechtl and Beintema (1968). This recognition marked a turning point in infant research (Als, Tronick, Lester, & Brazelton, 1979; Korner, 1972). Researchers following in this tradition have examined organizational state both as a behavioral response and as a platform for other behaviors. Infant arousal as indexed by smiling, vocalization, and physiological measures has been shown to vary contingently with maternal response, both positively, as high levels of interaction lead to increased infant arousal (Symons & Moran, 1987), and negatively, in that deliberate simulation of non-responsive maternal behavior has been shown to result in disrupted infant arousal and affect (Cohen & Tronick, 1983). In the cognitive domain, the infant's disposition to attend to information and to process experience is dependent on momentary state (Aslin & Fiser, 2005; Rothbart, Ziaie, O'Boyle, Eisenberg, & Fabes, 1992).

Beyond these transient effects, organizational state is also a potent mediator of further experience, determining opportunities to engage in social activity, demonstrate competence, and acquire new skills. This is evident in the differential experience of infants of divergent temperamental dispositions (Super & Harkness, 1986b; Thomas

& Chess, 1977; van den Boom, 1994). In addition, however, daily routines and social settings provided by the infant's caretakers also provide varying opportunities for social and physical interaction, and these in turn influence the development of organizational state. For example, recent advances in understanding stress and its influence on neural architecture and functioning of the hypothalamic-pituitary-adrenal axis suggest life-long consequences of emotional experience and arousal states in infancy (Meaney et al., 1991; Suomi, 1991). Thus, infant-environment interactions during early development influence the organization of states and self-regulatory processes as a substrate for subsequent behavior throughout the domains of cognitive performance and academic learning, emotional expression, and social interaction.

The infant's competence in organizing internal resources for management of the self and interactions with the world emerges in accord with species-specific developmental principles. Nevertheless, as indicated above, transactions with the infant's physical and social environment play a formative role, and in this light, it is evident that culture as an organizer of the environment puts its imprint on the process (Super & Harkness, 2002). What aspects of development are seen as important and what caretaking behaviors are applied to those ends are cultural phenomena; that is, cultures have their own developmental agendas. Parents and other caregivers in a cultural community share beliefs and action plans, or cultural models, concerning the processes and goals of early development (Harkness & Super, 1996b).

Cross-cultural variability in parents' beliefs and practices related to infant care and development has been documented in a number of studies. LeVine (1974), for example, has argued that in societies characterized by high rates of infant mortality, such as traditional sub-Saharan communities, the attention of caregivers is organized around constant vigilance for the physical safety of the infant, at the expense of psychosocial development. A vivid portrayal of parents' beliefs and practices related to infants in one such culture has been provided by Gottlieb's (2004) detailed study among the Beng of West Africa, where infants are seen as hesitant travelers from the afterlife who must be gently persuaded to remain in the world of the living. In another dimension of contrast, Tronick and his colleagues have examined patterns of multiple caretaking among the Efe pygmies of central Africa as counterpoint to the Western insistence on the importance of a single primary caretaker (Tronick, Morelli, & Ivey, 1992). Caudill and Weinstein's classic study of Japanese and U.S. mother-child interaction contrasted a soothing, intimate style of caretaking by Japanese mothers that seemed designed to socialize the infant into close, mutually dependent relationships, with the more arousing style of American caretaking intended to foster the growth of active independence (Caudill & Weinstein, 1969).

Such cultural contrasts are not confined to East versus West or post-modern versus pre-industrial societies. For example, New and Richman (1995) compared long-term goals and socialization practices among northern Italian and New England middle-class mothers, suggesting that specific practices such as putting the baby on the floor to play and explore the environment are related to an emphasis on the importance of achieving independence versus an interdependent family lifestyle. Most often in studies such as these, however, only indirect evidence for parents' developmental agenda is provided, even when expectations for some particular behavioral milestones are

quantified (Frankel & Roer-Bornstein, 1982; Ninio, 1979). There are few detailed, integrated, comparative studies of how parents conceptualize their infants, think about development, and understand the meaning of their own caretaking practices in relation to such concepts.

A Theoretical Model of Parental Ethnotheories, Parenting Practices, and Developmental Outcomes

Of particular importance in advancing a scientific understanding of developmental processes is a more complete model of the links between cultural communities and parental ethnotheories, between ethnotheories and everyday practices, and between practices and developmental outcomes. A brief look at the current literature on environments and development makes the lacunae obvious. On the one hand, neuroscientists are making rapid advances in the laboratory analysis of brain mechanisms underlying infants' cognitive behaviors (Aslin & Fiser, 2005; Johnson & Munakata, 2005). However, as the environments referenced in theoretical approaches to "gene-environment interaction" are the everyday environments, not laboratory environments, this line of research, powerful though it is, cannot complete the model. On the other hand, psychological research outside the laboratory generally follows the discipline's mono-cultural tradition, reducing variation in environments to unidimensional differences in maternal personality, minority status, deprivation, or pathology (Dumas et al., 2005; Matheny, Wachs, Ludwig, & Phillips, 1995; Wachs & Cucinotta, 1971). In light of the rapid and often superficial translation of much contemporary research on early development into the public domain (Bruer, 2002), it is particularly important to elucidate a model of individual-environment transactions that presupposes the possibility of multiple pathways to healthy development.

Several models of the environment as a cultural construction have been offered by Super and Harkness (1986a), Weisner (2002), and Worthman and Brown (2006). With slightly different emphasis on the individual, the family, or the biosocial nature of development, each of these models suggests a way to acknowledge both the environment's organization as a system and the immediacy of that organization for the individual child. The Development Niche framework elaborated by Super and Harkness has been widely applied in studies of infancy and later stages of development (Grigorenko & Sternberg, 2001; Harkness, Wyon, & Super, 1988; Pellegrini & Stanic, 1993; Super, 1976; Super & Harkness, 1982, 1986a, 1994; Super, Keefer, & Harkness, 1994). In this framework, there are three mutually interacting subsystems that directly interface with the growing individual: the physical and social settings of everyday life, the customary practices of child care, and the psychology of the caretakers, including shared beliefs, or parental ethnotheories. Each of these subsystems is influenced by aspects of the culture. In the present study, for example, aspects of the wider environment (such as type of housing and neighborhood characteristics) had an obvious impact on the baby's immediate settings of daily life and on customs of care, such as taking the baby out for a walk in the carriage. Nevertheless, parents' beliefs—especially those that are shared with a community in a given time and place—are

powerful influences on the two other subsystems of the developmental niche. That is, within the constraints given by the wider environment, parents make choices—mostly implicit—about the best ways to take care of their infants, and these choices tend to follow culturally recognizable patterns. As we have written elsewhere, parental ethnotheories thus function "as the nexus through which elements of the larger culture are filtered, and as an important source of parenting practices and the organization of daily life for children and families" (Harkness et al., 2006, p.62).

Recognition of the importance of parental ethnotheories for the organization of the child's daily life, however, still leaves open the question of how beliefs relate to behavior—in this case, parental behavior. The history of research and thinking on the belief-behavior connection over the last 50 years or so reveals a continuing tension between an emphasis on the necessity of recognizing beliefs for understanding behavior, on the one hand, and an insistence, on the other, that behavior cannot be simply predicted on the basis of beliefs. Goodnow and Collins (1990) succinctly summarized this history as it relates to the study of parental beliefs, from early optimism about the importance of parents' expectations and attitudes, to a narrowed focus on behavior in the 1960s, and then to renewed interest in beliefs as the neglect of parents' thinking came to seem inappropriate. The "cognitive revolution" of the 1970s, as Harkness and Super (Harkness & Super, 1996a) pointed out, also contributed to renewed interest in studying not only the way people act, but the way they think as an important topic in its own right. Recognition of the cultural framing of parental thinking was put into sharper focus, within psychology, by cross-cultural studies of "developmental timetables" or parental expectations of when children should achieve certain universal developmental milestones such as sitting without support. More recently, studies have documented the correspondences among parental ethnotheories, culturally shaped practices, and developmental outcomes for children across a wide array of cultures and domains (Harkness & Super, 1996b; Harkness, Super, & van Tijen, 2000). However, there is little research to date that traces the specific linkages from parental ethnotheories to behavior, and ultimately to developmental outcomes for children and families.

In the present paper, we present partial results from a cross-cultural investigation incorporating multiple methods for the study of parental ethnotheories, parenting behavior, and child outcomes particularly as they relate to the development of patterns of rest, arousal and self-regulation in infancy. Our approach makes use of a heuristic model in which beliefs are organized in a hierarchical order (Harkness & Super, 2005), and linked indirectly although powerfully to behavior (see Figure 1). At the top of the hierarchy are the most general, implicit ideas about the nature of the child, parenting, and the family. Below this triad are ideas about specific domains, such as infant sleep or social development. These ideas are closely tied to ideas about appropriate practices, and further to imagined child or family outcomes. Ideas are translated into behavior as mediated by factors such as child characteristics, situational variables, and competing cultural models and their related practices. The final results can be seen in actual parental practices or behaviors, and actual child and family outcomes. The present paper focuses on the first part of the model: Ideas about aspects of child development and about parenting practices, specifically in relation to early infancy. An understanding of these beliefs about the child and about practices is fundamental to

Implicit Culture Models

Family
Child   Parent

Specific Beliefs

About Child
About Practices   About Outcomes

| Child Characteristics |
| Parent Characteristics |
| Aspects of the Culture |

Intervening Factors

Actual Practices

Assigned Settings   Interaction   Daily Activities

Actual Outcomes

Child Development   Family Functioning
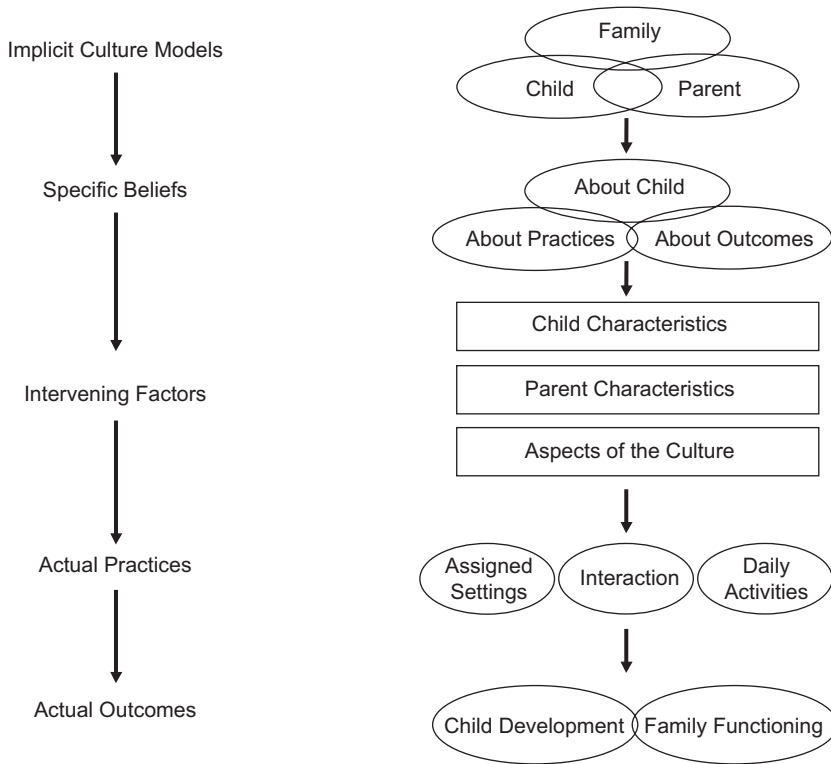
FIGURE 1. Theoretical Model of Ethnotheories, Practices, and Outcomes

the formulation of parental ethnotheories at their most general, abstract level, on the one hand, and to the interpretation of actual parenting behavior, on the other. In our conclusion, we offer some hypotheses about the implications of cultural differences in parental ethnotheories for the development of organization of state during infancy.

The International Baby Study, from which the present data are drawn, is a five-site collaborative project focused on how parental ethnotheories and practices influence emerging patterns of rest, arousal, and self-regulation during the first two years of life. The study builds on findings of the International Study of Parents, Children, and Schools, a seven-site project that developed some of the methods used here (Harkness et al., 2006; Harkness et al., 2000; Super et al., 1996). The present article focuses on key beliefs and practices related to early infancy within each site, as described in parental interviews. By understanding how parents think about their babies and how best to take care of them in the early infant period, we can begin to elucidate the implicit developmental agendas that shape caretaking practices and thus build the platform for further development. To the extent that such developmental agendas vary consistently across cultures, we can identify differing strategies that may, ultimately, be key influences in setting characteristic patterns of organizational state in infancy and beyond.

Methods

Samples

The samples for the present study are drawn from a larger two-year longitudinal study in the United States and the Netherlands, augmented with partial replications in Spain and Italy, and most recently Korea. Study sites in each country were chosen to be broadly representative of a local middle-class population in a city or region. Because the central purpose of the project was to identify shared cultural models and their directive role in early development, the samples were restricted to families in which both parents were native-born and native speakers of the local language, one or both parents worked, and there were no serious health problems. Other family characteristics such as parental age and education, marital status, parental employment, and child care arrangements were left to vary freely. How representative these samples might be of the larger societies from which they were drawn is an empirical question not addressed here; the goal of the study was not to establish national profiles, much less capture intracultural variability within the increasingly multicultural populations, but rather to identify shared parental ideas and their relationship to parenting practices and child outcomes within somewhat homogeneous groups in each cultural site. Accepting the normal variation of demographic characteristics found within the target communities increases the representativeness of the samples for their own larger social context, and at the same time makes it possible to examine the relationships between some parental characteristics and particular ideas or practices, both within and across sample membership. Table 1 presents a summary of the sample characteristics in each cultural site. Group differences in parental education, maternal employment, and (to a lesser degree) parental age are statistically significant.

Research participants in each country were recruited using a variety of methods including advertisements in health clinics, prenatal classes, and child care centers, as well as word-of-mouth through social networks. Enrollment took place during pregnancy and the first two months after the birth. Parents who expressed interest in participating were called by a member of the research team to check for appropriateness in terms of the general parameters mentioned earlier. The nature and purpose of the study were then explained by a member of the research team, and normal consent procedures in each site were followed.

Italy

The Italian families lived in and around Padua, a modern city in northeastern Italy comprised of mostly middle- and upper-middle-class working and professional families. The city has a population of 200,000 and lies in an economically productive region characterized by small- to medium-sized industries. Most participating families were middle-class and lived outside the town center in modern condominium apartments or separate houses. Although the neighborhoods varied in terms of density of population and availability of services (e.g., health care agencies, shops, parks), in

Table 1. Sample Characteristics (mean and range, or percent)

	Italy	Korea	Netherlands	Spain	USA	F (df = 4/79) or Chi-square	p
Number of families	20	21	15	20	20		
Mother's age	31.5	29.7	32.6	31.9	31.3		
	(22–39)	(23–37)	(22–36)	(24–42)	(22–37)	11.80	<.0001
Father's age	35.0	32.7	36.6	32.3	33.5		
	(27–43)	(27–41)	(31–43)	(21–47)	(22–49)	4.33	.003
Mother's years of education	12.9	15.7	13.0	15.6	17.5		
	(8–18)	(12–18)	(10–16)	(12–17)	(13–24)	2.08	.11
Father's years of education	13.6	16.2	13.4	16.1	15.6		
	(8–21)	(12–18)	(11–16)	(12–19)	(12–24)	2.73	.04
Percent mothers employed	15%	13%	0%	5%	80%	46.17	<.0001
Hours per week (if employed)	36.3	30.0		24.4	21.3		
	(17–50)	(10–50)	–	(10–40)	(6–52)	0.5	ns
Percent male infants	50%	61%	53%	50%	55%	0.71	ns
Percent first-born infants	70%	43%	60%	50%	65%	4.07	ns

general they were urban, residential communities offering parents the possibility to go out for walks with their babies and meet other families in public spaces (e.g., playgrounds). Relatives including grandparents, aunts and uncles, and cousins generally lived in the same city and were part of the social landscape of the sample families. Occupations of the fathers, and of those mothers who worked before childbirth (50% worked full-time, 30% part-time), covered a broad range of income and status, including baker and biologist, fireman and physician, shopkeeper and skilled worker, engineer and teacher, financial analyst, nurse, architect, baby-sitter, and clerical worker. At the time of recruitment into this project, three mothers were housewives, and seventeen were on maternity leave. In Italy, maternity leave and pay are among the most generous in the European Union, although employers provide very few family-friendly arrangements (Hardy & Adnett, 2002). Each parent can take a 10-month-parental leave at any time until the child is 8 years old, which is extended to 11 months if the father takes at least three months. This is paid by the government at 30% of normal earnings. Italian parents can also use parental leave to shorten their working hours by two hours per day during the child's first year; usually mothers take advantage of this possibility because it facilitates breastfeeding and allows them to manage the household more easily (Hardy & Adnett, 2002).

Korea

The Korean families in the sample lived in two cities, Daejeon and Incheon. Daejeon is a metropolitan city with a population of 1,440,000. Many national and private

companies maintain high technology research laboratories in Daejeon and thus many fathers of the sample families were working as researchers. Incheon is also a metropolitan city, with a population of 2,660,000. Incheon hosts Korea's primary international airport and second biggest harbor. Most families in the sample were middle-class and lived in apartments; only a few lived in separate houses. In Korea it is very common for a family, especially with small children, to live in an apartment within a very large group of apartment buildings surrounding small parks and playgrounds. At the time of this research, many of the participating families were living with their parents temporarily, as it is a very common practice for grandmothers to look after the new babies and provide postpartum care for mothers. Even though the occupations of the fathers ranged from shopkeeper and skilled worker to dentist and lawyer, most fathers worked as salaried employees for big companies or research institutes. Most of the mothers who worked before childbirth (50% worked full-time) were teachers or office workers. In Korea, working women get 90 days of paid maternity leave before or after childbirth. By the time of recruitment (i.e., when the infant was age 2 months), three mothers had already gone back to work (two mothers full-time, one mother part-time).

The Netherlands

The Dutch sample was recruited from the more rural towns in the most densely populated area of the Netherlands, south of Amsterdam. All participating families lived in residential communities in attached row-houses, with pedestrian walkways and bike paths along the streets and easy access to schools, playgrounds, small parks, and village shopping. A Dutch mother is entitled to have at least 16 weeks of paid perinatal leave from work, and all the mothers in our sample were still home from work at the 2-month interview. These mothers had also had the help of a paid "childbirth caretaker," a paraprofessional who comes to the home to help with both health care and household management for approximately a week after the baby's birth, which for most of these mothers took place at home. Many of the mothers later took up employment, often part-time, in such positions as teacher, nurse, sales clerk, or accountant. Fathers in the Dutch families were employed in a range of occupations, including store manager, chemist, salesman, teacher, landscaper, and journalist.

Spain

All the mothers in the Spanish sample lived in Seville, the capital city of Andalucia, with a population of around 700,000 inhabitants. Most of the families had members of the extended family living in the city (sometimes in the same neighborhood) and family visits took place at least on a weekly base. The families in the Spanish sample lived in apartments in large buildings, a typical living arrangement in Spanish cities. These apartment buildings are easily accessible with a baby carriage and parents do not normally need to walk far away to find a park or a public place where they can spend time with the baby outside the home. The weather in southern Spain is very

mild during the winter months, and families like going outside with the baby to simply spend time in the sun or to visit relatives or friends, or to socialize the baby. For those mothers who are employed, there is a maternity leave of four months. This leave is fully paid and fathers can take part of the leave. In the Spanish sample, 75% of the parents were married or in domestic unions. Most of the mothers were working (all but 12.5%), and their jobs were quite varied, including teachers, nurses, clerks, and sales assistants. At the time of the two-month interviews, all but one of the mothers (who was a university teacher) were home on maternity leave.

The United States

The U.S. families lived in suburbs and small towns in central and eastern Connecticut. Almost all owned or rented their own homes, usually surrounded by a small yard. Although this arrangement provides easy access to the outdoors and open play space, the generally dispersed housing patterns meant that shops, schools, and other institutions were rarely within walking distance. In the semi-rural or suburban areas, there were few sidewalks, making it difficult to even walk with the baby in a the carriage; some mothers solved this problem by packing the baby up in the car and driving to a local mall with outdoor walkways where they could stroll around, shop, and get a bite to eat. Few mothers had family close by, although most had relatives in the same or a nearby town. Most of the mothers in this sample were employed before giving birth, and the majority had resumed work, at least part-time, by the baby's second month, as paid maternity leave is not common. Most of the fathers were able to arrange some time at home after the birth, but none had lengthy paternity leave. The mothers' occupations covered a wide range including salesclerk and foster parent, social worker and attorney, librarian and preschool teacher. The fathers, too, worked in varied positions, including truck driver, professor, attorney, software technician, and business manager.

Procedures

The interviews analyzed here are part of a larger set of data collection methods, including videotaped observations, questionnaires, and assessments of infant reactivity (e.g., to a bath or to arm restraint) that were carried out at various ages. Given our interest in learning about cultural influences on early regulation of state, the interviews included questions about the baby's daily routines and parents' strategies for organizing feeding and sleep into regular patterns. In order to explore parental ethnotheories of the infant as they might influence caretaking practices, we also asked about what kinds of activities the parents thought should be included in the baby's day, and what was most important for the baby's development at that particular time. The interview also covered other topics such as perceptions of the baby's personality, mothers' sources of advice and support, emotional well-being, and coping with the demands of parenthood. In the Unites States, Spain, Holland, and Korea, most families in the study were enrolled during the last half of pregnancy, and were visited at home, shortly after

Table 2. Themes and Practices Coded

Themes	
1. Cognitive processing	11. Affectionate closeness, caress
2. Physical closeness	12. Physical proximity, hold, touch
3. Physical experience and well-being	13. Physical manipulation, massage
4. Regularity of routines	14. Bath
5. Sleep/rest	15. Breast feed
6. Social intelligence	16. Give pacifier
7. Social-emotional closeness	17. Adjust diet (mother or baby)
8. Stimulation of development	18. Change diaper, clothes
9. Tranquility/calm	19. Leave alone to entertain self
	20. Not respond (though present)
Practices	21. Decrease stimulation, quiet environment
1. Give toy, object, mobile	22. Put down for nap or rest
2. Physically active play	23. Put to bed, not in busy place
3. Exercise device: jumper, bouncer	24. Nap in car
4. Play, unspecified	25. Co-sleep
5. TV, video	26. Do specified practice at set time
6. Just be with	27. Take specific safety measure
7. Talk to, encourage sounds	28. Include baby in daily routines
8. Sing	29. Take or leave outside
9. Play music	30. Take on errands, shopping
10. Read book	31. Take to social place
	32. Take to daycare

the birth of the child, and again at two weeks of age. The interviews analyzed here, therefore, were from the fourth meeting with the parents. In Italy, and for some late enrollments in the other sites, the present interview was the first point of data collection. Interviews were carried out at home at a time convenient to the parents. Most of the two-month interviews were with only with the mother, and we therefore focus here on her responses. Interviews were tape-recorded and transcribed in the original language for coding. Translations were used only for communicating across the sites and for publication purposes.

For the present paper, analysis of the interviews involved identifying themes of child development and care and related parenting practices. Both the themes and practices were inductively derived from the interviews themselves as well as from previous related research (Harkness et al., 2006; Super et al., 1996). This process was an iterative one, with several rounds of revision and recoding as new themes emerged or further refinement of their definitions became necessary. The themes and practices were encoded using Nvivo, a commercial computer program for qualitative analysis (QSR, 2002). Ultimately, we decided to focus on nine developmental themes that appear to capture key concepts in all the sites and, with some allowance for variation in nuance, allow for cross-cultural comparison. These themes, as well as the 34 practices identified in relation to them, are presented in Table 2.

The themes and practices were analyzed using both quantitative and qualitative approaches. For the quantitative analysis, we assumed that the more frequently a theme was used, the more important it was for the parents, an approach we have used successfully with other similar data (Harkness et al., 2007; Harkness & Super, 2005;

Harkness et al., 2000). It was evident, however, that some discussions were more abstract than others, without convincing detail as to why the idea was important for development and what the parents did in regard to it. On the other hand, mothers would sometimes include considerable detail as to what they did and why, even if they did not return frequently to the topic. An index of Theme-and-Practice Salience was constructed, therefore, to reflect these twin aspects of mothers' discourse for each of the themes: frequency of use and number of associated practices. First, for each interview, the relative frequency of each of the nine themes was calculated as a percent of all instances of all themes; and second, the number of practices identified with each theme was calculated as a percent of all practices mentioned for all nine themes. The Salience Index for each theme was then computed by multiplying its relative frequency by the proportion of practices linked to it. Finally, the results were made proportional within each sample (by calculating them as percents), to facilitate cross-group comparisons. The qualitative analysis builds from the quantitative results and seeks to find patterns of meaning through closer examination of how the themes and practices were described by mothers in the context of talking about their infants. Ultimately, this qualitative analysis forms the basis for deriving our interpretation of cultural models of the child and of parenting.

Results

We begin with a comparison of Salience scores for the five samples and an evaluation of the culturally unique patterns. We then examine variation within the samples, and conclude the quantitative analysis by repeating the comparative analysis while controlling for parental education.

Table 3 presents the average Theme-and-Practice Salience Index for each theme in each of the five cultural samples. It is evident from the relatively high values for Sleep/Rest and, with one exception, for Regularity of Routines, that these are salient concerns for most mothers. Table 3 also presents the results of an Analysis of Variance for the significance of group differences. In the case of Regularity, the results indicate that the sizeable differences among the groups are unlikely to have occurred by chance and, therefore, that we can reasonably interpret those differences as real and reliable ones. The Dutch mothers' very high score on this theme reveals that they mention and elaborate Regularity of Routines much more than the other groups. The Dutch mothers also focus considerably on Rest/Sleep, but the between-group variation is smaller here, as one might expect for this topic among mothers of two-month-olds. Other significant group differences are found regarding Tranquility/Calmness (an almost uniquely Italian concern), as well as Social-Emotional Closeness (again highest in Italy, although Spain is not significantly different). The U.S. mothers stand alone in their focus on Cognitive Processing, supplemented by a more general concern with Simulation of Development, both of which involve significant between-group variation. The Spanish mothers are not uniquely high on any one of these Salience measures, although they do score highest on the Index for Social Intelligence and for Physical Experience and Well-being. Finally, the Korean mothers share both the Dutch

Table 3. Theme-Practice Salience Index in the Five Samples

Theme	Italy	Korea	Netherlands	Spain	USA	F (df = 4,93)	p
Cognitive Processing	0.7	4.7	0.8	5.7	15.6	9.22	<.0001
Physical Closeness	2.9	2.3	0	4.5	7.9	2.26	.07
Physical Experience and Well-Being	8.1	11.4	8.1	13.8	10.3	0.78	ns
Regularity of Routines	2.2	25.3	43.6	17.5	15.4	11.77	<.0001
Sleep/Rest	22.9	37.1	30.9	27.5	26.7	1.07	ns
Social Awareness and Intelligence	2.4	3.8	0.4	5.9	0.4	2.11	.08
Social-emotional Closeness	20.2	3.5	7.9	18.9	3.6	7.82	<.0001
Stimulation of Development	7.4	11.7	1.3	0.4	16.4	6.25	.0002
Tranquility/Calm	33.2	0.2	6.7	5.7	3.7	29.74	<.0001

focus on Regularity of Routines and the U.S. emphasis on Stimulation of Development. (Although all these measures have somewhat skewed distributions, re-analysis using a non-parametric medians test yielded identical conclusions, except that the two marginal results in Table 3—concerning Physical Closeness and Social Intelligence—were shown to be highly significant, $p < .001$.)

Overall, these patterns are distinctive enough that a Discriminant Function Analysis assigns 87 percent of the individual cases to their correct cultural group, using only the nine Theme-and-Practice Salience scores. Of the 13 errors, five were Korean mothers incorrectly assigned to Holland (four) or Spain (one); three were U.S. mothers incorrectly assigned to Holland (two) or Korea (one); two were Dutch classified with the Korean (one) and U.S. mothers (one); one was Spanish classified with the Dutch; and one Italian and one Spanish mother whose assignments were indeterminate.

Distinctiveness from other groups, however, does not imply uniformity within the culture, and as Wallace (1961) and others have pointed out, the organization of diversity with a cultural group is itself a cultural phenomenon. Although the present samples are chosen to represent a particular cultural community within their larger nation-state, and as such are seen to be distinctly different from the other samples, it nevertheless remains worthwhile to search for variation in ethnotheories within each sample as it might be related to background variables such as parental education. In the present case, we find significant associations between parental education and Theme-and-Practice Salience Index almost exclusively in the United States (the one exception: in Italy, higher paternal education is associated with less emphasis on Social Intelligence). In the U.S. sample, higher maternal education is associated with significantly greater emphasis on Stimulation of Development ($r = .75$, $p < .001$) and Physical Experience and Well-being ($r = .45$, $p = .05$), and significantly less emphasis on Physical Closeness and Sleep/Rest ($r = -.54$ and $-.50$, $p < .03$). Correlations with paternal education are similar. It is noteworthy, however, that these instances of variation related to maternal education do *not* influence correct group assignment by the discriminant function described above: correct or incorrect assignment in the U.S. sample is unrelated to maternal education.

As Table 1 indicates, the samples differ in average years of mothers' and fathers' education; these differences have little influence, however, on the variation in Theme-and-Practice Salience as displayed in Table 3. The Analysis of Variance was repeated with maternal (and separately, paternal) education as a covariate control. Maternal education proved a significant factor for only two of the nine Salience measures (Cognitive Development and Stimulation of Development), and even there the sample differences remained significant or marginally so (p = .002 and .07, respectively). Similar results were found in relation to paternal education.

Cultural Models and Developmental Agendas

With the confidence in the reliability of these group differences, based on the statistical comparisons above, we now turn our attention to the patterns found in mothers' narratives concerning their infant care practices and the meanings they attach to them.

The U.S. Mothers: Stimulation of development through an environment rich in objects and sensory input

The most salient themes for the American mothers were Stimulation of Development, and, relatedly, Cognitive Processing. Together, these two themes capture these mothers' concern with getting their babies off to the best possible start in maximizing their potential as actively thinking persons, a concern underlined by popular promotion of the importance of early brain development. The theme of stimulation encompassed all domains of development, cognitive, socio-emotional, and physical-motor. Cognitive and sensory development seemed to be the key concerns. The most common practices for promoting cognitive and sensory development were the use of toys, or devices such as gyms or arches containing hanging toys which the baby could kick at or view overhead.

> . . . I do try to at least put him in the bouncy, all of these things during the day, the bouncer, you know, to see the little fishes go around and to get the vibration, the mat, just to get some hand-eye coordination stuff going . . .

> Somebody got us a video. It's Baby Einstein. It works a lot with colors and music and just stimulating, so we play that for him. Not every day, but almost every day. Just, there's a whole different range of things. One of them is colors. One is language. The other one is just, you know, shapes and . . . It's stimulating to him. We try to stimulate him in some way.

Providing a variety of sensory experiences was a key theme within the broader theme of stimulation. One younger mother, who brought her son to the university child care center, was well versed in the various types of sensory stimulation offered to him throughout the day. She explained:

> . . . there are five areas in the room . . . for different areas of development . . . sensory and cognitive. So . . . for a sensory experience, they might put him in a sensory table that has cornmeal, and musical instruments, and lay him on a Boppy and . . . if he's moving around

and stuff, he can feel that cornmeal or . . . they might have a mat where there's like, um, a part where toys are hanging . . . so babies get moved around throughout the day.

These mothers perceived their babies as needing stimulation; as one mother said:

. . . I think he needs to be warm, to be fed, to be clean, dry, that kind of thing, but I also think he definitely needs some stimulation. There are times when he is in a chair and we're not paying attention to him or, you know . . . He needs some stimulation, something of interest to look at, something to, you know, just for him to play with, or . . . like now, he's sucking his hands. And now he's getting to the stage where he's beginning to look at his hands and see things, so he can kind of occupy himself, but just something…

The mothers' perception of the importance of early stimulation was reinforced by the messages they were receiving from pediatricians, books, and other "expert" sources. As one mother explained:

I definitely try and do some introducing her to the toys and having her like, just in the past week and a half I brought out the little gym that goes above her so she can start batting at some rattles and she is starting to kind of figure out, but you know her hands are doing that . . . um, so yeah, making sure, I try and read up on you know what a two month old should be doing, what a three month old should be doing, so I can make sure that I do some activities that are helping her develop those skills and things that she needs to do . . . some stimulation where she can start focusing on things, but not over-stimulation 'cause I can see that really, you know, makes her crazy.

Another mother reflected on the current media blitz about early brain development:

You hear about studies of brain development and having the brain make certain connections at certain points so early on, and if they're not exposed to music or things like that, that certain parts of their brain won't develop as well . . . things in my baby magazines that they give you in the OB/GYN office, books that you buy that tell you how to raise your kids. Experts, I guess.

Current expert advice from pediatricians, books and daycare providers also made clear to these mothers the necessity of establishing a regular routine of eating and sleeping, although not all the mothers were equally convinced. All the mothers in the U.S. sample talked about the theme of regularity of routines, and most mothers talked about trying to get their babies on a regular schedule, but they had differing reasons for doing so. For some, the establishment of a regular schedule for the baby was an important goal in and of itself. For others, however, regular routines were a developmental achievement of the baby. As one mother noted with evident pride:

. . . it's very routine, her day now. She doesn't get up at six anymore, now she's up at seven, by 7:15 she's ready for the food and then a diaper and then she sleeps, so she's much more structured and she just kind of fell into that, I didn't have to do a whole lot to get her organized. She's a pretty organized baby.

Part of the rationale for putting babies on a regular schedule was to benefit not only the baby, but other members of the family as well. Typically, mothers who had other children talked about needing to coordinate the baby's schedule with that of the older siblings.

Well, she needs sleep, especially in the afternoon or else she will get really cranky and tired. And, plus, I need some time just to get some things done without worrying about her being awake. I need to have some time in the crib for her so I can accomplish some things around here.

Relatedly, another mother expressed appreciation for her baby's ability to adapt to life in a busy household:

She is easy-going, she doesn't get upset over much of anything. All the activity around her doesn't bother her. She is not fussy. She doesn't wake up.. She doesn't get woken up easily by every little noise. She can just kind of roll with the flow. She can sleep through the activity . . . You know, she fits in really well.

As indicated by the mothers quoted above, the key element in a regular daily routine for babies was establishing a sleep schedule coordinated with the parents' own needs. Thus, many of the same practices were associated with both regularity and sleep or rest: feeding (especially breastfeeding), putting the baby to bed in a quiet place, decreasing environmental stimulation (by turning down the lights, for example), being physically close to the baby, and co-sleeping. Despite the press toward establishing a regular schedule for the baby, some mothers in the U.S. sample spoke of *not* yet worrying about this, or establishing regularity in only one type of activity such as a daily outing, a regular bath, or a special nighttime massage.

Closeness to the baby—physical and, to a lesser extent, social-emotional—was mentioned less frequently, but the U.S. mothers had strong feelings about its importance for the baby's sense of well-being. The theme of Social-Emotional Closeness, and relatedly Physical Closeness, was sometimes presented as a counterpoint to the press towards achievement of a regular schedule. The idea of communicating love effectively to the baby, so the baby would *know* he or she was loved, was at the core of these parents' statements relating to emotional closeness. As one mother put it:

Right now, at his age, I try to hold him as much as I can, and I have Michael hold him as much as he can, and I have Tony give him kisses because I feel that even at this young age, we're instilling love in him, and he knows that we love him, and I don't want him to ever think that he's not loved. And so I feel, at this point, the best thing we can do for him is to shower him with love, and pick him up when he cries, and...I mean, we still let him cry, don't get me wrong, we don't pick him up the second he cries, but I think he's starting to know that we're here and we'll never leave him.

In summary, the theme of Cognitive Processing is interwoven with all the other themes, as parents seemed to conceptualize their young infants as thinking persons capable of learning a variety of things about their environments and organizing their behavior accordingly. The challenge in this regard was to balance the developmental agenda of rapid learning with the baby's tolerance for stimulation - to push stimulation to the maximum without going over the edge into dysregulation of basic state control. Nevertheless, these mothers seemed to perceive their babies as generally adaptable, resilient beings who could tolerate a certain amount of activity and inconsistency in their environments. Thus, mothers' concerns about regularity of routines

and sleep or rest seemed to be focused as much on the needs of the family as on the perceived needs of the baby.

The Dutch Mothers: The development of self-regulation through a regular and restful environment of daily life

The themes of Regularity and of Sleep/Rest dominate much of the interviews with the Dutch mothers. The two themes are closely intertwined, as rest and regularity are the two main pillars of the Dutch "three R's" of infant care (Super et al., 1996). It is apparent from the present interviews that the Dutch mothers (and fathers), at least in this community, were highly attentive to the development of regular sleep routines starting in early infancy. Although most of the mothers in our sample started off breastfeeding their babies, bottle feeding was preferred by some after a few weeks as it allowed parents to know exactly how much food the baby was getting, and therefore how long the baby might be able to wait until the next feeding. Putting the baby in a quiet place such as his own bed or baby carriage was also seen as the key to ensuring good sleep patterns:

> Mother: We try to give feedings at the same time, and recently we also have started putting him in his own bed for naps during the day.
> Father: Not here in the playpen any more, there's no point in that.
> Mother: So when I'm at home, I try to make sure that he goes in his own crib, his own bed (upstairs). Not down here any more, but just in his own bed and that way it goes better. Then he also sleeps—otherwise he just has short "rabbit-naps" because he doesn't sleep very much during the day and now he sleeps longer in his own bed. . . . Just nicely in his own bed, and then I don't just sit around! I'm busy doing things, but only if he's in his own bed.

Mothers were closely attuned to signs that the baby was tired and used a variety of practices to help the baby sleep. As one mother recounted:

> (I can tell when he's tired because) then he fusses, or he just goes to sleep in my arms, or I put him in the baby carriage or his own little bed, and then he usually goes to sleep. And often with his pacifier, then it goes well, he goes to sleep more quickly.

When there was a conflict between the baby's need for sleep and a regular schedule, sleep seemed most important to these mothers. A familiar story was told by one mother:

> So, for example, today he really slept a lot—probably he needed that. So, that's great, I just let him . . . He slept nicely almost all morning and all afternoon. So, great, if he needs that, then I won't say anything against it. And so the feedings follow that: if he comes around, then he comes, and if he doesn't come I just let him sleep nicely.

These mothers seemed to have a clear script in mind for how the day was divided up, with blocks of sleep alternating with particular activities in a regular, predictable pattern of time and locations. One mother described how she arranged the day's rou-

tine for her baby, together with her toddler and herself in terms of a regular schedule of activities, each marked by determined locations within or outside the house:

> Mother: Well, the day really begins at around 9:30. Then he has a bath, he gets a feeding and then he goes downstairs and then he and Peter (older brother) and I are all set. And then either Peter has to have something to eat or he already ate, that depends a little, but then Luke (baby) is downstairs in any case, and then we have something to eat, then we take the dog out and then we go shopping or we go to Grandma's or . . . in any case, we take the dog out and then, depending on the weather, we might go look at the ducks (in the park), and feed them. At about 11:30 Peter goes to bed and then I try to have Luke do that also. At 12:00 or 12:30 I change his diaper or I feed him, so both of them can pack in a couple of hours.
> Interviewer: So does he sleep in his own bed upstairs?

> Mother: Yes, both of them sleep upstairs. Because down here, if I'm vacuuming or whatever, you know. And then they wake up again, it depends, sometimes it's Peter before Luke, sometimes Luke before Peter. But anyway, so, at about 3:00 all three of us are downstairs. And then we take the dog out again, we take a little walk, or play here with other children. . . . but Luke is always here with us so I put him in the baby carriage. And then at about 4:00 or 4:30 we usually are home again, and then I put him in his playpen or bouncy seat. And then I try to do something about getting dinner ready, but it doesn't always work out.

As in the above example, taking the baby out for a walk in the baby carriage was an important part of the day for many of the Dutch mothers, and it was associated with several themes including regularity, sleep, tranquility, stimulation of development, and physical well-being. The organization of the villages where these mothers lived, with their convenient sidewalks and bicycle paths along every street, plus the small scale of the towns themselves, made it easy to walk into the town center to shop or to a nearby park. The streets tended to be full of life, with pedestrians, cyclists, weekly outdoor markets, and on weekends even a marching band. Quiet neighborhoods lay just outside the town center, and these were also pleasant places to go for a stroll. As one mother said:

> Now, I have the idea that it's healthy to be outside and he really likes it . . . also when he's restless like yesterday evening . . . and then I just go about a block with him . . . and then often he just goes to sleep.

Another mother summarized why she thought taking the baby outside was important:

> Ya, we are all outside a lot. Ya, it's really nice outside. It's beautiful weather and it's so easy to go outside and take him along, and now he sees more things, and he sits so nicely looking at the trees, and ya, it's just nice to see.

In contrast to the U.S. mothers, the Dutch mothers did not seem to be concerned about stimulating their babies' development at this age: "playing" with the baby generally meant playful interactions including singing and talking rather than playing with toys. One mother described her ideas about activities with her baby:

> It's not that I take him to baby swimming lessons, but we have little outings with my husband, the three of us go out and have a nice time. When he's had his bath, I give him a little massage with lotion. You know, I do what he enjoys. Or I read books with him, or he

likes pictures, showing him pictures, that kind of thing. . . . You notice that he likes it, and it makes him calm.

When pressed by the interviewer about whether she did anything to stimulate the baby's cognitive development in particular, this mother elaborated:

> Now, you see very well, you could naturally just leave him lying down all day, but you can also stimulate him, so he sits a little bit, so he's more active. We did that with Ana (older sister), and it worked well, and I notice that Jan isn't really lazy or anything, that he likes to sit if you hold him in your arms. . . I think it's nice for a baby just to be near you. And that a baby is not just left lying there."

Implicit in much of the Dutch mothers' talk about their babies' daily routines was a concept of the baby as taking its place in the midst of a larger social world of family and community, even while remaining somewhat separated by being placed in his or her own designated "container" such as a playpen, baby carriage, bouncy seat, or even a blanket on the couch. The themes of Social-Emotional and Physical Closeness were hardly expressed in these mothers' descriptions, even though it is clear that the Dutch mothers spent a lot of time with their babies and were highly attentive to their needs. Rather, the Dutch mothers' cultural models centered around the development of self-regulation through creating regularity in the environment of daily life, with special emphasis on the importance of getting plenty of sleep. According to this developmental agenda, providing structure and regulating the amount of stimulation that the baby received were primary responsibilities of good parenting. Sleep was seen as an inherently pleasurable activity; thus, napping in the baby carriage while out on a walk was considered a pleasant experience rather than a missed opportunity for stimulation. It is important to note that the Dutch emphasis on the importance of sleep was not colored by the mothers' needs for time to "get something done" as in the U.S. sample. At the same time, it is evident that these mothers, by their own report, made fewer demands on themselves for entertaining or "stimulating" their babies than did the American mothers.

The style of parenting evoked in the Dutch mothers' narratives is more distal than proximal, with only occasional episodes of close physical contact and play. Babies were expected to regulate their own state of arousal while awake with little immediate support from mothers beyond appropriate feeding and basic physical care; fussing, in this context, was interpreted as a sign of tiredness rather than a need for social stimulation. In this "horticultural model" of childcare, parents seemed to see themselves as taking care of the baby by controlling the environment and monitoring the baby's behavior within the environmental array of different kinds of experience.

The Italian mothers: Supporting development through emotional closeness

Among the different themes emerging from Italian mothers' interviews, the most salient included Tranquility/Calmness, Sleep/Rest, and Social-Emotional Closeness.

These aspects were considered particularly important for healthy development and may be viewed as an expression of parents' sensitivity to the baby's need for emotional balance. The emphasis on sleep, tranquility, and calmness reflected not only a concern about the infants' health and well-being, but also mothers' personal need for rest:

> Well, actually there is nothing more I wish, because you see, when they ask me if she is a good or a bad baby, I always answer that we are lucky, she is not a bad baby for sure . . . but at the same time she is not like some people say, "My baby just eats and sleeps!" and maybe it wouldn't be right either. . . . So I'm not asking anything else, just maybe I wish she fell asleep earlier at night, because . . . even if she sleeps all through the night and we are really lucky, we have to wait to feed her until 1:30 or 2 am after a long day, sometimes we are really exhausted . . . It may happen that in the afternoon, if she sleeps, I manage to take a rest for half an hour, but not three hours, that's for sure . . .

In contrast to the Dutch mothers, the majority of mothers in the Italian sample did not expect their babies to self-regulate their state of arousal; rather, they tended to accommodate the infant's inborn sleeping and feeding schedules without imposing any rules, since "babies learn to regulate themselves." One mother emphatically rejected the idea of scheduling her breast-feedings:

> No, absolutely not—no scheduling with this one. With the other one I did . . . Because with the bottle you give him 200 ml at two o'clock, so you can't give him 100 ml at three . . . It's completely different, in my opinion. When you breastfeed, you not only give your milk, but many more things so you can't refuse it—it's not that you don't want to, it's just unthinkable, it's as if your child said, "Mummy, give me a kiss," and you said, "Not now, Sweetie, at three o'clock!"

Common practices used to promote infant sleep were physical proximity (e.g., rocking or holding), a quiet environment, decreased stimulation, breastfeeding, and giving a pacifier, but also activities such as taking a walk, visiting other people, or giving the baby a bath. Similarly, tranquility and calmness were achieved through the use of strategies such as breastfeeding, bathing, decreased stimulation, giving a pacifier, playing music, and taking the baby to a social place (e.g., grandparents' house). The calming effect of social relationships is well described by this mother:

> He is a boy who needs company, he really likes having other people around. For example, the other day some friends came to visit us, and he was in his infant seat. Just hearing us talk made him somehow feel involved, and this relaxed him . . . sometimes he even falls asleep! Unless people speak loudly, he calms down because he feels that he is in a relaxing, serene environment.

In case of infant cry or distress, most mothers reported that they picked up their babies immediately to avoid excessive arousal, although in some cases they preferred to use a pacifier or to respond to the baby's crying with alternative soothing strategies, such as distraction and play. According to these mothers, a necessary condition for infants' emotional well-being is a serene atmosphere in the home environment, since babies need to "feel the love, the warmth of the person who is close to them, and feel that the mother is relaxed . . . because if there is tension around them, babies feel it, even if they are so little." As one mother stated:

Well, I think she's good-natured . . . As you can see she is a calm baby, serene, and sociable, because I see she likes being with everyone. For example, yesterday I was out with her to visit a neighboring family, and the woman asked me if she could hold her. I said "Yes" even if I was a bit jealous . . . I'm the mother, you understand . . . but she stayed calm in her arms, and looked around the house: she was feeling good . . . She likes looking around, even if she can't see yet, but she likes it . . . She likes drawing people's attention, because when people talk to her, smile at her, if she hears a voice, she starts smiling.

Another recurrent theme emerging from the interviews was Social-Emotional Closeness, defined as the developing infant's ability to form significant affective relationships with others—both inside and outside the family. Specifically, mothers provided their babies with a socially rich environment to stimulate interaction and emotional experiences:

In my opinion he is a demanding little boy, I mean he wants to see, to do things. I don't think he likes being alone, at least now, maybe because he gets bored . . . and also because he is used to having me or other people around talking to him: aunt, grandpa or this woman who takes care of my father. There's always somebody talking to him, perhaps he's more used to seeing faces than to playing. . . . He has so much fun when somebody talks to him, puts him on the couch, plays with him, or on his bed. . . . When he's in the mood, he has more fun than with his toys!

The formation of social relationships was encouraged through a number of practices occurring on a daily basis, such as taking the baby on social outings, talking to baby, just being with him/her, physical proximity, playing/giving a toy, caressing, and including the baby in the family's routines. From this perspective, the Italian mothers' conception of infant stimulation may be considered as an extension of the developmental theme of Social-Emotional Closeness, as it was generally defined in terms of the promotion of activities involving social contact (e.g., taking to social place) or verbal communication (e.g., talking to baby). As one mother described it:

Either in the late morning or in the early afternoon we spend time outside, and when I come back it's almost time to nurse her . . . I would actually stay half an hour longer, also because it is good for her, too, but actually at that time I come home, she is hungry and I feed her. We just go out for a walk or to visit someone, my parents, for example, who live nearby . . . when she sees a face she has never seen before, she looks in such a way . . . When she was little she just looked, without really seeing people, but now you can see she looks at people she has never seen before in a different way.

The importance of social intelligence and emotional experience are closely related to these themes and support the idea of a cultural model centered on the infant's ability to build significant relationships from the opening months of life. Again, common practices included taking the baby to a social place, just being with the baby, and talking to him/her. According to most mothers, this pattern of caretaking behaviors makes babies feel their mothers' presence, and enhances infants' understanding of ongoing situations through their participation in everyday activities:

I don't think such a little baby can be left alone . . . he knows when he is alone, because he doesn't hear our voices anymore . . . for example in the morning, when he is here and I'm

in the other rooms doing the house chores, he wakes up, maybe he hears the music, but if he can't hear my voice he starts crying because he feels alone . . . He really needs to hear my voice, so I talk to him and explain what I am doing.

Finally, several mothers emphasized physical closeness and security as two relevant aspects of infant development that may serve to enhance the developing attachment relationship between the baby and his/her primary caregiver. In particular, parental behaviors involving proximity (e.g., holding, cuddling, kissing) often occurred during specific routines (e.g., bath, change of diaper) and were described as a "special time" for both mother and baby:

> There is this special moment when I leave him on the changing table without his diaper, usually in the evenings . . . I talk to him, sing songs, tickle him to make him laugh, and he always responds! We both really enjoy it. Sometimes, when he is a bit fussy, I also massage him and he calms down.

The thematic analysis of Italian mothers' narratives revealed that the most salient parental ethnotheories focused on infant sleep, rest, and tranquility as well as social-emotional closeness. On one hand, mothers emphasized the importance of providing a serene and harmonious home environment to foster their babies' sense of security and emotional well-being; on the other hand, they promoted social interaction and emotional experiences with family members and others as a means to form close relationships and stimulate their babies' development. This pattern of findings reflects parents' sensitivity to the baby's need for emotional balance and supports a conception of the infant as an emotional being who is exposed to a socially rich environment and encouraged to interact with familiar and unfamiliar people from the earliest months of life. Specifically, emotional closeness defines infant development in terms of expressiveness and liveliness (the *"vivace"* [literally, lively] child), closeness to other people (the "sociable" child), and emotional security (the "serene" child). In this cultural context, parental stimulation of development acquires a specific meaning. In particular, mothers tended to describe their ideas about stimulation not so much in terms of cognitive development, but rather as a means to convey emotional closeness. For example, most babies were provided the opportunity to participate in social situations/activities as well as communication routines, and were frequently exposed to a number of different people from the earliest months of life (e.g., grandparents, relatives, neighbors). Overall, a composite picture emerges in which social-emotional closeness and emotional security form the core developmental agenda for early infant development, and are accomplished by mothers' active encouragement to establish relationships with other people (i.e., children and adults) as well as through the adoption of a particular parenting style characterized by high levels of physical affection, intimacy, and face-to-face interactions.

The Spanish mothers: Promotion of health and well-being through attention to the baby's physical and emotional needs

The Spanish mothers' cultural models of the baby and of parenting are distinctive in their central focus on the baby as a physical being, in combination with *both* a reg-

ular schedule *and* intimate, proximal and affectionate style of caretaking. In this sense, the Spanish mothers shared some common themes with the Dutch mothers and others with the Italian mothers. The combination of these themes, and their particular constellation of associated practices, makes the Spanish mothers' cultural models both recognizable and unique within the larger group.

All the Spanish mothers shared a common assumption, derived from both personal and professional sources, that a regular schedule was important for babies, and they were closely attuned to their babies' patterns of sleep and wakefulness. The following mother's description of her baby's feeding schedule is typical:

> She has six or seven feedings a day. She eats every four hours, between three and four hours. And although it happens that sometimes she can last four and a half hours, like at night she eats every six hours, she makes up for that by sometimes eating every three hours . . .

The themes of sleep and rest, and relatedly tranquility or calmness, were also emphasized by the Spanish mothers, who described a number of practices to get their babies to sleep, especially singing or playing music, breastfeeding, holding the baby and caressing or massaging the baby's body. Most of the mothers did not expect that their babies would be able to get to sleep on their own:

> When I put her to bed it's that she's already completely asleep, and she wakes up when she's put down in her cradle so I rock it a little, I sing some more or I pick her up so she'll fall asleep again.

> . . . I rock him, I caress him, I try also at times when he seems very excited if it's daytime, I try to darken his room a little bit and it seems like he calms down a bit, but when he's tired it doesn't matter if there's light, he falls asleep.

The themes of sleep and rest, and of tranquility, were closely interwoven with themes of Social-Emotional and Physical Closeness. Even while asleep, according to some mothers, babies might prefer to be near other people:

> . . . she doesn't like to be alone in the dark in her room, so normally I bring her in here to the living room, so there's noise and it seems she likes to sleep with some noise.

In general, babies' environments of care were described in terms of relationships with people, not mediated by objects: mothers virtually never mentioned giving toys or reading to the baby, as they were not considered old enough for that. Rather, mothers referred to simply playing with their babies, occasionally describing such play in terms of playful interaction, talking, or manipulating the baby's body. Babies were not expected to entertain themselves for more than a few moments. In answer to a question by the interviewer, "Does she entertain herself when she's alone?" one mother responded:

> Yes, she entertains herself, but what happens is that she demands, she asks you to say something to her, she is looking for you with her gaze, you notice that she appreciates it and seeks it.

Although much of the baby's day was taken up with sleep, feedings and routine physical care, according to these mothers, the focus of the day was generally taking the baby out for a walk, going on errands, or going to visit relatives. The daily outing

to "the street"—often described as lasting several hours of the "afternoon" up to 8:00 or 9:00 PM—was recommended by pediatricians, by relatives, "by everyone" as healthy for not only the baby but also the mother. Such outings provided relief from being "inside four walls," and an opportunity for the baby's enjoyment of the physical, social and cognitive stimulation of the outside world. As one mother explained:

> I believe that it is important for the baby to go out to get some fresh air and sunshine and . . . so that she relates to her environment. . . . There are some things that she doesn't see in the house. The trees, the branches, she looks at them and she likes looking at the children in the street . . . All these are different kinds of stimulation that she doesn't see in the house.

Taking the baby out was also important for training the baby to interact with new people, even if the baby found it challenging:

> I like the fact that she meets many different people who touch her and hold her, you know? For example when we came back recently from a trip, we were there for 10 days, it bothered her more that others were holding her and before she wasn't like that, she was more adaptable, with her aunt, her grandmother, whoever, our friends, and it didn't bother her at all.

The practices of physical care, a regular schedule of eating and sleep, affection and closeness with other family members, and the daily walk formed a seamless whole whose central theme was the baby's sense of well-being, as illustrated by these mothers' responses to the question "What is the most important thing you can do for your baby?":

> Well, what I am doing, right? I try to give him experiences, I try above all to give him a lot of affection, and that he eats, that he sleeps, that he's clean, that he has a relationship with his brother, with his father, that he goes out, gets some sunshine . . . that he moves, when I bathe him I exercise his little legs, I talk to him a lot . . . .
> Give her security, feed her, keep her clean, take her out on walks, that is, so she develops from the beginning as a secure person. So that she is not fearful.

In summary, the Spanish mothers' themes and practices centered on promotion of health and well-being through attentive care focused on the baby's physical and social needs. Establishing a regular schedule played a part in this developmental agenda, as it was seen as an important dimension of nurturance. The style of care described by these mothers required their own close presence, including helping the baby make the transition from wake to sleep, as well as assuring the baby that he or she was not alone. The mothers themselves appeared to be surrounded by a comforting network of relatives and friends to support the healthy development of their baby as the newest member of the family and community.

The Korean mothers: Protecting and educating the baby

The most salient themes from Korean mothers' interviews were the Regularity of Routines, Sleep/Rest, Stimulation of Development, and Physical Well-being. In this regard, the Korean mothers presented a unique mix of cultural themes and reported

practices that are both similar to—and different from—themes from each of the other cultural samples. The Korean mothers seemed to believe that babies fix their own schedule of feeding and sleeping as they "grow up;" therefore, they did not want to force their babies to follow a mother-imposed schedule, but instead tried to be sensitive to the baby's needs:

> Her routine was very irregular before . . . There was no cycle at all. Nowadays there are sleeping times, feeding times . . . I don't like them necessarily (laugh). Anyway, she has patterns. I cannot see that she is growing because I see her everyday. But when I notice that she has a pattern, I think she has grown up some.

Most mothers in the Korean samples mentioned regularity of routines in terms of their feeding schedule. Many mothers thought babies had preferences and believed it was the mother's job to do things as the babies wanted:

> I do not calculate the amount or intervals of feeding. I feed him when he wants to and as much as he wants to. He does not eat unless he really wants to. Also he does not like certain feeding postures.

One of the reasons why the Korean mothers could follow the baby's every desire at this time is the existence of extra family support. In Korean culture, postpartum mothers are typically looked after by their mother or mother-in-law for at least a month. In fact, many mothers in our sample were living with their parents or in-laws temporarily. The grandmothers took care of the household chores and other work so the new mother could totally concentrate on her recovery and her new baby.

The second major theme in the Korean interviews was sleep and rest. This theme was very much involved with practices such as co-sleeping and physical proximity. The Korean traditional custom of sleeping is on a heated floor. Even though many Koreans use beds nowadays, Korean mothers who are going through the postpartum period often sleep on a spacious mat on a heated floor to recover from childbirth, so it is very natural for them to sleep with their babies. None of the babies in the sample slept alone in a separate bedroom. If the mother was not sleeping with the baby, the grandmother or father was. This proximal style of care was evoked in a mother's description of how her baby went to sleep:

> My baby does not fall asleep lying down. I have to walk around or sit in a chair holding her in my arms. When she goes into sleep, I always sleep next to her—that way she can sleep well.

Many of the Korean mothers put a lot of effort into putting the baby to sleep. The process could be tiring and time-consuming, as one mother described:

> My baby has to be worked on . . . for about thirty minutes. I can put her to sleep in thirty minutes, but it takes longer to leave her. My baby prefers to be held vertically rather than horizontally. She likes to put her arms around my shoulder. I hold her with one arm and with the other I pat her. At the same time I sing to her, then she yawns. Then she will rub her face on my shoulder and go to sleep. I hold her for a while and slowly sit down. I pat her sitting down on a sofa. I keep singing to her to make her sleep better. When she is sound asleep I put her down in the bed. If she wakes up again, I have to do this routine from the beginning all over again.

The third most important theme in the Korean mothers' interviews was stimulation of development. Like the U.S. mothers, these mothers were very much interested in the baby's development, especially cognitive development and the parent's role in it; in fact, the U.S. preoccupation with stimulation of early development seems almost trivialized by the intensive practices described by the Korean mothers. Common practices for stimulation of development were giving toys to the baby, reading books or playing CDs and tapes, as well as playing together and showing things to the babies. Related to stimulation of development was the theme of cognitive processing, as expressed by one mother:

> My baby looks at new things very intensively for a long time. I think he recognizes things and he is thinking. I like it. It is his brain development. I would like to show him lots of things to help and encourage his brain development . . . I put some pictures on the wall to show him things . . . I would like to do more for him. The emotional development is also important. I have to do lots of things for him. Also I have to use good words.

According to the Korean mothers, stimulation should be started as early as possible, and should be not just simple playthings but planned early education.

> There is a song I sang while he was in the womb. He seems to recognize it nowadays. When he is crying, if I sing the song he will calm down easily.

> Nowadays, I play music tapes—English songs and English stories. He likes listening to tapes. I draw pictures and show him, and I talk to him showing photos.

It is a common practice for Korean mothers to avoid taking their baby outside until the baby is considered to be stabilized. This reflects a particular concern for the baby's physical well-being. Nowadays, the timing of taking the baby outside could vary widely according to the family's beliefs and weather conditions; however, traditionally Koreans thought the baby would be stabilized only after one hundred days after the birth. In traditional Korean society, visitors were not allowed in the house for up to "three seven-days" (21 days) in order to keep newborn babies and their mothers safe from outside germs in the postpartum period. Therefore, Korean mothers might tend to think they have to provide lots of stimulation for the baby since the baby is only staying in the house:

> We never take the baby outside except for hospital checkups. They say we could take the baby out, and I would like to go out too. But there is yellow wind outside and maybe we should stay until the yellow wind is gone. My husband and I wanted to go to his parent's house to show the baby after "three seven-days" but his parents worried too much. They wanted to take the baby out only after the hundredth day. So we are still here staying home. . . . A few days ago, my sister came with her children. We are always staying home and that was the first time he heard the sound of other children and he was paying so much attention. He keeps looking at them and following them with his eyes.

Some mothers also described trying to stimulate the baby physically by doing some baby massage or exercises.

> During a few times a day when I am playing with the baby, I stretch her legs and arms. I rub her stomach, pat her back and massage her.

> When the baby wakes in the morning, I play him some English tapes. And I play with him . . . I sing to him. They say listening to human voices is good for him. I also do some exercise with him. I have an exercise video for babies so I play the tape and do exercise with him. When he goes to sleep I play English tapes, stories or songs or sometimes quiet music. That's all I do.

In sum, Korean mothers look at their babies as needing a lot of protection and motherly attention. Even the extended families joined in to make sure that the new baby and mothers get sufficient protection and support. In this context, good parenting was defined as providing everything the baby needed and in order to do that staying physically close to the baby.

> Being a mom is very happy event, but at the same time I feel a heavy responsibility. I will do the best for the baby. I have to set some standards for him. I don't know how much the baby will follow . . . I think I have to be flexible. If I push him too much then it will be too stressful for the baby and for me too. So I have to learn and study about parenting. And I need to plan ahead.

In order to be good parents in Korea, the parents should stay very close to the baby, attending baby's every need and putting the parent's need second. Physical proximity, touching and physical protection are important for Korean parenting.

> I think the most important thing at this stage is holding and making eye contact with the baby. Some people say it might spoil the baby if I hold him too much. But I have a different opinion. I am willing to hold him whenever he wants to be held even though it might be physically hard for me.

For the Korean mothers it was the caretakers, not the baby, who were in charge of the baby's state of arousal. There was a consistent effort to maintain a low state of arousal, for instance, avoiding crying and not letting the baby get too hungry before feeding. Even though Korean mothers try to provide stimulation for their baby's development and there is an emphasis on early education, they justify the practice as following the babies' wishes—doing what the baby likes to do. Many Korean mothers said the babies liked the stimulation the parents provided.

> He likes to get stimulation of his hands . . . I discovered that he laughs when his hands are stimulated. Nowadays he watches TV . . . maybe because the screen is flashing. Also he follows my movement with his eyes. I think now he sees things clearly and listens to sounds clearly . . . I think babies like to be stimulated.

> I showed him new pictures today . . . I stuck the pictures on the chest in the living room. . . . The baby was looking at the pictures for some time with full attention. The baby likes looking at the pictures. Maybe all babies are like that. But my baby surely liked looking at pictures and also he seemed to know that the pictures are changed. I pointed to them, "This is a bear, this is a fox," and he liked it.

In summary, the Korean mothers' developmental agenda was based on a cultural model of the young baby as a vulnerable being who must be protected from the dangers of the outside world for a period of time. During this time (the "one hundred days" or approximately the first three months of life), good parenting was defined in terms of sensitivity to the baby's cues. Physical proximity was a central practice, in-

cluding while the baby was asleep, and this was seen as an essential need of the baby. In this regard, the Korean mothers described themselves as somewhat similar to the Italian and Spanish mothers, but more so. Added to this cultural model, however, were expectations of early cognitive development more reminiscent of the U.S. mothers—and here also the parents were expected to be attentive and sensitive teachers who were already engaged in early pre-academic activities with their babies. Although the two main components of the developmental agenda—protection and early stimulation of cognitive development—may seem incompatible from a Western perspective, they were united for the mothers in our sample by a central concern with sensitive parenting for optimal development.

Discussion

Some of the themes identified in our interviews with the mothers in these cultural samples are already familiar through other research, including ours, as well as through the media. For example, previous research has shown that Italian parents' socialization goals include physical and emotional closeness between parent and child, exploration, physical health, and a serene home environment (Axia, Bonichini, & Moscardino, 2003; Harkness et al., 2001). Northern Italian mothers believe that sociability, liveliness, and activity are positive manifestations of their babies' health and therefore tend to appreciate these characteristics (Axia & Weisner, 2002). The Italian mothers in our sample predominantly associated stimulation with social relationships and emotional, verbal, and physical interactions, a finding that has been reported in other studies (Axia, 1999; Bornstein, Cote, & Venuti, 2001; Gandini & Edwards, 2000; Harkness et al., 2006; New, 1989).

Likewise, the American middle-class emphasis on promotion of rapid cognitive development in children has been noted by many observers including the Swiss psychologist Jean Piaget, who referred to this predilection as "the American question." Previous research by Harkness, Super, and their colleagues contrasted a focus on children's cognitive qualities by American parents with greater attention to social qualities on the part of Dutch parents (Harkness et al., 2000). The importance of rest and regularity in the Dutch cultural model of parenting has also been previously documented (Super et al., 1996). Asian parents' attention to their children's development in school-related skills has also been documented in many studies (Parmar, Harkness, & Super, 2004). Finally, the Spanish mothers' focus on helping the child's early development of social relationships is consistent with previous research indicating concern about social competence (Harkness & Super, 2005). The present study, however, is distinctive in identifying these and other cultural themes so early in infancy.

The sample differences in cultural models of the child and developmental agendas have distinct implications for cognitive, affective, and social development in infancy and beyond. It is clear from our interviews that these aspects of development were very much on the minds of the mothers in the different cultural samples. It is also evident, however, that all the mothers were equally (if not more) concerned about regulating

their baby's state of arousal. Given the breathtaking rapidity with which young infants can move through various states from peaceful sleep to full-throated crying, it seems natural that caretakers should attempt to modulate the baby's organizational state, particularly in order to avoid the highest levels of arousal. Mothers in the different samples had distinctively different cultural strategies for achieving this goal, however, and these strategies may have implications for later group tendencies in this important substrate of behavioral development. The different cultural models and practices of care described by the mothers point to four dimensions of contrast. Interestingly, the cultural samples align themselves uniquely on each one.

1) Promotion of high versus low states of arousal

A basic dimension of contrast is the extent to which cultural models of infant care generally promote high arousal in contrast to a calmer, less aroused state. On this dimension, it seems clear that the practices described by the U.S. mothers were most likely to promote high arousal, in particular through placing the baby in electronic mini-worlds full of flashing lights, sounds, and movements that provided stimulation of many senses at the same time. The U.S. mothers were also less likely, as they described it, to modify the level of noise and commotion in the baby's environment, preferring instead (with the encouragement of their pediatricians) to help the baby learn to cope with the realities of life in a busy household. At the other end of this dimension are the Korean mothers, whose protectiveness and sensitivity to the baby were expressed through maintaining a low level of sensory input, even if it might include sophisticated elements such as English-language videotapes. The Dutch, Italian, and Spanish cultural models of care also seem to imply more concern than the U.S. with avoiding over-stimulation, although they took distinctive approaches to doing so as discussed below.

2) Promotion of sleep and rest: Is there ever too much?

The promotion of rest and sleep is a separate dimension of contrast illustrated by the mothers in our samples. Here, the Dutch mothers clearly indicated the strongest commitment to sleep as essential to healthy growth and development. Sleep was seen by these mothers as more important even than eating on a regular schedule, as demonstrated by one mother quoted earlier (and in contradiction to the official national child health guidelines). Sleep was seen almost as a form of recreation by some of the Dutch mothers, who described the baby as "sleeping nicely" while out on a walk in the carriage, parked in the sunshine, or simply upstairs in bed. The U.S. mothers again provide the highest contrast, in that their concern with infant sleep seemed to be more for themselves than for the well-being of the baby. The Spanish and Italian mothers placed more emphasis on "calmness" than on sleep *per se*, with the apparent implication that sleep would take care of itself if the baby were in a supportive environment.

The Korean mothers seemed to emphasize creating a restful environment so that the baby could determine its own need for sleep.

3) Regulation of state as an individual task versus a joint project

There was marked variation across our cultural samples in the extent to which regulation of the baby's state of arousal was regarded as a developmental task to be mastered individually by the baby, in contrast to a perception that young babies need to be supported in that regard. This was particularly evident in management of the transition from wake to sleep. The Korean mothers represented one extreme in this regard, as recounted by the mother who described her lengthy process of putting the baby down to sleep. Having a person (whether the mother or another caretaker or relative) sleep next to the baby as a way to support good sleep also reinforced this cultural model of joint responsibility for the baby's state. At the other end of the continuum were the Dutch mothers, who relied more on props such as a pacifier, and on putting the baby down to sleep in a quiet, darkened room, than on their own physical support for the baby's transition to sleep. Both the Italian and Spanish mothers, in contrast, specifically talked about helping their baby get to sleep by nursing, cuddling, singing, rocking, even talking to the baby. The importance of social support for sleep was mentioned by mothers in both these samples, who mentioned that their babies seemed to sleep better knowing that others were nearby. In particular, these mothers also emphasized the importance of a tranquil, serene atmosphere in the home as an important support for the baby's sleep. Interestingly, the U.S. mothers talked relatively little about methods for getting the baby to sleep at this age.

4) Self-regulation through regularity versus contingent social support

Related to all the other dimensions of contrast, finally, is the contrast between socialization for individual self-regulation through one's own schedule versus learning self-regulation as contingent on social cues from the environment. Here, the U.S. and Dutch mothers are paired at one end of the continuum in their commitment to training the baby to attain a regular schedule (ideally one that matches the needs of the rest of the family), which then functions as its own self-regulating mechanism. This cultural model of child development corresponds to a distal style of caretaking as described by the mothers, in which the baby's daily routine is described in terms of spending certain amounts of time in various "containers" (e.g., the baby carriage, the bouncy chair) or in interaction with various kinds of toys and mechanical or electronic sources of stimulation. At the other end are the Italian, Spanish, and Korean mothers' cultural models of care, in which there is little mention of play with toys or what kind of carrier the baby is placed in; but a great deal of talk about proximal kinds of play and social interaction. In this model, the baby's physical state can dictate organization of the environment, as in the Korean mothers' attempts to be sensitive to the baby's cues of

sleepiness or hunger; but it can also be shaped by other things going on in the social environment, as in having a nap in the midst of a social gathering of the mother and her friends.

Conclusions:
Developmental Agendas for the Regulation of State

Qualitative and quantitative analysis of these interviews demonstrate that mothers in the various groups hold distinctive developmental agendas; it is further evident that the differences in ethnotheories and the associated practices, as described by the mothers, have important implications for the regulation of arousal state, both in the short term and as a framework for later functioning.

Infants in the U.S. sample spend their days in an environment that encourages high levels of arousal and activity. Stimulating development through sensory and cognitive experiences that will move the baby forward is a salient theme in the U.S. mothers' narratives; relatedly, the mothers also routinely use objects (e.g., toys, videotapes) to supplement their own efforts at soothing and regulating arousal. It follows that these infants will develop a scheme for daily life, a setpoint for "normality," that includes sustained levels of high arousal that are moderated, as needed, by periods of calm engagement or rest. As the U.S. infants attain skill in self-regulation of state, one can predict that it will include substantial use of objects as moderators.

The ethnotheories and practices of the Korean mothers contrast sharply with the U.S. picture, despite a common theme of stimulating cognitive development. For the Korean mothers, maintaining a quiet calm is particularly salient, and they see this as fully their responsibility. As the Korean infants establish internal regulation of their own states, therefore, we can expect them to have a scheme that includes a lower level of arousal than would be the case for the U.S. infants. Further, given the mothers' attention to ensuring calm through personal intervention, one can predict that the Korean infants' emerging schema for self-regulation will initially center on social relationships rather than objects.

The Dutch mothers present another variation for their infants to model. Their emphasis on rest and regularity bears some similarity to the Korean focus, but they are more conscious of helping their infants to learn self-regulation of state transitions (in particular, sleep). In addition, the Dutch infants presumably establish relatively early a sense of temporal regularity concerning normal daily activity and rest, which should be sensitive to *Zeitgebers* (environmental cues for time of day, such as light and dark and regular mealtimes).

The Spanish mothers also present in these interviews a heightened awareness of regularity and rest, but is it more balanced and combined with relatively elaborated themes of physical care, including feeding, bathing, and attention to their babies' digestive patterns. Attentive physical care, plus the mandatory daily outing in the baby carriage, together represented the correct prescription for physical well-being and emotional security—both essential for an optimal state of arousal while awake.

Finally, the Italian mothers are distinctive in their focus on facilitating their infants' emotional growth and integration with a relatively large number of family members and other persons. One might expect that the babies' emerging schema for everyday life would include a greater complexity of emotional states and more rapidly changing pattern of arousal and calm when awake.

Each of the developmental agendas expressed by mothers here provides an adequate and effective framework for managing the arousal states of young infants and leading them to a more mature pattern of self-regulation. They are not identical, however, in either their momentary effect nor, one can expect, in their long-term consequences. The mothers' understandings and practices are organized by shared cultural models and, in turn, they provide a culturally shared framework for their infants' emerging behaviors. As the infants construct enduring schemes for their own patterns of arousal and attention, they accelerate their enculturation and build a basis for their future engagement in the social, emotional, and educational life of their developmental niches.

Acknowledgments

References

Als, H., Tronick, E., Lester, B. M., & Brazelton, T. B. (1979). Specific neonatal measures: The Brazelton Neonatal Behavioral Assessment Scale. In J. D. Osofsky (Ed.), *Handbook of infant development* (pp. 185–215). New York: John Wiley & Sons.

Aslin, R. N., & Fiser, J. (2005). Methodological challenges for understanding cognitive development in infants. *Trends in Cognitive Sciences, 9*(3), 92–98.

Axia, G. (1999). *La timidezza [Shyness]*. Bologna: Il Mulino.

Axia, G., Bonichini, S., & Moscardino, U. (2003). Dalle narrative parentali ai dati quantitativi: Etnoteorie parentali in famiglie italiane e nigeriane immigrate in Italia [From parental narratives to quantitative data: Parental ethnotheories in Italian and Nigerian immigrant families in Italy]. In C. Ponderico, P. Venuti, & R. Marcone (Eds.), *Diverse culture, bambini diversi? [Different cultures, different children?]* (pp. 119–140). Milan: Unicopli.

Axia, G., & Weisner, T. (2002). Infant stress reactivity and home cultural ecology of Italian infants and families. *Infant Behavior and Development, 140*, 1–14.

Bornstein, M. H., Cote, L. R., & Venuti, P. (2001). Parenting beliefs and behaviors in Northern and Southern groups of Italian mothers and young infants. *Journal of Family Psychology, 15*(4), 663–675.

Bruer, J. T. (2002). Avoiding the pediatrician's error: How neuroscientists can help educators (and themselves). *Nature Neuroscience Supplement, 5*, 1031–1033.

Caudill, W., & Weinstein, H. (1969). Maternal care and infant behavior in Japan and America. *Psychiatry, 32*, 12–43.

Cohen, J. F., & Tronick, E. Z. (1983). Three-month-old infants' reaction to simulated maternal depression. *Child Development, 54*, 185–193.

Dumas, J. E., Nissley, J., Nordstrom, A., Phillips Smith, E., Prinz, R. J., & Levine, D. W. (2005). Home chaos: Sociodemographic, parenting, interactional, and child correlates. *Journal of Clinical Child and Adolescent Psychology, 34*(1), 93–104.

Frankel, D. G., & Roer-Bornstein, C. (1982). *Traditional and modern contributions to changing infant-rearing ideologies of two ethnic communities*. (Vol. 47).

Gandini, L., & Edwards, C. P. (2000). *Bambini: The Italian approach to infant-toddler care*. New York: Teachers College Press.

Goodnow, J. J., & Collins, W. A. (1990). *Development according to parents: The nature, sources, and consequences of parents' ideas*. London: Erlbaum.

Gottlieb, A. (2004). *The afterlife is where we come from*. Chicago: University of Chicago Press.

Grigorenko, E. L., & Sternberg, R. J. (2001). Arguing for the concept of developmental niche. In *Family environment and intellectual functioning: A life-span perspective*. (pp. 23–48). Hillsdale, NJ: Erlbaum.

Hardy, S., & Adnett, N. (2002). The parental leave directive: Towards a 'family-friendly' social Europe? *European Journal of Industrial Relations, 8*(2), 157–172.

Harkness, S., Blom, M. J. M., Oliva, A., Moscardino, U., Zylicz, P. O., Rios Bermudez, M., et al. (2007). Teachers' ethnotheories of the "ideal student" in five Western cultures. *Comparative Education*, in press.

Harkness, S., Moscardino, U., Rios Bermudez, M., Zylicz, P. O., Welles-Nystrom, B., Blom, M. J. M., et al. (2006). Mixed methods in international collaborative research: The experiences of the International Study of Parents, Children, and Schools. *Cross-Cultural Research, 40*(1), 65–82.

Harkness, S., & Super, C. M. (1996a). Introduction. In S. Harkness & C. M. Super (Eds.), *Parents' cultural belief systems: Their origins, expressions, and consequences* (pp. 1–23). New York: Guilford.

Harkness, S., & Super, C. M. (2005). Themes and variations: Parental ethnotheories in Western cultures. In K. H. Rubin & O.-B. Chung (Eds.), *Parental beliefs, parenting, and child development in cross-cultural perspective*. (pp. 61–79). New York: Psychology Press.

Harkness, S., & Super, C. M. (Eds.). (1996b). *Parents' cultural belief systems: Their origins, expressions, and consequences*. New York: Guilford.

Harkness, S., Super, C. M., Axia, V., Eliasz, A., Placios, J., & Welles-Nyström, B. (2001). Cultural pathways to successful parenting. *International Society for the Study of Behavioral Development Newsletter, 1*(38), 9–13.

Harkness, S., Super, C. M., & van Tijen, N. (2000). Individualism and the "Western mind" reconsidered: American and Dutch parents' ethnotheories of children and family. In S. Harkness, C. Raeff & C. M. Super (Eds.), *Variability in the social construction of the child* (Vol. *New Directions for Child and Adolescent Development*, 87, pp. 23–39). San Francisco: Jossey-Bass.

Harkness, S., Wyon, J. B., & Super, C. M. (1988). The relevance of behavioral sciences to disease prevention and control in developing countries. In P. Dasen, N. Sartorius, & J. Berry (Eds.), *Psychology, culture, and health: Toward applications* (pp. 239–255). Beverly Hills, CA: Sage.

Johnson, M. H., & Munakata, Y. (2005). Processes of change in brain and cognitive development. *Trends in Cognitive Sciences, 9*(3), 152–158.

Korner, A. F. (1972). State as a variable, as obstacle, and as mediator of stimulation in infant research. *Merrill-Palmer Quarterly, 18*, 77–94.

LeVine, R. A. (1974). Parental goals: A cross-cultural view. *Teachers College Record, 76*(2), 226–239.

Matheny, A. P., Wachs, T. D., Ludwig, J. L., & Phillips, K. (1995). Bringing order out of chaos: Psychometric characteristics of the Confusion, Hubbub, and Order Scale. *Journal of Applied Developmental Psychology, 16*, 429–444.

Meaney, J. J., Mitchell, J. B., Aitken, D. H., Bhatnagar, S. D., Bodnoff, S. R., Iny, L. J., et al. (1991). The effect of neonatal handling on the development of the adrenocortical response to stress: Implications for neuropathology and cognitive deficits in later life. *Psychoneurendocrinology, 61*, 58–103.

New, R. S. (1989). The family context of Italian infant care. *Early Child Development and Care, 50*, 99–108.

New, R. S., & Richman, A. L. (1995). Maternal beliefs and infant care practices in Italy and the United States. In S. Harkness & C. M. Super (Eds.), *Parents' cultural belief systems: Their origins, expressions, and consequences.* New York: Guilford Press.

Ninio, A. (1979). The naive theory of the infant and other maternal attitudes in two subgroups in Israel. *Child Development, 50*, 976–980.

Parmar, P., Harkness, S., & Super, C. M. (2004). Asian and Euro-American parents' ethnotheories of play and learning: Effects on pre-school children's home routines and school behavior. *International Journal of Behavioral Development, 28*(2), 97–104.

Pellegrini, A. D., & Stanic, G. M. A. (1993). Locating children's mathematical competence: Application of the developmental niche. *Journal of Applied Developmental Psychology, 14*, 501–520.

Prechtl, H. F. R., & Beintema, J. (1968). *The neurological examination of the full-term newborn infant* (Vol. 28). London: Spastics International Medical Publications.

QSR. (2002). NVivo: QSR International.

Rothbart, M. K., Ziaie, H., & O'Boyle, C. G. (1992). Self-regulation and emotion in infancy. In N. Eisenberg & R. A. Fabes (Eds.), *Emotion and its regulation in early development.* (pp. 7–23). San Francisco: Jossey-Bass.

Suomi, S. J. (1991). Early stress and adult emotional reactivity in rhesus monkeys. *Ciba Foundation Symposium, 156*, 171–183, discussion 183–178.

Super, C. M. (1976). Environmental effects on motor development: The case of African infant precocity. *Developmental Medicine and Child Neurology, 18*, 561–567.

Super, C. M., & Harkness, S. (1982). The infant's niche in rural Kenya and metropolitan America. In L. L. Adler (Ed.), *Cross-cultural research at issue* (pp. 47–56). New York: Academic Press.

Super, C. M., & Harkness, S. (1986a). The developmental niche: A conceptualization at the interface of child and culture. *International Journal of Behavioral Development, 9*, 545–569.

Super, C. M., & Harkness, S. (1986b). Temperament, culture, and development. In R. Plomin & J. Dunn (Eds.), *The study of temperament: Changes, continuities, and challenges* (pp. 131–150). Hillsdale, NJ: Lawrence Erlbaum Associates.

Super, C. M., & Harkness, S. (1994). The cultural regulation of temperament-environment interactions. *Researching Early Childhood, 2*(1), 59–84.

Super, C. M., & Harkness, S. (2002). Culture structures the environment for development. *Human Development, 45*(4), 270–274.

Super, C. M., Harkness, S., van Tijen, N., van der Vlugt, E., Dykstra, J., & Fintelman, M. (1996). The three R's of Dutch child rearing and the socialization of infant arousal. In S. Harkness & C. M. Super (Eds.), *Parents' cultural belief systems: Their origins, expressions, and consequences.* (pp. 447–466). New York: Guilford Press.

Super, C. M., Keefer, C. H., & Harkness, S. (1994). Child care and infectious respiratory disease during the first two years of life in a rural Kenyan community. *Social Science and Medicine, 38*(2), 227–229.

Symons, D. K., & Moran, G. (1987). The behavioral dynamics of mutual responsiveness in early face-to-face mother-infant interactions. *Child Development, 58*, 1488–1495.

Thomas, A., & Chess, S. (1977). *Temperament and development*. New York: Brunner/Mazel.

Tronick, E. Z., Morelli, G. A., & Ivey, P. K. (1992). The Efe forager infant and toddler's pattern of social relationships: Multiple and simultaneous. *Developmental Psychology, 28*(4), 568–577.

van den Boom, D. C. (1994). The influence of temperament and mothering on attachment and exploration: An experimental manipulation of sensitive responsiveness among lower-class mothers with irritable infants. *Child Development, 65*, 1149–1469.

Wachs, T., & Cucinotta, P. (1971). The effects of enriched neonatal experiences upon later cognitive functioning. *Developmental Psychology, 5*(3), 542–545.

Wallace, A. F. C. (1961). *Culture and personality*. New York: Random House.

Weisner, T. S. (2002). Ecocultural understanding of children's developmental pathways. *Human Development, 45*(4), 275–281.

Wolff, P. H. (1959). Observations on human infants. *Psychosomatic Medicine, 221*, 110–118.

Worthman, C. M., & Brown, R. A. (2007). Companionable sleep: Social regulation of sleep and co-sleeping in Egyptian families. *Journal of Family Psychology, 21(1)*, 24–35.

Growing Up Cooperatively:

Family Processes and Infant Care in Marmosets and Tamarins

Charles T. Snowdon (Corresponding author)
Department of Psychology
University of Wisconsin
Snowdon@wisc.edu

Toni E. Ziegler
Wisconsin National Primate Center
University of Wisconsin

Abstract: *Parenting patterns range widely among human and nonhuman primates. Rarely do single mothers parent without help. Many female-bonded species have female relatives (grandmothers and aunts) to help with infant care. In other species both parents assist in infant care, or there is cooperative care where several group members work together to rear a single infant or litter. Cooperative care is relatively uncommon in primates, but is found in many birds and in some non-primate mammals such as wolves and meerkats. In primates, cooperative care is seen primarily in marmosets and tamarins, small monkeys from the New World. We first describe patterns of cooperative care of infants in cotton-top tamarins* (Saguinus oedipus) *and common marmosets* (Callithrix jacchus). *Then we examine the cooperative care family as a social system describing the mechanisms that maintain relationships among family members to maintain cooperative care. Human beings also require cooperative care due to the long duration of infancy and childhood, so we conclude with some speculations about how cooperative care benefits children and how research with cooperative care primates might help us to become more successful parents.*

Growing Up Cooperatively

Childcare in mammals is often studied and discussed only in the context of mother-infant interactions because mothers bear the costs of gestation and lactation. Occasionally there are studies on fathers and the role they play in infant care. Rarely is infant care and infant development studied in the context of families and the contributions that each family member might make to successful infant care. The animal models that are used to study parenting are typically species where mothers alone are responsible for all infant care (e.g., rats, Fleming, 1996; vervet monkeys, Fairbanks,

1996; rhesus macaques, Roma, Ruggiero, Schwandt, Higley, & Suomi, 2006). Yet a survey of primate parenting by field primatologists John Mitani and David Watts (1997) found a broad spectrum of infant care ranging from the solitary parenting of orangutan mothers; through female-bonded species such as baboons and macaques where female relatives assist in infant care and males defend groups; to biparental species such as titi monkeys where fathers are active participants in infant care; to the cooperative families of marmosets and tamarins, where not only fathers but older siblings play important roles in infant care and survival. Mitani and Watts (1997) noted that nonhuman primate species with greater infant care support for mothers have higher reproductive success (greater infant survival and shorter interbirth intervals) than those species where mothers must do more by themselves. In a recent book, *Parenting for Primates* (2005), Harriet Smith argues that primate parenting is energetically costly and is characterized by continuous attention to infant needs, by the importance of helpers for mothers, and by the learning of parenting skills.

Nowhere are Smith's three principles of primate parenting better illustrated than in the cooperatively breeding primates, marmosets and tamarins. However, few scientists studying human development are aware of these species and the causes and benefits of cooperative infant rearing that have been shown. Because most of the basic research on nonhuman primates has focused on species where mothers must do all of the infant care, there has been little attention given to primate models that might illustrate the importance of families in caring for human infants.

Here we first describe the broad patterns of cooperative infant care in mammals and follow with a description of cooperative care in marmosets and tamarins, the hypothesized reasons for the development of this system and the benefits to infants. Second, we examine the marmoset and tamarin family as a social system requiring coordination and cooperation as well as the deferral of reproduction by non-breeding helpers (i.e., alloparents). We conclude with a discussion of how research results from studies of cooperative care in nonhuman primates might have implications for informing appropriate infant care in our own species.

Cooperative Breeding

In many bird species and some mammals such as California mice, prairie voles, hamsters and titi monkeys, both fathers and mothers are actively involved in infant care. In biparental bird species, fathers and mothers take turns incubating eggs and, once eggs hatch, both parents are involved in nest guarding, thermoregulation, and providing food for the chicks. In mammals, mothers must provide all of the care during pregnancy and by nursing. However, fathers can play critical roles in defending the mother and infants, in retrieving infants that leave the nest, and in providing food and thermoregulation for mother and infants. A characteristic of biparental birds and mammals is a close social relationship between parents, often called a pair bond. Recent research using DNA fingerprinting indicates that some offspring of biparental birds are sired by males other than the one living with the mother, meaning that the relationship between mates is one of social monogamy rather than genetic monogamy.

In at least one biparental rodent, the California mouse, monogamy is both social and genetic. The male living with the mother sires all of the pups (Ribble, 1991).

Cooperative breeding species differ from biparental species in the importance of alloparents in assisting parents with infant care. Alloparents in cooperatively breeding species typically delay their own reproduction while assisting a breeding pair with their infants. This deferral of reproduction is often accompanied by a physiological suppression of fertility in at least one sex. Thus in pied kingfishers, sons are reproductively suppressed and unable to mate while in their natal group, although unrelated male alloparents are found and they are not reproductively suppressed (Reyer, Dittami, & Hall, 1986). In mammals such as wolves (Moehlman & Hofer, 1997; Asa, 1997), mongeese (Creel & Waser, 1997), meerkats (Griffin, Pemberton, Brotherton, Gaynor, & Clutton-Brock, 2003), naked mole rats (Lacey & Sherman, 1997; Faulkes & Abbott, 1997), and marmosets and tamarins, it is usually females that are reproductively suppressed—either not ovulating while in the presence of a reproductive female, or ovulating but not becoming pregnant.

Among monkeys and apes, the marmosets and tamarins have the most pronounced system of cooperative breeding. Field data on mustached tamarins (*Saguinus mystax*), (Garber, Moya, & Malaga, 1984) and on cotton-top tamarins (Savage, Snowdon, Giraldo, & Soto, 1996b) demonstrated that infant survival is directly related to the number of helpers present, reaching maximum survival in groups of five or more potential caretakers (parents plus three alloparents). Surprisingly, we have found similar results in our captive colony of cotton-top tamarins with group sizes of five or more having the greatest infant survival (Snowdon, 1996).

Why are helpers so important for cooperatively breeding species? First, cooperative breeding can maximize the reproductive output of a female. In marmosets and tamarins, mothers usually give birth to twins that weigh up to 20% of the mother's weight at birth. (Imagine a 130 pound woman giving birth to twins that weigh 13 pounds each at birth.) In captivity and in many field conditions, the reproductive female can become pregnant within two to four weeks postpartum and give birth to twins twice a year (tamarins: Ziegler, Bridson, Snowdon, & Eman, 1987; marmosets: Lunn & McNeilly, 1982). Thus, a female marmoset or tamarin can produce four infants a year, compared with one infant each year in baboons or macaques and one infant every four to five years in great apes.

Second, infant care by the father and by others relieves the female of the energetic burden of carrying infants. Infants that at birth weigh 20% of the mother's weight and become larger after that do represent significant energetic costs for those that carry them. Two studies of captive cotton-top tamarins, where the monkeys had more than adequate food resources and where the energetic costs of traveling through the trees in search of food and shelter were eliminated, have found that tamarin males lose up to 10% of their body weight during the most intensive period of infant care (Sanchez, Peleaz, Gil-Burmann, & Kaumanns, 1999; Achenbach & Snowdon, 2002). With increasing numbers of alloparents, the weight loss of any one carrier is reduced (Achenbach & Snowdon, 2002). In the wild, a weight loss of 10% would represent a significant energy stressor for males, and one can see immediately why multiple caregivers are critical. Another study of captive tamarins found that those carrying infants spent

significantly less time foraging, eating, moving, or engaging in social interactions (Price, 1992). Male marmosets and tamarins in captivity gain weight during their mate's pregnancy (Ziegler, Prudom, Schultz-Darken, Kurian, & Snowdon, 2006), which may prepare them for the subsequent weight loss that results from infant care.

Third, fathers and alloparents are important not only for carrying infants, but they also play a critical role in the weaning process. Food-sharing, either through direct offering of food to infants or through tolerating infants taking food, is common in all marmoset and tamarin species studied to date (Brown, Almond, & Van Bergen, 2004). In some species, adults have specific, intense forms of food-associated calls that appear to attract infant attention to food and to indicate that food is available. In captive cotton-top tamarin groups, infants have a higher probability of obtaining food from the adult when the adult produces these calls compared to when they do not (Roush & Snowdon, 2001; Joyce & Snowdon, 2007). In wild golden lion tamarins, adults use these infant-directed calls to lead juveniles toward hard to catch insect prey or to locations where juveniles can obtain insect prey (Rapaport & Ruiz-Miranda, 2002; Rapaport, 2006).

The functions of food sharing are hypothesized to supplement nutrition and/or to provide information to infants about novel foods. Studies of golden lion tamarins in captivity (Rapaport, 1999) indicate that food sharing is greater with foods novel to the infant or foods that are difficult to process. Field studies on the same species find that food sharing is used to help young locate and obtain hard to acquire animal prey, with adults doing less food sharing as infants and juveniles become more competent (Rapaport & Ruiz-Miranda; 2002, Rapaport, 2006). Since animal prey is highly nutritious, both nutritional and informational hypotheses are supported. The informational hypothesis has not been supported by studies on captive common marmosets where parents do not preferentially transfer novel foods with infants (Brown, Almond, & Bates, 2005). Regardless of whether food sharing has a nutritional or informational function, the net result is that food sharing may help infants complete the weaning process earlier than they might have without food sharing. Notably cotton-top tamarins begin food sharing with twins sooner than they do when they have singletons (which are less energetically demanding) and subsequently twins feed independently earlier than singletons (Joyce & Snowdon, 2007).

A final role played by fathers and helpers is in vigilance against predators (Caine, 1993). In wild cotton-top tamarin groups, individual animals took turns in carrying infants versus serving as sentinels. These roles changed frequently throughout the day (Savage, Snowdon, Giraldo, & Soto, 1996b).

For marmosets and tamarins, infant rearing is definitely a family affair. We have seen that infant survival is a function of having multiple caregivers. Caregivers incur significant costs as reflected by weight loss during the period of infant care and further through sharing high quality food with infants during the weaning process. Various family members take turns carrying infants, looking for food resources, and serving as sentinels for the family. Much of this is done by post-pubertal animals that, instead of reproducing themselves, are helping to care for infants not their own. The coordination of food finding, infant care, and vigilance requires a high degree of communication among group members. Furthermore, close social relationships are likely

to be critical, not only to maintain the pair bond between the two parents, but in preventing others from reproducing—while at the same time keeping those individuals within the group and functioning as alloparents. To understand the mechanisms of how cooperative breeding works, it is necessary to look at family dynamics.

Family Dynamics

Family dynamics in marmosets and tamarins can be separated into four types of relationships: adult-adult relationships both as partners and as parents, adult-alloparent relationships, sibling relationships, and infant-family relationships. First, it is essential that there is a close bond between the breeding adults before breeding begins and subsequently that there is close coordination during infant care. Second, the breeding adults face the problem of how to recruit others to serve as alloparents and to prevent these alloparents from reproducing while contributing to the survival of the infants. Third, one can expect potential sibling conflicts over access to infant care and over potential breeding opportunities should they occur. Finally, do infants have different relationships with different family members? How is infant development affected by cooperative rearing? We examine each of these dynamics in turn.

Parental Relationships as Mates

Since paternal investment in infant care is critical for infant survival in marmosets and tamarins, both parents should be careful in choosing a mate. A female needs some assurance that her mate will stay with her and be available to care for infants after they are born. A male needs to be confident that the infants he will help care for at considerable energetic costs are his own and not those of another male. This reasoning suggests that there should be caution by both sexes in mate choice and that established mates should have well-developed mechanisms for reassuring each other and maintaining trust.

However, we know relatively little about mate choice and initial pair formation from field studies because pair relationships are generally long lasting with changes occurring only with the death of one mate or following some environmental catastrophe. What information we do have suggests unexpectedly that mate choice may rarely be an option in the wild. Animals must find partners and mate opportunistically. If mate choice prior to pairing is limited, then there is an even greater need to have mechanisms to maintain the relationship after pairing. In wild cotton-top tamarins, we observed stable pair bonds over three consecutive years, but following a drought that left no surviving infants, animals changed partners, forming new breeding pairs, which were then stable for the three additional years of our study (Savage, Giraldo, Soto, & Snowdon, 1996a). Savage, Giraldo, Soto, and Snowdon (1996a) also observed that many subadult animals of both sexes left their groups. When animals could be located subsequently, none had yet become breeding adults, suggesting that dispersing tamarins cannot easily establish new breeding territories.

In wild common marmosets, Lazaro-Perea, Castro, Harrison, Arajau, Arruda, and Snowdon (2000) observed the deaths of breeding females in three groups. In one group, a new female from outside the study population appeared in the group within two weeks and subsequently became pregnant within two weeks of joining the group. In the other two groups, replacement of the breeding females was slower. The males (fathers and brothers) in each group began spending more time separated from the females (daughters), and after four months, the males formed new groups with females from outside the study population. The remaining females in each group formed a new group with males from outside the study population. Within a month of forming the new groups, all females gave birth. Since the gestation period is five months, these females became pregnant (presumably with unrelated males) soon after the death of the breeding female, their mother. The relative lack of new breeding opportunities and the rapidity with which other females become pregnant following the loss of a breeding female suggest that animals make the best of any breeding opportunities, reinforcing the hypothesis that mate choice may not be much of an option for wild marmosets and tamarins. This again emphasizes the importance of mechanisms to maintain relationships after pairing.

In captivity, high levels of sociosexual activity are seen in the first hours and days of formation of new pairs. Over successive weeks the high rates of sociosexual behavior decrease, although animals still mate on an average of at least once a day (Savage, Ziegler, & Snowdon, 1988). A characteristic that marmosets and tamarins share with humans is continuous receptivity (Converse, Carlson, Ziegler, & Snowdon, 1995). Animals mate throughout the ovulatory cycle and during pregnancy as well. Figure 1 illustrates the observed rates of mounting behavior (part of copulatory behavior) in 30 minute daily observations of four pairs of tamarins over several ovulatory cycles in the first year after pairing (Porter & Snowdon, 1997). Day 0 is the day of ovulation as determined by a peak in urinary excretion of luteinizing hormone (Ziegler, Bridson, Snowdon, & Eman, 1987). It should be obvious from the figure that there is no consistent relationship of mounting behavior with respect to ovulation in these newly formed pairs.

Frequent sexual behavior across the ovulatory cycle and during pregnancy may be one way in which adults maintain their relationship. Increased sexual behavior may also serve to reassure mates when the relationship is challenged. In two studies of mated pairs, we observed increased sexual behavior following a minor challenge to the relationship. Porter (1994) separated pairs for 30 minutes and then reunited them and observed them for another 30 minutes. The left two histograms in Figure 2 show baseline rates of mounting with a doubling of mounting rates following reunion after a brief separation. Ziegler, Epple, Snowdon, Porter, Belcher, and Kuederling (1993) transferred scents from a cycling female to several pairs of tamarins over the entire ovulatory cycle of the donor female. The behavior of the mates with each other was observed daily immediately following the scent transfer, and mounting behavior is shown in the right two histograms of Figure 2. The mounting rate in response to the odors of a novel female was equal to the mounting rate following brief separations, but the mounting rate doubled on the days when the donor female was ovulating. This suggests that pairs increase sexual behavior following the challenges of separation and
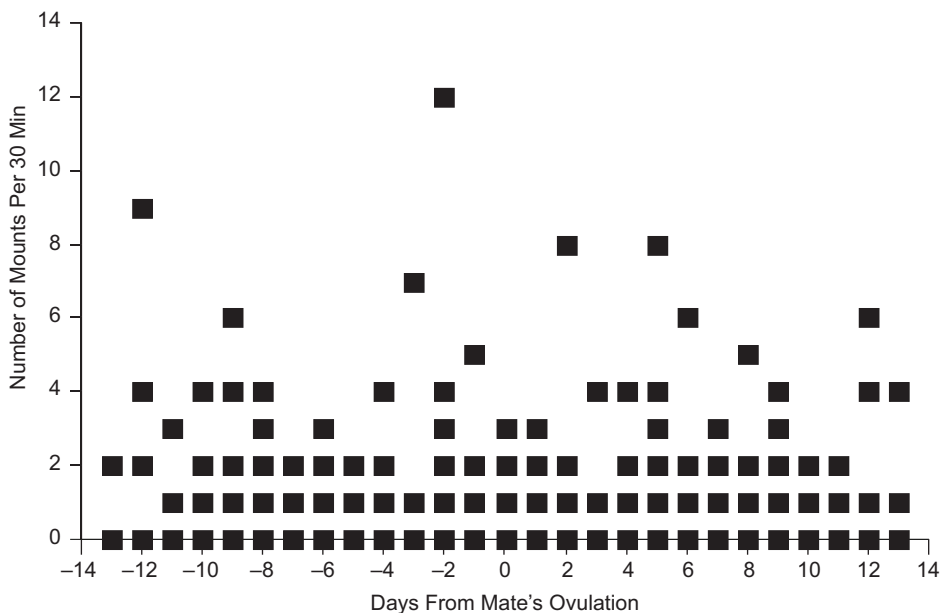
FIGURE 1. Mounting behavior by cotton-top tamarin males in relation to their mates' ovulation date. Day 0 is ovulation as determined by a peak in luteinizing hormone. Data are from four pairs studied over multiple ovulations in the first year after pair formation (from Porter & Snowdon, 1997).
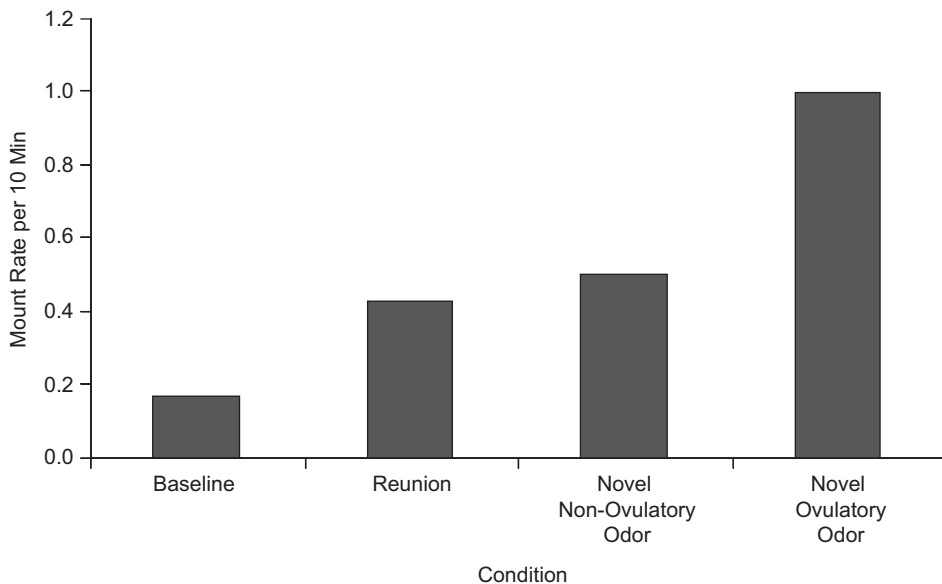
FIGURE 2. Male mounting behavior in baseline conditions, during reunion following a 30 minute separation, in response to an odor of a novel non-ovulating female and a novel ovulating female. (Adapted from Porter, 1994 and Zeigler et al., 1993).

following presentation of odors from a novel female, especially when the novel female is fertile. Males also displayed more frequent erections on days where the odors were from an ovulating novel female compared with other days in her cycle. In another study, females demonstrated an eight-fold increase in solicitation behavior when odors of a novel, reproductive female were presented (Washabaugh & Snowdon, 1998). These studies suggest that both sexes are responsive to olfactory cues from novel reproductive females. Increased sexual arousal in males coupled with increased proceptivity by females led to increased sexual behavior that appears to maintain and reinforce pair bonds in the face of threats to the relationship. Alternatively, males may be aroused by ovulatory odors in general and the increased responsiveness of the mate diverts the male's sexual interest to her.

Although both males and females have high stakes in maintaining relationships, one might argue that males, due to uncertainty of paternity and their energetic costs of infant care, might have a greater stake in relationship maintenance than females. In cotton-top tamarins, we have seen asymmetries in responses of males and females. In the brief separation-reunion tests described above, tamarins often give plaintive-sounding long calls during the period of separation. As shown in Figure 3, both sexes increased the rate of long calls during separation, but males gave these calls significantly more often than females (Porter 1994).

Another test of the strength of pair relationships involves presenting mated pairs with intruders. French and Snowdon (1981) presented paired cotton-top tamarins with intruders of both sexes. Males displayed high levels of aggression toward male intruders and females responded to female intruders with increased scent marking rather
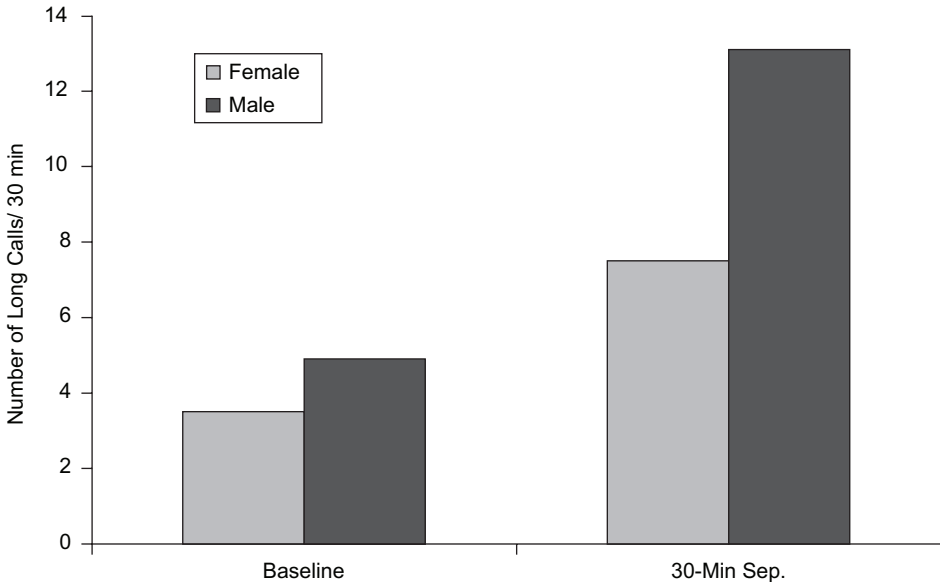

FIGURE 3. Mean number of long calls given by male and female cotton-top tamarins in baseline conditions and during a 30 minute separation from the mate. (Adapted from Porter, 1994).
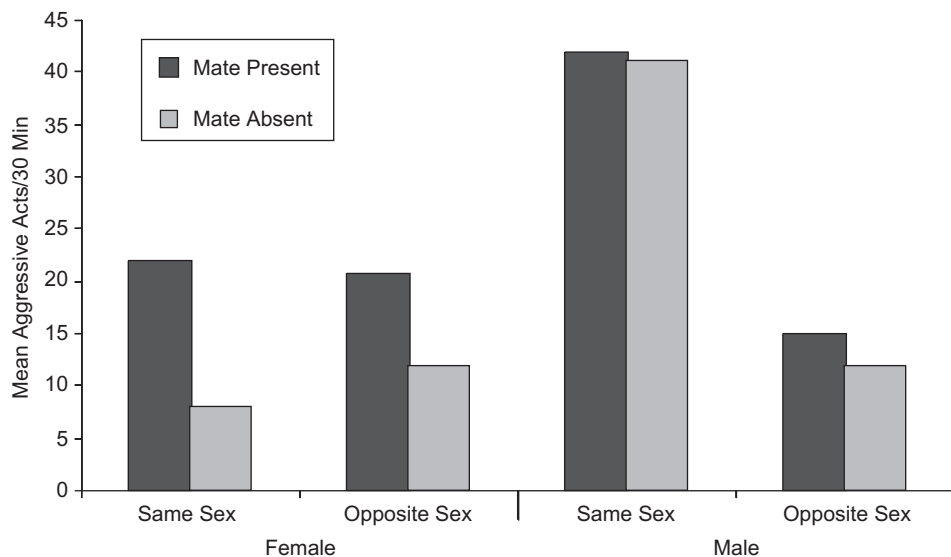
FIGURE 4. Mean number of aggressive acts directed toward same sex and opposite sex intruders by female and male cotton-top tamarins as a function of whether the mate was present or absent. (Adapted from Porter, 1994).

than aggression. In a subsequent intruder study, Porter (1994) presented males and females with intruders of both sexes, but also tested each animal alone as well as with its mate present. As in the French and Snowdon study (1981), females responded to other females with more scent marking than direct aggression. As shown in Figure 4, females responded with more aggression when their mate was present than when he was absent to both male and female intruders. Males, however, did not respond differently based on mate presence. Although they always responded more aggressively toward males than females, they showed as much aggression toward intruders when the mate was absent as when she was present. Males may be more responsible than females for ensuring the maintenance of the pair bond.

Another behavior often thought to be involved in maintaining relationships is grooming. In many nonhuman primates, subordinates groom more dominant animals. In cotton-top tamarins, we have found a striking asymmetry with breeding males grooming their mates more often than the reverse. The left histogram in Figure 5 shows that in 100% of 10 tamarin pairs, males groomed their mates more often than vice versa. In wild common marmosets, reproductive pairs also spent considerable time in grooming each other. Mates groomed each other more than 20% of observation time in focal samples (Lazaro-Perea, Arruda, & Snowdon, 2004). As with captive cotton-top tamarins, males groomed females more than vice versa in every single group (Figure 5 center histogram).

In summary, cotton-top tamarins engage in high rates of non-conceptive sex at the onset of a relationship and at lower but still daily rates throughout the relationship. The increased rate of non-conceptive sex following brief separations and in response to olfactory cues from novel females suggests that non-conceptive sex also is impor-
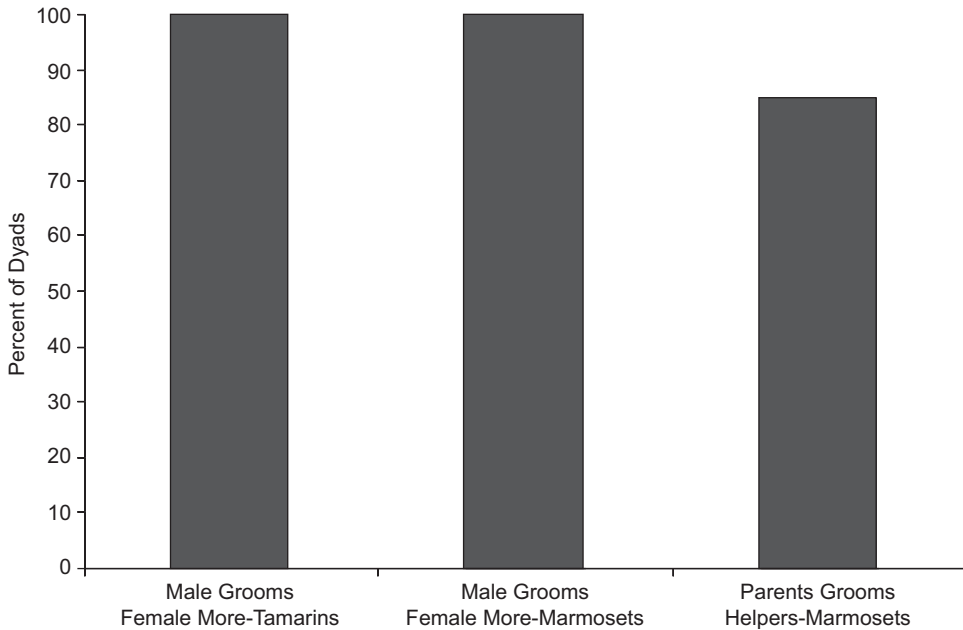
FIGURE 5. Percent of dyads in which males groom females more or adults groom helpers more. (Tamarin data adapted from Ziegler et al., 2004, marmoset data adapted from Lazaro-Perea et al., 2004).

tant to restore or reinforce relationships in the presence of some threat. Finally, there is a sexual asymmetry with males being more upset by separation than females, being aggressive toward intruders regardless of the presence or absence of the mate, and by males grooming females more often than their mates groom them. This grooming asymmetry is also seen in common marmosets. This asymmetry makes sense in the context of male uncertainty of paternity and the high costs including weight loss during infant care.

Other marmoset and tamarin species display somewhat different responses. In golden lion tamarins, intruder studies similar to those of French and Snowdon (1981) found that females were highly aggressive to other females, whereas males showed less aggression toward male intruders (French & Inglett, 1989). In wild populations, multiple females in the same group are pregnant at the same time and fertility suppression of females is much weaker than in cotton-top tamarins (Baker, Dietz, & Kleiman, 1993), suggesting a higher potential cost to breeding females by failing to keep unrelated females out of the group.

Intruder studies with common marmosets indicate that male responses are conditional on the presence of the female in contrast to the tamarin results. Evans (1983) and Anzenberger (1985) found that male marmosets courted novel females when tested in the absence of their mates, but were aggressive toward the same females when their mate was physically present or could be viewed behind a one-way mirror.

Following from these behavioral results, Ziegler, Schultz-Darken, Scott, Snowdon, and Ferris (2005) studied the responses of male common marmosets to the odors of

novel, ovulating females. Some males showed increased arousal to odors of novel, ovulating females including erections, and many males also had increased blood levels of testosterone within 30 minutes of the presentation of the odor. There was considerable variation among males and it was observed that the significant increase in testosterone was found only in single males and in paired males without infants. Fathers showed little behavioral interest and no testosterone increase to odors of novel females, suggesting that fatherhood inhibits the response to novel females.

However, in field studies of common marmosets, Lazaro-Perea (2001) observed nearly daily encounters between each of her focal groups and one of its neighboring groups. These territorial encounters included increased scent marking, long calling, lunges and fights, but Lazaro-Perea also observed frequent copulations between a male from one group and a female from the other group. These copulations primarily involved non-breeding members of the group although breeding males were also observed to copulate with neighbors. The breeding females, however, remained in the central part of the family's territory and did not engage in boundary conflicts or copulate with others. Females that engaged in extragroup copulations did not become pregnant, except when the breeding female in their group had died. Lazaro-Perea (2001) suggested that the extragroup copulations accompanying territorial conflicts allowed marmosets to assess their neighbors, detecting when a breeding position might be available, and possibly evaluating future mates.

Why do breeding male common marmosets court other females and engage in extra-group mating when cotton-top tamarin males do not? One possibility is that the costs of paternal care may be less in common marmosets than in tamarins. One study of male body weights in captive common marmosets after birth found no weight loss (Nievergelt & Martin, 1999) in contrast to the weight loss seen in cotton-top tamarins. However, in both species, males gain weight during their mate's pregnancy (Ziegler, Prudom, Schultz-Darken, Kurian, & Snowdon, 2006). Expression of male parental care appears to be more variable in marmosets than in tamarins (Zahed, Prudom, & Ziegler, in preparation; Zahed & Snowdon, in preparation). Thus, if male marmosets do not need to invest as much in infant care as tamarins, then their relationship with their mate may be more tentative.

Parental Relationships in Parenting

So far we have focused on the relationships that parents have with each other without consideration of infants, but how parents relate to each other in the context of infant care is equally of interest. Several studies have indicated hormonal changes in males during infant care. One of these hormones, prolactin, stimulates milk production in female mammals. Dixson and George (1982) first documented that serum prolactin levels increased in male marmosets when they were carrying infants. Mota, Franci, and Sousa (2006) replicated these results, finding elevated levels of prolactin in males when they were carrying infants, but not at other times postpartum. These results suggest that prolactin levels are a result of infant carrying. Almond, Brown, and Keverne (2006) gave experienced marmoset fathers cabergoline, a drug that is a

dopamine agonist, which has the effect of lowering prolactin concentration. There was no decrease in paternal behavior. Instead, males carried infants at the same rate as they had before. The treated males (compared to their non-treated control condition) showed increased interest in infants when they were not carrying them. These results taken together suggest that for experienced common marmoset fathers, prolactin is not necessary to cause paternal care and appears instead to increase as a result of infant care. If prolactin served as a social reinforcer (as seen in studies of human sexual behavior where prolactin levels are elevated at orgasm, see Krueger, Haake, Chereath, Knapp, Janssen, Exton, Schedlowski, & Hartmann, 2003), then an increase in prolactin during infant care may reward the father and keep him involved in infant care. Cabergoline suppression of prolactin reduced infant care responses when males were tested away from the influences of other family members (Ziegler & Prudom, unpublished data).

We found that male cotton-top tamarins displayed high levels of urinary prolactin during the period of infant care, with levels correlating with the amount of experience a male had as a father (Ziegler, Wegner, & Snowdon, 1996). Prolactin concentrations were higher in males that had more litters. Male prolactin levels postpartum were as high as those of lactating females (Ziegler, 2000). When we looked at prolactin levels in the two weeks prior to birth, we were surprised to find no differences between prepartum and postpartum prolactin levels. Do males anticipate the birth of infants and change hormone levels before infant birth? If they do, what cues does a male use to detect that his mate is pregnant?

We studied several males throughout the pregnancy of their mates and gathered hormonal samples two or three times each week (Ziegler, Washabaugh, & Snowdon, 2004). Half of the males were experienced with more than three sets of surviving offspring and the other half were first time fathers or had fathered a previous litter that had not survived. We monitored the males for several hormones: prolactin, estradiol, testosterone, dihydrotestosterone, cortisol, and corticosterone. We also monitored female hormonal changes throughout the cycle. At approximately the midpoint in pregnancy, the fetal adrenal gland begins to secrete glucocorticoids that we were able to detect in urine of the pregnant female. Within a week of the increase in glucocorticoid excretion in female urine, every experienced father displayed an increase in excreted corticosterone, and following that was a cascade of hormonal changes with experienced fathers developing elevated estradiol and testosterone levels not seen in less experienced fathers. All experienced males displayed elevated levels of prolactin by the midpoint of pregnancy, whereas the less experienced fathers displayed an increase in prolactin levels only in the month before infant birth.

What could be involved in this difference? It could be the behavior between mates, but we could find no consistent patterns of behavioral change in experienced pairs. However, the less experienced pairs spent increased time in contact and grooming behavior in the month before infant birth. Ziegler, Washabaugh, and Snowdon (2004) hypothesized that experienced males had learned to respond to cues produced by the pregnant mate, which initiated the pattern of hormonal changes whereas the less experienced males are not able to respond to these cues, but needed the increased affiliation in the month before birth to initiate hormonal changes.

However, the design of the study was confounded. Because female tamarins ovulate two to four weeks after birth, experienced fathers are still caring for the previous infants during the early stages of pregnancy, whereas less experienced fathers do not have infants. Can we separate the effects of infant presence from the potential cues from a pregnant female? We took experienced fathers and paired them with nulliparous females and then collected hormonal samples throughout the female's first pregnancy. These males had considerable experience through multiple pregnancies of a previous mate, but there were no infants present during the pregnancy of the new mate. These males did not show the early pregnancy increase in prolactin levels, suggesting that the elevated prolactin levels we had observed earlier were due to stimuli from the previous infants. The males demonstrated the increase in corticosterone within a week of the rise in the pregnant female, suggesting that the glucocorticoid increase is due to some cues from the mother or the fetuses (Almond, Ziegler, & Snowdon, in preparation). Since the increase in glucocorticoid secretion may be due to activation of the fetal adrenal gland, this could represent a communication system whereby the fetuses communicate through their mother to induce changes in their father's hormones to prepare for their birth. More research is needed to test this hypothesis.

The mother's tolerance of the father's involvement in infant care is critical. We have found great variability in the contribution of fathers and mothers to infant care in first time parents. Carrying by the mother can range from 20% to 80% of the time in the first weeks after birth. In the wild, we have also observed that first time mothers carried infants in more than 90% of the observations in the first two weeks, whereas experienced mothers more readily allowed others to carry their infants. First time parents typically have higher mortality of infants than more experienced parents (Snowdon, 1996), and this higher mortality may be due to lack of coordination between parents or to the unwillingness of first time mothers (or fathers) to share infant carrying with mates. In experienced parents with alloparents present, mothers typically carry infants only 15% of the time, contacting their infants only to nurse them (Ziegler, Widowski, Larson, & Snowdon, 1990).

Parent-Alloparent Relationships

As noted above, in both field and captive studies the presence of alloparents increases infant survival and reduces the energetic burden on both parents. The presence of non-reproductive helpers primarily affects the amount of effort that fathers invest in carrying infants (McGrew, 1988; Zahed & Snowdon, in preparation). To be effective alloparents, animals must not compete with the parents for reproduction. But why should an alloparent delay reproduction, and what are the dynamics of the relationships between parents and alloparents that recruit alloparents and prevent them from reproducing?

Across all cooperative care species, alloparents may gain both direct and indirect benefits from delaying reproduction. First, in most groups alloparents are the older siblings of the infants being cared for. Thus, alloparents are assisting in the survival of their own kin and increasing inclusive fitness. Second, several studies in marmosets and tamarins have shown that early experience caring for someone else's infants is

critical to becoming competent parents. Data from multiple colonies have documented very low reproductive success in tamarins with no previous experience in infant care (Epple, 1978; Tardif, Richter, & Carson, 1984; Johnson, Petto, & Sehgal, 1991). There is some debate over what is important about this experience (Tardif, 1997). Animals with no prior infant exposure display an interest in infant related cues and will retrieve a crying infant, but they display discomfort when an infant is on the back, often biting and pushing the infant off, only to retrieve it again. Third, infant care may be a passport for entry into a group and may improve an alloparent's subsequent breeding success if it makes that animal more likely to take over a future breeding vacancy or to court a mate more effectively. Thus, although an unrelated group member does not benefit from increased inclusive fitness, serving as an alloparent may improve future direct fitness by increasing the likelihood of subsequent mating and acquiring skills in infant care. Given the relative lack of breeding options available to wild marmosets and tamarins as discussed above, serving as a temporarily non-breeding alloparent may be the best option available (Snowdon & Cronin, in press).

We have presented some of the possible reasons why alloparents might benefit, but is there a role that parents play in regulating fertility and rewarding the behavior of non-reproductive alloparents so that they will remain as care providers? Studies of marmosets and tamarins have provided evidence that parents can control fertility in female offspring. In our colony of cotton-top tamarins, we have collected daily urine samples from subordinate females at a variety of ages over several months. In 31 of 31 females, there was no evidence of ovulation (Figure 6, left histogram). We hypothesized that odor cues from the reproductive female inhibited fertility in other females. In a scent transfer study, we found that females removed from the direct presence of a reproductive female, but receiving daily scent transfers from their mothers, delayed ovulation by at least a month after pairing, and they did not become pregnant during the 60 days of scent transfer. In contrast, control females receiving water blanks ovulated readily and became pregnant in as few as eight days after being paired (Savage, Ziegler, & Snowdon, 1988). However, cues from the reproductive female were not the only cues leading to inhibition. When we housed females with fathers or brothers away from the reproductive female, we observed no ovulation (Widowski, Ziegler, Elowson, & Snowdon, 1990). Only when females could see, hear, and smell novel males did they ovulate (Widowski, Porter, Ziegler, & Snowdon, 1992; see Figure 6 center and right histograms). Data from the field indicated that pregnancy in more than one female was rarely observed and only in groups where a novel male had entered prior to presumed conception. Thus for cotton-top tamarins, females are prevented from ovulating both by cues from the reproductive female and from familiar group males.

Male tamarins do not appear to be reproductively suppressed through either behavioral or hormonal mechanisms (Ginther, Ziegler, & Snowdon, 2001). Adult sons were studied while living in family groups and then three years later after becoming successful fathers with their own infants. These males showed no change in mean urinary levels of luteinizing hormone, testosterone, and dihydrotestosterone (Ginther, Ziegler, & Snowdon, 2001). Adult sons in families actually displayed as much sexual activity as when they were paired with a novel female, but sons in families directed most of their sexual activity toward siblings with the majority directed toward brothers (Ginther, Ziegler, & Snowdon, 2001). In some primate species development is sup-
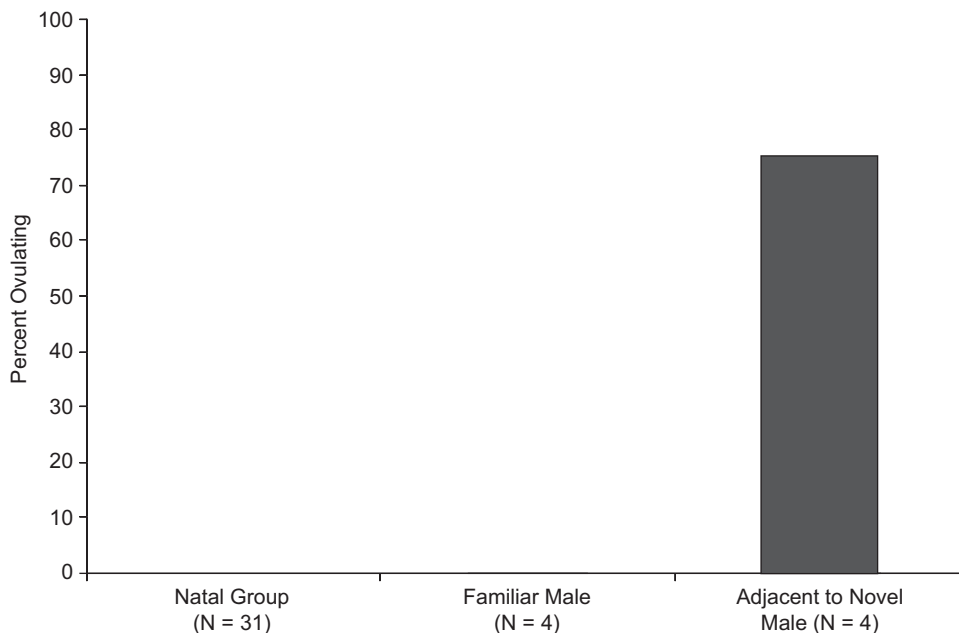
FIGURE 6. Percent of cotton-top tamarin females ovulating in natal group while living with their mother, when living without the mother but with a familiar, related male and when housed adjacent to a novel, unrelated male.

pressed in subordinate males or helpers. However, in a longitudinal study of development, sons achieved testicular size, body weight, and levels of reproductive hormones equal to those of experienced breeding fathers (Ginther, Washabaugh, & Snowdon, 2000; Ginther, Carlson, Ziegler, & Snowdon, 2002)

A somewhat different story emerges in common marmosets. At least one subordinate, post-pubertal female was observed to ovulate in about 50% of captive, family groups (Abbott, 1984; Ziegler & Sousa, 2002) although subordinate, ovulating females did not become pregnant. When peer groups were formed of multiple males and females, only one female ovulated (Saltzman, Schultz-Darken, & Abbott, 1997). Scent transfers from reproductive females to previously suppressed females also prevented these females from ovulating as in tamarins (Barrett, Abbott, & George, 1990). As noted above, subordinate female wild common marmosets often engage in extragroup copulations during territory interactions, but there was no evidence that any of these copulations resulted in pregnancy until after the death of the reproductive female (Lazaro-Perea, Castro, Harrison, Arajau, Arruda, & Snowdon, 2000). As with cotton-top tamarins, there was no evidence of male reproductive inhibition (Baker, Abbott, & Saltzman 1999).

More limited data from captive saddleback tamarins (*Saguinus fuscicollis*) (Epple & Katz, 1984) show that reproductive suppression also occurs and can be maintained by scents from reproductive females. Pygmy marmosets (*Cebuella pygmaea*) are similar to common marmosets with some females displaying ovulation at the same time

as the reproductive female but not becoming pregnant (Carlson, Ziegler, & Snowdon, 1997). Lion tamarin reproductive females and their daughters appear to display synchrony in patterns of estrogen secretion (French & Stribley, 1987), but it is not known whether daughters actually ovulated since estrogen levels were much lower than in mothers and luteinizing hormone levels were not measured. However, field studies indicate that multiple pregnancies can occur in lion tamarins when a male unrelated to the reproducing daughter is present (Baker, Dietz, & Kleiman, 1993).

In summary, although the details differ somewhat between species, some physiological reproductive suppression is seen only in females and never in males. In many species scent marks or other olfactory signals from the reproductive female maintain the suppression; exposure to stimuli from novel males can release the suppression and lead to pregnancy.

Although reproductive animals can control the fertility of female alloparents, they also display behavior indicative of reward or at least tolerance of the alloparents. Lazaro-Perea, Arruda, and Snowdon (2003) found asymmetries in grooming behavior with parents grooming alloparents significantly more than the reverse (See Figure 5, right histogram). Grooming has been shown to release endogenous opioids in the brains of those being groomed (Keverne, Martensz, & Tuite, 1989) and tactile stimulation can release oxytocin that also serves as a social reward (Carter, 1998). In most Old World primate species, subordinates groom dominant animals more than the reverse, so the fact that reproductive adult marmosets groom helpers more than the reverse is significant.

The lack of physiological suppression of male alloparents is curious in light of the clear mechanisms suppressing female fertility. Behavioral mechanisms such as aggression could be used to control mating in male alloparents, but aggression between the reproductive male and other males in the group has been rarely observed (Ginther, Ziegler, & Snowdon, 2001). In fact, when a father and son are removed from the natal group and placed with a novel female, both cotton-top tamarins (Price & McGrew, 1991) and common marmosets (Baker, Abbott, & Saltzman 1999) display extreme tolerance of each other and both males mate with the female. Even more striking is the behavior between fathers and adult sons in natal tamarin groups. We have observed sons engaging in mounting behavior with their mother on several occasions and rarely did we observe the father interfering with the copulation attempt by the son nor did we observe any aggression directed by either parent toward the son after a copulation attempt (Ginther, Ziegler, & Snowdon, 2001; Ginther, unpublished observations).

Sibling Relationships

The relationship between siblings changes with development. Older siblings play an important role in carrying infants and sharing food with infants, but as young marmosets and tamarins mature, there is potential for conflict both over carrying infants and eventually over future reproduction (Price, 1991). Although aggression between fathers and sons is quite rare as stated earlier, we have observed several serious fights in captive environments that led to injury and the need to remove an animal from its

group (Snowdon & Pickhard, 1999). Fights between brothers have been most common, with an older brother harassing and eventually attacking a younger brother. This is curious since the same older brother would have been actively involved in taking care of this brother as an infant. Fights between sisters or between mothers and daughters have been less common. Severe aggression between mothers and daughters develops when daughters begin to scent mark, an indication that reproductive suppression is not as effective. Virtually all of the serious fights have occurred when group sizes are between 6-9 animals, the typical range of group sizes found in wild populations. Similar fights have not been observed in the wild, perhaps because animals can more easily avoid one another, or an animal can migrate to a new group once tensions arise. Two other studies have reported cases of severe aggression in lion tamarins, with most of the aggression between females in contrast to cotton-top tamarins (Kleiman, 1979; Inglett, French, Simmons, & Vires, 1989). Remember that mechanisms of suppression appear to be minimally developed in lion tamarins, making direct competition between females more likely.

What happens when multiple females are pregnant at the same time? In field studies of cotton top tamarins where two females were pregnant at the same time, at least one female miscarried before birth (Savage, Giraldo, Soto, & Snowdon, 1996a). Multiple pregnancies have been observed frequently in wild groups of common marmosets (Digby, 1995; Lazaro-Perea, Castro et al., 2000). In cases where two births occurred close in time, one mother began harassing the infants of the other mother, frequently leading to the death of the infants. When multiple births were separated by at least two months, then there was much less evidence of harassment and no reported deaths. In most of the observed cases of female infanticide, the attacking female was known to be related to the female whose infants she was attacking; in several cases they were sisters. Thus, we have female marmosets killing their nieces and nephews. What can be the benefit to the infanticidal females? The best explanation is that the females are competing for the services of alloparents. Presumably if both sets of infants survived, alloparental care would be stretched between both litters. With one litter killed, all alloparental care can be directed toward the surviving infants. When females give birth asynchronously, then the same alloparents will have finished the major care of the first litter when the second litter is born. When alloparents can be time-shared, conflict between siblings is reduced.

In summary, although siblings share infant care duties with each other and appear to be highly cooperative, siblings can also become highly competitive with each other—driving each other out of family groups in captivity and killing their own relatives in the wild. Cooperative breeding, therefore, involves a delicate balance of cooperation and competition.

Infant-Caretaker Relationships

Several studies in rodents and nonhuman primates have demonstrated that variation in maternal care can influence how infants develop, both physiologically and behaviorally. Rat mothers that lick and groom their infants more produce offspring that

are more resilient to stress and will in turn groom their infants more (Caldji, Tannenbaum, Sharma, Francis, Plotsky, & Meaney, 1998). Fairbanks (1996) has documented two orthogonal dimensions in maternal behavior, an accepting-rejecting dimension intersecting with a laissez-faire-restrictive dimension. In vervet monkeys as well as in rhesus macaques (Suomi, 1987) and baboons (Altmann, 1980), variation in maternal style has an important influence on the infant's behavioral development and for female offspring, subsequent maternal style. Noteworthy is that in each of these species, mothers are typically the only caretaker of infants.

What are the consequences of having multiple caretakers on infant development? In macaques, separation of infants from their mothers can have important consequences that vary according to the degree of alloparental care available. Pigtail macaque infants, where mothers do not allow others to interact with infants, show much more distress when mothers are removed than do bonnet macaque infants where mothers allow other females to interact with their infants (Rosenblum & Kaufman, 1968).

In contrast, a study on infant common marmosets (Arruda, Yamamoto, & Bueno, 1986) found no effect of removal of either parent on infant behavior. Other family members quickly substituted for the parent that was removed. Kostan and Snowdon (2002) observed which family members spent the most time carrying and food sharing with an infant. When the infants were independent of carrying, Kostan and Snowdon presented a series of frightening stimuli and observed the response of the infant. In every case, the infant ran to the family member that had spent the most time carrying and sharing food with the infant—the father or an older brother. In no case was the mother the primary caretaker and in no case did an infant seek its mother as a secure base. Similar results are found in the biparental titi monkey. When given a choice between going to the mother or to the father, infants always prefer the father, who provides more care (Mendoza & Mason, 1986). Thus, in biparental and cooperatively breeding species, infants do not form a primary attachment to the mother or treat the mother as a secure base. Instead, infants seek out the individual that had provided the infant with the most care.

What does cooperative rearing do for maternal style effects on infant development? Washabaugh, Ziegler, and Snowdon (2002) observed caretaking behavior in three successive litters in ten tamarin families that varied in the degree of prior infant caretaking experience and in family composition. There was a wide variation in the amount of care that individual family members provided to the infants. However, when we looked at care from the perspective of what an infant received, all infants received equal quality caretaking (i.e., total time carried, transfers between carriers, rejections, food sharing) regardless of the variation in different caretakers, variation due to experience or variation due to group size. It appeared that having multiple helpers provided a buffer against the variation in care by any particular family member to assure that each infant received consistent care.

What are the consequences for infants? We looked at several measures of infant behavior including age to move independently, first independent feeding, exploration, and response to novel objects. The variation between twins within a litter was as great as the variation between litters from different families. The lack of variation between families in the amount and quality of caretaking that infants receive and the high be-

havioral variation within a pair of twins suggests that the behavioral variation is unlikely due to differences in parenting styles, but instead is likely due to inherent variation within each infant. This result contrasts with the findings from the species reviewed earlier where mothers are primary caretakers and maternal style affects infant behavioral development.

The buffering of different parenting styles and effort by multiple caretakers has important implications. Behavioral variation in infant tamarins may be more likely due to temperament or genetic variation rather than a result of parental behavior. The ability of other family members to compensate for a lack of interest in or rejection of infants by a mother, increases the quality of care an infant will receive and assures that all infants receive consistent care.

Cooperative Breeding and Human Infants

The varieties of human child rearing make difficult any comprehensive comparison of cooperative breeders with human childcare. Although there are substantial differences between humans and marmosets, here we briefly examine some interesting commonalities. Sarah Blaffer Hrdy (1999) has argued that humans are cooperative breeders due to the long period of infant and juvenile development that requires considerable parental investment for a decade or more. Such high investment makes it difficult for a single parent to successfully rear an infant without some sort of economic or social support whether it be from a spouse, partner, relatives, friends or hired day care. (Note that human infant care may be provided by unrelated alloparents such as stepparents, partners or hired caretakers.) If cooperative breeding is a characteristic of the human species, then many of the same principles of family dynamics seen in other cooperative breeders should apply to humans. We briefly review the importance of multiple parents or parental figures, the effects of the parental pair bond on children's adjustment, how the quality of parenting received influences one's own pair relationships (and subsequent parenting), sex differences in parental skills and the role of siblings as alloparents.

Divorce is a clear case where the parental pair bond is poor and where there is a loss of multiple caregivers. A recent study on infanticide in Sweden found much higher rates of infanticide of children living with a single genetic parent versus either two genetic parents or a genetic parent and a stepparent (Temrin, Buchmayer, & Enquist, 2000), suggesting the critical importance of multiple caregivers. One-parent families have reduced economic security often with psychological consequences for children (Thompson, McLanahan, & Curtin, 1992). Hetherington (1989) reported boys in divorced families and both boys and girls in remarried families showed significantly more behavioral problems than children in non-divorced families. She also reports that negative effects of divorce were least when the custodial parent had other sources of social support, including grandparents. Among non-divorced couples, closeness of the marital relationship and support by the spouse predicted parental warmth and positive involvement with children and reduced parent-child conflict. Children in high-conflict, non-divorced families had more problems in self-esteem and psychological adjustment

than children in low conflict divorced families, suggesting that parental pair bond quality is important to children (Hetherington, Bridges, & Insabella, 1998).

Many traditional hunter-gathering cultures have exhibited infant care behavior more similar to cooperative care than has been the norm in industrialized societies. The most egalitarian society noted is the Aka Pygmies (Hewlett, 1992). Aka fathers provide more direct care of infants than in any other society, and husbands and wives spend considerable time together with infant care being only one of many shared tasks. Hewlett (1992) reviewed other societies and reports a statistically significant relationship between the degree of daily interactions and shared tasks between husbands and wives and the amount of care fathers provide infants. Since time spent together is a measure we use to evaluate pair bond quality in tamarins, this is a direct parallel between species. The stronger the pair bond, the more paternal effort is seen, paralleling Hetherington's (1989) results with western cultures. Blurton- Jones (1993) compared the Hazda of Tanzania with the !Kung of Botswana and Namibia. Both cultures display cooperative care with fathers and other group members taking care of infants. Hurtado and Hill (1992) examined the hypothesis that pair bonding leads to greater reproductive success. In the Ache in Paraguay, both the death of a father or parental divorce led to a significant increase in offspring mortality. Children whose parents divorced during their first year of life were more likely to die of illness or homicide than children whose parents remained together. These results suggest that for the Ache, as for cotton-top tamarins, fathers are essential for infant survival. However, Hurtado and Hill (1992) also reported on the Hiwi, a traditional culture from Venezuela, where parents also have strong pair bonds, but the absence of a father does not affect infant survival. Hurtado and Hill (1992) suggest that strong, lasting pair bonds do not develop simply for infant survival, but may develop for other reasons such as a relative lack of suitable alternative mates. Nonetheless, the Ache data suggest that when infants are at risk, the presence of a strong pair bond between parents can affect infant survival and well being.

An emerging literature suggests that one's developmental history affects pair bonding success. Hazan and Shaver (1994) have used attachment theory as an organizational framework for studying close relationships in adults. Simpson (1990) found that couples where both partners had secure attachment styles as children had more commitment, trust, and satisfaction than couples where one or both partners had anxious or avoidant attachment styles. Collins and Read (1990) found that partners tended to match based on the similarity between the partner and one's opposite sex parent. Donnellan, Larsen-Rife and Conger (2005) found that the parent-child socialization process affected the subsequent expectations and success of romantic relationships when the children were adults. Kinnunen and Pulkkinen (2003) reported that anxiety and passivity in childhood for women and anxiety, emotional lability, and aggression in childhood for men were predictors of poor-quality adult relationships. The conclusion drawn from these studies is that parental behavior plays a major role in the next generation's quality of adult pair relationships. If biparental or cooperative infant care leads to more secure attachment, then cooperative childcare should lead to more positive adult social relationships.

Are there sex differences in how men and women parent? Field (1978) compared fathers that were primary caretakers versus fathers that were secondary caretakers dur-

ing interactions with their four-month-old infants. Field found no differences between mothers and primary caretaker fathers on measures of smiling and imitative vocalizations and gestures, whereas secondary fathers engaged in these behaviors less frequently. Lamb (1976) reported that both fathers and mothers interacted with their infants with few differences. Mothers initiated more play with daughters and fathers showed more physical and idiosyncratic play than mothers. Kotelchuck (1976) reported few differences in how infants reacted to departures and arrivals of mothers versus fathers and concluded that infants have no innate bias to prefer mothers to fathers. Furthermore, infants from families with multiple caregivers showed shorter separation protest than those with only a maternal caretaker. Lamb, Pleck, Charnov, & Levine (1987) reviewed several studies indicating fathers responded as much and as competently to newborns as did mothers. Thomson, McLanahan and Curtin (1992) found that both male and female single parents reported less restrictive rules for their children than did married parents. Stepmothers, stepfathers and cohabiting partners were less actively involved with and displayed less positive behavior toward infants than biological parents. Hall, Walker, and Acock (1995) reported that single fathers spent less time in private talks, more time in play, and more time in "masculine" household tasks than single mothers. The majority of these studies done in Western societies suggest that fathers and mothers can interact equally well with infants and older children and that children can form attachments to both parents (or both partners), if both are active as primary caretakers. It is likely that involvement of both primary infant caregivers would have a similar buffering function as seen in tamarins.

Our industrial culture has had until recently well defined economic and parental roles for males and females. These roles have changed in our post-industrial culture. Societies that allow women to contribute significant economic benefits through work outside the home allow fathers to demonstrate greater involvement in infant care. This has led to some difficulty in negotiating new parenting relationships between men and women.

Weisner (1987) reviewed societies where sibling caretaking is important and showed that sibling care of infants is widespread across many human cultures. Frequently older siblings care for infants while mothers forage (or work) and fathers are often absent. In families with extensive sibling care, there is a shared mission between parents and older siblings to provide good quality care. Mothers and fathers often model and supervise care by siblings, but sibling caregivers also develop independence and feel autonomy and competence. Childcare skills are acquired first, followed by autonomy and subsequent management of the household, paralleling how marmosets and tamarins must acquire infant care skills first before becoming independent and breeding on their own. This contrasts with the Western model where household management comes first, followed by acquisition of mate, with parenting skills developing last. Hetherington (1989) notes that children of divorced families took over more responsibility at an earlier age, and they played an important role in supervising younger siblings, with grandparents also playing an important stabilizing role. The involvement of older siblings and grandparents in infant care suggest a pattern of care reminiscent of cooperatively breeding primates.

Summary

We have described the cooperative breeding system found in marmosets and tamarins, showing how cooperative care benefits infants and we have illustrated the family dynamics involved in cooperatively breeding primates. Although a framework of cooperative breeding has not usually been applied to studies of human parenting, the data that are available suggest some interesting parallels not only for how parental care can be shared between fathers and mothers, but also how siblings can become involved in infant care. Fathers and mothers have equal capacity to care for children. Close bonds between parents and equal economic opportunities for both parents appear most conducive to shared parenting. Sibling involvement in childcare may lead to skill development that would make these children more successful parents and also more attractive as mates. A more securely attached relationship with one's own parents (or caregivers) appears to predict a stronger adult pair bond and potentially more successful infant care leading those children to become more successful parents.

Acknowledgments

References

Abbott, D. H., (1984). Behavioral and physiological suppression of fertility in subordinate marmoset monkeys. *American Journal of Primatology, 6*, 169–186.

Achenbach, G. G., & Snowdon, C. T. (2002). Costs of caregiving: Weight loss in captive adult male cotton-top tamarins (*Saguinus oedipus*) following the birth of infants. *International Journal of Primatology*, *23,* 179–189.

Almond, R. E. A., Brown, G. R., & Keverne, E. B. (2006). Suppression of prolactin does not reduce infant care by parentally experienced common marmosets (*Callithrix jacchus*). *Hormones and Behavior, 49*, 673–680.

Almond, R. E. A., Ziegler, T. E., & Snowdon, C. T. (in preparation). Changes in prolactin and glucocorticoid levels in cotton-top tamarin fathers during their mate's pregnancy: The effect of infants and paternal experience.

Altmann, J. (1980). *Baboon mothers and infants*. Cambridge, MA: Harvard University Press.

Anzenberger, G. (1985). How stranger encounters of common marmosets (*Callithrix jacchus jacchus*) are influenced by family members: The quality of behavior. *Folia Primatologica, 45*, 204–224.

Arruda, M. F., Yamamoto, M. E., & Bueno, O. F. A. (1986). Interactions between parents and infants and father-infant separation in the common marmoset, *Primates, 27,* 215–228.

Asa, C. S. (1997). Hormonal and experiential factors in the expression of social and parental behavior in canids. In N. G. Solomon & J. A. French (Eds.), *Cooperative breeding in mammals*, (pp. 129–149). New York: Cambridge University Press.

Baker, A. J., Dietz, J. M, & Kleiman, D. G. (1993). Behavioural evidence for monopolization of paternity in multi-male groups of golden lion tamarins. *Animal Behaviour, 46*, 1091–1103.

Baker, J. V., Abbott, D. H., & Saltzman, W. A. (1999). Social determinants of reproductive failure in male common marmosets housed in their natal family. *Animal Behaviour, 58,* 501–513.

Barrett, J., Abbott, D. H., & George, L. M. (1990). Extension of reproductive suppression by pheromonal cues in subordinate female marmoset monkeys. *Journal of Reproduction and Fertility, 90*, 411–418.

Blurton-Jones, N. (1993). The lives of hunter-gatherer children: Effects of parental behavior and parental reproductive strategy. In M. Pereira & L. A. Fairbanks (Eds.), *Juvenile primates: Life history development and behavior*, (pp. 309–326). New York: Oxford University Press.

Brown, G. R., Almond, R. E. A., & Bates, N. J. (2005). Adult-infant food transfer in common marmosets: An experimental study. *American Journal of Primatology, 65,* 301–312.

Brown, G.R., Almond, R. E. A., & van Bergen, Y. (2004). Begging, stealing, and offering: Food transfers in nonhuman primates. *Advances in the Study of Behavior, 34,* 265–295.

Caine, N. G. (1993). Flexibility and co-operation as unifying themes in *Saguinus* social organization and behaviour: The role of predation pressures. In A. B. Rylands *Marmosets and tamarins: Systematics, behaviour and ecology,* (pp. 200–219). Oxford: Oxford University Press.

Caldji, C., Tannenbaum, B., Sharma, S., Francis, D., Plotsky, P. M., & Meaney, M. J. (1998). Maternal care during infancy regulates the development of neural systems mediating the expression of fearfulness in the rat. *Proceedings of the National Academy of Science (USA), 95,* 5335–5340.

Carlson, A. A., Ziegler, T. E., & Snowdon, C. T. (1997). Ovarian function of pygmy marmoset daughters (*Cebuella pygmaea*) in intact and motherless families. *American Journal of Primatology, 43,* 347–355.

Carter, C. S. (1998). Neuroendocrine perspectives on social attachment and love. *Psychoneuroendocrinology, 23,* 779–818.

Collins, N. L.,& Read, S. J. (1990). Adult attachment, working models and relationship quality in dating couples. *Journal of Personality and Social Psychology, 58*, 644–663.

Converse, L. J., Carlson, A. A., Ziegler, T. E., & Snowdon, C. T. (1995). Communication of ovulatory state to mates by female pygmy marmosets (*Cebuella pygmaea*). *Animal Behaviour, 49*, 615–621.

Creel, S. R., & Waser, P. M. (1997). Variation in reproductive suppression among dwarf mongooses: Interplay between mechanisms and evolution. In N. G. Solomon & J. A. French (Eds.), *Cooperative breeding in mammals*, (pp. 150–170). New York: Cambridge University Press.

Digby, L. (1995) Infant care, infanticide and female reproductive strategies in polygynous groups of common marmosets (*Callithrix jacchus*). *Behavioral Ecology and Sociobiology, 37*, 51–61.

Dixson, A. F., & George, L. (1982). Prolactin and parental behavior in a male New World primate. *Nature, 299*, 551–553.

Donnellan, M. B., Larsen-Rife, D., & Conger, R. D. (2005). Personality, family history and competence in early adult romantic relationships. *Journal of Personality and Social Psychology, 88,* 562–576.

Epple, G. (1978). Reproductive and social behaviors of marmosets with special reference to captive breeding. *Primates in Medicine, 10*, 50–62.

Epple, G., & Katz, Y. (1984). Social influences on estrogen secretion and ovarian cyclicity in the saddle-back tamarin (*Saguinus fuscicollis*). *American Journal of Primatology, 6*, 215–227.

Evans, S. (1983). The pair-bond of the common marmoset, (*Callithrix jacchus jacchus*): An experimental investigation. *Animal Behaviour 31,* 651–658.

Fairbanks, L. A. (1996). Individual differences in maternal style: Causes and consequences for mothers and offspring. *Advances in the Study of Behavior, 25,* 579–611).

Faulkes, C. G., & Abbott D. H. (1997). The physiology of a reproductive dictatorship: Regulation of male and female reproduction by a single breeding female in colonies of naked mole rats. In N. G. Solomon & J. A. French (Eds.), *Cooperative breeding in mammals* (pp. 302–334). New York: Cambridge University Press.

Field, T. (1978). Interaction behaviors of primary versus secondary caretaker fathers, *Developmental Psychology, 14,* 183–184.

Fleming, A. S., Morgan, H. D., & Walsh, C. (1996). Experiential factors in postpartum regulation of maternal care. *Advances in the Study of Behavior, 25,* 295–332.

French, J. A., & Inglett, B. J. (1989). Female-female aggression and male indifference in response to unfamiliar intruders in lion tamarins. *Animal Behaviour, 37,* 487–497.

French, J. A., & Snowdon, C. T. (1981). Sexual dimorphism in responses to unfamiliar intruders in the tamarin *(Saguinus oedipus)*. *Animal Behaviour*, *29*, 822–829.

French, J. A., & Stribley, J. A. (1987). Ovarian cycles are synchronized between and within social groups of lion tamarins (*Leontopithecus rosalia*). *American Journal of Primatology, 12,* 469–478.

Garber, P. A., Moya, L., & Malaga, C. (1984). A preliminary field study of the mustached tamarin monkey (*Saguinus mystax*) in Northeastern Peru: Questions concerned with the evolution of a communal breeding system. *Folia Primatologica*, *42*, 17–32.

Ginther, A. J., Carlson, A. A., Ziegler, T. E., & Snowdon, C. T. (2002). Neonatal and pubertal development in males of a cooperatively breeding primate, the cotton-top tamarin (*Saguinus oedipus oedipus*). *Biology of Reproduction, 66*, 282–290.

Ginther, A. J., Washabaugh, K., & Snowdon, C. T. (2000). Measurement of scrotum and testis size of unrestrained captive cotton-top tamarins (*Saguinus oedipus oedipus*). *American Journal of Primatology, 51*, 187–195.

Ginther, A. J., Ziegler, T. E., & Snowdon, C. T. (2001). Reproductive biology of captive male cotton-top tamarin monkeys as a function of social environment. *Animal Behaviour*, *61*, 65–78.

Griffin, A. S., Pemberton, J. M., Brotherton, P. N. M., Gaynor, D., & Clutton-Brock, T. H. (2003). A genetic analysis of cooperative breeding in meerkats (*Suricata suricatta*). *Behavioral Ecology, 14,* 472–480.

Hall, L. D., Walter, A. J., & Acock, A. C. (1995). Gender and family work in one-parent households. *Journal of Marriage and the Family, 57,* 685–692.

Hazan, C., & Shaver, P. R. (1994). Attachment as an organizational framework for research on close relationships. *Psychological Inquiry*, *5*, 1–22.

Hetherington, E. M. (1989). Coping with family transitions: Winners, losers and survivors. *Child Development, 60,* 1–14.

Hetherington, E. M., Bridges, M., & Insabella, G. (1998). What matters? What does not? Five perspectives on the association between marital transitions and children's adjustment. *American Psychologist, 53,* 167–184.

Hewlett, B. S. (1992). Husband-wife reciprocity and the father-infant relationship among Aka pygmies. In B. S. Hewlett (Ed.), *Father-child relations: Cultural and biosocial contexts*, (pp. 153–176). New York: Aldine de Gruyter.

Hrdy, S. B. (1999). *Mother nature*. New York: Ballantine Books.

Hurtado, A. M., & Hill, K. (1992). Paternal effects on offspring survivorship among Ache and Hiwi hunter gatherers: Implications for modeling pair bond stability. In B. Hewlett (Ed.), *Father-child relations: Cultural and biosocial contexts*. (pp. 31–55). New York: Aldine de Gruyter.

Inglett, B. J., French, J. A., Simmons, L. G., & Vires, K. W. (1989). Dynamics of intrafamily aggression and social reintegration in lion tamarins. *Zoo Biology, 8*, 67–78.

Johnson, L. D., Petto, A. J., & Sehgal, P. K. (1991). Factors in the rejection and survival of captive cotton-top tamarins (*Saguinus oedipus*). *American Journal of Primatology, 25,* 91–102.

Joyce, S. M., & Snowdon, C. T. (in press). Developmental changes in food transfers in cotton-top tamarins (*Saguinus oedipus*). *American Journal of Primatology*.

Keverne, E. B., Martensz, N. D., & Tuite, B. (1989) Beta-endorphin concentrations in cerebrospinal fluid of monkeys as influenced by grooming relationships. *Psychoneuroendocrinology, 14*, 155–161.

Kinnunen, U., & Pulkkinen, L. (2003). Childhood socio-emotional characteristics as antecedents of marital stability and quality. *European Psychologist*, 8, 223–237.

Kleiman, D. G. (1979). Parent-offspring conflict and sibling competition in a monogamous primate. *American Naturalist, 114*, 753–760.

Kostan, K. M., & Snowdon, C. T. (2002). Attachment and social preferences in cooperatively-breeding cotton-top tamarins. *American Journal of Primatology*, 57, 131–139.

Kotelchuck, M. (1976). The infant's relationship to the father: Experimental evidence, in M. Lamb (Ed.), *The role of the father in child development* (1st ed., pp. 329–344). New York: John Wiley & Sons.

Krueger, T. H. C., Haake, P., Chereath, D., Knapp, W., Janssen, O. E., Exton, M. S., Schedlowski, M., & Hartmann, U. (2003). Specificity of the neuroendocrine response to orgasm during sexual arousal in men. *Journal of Endocrinology*, 177, 57–64.

Lacey, E. A., & Sherman, P. W. (1997). Cooperative breeding in naked mole-rats: Implications for vertebrate and invertebrate sociality. In N. G. Solomon & J. A. French (Eds.), *Cooperative breeding in mammals* (pp. 267–301).New York: Cambridge University Press.

Lamb, M. (1976). Interactions between eight-month-old children and their fathers and mothers. In M. Lamb, *The role of the father in child development (*1st ed., pp. 307–327). New York: John Wiley & Sons.

Lamb, M. E., Pleck, J. H., Charnov, E. L., & Levine, J. A. (1987). A biosocial perspective on paternal behavior and involvement. In J. Lancaster, J. Altmann, A. S. Rossi, & L. R. Sherrod (Eds.), *Parenting across the lifespan* (pp. 111–142). New York: Aldine de Gruyter.

Lazaro-Perea, C. (2001). Intergroup interactions in wild common marmosets (Callithrix jacchus): Territorial defence and assessment of neighbours. *Animal Behaviour, 62*, 11–21

Lazaro-Perea, C., Arruda, M. F., & Snowdon, C. T. (2004). Grooming as reward? Social functions of grooming in cooperatively breeding marmosets. *Animal Behaviour*, 67, 627–636.

Lazaro-Perea, C., Castro, C. S. S., Harrison, R., Araujo, A., Arruda, M. F., & Snowdon, C. T. (2000). Behavioral and demographic changes following the loss of the breeding female in cooperatively breeding marmosets. *Behavioral Ecology and Sociobiology, 48,* 137–146.

Lunn, S. F., & McNeilly, A. S. (1982). Failure of lactation to have a consistent effect on interbirth interval in the common marmoset, *Callithrix jacchus jacchus. Folia Primatologica, 37,* 99–105.

McGrew, W. C. (1988). Parental division of infant caretaking varies with family composition in cotton-top tamarins. *Animal Behaviour, 36*, 285–286.

Mendoza, S. P., & Mason, W. A. (1986). Parental division of labor and differentiation of attachments in a monogamous primate (*Callicebus moloch*). *Animal Behaviour, 34,* 1336–1347.

Mitani, J. C., & Watts, D. (1997). The evolution of non-maternal caretaking among anthropoid primates. Do helpers help? *Behavioral Ecology and Sociobiology, 40*, 213–220.

Moehlman, P. D., & Hofer, H. (1997). Cooperative breeding, reproductive suppression and body mass in canids. In N. G. Solomon & J. A. French (Eds.), *Cooperative Breeding in Mammals.* (pp. 76–128). New York: Cambridge University Press.

Mota, M. T., Franci, C. R., & Sousa, M. B. (2006). Hormonal changes related to paternal and alloparental care in common marmosets (*Callithrix jacchus*). *Hormones and Behavior*, 49, 293–302.

Nievergelt, C. M., & Martin, R. D. (1999). Energy intake during reproduction in captive common marmosets (*Callithrix jacchus*). *Physiology and Behavior, 65*, 849–854.

Porter, T. A. (1994). The development and maintenance of heterosexual pair associations in cotton-top tamarins (*Saguinus oedipus oedipus*). Unpublished doctoral dissertation, University of Wisconsin, Madison.

Porter, T. A, & Snowdon, C. T. (1997). Female reproductive status and male pairmate behavior in cotton-top tamarins. *Annals of the New York Academy of Science, 807*, 556–558.

Price, E. C. (1991). Competition to carry infants in captive families of cotton-top tamarins (Sagui-nus oedipus). *Behaviour, 118,* 66–88.

Price, E. C. (1992). The costs of infant carrying in captive cotton-top tamarins. *American Journal of Primatology*, *26,* 23–33.

Price, E. C., & McGrew, W. C. (1991). Departures from monogamy in colonies of captive cotton-top tamarins. *Folia Primatologica, 57,* 16–27.

Rapaport, L. G. (1999). Provisioning of young in golden lion tamarins (Callitrichidae, *Leontopithe-cus rosalia*): A test of the information hypothesis. *Ethology*, *105*, 619–636.

Rapaport, L. G. (2006). Provisioning in wild golden lion tamarins (*Leontopithecus rosalia*): Bene-fits to omnivorous young. *Behavioral Ecology, 17,* 212–221.

Rapaport, L. G., & Ruiz-Miranda, C. R. (2002). Tutoring in wild golden lion tamarins. *International Journal of Primatology*, *23*, 1063–1070.

Reyer, H. U., Dittami, J.. & Hall, M. R. (1986) Avian helpers at the nest: Are they psychologically castrated? *Ethology, 71*, 216–228

Ribble, D. O. (1991). The monogamous mating system of *Peromyscus californicus* as revealed by DNA fingerprinting. *Behavioral Ecology and Sociobiology, 29*, 161–166.

Roma, P. G., Ruggiero, A. M., Schwandt, M. L., Higley, J. D., & Suomi, S. J. (2006) The kids are alright: Maternal behavioral interactions and stress reactivity in infants of differentially reared rhesus monkeys. *Journal of Developmental Processes, 1*, 103–122.

Rosenblum, L. A.. & Kaufman, I. C. (1968). Variations in infant development and response to ma-ternal loss in monkeys. *American Journal of Orthopsychiatry*, *38*, 418–426.

Roush, R. S., & Snowdon, C. T. (2001). Food transfers and the development of feeding behavior and food-associated vocalizations in cotton-top tamarins. *Ethology, 107*, 415–429.

Saltzman, W., Schultz-Darken, N. J., & Abbott, D. H. (1997). Familial influences on ovulatory func-tion in common marmosets (*Callithrix jacchus*). *American Journal of Primatology, 41*, 159–177.

Sanchez, S., Peleaz, F., Gil-Burmann, C., & Kaumanns, W. (1999). Costs of infant carrying in the cotton-top tamarin. *American Journal of Primatology, 48,* 99–111.

Savage, A., Giraldo, H., Soto, L., & Snowdon, C. T. (1996a). Demography, group composition and dispersal of wild cotton-top tamarin groups. *American Journal of Primatology***,** *38,* 85–100.

Savage, A., Snowdon, C. T., Giraldo, H., & Soto, H. (1996b). Parental care patterns and vigilance in wild cotton-top tamarins (*Saguinus oedipus*), In M. Norconk, A. Rosenberger, & P. A. Garber (Eds.), *Adaptive radiations of neotropical primates*, (pp. 187–199). New York: Plenum Press.

Savage, A., Ziegler, T. E., & Snowdon, C. T. (1988). Sociosexual development, pair bond formation and mechanisms of fertility suppression in female cotton-top tamarins (*Saguinus oedipus oedi-pus*). *American Journal of Primatology*, *14*, 345–359.

Simpson, J. A. (1990). Influence of attachment styles on romantic relationships. *Journal of Person-ality and Social Psychology*, *59*, 971–980.

Smith, H. J. (2005). *Parenting for primates*, Cambridge: Harvard University Press.

Snowdon, C. T. (1996). Parental care in cooperatively breeding species. In J. S. Rosenblatt & C. T. Snowdon (Eds.), *Parental care: Evolution, mechanisms and adaptive significance.* (pp. 643–689). San Diego: Academic Press.

Snowdon, C. T., & Cronin, K. A. (in press). Cooperative breeders do cooperate. *Behavioural Processes*.

Snowdon, C. T., & Pickhard, J. J. (1999). Family feuds: Severe aggression among cooperatively breeding cotton-top tamarins. *International Journal of Primatology*, *20,* 651–663.

Suomi, S. J. (1987). Genetic and maternal contributions to individual differences in rhesus monkey biobehavioral development. In N. A. Krasnigor, E. M. Blass, M. A. Hofer, & W. P. Smotherman (Eds.), *Perinatal development: A psychobiological perspective* (pp. 397–419). Orlando, FL: Aca-demic Press.

Tardif, S. D. (1997). The bioenergetics of parental behavior and the evolution of alloparental care in marmosets and tamarins. In N. G. Solomon & J. A. French (Eds.), *Cooperative breeding in mam-mals* (pp. 11–33). New York: Cambridge University Press.

Tardif, S. D., Richter, C. B., & Carson, R. L. (1984). Effects of sibling experience on future reproductive success in two species of Callitrichidae. *America Journal of Primatology, 6*, 377–380.

Temrin, H., Buchmayer, S., & Enquist, M. (2000) Step-parents and infanticide: New data contradict evolutionary predictions. *Proceedings of the Royal Society, London, Series B. 267*, 943–945.

Thompson, E., McLanahan, S, & Curtin, R. B. (1992). Family structure, gender and parental socialization. *Journal of Marriage and the Family, 54,* 368–378.

Washabaugh, K., & Snowdon, C. T. (1998). Chemical communication of reproductive status in female cotton-top tamarins (*Saguinus o. oedipus*). *American Journal of Primatology, 45,* 337–349.

Washabaugh, K. F., Ziegler, T. E., & Snowdon, C. T. (2002). Variations in care for cotton-top tamarin (*Saguinus oedipus*) infants as a function of parental experience and group size. *Animal Behaviour*, *63,* 1163–1174.

Weisner, T. S. (1987). Socialization for parenthood in sibling caretaking societies. In J. Lancaster, J. Altmann, A. S. Rossi, & L. R. Sherrod (Eds.), *Parenting across the Lifespan*, (pp. 237–270). New York: Aldine de Gruyter.

Widowski, T. M., Porter, T. A., Ziegler, T. E., & Snowdon, C. T. (1992). The stimulatory effect of males on the initiation, but not the maintenance, of ovarian cycling in cotton-top tamarins (*Saguinus oedipus*). *American Journal of Primatology*, *26,* 97–108.

Widowski, T. M., Ziegler, T. E., Elowson, A. M., & Snowdon, C. T. (1990). The role of males in stimulation of reproductive function in female cotton-top tamarins, *Saguinus o. oedipus*. *Animal Behaviour, 40,* 731–741.

Zahed, S. R., Prudom, S. L., Snowdon, C. T., & Ziegler, T. E. (in review). Male parenting and response to infant stimuli in the common marmoset (*Callithrix jacchus*).

Zahed, S. R., & Snowdon, C. T. (in preparation) Longitudinal study of infant carrying by cotton-top tamarin family members.

Ziegler, T. E. (2000). Hormones associated with non-maternal infant care: A review of mammalian and avian studies. *Folia Primatologica*, *71,* 6–21.

Ziegler, T. E., Bridson, W. E., Snowdon, C. T., & Eman, S. (1987). Urinary gonadotropin and estrogen excretion during the postpartum estrous, conception and pregnancy in the cotton-top tamarin (*Saguinus oedipus oedipus*). *American Journal of Primatology*, *12,* 127–140.

Ziegler, T. E., Epple, G., Snowdon, C. T., Porter, T. A., Belcher, A., & Kuederling, I. (1993). Detection of the chemical signals of ovulation in the cotton-top tamarin, *Saguinus oedipus*, *Animal Behaviour*, *45,* 313–322.

Ziegler, T. E., Prudom, S. L., Schultz-Darken, N. J., Kurian, A. V., & Snowdon, C. T. (2006). Pregnancy weight gain: Marmoset and tamarin dads show it too. *Biological Letters of the Royal Society, 2,* 181–183.

Ziegler, T. E., Schultz-Darken, N. J., Scott, J. J., Snowdon, C. T., & Ferris, C. F. (2005). Neuroendocrine response to female ovulatory odors depends upon social condition in male common marmosets, *Callithrix jacchus. Hormones and Behavior, 47,* 56–64.

Ziegler, T. E., & Sousa, M. B. (2002). Parent-daughter relationships and social controls on fertility in female common marmosets. *Hormones and Behavior, 42,* 356–367.

Ziegler, T. E., Washabaugh, K. F., & Snowdon, C. T. (2004). Responsiveness of expectant male cotton-top tamarins, *Saguinus oedipus*, to mate's pregnancy. *Hormones and Behavior*, *45,* 84–92.

Ziegler, T. E., Wegner, F. H., & Snowdon, C. T. (1996). A hormonal role for male parental care in a New World primate, the cotton-top tamarin *(Saguinus oedipus)*. *Hormones and Behavior*, *30,* 287–297.

Ziegler, T. E., Widowski, T. M., Larson, M. L., & Snowdon, C. T. (1990). Nursing does affect the duration of the postpartum to ovulation interval in cotton-top tamarins (*Saguinus oedipus*). *Journal of Reproduction and Fertility*, *90,* 563–570.

Changing Habits of Emotion Regulation

at Transition Points in Infancy:

A Dynamic Systems Analysis

Marc D. Lewis (Corresponding author)

Department of Human Development and Applied Psychology
Ontario Institute for Studies in Education
University of Toronto
mlewis@oise.utoronto.ca

Margaret Lloy Cook

Department of Human Development and Applied Psychology
Ontario Institute for Studies in Education
University of Toronto

Abstract: *Previous models of developmental transitions in infancy have proposed global reorganizations in cognitive and emotional functioning. Neo-Piagetian theories suggest a specific timetable for normative shifts in cognitive development, but dynamic systems constructs may be necessary to tap corresponding transitions in emotion regulation. We looked for reorganizations in attentional habits for regulating emotion in 12 infants assessed longitudinally over 16 sessions in the first year. Sensorimotor tasks and a frustration-induction procedure were conducted in each session. Videotapes of behavior were coded for attentional focus and distress. The strength of attentional habits was operationalized as the rate at which infants returned attention to their mother or a frustrating toy following a break in engagement. Event history analysis was used to test for changes in this rate. Results indicated cognitive-developmental shifts at 4.5 and 9 months, as predicted by neo-Piagetian theory. At both these ages, reduced rates of reengagement indicated increased plasticity in habits for attending to mother, though this effect was eliminated in the presence of distress. Reengagement of attention to the toy changed in unpredicted ways.*

One of the most important contributions of dynamic systems approaches to developmental psychology has been operationalizing developmental transitions. Historically, developmental transitions have been identified as stage-like shifts in competencies or changes in the incidence of particular behaviors. But these definitions rely on the content of behavior, and, particularly in the socioemotional domain, the content of behavior may reflect contextual effects and individual differences as much as universal developmental mechanisms. In their pioneering monograph, Thelen and Ulrich (1991) proposed

a definition of transitions that relies instead on change in the structure or organization of behavior. They proposed that developmental transitions were *phase transitions* in the trajectory of a dynamic system, identifiable by a breakdown in the orderliness of behavior (regardless of its content), or a temporary increase in behavioral variability, prior to the consolidation of new habits or patterns. The purpose of the present study was to predict and identify phase transitions in attentional habits for regulating emotion in the first year of life, corresponding to cognitive-developmental milestones.

Developmental transitions have been of great theoretical interest for many years. Acquisitions such as social referencing, the naming explosion, self-consciousness, and conservation have been hypothesized to arise discontinuously against a background of more gradual change. Generally, developmental transitions are thought to indicate some underlying reorganization in the psychological system (Kagan, 1984; McCall, Eichorn, & Hogarty, 1977). These reorganizations can be explained by maturational changes (e.g., Diamond, 1990); advances in cognitive development (e.g., Case, 1988; Fischer & Canfield, 1986); the spreading impact of a pivotal skill or ability (e.g., Bertenthal, Campos, & Barrett, 1984; Trevarthen, 1980); developmental differences in the effects of experiences (e.g., Bornstein, 1989), and change in the relations between child attributes and social contextual factors (e.g., Lerner, 1991; Rutter, 1987). In the case of socioemotional development, underlying changes in sensorimotor, cognitive, or regulatory capacities have generally been hypothesized to bring about new constellations of emotional expression, behavior, and coping (e.g., Barrett & Campos, 1987; Kopp, 1989; Lewis & Michalson, 1983; Sroufe, 1979; Thompson, 1993).

Reorganizations in infant socioemotional development were initially proposed by psychoanalytic writers such as Freud, Klein, and Erikson, and later Mahler and colleagues (Mahler, Pine, & Bergman, 1975), who described a series of stages characterized by unique affective and defensive themes. Spitz (1965) introduced the more contemporary notion of developmental organizers in infancy—changes in the child's regulatory and attentional systems that alter the style of interactions with caregivers. Emde, Gaensbauer, and Harmon (1976) examined parallels between socioemotional transitions, construed as biobehavioral shifts, and sensorimotor advances. Other infancy researchers such as Brazelton and Yogman (1986), Sander (1975), Sroufe (1979), Trevarthen (1980), and Kaye and Fogel (1980) proposed inflection points in socioemotional development marked by changes in the structure and/or content of interactions with caregivers. For some theorists (Abe & Izard, 1999; Lewis, 1995, 1997; Magai & Hunziker, 1993), such changes reflect personality reorganizations caused by new cognition-emotion organizations.

A number of theorists have proposed that transitions in socioemotional functioning correspond with more general developmental reorganizations, most notably in the cognitive domain. So-called constructivist theorists posit changes in emotional and coping responses due to cognitive-developmental advances, such as new Piagetian stages and substages (e.g., Sroufe, 1979, 1995). Along these lines, advances in emotion regulation have been specifically tied to cognitive-developmental acquisitions (Kopp, 1989; Kopp & Neufeld, 2003). These cognitive-constructivist hypotheses have been elaborated and operationalized by neo-Piagetian theorists. Their claim is that fundamental age-related cognitive reorganizations provide situations with new mean-

ings, eliciting new emotions, as well as tools for assembling new coping strategies for regulating those emotions (Case, Hayward, Lewis, & Hurst, 1988; Fischer, Shaver, & Carnochan, 1990; Lewis, 1993; Lewis, Koroshegyi, Douglas, & Kampe, 1997; Mascolo & Griffin, 1998). In an alternative model, Campos and colleagues (e.g., Campos et al., 2000; Bertenthal et al., 1984) see locomotor changes as the motor behind socioemotional reorganizations. Although neo-Piagetian explanations seem at odds with Campos's emphasis on motor development, both approaches focus on critical changes in the structure of infants' goals (see Kopp & Neufeld, 2003).

Case's (1985) neo-Piagetian theory postulates two major shifts in cognitive development within the first year, and both may have reverberations in the socioemotional domain (Case et al., 1988; Lewis et al., 1997). The first is the shift into the stage of "unifocal coordination" at about 4 months. This is the age when infants begin to coordinate elemental sensorimotor operations (e.g., reaching and grasping) into more comprehensive skills, permitting them to manipulate objects deliberately and flexibly (see Bremner, 1997). Such a change ushers in the often-observed fascination with toys and other non-human targets (Trevarthen, 1980), but it also corresponds with more directed protest or anger expressions (Demos, 1986; Lamb & Malkin, 1986) and new emotion regulation capabilities that rely on attentional disengagement (Rothbart, Ziaie, & O'Boyle, 1992). The second shift is the transition to the stage of "bifocal coordination" at about 8-9 months. At this point two sensorimotor schemes for manipulating objects become coordinated, or a scheme for manipulating objects becomes coordinated with a scheme for acting on caregivers. As a result, infants become capable of adjusting means for achieving ends in the object world as well as joint attention and social referencing in the interpersonal world (e.g., Corkum & Moore, 1998; Tomasello, 1995). Corresponding changes in the socioemotional domain include separation distress, stranger anxiety, and deliberate efforts to engage mother's help (e.g., Emde et al., 1976; Thompson & Limber, 1990). The 9-month shift is more universally recognized by infancy researchers than the 4-month shift, but Sroufe, Case, Fischer, Trevarthen and others stipulate both as critical junctures in early development. Kopp's (2002) summary of recent research on attentional development also identifies new epochs of attentional control beginning at 4 and 9 months. Her stages of instrumental attention (beginning at 4 months) and "intelligent" attention (beginning at 9 months) correspond both in content and timing to those of traditional neo-Piagetian models, and she notes their likely impact on the development of emotion regulation.

Despite their importance, developmental shifts are difficult to study. Most advocates have assumed discontinuities on the basis of qualitative descriptions of behavioral change, differences in selected measures between consecutive developmental epochs, or changing correlations across a series of observations (see reviews by Fischer, Pipp, & Bullock, 1984; Rutter, 1987). But direct evidence for developmental reorganizations is rare, and this is certainly true in the socioemotional domain. We suggest at least two reasons for this gap. First, fine-grained longitudinal studies are extremely difficult to conduct, and coarse-grained longitudinal and cross-sectional comparisons are not suited to capture developmental transitions (e.g., Mangelsdorf, Shapiro, & Marzolf, 1995; Parritz, 1996). Particularly in socioemotional development, co-occurring changes tend to be conflated (Barrett, 1998; Fogel, 2006; Kopp, 1989;

Thompson, 1994), and snapshots at different ages cannot capture this complexity. Second, investigators usually search for a universal pattern of change at developmental junctures (e.g., an increase in the frequency of stranger distress). However, socioemotional development is characterized by context effects that depend in turn on individual differences in temperament, parenting style, and attachment status (Sroufe, 1979; Thompson, 1993; Tronick, Ricks, & Cohn, 1982). One child may become shy and inhibited in the presence of strangers while another becomes more sociable. These differences are the signal rather than the noise in socioemotional development; thus, universal content may be the wrong metric for socioemotional transitions.

The present study was intended to address these problems with a dynamic systems (DS) analysis of transitions in attentional habits related to emotion regulation. DS approaches construe transitions as global reorganizations in the patterns of interaction among the elements (e.g., concepts, skills, neurons) of a developing system, and such reorganizations are often portrayed as *phase transitions*. A phase transition is defined as an abrupt or discontinuous change in the child's behavioral habits, possibilities, or tendencies, often triggered by an incremental or continuous change in one or more parameters (Kelso, 1990; Thelen & Ulrich, 1991). Phase transitions are evident through changes at two time scales. In developmental time, there is first a period of stability, reflecting an enduring structural organization (e.g., a stable neo-Piagetian stage). This gives way to a period of fluctuation or instability, when old forms or habits alternate with new ones (Fogel & Thelen, 1987; Thelen & Ulrich, 1991; van Geert, 1991). Finally, new forms or habits stabilize. At the second time scale, "real time" or micro-development, behavior self-organizes within seconds or minutes, but this process becomes more variable, and behavior becomes more plastic and indeterminate, during a phase transition (e.g., Kelso, 1995; Thelen & Smith, 1994; van der Maas & Molenaar, 1992). In DS terms, increased indeterminacy means that the system's attractors become weaker. Attractors are habitual states in which behavior stabilizes and to which it returns following a perturbation. At phase transitions, attractors become less attractive, so to speak; they hold behavior less tightly. Thus, the *return time*—the time it takes for behavior to return to its attractor—becomes extended, and behavior is freed up to explore new possibilities (Thelen & Ulrich, 1991).

DS approaches are still fairly new in developmental psychology, particularly in the area of emotional development (Camras, 1992; Lewis & Granic, 2000), but they have attracted perhaps most attention as a means for studying developmental reorganizations. Through mathematical modeling of interacting system elements, van Geert and colleagues (1991, 1994) have generated theoretical growth curves that capture the properties of transitions in cognitive and linguistic development. More recently, van Geert and van Dijk (2002) presented novel statistical and graphing methods for assessing transitions in infant development. Other DS developmentalists (e.g., van der Maas & Molenaar, 1992) have modeled discontinuous change in cognitive strategies as a movement across a catastrophe cusp, a mathematically modeled transition between two stable states or periods. These methods are capable of analyzing changes (e.g., increased variability) in the overall frequency of behaviors, regardless of situational context, and are thus useful for studying normative shifts in cognitive and linguistic

skills. However, socioemotional patterns are notoriously sensitive to context effects, and methods that ignore context may be inappropriate for studying them. Several recent studies have used "state space grid" methods for assessing transitions in socioemotional development (Lewis, Zimmerman, Hollenstein, & Lamey, 2004; Granic, Hollenstein, Dishion, & Patterson, 2003). Although these methods take context into account graphically and statistically, the present study is based on an approach that captures context effects mathematically.

Event history analysis allows one to capture changes in the probability of any behavioral event, given a preceding event, while accounting for the influence of one or several covariates. In this sense, event history analysis can be highly sensitive to context and in fact uses context as the lynch-pin for identifying windows of behavior of primary interest. In a recent study based on DS principles, Hsu and Fogel (2003) used event history analysis to explain patterns of change and stabilization in mother-infant communication patterns. They showed that a dyad's recent history of interactions was the best predictor of subsequent transitions among the dyad's patterns of interaction, with long-term history providing additional predictive power. These authors demonstrated the suitability of event history analysis for a context-sensitive, process-level description of behavior that unfolds over time, as an alternative to conventional statistics that ignore time and DS methods that ignore context.

In the present study, we used event history analysis to measure changes in the variability of attentional habits for regulating emotion, at two cognitive-developmental transitions predicted by Case (1985): 4 months and 8-9 months. Increased variability was operationalized as an increase (or slow-down) in return time to either of two attractors describing infant attentional focus—one attractor being attention to mother and the other being attention to a toy placed out of reach. A slow-down in return time would indicate an increase in attentional variability or malleability, suggesting a temporary weakening of the attractor. No attempt was made to predict universal changes in infants' preference for mother or toy at either age, because of the assumption of context and individual difference effects. As we were interested in attentional habits related to emotion, we developed an emotion-induction procedure designed to elicit frustration, and we coded infants' focus of attention and degree of negative affect from video recordings of their behavior during this procedure. A fine-grained longitudinal design permitted close tracking of developmental changes in emotion-attention habits. Infants were tested at home every 2, 3, or 4 weeks, depending on their age (see next section). Frequent test sessions enabled us to map out a relatively fine-grained time series, showing change in emotion-attention habits, and to compare the timing of that change to the ages predicted for universal phase transitions. Sensorimotor tasks conducted each session allowed us to track changes in cognitive-developmental functioning in parallel. We hypothesized that sensorimotor performance would move up one level at about 4 months, on average, and up a second level at 8–9 months, on average, as predicted by Case. We also hypothesized a phase transition in emotion-regulatory habits, indexed by increased attentional variability (slower return time to the attractor) in frustrating contexts, corresponding in age with these cognitive-developmental shifts.

Methods

Overview

Infants and their mothers were assessed at home 16 times over the first year. On each visit, two sensorimotor tasks were administered, followed by a frustration-induction task that involved giving and taking away toys. Videotapes of behavior during this task were coded for attentional focus and distress. Return times for attention to mother and toy were calculated for each session, and their developmental profiles were compared with the profile of sensorimotor development.

Participants

The participants were 12 infant-mother dyads, drawn from a larger sample of 31 dyads. The 5 boys and 7 girls represented a range of socioeconomic levels from upper to working class, and 10 of the 12 were from 2-parent families. The initial sample was recruited through notices posted in pediatricians' offices, newspaper ads, and a radio bulletin. Selection criteria stipulated that the infant be born to term (+/– 2 weeks), in order to minimize discrepancy between chronological and mental age. Because of the obvious difficulties of conducting 16 home visits successfully, we expected that nearly half the original sample would have to be discarded. We rated all 31 families with letter grades (A or B) reflecting the number of sessions missed, spoiled, or lost to attrition. Spoiled sessions were most often due to fussiness and family interruptions, and missed sessions were mostly due to illness and travel. We tried to make up missed sessions within a reasonable period following the target date for that session. By the end of the study, only 12 families were included in the "A" category, but we decided that complete data sets outweighed the disadvantage of a small sample size.

The 16 sessions were timed at increasing intervals over the year, reflecting the general slowdown of developmental change with age. Sessions were two weeks apart from 12 to 24 weeks, three weeks apart from 24 to 39 weeks, and four weeks apart from 39 to 55 weeks.

Procedure

A single examiner was assigned to each family for the duration of the study. All infants were seen at home at a time when their mothers expected them to be awake and alert. Mothers were telephoned before each session to ensure that the baby was in "good shape," and sessions were rescheduled if necessary. At least 10 minutes elapsed after feedings before sessions were begun, and other family members were excluded from the room during the videotaping. Both sensorimotor and emotion-induction tasks were videotaped continuously, using one Sony camcorder mounted on a tripod. For the sensorimotor tasks, the infant was seated in an infant seat, with the video camera

focused on his or her face, torso, and arms. For the emotion-induction task, the infant was strapped into a high chair, with the camera aimed from over the mother's shoulder, focused on the infant's face and body and the tray of the high chair.

Sensorimotor assessment. The tasks administered at each session were determined by the infant's age. From 12 to 24 weeks, *Reach & Grasp* and *Adjusted Reach* were administered, as these tasks assess the shift from pre-coordination to unifocal coordination, and this milestone is generally reached by 20 weeks (Lewis & Ash, 1992). From 27 to 55 weeks, *Hidden Object* and *Cloth Pull* were administered, as these tasks assess the shift from unifocal to bifocal coordination, generally expected at 8-10 months. All tasks were developed and tested by Lewis and Ash (1992) and Lewis and colleagues (1997), and the latter two are based on Piaget's original tasks.

Two tasks were administered at the beginning of each session after the baby was deemed to be alert, content, and engaged. Each task was scored on a pass-fail basis by the examiner. Videotapes were later reviewed for reliability, but the small number of disagreements were resolved in favor of the examiner, whose proximity permitted a more precise assessment.

1. *Reach & Grasp*. A colorful toy was held directly in front of the infant's hand and "squeaked" in order to stimulate reaching. A pass was scored if the infant reached directly for the toy and made initial contact with the palm of the hand (indicating reach-grasp coordination). Two passes in four trials were scored as a "pass" for that session.

2. *Adjusted Reach*. A colorful toy was moved slowly back and forth in front of the infant's hand. The toy was kept out of reach while adjustments in arm movement were observed. A pass was scored for continuous lateral adjustments in reach, corresponding to the movement of the toy, for at least two consecutive traverses (indicating coordination of visual tracking and reaching). Two 30-second trials were allowed.

3. *Hidden Object*. After manipulating a 9×15 cm plastic cup, the infant was given a colorful set of plastic keys. Another 10 seconds later, the keys were removed and covered by the cup. The infant's arms and torso were restrained during this event (for about 3–5 seconds). A pass was scored if the infant removed the container and, within 5 seconds, touched the keys. Two trials were allowed.

4. *Cloth Pull*. The infant was given a wobbly plastic toy to play with as a 60-cm cloth was placed with its near edge 10 cm from the edge of the table. While the infant watched, the toy was moved out of reach, to the far end of the cloth. A pass was scored if the infant retrieved the toy within 20 seconds by pulling on the cloth while watching the toy. If the child lost attention to the toy, the examiner tapped it to reengage the infant. Two trials were allowed.

Socioemotional assessment. Mothers were asked to kneel or squat in front of the high chair and to give and take away toys according to a fixed schedule. After placing the camera and preparing the participants, the examiner left the room during this procedure, but communicated with the mother by means of a beep signal when it was time to give or remove a toy. The task was arranged in six cycles of giving, removing, and

re-giving each toy, in order to produce ongoing frustration while maintaining novelty and engagement. The mother initially presented the infant with a toy to handle, encouraging her or him to gaze at or grasp the toy by shaking and rattling it or gently touching it to the infant's hand. After 20 seconds, she removed the toy and placed it on the opposite side of the tray from the infant for 30 seconds. The position of the toy during this episode was within 15 degrees from the center-line and 8 cm out of the infant's grasp. Next, the toy was returned to the infant for 20 seconds. Then, another cycle began with the presentation of a new toy at the same time that the current toy was removed from the baby's hand (if grasped).

The selection of toys and the schedule of toy presentations was the same for all participants. New and more advanced toys were gradually introduced with age and more primitive toys were discontinued. Counterbalancing the order of presentation ensured that the sequence was different from session to session.

Mothers were encouraged to conduct all six give-and-take cycles unless infant emotion crossed the line from fussiness to real distress. The procedure was terminated by the examiner if the baby showed (1) intense upset (e.g., crying) in any one episode for 15 continuous seconds or (2) fussiness for 75% or more of the time for two consecutive episodes. Mothers were requested to maintain a neutral face as much as possible, but not to restrict eye contact with their child.

Coding procedures. The videotaped emotion-induction sessions were coded second-by-second for attentional engagement and level of distress. We initially coded for motor behaviors (e.g., gaze aversion, hand-sucking) as well, but these were too sporadic or infrequent to provide useful data. Attentional engagement had four exclusive categories: "toy," "mom," "other," and "scan." For "toy," either manual or oral manipulation or gaze at the toy was coded. "Other" was coded for a gaze directed for at least 2 seconds toward objects other than the toy. "Scan" was coded for wide-range scanning across at least two locations. "Mom" was coded when the infant looked at the mother's face. All codes except "mom" required a minimum duration of 2 seconds, while "mom" was coded for intervals of any length. Generally, coding short-lasting states added little to the overall profile of attention but produced a high degree of complexity and diminished reliability. However, gazes at mother were considered crucial to capture, whatever their duration, and such gazes were often quite brief. When gaze at mother overlapped with manipulation of the toy, the "mom" code superseded the "toy" code.

Distress coding involved judgments along a 4-point scale based on facial cues that included eyebrows, eyes/cheeks, and mouth. These regions are demarcated in the MAX and AFFEX scoring systems (Izard, 1979), and coders studied the manuals to become familiar with them. Distress was coded second-by-second, and competing codes within 1-second intervals were resolved in favor of the higher-intensity code. Facial expressions that showed contentment, happiness, interest, puzzlement, or a neutral expression were coded 0. Expressions that appeared troubled, uncomfortable, or mildly anxious, and that included no more than two facial regions, were coded 1. A fully articulated negative expression, including all three regions, was coded 2. An intense negative facial expression, such as a pre-cry face or cry face, was coded 3.

Two raters were trained in the use of each coding procedure. For the attentional coding, two sessions for each infant were first coded conjointly to identify idiosyncratic features. Interrater reliability was computed on 15% of the (remaining, in the case of attentional coding) sessions, selected pseudo-randomly with at least one session per infant. Cohen's Kappa was .84 for attention codes and .70 for distress codes.

Data Analysis and Results

Sensorimotor Shifts

No infant passed either of the two tasks initially, that is, at the beginning of the study (12 weeks) or the beginning of the second phase of tasks (27 weeks). Then, for each phase, 11 infants passed both tasks within three weeks of passing the first task. The remaining infant passed one task or the other for more than four sessions before passing both (suggesting an idiosyncratic response to one of the tasks). To accommodate these uneven profiles, we defined each sensorimotor shift point as the first session both tasks were passed or the third consecutive session a single task was passed.

As shown in Figure 1, the shift points for each sensorimotor milestone were generally as predicted. The mean and median ages for the first shift were 20 weeks (4.6 months). The mean and median ages for the second shift were 37.75 weeks (8.7 months) and 37.5 weeks respectively.
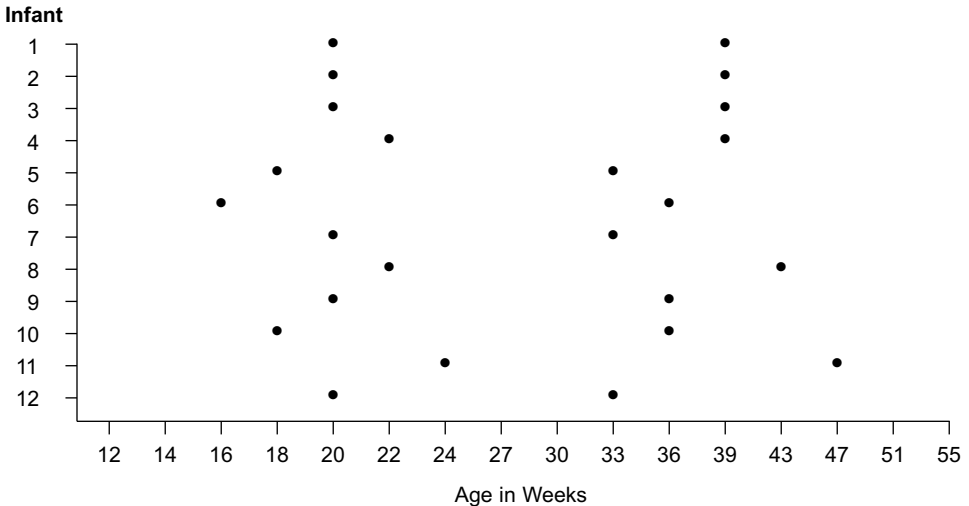

FIGURE 1. Distribution of shift-points in sensorimotor performance. Each data point shows the age at which the infant first passed both tasks or passed one task for the third time in a row.

Attentional Habits

As shown in Table 1, "toy" was by far the most common focus of attention, particularly when the toy was within reach. "Toy," "other," and "scan" each accounted for about 30% of attention allocated during the withhold-toy episode. Gaze at mother accounted for less duration overall, and its duration was roughly equivalent for all three episodes.

All attentional codes showed group developmental profiles that were essentially flat, except for the "mom" code. Gaze at mother's face was highest at 12 weeks (M = .19 for both the give-toy and withhold-toy episodes). It then dropped to its lowest value at 16 weeks (Ms between .03 and .05 across all three episodes), and then rose slightly but linearly from 22 to 55 weeks. These normative means were not considered particularly interesting, as they obscured large individual differences in attentional style. They also obscured the effects of frustration on attention, which, again, varied greatly across individuals.

In order to examine change in infants' attentional habits, we selected two codes, "mom" and "toy," for analysis. "Other" and "scan" were the lowest-frequency codes during the give-toy and return-toy episodes, and their higher incidence during the withhold-toy episode may not have indicated attentional habits so much as breaks in attention to mother or toy.

Distress

Distress was generally much lower than expected. However, as assumed, distress was more common in the withhold-toy episode than the other two episodes. With distress scores amalgamated, episode means for distress as a proportion of total time were .02, .10, and .03 for give-toy, withhold-toy, and return-toy episodes respectively. A multivariate repeated-measures ANOVA revealed a significant quadratic effect for episode, $F (1, 11) = 31.77$, $p < .001$.

Return Time Calculations

Rather than attempt to define attractors for individual infants, we assumed that attention to mother and attention to toy had attractor-like qualities for all infants, and we

Table 1. Means and *SD*s for proportional duration of each attention code, broken down by episode type.

Attentional focus	Give-toy	Withhold-toy	Return-toy
Toy	.90 (.05)	.30 (.07)	.87 (.06)
Mom	.07 (.05)	.11 (.05)	.08 (.03)
Other	.04 (.03)	.31 (.10)	.06 (.04)
Scan	.03 (.02)	.32 (.11)	.05 (.03)

Note: Proportions sum to slightly more than 1.0 because the sum of duration values sometimes exceeded the 20- or 30-second values assigned for episode durations.

focused on changes in the relative strength of these presumptive attractors. To do this, we conceptualized the return of attention to the mother or toy, after any interruption, in terms of "return time to the attractor." The first step was to identify a time window as the period within which to evaluate return time. We tried windows of 5, 8, and 10 seconds. Any window longer than 10 seconds seemed inappropriate, because an attentional state recurring after 10 second may not indicate a return so much as an independent behavioral event.

After pooling data for all infants for each age point, return rate at each second was calculated by dividing the number of returns at that second by the number of potential returns at that second (all segments that have not yet returned). Thus, return time was translated into return rate (i.e., propensity to re-engage mom), with high rates indicating more rapid return times. Figure 2 shows, for each time window, the return rate to "mom" (propensity for the "mom" code to recur since the offset of a previous "mom" code). The "average return rate" represents an average of the return rates for each second within the identified window. As can be seen, return rates were lowest for weeks 20-22 and then again for the period centered on week 36. These results were consistent with our prediction that return time would slow down, indicating greater attentional plasticity, at the two sensorimotor shifts. There was little difference between the profile of results using 5-, 8-, and 10-second windows. Hence we chose the 8-second window for all subsequent analyses and tests.
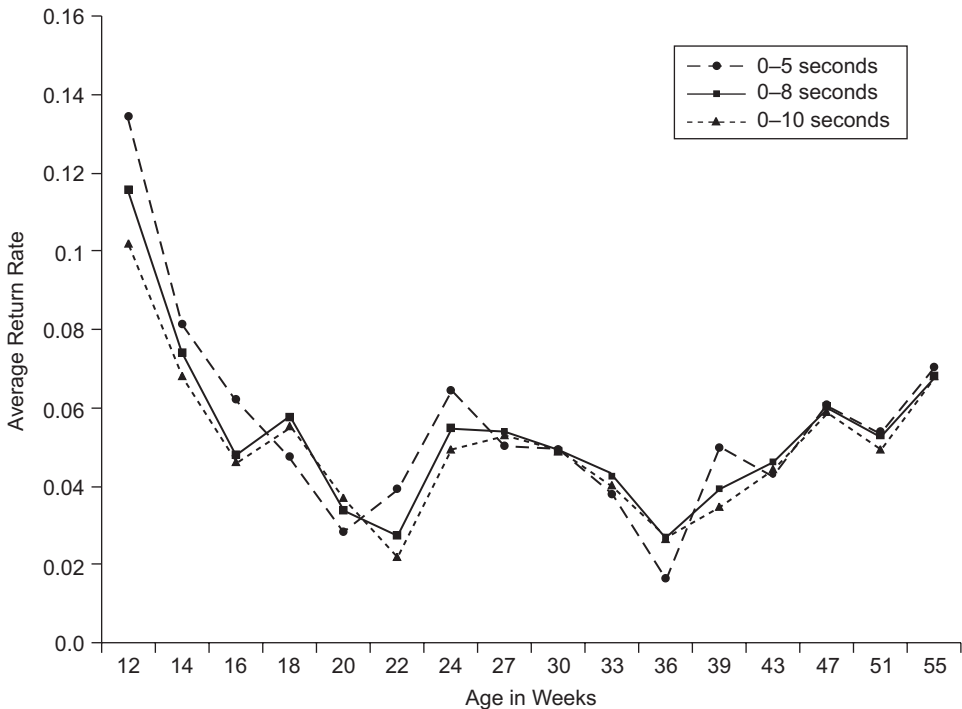

FIGURE 2. Average rate at which attention returned to "mom" within 5, 8, and 10 seconds of a previous "mom" event, by age, for undistressed segments. Dips in return rate at 20–22 weeks and 36 weeks were consistent with our hypotheses.

In order to estimate the effect of distress on attention, we calculated return rates separately for returns with and without a prior distress code. In other words, we parsed the data into segments in which return events directly followed a previous attentional event and those in which a distress code overlapped with or followed the previous attentional event. As shown in Figure 3, distressed return rates showed no systematic profile. It is notable that return rates did not drop at the sensorimotor shift periods for distressed segments, thereby deviating from nondistressed segments most at those ages.

Return rates for the "toy" code were calculated in the same way. As shown in Figure 4, the developmental profile of return rates is best characterized as a linear increase with age for both nondistressed and distressed segments, contrary to our predictions. In other words, there was no indication of any phase transitions at which return rates temporarily increased. Moreover, the propensity to return gaze to the toy was lower for distressed segments consistently across age.

Event History Analysis

Because the number of events per session was insufficient for modeling, our next step was to divide the age span into periods, and to test for differences between shift periods and nonshift periods. As shown in Figure 5, the hypothesized sequence was stable-unstable-stable-unstable-stable, so we divided the 16-week age span into five

FIGURE 3. Average rate at which attention returned to "mom" within 8 seconds of a previous "mom" event, by age, for both undistressed and distressed segments.
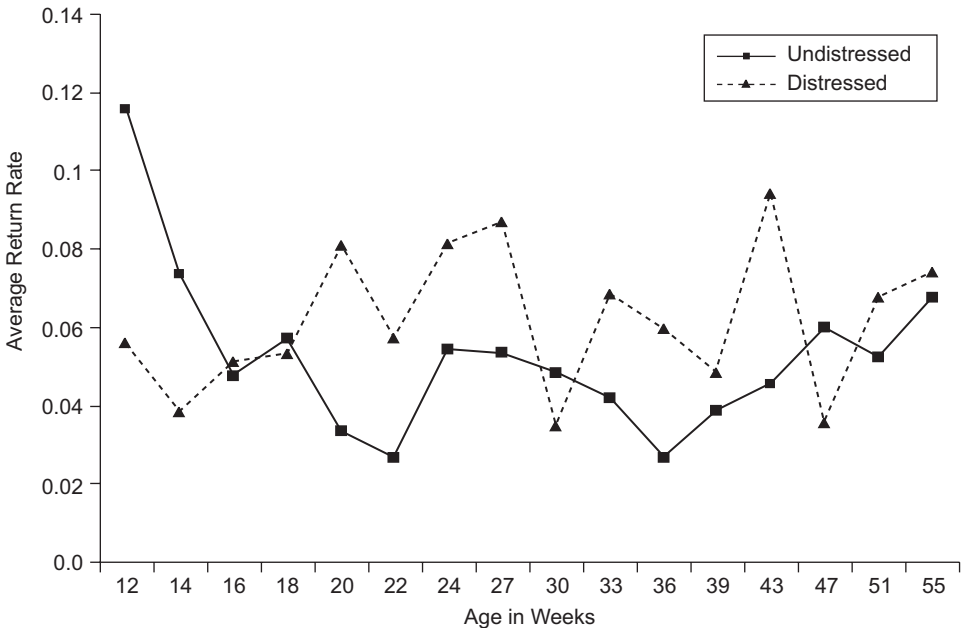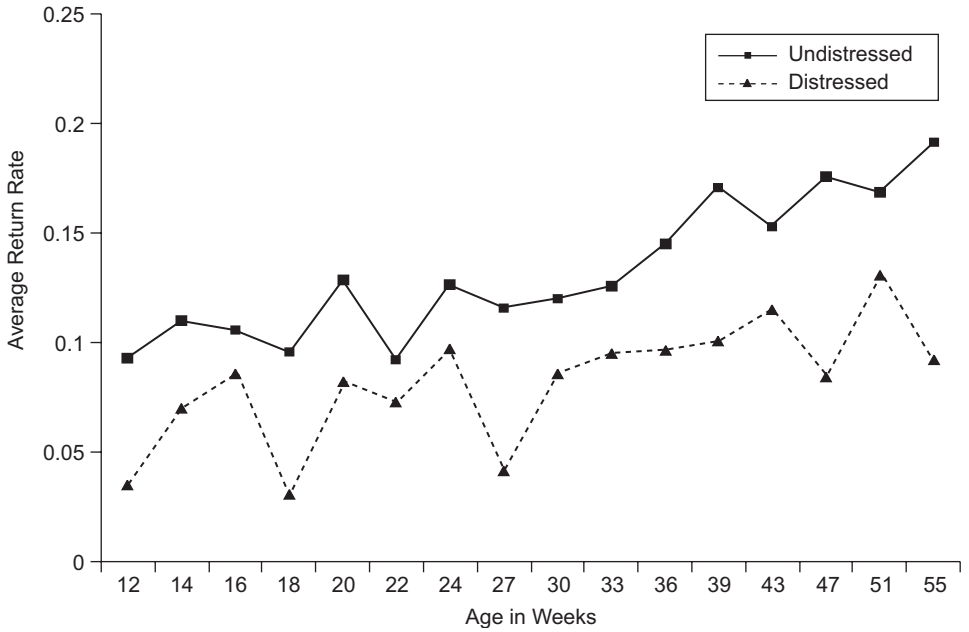
FIGURE 4. Average rate at which attention returned to "toy" within 8 seconds of a previous "toy" event, by age, for both undistressed and distressed segments.
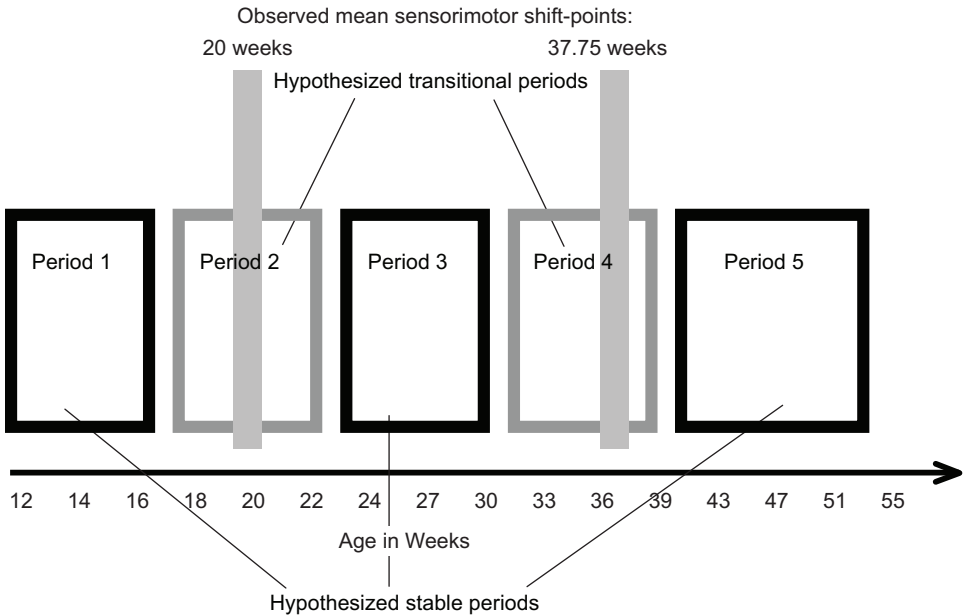
FIGURE 5. Timeline of sessions divided into five nearly equivalent periods. Periods are denoted as hypothetically stable or transitional, and mean sensorimotor shift-points are superimposed on them.

periods, the first four containing three weeks each and the fifth containing four weeks. Using this scheme, the shift periods—periods 2 (18-22 weeks) and 4 (33-39 weeks)—were roughly centered on the observed mean ages of the sensorimotor shifts. Figures 6 and 7 show average return rates for "mom" and "toy" (within 8 seconds) by period, for all segments and for segments with and without distress. Return rates for "mom" showed the hypothesized "W"-shaped profile for nondistressed segments, and a slightly blunted but similar profile for all segments taken together. It was notable as well that distress reduced return rates dramatically in period 1 only: very young infants did not return their gaze to mother as quickly when distressed.

Event history analysis examines the transition rate (or propensity to change) from one state to another over time. One can produce a default model of transition rates and then test that model for different sets of events. To test the hypothesis regarding return time differences by period, we performed a separate analysis for "mom" and "toy," each comparing the two shift periods with a default model based on the three nonshift periods. To simplify the analyses, given a very short time window, we were able to use a basic exponential model, which assumes a constant transition rate over time. However, this does not imply an even distribution of transitions over the 8 seconds, because events get "used up" from second to second, and the actual distribution of transitions exhibits an exponential curve. The program we used is called Transitional Data Analysis (Röhwer & Potter, 2003).

Transitions back to "mom." In our model, transition rate (within 8 seconds) was the dependent variable, with higher transition rates back to "mom" indicating faster
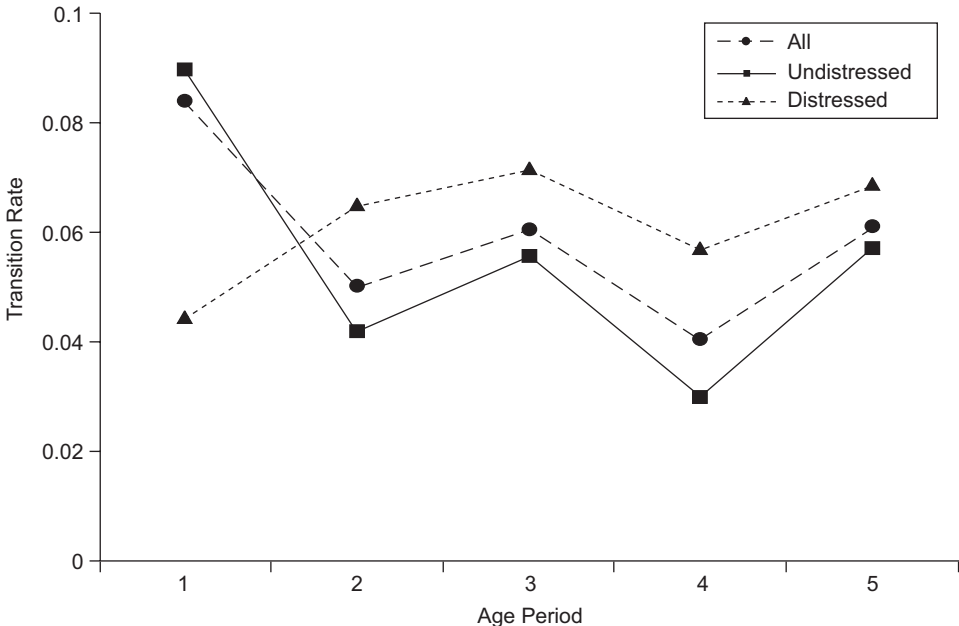
FIGURE 6. Transition rate for returns to "mom" within 8 seconds, by age period.
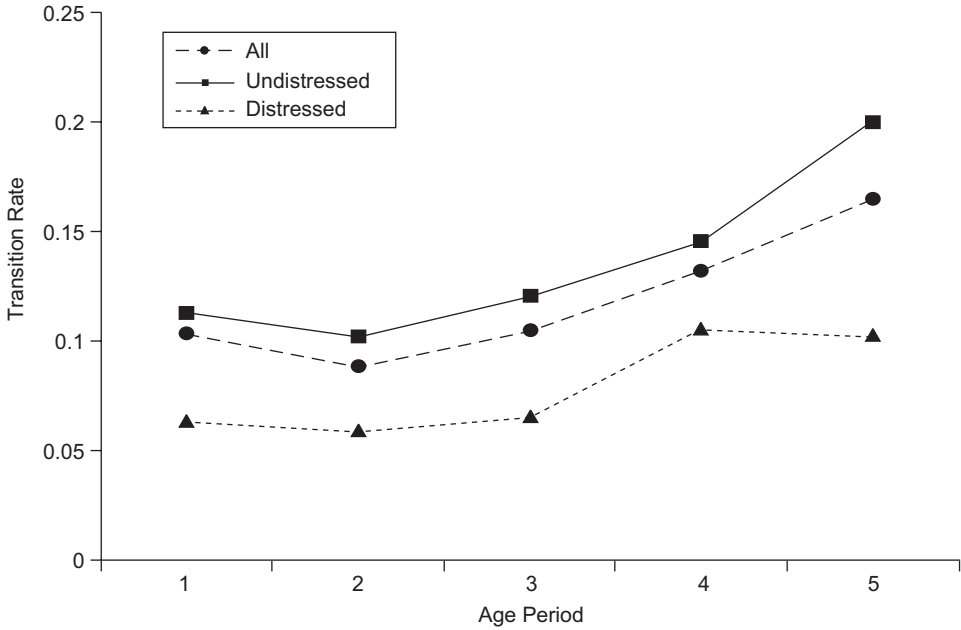
FIGURE 7. Transition rate for returns to "toy" within 8 seconds, by age period.

return times. The default model for "mom" events estimated the transition rate for the three nonshift periods taken together (periods 1, 3, and 5). Specifically, the model included a 5-level covariate representing period, with no data for levels 2 and 4 (representing the shift periods). The next covariate entered was distress, a time-varying dichotomous variable indicating whether distress had occurred since the offset of the previous "mom" event. In order to allow for an interaction effect between distress and period, the distress covariate was computed as a 6-level variable, with zero representing no distress and the other five values corresponding to distress at each wave. After deriving a base rate and beta coefficients, we fixed both parameters. We then added two more sets of covariates and reran this more complex model on the full data set. The first set was a pair of time-constant variables representing the first and second shift periods (periods 2 and 4). These were included to test the hypothesis of lower transition rates (back to "mom") during the shift periods. The second set was a pair of time-varying distress covariates representing distress in periods 2 and 4.

There was a small but significant effect for period (beta = –0.089, $p < .001$) in the default model, indicating that return rates decreased with age, perhaps suggesting a steady rise in attentional flexibility. Transition rate due to distress was higher, at the level of a trend (beta = 0.040, $p < .10$), suggesting less overall flexibility. The test for the effect of the shift periods (with all data included) revealed that the complex model fit the data better than the default model (chi-square = 41.22 on 4 df, $p < .01$). In fact, as shown in Table 2, three covariates showed significant effects, with a trend evident for the fourth. Specifically, there were significantly lower transition rates in periods 2

Table 2. Contributions of shift periods and corresponding distress to transition rates (≤ 8 seconds) in attention to mother.

Variable name	Beta	p-level
Period 2	–0.533	< .0001
Period 4	–0.694	< .0001
Distress (period 2)	0.358	< .10
Distress (period 4)	0.486	< .001

and 4, as portrayed in Figure 8, and distress during period 4 had a significant impact on transition rate. Distress, represented by a positive coefficient, attenuated the effect of period, represented by a negative coefficient. Thus, transitions back to "mom" were less frequent during shift periods, indicating greater flexibility, as hypothesized; but distress during these periods increased transitions (decreased flexibility) to approximately the level found during nonshift periods.

Transitions back to "toy." As with "mom," the default model for "toy" included a 5-level covariate representing period, with no data for levels 2 and 4, and a 6-level distress covariate. Again, two new pairs of covariates were added, representing shift periods and distress during shift periods, and the model was rerun on the entire data set.

FIGURE 8. Effects on transitions back to "mom" for shift periods and for distress during shift periods, shown in comparison with the default model based on three nonshift periods. Transition rates drop due to shift periods, but distress counteracts this effect by raising transition rates almost to their default level.

Table 3. Contributions of shift periods and corresponding distress to transition rates (≤ 8 sec) in attention to toy.

Variable name	Beta	p-level
Period 2	–0.121	ns
Period 4	–0.114	< .10
Distress (period 2)	–0.257	ns
Distress (period 4)	0.254	< .05

The default model showed significant effects for both period and distress covariates: for period, beta = 0.176, p < .0001; for distress, beta = –0.145, p < .0001. This indicated that return rates to the toy increased (and flexibility decreased) with development but that distress dampened this effect. For the full data set, the complex model was a better fit than the default model (chi-square = 10.24 on 4 df, p < .05). Specifically, as shown in Table 3, there was a trend toward lower transition rates for period 4, but a compensatory significant increase due to distress in period 4. Figure 9 portrays these results graphically, if not intuitively: the value for "shift period distressed" is above the line plotted for "default distressed," despite the reduction already contributed by "shift period undistressed." Thus, return time to "toy" tended to decrease
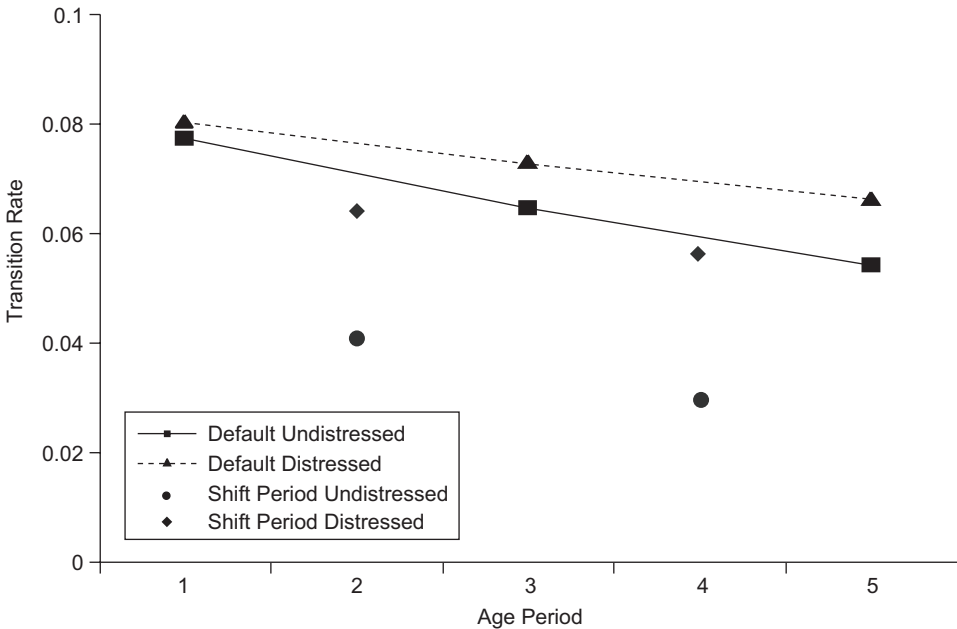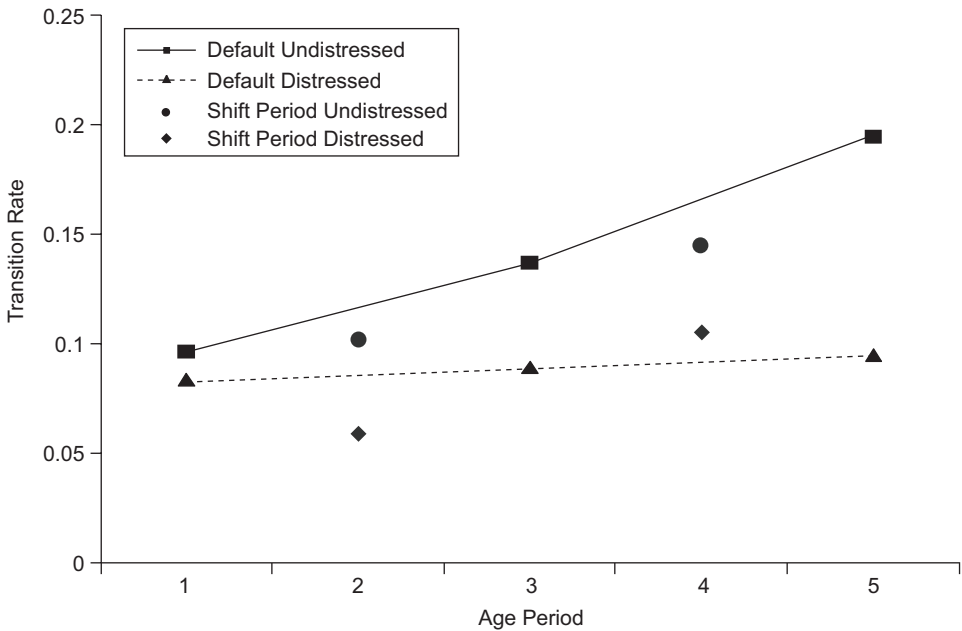

FIGURE 9. Effects on transitions back to "toy" for shift periods and for distress during shift periods, shown in comparison with the default model based on three nonshift periods. Transition rates drop somewhat due to shift periods, but distress counteracts this effect for period 4 only.

at the time of the second shift but not the first shift; and, as with attention to "mom," distress partly counteracted this effect.

Discussion

In this study we used shifts in sensorimotor coordination as anchor points for cognitive development, and examined changes in the organization of attentional habits related to emotion regulation at corresponding ages. As predicted by neo-Piagetian theory, sensorimotor task performance went up a level at about 4.5 months and then again just before 9 months. Also as predicted, return time to the attentional attractor of mother's face slowed down at both these ages, except during occasional bouts of distress, consistent with a DS model of phase transitions in the development of emotion regulation. These results suggest that the tendency to maintain attention to mother, during potentially frustrating situations, diminished in strength at times of cognitive-developmental change. We interpret this as indicating a period of increased plasticity or indeterminacy, as attentional habits became readjusted or reorganized in response to increasing cognitive capacities. However, return time for attention to an out-of-reach toy decreased only at the level of a trend and only at the second shift period, again as counteracted by distress. Thus, our hypothesis regarding phase transitions in emotion regulation was only partly borne out.

Older models have also proposed that attentional habits, including those for regulating emotion, become reorganized along with cognitive abilities at developmental junctures in infancy. Spitz's (1965) model of developmental organizers, and Emde et al.'s (1976) observation of parallels between socioemotional and sensorimotor advances, represent particularly elegant examples. These models go further than the general constructivist notion that emotional development should change in some way with cognitive development, because they specifically postulate reorganizations in the psychological system with ramifications for both cognitive performance and emotional functioning. The search for global developmental reorganizations fell out of favor for most of the last two decades, perhaps because a universal timetable for changes in the content of behavior was elusive and probably nonexistent. However, new methods inspired by DS theories of development may revive these efforts. Our results suggest that reorganizations in emotion-related attention may still be a valid way to characterize global transitions in infancy. Our emphasis on the structure rather than content of behavior may have tapped the re-setting of emotion regulation strategies within individual infants, demonstrating a normative developmental timetable despite varied individual trajectories.

It is important to emphasize that a normative timetable was observed in the form, not the content, of developmental trajectories. The content of socioemotional changes was individual or idiosyncratic in nature. Had we tested for a normative change in the content of socioemotional behavior, we would have come up with noise, and we would not have been able to capture the predicted profile of the timing of socioemotional transitions.

It remains somewhat counter-intuitive that we discovered no systematic developmental trends in the overall duration of attention to toy or mother across the 16 sessions. It would not have been surprising if attention to toy diminished with age, either continuously or abruptly, particularly during the withhold-toy episodes. Also, it would have made sense if attention to mother increased with development, perhaps discontinuously at the time of the 9-month transition. Other recent studies investigating cognition-emotion transitions in the first year similarly found no age-specific changes in the content of behavior at the group level (Lewis, 1993; Lewis et al., 1997), despite evidence for age-specific changes in correlations between cognitive and emotional measures. Given these previous findings, no hypotheses about the content of attention were proposed for this study. However, both predicted and unpredicted changes in the return time of attention to mother and toy were observed. This indicates that the style or structure of attentional habits changed with development, even though the overall amount of looking did not.

Our results also indicate an interesting interaction between distress, developmental period, and attention to mother. The increased plasticity of attention to mother at shift periods was only evident when non-distressed events were considered. Distressed events during shift periods produced the same rapid return time to the attractor as characterized nonshift periods. One interpretation of these findings is that attention during distress is not controlled in the same way as non-distressed attention. Thus, any developmental change in strategies for allocating attention may disappear when distress exceeds some threshold. A related interpretation holds that infants worked harder to regulate felt distress, essentially retooling their engagement habits, by looking more frequently to mother during shift periods, and this eclipsed the tendency toward increased behavioral malleability. In fact, the significant effect for distress in period 4 may be explained by infants' developing propensity to seek their caregiver's help, proposed to peak at 9 months by some theorists. This suggests a *context-dependent* normative change that would not have been evident using more traditional analytic methods.

It is also interesting that distress dampened a steadily rising return time for attention to the toy over development, but it increased return time in period 4. Frustration may have increasingly counteracted infants' tendency to remain engaged with objects, suggesting growing capabilities for avoiding distress across the first year. The reversal of this effect in period 4 is difficult to explain, but it does parallel the effect of distress on attention to the mother. Infants were more likely to re-engage the toy as well as the mother when distressed at the time of the 9-month shift, counteracting their increased behavioral malleability, and perhaps suggesting a temporary lapse in the efficiency of their emotion regulation skills.

This was quite an ambitious study, and while the hypotheses were partially supported, a number of limitations need to be considered. First, small sample size is often a trade-off for fine-grain longitudinal research, and thus should not be considered a limitation in itself. However, the high degree of variability in developmental profiles, describing both attentional habits and distress reactions, begs for an individual difference analysis, and this was not possible with only 12 dyads. The absence of systematic developmental trends in the averaged profiles may correctly indicate that socio-

emotional development is not normative in behavioral content. However, the normative *timing* of structural changes suggests major reorganizations of individual repertoires, and an analysis of individual trends might have provided the details. Second, the aggregation of sessions into periods was necessary to compensate for relatively low event counts. But this detracted from the precision of our modeling of developmental transitions. Third, the sensorimotor task scores, though showing a predicted pattern of results, probably underestimated developmental capabilities. The fact that any infant could pass one or another task without passing both for several weeks indicates that mood, distractibility, or other factors interfered with performance and blurred the assessment of cognitive-developmental changes. Finally, we were surprised that a repeated cycle of frustrating events elicited little distress in some infants. Emotion induction procedures are extremely tricky, especially with young children, and it may require considerably more imagination to tap negative emotion, and its attentional concomitants, in a more systematic manner.

References

Abe, J. A., & Izard, C. E. (1999). The developmental functions of emotions: An analysis in terms of differential emotions theory. *Cognition and Emotion*, *13*, 523–549.

Barrett, K. C. (1998). A functionalist perspective to the development of emotions. In M. F. Mascolo & S. Griffin (Eds.), *What develops in emotional development?* (pp. 109–133). New York: Plenum.

Barrett, K. C., & Campos, J. J. (1987). Perspectives on emotional development II: A functionalist approach to emotions. In J. D. Osofsky (Ed.), *Handbook of infant development* (pp. 555–578). New York: John Wiley & Sons.

Bertenthal, B. I., Campos, J. J., & Barrett, K. C. (1984). Self-produced locomotion: An organizer of emotional, cognitive, and social development in infancy. In R. N. Emde & R. J. Harmon (Eds.), *Continuities and discontinuities in development* (pp. 175–210). New York: Plenum.

Bornstein, M. H. (1989). Sensitive periods in development: Structural characteristics and causal interpretations. *Psychological Bulletin*, *105*, 179–197.

Brazelton, T. B., & Yogman, M. W. (1986). Introduction: Reciprocity, attachment, and effectance: Anlage in early infancy. In T. B. Brazelton & M. W. Yogman (Eds.), *Affective development in infancy* (pp. 1–9). Norwood, NJ: Ablex.

Bremner, J. G. (1997). From perception to cognition. In G. Bremner, A. Slater, & G. Butterworth (Eds.), *Infant development: Recent advances* (pp. 55–74). East Sussex, England: Psychology Press.

Camras, L. A. (1992). Expressive development and basic emotions. *Cognition and Emotion*, *6*, 269–283.

Campos, J. J., Anderson, D. I., Barbu-Roth, M. A., Hubbard, E. M., Hertenstein, M. J., & Witherington, D. (2000). Travel broadens the mind. *Infancy, 1,* 149–219.

Case, R. (1985). *Intellectual development: Birth to adulthood*. New York: Academic Press.

Case, R. (1988). The whole child: Toward an integrated view of young children's cognitive, social, and emotional development. In A. D. Pellegrini (Ed.), *Psychological bases for early education* (pp. 155–184). New York: John Wiley & Sons.

Case, R., Hayward, S., Lewis, M. D., & Hurst, P. (1988). Toward a neo-Piagetian theory of cognitive and emotional development. *Developmental Review*, *8*, 1–51.

Corkum, V., & Moore, C. (1998). The origins of joint visual attention in infants. *Developmental Psychology, 34,* 28–38.

Demos, V. (1986). Crying in early infancy: An illustration of the motivational function of affect. In T. B. Brazelton & M. W. Yogman (Eds.), *Affective development in infancy* (pp. 39–73). Norwood, NJ: Ablex.

Diamond, A. (1990). Developmental time course in human infants and infant monkeys and the neural bases of inhibitory control in reaching. In A. Diamond (Ed.), *The development and neural bases of higher cognitive functions* (pp. 637–669). New York Academy of Sciences.

Emde, R., Gaensbauer, T., & Harmon, R. (1976). *Psychological issues: Vol. 10. Emotional expression in infancy: A biobehavioral study*. New York: International Universities Press.

Fischer, K. W., & Canfield, R. L. (1986). The ambiguity of stage and structure in behavior: Person and environment in the development of psychological structures. In I. Levin (Ed.), *Stage and structure: Reopening the debate* (pp. 246–267). New York: Plenum.

Fischer, K. W., Pipp, S. L., & Bullock, D. (1984). Detecting developmental discontinuities: Methods and measurement. In R. N. Emde & R. J. Harmon (Eds.), *Continuities and discontinuities in development* (pp. 95–121). New York: Plenum.

Fischer, K. W., Shaver, P. R., & Carnochan, P. (1990). How emotions develop and how they organize development. *Cognition and Emotion*, *4*, 81–127.

Fogel, A. (2006). Dynamic systems research on interindividual communication: The transformation of meaning-making. *Journal of Developmental Processes, 1,* 7–30.

Fogel, A., & Thelen, E. (1987). The development of early expressive and communicative action: Reinterpreting the evidence from a dynamic systems perspective. *Developmental Psychology*, *23*, 747–761.

Granic, I., Hollenstein, T., Dishion, T. J., & Patterson, G. R. (2003). Longitudinal analysis of flexibility and reorganization in early adolescence: A dynamic systems study of family interactions. *Developmental Psychology, 39,* 606–617.

Hsu, H.-C., & Fogel, A. (2003). Stability and transitions in mother-infant face-to-face communication during the first 6 months: A microhistorical approach. *Developmental Psychology, 39,* 1061–1082.

Izard, C. E. (1979). *The maximally discriminative facial movement coding system (Max)*. Newark: Instructional Resources Center, University of Delaware.

Kagan, J. (1984). *The nature of the child*. New York: Basic Books.

Kaye, K., & Fogel, A. (1980). The temporal structure of face-to-face communication between mothers and infants. *Developmental Psychology*, *16*, 454–464.

Kelso, J. A. S. (1990). Phase transitions: Foundations of behavior. In H. Haken & M. Stadler (Eds.), *Synergetics of cognition*. Berlin: Springer-Verlag.

Kelso, J. A. S. (1995). *Dynamic patterns: The self-organization of brain and behavior*. Cambridge, MA: Bradford/MIT Press.

Kopp, C. B. (1989). Regulation of distress and negative emotions: A developmental view. *Developmental Psychology*, *25*, 343–354.

Kopp, C. B. (2002). Commentary: The codevelopments of attention and emotion regulation. *Infancy, 3*, 199–208.

Kopp, C. B., & Neufeld, S. J. (2003). Emotional development during infancy. In R. J. Davidson, K. R. Scherer, & H. H. Goldsmith (Eds.), *Handbook of affective sciences* (pp. 347–374). New York: Oxford University Press.

Lamb, M. E., & Malkin, C. M. (1986). The development of social expectations in distress-relief sequences: A longitudinal study. *International Journal of Behavioral Development*, *9*, 235–249.

Lerner, R. M. (1991). Changing organism-context relations as the basic process of development: A developmental contextual perspective. *Developmental Psychology*, *27*, 27–32.

Lewis, M., & Michalson, L. (1983). The structure of emotion: The development of five components. In *Children's emotions and mood: Developmental theory and measurement*. New York: Plenum.

Lewis, M. D. (1993). Emotion-cognition interactions in early infant development. *Cognition and Emotion*, *7*, 145–170.

Lewis, M. D. (1995). Cognition-emotion feedback and the self-organization of developmental paths. *Human Development*, *38*, 71–102.

Lewis, M. D. (1997). Personality self-organization: Cascading constraints on cognition-emotion interaction. In A. Fogel, M. C. Lyra, & J. Valsiner (Eds.). *Dynamics and indeterminism in developmental and social processes* (pp. 193–216). Mahwah, NJ: Lawrence Erlbaum Associates.

Lewis, M. D., & Ash, A. J. (1992). Evidence for a neo-Piagetian stage transition in early cognitive development. *International Journal of Behavioral Development*, *15*, 337–358.

Lewis, M. D., & Granic, I. (Eds.). (2000). *Emotion, development, and self-organization: Dynamic systems approaches to emotional development*. New York: Cambridge University Press.

Lewis, M. D., Koroshegyi, C., Douglas, L., & Kampe, K. (1997). Age-specific associations between emotional responses to separation and cognitive performance in infancy. *Developmental Psychology*, *33*, 32–42.

Lewis, M. D., Zimmerman, S., Hollenstein, T., & Lamey, A. V. (2004). Reorganization of coping behavior at 1½ years: Dynamic systems and normative change. *Developmental Science, 7,* 56–73.

Magai, C., & Hunziker, J. (1993). Tolstoy and the riddle of developmental transformation: A lifespan analysis of the role of emotions in personality development. In M. Lewis & J. M. Haviland (Eds.), *Handbook of emotions* (pp. 247–259). New York: Guilford Press.

Mahler, M. S., Pine, F., & Bergman, A. (1975). *The psychological birth of the human infant*. New York: Basic Books.

Mangelsdorf, S. C., Shapiro, J. R., & Marzolf, D. (1995). Developmental and temperamental differences in emotion regulation in infancy. *Child Development, 66*, 1817–1828.

Mascolo, M. F., & Griffin, S. (1998). Alternative conceptions of emotional development: Controversy and consensus. In M. F. Mascolo & S. Griffin (Eds.), *What develops in emotional development?* (pp. 319–340). New York: Plenum.

McCall, R. B., Eichorn, D. H., & Hogarty, P. S. (1977). Transitions in early mental development. *Monographs of the Society for Research in Child Development*, *42*, (3, Serial No. 171).

Parritz, R. H. (1996). A descriptive analysis of toddler coping in challenging circumstances. *Infant Behaviour and Development, 19,* 171–180.

Rohwer, G., & Pötter, U. (2003). Transitional Data Analysis (6.4e). http://www.stat.ruhr-uni-bochum.de/tda.html.

Rothbart, M. K., Ziaie, H., & O'Boyle, C. G. (1992). Self-regulation and emotion in infancy. In N. Eisenberg & R. A. Fabes (Eds.), *New Directions for Child Development, 55,* 7–23. San Francisco: Jossey-Bass.

Rutter, M. (1987). Continuities and discontinuities from infancy. In J. D. Osofsky (Ed.), *Handbook of infant development* (2nd ed., pp. 1256–1296). New York: John Wiley & Sons.

Sander, L. W. (1975). Infant and caretaking environment: Investigation and conceptualization of adaptive behavior in a system of increasing complexity. In E. J. Anthony (Ed.), *Explorations in child psychiatry* (pp. 129–166). New York: Plenum.

Spitz, R. (1965). *The first year of life*. New York: International Universities Press.

Sroufe, L. A. (1979). Socioemotional development. In J. Osofsky (Eds.), *Handbook of infant development* (pp. 462–518). New York: John Wiley & Sons.

Sroufe, L. A. (1995). *Emotional development: The organization of emotional life in the early years*. New York: Cambridge University Press.

Thelen, E., & Smith, L. B. (1994). *A dynamic systems approach to the development of cognition and action*. Cambridge, MA: MIT Press/Bradford.

Thelen, E., & Ulrich, B. D. (1991). Hidden skills: A dynamic systems analysis of treadmill stepping during the first year. *Monographs of the Society for Research in Child Development*, *56*, (Serial No. 223).

Thompson, R. A. (1993). Socioemotional development: Enduring issues and new challenges. *Developmental Review*, *13*, 372–402.

Thompson, R. A. (1994). Emotion regulation: A theme in search of definition. *The development of emotion regulation: Biological and behavioral considerations. Monographs of the Society for Research in Child Development*, *59* (2–3, Serial No. 240).

Thompson, R. A., & Limber, S. P. (1990). "Social anxiety" in infancy: Stranger and separation reactions. In H. Leitenberg (Ed.), *Handbook of social and evaluation anxiety* (pp. 85–137). New York: Plenum.

Tomasello, M. (1995). Joint attention as social cognition. In C. Moore & P. J. Dunham (Eds.), *Joint attention: Its origins and role in development* (pp.103–130). Hillsdale, NJ: Lawrence Erlbaum Associates.

Trevarthen, C. (1980). The foundations of intersubjectivity: Development of interpersonal and cooperative understanding in infants. In D. R. Olson (Ed.), *The social foundations of language and thought: Essays in honor of Jerome S. Bruner* (pp. 316–342). New York: Norton.

Tronick, E. Z., Ricks, M., & Cohn, J. F. (1982). Maternal and infant affective exchange: Patterns of adaptation. In T. Field & A. Fogel (Eds.), *Emotion and early interaction* (pp. 83–100). Hillsdale, NJ: Lawrence Erlbaum Associates.

van der Maas, H. L. J., & Molenaar, P. C. M. (1992). Stagewise cognitive development: An application of catastrophe theory. *Psychological Review*, *99*, 395–417.

van Geert, P. (1991). A dynamic systems model of cognitive and language growth. *Psychological Review*, *98*, 3–53.

van Geert, P. (1994). *Dynamic systems of development: Change between complexity and chaos*. New York: Prentice Hall/Harvester Wheatsheaf.

van Geert, P., & van Dijk, M. (2002). Focus on variability: New tools to study intra-individual variability in developmental data. *Infant Behavior and Development, 25,* 340–374.

Nurturing Developmental Processes

in Early Abstraction

Robert Pasnak (Corresponding author)
Department of Psychology
George Mason University
Fairfax, Virginia
rpasnak@gmu.edu

Julie K. Kidd
College of Education & Human Development
George Mason University
Fairfax, Virginia

Melissa Ferral-Like
Marinka K. Gadzichowski
Deborah A. Gallington
Robin P. Saracina
Department of Psychology
George Mason University
Fairfax, Virginia

Abstract: *The ability to abstract simple relations has ordinarily developed at the time children begin their formal education. When this developmental process has been slow, children often have difficulty with instruction in kindergarten classrooms. To compensate, understandings usually arising from unstructured interactions with the environment can be nurtured by condensing and structuring such interaction with a wide variety of common objects. Such* learning set *methods from comparative, developmental, and educational psychology were adapted to a form of guided play in the present research. This approach simulated child-environment interactions in a concentrated and unambiguous way. It helped underachieving kindergartners to internalize key components of early abstract thought and consequently promoted cognitive and academic advances.*

Nurturing Developmental Processes in Early Abstraction

Adam was happily at play—a favored activity for 5-year-olds. He had a plastic dinosaur he called Biter, and Miss Sampson had one she called Topsy. Topsy would always put out four objects in front of Biter, and say, "I want to eat the one that is the

most different! Find it for me. Which is not like the others?" Adam loved this game. Biter had learned quickly to select the odd object in the first six games. Three of the objects were always identical in shape and one was different. Before long, it became obvious to Adam, and therefore Biter, that he should consider the shapes and find the one that looked different. The games became a little harder when all the objects were different in color, because Adam was tempted to respond to the color rather than picking the odd shape, but it wasn't hard to learn which object was shaped differently and coincidently identify its color.

Having played the games for two weeks, Adam was pretty confident of his ability to pick the objects that Topsy would eat, but now he was a little puzzled. In the last game, Topsy had given him three big red triangular paper clips and one small one. She had refused the big one Biter had first chosen, saying it was like most of the others and she wanted the one that was not the same. She had also refused him again when he offered another big one and still again when he offered the other big one. He tried the first big one again, and Topsy spurned it again, saying, "I want the one that is not like the others, the one that is different!" But she had happily accepted the little one he offered next. Biter had continued to offer it on subsequent trials, and Topsy always enthusiastically gobbled it up.

Then she had given him a new group of objects—three little blue buttons and one big one. When Biter confidently offered the big one to her, she ate it! Adam wasn't surprised; he thought anyone would like a big one better than a little one. But when Topsy gave Biter three big feathers and one little one, she refused his choice of a big one, and continued to refuse it, asking him to give her the one that was different, that was not like the others. Then an idea began to form. Maybe she liked the big ones sometimes and the small one sometimes. When Biter gave Topsy the small one she became very excited and gobbled it up! Adam was still uncertain. On subsequent attempts Biter sometimes offered a large object, but before long he was offering the small one consistently. Topsy always loved it!

When she moved on and offered new objects to choose from, Adam often showed his bias for picking a large object, but after playing with a dozen sets of objects he knew the answer and always offered the odd one, whether it was large or small. It was a triumph. Adam knew he had figured things out and was enormously pleased by his success. He had started to acquire the concept of selecting the odd object in any group, but there was still a ways to go. Adam would have trouble learning to select the odd object when the difference was orientation rather than size or shape, but he would eventually succeed, have fun while he did, and come to think of himself as more and more capable. He had been a little concerned about that because many of his classmates in this strange new world of kindergarten had seemed to understand things better than he did. His confidence was growing, because he knew he had been a good problem-solver in the dinosaur game.

Adam was in transition from thinking like a preschooler to thinking like a typical kindergartner. Preschoolers generally make sense of their environment by discriminating concrete, absolute properties of objects and events that have important implications or consequences. Much of their problem-solving is based on such consideration of absolute qualities, and success in problem solving depends on whether they have

considered the right ones. Maybe the right one is the big one, or the red one, or the one on the left. The relation between objects or events is not often a consideration and often cannot be conceptualized. However, as preschoolers mature, continued interaction with their environment induces the recognition of relationships between properties of objects that govern accurate decision-making. Abstracting relationships between objects and events, rather than responding only to absolute qualities, produces superior understanding and decision-making.

By the time they enter kindergarten, most children have internalized certain key principles of abstract thought from interactions with their environments (Inhelder & Piaget, 1964/1959). The extent to which they have mastered such abstractions predicts their performance in kindergarten and the early grades (Freyberg, 1966; Kingma & Koops, 1983; Silliphant, 1983). Pasnak, Hansbarger, Dodson, Hart, and Blaha (1996) and Pasnak, McCutcheon, Holt, and Campbell (1991) showed that three very early forms of abstraction were particularly important predictors of academic performance in kindergarten. These abstractions are those intrinsic to the oddity principle, insertions into series, and some form of conservation.

The Oddity Principle

The oddity principle is probably the first pure abstraction that children ever develop. When applied to one dimension at a time, it is the understanding that the relationship between items determines which belong to the same set and which to a different set, rather than their absolute qualities. For example, if one has a red rose, a pink tulip, a yellow tulip, and a white tulip, the rose is the "odd" flower. If on the other hand one has a red rose, a pink rose, a yellow rose, and a white tulip, it is the tulip that is odd. The ability to comprehend and base responses on this relationship, when appropriate, is a significant advance over the thinking of a preschooler, who is forever lost in trying to solve problems on a concrete basis (e.g., always selecting a red rose as different whether it is the odd object, as in the first set, or not, as in the second). The ability to abstract oddity arises sooner for some dimensions, such as shape, than for others, such as size or orientation, but it is ordinarily well developed by the time a child enters kindergarten.

Perhaps because Piaget had little to say about it, the oddity principle has not received as much attention as other forms of classification. Researchers have focused on sorting and hierarchical classification, which develops sooner, or class inclusion, which develops later. It is clear from many studies that preschoolers are "perceptually oriented," when they categorize or classify objects (Namy & Gentner, 2002). Several studies have demonstrated that this reliance on perceptual dimensions of objects interferes with their ability to respond to objects conceptually (Gentner, 1978; Baldwin, 1989, Imai, Gentner, & Uchida, 1994). Two-year-olds have generally acquired the ability to categorize objects as same or different according to one dimension, (Jacques, Zelazo, Kirkham, & Semcesen, 1999), but 2- and 3-year-olds cannot shift from one dimension to another if required to do so. This inability persists even when they know the dimension to which they should respond (Zelazo, Frye, & Rapus, 1996). The representational flexibility emerges at age 4 years for many children and at age 5 years for 90% (Jacques et al., 1999).

Discriminating the odd object from a group requires at a minimum the recognition that it differs from the others, which may also differ from each other on one or more dimensions (Chalmers & Halford, 2003). Gentner and Namy (1999) argue that strong perceptual similarity creates an invitation to comparison which promotes noticing of commonalities and hence that all of the objects in a group except the odd one are alike in some respect. This relational similarity can work in tandem with perceptual commonalities to direct choices. In both problems that Adam faced, where three of the four paper clips he considered were identical in shape, this structural realignment could have produced the recognition that three of the clips were alike in shape and one was different, but initially it did not. The objects were all just differently colored paper clips to Adam. Adam was able to respond to the dissimilarity in shape for these clips relatively quickly. But for a young preschooler, it may be extremely difficult and unnatural. The issue here is probably that the structural alignment involved in response to taxonomic categories (Gentner & Namy, 1999; Namy & Gentner, 2002) is a much simpler abstraction of relational similarity than that involved in the oddity principle.

Abstraction of what is the odd member of an array is a process that shows a very substantial horizontal decalage across different characteristics of objects. Campbell, Pasnak, and Gadzichowski (2004) studied children with mental disabilities, whose progress is much slower and detectable. They noticed that the first successes in applying the oddity principle are with object oddity, wherein all objects in a group are identical but one, which differs in multiple dimensions like color, shape, and size from the others. This would, in the analysis presented by Chalmers and Halford (2003) be a simple binary discrimination, and a remarkably easy one, where *any* difference that is noted provides a basis for correct solutions. Solutions of hierarchical oddity problems (a speedboat, battleship, sailboat, and a car) also come early. The main issue with these seems to be whether the child knows the category to which the objects belong. The next successes in employing the oddity principle are with the dimension of color, when there are no distracting differences in shape or any other dimension. This is again a simple binary problem, according to relational complexity theory (Halford, Wilson, & Phillips, 1997; Chalmers & Halford, 2003), because only one dimension has to be processed. Soon thereafter children develop the ability to abstract color oddity even when there are shape differences, a ternary relation.

The present research was aimed at the next steps in the process—shape oddity, size oddity, and oddity of orientation—because previous research had indicated that virtually all local 5-year-olds were able to solve color oddity problems. Although relational complexity indicates that oddity on all of these dimensions should be equally easy or difficult for children, Pasnak and his collaborators found that there were substantial differences in difficulty, depending on just which dimensions were involved (Pasnak et al., 1987; Pasnak et al., 1991; Pasnak et al., 1996).

Seriation on One Dimension

The ability to insert items into a series emerges at nearly the same time, again in an erratic process. This has usually been studied in terms of children's ability to line up objects from smallest to largest, or vice versa, and then to insert an object where it should

go in the ordered array (Baylor, Gascon, & Lemoyne, 1973; Young, 1976; Leiser & Gillieron, 1990). The first concept a child must have is that objects *can be* aligned according to their size. As Southard and Pasnak (1997) point out, not all children grasp this, even at age four years and even after repeated demonstrations of how it is done by adults. When the idea of forming objects into an ordered series has emerged, preschoolers are easily distracted by irrelevant perceptual characteristics of whatever they are seriating (e.g., their color) and often go through a phase where a series is half formed according to size but half according to whatever irrelevant characteristics the object have (Southard & Pasnak, 1997). Another early approach is to form objects into pairs of large and small objects and then arrange the pairs into a line (Elkind, 1964). The seriations that result are almost always incorrect saw-toothed lines, because the pairs are not formed from objects that would be adjacent in the series, and ordering of the objects in the pairs is not consistent. Other preschoolers search for endpoints—the largest and smallest objects, often using verbal labels like Daddy, Baby—and may succeed in starting and ending the series with the correct objects, but the interior of the series is chaotic. Still other children—or the same child at an earlier or later time—use a trial and error approach and may be successful if the series is short and they are persistent.

As their understanding of seriation develops, preschoolers begin to use what is sometimes called the "method of extremum" (Piaget & Inhelder, 1969/1966; Leiser & Gillieron, 1990). A child may select the smallest object in the group to be seriated, set it out to start the series, select the smallest remaining object in the group, set it out next in line, select the smallest object remaining in the group, set it out as third in the line, and continue this process until all of the objects in the group have been seriated. Some children do this very systematically and accurately, others less so. Elkind (1964) defined this as the third stage in the development of relational seriation (forming pairs of objects into a saw-toothed line was stage 1 and trial and error was stage 2). However, children are inconsistent in which method they attempt, often using a less advanced approach months after they had developed a more advanced approach, just as Siegler's (1996) overlapping waves theory predicts. A longitudinal study in which Southard and Pasnak (1997) attempted to scale the processes to determine which occurred earliest and which latest in the development of seriation was not very successful. Instead of a sensible progression from immature to mature approaches to seriation, children showed many reversions from more accurate and insightful approaches to those that were less so, over the course of a year.

Inhelder and Piaget (1964/1959) initially thought that the method of extremum showed that children completely understood the relations between the objects in a series, but this is not true. What the child is doing is selecting an object by an absolute characteristic, i.e., "pick the small one and put it on the end of the line," and doing this repeatedly. Success in forming a seriated line depends on being careful and on whether the child has a good method for correcting errors (Southard & Pasnak, 1997). To insert an object where it should go in the interior of the series is much more difficult since it involves abstracting the relation between three or more items. Piaget and Inhelder (1969/1966) recognized this as the essential evidence that a child understood the relations between the items in an ordered series. This understanding is well developed by the time most children reach age 5.

Number Conservation

The abstractions involved in conservation arise a bit later than those involved in seriation or the oddity principle. Conservation is the understanding that no dimension of matter can change unless there has been an addition or subtraction. This is not at all obvious to preschoolers, who universally think that number, amount, weight, length, area, or volume has changed if it *looks* like it has changed, whether or not there has been an addition or subtraction. Moving away from reliance on perceptual solutions to conservation problems, appreciation of the necessity of addition or subtraction to change number or amount and understanding of the abstract principles of reversibility and identity involved in conservation develops first with the dimensions of matter that a child encounters most unambiguously in nature: number and mass. Children in local school systems usually develop these forms of conservation before they turn six.

The Role of Learning Sets in Developing Abstractions

Investigations in the early part of the last century uncovered one process by which abstractions can be developed or the rate at which they develop accelerated. *Learning sets* (Fields, 1932; Harlow, 1949, 1959) consist of many variable problems that can all be solved via the same abstract principle. If the problems are numerous enough and variable enough, solutions gradually shift from memorization of concrete properties that permit solutions of a single problem to abstraction of relations that permit solution of all problems embodying the same principle. In the words of Halford, Wilson, and Phillips (2006, p. 5), "just how this occurs has never been satisfactorily explained," but considerable analysis has been devoted to it. Halford (1993) observed that learning sets entail learning both the structure of the task and the relation between objects on different trials. The process that underlies the transfer of learning between problems entails forming a schema that incorporates this relation, and transferring it between problems by analogical mapping. This is in Halford's (1993, p. 223) words, "a case of transfer based on structure mapping par excellence," and a form of abstraction that depends upon relational knowledge.

Some of the ways in which learning sets facilitate abstraction have been identified. The problems in a learning set can be considered to be a condensation of problems posed by the environment. Those contrived by researchers specifically to teach a particular abstraction are more clear-cut than the messy ones Mother Nature provides, and solution of several hundred, in the case of a nonhuman primate, or a few score, in the case of a child, is often sufficient to produce understanding of the concept. This understanding arises in part from strengthening helpful supporting habits of observation and comparison (Gagné, 1968; Gagné & Paradise, 1961). If the abstractions to be taught are far above the child's head, subordinate learning sets may be required to bridge the gap (Lopata & Pasnak, 1976). Another important factor is reduction of error-producing tendencies (Harlow, 1959). In the case of a young child, the principle error-producing tendencies are reliance on concrete, perceptual cues to solve problems (Namy & Gentner, 2002). The 2- and 3-year-olds studied by Zelazo, Resnick, and

Pinon (1995) and Jacques et al. (1999) are examples of children for whom a learning set might be particularly successful. They knew the rule by which they were supposed to respond, but persistently responded in terms of another. Such tendencies are quite resistant to extinction, but the repetitive, day-after-day requirements of learning sets for choices based on a new rule gradually extinguish error-producing tendencies and supplant them with correct ones.

In addition to strengthening supporting tendencies that support correct solutions and reducing competing tendencies, a learning set produces generalization of the abstraction within the range of examples it provides, and to some extent outside this range, which is accompanied by stimulus independence or freedom from reliance on specific cues. The social and educational environment that children encounter as they mature is challenging enough to require many decisions in terms of abstractions and may pose many thousands of problems that can only be solved in terms of abstractions, particularly as children are exposed to formal schooling. Hence, using learning sets to teach abstractions may be an effective simulation of the interactive process by which children normally acquire them.

The Role of Play in Developing Children's Thought

A key aspect of the process by which young children interact with their environment is play. Before they enter the school system, they receive relatively few lessons in problem-solving that are composed and directed by adults. However, they often play with objects in their environments. It is in this play, which is often quite imaginative and creative, that they exercise their mental faculties with most enthusiasm and often reach their highest levels. Vygotsky (1978) observed this, and early childhood educators independently discovered the truth of this assertion (Eisner, 1990; Weininger & Daniel, 1992). It is no accident that much of preschool and part of kindergarten consists of enriched play. In the present research, a method devised by Garrett, Busby, and Pasnak (1999) and Ciancio, Pasnak, Rojas, and Kelly (2001) for combining a learning set with exciting play was used to simulate the process by which children might ordinarily acquire principles of abstract thought.

The Research Design

A fundamental question is whether understanding the oddity principle, being able to insert items in to series, and understanding the abstractions involved in early forms of conservation are really important in the development of children's thought. If they are, then strengthening these abilities should enable children to profit very generally from the lessons teachers give them in their classrooms. If these abstractions are not of much importance, then learning them would produce little in the way of academic progress. The present research was conducted to determine whether strengthening children's mastery of these abstract thinking abilities would lead to better understanding of the lessons in numeracy and literacy (letters and letter sounds) that are taught in kindergarten.

The mechanism for doing this was to use active control groups. One group of children was taught oddity, insertions, and number conservation. Another was taught literacy, another numeracy, and a third art. The literacy and numeracy groups constitute "active" control groups (Pasnak & Howe, 1993). They have equal contact with research personnel and receive equal investment of time and resources in constructive activities with expectations of consequent achievement. The art group is a passive control group (Pasnak & Howe, 1993). These children also have equal contact with research personnel and receive equal investment of time and resources, but in noncognitive activities that are not oriented towards academic achievement. This superior design eliminates many of the problems which plague field research. If the children receiving the cognitive intervention match or exceed the control children on the academic material which the control groups are taught, it would be evidence that the cognitive intervention was fruitful. Having learned to think on a level appropriate for kindergarten, the children who improved their ability to abstract would have learned more from the classroom environment and regular academic instruction and hence might equal or exceed the achievement of children who received some specific instruction in these subject matters. All should exceed the passive control group, which matched the other groups in all respects except that of receiving instruction that would improve academic performance.

The following were the specific hypotheses tested:

1. Children receiving the cognitive instruction would surpass the other groups on measures of oddity, insertions, and conservation.
2. Children receiving the cognitive intervention would match the literacy group and exceed the other groups in literacy.
3. Children receiving the cognitive intervention would match the numeracy group and exceed the other groups in numeracy.
4. The literacy group would exceed the other control groups in literacy.
5. The numeracy group would exceed the other control groups in numeracy.

Methods

Participants and Setting

Participants included 143 kindergarten students in a culturally and socio-economically diverse, metropolitan school district. Initially, 574 students in 25 classrooms were screened with 10 insertion problems to determine their eligibility for the study. Children who demonstrated an understanding of the oddity principle and seriation in a series by scoring 80% or higher on the screening tests were excluded because they appeared to possess the cognitive abilities targeted by the intervention. After attrition, the final sample included 82 boys and 61 girls. Of these kindergarten students, 56 (39%) were Hispanic/Latino; 36 (25%) African American; 29 (20%) White; 19 (13%) Middle Eastern; and 3 (2%) Asian. They were treated in accordance with the ethics principles established by APA (2001).

Materials

Instruction. Objects found in nature or purchased in drugstores, sewing stores, craft stores, grocery stores, and toy stores were combined into 60 sets that could be used to teach the oddity principle. Each set had one object that differed in one dimension from three other objects that were otherwise identical. The odd object differed only in shape for 20 games (e.g., a round button and three octagonal buttons or an oblong bead and three twisted spiral beads). Twenty games each had one object that differed from the other three only in size (e. g., three small safety pins and a large one or three small beans and a large one). The odd object was smaller in 10 cases and larger in 10. Twenty orientation oddity games each had four identical objects, but one was presented vertically and three horizontally (or vice versa), or one was slanted 45 degrees one way and the others 45 degrees the other (or vice versa), or one faced left and three other right (or vice versa).

Sets of objects ranging from bolts to wooden squares were used for insertion games. There were 15 games with three objects, 20 with four, 15 with five, 5 with six, 5 with seven, and 5 with eight. The objects might be similar or different in shape, but differed in length or width or overall size.

The sets of objects used for conservation games had 7, 9, 11, 13, 15, 17, 19, 21, 23, 25, 27, 29, 31, 33, and 35 objects (e.g., hair ties, candle holders, etc.).

Sets of foam numbers and many items that could be counted (e.g., stars, cubes, etc.) and cardboard "coins" were used for numeracy games.

Sets of foam letters and letter bags were used for literacy games. The latter were each labeled with a letter or a consonant blend and contained many small objects or pictures of objects whose name began with that letter or consonant blend.

The art materials were crayon, pencil, paint, Play Dough, construction paper, cotton wool, pasta, seeds, paste, glue, and art worksheets.

Tests. New objects were used to construct oddity, insertion, and conservation tests. The Phonemic Awareness and Literacy Screening (PALS) measure of early literacy, the classification scale from the Otis-Lennon School Ability Test (O-LSAT) Primary I, and the Woodcock-Johnson III Problem- Solving scale (W J III) test of numeracy were also used.

The oddity test had four form, four size, and four orientation oddity problems. It was designed to test near generalization. Could the children solve oddity problems that were similar in format to those they had previously solved, but with new objects?

For the insertion test, two problems had three objects, two had four objects, two required the child to insert a fourth object after seriating three, two required insertion of a fifth object after seriating four, and two required insertion of a sixth object after seriating five. This test also measured whether the children could apply what they had learned to new sets of objects.

For the conservation test, each of ten problems had two rows of 3–10 objects. There were equal or different numbers of objects in each row. While a child watched, one or both rows would be expanded or contracted and the child would be asked whether the rows still had the same number of objects or whether the row which initially had more objects still had more. For the last eight problems, one or more objects were added to or subtracted from a row. This might either equalize the number of ob-

jects in the rows or make them differ more. The terms more, less, and the same, and the order in which the rows were named were varied systematically. Children were asked to explain their answers.

The manual (Otis & Lennon, 1997) gives Kuder-Richardson (K-R 20) reliabilities of .88-.90 for the O-LSAT Primary I. There are twelve rows of five drawings in the classification scale. Each drawing in a row is different, but four are alike in some way that differentiates them from the other. The nature of the similarity of the four draw-ings in a row is not overall shape, size, or orientation. Rather, it is in the consistency of some internal detail or some form of hierarchical classification. One involves four different kinds of horns and a drum and one has five different geometric forms, one of which has chevrons that are inverted. This is a test of far generalization because the children must apply the oddity principle to drawings rather than objects, overall form, size, or orientation are never relevant, and the drawings have many distracting details which are irrelevant to the solutions.

The manual (McGrew & Woodcock, 2001) gives a reliability coefficient of .86 for first graders for the Woodcock Johnson III Applied Problems (quantitative) scale, with a standard error of 3.7. It begins with "Show me just one finger" and proceeds through problems involving money, measurement, and addition, and subtraction.

The PALS is a secure test used in this school system to measure knowledge of let-ter sounds and early literacy. It assesses name-writing, beginning sounds, rhyming sounds awareness, print and word awareness, and nursery rhyme awareness. At the kindergarten level test-retest reliability is .95; correlations with the Stanford 9 Total Reading Score is .70.

Procedures

All kindergarten students in 26 classrooms in five schools were screened on inser-tions into series. In a yoked control design, those who scored less than 80% correct on the test of insertion were assigned to yoked quartets by a restricted randomization. The restriction was that to the extent possible each classroom contributed equal numbers of children to each of four conditions: the cognitive intervention, literacy instruction, numeracy instruction, and art instruction.

Pasnak and Howe (1993) recommended this advanced design. The children in the art control group constitute a "passive" control group that has equal contact with the researchers and equal time and resources spent in constructive activities. The art ac-tivities should not have any effect on the dependent variables and in this sense are pas-sive. The children in the literacy and numeracy groups also had equal attention, time, and investment of resources, but these were put into activities that could affect a de-pendent variable: literacy or numeracy, as the case may be. Hence, these groups pro-vided tests of whether the cognitive instruction would be followed by literacy or nu-meracy achievement less than, equal to, or greater than that provided by instruction aimed directly at increasing literacy or numeracy achievement.

Each of the 26 classrooms had three college students (researchers), each visiting one morning per week to compensate the teacher for the time spent on the experimen-

tal instruction. Each group of children (cognitive, literacy, numeracy, and art) had three 10–15 minute sessions of experimental instruction per week. There were one to three children in each group, depending on the number of children in each class who had did not pass the insertion test and the random assignments. The children's responses were noted after each session, and the authors of the study supervised the experimental instruction every day.

To keep the experimental children enthusiastic about learning the concepts of oddity, insertions into series, and conservation, which were presently over their heads, a game-like procedure was devised to help the children enjoy the sessions. It may be especially important for children who are having problems in their kindergarten classes to enjoy what they are doing when trying to learn abstract thinking processes that they have been slow to develop. Vygotsky (1978) emphasized the importance of play in the development of children's thought, "In play a child is always above his average age, above his daily behavior, in play it is as though he were a head taller than himself" (p. 129). Hence, the researchers kept the instruction playful, and the children were allowed considerable freedom to help shape it, except that the games had to stay focused on the abstract principle that was to be learned. Adults and children all held toy animals (ponies or dinosaurs). The adult's animal, speaking in a special high-pitched or growly voice, said such things as, "I'm hungry, feed me the thing that is different," when playing the 60 different oddity games. The child's animal would try to oblige. If the choice was correct, the adult's animal would gobble it enthusiastically. If the choice was wrong, the adult's animal would say, "Oh that is like these others, they're all ____; I want the one that is not the same." The verbal interaction between adult and child during the game was brief, but is important in speeding learning by identifying the point of the game (Chalmers & Halford, 2003). First, the shape oddity games were played. The criterion for mastery on these and all subsequent games was that a child be correct on the first try on three consecutive days. When the children were this good at selecting objects that were odd in shape, they went on to playing size oddity games. In these games, the relative size of the odd object, large or small, was alternated from game to game. When these became easy, oddity by orientation games began. Initially, three objects were placed horizontally and one was placed vertically or vice versa. The position of the odd object was changed from trial to trial. After the children met criterion on these games, games began in which three objects were slanted 45 degrees in one direction and the different object was slanted 45 degrees in the opposite direction. When the children met criterion on these games, games began with three objects faced right and the different object faced left.

When criterion was met on oddity games, insertion games began. For insertion games the adult began by taking the three objects that comprised a game. The adult's animal said, "Look what I can do. I can line these things up by little, medium, big." After demonstrating this, the adult's animal would give the objects to the child and say, "Can your animal do that?" After criterion was met for all 15 three-object games, this procedure was repeated for the 20 five-object games.

When children could seriate all of the problems involving four objects, these same problems were repeated, but with a crucial change. Now three of the objects in a set were given to the children, but one of the mid-sized objects was held back. After the

child's animal put these three in order, the adult's animal then told them, "Here's another. Where does it go?" This was the "hump" of the instruction, for nearly all the children. When they reached criterion on these games, five-object games were introduced. The children's animals were to put four objects in order and then insert a missing middle-sized object into the sequence. If the child's initial sequence was not correct, the adult's animal gently nudged the objects into the correct order before giving the child the object to insert. Problems with 6, 7, and 8 objects were presented after criterion was reached on five-object problems, with a mid-sized object always being held back for insertion.

The conservation games began with two rows of three or more equally spaced items. The adult's animal would ask the child's animal, "Do we have the same number of (hearts, stars, etc.), do you have more, or do I have more?" After the child's animal agreed that the two rows had the same number of objects, the adult's animal then expanded one row and contracted the other. Then the adult's animal would ask the child's animal, "Are there still the same number of hearts, stars, etc. in my row and your row or are there more in your row or more in my row?" As children developed more understanding of conservation, the number of objects in the rows with more objects was increased. The rows might have equal or unequal numbers of objects to start with, and addition or subtraction of objects from one or both rows was introduced. The addition or subtraction might make the number of objects in the rows equal or unequal. The questions the adult's animal asked were varied systematically.

Foam letters were used to teach upper and lower case letters to children in the literacy group. The adult's animal might ask the animal to name a letter it had picked out or to pick out a letter it had named. At first only two or three letters were presented at a time. New letters were added to the old, presented in an intermixed order, until all the letters in the alphabet had been learned. Then the adult's animal modeled making consonant and short vowel sounds that corresponded to each letter, again proceeding a few letters at a time, until all had been learned. When children were proficient at this, the adult's animal began making one-syllable words and asking the children's animals what letter the word had started with. Efforts were made to keep the children giggling by being funny during this process. Letter bags were used throughout instruction. These were bags of a dozen or more objects or pictures of objects which all began with the same letter. The children's animals were asked to name each and told the name if they did not know. When children knew the names of all the objects in several bags, the objects of two bags were mixed together and the children asked to have their animals sort them by their initial sound. When all of the letter bags had been sorted, the games proceeded to identifying words that rhymed from several words that the adult's animal presented and finally to blending the sounds of letters to make short words or syllables. These procedures were all devised by the second author, an expert in developing early literacy skills.

Foam numbers were used to teach the numbers 1-10 to the children in the numeracy group. The adult's animal named a specific number and asked the child's animal to pick it from several numbers displayed (number identification). When they could do this correctly for all ten numbers on three consecutive days, they were asked to verbally name numbers the adult's animal picked out (number recognition). When a child

recognized the numbers 1-10, the adult's animal selected a number and gave the child some small blocks, stars, or other items. The adult's animal then asked the child to help him count out that number. At first a child would only be given one or two items more than the number that was to be counted out. Extra items were added as they became better at counting. The numbers 1-10 were learned one at a time. Thereafter, new numbers were taught three to five at a time. Familiar numbers that had already been learned were always mingled with the new numbers. Periodically, the children's enthusiasm was revived by having them play a version of bingo with numbers they knew. Bingo cards with numbers up to 5, 10, 15, or 20 were given to the children. As the adult's animal called out numbers, the children put chips on those numbers on their card until they had a line or a row.

When children knew all numbers up through 30 and could also count that far, they were taught to count by fives, using small blocks, stars or other items grouped in fives as aids. Finally the adult's animal held up a number and asked the children's animals to give it a higher number. For example, the adult's animal would hold up an 8 and ask, "Will you give me a number that is higher than 8?" Alternatively, the request might be, "Please give me a number less than 8." All of these activities were adaptations of standard instructional methods designed to meet state standards for the development of early numeracy.

The art control group made self-portraits and representations of people, plants, animals, and things in pencil, crayon, paint, and play dough. They identified patterns, colors, and geometric shapes and improved fine motor skills by using paste, scissors, glue, folding paper, printing, and rubber stamps. All activities for the art group were directed at the outcomes mandated in the state standards of learning.

When a child in the cognitive group met criterion on oddity, insertions, and conservation, their instruction and that of the literacy, numeracy, and art children yoked with them was terminated. The average number of sessions for all groups was 47.3, even though the children learned at different paces. Testers blind to which instruction children had received assessed them in the last two weeks of May and the first week of June on insertion, oddity, conservation, the oddity scale from the O-LSAT, and the W-J III Applied Problems (numeracy) scale. The school system provided PALS test scores for 129 children. The PALS scores for 19 children were not available, for reasons unrelated to the research. Seven of these missing PALS scores were for children who were in the cognitive group, three for the literacy group, three for the numeracy group, and six for the art group.

Results

ANOVA showed significant overall differences on oddity, insertions, conservation, and the O-LSAT (see Table 1). Overall differences on the PALS and W-J III approached significance. Since planned comparisons between each pair of groups were desired, *a priori* t tests were carried out (Winer, 1962, 1971). They were unidirectional where instruction could only favor one group, but bidirectional when instruction might favor either group or was irrelevant. The group which received the cognitive in-

Table 1. Analyses of Variance for Cognitive and Achievement Scores

Source	df	Mean Square	*F*	p
Oddity	3	10.77	2.86	.040
Error	134	501.67		
Insertion	3	28.34	3.82	.011
Error	134	7.43		
Conservation	3	44.11	4.43	.005
Error	134	0.96		
O-LSAT	3	22.20	2.79	.043
Error	134	7.96		
PALS	3	182.91	1.75	.160
Error	115	104.29		
W-J III	3	26.17	2.01	.115
Error	134	13.02		

Table 2. Scores on seven measures of abstraction and achievement

	Cognitive	Numeracy	Literacy	Art
Oddity Scores (12 possible)				
Mean	10.78	9.76	9.54	9.84
SD	1.89	1.68	2.17	1.97
Seriation Scores (10 possible)				
Mean	8.69	6.87	7.00	6.84
SD	2.15	2.75	2.98	2.94
Conservation Scores (10 possible)				
Mean	7.20	4.91	4.92	5.28
SD	2.55	3.22	3.54	3.23
Literacy (PALS) Scores				
Mean	91.03	85.90	89.06	91.38
SD	8.74	11.98	10.51	9.04
Numeracy (W-J III) Scores				
Mean	19.75	18.15	18.00	17.97
SD	3.78	3.09	3.51	3.99
O-LSAT Oddity Scores (12 possible)				
Mean	8.03	6.48	6.32	6.59
SD	2.47	3.05	2.94	2.80

struction made the highest scores on all variables (see Table 2). The first hypothesis was confirmed, as this group scored significantly higher than each of the other groups on the tests of oddity, seriation, and conservation as well as on the O-LSAT oddity scale and was near ceiling for kindergartners, who are nothing if not distractible, on the first two. Effect sizes (Cohen, 1992) are given in Table 3. They range from just

Table 3. Significance of differences between group means

Variable	t	df	*p*	d
Cognitive versus Literacy group				
Oddity	2.59	71	.006	.61
Seriation	2.78	71	.004	.66
Conservation	3.12	70	.002	.75
PALS	.80	61	.425	
W-J III	2.05	71	.022	.48
O-LSAT	2.68	71	.005	.63
Cognitive versus Numeracy group				
Oddity	2.36	67	.011	.58
Seriation	3.06	67	.002	.74
Conservation	3.45	67	.001	.79
PALS	1.88	57	.033	.50
W-J III	1.91	67	.060	
O-LSAT	2.31	67	.012	.56
Cognitive versus Art group				
Oddity	1.98	65	.025	.49
Seriation	2.99	66	.002	.73
Conservation	2.71	66	.002	.66
PALS	.15	53	.443	
W-J III	1.89	66	.032	.46
O-LSAT	2.24	66	.014	.55
Literacy versus Numeracy groups				
Oddity	0.46	68	.644	
Seriation	0.18	68	.861	
Conservation	0.22	68	.824	
PALS	1.12	62	.133	
W-J III	0.19	68	.425	
O-LSAT	0.22	68	.824	
Literacy versus Art groups				
Oddity	0.38	66	.700	
Seriation	0.22	67	.828	
Conservation	0.44	67	.660	
PALS	0.90	58	.186	
W-J III	0.04	67	.972	
O-LSAT	0.39	67	.763	
Numeracy versus Art groups				
Oddity	0.18	62	.859	
Seriation	0.05	63	.961	
Conservation	0.67	63	.506	
PALS	1.91	54	.062	
W-J III	0.21	63	.419	
O-LSAT	0.15	63	.882	

below .50 (medium) to just below .80 (large). Differences are smallest on oddity and largest on conservation. This makes sense, since children tend to master oddity first in the normal course of maturation and interaction with their environments and that process was well along for most children in the control groups by the end of the school year. Seriation tends to be mastered later, and conservation is mastered last. Therefore, the control children lagged further behind the group that received cognitive instruction on these constructs.

The cognitive and literacy groups did not differ on the PALS. The difference between the scores of the cognitive group and the numeracy group was significant; but that between the cognitive and art groups was not. This was the outcome hypothesized if the superior abstract thinking abilities the cognitive group acquired helped them to develop better literacy skills, except that the art group should have scored no better than the numeracy group. It appears that the cognitive activities were as effective as the literacy activities in improving literacy and certainly more effective for this dependent variable than the numeracy activities, but the scores of the art group are anomalous.

The difference between the cognitive and numeracy groups on the W-J III favored the cognitive group; it approached but did not attain statistical significance. The cognitive group's scores were significantly higher on this numeracy measure than those of the literacy or art groups. This was what would be expected if the improved abstraction abilities of the cognitive group helped them with numeracy. It appears that the numeracy instruction was barely as effective as the cognitive instruction in promoting numeracy, if that.

The literacy group was not significantly better than the other control groups in literacy, and the numeracy group was not significantly better than the others in numeracy. This appears to confirm what the classroom teachers already suspected. The children did not understand age-appropriate lessons in these subject matters, presumably because they lacked an adequate cognitive base.

Discussion

Understanding the Oddity Principle

The children's progress through the oddity problems revealed several steps in the process by which the concept is extended to new dimensions. First came success in identifying the odd object in groups where all but one object had the same overall shape, with no other differences. This was followed by successful application of the oddity principle when each object was unique in color but only one differed in shape. This difference in difficulty is presumably due to the extra dimension that must be processed and ruled out as a basis for decision. When color does not differ, the problem is a binary relation; when color varies, it is ternary (Halford, Wilson, & Phillips, 1997; Chalmers & Halford, 2003). Interestingly, the hardest shape oddity problems were those in which the odd object differed from the others only by missing a part. If one of four identical cars was missing a wheel, it was very difficult for preschoolers to recognize that it was the odd one, and they often made random choices even though they had solved other

oddity problems. Likewise, if one block in an otherwise identical collection of blocks had a corner removed, they were slow to apply the oddity principle in distinguishing the odd object from the other choices. It is as if the overall shape or nature of an object is the only aspect to which the children can apply the oddity principle.

This is probably what would be predicted from Gentner and Namy's (1999) study of 4-year-olds. Comparison of the objects in a group promotes conceptualization of the kind of objects they are, not of perceptual details which are irrelevant to this relational similarity. Probably for this reason, problems in which overall shapes are the same but interior details differ are very difficult and problems in which overall shapes are all different and the determination of oddity must be based on interior details are the most demanding. Six of the first 12 problems of the Otis-Lennon School Ability Test for 5-year-olds, which is predictive of success in kindergarten, are composed of such oddity problems.

Size oddity is the next understanding to develop, but it was much harder for the children to learn than applying the oddity principle to shapes. When considering several identical objects that were one size and an otherwise identical object that was another, many children were quite likely to perseverate in trying to solve the problem on the basis of absolute size. A child who saw three large safety pins and one small one might persistently pick only large pins as "different." The same child could easily solve a problem with three small pins and one large one. Another child would solve the first problem readily by picking the only small pin, but when confronted with several small pins and one large one would select one small pin after another as the "odd" object. These tendencies persisted with other problems, whether the objects were beans, bolts, or toy boats, and were relatively resistant to change.

Applying the oddity principle to differences in orientation is the last step that Pasnak and his collaborators (Pasnak et al., 1987; Pasnak et al, 1991) uncovered in the process by which children abstract oddity from collections of objects. There is again a decalage. Children easily apply the oddity principle to problems in which only one object is upside down while all others are right side up, or one is oriented vertically while the others are all horizontal, or vice versa. However, problems in which one object faces left and the others right, or vice versa, are exceedingly difficult for many children. Some 5-year-olds never succeed in applying the oddity principle to such problems, even though they are not dyslexic and have no other disabilities.

Juan's progress through the orientation games was very illustrative of the process by which children developed their understanding of and ability to apply the oddity principle. Juan had already progressed through shape oddity and size oddity. He had played the games enthusiastically, always happy to have his turn. He had given the name "Brownie" to his favorite animal, a plastic tyrannosaurus, and Brownie ate the odd objects quite enthusiastically, with considerable growling supplied by Juan. This continued unabated when the orientation oddity games were introduced. Brownie snapped up a Lego that was placed horizontally while the other Legos were placed vertically. He gorged on a car placed upside down while the others were right side up, grinding it into the table with his muzzle. Other orientation problems involving vertical-horizontal or upside down versus right side up discriminations were as easy. However, Brownie initially failed when offered three lizards facing along a 2–7 o'clock axis and one oriented

from 11 o'clock to 5 o'clock. After hesitation, he picked the one on the end, which was not correct, and when told his choice was wrong really had no idea how to be correct. Progress came, slowly, when the adult repeatedly pointed out the directions in which the lizards were looking, moving a finger along the path their faces were pointed. "Look, this one and this one and this one are looking at you, but this one is looking away." When the game was scaffolded repeatedly, Juan began to pay careful attention to the lizards' faces, and Brownie eventually was able to pick the right lizard for his meal. But the learning process started all over again when the lizards were followed by three arrowheads slanted in the 11–5 o'clock orientation and one in the 2–7 o'clock orientation. It took seven sessions before Juan could master all problems involving three objects slanted one way and one another. The next problems were even harder. For all his continued enthusiasm, Juan required nine more sessions before he could reliably feed Brownie one object that faced left while the others faced right, or vice versa.

These observations appear to answer the question Zelazo and Muller (2002) posed for relational complexity theory (Halford, Andrews, Dalton, Boag, & Zielinski, 2002). Experience-driven learning, which is what the children had here, does not promote much positive transfer across domains. Chalmers and Halford (2003) treated color, shape, and size as essentially equivalent dimensions, one no more difficult in oddity problems than the other, both theoretically and in the randomly ordered problems they posed for children. However, in the present research and similar research conducted with other stimuli and children (Pasnak et al., 1987; Pasnak et al., 1991; Pasnak et al., 1996), significant amounts of training were needed before the children could generalize the oddity concept from shape to size to orientation oddity. Even within the domains of shape and orientation, a substantial amount of structured and reinforced experience was needed to apply the concept of oddity to shapes with pieces missing, or to new orientations, despite verbal correction and feedback. In this respect, the children were similar to the unsuccessful 3-year-olds described by Zelazo and Frye (1998). They already knew the oddity rule, but could not shift it from one dimension to another. What remains to be determined is whether this was due to difficulty in developing a higher-order rule (Jacques et al., 1999), as predicted from cognitive complexity and control theory (Frye, Zelazo, & Palfai, 1995; Zelazo & Frye, 1997), or to a failure to inhibit unsuccessful response biases (Dempster, 1992; Harnischfeger & Bjorklund, 1993). It is likely that both were involved and both are susceptible to resolution by learning sets. Gagné (1965) and Gagné and Paradise (1961) offered a theoretical account of how the construction of superordinate choice rules are developed via learning sets, and Lopata and Pasnak (1976) provided a practical example of how it can be done. Harlow's (1959) error factor theory is a succinct explanation of the ability of learning sets to inhibit incorrect responses.

Conflicts between choices based on color and shape were quite noticeable during shape oddity instruction, and inhibiting responses based on color was an important part of the children's initial learning. This was especially true when a choice that had been correct before was available but wrong in a new problem. For example, children might solve a problem with yellow, blue, and pink shell-shaped beads and a purple unicorn bead. When next confronted with yellow, blue, and purple unicorn beads and a pink shell-shaped bead, there were (unsurprisingly) many choices of the purple unicorn bead. These errors should not have occurred if the children were simply noting

which object was different or most different—the approaches Chalmers and Halford (2003) found most prevalent for their subjects. It is understandable, however, as symptomatic of an only partially developed abstraction. There is a conflict between the concrete stimulus features of the previously correct choice (purple unicorn bead) and the requirement to choose in terms of the restructured oddity relation between the beads. Simply choosing whatever object had previously been correct, a response that has been previously rewarded and emerged readily, while ignoring the new relation between objects, was easy and natural for children who had only partly understood the oddity principle. This error-producing tendency—choosing the purple unicorn bead in the example given—had to be inhibited before response to the relation could be further strengthened. Response inhibition also came into play in mastery of size oddity problems, which was delayed by persistent choices of large sizes (or, in other cases, persistent choices of small sizes). These erroneous response biases had to be extinguished. One of the virtues of learning sets is that error-producing tendencies, which reappear at nearly full strength after being extinguished for one problem (Harlow, 1959), are gradually fully extinguished as problem after problem is mastered.

Understanding Seriation on One Dimension

Seriation, broadly defined, develops at about the same time as classification, but with both concepts the devil is in the details. Studies with children who have mental disabilities indicate that insertion into a series develops a little later than the understanding of shape and size oddity. In the present research, children were helped to learn how to seriate three or four objects if they could not already do so. Few children had difficulty seriating three objects. Four object seriations were more challenging, and some children lacked a procedure for correcting errors. Sarah, a winsome little sprite who usually wore her hair in a pony tail, seemed to have no idea what to do if her pony made a mistake. The absence of any tendency to correct errors, or any method for doing so, is not unusual for young children (Young, 1976; Southard & Pasnak, 1997). It represents a failure of the fourth (evaluation) stage of the four temporally distinct phases of executive function proposed by Zelazo, Carter, Reznick, and Frye, (1997). Sarah's friend Brittany did recognize errors and had an idea for correcting them, but it was not a good one. Her pony would nudge one object from the line of four (not necessarily the one that was misplaced) and push it to the end of the line. That was it—one "correction" only and that one often leaving the array disordered. Young (1976), Leiser and Gillieron (1990), and Southard and Pasnak (1997) all observed this approach by 4- and 5-year-old children and also reported perseverations in this approach—moving several objects, one after another, to the end of the line, even though that method cannot be successful. Another common error tendency was switching objects in the series arbitrarily, without considering or comparing their size. This might, by chance, produce a correct ordering of four objects, but that ordering would not be repeated when the child attempted the problem again. These poor approaches to corrections gradually disappeared, and initial seriations became more likely to be correct, as children had experience with more of the games; in general, progress was rapid.

The most difficult part of learning seriation for the children was inserting objects into a series. Fatima's approach was very typical; her pony "Peaches" put the new object at the end of the line. Peaches could readily seriate all four objects if offered them all together; indeed, one of her efforts was to just destroy the seriation of three objects and start all over when given the new one. This approach is, in fact, much easier for young children than inserting a new object in a series. She was prevented from doing that, and as her error of placing any new object last gradually extinguished, Fatima eventually realized that the new object had to be put in the middle of the series. The adult's pony scaffolded this by leaving an extra wide space in the line where the object was to be inserted until this extra cue was no longer needed and Peaches was consistently and effortlessly successful.

Inserting a fifth object into a series of four they had just constructed still involved some learning, but progressed much more rapidly than the previous step of inserting a fourth object into a series of three. Making insertions into longer series seemed to involve paying attention to details—aligning bases of the objects carefully and being orderly—rather than conceptual learning. At this point in the development of their seriation abilities, children typically picked up objects on the basis of handiness, put them about where they might go in the line, switched objects correctly when they were incorrectly placed. Then after forming the initial seriation, they inserted a new object by comparing it to others of approximately its size and making a space for it between the objects just larger and just smaller. Errors were infrequent and usually did not require much instruction or correction from the adult.

In contrast to the acquisition of the oddity principle, learning to insert objects into a series did not appear to require extinction of perceptual biases or competing response tendencies for these 5-year-olds. The primary problem that the children had was that they had little grasp of how to form a correct series, how to insert an object into one, and how to correct errors. When the adult's animal showed them how to do these things and the process was scaffolded to make it easy to do, the children gradually improved their ability to use the adult's approach. Inadequate correction tendencies extinguished rapidly. There appeared to be little need for selection between rules (Zelazo & Muller, 2002; Chen & Siegler, 1998).

Understanding Number Conservation

Developing the ability to conserve numbers was the greatest challenge for the children. Conservation makes many demands on children. These include the elimination of reliance on perceptual cues, familiarity with the dimension to be conserved, encoding of multiple aspects of the conservation problem, the ability to remember what has been done, the ability to reverse actions mentally, and the cognitive capacity to do this, and the determination of which changes are relevant and which are not. For the children in this study, the primary problems were the perceptual conflict that afflicts both children and adults and the need to understand firmly that only addition or subtraction of one or more objects could change the number of objects that were present. Overcoming these problems required the continual correction of perceptually based choices and the rein-

forcement of the primacy of the addition and subtraction operations. The children had to first learn that spreading objects out or compressing the array did **not** change the number of objects that were present. They then had to learn that addition of an object increased the number that were present, even if a row was subsequently compressed, so that it looked like there were fewer, and that subtracting an object meant that a row had fewer objects even if those remaining were spread out so that it looked like there were more of them. Finally, they had to learn that addition or subtraction per se was not a sufficient determinant of the correct answer. An addition or subtraction must involve enough objects to equalize or reverse the relations between rows. If one row had 11 objects and the other 13, adding one object to the first row still left it with the smallest number. Variations on this theme had to be solved by considering not just the initial equality or inequality in number, but also how much the subsequent additions or subtractions changed number, while ignoring misleading perceptual cues produced by expanding or contracting the rows. In other words, not only did the children have to develop increasingly accurate rules for determining number (Siegler, 1996), but also the executive function of the children had to improve until they used the right rule to solve the problem (Zelazo & Frye, 1998; Zelazo & Muller, 2002).

Some of this can be seen in the final conservation game, which was always the same. When Tyrone, one of the quickest learners, played it, he and his dinosaur, Bonker, were faced with two rows of playing cards: 17 in Bonker's row, 18 in Stego's row. The college student manipulating Stego asked whether both had the same number or one had more in her most gravelly voice, and Tyrone blurted out, "You do!" Stego took a card from Bonker's row and threw it aside, then took three from his own row and discarded them. Then Stego spread his own row out, and had Bonker to shove all of his cards closer together. "Who has more now?" growled Stego. "Do I have more, does Bonker have more, or do we both have the same number?" "Bonker has more!" trilled Tyrone happily. "You're right!" growled Stego. "Why does he have more?" "Because you took too many from you," said Tyrone. "That's right, I did," replied Stego, and the dinosaurs engaged in a brief play fight, as they always did when answers were correct.

Summary and Conclusions

There are three overarching findings. The first is that play that involved abstract thinking increased competency in abstraction. Second, this increased competency in abstraction interacted with the classroom environment to produce academic gains. Third, in the absence of such competency, the extra control instruction in literacy and numeracy produced no measurable gains.

The Role of Play

The form of play employed here may simulate the process by which early abstract thought evolves during the interaction of young children with their environments. Much of a young child's interaction with the environment *is* play, although adults add

some structured learning experiences. As children develop, their play becomes imaginative and symbolic at ages 2 or 3 years and then develops into symbolic play that is sociodramatic. This type of play, which is what was employed here, reaches a peak at 4 or 5 years of age (Fein, 1986; Howes & Matheson, 1992). In this play, children learn relations between objects, actions, and actors. By age 5 children begin to prefer rule-governed sociodramatic pretend play. For example, children of this age use rules such as, "Whoever is the smallest has to be the baby." This is the kind of rule the ponies and dinosaurs taught the children, except that the rules learned during the play in this research were somewhat more advanced. Piaget and Inhelder (1969/1966) suggested that the emergence of a preference for play with such rules indicated that children were about to make the transition in cognitive development to concrete operations.

Readiness for Formal Instruction

Employment of the oddity principle, insertions into series, and number conservation are in fact early concrete operations, which Piaget considered the sine qua non of "readiness" for schooling (Piaget & Inhelder, 1969/1966). Kindergarten lessons in numeracy, literacy, and everything else have to be pitched at the level of abstraction employed by the great majority of the children, and at age 5 in local school systems that is the early concrete operations. The relatively small number of children who are still functioning at the preoperational level are confronted with lessons that are too abstract for them. Helping such children strengthen their concrete operational thinking presumably helped them to understand some of the classroom instruction, probably with a direct impact on their understanding of the number line and the role of addition and subtraction in changing quantity. Whether there was a synergistic effect by which understanding the abstractions they were taught led to the development of other abstract thinking which helped even more with understanding kindergarten instruction remains to be determined.

The superiority of the cognitive group on the cognitive measures at the end of year indicates that play with many sets of objects did have a positive effect on the children's ability to abstract and that the effect lasted at least until the end of the school year. Since children ordinarily develop and strengthen these abilities unaided in the normal course of interactions with their environment, there is no reason to expect any group to decline in the years ahead. The advantages of the children in the cognitive group in literacy and numeracy presumably arose not from their cognitive superiority at the end of the year, but rather because they became superior by midyear or shortly thereafter. These children had several months in which to employ their strengthened abstractive abilities to understand the instruction in numeracy, literacy, and all other subjects that were offered all day long in their classrooms.

The significant advantage of the cognitive group on the O-LSAT problems indicates that the children could apply their reasoning not only to sets of objects, but also to graphics in a printed format much like the activities commonly encountered in kindergarten. The O-LSAT oddity scale is the simplest of three O-LSAT scales empirically found to be useful in predicting learning in kindergarten. It involves oddity of a

different sort than that involved in the intervention. In the latter, all objects were identical except the odd one, which differed in its overall shape, size, or orientation. In the O-LSAT, all the items in any set differ, and oddity lies in internal details, or type (i.e., four kinds of vegetable dishes versus a meat dish or four quartets versus a triplet). Hence, it appears that the children generalized their new ability very widely.

This would account for the ability of the cognitive group to perform as well on the PALS as the group that received special instruction on letters and letter sounds and better than the group that had special sessions on numeracy. The three 10-minute control sessions the literacy group received were only a very small part of the ongoing literacy instruction all children received from their classroom teachers and assistant teachers. It appears that the better abstractive abilities the cognitive group came to enjoy helped them learn enough from the kindergarten curriculum to offset any effect of the control literacy instruction provided to the control group.

The cognitive group ended up with greater advantages in numeracy, being at least a match for the group receiving control numeracy instruction and significantly better than the other control groups. This may reflect the difficulty children have with numerical relationships when they lack key abstract thinking abilities. Letters and letter sounds can be memorized. Understanding numerical relationships may be more difficult for children who cannot order concrete objects along a dimension of size with ample time to compare them and who fail to understand that addition and subtraction are critical to changing quantities.

It is interesting that the art group did not lag behind the other control groups on either the PALS or the W-J III. It appears that the control literacy and numeracy instruction made little difference. This may reflect the fact that all groups received much classroom instruction in both literacy and numeracy, the greatest priorities in the kindergarten curriculum, swamping the effect of the control sessions. It may also be that the control sessions could not be very effective for children lacking the abstraction abilities which are normal for and needed by children who receive kindergarten literacy and numeracy instruction. Or, it may be a combination of these factors. What is clear is that strengthening the cognitive group's powers of abstraction helped them profit from the kindergarten curriculum in both numeracy and literacy. Hence, this study corroborates and extends the finding of Pasnak et al. (1991) and Pasnak et al. (1996) that there is a case for strengthening the abstraction abilities of 5-year-olds by encouraging and guiding play with many sets of objects that embody relationships children gradually discover in the course of cognitive maturation and interactions with their environments. Positive effects may be limited, however, to children who have not kept pace with their peers.

References

Baldwin, D. A. (1989). Priorities in children's expectations about object label reference: Form over color. *Child Development, 60*, 1289–1306.

Baylor, G. W., Gascon, J., & Lemoyne, G. (1973). An information processing model of some seriation tasks. *The Canadian Psychologist, 14*, 167–196.

Campbell, J. L., Pasnak, R., & Gadzichowski, M. (2004). Learning set instruction in seriation and the oddity principle for a child with severe mental disabilities. *Education and Training in Developmental Disabilities, 39*, 337–345.

Chalmers, K. A., & Halford, G. S. (2003). Young children's understanding of oddity: Reducing complexity by simple oddity and "most different" strategies. *Cognitive Development, 18*, 1–23.

Chen, Z., & Siegler, R. S. (2000). Across the great divide: Bridging the gap between understanding the thought of toddlers and older children. *Monographs of the Society for Research in Child Development, 65* (2, Serial No. 261).

Ciancio, D. S., Rojas, A. C., McMahon, K., & Pasnak, R. (2001). Teaching oddity and insertion to Head Start children: An economical cognitive intervention. *Journal of Applied Developmental Psychology, 22*, 603–621.

Cohen, J. (1992). A power primer. *Psychological Bulletin, 112*, 155–159.

Dempster, F. N. (1992). The rise and fall of the inhibitory mechanism: Toward a unified theory of cognitive development and aging. *Developmental Review, 12*, 45–75.

Eisner, E. W. (1990). The role of art and play in children's cognitive development. In E. Klugman & S. Smilansky, (Eds.), *Children's play and learning: Perspectives and policy implications* (pp. 43–56). New York: Teachers College Press.

Elkind, D. (1964). Discrimination, seriation, and numeration of size and dimensional differences in young children: Piaget replication study VI. *Journal of Genetic Psychology, 194*, 275–296.

Fields, P. (1932). Studies in concept formation. *Comparative Psychology Monographs, 9*, No. 2, 1–70.

Fein, G. G. (1986). Pretend play. In D. Gorlitz & J. F. Wohlwill (Eds.), *Curiosity, imagination, and play*. Hillsdale, NJ: Lawrence Erlbaum Associates.

Freyberg, P. S. (1966). Concept development in Piagetian terms in relation to school attainment. *Journal of Educational Psychology, 57*, 164–168.

Frye, D., Zelazo, P. D., & Palfai, T. (1995). Theory of mind and rule-based reasoning. *Cognitive Development, 10*, 483–527.

Gagné, R. M. (1968). Contributions of learning to human development. *Psychological Review, 75*, 177–191.

Gagné, R. M., & Paradise, N. E. (1961). Abilities and learning sets in knowledge acquisition. *Psychological Monographs, 75*, (Whole number 518).

Garrett, K. N., Busby, R. F., & Pasnak, R. (1999). Cognitive gains from extended play at classification and seriation. *Journal of Research and Development in Education, 32*, 267–274.

Gentner, D. (1978). What looks like a jiggy but acts like a zimbo? A study of early word meaning using artificial objects. *Papers and Reports on Child Language Development, 15*, 1–6.

Gentner, D., & Namy, L. L. (1999). Comparison in the development of categories. *Cognitive Development, 14*, 487–513.

Halford, G. S. (1993). *Children's understanding: The development of mental modes*. Hillsdale, NJ: Lawrence Erlbaum Associates.

Halford, G. S, Andrews, G., Dalton, C., Boag, C., and Zielinski, T. (2002). Young children's performance on the balance scale: The influence of relational complexity. *Journal of Experimental Child Psychology, 81*, 383–416.

Halford, G. S., Wilson, W. H., & Phillips, S. (1997). Abstraction: Nature, costs, and benefits. *International Journal of Educational Research, 27*, 21–35.

Halford, G. S., Wilson, W. H., & Phillips, S. (2006). Abstraction: Nature, costs, and benefits. http://staff.aist.go.jp/steven.phillips/papers/abstraction.pdf[1]

Harlow, H. (1949). The formation of learning sets. *Psychological Review, 56*, 51–65.

Harlow, H. (1959). Learning set and error factor theory. In Koch, S. (Ed.) *Psychology: A study of a science. (Vol. 2)*. New York: McGraw-Hill.

Harnischfeger, K. K., & Bjorklund, D. F. (1993). The ontogeny of inhibition mechanisms: A renewed approach to cognitive development. In M. L. Howe and R. Pasnak (Eds.), Emerging themes in cognitive development (Vol. 1. pp. 28–49). New York: Springer-Verlag.

Howes, C., & Matheson, C. C. (1992). Sequences in the development of competent play with peers: Social and pretend play. *Developmental Psychology, 28*, 961–974.

Imai, M., Gentner, D., & Uchida, N. (1994). Children's theories of word meanings. *Cognitive Development, 9*, 45–75.

Inhelder, B., & Piaget, J. (1964). *The early growth of logic in the child: Classification and seriation.* (E. A. Lunzer & D. Papert, Trans.) London: Routledge and Kegan Paul. Original work published 1959.

Jacques, S., Zelazo, P. D., Kirkham, N. Z., & Semcesen, T. (1999). Rule selection versus rule execution in preschoolers: An error detection approach. *Developmental Psychology, 35*, 770–780.

Kingma, J., & Koops, W. (1983). Piagetian tasks, traditional intelligence, and achievement tests. *British Journal of Educational Psychology, 53*, 278–290.

Leiser, D., & Gillieron, C. (1990). *Cognitive science and genetic epistemology: A case study of understanding.* New York: Plenum Press.

Lopata, D., & Pasnak, R. (1976). Accelerated conservation acquisition and IQ gains by blind children. *Genetic Psychology Monographs, 93*, 3–25.

McGrew, K. S., & Woodcock, R. W. (2001). *Woodcock-Johnsson III Technical Manual.* Itasca, IL: Riverside.

Namy, L. L., & Gentner, D. (2002). Making a silk purse out of two sow's ears: Young children's use of comparisons in category learning. *Journal of Experimental Psychology: General. 13*, 5–15.

Otis, A. S., & Lennon, R. T. (1997). *Otis-Lennon School Ability Test* (7th ed.). San Antonio, TX: Psychological Corporation.

Pasnak, R. (1987). Accelerated cognitive development of kindergartners. *Psychology in the Schools, 28*, 358–363.

Pasnak, R., Brown, K., Kurkjian, M., Mattran, K., Triana, E., & Yamamoto, N. (1987). Cognitive gains through training on classification, seriation, and conservation. *Genetic, Social, and General Psychology Monographs, 113*, 293–321.

Pasnak, R., Hansbarger, A., Dodson, S., Hart, J., & Blaha, J. (1996). Differential results of instruction at the preoperational—concrete operational transition. *Psychology in the Schools, 33*, 70–83.

Pasnak, R., & Howe, M. L. (1993). New approaches to the development of cognitive competence. In R. Pasnak and M. L. Howe (Eds.). *Emerging themes in cognitive development Vol. II: Competencies.* New York: Springer-Verlag.

Pasnak, R., McCutcheon, L., Holt, R., & Campbell, J. W. (1991). Cognitive and achievement gains for kindergartners instructed in Piagetian operations. *The Journal of Educational Research, 85*, 5–13.

Piaget, J., & Inhelder, B. (1969). *The psychology of the child.* (H. Weaver, Trans.). New York: Basic Books. (Original work published 1966).

Siegler, R. S. (1996). *Emerging minds: The process of change in children's thinking.* Oxford: Oxford University Press.

Silliphant, V. (1983). Kindergarten reasoning and achievement in grades K–3. *Psychology in the Schools, 20*, 289–294.

Southard, M., & Pasnak, R. (1997). Effects of maturation on preoperational seriation. *Child Study Journal, 27*, 255–268.

Vygotsky, L. S. (1978). *Mind in society.* (M. Cole, V. John-Steiner, S. Scribner, & E. Souberman, Eds.). Cambridge, MA: Harvard University Press.

Waller, T. G. (1977). *Think first, read later: Piagetian prerequisites for reading.* Newark, DE: International Reading Association.

Weininger, O., & Daniel, S. (1992). *Playing to learn: The young child, the teacher and the classroom.* Springfield, IL: Charles Thomas.

Winer, B. J. (1962). *Statistical Principles in Experimental Design.* New York: McGraw-Hill.

Winer, B. J. (1971*). Statistical Principles in Experimental Design* (2nd ed.). New York: McGraw-Hill.

Young, R. M. (1976). Seriation by children: An artificial intelligence analysis of a Piagetian task. Basel, Germany: Birkhauser Verlag.

Zelazo, P. D., Carter, A., Resnick, J. S., & Frye, D. (1997). Early development of executive function: A problem-solving framework. *Review of General Psychology, 1*, 198–226.

Zelazo, P. D., & Frye, D. (1997). Cognitive complexity and control: A theory of the development of deliberate reasoning and intentional action. In M. Stamenov (Ed.), *Language structure, discourse, and the access to consciousness* (pp. 113–153). Amsterdam: Benjamins.

Zelazo, P. D., & Frye, D. (1998). Cognitive complexity and control: II. The development of executive function. *Current Directions in Psychological Science, 7*, 121–126.

Zelazo, P. D., Frye, D., & Rapus, T. (1996). An age-related dissociation between knowing rules and using them. *Cognitive Development, 11*, 37–63.

Zelazo, P. D., & Muller, U. (2002). Executive function in typical and atypical development. In U. Goswami (Ed.), *Handbook of child cognitive development*. Oxford, UK: Blackwell.

Zelazo, D. P., Resnick, J. S., & Pinon, D. E. (1995). Response control and the execution of verbal rules. *Developmental Psychology, 31*, 508–517.

Author Note

Endnote

[1]There are two writings with the same title by these same authors in the same order. One is a journal article. The other can be found from the URL given. They are substantially different.

The Language of Affect: Using Narration to Help Children Conceptualize and Express Emotions

Noah Z. Kempler
P.O. Box 758
Tiburon, CA 94920
zane03@sbcglobal.net

Abstract: *This brief report introduces* narration *as a useful clinical intervention for assisting parents and professionals in helping children to identify and express their emotions. Narration asks the helping adult to attune to the child's affective experience and then model for him how to apply language and problem-solving to it. This modeling is eventually internalized by the child, who is then able to use language to organize and express his own emotional experience. This report includes an explanation of the principles of narration, examples of its application, and a brief review of related literature. Potential benefits of narration, including increases in empathy, emotional expression, and parent-child affective resonance are also discussed.*

Child psychotherapy practice, and indeed, many other types of helping relationships are often informed by techniques developed through the course of the therapist's clinical practice. These tools add to, and sometimes modify, the arsenal of interventions learned through the more typical educational and professional training modes. In my own experience, techniques that develop naturally, and prove able to withstand the rigors of daily clinical practice, are often equally useful and effective as those learned outside the walls of the consultation room. This paper focuses on one such intervention, narration, which evolved naturally for me as a way to assist parents in helping their children connect to and express their emotions through language. This process of putting words to affect is at the heart of narration, and is achieved through a collaborative investigation between adults and children into the child's emotional experience. The goal of this paper, then, is to introduce narration as a viable intervention for assisting children in the identification and expression of emotions, ultimately adding another useful tool to the body of clinical interventions available to those working with children and families.

An introduction to the components of narration begins with a focus on the importance of the child's emotionality. Schore (2001a) emphasizes the central role of emotion in modulating parent-child affective states, thus enabling the child to organize and manage the inherent stressors of social interaction. In addition, Siegel (1999) describes affect as a central organizing factor in many key psycho-physiological functions such as encoding memory, appraisal and evaluation of internal and exter-

nal stimuli, arousal as a response to one's environment, and in mediating the flow of energy and information in the brain. The scope of the effect of emotions is stated succinctly by Siegel (p.181) when he speaks of ". . . the intimate influence of emotion on all cognitive processes, from attention and perception to memory and moral reasoning."

The practice of narration acknowledges the importance of both individual and social aspects of emotion, and focuses on increasing emotional communication between adult and child. The goals of narration, then, include aiding the child's emotional development, as well as deepening the adult-child relationship.

Empirical Foundations

The utility of assisting children in developing effective strategies for expressing emotional states has been highlighted in several studies throughout the past two decades. Specifically, how parents communicate, model, and ultimately encourage (or not) the expression of emotion is relevant to this report, as these are the central tenets of the intervention called narration. Eisenberg, Cumberland, and Spinrad's (1998) study explores the relationship between parental reactions to children's emotions and their ultimate effect on those children's social competence. Social competence is defined broadly as including the ability to understand one's and others' emotions, the appropriate expression of those states, and the ability to modulate emotion/behavior in a socially acceptable manner. Of course, "socially acceptable" must take into account context, subculture, and cultural variations, which the authors do. In addition, Eisenberg et al. (1998, p. 246) take care in adding that other "socializers" such as non-parental adults, siblings, peers, etc., are ". . . likely to play significant roles in teaching children about emotion, its causes and consequences, and its expression and regulation." This is an important distinction because one of the benefits of narration is that it can be utilized by anyone engaged in social communication with the child.

One of the general findings of the Eisenberg et al. study is that parental socialization practices do indeed have an effect on children's emotional and social competence. In the study, "socialization practices" are further defined to include parental reactions to children's emotions and parental discussion of emotions. With regard to parental reactions, Eisenberg et al. found that supportive parental reactions have the potential to aid the child in reducing emotional arousal, providing a means for coping with stressful situations and enhancing attachment to the parent. In addition, the authors (p. 15) conclude that ". . . moderately high levels of encouragement of the expression of emotion are associated with positive socioemotional development for children."

With regard to parental discussion of emotion, the authors highlight the link between parents' discussion of emotion and children's understanding of emotion and general socioemotional competence, especially in the early years of life. The findings regarding parental reactions and discussions of emotions are particularly relevant to the practice of narration because it is rooted in the parent's response to the child's emotional states and is itself a mode of discussion of the child's affect.

Another study involving parental discussion of the internal states of children was conducted by Meins et al. (2002), this time with a focus on parents' influence on the development of the child's theory of mind, defined as the ability to represent the mental states of themselves and others. One of the main goals was to ascertain whether mothers' mind-mindedness, or their ability to reflect their infants' mental states through language, had an effect on their children's own theory of mind development. According to the authors, a mother's use of language specifically to "comment appropriately on her infant's mental states" (p. 1722) was a viable predictor of her child's later theory of mind performance. In addition, it was found that only specific kinds of mental state language, such as appropriate reflections of the infant's state of mind, facilitated the child's later theory of mind performance. Though the study was conducted with infants 6 months old, the authors are careful to note the probable value of continuing parental mind-mindedness with children into the preschool years. Meins et al. (2002, p. 1724) also suggest that this type of reflective mental state language ". . . provides children with an opportunity to integrate their own behavior with an external comment that makes reference to the mental states underlying that behavior." These "external comments" are similar to the reflective language used in narration, which is itself a form of "mental state language" in that it asks the adult to focus in, or attune to, and comment on the child's intention, emotion, and underlying mental states.

An additional relevant study was conducted by Denham and Auerbach (1995). The authors examined four aspects of emotional dialogue between mothers and their preschool age children to see if patterns of emotional language were indices of positive social-emotional development. The four areas observed were: (1) differences in frequency of affective label usage in the mother-child dyad; (2) relations between mothers' and their children's usage of emotional language; (3) relations between usage of affective language and children's ability to understand emotions and regulate their own affect; and (4) relations between usage of emotional language and children's ability to respond positively to the affect of peers. The results of the study confirmed the authors' prediction that young children, of various ages and both genders, who experience a more complex, emotionally related discourse with their mothers score higher in ratings of emotional competence. Also emphasized in the study was the influence of children's emotional expression through language on their capability in the areas of self-control, self-expression, comprehension of affective situations, and the ability to understand the causal relationship between emotions and the situations in which they occur. The findings of this study support the central principles of narration, chiefly that there is great value in helping children to gain awareness of and to express emotion through language.

This brief review of studies related to the principles of narration is by no means a meta-analysis of all relevant literature. The focus of this report is to introduce narration as built upon a base of knowledge that may be gained both through empirical research and through professional experience. Several further references to studies can be found in the *Potential Benefits of Narration* section.

A Focus on Language

My initial interest in conceptualizing the elements of effective emotional communication between parents and their children began in the Child and Family Study Center at Cedars-Sinai Medical Center in Los Angeles. In my clinical child development training, based in part on the principles of Stanley Greenspan's D.I.R. model (see www.floortime.org for a brief description of D.I.R./Floortime), I quickly discovered that the senior clinical staff had developed a natural and unique way of using language—one that both supported the relational work as well as provided the child (and parents) with a framework for how to apply language in a way that maximized each child's potential for social and emotional development. They called it "narration" and I immediately felt its impact on my clinical work.

Since then, I have continued to apply, define, and refine the practice of narration in my child and family psychotherapy practice, and now find it an essential part of relational child therapy. One of the advantages of conceptualizing how to apply language to child therapy settings is that it provides parents with a clear and usable set of ideas and practices that, in my experience, reduce the anxiety and distress I often see in families first entering the world of psychotherapy with their young child. In this writing, I provide a description of the main components of narration, along with examples of its application to the treatment of young children. Finally, I discuss some of the potential clinical benefits of using narration.

How Narration Works

Narration is focused primarily on *how* language is used in relationships. It starts with the premise that behaviors are driven by affective states, and so shifts the focus of conversation with the child from surface behaviors to the underlying emotions that drive them. Greenspan, Wieder, and Simons (1998) recommend a similar shift in focus when observing a child's play. They state, "You can learn to see through the surface details of the play . . . to the emotional content underneath" (p. 206). This focus on emotions is important because it is what gives the child the experience of verbal affective attunement, while at the same time helping her to link her internal states to her behaviors and ideas. Attunement is defined here as the ability of an adult to understand a child's internal states (e.g. affect, perspective, intention) and to communicate this understanding back to the child.

Narration is simple yet powerful. It can be easily integrated into any child treatment program and can be a potent tool that parents can learn and continue to practice at home. In essence, narration means simply that we talk out loud about what is going on with ourselves and what we suspect is going on with the child. It sounds simple, but what actually happens is that much of the time we as parents or clinicians only give a small part of the message to the child out loud, like when a child misbehaves and a parent only addresses the surface behavior. Likewise, a well-intentioned therapist might focus on underlying affect, only to end up stumped when the child fails to respond to questions about how he is feeling.

Narration asks the parent and therapist to *wonder out loud with the child*. This creates a collaborative investigation into the child's experience that leaves room for the child to own the solution. If we dispense with labeling behavior (e.g., good, bad, etc.) and/or telling the child what *we* think she is feeling, we open the door for the child's natural drive toward autonomy to fuel her interest in figuring out what *she* thinks is happening. This requires therapists and parents to operate on a level playing field and to respect the child's ideas as much as their own—a sometimes difficult task.

Narration is a neutral language. It needs to be that way because we are putting words and ideas on the table for the child to grab and make his own. He will not do this if *we* own the idea. We need to resist wanting to show the child how much we know or can figure out about him. Children often react in opposition to adult ideas (even if they are correct!) because they are trying to gain their own sense of mastery by wanting to figure things out for themselves. Narration sounds like "I'm wondering if . . ." or "You might be . . ." or "Maybe . . ." It is language that allows children to grab the idea (or feeling) and take ownership of it. They can then experience the esteem of your resonance with their inner world, in combination with *their* ability to express themselves through these "borrowed" words and ideas.

Think of narration as lending a framework of language to the child's experience; language that she can discard or choose to make her own. Either way, she slowly begins to absorb the *process* of how to organize and put words to problems and emotions. This framework of language becomes a map that shows the child how to identify and express affect and how to solve problems. Over time, it is internalized by the child, who eventually becomes equipped to deal with life's triumphs and difficulties through the use of language. The move from behavioral to verbal expression of affect and ideas is a cornerstone of child therapy and is facilitated by narration. Besides providing the child with a working model for how to create this move, it is also a validation of the child's experience, which builds a healthy sense of self because the child feels understood.

Narration is similar to the oft overused and misunderstood, "Honey, use your words" that has become the new parenting mantra. The difference is that with narration, we stop and wonder with the child *what those words might be*.

Ways to Narrate a Child's Emotional Experience

The first thing that narration requires is a conscious shift from focusing on the child's *behavior* to the underlying affect that drives the behavior. This can be difficult for many parents, as they are accustomed to addressing the child's surface behaviors first. I often ask parents, when responding to a child's difficult behavior, not to mention the behavior in their first sentence to the child. This gets them used to focusing first on underlying emotions and begins the process of verbal emotional attunement. Instead, I emphasize attuning to the child's non-verbal communication as a clue to what the child is feeling, and what is driving his behavior. I ask parents to notice changes in facial expressions, posture, energy, activity, organization, tone of voice, etc., to further gain information that will direct their response (narration) to the child.

Examples of Narration

Following are several ways to use narration in different situations.

1. Validate the child's intentions.

I often begin my conversation with the child in this way. It helps both of us begin to understand the purpose of his behavior. I also call this *acknowledging the wish* because it aligns us with the child's perspective. Validating the child's needs and desires helps both the adult and child foster awareness of the child's intentions, which have their roots in the emotional self and are the foundation for all purposeful behavior. In addition, this process helps to shift the adult-child relational dynamic from a reactive to a collaborative one because it moves the focus beyond controlling the child's behavior to understanding his needs.

In the following example I use narration to show 3-year-old Maya that I'm attempting to understand the message behind her protest. I say:

> Wow, you started screaming and crying when I said it was almost time to put the toys away. Maybe you're trying to tell us that you need a few more minutes to play. You know, you could say "I'm not ready to stop!" if that's what you're upset about.

In this situation I use narration to try to help the girl connect to the intention behind her behavior. First I help her notice how she is using her behavior to communicate (e.g., screaming, crying) instead of using language. Next, I use my estimation of the event to offer her a possible explanation (or sometimes two) of the cause of her distress. Finally, I model for her how she might use language to get her needs met.

Another example shows a child who did something he *didn't* intend to do. Dylan, a highly active 4-year-old, just inadvertently spilled juice on the rug and now he's running around the table disorganized. I stop him and look into his eyes, saying:

> Dylan, look at me. I saw what happened. You spilled the juice by accident. You might be worried that I'm mad about it. If you look at my face, you'll see that I'm not mad. I know you didn't do it on purpose, your body just gets speedy sometimes.

This scenario recently happened to me and the boy stopped and looked at me with astonishment, as if I was the first person to ever move beyond censuring his actions and instead describe his experience for him. He then calmly walked back to the table, cleaned up the juice, and ate the rest of his snack. Notice that I didn't focus on prompting him to "slow down," "be careful," or even "clean up the juice." My primary concern was that he feels my understanding of him and his struggle with self-regulation. The act of resonating (attuning) with his experience enabled him to access his problem-solving abilities (the juice had to be cleaned up). This motivated him to do so because we were operating in a collaborative mode.

2. Wonder what might be going on emotionally with the child.

This helps create awareness of the link between children's affective states and their behaviors and expressions. For example, I might say:

> Hey Alex, I saw how your face changed when James and Henry stopped playing with you and went outside. Your mouth went from a smile to a frown and your eyes look squinty. Now you're being very quiet. I wonder if you're feeling some mad feelings.

Then I can model how he might use language to express this feeing, by saying, "I wonder if you want to say something like, 'Guys, I didn't like it when you left me alone!'" Here I'm validating the child's experience and possible feelings, connecting his non-verbal expressions to his feelings, and giving an example of how someone might put his feelings into words.

Here's another example of helping to make *conscious connections* to the emotions that drive behaviors. This child becomes easily dysregulated by his feelings. I say:

> Roberto, you've been jumping up and down and being very silly ever since I said it was almost time to go. I'm not sure you're really happy about leaving. Maybe it's hard for you to say, "I don't want to go!" and this is how your body is showing me. Let's see if we can find the word for the feeling. Is it *mad, sad* or *frustrated*?

In this example I help the dysregulated child become congruent with his emotional experience by narrating the situation and then challenging him to move to verbal communication of feelings that are more congruent with his behavior and the current situation.

Note that, in this situation, I can confidently challenge his "happy/silly" feelings not only because they appear incongruent with the current circumstances, but also because I've developed an emotionally-based relationship with him and know that he doesn't like having his play interrupted. I narrate three possible feelings for him to choose from—feelings I think are most likely to correlate with his internal experience.

Narration can also be used to help make conscious connections to children's developmental needs. To the child saying "NO!" in her struggle for autonomy and self-direction, the adult might narrate:

> Wow, looks like you really need to say "no" right now. I guess you're feeling like you want to be in charge of this. Can you tell me which part you want to be the boss of? Well, I'm sorry but this part is Daddy's decision and you're not in charge, but here are some things you *can* be in charge of.

In this example, first I validate the child's need for autonomy and then invite her to expand beyond "no" to a more functional verbal protest—one that could be the beginning of a constructive negotiation. I then help the child understand the limits of her power by holding the limit. Finally, I respect her developmental need for self-direction by offering alternative choices for control.

3. Wonder about the possible causes of problems/feelings.

I might use language like, "Looks like you might be getting frustrated with that car. I wonder if that broken wheel is making it hard to play with." Or, for an older child I could say, "So Sarah told Hannah your secret and now you're not feeling like eating lunch. Maybe you're not hungry because you're having a big feeling about it. Let's see, what would you call that feeling?" In these examples, I'm helping the children connect to the causes of their feelings. This promotes cause/effect thinking and problem-solving. For the older child, I can also explore labeling feelings.

4. Wonder about possible solutions (using the previous example).

I might say, "I wonder if you asked for some help, if someone could help you fix that wheel. Or maybe you'll just choose another car." Or, for the older child, I could say, "I wonder if you want to say something to Sarah about how this made you feel?"

Notice that we are trying not to *give* the child the solution or *tell* him how he feels. We are merely wondering out loud about possibilities and modeling the process of adding language to emotional situations. These possibilities are based on reading the child's non-verbal expression and applying our own experience of how to negotiate problems. The distinction between wondering out loud with the child and telling him how he is feeling is an important one. Wondering out loud is somewhat directive because you are offering plausible labels and explanations for the child's affective experience. However, the critical difference is that the adult's intention remains focused on helping the child *decide for himself* what language fits his feeling or situation, and then encouraging him to practice *his words*; it's the difference between painting the picture for him and sitting with him noticing and naming the landscape. Over time, this ability to find words to express emotions and problems is internalized by the child and necessitates less and less of the adults' ideas, words, and directive influence.

5. Help sort out multi-layered feelings.

Children frequently have several feelings at once and have a hard time conceptualizing the experience. Their faces often tell the story. Several times with Emma, age 5, I walked into her classroom and saw a perplexing face looking at me with angry, squinted eyes and a half-smile. I remember saying:

> I'm not sure if that's a happy face or an annoyed face. Maybe it's both. Go look in the mirror and tell me what *you* think. Maybe you're a little glad to see me, but were also expecting Julie today.

In this example, my goal is to help Emma gain awareness of her non-verbal expressions and introduce the possibility of having several feelings at once. Again, this is done by lending her the ideas necessary to understand her behavior and then help sort through the complexity of multi-layered affect.

6. Narration can also be used between parents/teachers/therapists, etc.

You might say to another adult (in front of the child):

> I see Brandon asking you about going outside and I don't know if you know that I already gave him an answer. Maybe he didn't like my answer and he's thinking he might get a different one from you. You know, he could tell me if he didn't like my answer.

This kind of narration decreases the child's attempt to split adults' unity in decision making, and encourages the child to negotiate directly with the source of his distress.

Narrating might feel unnatural at first. You are saying the things that typically go unsaid. Remember, it's simply wondering out loud and there's no right or wrong narration. You might narrate the child's experience exactly, or maybe not. Guessing what the child's experience is correctly every time is not necessary for narration to work. Narrating your "best guess" at what the child is feeling may result in the child responding with a resounding, "No, that's not it!" which is also useful because it means the child is beginning to define her experience. In addition, a child's "no" is a great starting point for a collaborative discussion about what the actual feeling is. The critical aspect of this type of discussion is helping the child come to understand how we begin to think about, process, and add language to emotional experience. It puts pos-

sibilities on the table about how and why things happen, how we feel about them, and how we might want to respond to them. It gives the child an external framework for problem solving and emotional expression that is internalized over time. Also keep in mind that there is no correct length of narration. How many words or sentences you use to narrate to a child depends on the child's age and comprehension abilities. Young children, or children with poor verbal comprehension, may best be served by condensing the previous examples into fewer words. One way to do this is to simply label for the child the feeling that you suspect she has. Matching the affective tone with the word is helpful also. Instead of saying "mad" when you suspect a mad feeling, you might say *"MAD!!"* and hand her a mirror so that she can connect the feeling to the face. This method is a bit more directive, but works well as long as your tone is one of wondering or investigating, as opposed to telling the child what you know she is feeling.

I also tell parents, "don't feel like you have to narrate every little thing." The rule is, the more emotion you think is involved, the more important it is to narrate. Also remember that, just as in learning any other skill, it takes time and lots of repetition for children to become connected to their feelings. If you miss opportunities or the situation becomes interrupted, it is likely to happen again and you'll have many more chances.

Eventually a child begins to narrate her own feelings, which shows you that she's internalizing the process. It also shows you that the child's inner experience is making sense to him. A child who can talk about his feelings, problems, and possible solutions is a child who doesn't need to act out to get help. Notice with the child her successes in connecting with her feelings through language. Whether it's the first time he uses, I'm angry!" instead of hitting or whether he was able to come to you and tell you about a social situation that evoked strong emotion for him, notice it. Celebrate the child's mastery of emotional communication and your success in providing her with the tools to organize and express her inner world.

Potential Benefits of Narration

Narration can be considered the *verbal* aspect of attunement. Attunement itself is at the heart of several important early developmental processes. First, attunement is necessary for developing a secure attachment between parent and child (Ainsworth, 1978, as cited in Siegel, 1999). A study by Meins, Fernyhough, Fradley and Tuckey (2001) supports the link between attachment and verbal attunement. The authors found an aspect of maternal sensitivity, specifically mothers' tendency to comment appropriately on their infants' mental states and processes, a predictor of later attachment security. Bretherton (1990) also speaks of the relationship between satisfactory emotional communication and secure infant attachment. The author asserts that patterns of communication between caregiver and child, especially in situations of stress or distress, become reciprocally engrained as early as one year of age and contribute to a secure or insecure attachment.

Attunement is also needed for the development of effective regulation of affect and arousal. Tronick (1989) suggests that a main goal of mother's interactions in the first year of life is to use her own affective displays to regulate the child's positive vs. negative arousal. These affective displays are an effective means of interactive regulation if they are based on emotional resonance, or attunement, with a primary caregiver. A product of successful interactive regulation is that children progress in their ability to anticipate and control their own flow of emotions; thus they begin to auto-regulate (Schore, 2001b). Gottman, Katz, and Hooven (1996) found a similar link between parents' constructive emotional philosophy, based on acceptance of the expression of emotion along with a willingness to help the child deal with emotions, and their children's abilities to regulate emotional arousal, a basic ingredient in social and emotional competence. According to Siegel (1999), the process of learning to regulate one's own emotion and arousal is based on attunement and emotionally contingent communication between caregiver and child. This communication, which is likely a component of parents' constructive emotional philosophy, begins at birth and at that time is largely non-verbal. However, as the child develops, the language aspect of attunement becomes more and more relevant and can serve as both a form of emotional resonance with the child, as well as a working model for how to apply language to one's internal states. Narration has the potential to facilitate this critical link between parent and child.

Because narration is a component of active attunement, it gives the child the experience of being understood on an emotional level. At its core is validation of each child's subjective experience. Additionally, it serves as a model for expression of that subjective emotional experience because it helps the child put that experience into language. In short, it teaches children about their own emotional process and expression, while at the same time giving them the experience of being deeply understood. These are critical experiences for young children because they are the foundation for developing an understanding of themselves (i.e., autonoetic knowledge, self definition) and for expression of self through language.

A frequent concern of parents in the course of child therapy is how to help their child develop more empathy, or emotional understanding, of others. They understand that empathy is important for the development of close, lasting relationships, but are often frustrated because they cannot get their child to understand and value *the concept*. What parents often don't understand is that a large part of empathy cannot be learned didactically. This is due to what Roberts and Strayer (1996, p.466) refer to as "the dual cognitive-emotional nature of empathy." The experience of understanding the emotional perspective of another can only come from having that experience oneself. Empathy is learned *experientially* by having significant adults attune to the child's emotional experience and communicate their understanding of that experience. It is this resonance with the adult that enables the child to turn to a peer and resonate similarly with him. Roberts and Strayer found a significant link between children's empathy and their ability to connect to and express their emotions. This process of developing the ability to understand and express one's own affective states, and ultimately develop emotional empathy toward others, is promoted by the *validation*

aspect of narration, and is the first thing I teach parents who wish to help their child develop this facet of social relatedness. Here again, narration can be a powerful tool because, whether absent due to emotional or developmental issues, narration can help augment the child's understanding of the experience of others.

I have also found narration extremely helpful for parents and caretakers who either have difficulty attuning to their child, or who lack the emotional vocabulary to make this deep connection through language. In my experience, most of these adults did not learn, in their families of origin, how to conceptualize, communicate, and process emotions. Men, in particular, seem to be disadvantaged in this area due to the many cultural standards which send them into the world (and parenthood) with little skill in processing and expressing emotion. Narration, then, gives parents and caretakers a working model for how to develop this type of communication with children, which not only benefits their development, but also adds a new dimension to the adult/child relationship.

Finally, it is possible that narration has the potential to aid the developing child in the process of bilateral integration of the left and right brain hemispheres. The vehicle of narration, verbal language, emanates primarily from "left brain" functions and in itself does not provide the child with essential contextual, non-verbal, and emotional components of social interaction. However, if language is used to attune to the child's subjective experience, increase emotional awareness of self and others, facilitate regulation of emotional states, and create awareness of the link between behaviors and the emotional forces behind them, it can be an integrating force because these processes require activation of both the logic/language-based left hemisphere with the emotional, regulatory, and contextual processes of the right. Siegel (1999, p. 207) supports this view when he speaks of the power of "reflective dialogues" that emanate from emotional relationships, which ". . . may foster bilateral integration between the two hemispheres of both child and parent." Future research may confirm this integrative benefit of narration.

Like Floortime, narration begins as an application, but soon becomes more of a *mode of relating* to children and families. I have applied narration to my work with children of various ages and with a wide variety of developmental issues, including Autistic Spectrum Disorders. In addition, I have found it very effective to teach narration as a parenting tool, which results in deepening the parent/child relationship. I emphasize the use of narration with young children (ages 2-7), because these are the critical years where the foundations of expression, regulation, and social relating are all being integrated into language.

A Note on Limits

Although narration helps provide a child with an organized and emotionally connected experience, it alone is often not enough to change existing, engrained behavioral patterns. In addition, the younger children are, the less they are able to apply logic and impulse control to their behaviors. It is for these reasons that applying consistent limits and expectations for behavior, *in addition to narration*, completes the

picture. I often remind parents that reasonable, consistent limits, especially with regard to safety, aggression, etc. are an appropriate way to help children understand the limitations of their power.

Limits are a natural part of development. They are the edges or boundaries that the child developmentally needs to bump up against in order to sharpen her own sense of self. Limits help a child define herself and gain an understanding of her social world. Using narration while setting reasonable limits allows the child to be included in the process because it provides respect for the child's intention. In addition, it provides a descriptive learning experience for the child about the emotions that are causing the undesired behavior. In essence, narration moves the relational dynamic from controlling to collaborative, while respecting both the child and adult's needs. This fosters negotiation, compromise, flexibility, and for the child, a developing sense of internal control that is not dependent on prompts, rewards, or punishment.

A Natural Bridge

Narration can also be a valuable tool in bridging behavioral and relational styles of thinking. Many parents come into my office having as their only experience in child therapy Applied Behavior Analysis (ABA) or other therapeutic models whose focus is primarily on changing behaviors through externally-based positive or negative reinforcement. Even if parents haven't participated formally in behavioral therapy, many contemporary parenting ideas are rooted in this approach. Rather than attempting immediate conversion to a more relational approach, such as Floortime, I ask them to learn about narration. Helping parents shift the focus of their language from surface behaviors to validation and understanding of internal experience often has an immediate "felt" effect on the parent-child relationship. This shift usually motivates parents to want to learn more about an approach based on understanding the child developmentally and helping via a meaningful relationship between adult and child.

Conclusion

Clarifying ideas for how to apply language to help children develop socially and emotionally is valuable in several respects. First, it provides the child therapist with an organized set of ideas and practices for how to interact with children in ways that promote attunement to the child's emotional world, and also aids the child in developing in the areas of self-understanding, empathy, problem-solving, and the application of language to affect. Secondly, it is a set of concrete ideas that is easily taught to parents with often marked and immediate relational results. In my clinical experience, narration achieves both of these objectives and can be a powerful tool for professionals and parents alike. Narration helps the child identify, organize, and regulate his internal affective experiences. In addition, it provides adults with a means to lend their competence in applying language and problem-solving skills to the young child in a collaborative manner.

Greenspan's et al. (1998, p.108) observation that "many children lack the ability to connect their underlying wishes, desires, or emotions to behavior or words that can communicate them" is an important one and underscores the need for new tools that can facilitate this process. Narration is one such tool and complements the principles of D.I.R. and other relational models through its focus on joining with the child and helping him connect to and communicate his affective states.

Though the object of this paper is to introduce narration as a viable intervention, based in both my own clinical experience and empirically validated theory, a brief discussion of its potential limitations is necessary. Foremost, I am aware of the limitations of the relatively small review of literature, in addition to the fact that this therapeutic tool has not itself been validated through objective studies. In addition, individual cultural, gender, age, genetic, and developmental differences of children and parents practicing narration must be considered. For instance, cultural factors can certainly affect parents' proclivity to encourage the expression of emotion, as well as, children's receptivity to engaging in "feelings talk" in peer settings. It is my hope that questions raised by this introduction of narration will eventually be answered by clinicians adopting, using, and refining this technique, and future research validating its efficacy.

Talking and learning about emotionality is not a new idea in child treatment. What is new is employing contemporary views, gained from research and clinical experience, to understanding why emotional communication is so critical to development. Additionally, developing tools for how to apply language to maximize the child and family's benefit is of equal use for clinicians. Narration is such a tool and its effects can be seen both behaviorally and emotionally in the young child. Children whose early development includes a focus on emotions and how to use language to identify and share their unique experiences are children who walk into the world with a more organized, integrated sense of self that ultimately helps them face the many challenges ahead.

References

Ainsworth, M. D. S., Blehar, M. C., Waters, E., & Wall, S. (1978). Patterns of attachment: A psychological study of the strange situation. Hillsdale, NJ: Lawrence Erlbaum Associates.

Bretherton, I. (1990). Communication patterns, internal working models, and the intergenerational transmission of attachment relationships. *Infant Mental Health Journal, 11*, 237–250.

Denham, S. A., Auerbach, S. (1995). Mother-child dialogue about preschoolers' emotions and preschoolers' emotional competence. *Genetic, Social & General Psychology Monographs, 121*, 311–337.

Eisenberg, N., Cumberland, A., & Spinrad, T. L. (1998). Parental socialization of emotion. *Psychological Inquiry, 9*, 241–273.

Gottman, J. M., Katz, L. F., & Hooven, C. (1996). Parental meta-emotion philosophy and the emotional life of families: Theoretical models and preliminary data. *Journal of Family Psychology, 10*, 243–268.

Greenspan, S. I., Wieder, S., & Simons, R. (1998). The child with special needs: Encouraging intellectual and emotional growth. New York: Da Capo Press.

Meins, E., Fernyhough, C., Fradley, E., & Tuckey, M. (2001). Rethinking maternal sensitivity: Mothers' comments on infants' mental processes predict security of attachment at 12 months. *Journal of Child Psychology and Psychiatry, 42*, 637–648.

Meins, E., Fernyhough, C., Wainwright, R., Das Gupta, M., Fradley, E., & Tuckey, M. (2002). Maternal mind-mindedness and attachment security as predictors of theory of mind understanding. *Child Development, 73*, 1715–1726.

Roberts, W., & Strayer, J. (1996). Empathy, emotional expressiveness, and prosocial behavior. *Child Development, 67*, 449–470.

Schore, A. N. (2001a). Effects of a secure attachment relationship on right brain development, affect regulation, and infant mental health. *Infant Mental Health Journal, 22*, 7–66.

Schore, A. N. (2001b). The effects of early relational trauma on right brain development, affect regulation, and infant mental health. *Infant Mental Health Journal, 22*, 201–269.

Siegel, D. J. (1999). The developing mind: Toward a neurobiology of interpersonal experience. New York: The Guilford Press.

Tronick, E. Z. (1989). Emotions and emotional communication in infants. *American Psychologist, 44*, 112–119.

JDP FORUM

Videophilia: Implications for Childhood Development and Conservation

Patricia A. Zaradic (Corresponding author)
Biology Department
Bryn Mawr College
pzaradic@brynmawr.edu

Oliver R.W. Pergams
Department of Biological Sciences
University of Illinois at Chicago
pergams@uic.edu

Abstract: *Direct experience with nature is the most highly cited influence on environmental attitude and conservation activism. Yet our research (using U.S. national park visits as a proxy) suggests a trend away from interactions with nature and a concurrent rise in the use of electronic entertainment media. We suggest this trend represents evidence of a fundamental shift away from "the innate tendency to focus on life and lifelike processes," or "biophilia" (Wilson, 1984) to "videophilia." We define videophilia as "the new human tendency to focus on sedentary activities involving electronic media." Increasing use of electronic media has been implicated in negative psychological and physical effects, including obesity, loneliness, depression, and attentional problems. Internet use at home is shown to have a strong negative impact on time spent with friends and family as well as time spent on social activities. Outdoor play and nature experience have proven beneficial for cognitive functioning, reduction in symptoms of ADD, increase in self-discipline and emotional well being at all developmental stages. Yet, in contrast to the hours spent per child per week in front of electronic entertainment, children living in the United States reportedly spend on average only 30 minutes of unstructured time outdoors each week. Virtual nature, which we here define as "nature experienced vicariously through electronic means," has potential conservation benefits such as providing unprecedented access to natural areas for many people. However, accessing virtual nature, particularly through electronic media, appears to reduce direct contact with nature. Virtual nature experiences tend to sensationalize nature's hazards and habitats, generating the perception that local natural areas are simultaneously dangerous and lackluster. In contrast, direct experiences of nature tend to be neither particularly hazardous nor momentously spectacular, but evidently intrinsically important to both development and conservation.*

Introduction

The greatest threat to conservation and to the environmental legacy represented by the U.S. national park system may be more subtle than bulldozers and chainsaws. A review of studies on attitude toward the environment suggests that direct contact with nature, especially as children, is the most critical influence on later attitude toward the environment (Bögeholz, 2006; Wells & Lekies, 2006). Family vacations and spending time with family and other mentors outdoors are cited as a major influence on later environmental attitude and activism (Chawla, 1998). Yet for the period 1987–2003 per capita visits to national parks (America's iconic family nature vacation) steadily declined as shown in Figure 1 (Pergams, Czech, Haney, & Nyberg, 2004; Pergams & Zaradic, 2006b), with this trend continuing at least through 2005 (Pergams & Zaradic, 2006a).

Teachers, environmental education, and exposure to nature through other venues (such as reading about nature) are credited with influencing environmental sensitivity, but to a much lesser degree than direct actual experience of natural areas (Chawla, 1998, 1999; Duda et al. 2003; Kahn & Kellert, 2002; Wells & Lekies, 2006). Similarly, direct sustained contact with nature best cultivates children's environmental knowledge and concern (Vaske & Kobrin, 2001; Fisman, 2005). Direct experience with nature appears to uniquely affect childhood development as compared to other types of nature encounters.

Kellert (2002) describes three modes of experiencing nature: direct, indirect, and vicarious. Direct experience involves actual physical contact with natural settings and nonhuman species. This is the spontaneous play in a forest, creek, neighborhood park, backyard, or even vacant lot. Although these settings are affected by human manipulation to some degree, they function largely independent of human intervention. Indirect experience of nature involves physical contact but in a much more controlled and restricted setting. Examples include zoos, nature centers, aquariums, natural history and science museums, and domesticated animals such as cats and dogs. Vicarious experience of nature occurs in the absence of actual physical contact with the natural world. Nature in this form ranges from stylized and symbolic art to photographs, videos, and virtual webcam tours of natural areas.

A comparative review by Kellert (2002) suggests that of the three modes of contact, direct experience with nature plays the most significant role in cognitive and evaluative development. Direct experience of nature offers a multiplicity of sights, sounds, smells, and tactile stimuli shifting continuously in space and time. The spontaneity and complexity of these sensory experiences engage a wide range of adaptive and problem solving responses, requiring alertness and attention (Sebba, 1991). In contrast, the more structured, indirect experiences of nature do not require the same level of spontaneous engagement and do not exert the same types of long-term developmental impacts on children (Kellert, 2002; Pyle, 2002). Similarly, Wells and Lekies (2006) found that direct contact with "wild" as compared to "domesticated" nature before age 11 is a particularly potent pathway to shaping environmental attitudes and behaviors in adulthood. Indirect experiences may exert the greatest positive effect in conjunction with direct encounters in familiar natural settings (Kellert, 2002). The
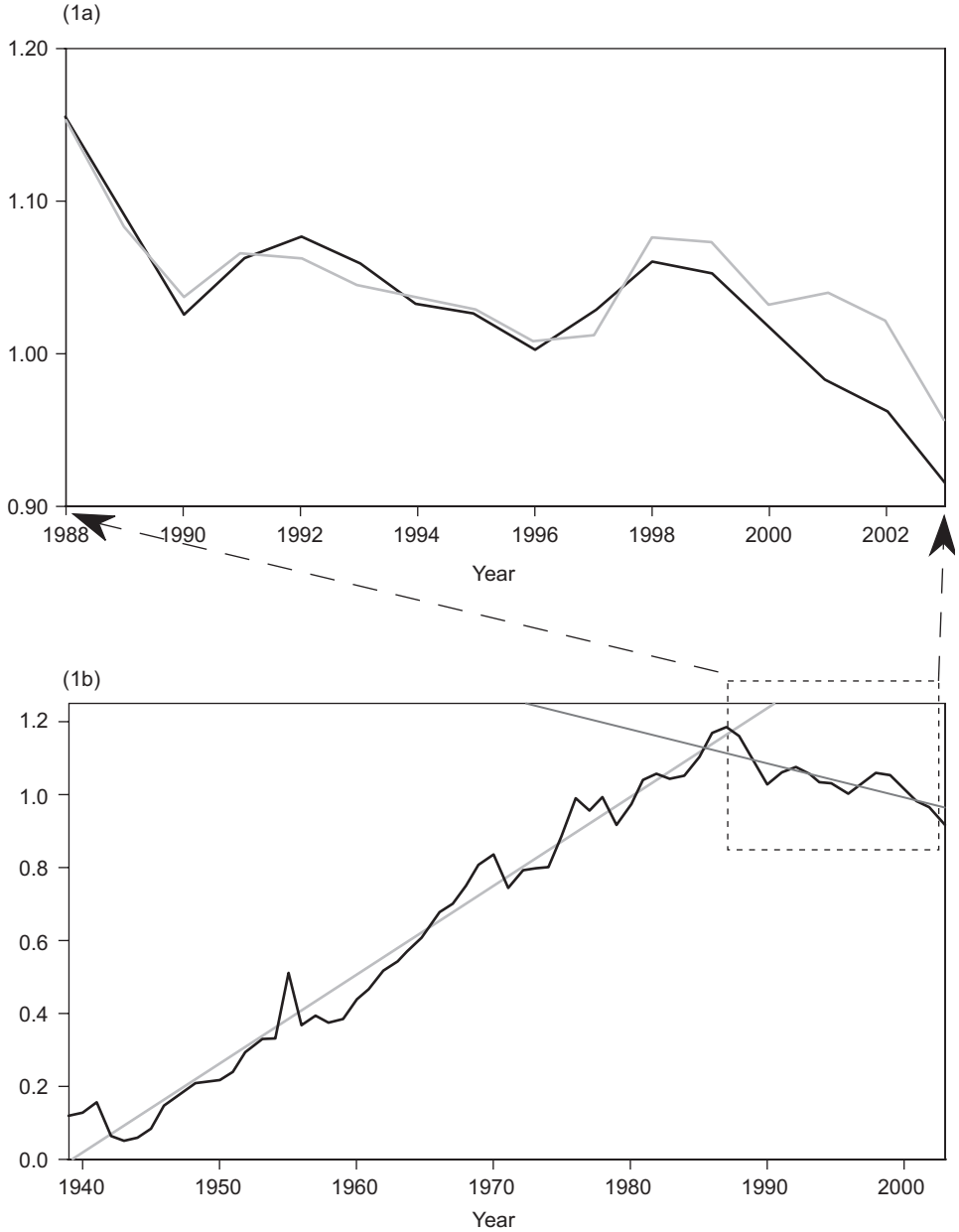
FIGURE 1a. The attendance portion of the graph from 1988 until 2003 in the dashed box is expanded to show both the actual attendance data (black) and the multiple linear regression model (grey) of four entertainment media variables and oil prices. Reprinted from Pergams and Zaradic (2006) with permission.

FIGURE 1b. Per capita U.S. national park attendance from 1939 until 2003 is graphed in black. In light grey is a linear regression calculated using park attendance between 1939 and 1987; and in dark grey, from 1988 until 2003.

least sensory engaging and spontaneous type of nature contact, vicarious experience through an electronic outlet, is becoming more prevalent. More families live in or near urban settings with more time committed to wage earning (Duda et al., 2002). Internet, video game, and home movie use continues to increase dramatically as direct contact with nature via outlets such as national parks decreases (Pergams & Zaradic, 2006a). What are the long-term impacts of this trend for childhood development and conservation?

Videophilia and National Parks

Our research results suggest the trends do not bode well for direct interactions with nature. After fifty years of steady increase, per capita visits to U.S. national parks (the quintessential family vacation) have declined since 1987 (Pergams & Zaradic, 2006a).[1] Prior to this, per capita national park visits increased from 1939 (the start of available data) until 1987. This fifty-year period is remarkable for its steady increase and only minor dips and jumps in the face of World War II, changing demographics, and economic depressions, recessions, innovation, and invention. After fifty years of steady visitation increase, there is an equally steady decline, from 1987 until today, coincident with the rise in electronic entertainment media (Pergams & Zaradic, 2006a).

Along with several electronic entertainment media variables (hours of TV, video games, theatre, home movies, and Internet), we compared the decline in per capita visits to a set of indicators representing alternate recreation choices and potential constraints. The other recreation choices included foreign travel, and more extreme nature experiences such as hiking the entire 3500 km Appalachian Trail. The possible constraints to the number of visitors included the average number of vacation days, median family income, aging baby boomers, federal funding to the National Park Service, park capacity at the most popular parks, and the price of oil (as a proxy for the cost of driving to and through the parks).

We used correlation analysis to consider the relationship of each of our chosen variables with the decline in national park visits. Park capacity was examined separately by graphical comparison to the decline in visitorship and was rejected as limiting since both total overnight stays and visits at the seven most popular parks rose well into the mid-1990s. There was no significant correlation of mean number of vacation days, indicating available vacation time is probably not a factor. Aging of baby boomers was also rejected as they are only now reaching retirement age, and thus during the period of visitation decline were still of prime family vacation age. Federal funding was rejected as a factor as funding to the park service increased during this period. However, it should also be noted that the costs of visiting parks need to be seen against a backdrop where the costs of all government services are being passed along to users, at a time when many potential users are experiencing declining real incomes. Income was significantly positively correlated with foreign travel, but negatively cor-

---

1. The full paper is accessible at www.videophilia.org.

related with national park visits, suggesting that wealthier sectors of the population may eco-tour outside of the United States.

In an ancillary analysis, trend effects were removed by comparing only the percentage of year-to-year changes. Home movies and oil prices were still significantly correlated with national park visits.

Finally, those raw variables that demonstrated a significant relationship with national park visits (i.e., television, home movies, theatre, video games, Internet use, oil prices, Appalachian trail hikers, and money spent on foreign travel) were used as independent variables in an automatic backward stepwise multiple linear regression to model the decline in visits.

Of the variables we considered, only the four more recently popularized electronic media variables (home movies, theatre, video games, and Internet use), together with the price of oil were significant in generating the closest multilinear fit with the data, explaining 97.5% of the 16 year decline in per capita U.S. national park visits (multiple $r^2 = 0.950$, adjusted multiple $r^2 = 0.925$, SE = 0.015, $F = 37.800$, $P < 0.0001$, Fig. 1). Significant entertainment media effects were per capita hours spent watching home movies ($P = 0.0003$), playing video games ($P=0.0066$), on the Internet ($P = 0.0012$) and in movie theatres ($P = 0.0195$). Variables rejected as not significant to the step-wise multiple linear regressions were per capita hours spent watching television, Appalachian Trail hiking, and foreign travel. Finally, oil prices also have a significant effect in explaining national park visits ($P = 0.0009$).

Although we wish we could predict the stock market as successfully as our multilinear model predicts the decline in national park visits, correlation is of course not causation. We have five rejoinders. First and most broadly, we are generating a plausible hypothesis with the hopes that further research will test our model. The preliminary mode of testing support for our hypothesis is correlation, in an ecological analysis. Second, one part of our analysis removed trend effects by comparing the percentage of year-to-year changes rather than comparing raw values. Two variables were significantly correlated with the percentage of year-to-year changes in park visits: hours spent watching home movies and oil prices. Third, we must note that a raw r value of 97.5% in a multiple linear regression denotes a huge amount of explanatory power. The two factors significant in percentage of year-to-year change correlations also led the way in explaining this regression (hours spent watching home movies with $P = 0.0003$ and oil prices with $P = 0.0009$), but the other three factors were not far behind. It is a little hard to imagine logically related factors with this much explanatory power being totally devoid of causal connection. Fourth, the media variables we consider are logically related to national park visits, in that all are competing for our limited time. Last, home video game and Internet use essentially came into existence around the time park visitation started declining, and this increases the likelihood of causality.

We think it likely that national park visits are simply a proxy for how much people in the United States are associated with nature in general, and that further research will find the same longitudinal declines in other nature-related activities. We intend to pursue such research. If this is indeed the case, this paradigm shift has huge conservation and childhood development implications. We may well be seeing evidence of a fundamental shift away from "the innate tendency to focus on life and lifelike

processes," or biophilia (Wilson, 1984; elaborated with Kellert, 1993; Kahn, 1997), to videophilia. Moreover, adult attitudes toward the environment are often nurtured through family vacations and spending time outdoors with family and mentors (Chawla, 1998). If parents, mentors, and children are indeed spending less recreational time in nature, the implications for conservation and impacts on childhood development may be compounded in future generations.

A Sedentary Society

Increasing time spent in sedentary indoor media activities has been implicated in the decline in time available for outdoor physical activities (Skidmore & Yarnell, 2004; Fotheringham, Wonnacott, & Owen, 2000; Utter, Neumark-Sztainer, Jeffery, & Story, 2003). An increasingly sedentary lifestyle in the United States is one of the explanatory factors in the rise in obesity (Flegal, Carroll, Ogden, & Johnson, 2002; Skidmore & Yarnell, 2004). Frequency of being overweight and obesity in U.S. children older than six and adolescents has doubled in the last two to three decades (Deckelbaum & Williams, 2001). Moreover, the spread of this sedentary behavior is resulting in similar doubling rates of obesity in developing countries (Deckelbaum & Williams, 2001). Even younger children are at risk because of this increasingly sedentary lifestyle, with more than 22 million children under 5 years of age overweight across the world (Deckelbaum & Williams, 2001).

Adult activity choices are significant for childhood development because children often depend on adults both for access to nature and as role models for recreational choices. Dong, Block, and Mandel (2004) provide an index of how much energy we currently spend on various activities during a 24-hour day in our sedentary society. In the period 1992–1994, 7,515 adults (weighted to be representative of the contiguous 48 states) were surveyed to create a detailed report of each activity performed in the previous 24 hours. An energy expenditure index was created by multiplying duration and intensity of each activity by each individual and summing across all individuals. The top five ranked activities (representing 42.9% of all energy expended) are reprinted in Table 1. "Watching TV/movie, home or theater" and "Activities performed while sitting quietly" (presumably including time on the Internet and playing video games) were together 14.4% of the total. The study was not designed to compare indoor vs. outdoor activities, but it is still interesting that the two clearly outdoor recreational activities ("Fishing and Hunting" and "Gardening") were together only 1.5% of the total, and ranked 22nd and 27th respectively. Given the activity choices adults are making, it should be of no surprise that children are also spending less time in outdoor recreation as compared to time in front of a video screen.

Children and Videophilia

American Academy of Pediatrics guidelines recommend zero hours/day of screen time for children less than 2 years old and 2 hours/day for older children. The guide-

Table 1. Energy Expended in Key Activities

Data reprinted from Table 2 of Dong et al. (2004), which provides an index of how much energy we currently spend on various activities during a 24-hour day in our sedentary society. The top five ranked activities represented 42.9% of all energy expended. Activities relevant to videophilia are in **bold**.

Rank	Activity	% of Total Score	Cumulative %	# of People
1	Driving car	10.9	10.9	6,574
2	Job: Office work, typing	9.2	20.1	2,094
3	**Watching TV/movie, home or theater**	**8.6**	28.8	**5,919**
4	Taking care of child/baby (feeding, bathing, dressing)	8.4	37.2	6,545
5	**Activities performed while sitting quietly**	**5.8**	42.9	**4,086**

Table 2. Activities Engaged in by Young Children

Data reprinted from Charts 1 and 6 of Rideout et al. (2005), a 2003 survey of 1000 parents of the parents of young children aged 0.5–6 years. Values below, related to videophilia, represent what % of young children of different age groups performed the activities listed in a typical day.

Activity	% of Children <2 Years Old	% of Children 0.5–6 Years Old (Total Sample)
Use any screen media	68	83
Watch TV	59	73
Watch home movies	42	73
Use a computer	5	18
Play video games	3	9

lines also recommend that there are no electronic media at all in young children's rooms. In contrast, in a 2003 survey of 1000 parents of the parents of young children aged 0.5–6 years, Rideout, Vandewater, and Wartella (2005) had a number of startling findings. Table 2 is taken from Charts 1 and 6 of the study, and represents the percentage of young children of different age groups that performed the activities listed in a typical day. Forty-three percent of children less than 2 years old watch television every day, and 26% have a television in their bedroom. Sixty-eight percent of children less than 2 years old spend more than two hours a day using screen media. The larger sample (children aged 0.5–6 years) used screen media a little under two hours a day. Almost all homes (95%) with children 0.5–6 years old had at least one VCR or DVD player, and 27% of children had one in their bedroom. On average, these children spend 40 minutes a day watching movies at home, with 25% watching videos every day. Video games still seem to start a little later, but by age 4–6, 50% of children play them, and 25% play several times a week or more, with an average time played of a little over an hour per day.

Children and the Natural Environment

Research has recently begun to explore children's relationships to the natural environment. Children under 13 living in the United States reportedly spend on average only about half an hour of unstructured time outdoors each week, consisting of gardening, boating, camping, picnicking, pleasure drives, walking, and hiking (Hofferth & Sandberg, 2001). Bartlett (1997) describes behavioral and emotional problems as a result of lack of opportunity to play outside. Hüttenmoser (1995) found that 5-year-old children, limited in playing outdoors by automobile traffic, exhibited poorer social, behavior, and motor skills and had fewer playmates than children not so limited. Grahn, Mårtensson, Lindblad, Nilsson, and Ekman (1997) found that children attending a day care facility surrounded by orchards, pastures, and woodlands (and where the children went outdoors every day regardless of weather) had better motor coordination and greater attention capacity than did children who attended an urban day care center surrounded by tall buildings. Wells, in one of the few studies to employ a longitudinal design (2000), found that children who moved to housing with more nature nearby tended to have higher levels of cognitive functioning than children who moved to housing with less nature. Taylor, Kuo, and Sullivan (2001) found that activities in green settings tend to lower the symptoms of children with ADD. Taylor, Kuo, and Sullivan (2002) also examined the effect of nearby nature on girls aged 7 to 12 living in Chicago public housing. The relative naturalness of window views was predictive of the girls' self-discipline, as defined by ability to concentrate, inhibit impulses, and delay gratification.

Wells and Evans (2003) interviewed 337 rural third, fourth, and fifth graders to determine whether vegetation near their homes provided a buffer to stressful situations such as family relocation, being picked on or punished at school, or being subject to peer pressure. The children's emotional well-being was assessed by both the children themselves and their parents. Stressful life events had less impact on psychological distress under "high nature" conditions than under "low nature" conditions. This buffering appears to be greatest for those at most risk: those experiencing the highest levels of life stress.

Early TV and ADD

Christakis, Zimmerman, DiGiuseppe, and McCarty (2004) applied logistic regression to the National Longitudinal Survey of Youth, containing data for some 2600 children at ages 1 and 3. The hypothesis tested was that early television viewing (at ages 1 and 3) is associated with attentional problems at age 7. Children watched an average of 2.2 hours (SD: 2.91) of television per day at age 1 and 3.6 hours (SD: 2.94) of television per day at age 3. They corroborated the hypothesis even after controlling for a number of potentially confounding factors, including prenatal substance abuse, gestational age, maternal psychopathology, and socioeconomic status. A 1-SD increase in the number of hours of television watched at either age 1 or age 3 was associated with a 28% increase in the probability of having attentional problems at age 7.

The developmental physiological mechanisms speculated to be responsible relate to the rapid development of the brain in young children. Environmental variables, including visual and auditory experiences, are thought to greatly influence the number and density of neuronal responses (Turner & Greenough, 1985; Greenough, Black, & Wallace, 1987; Wallace, Kilman, Withers, & Greenough, 1992). However, in contrast to the pace with which real life unfolds, television can rapidly portray changing scenes and events. Also, this speed of portrayal is not at all chronologically constant, but rather in itself varies greatly from moment to moment, scene to scene, show to show, movie to movie. Thus, this unevenness and rapidity in depicting the passage of time, during the critical period of synaptic development in early childhood, is speculated to affect the number and density of neuronal responses (Christakis et al., 2004). Though no similar research exists specifically for video games or movies, given their similarity one would be surprised if the same factors did not apply.

Internet and Socialization

One of the major trends in electronic media is the increase in use by children of younger ages. The National Center for Education Statistics (DeBell, 2005) provides a weighted sample representing approximately 58.3 million children age 3 and older in nursery school through the 12th grade in October 2003. A survey of this sample describes the use of computer and Internet technologies by age group: 67 percent of children in nursery school were already computer users, as were 80 percent of those in kindergarten. About one-quarter (23%) of nursery school children were already Internet users, rising to about 32% in kindergarten. By high school, nearly all students (97%) use computers and a large majority (80%) use the Internet (USDE, 2005).

The exponential rise in Internet use over a mere two decades from its initial availability offers little time to study its long-term developmental effects. However, these trends in adult Internet use at home clearly must have direct implications on time spent interacting with children, and indirect implications for parents as role models and gatekeepers of children's recreation choices. Nie and Hillygus (2002a) explore the effects of the Internet on interpersonal communication and sociability, collecting data from time diaries of their subjects. Internet use at home (but not at work) is shown to have a strong negative impact on time spent with friends and family as well as time spent on social activities. Similarly, Internet use during weekend days is more strongly related to decreased time spent with friends and family and on social activities than Internet use during weekdays. The relationship is highly significant: for every hour spent online at home or on the weekend, there is a corresponding 41 minutes less spent with family members ($\beta = -0.69$, t-stat $= -6.65$, $p < 0.001$). Nie and Hillygus (2002b) refine the parameters of this reallocation: in other words, what activities are affected, rather than in whose company they are performed. Not surprisingly, Internet time seems to be reallocated most from discretionary activities, especially social activities, hobbies, reading for pleasure, and television viewing. However, Internet time is also reallocated from nondiscretionary activities such as housework and childcare, especially by heavy (≥ 61 minutes/day) Internet users. These findings seem to strongly corroborate the hypothe-

sis that the Internet has created a shift in people's time allocation away from family and friends, and that this loss of time is suffered by a wide spectrum of specific activities.

Kraut et al. (1998) examine the social and psychological impacts of the introduction of the Internet to a household. The behaviors of 169 people in 73 households were tracked over the first 1–2 years of Internet use. Again, greater use of the Internet was associated with declines in communication with family members and in reduced social contact outside the home. In addition, increased Internet usage was associated with increases in loneliness and depression.

Media and Fear

Television and other electronic media probably provide most incidental information about nature (Bixler & Carlisle, 1994). As well as transmitting neutral information about nature, media depiction of nature's hazards can teach fear. Fears of evolutionarily relevant natural dangers such as snakes and spiders seem easier to acquire and harder to extinguish than fear of post-technological dangers such as cars and guns (Heerwagen & Orians, 2002). Children exposed to realistic media depictions of life-threatening events, such as fire and drowning, report feeling more at risk to those events and less likely to engage in activities related to the depicted tragedies (Bixler & Carlisle, 1994). Hence, media depictions of nature tend to focus on and sensationalize nature's hazards, promoting the perception that natural areas are dangerous.

Similarly, for parents, sensationalism in the media has greatly reinforced paranoia over children being abducted while playing outdoors. Finkelhor, Hootaling, and Sedlak (1992) report 200–300 stereotypical criminal child kidnappings per year (approximately 0.00008% of the population), as opposed to the tens of thousands per year suspected in the public imagination. The best inoculation against inaccurate and sensationalized depictions of nature is an accurate frame of reference for nature built from early firsthand experiences (Bixler & Carlisle, 1994).

Children's firsthand experience in natural settings plays an important role in developing environmental attitudes and preferences for nature (Heerwagen & Orians, 2002). Without early and regular exposure to nature, urban dwellers find the unfamiliarity of wilderness settings uncomfortable and overwhelming (Bixler & Carlisle, 1994), preferring built settings to natural environments (Heerwagen & Orians, 2002).

Biophilia must be nurtured to truly take hold (Verbeek & de Waal, 2002). Active behaviors that require direct involvement with live animals, such as fishing, hunting, and bird watching lead to the most consistent environmental attitude and knowledge (Duda et al., 2003). Values such as reverence and respect for nature appear to be derived in part from direct involvement (Matthews & Riley, 1995; Duda et al., 2003).

Conservation and Virtual Nature

One of the most potentially controversial issues pertaining to videophilia is the issue of "virtual nature," here defined as "nature experienced vicariously through elec-

tronic means." What are the costs? What are the benefits? For there are indeed (at least in theory) benefits. Certainly, the Internet has provided unprecedented access to natural areas for many people. From a viewpoint solely focused on *Homo sapiens*, some of the relaxing and educational aspects of nature can in fact be delivered through vicarious experience (Ulrich, 1993; Levi & Kocher, 1999) on a video screen, or as technology advances, through a virtual reality space. An example is the National Park Service webcam showing Old Faithful in Yellowstone National Park (National Park Service, 2006). In particular, children, not able to travel to the Amazon rainforest or Old Faithful on their own, can do so online without the need for a car, plane, or parent. Bugs, snakes, spiders, predators, and pests can all be left behind in virtual nature. There is even a little something for conservationists: endangered species and sensitive sites can be visited with little or no impact on habitat via webcam, and there is greatly reduced maintenance of natural areas when they do not have any real visitors. Lastly, whether or not we believe in the potential benefits of videophilia to conservation, we must unfortunately at least admit the possibility that the very strong current increase in videophilia (Pergams & Zaradic, 2006a) is a juggernaut in whose way we cannot stand. This might leave virtual nature as the best related conservation option.

The potential costs of virtual nature to conservation are, of course, huge, and may be compounded in future generations. Environmental awareness, primarily nurtured through parents and adult mentors while outdoors (Chawla, 1998), may be the cost of replacing real nature with virtual nature, and this possibility should not be underestimated. Moreover, today's children are tomorrow's parents, but potentially with greatly decreased connection to nature. If children experience Old Faithful primarily through a webcam, where is the nurturing connection that in the past was provided by the sharing the experience with family or an adult mentor? If parents and children are sharing the experience of virtual nature, will the nurturing connection be to the subject matter (nature) or to the media (the virtual experience)? From a conservation context, will they still go to see it in real life? Will they still pay their tax dollars to maintain Yellowstone?

Lacking direct experience of our natural environment, we lack the most immediate feedback of our impact on nature. When experiencing nature vicariously, we may not be aware of the sensory experiences we are missing through the virtual medium, but the real nature we leave outside continues to receive the footprint of our presence on the planet. If we spend our recreational time on virtual tours, do we still pick up litter at our local parks? Or do we opt for solutions consistent with our simulated experience of nature? In Los Angeles, it was proposed to replace highway median plantings with plastic trees, rather than to deal with the larger issue of air pollution (Levi & Kocher, 1999). In the long run, spending less time in real nature seems likely to speed the onset of environmental generational amnesia. This psychological phenomenon, described by Kahn (2002), is the tendency for each generation in its youth to take the existing environmental conditions as normal, even though with each ensuing generation the amount of environmental degradation increases.

If we generationally redefine normal conditions, we might well increasingly use experiences of vicarious nature as our benchmark rather than the local environment. A study of the effects of simulated experience through commercially available nature images suggests this type of vicarious contact with spectacular natural environments

increases support for national parks and forests, but decreased support for preservation and acquisition of local natural areas (Levi & Kocher, 1999). Thus, vicarious nature experiences tend to sensationalize nature's spectacular habitats, generating the perception that local natural areas are relatively lackluster.

Given that the frequency of direct contact with nature depends on local availability (particularly for children, due to their dependence on caregivers for access), the devaluing of local natural areas as compared to sensationalized virtual views of nature seems likely to further reduce direct experiences, and perforce increase our reliance on vicarious nature experiences. Moreover, the recent decline in per capita visits to national parks (Pergams, Czech, Haney, & Nyberg, 2004; Pergams & Zaradic, 2006a) suggests that although vicarious exposure to spectacular habitats may increase the perceived value of national parks, this increased value does not translate to increased direct experiences. In fact, the results of our research suggest just the opposite, that increased use of virtual electronic media is significantly correlated with decreased direct experiences with national parks (Pergams & Zaradic, 2006b). Concurrent with the almost 25% decline in national park visits, Internet use increased from none in 1987 to a per person annual average of 174 hours by 2003 and average overall annual electronic media use (i.e., home movies, theatre movies, video games, and Internet use) rose by an average of 327 hours per person (Pergams & Zaradic, 2006a). Thus virtual access to nature is, in our data, already very strongly associated with loss of direct contact with actual nature. In other words, visiting Old Faithful on the web more seems to result in visiting Old Faithful in person less.

Conclusion

Direct experience with nature is the most highly cited influence on environmental attitude and conservation activism. Yet our research suggests a trend away from interactions with nature and a concurrent rise in videophilia, the new human tendency to focus on sedentary activities involving electronic media. Videophilia has both direct and indirect implications for childhood development and the future of conservation.

Most directly, increasing videophilia has been implicated to yield negative psychological and physical effects. Some of the negative effects are linked to the sedentary nature of videophilia and reduced time available for outdoor physical activities and nature experiences. Conversely, outdoor play and nature experience have proven beneficial for cognitive functioning, reduction in symptoms of ADD, increase in self discipline, and emotional well being at all developmental stages. Other detrimental effects of videophilia seem to be more related to its potential for isolation and much faster pace than real time. High levels of children's electronic media consumption are correlated with attentional problems and increases in loneliness and depression.

Potentially more complex are the implications of virtual nature. Virtual nature, here defined as "nature experienced vicariously through electronic means," has some potential benefits, particularly for children who are dependent on adults for access to many natural areas. Although a sedentary, videophilic outlet, the Internet provides unprecedented access for children to natural areas, delivering some of the relaxing

and educational aspects of nature vicariously. Yet, given increasing Internet use by younger children, virtual nature appears to directly compete with time previously allocated to the more beneficial, direct contact with the outdoors. In addition, virtual nature experiences may further discourage direct contact with local nature by sensationalizing nature's hazards and habitats, generating the perception that local natural areas are simultaneously both dangerous and lackluster.

Ultimately, to more conclusively resolve the long-term impact of videophilia, further research is needed to answer the questions of exactly what videophilia means to a) children's development, b) their success and happiness as adults, and c) specifically, their environmental consciousness. We propose the initiation of a large-scale longitudinal study to determine the effects of videophilia on children's development and future outcomes. Such research would follow controlled groups of children from birth to adulthood, and quantify differences in as many areas as possible, correlated to exposure to nature and/or videophilia. Physical and mental health, educational achievement, career choices, and economic success as adults, would all be among areas considered in addition to environmental awareness. The proposed research would require the cooperation of a number of experts from a wide variety of fields. As daunting as the proposal might seem, children are already exposed, at earlier and earlier developmental stages, to an uncontrolled videophilia treatment. More daunting is the prospect of today's children (tomorrow's parents) in a culture devoid of contact with the evolutionary driver and life-support system that is our natural world.

Acknowledgments

References

Bartlett, S. N. (1997). No place to play: Implications for the interaction of parents and children. *Journal of Children and Poverty*, *3*, 37–48.

Bixler, R. D., & Carlisle, C. L. (1994). Observed fears and discomforts among urban students on field trips to wildland areas. *Journal of Environmental Education*, *26*, 24–33.

Bögeholz, S. (2006). Nature experience and its importance for environmental knowledge, values and action: Recent German empirical contributions. *Environmental Education Research*, *12*, 65–84.

Chawla, L. (1998). Significant life experiences revisited: A review of research on sources of environmental sensitivity. *Journal of Environmental Education*, *29*, 11–21.

Chawla, L. (1999). Life paths into effective environmental action. *Journal of Environmental Education*, *31*, 15–26.

Christakis D. A., Zimmerman, F. J, DiGiuseppe, D. L., & McCarty, C. A. (2004). Early television exposure and subsequent attentional problems in children. *Pediatrics*, *113*, 708–713.

DeBell, M. (2005). *Rates of computer and Internet use by children in nursery school and students in kindergarten through twelfth grade*. (NCES No. 2005-111). U.S. Department of Education. Washington, DC: National Center for Educational Statistics.

Deckelbaum, R. J. & Williams, C. L., (2001). Childhood obesity: The health issue. *Obesity Research*, *9*, S239–S243.

Dong, L., Block, G., & Mandel, S. (2004). Activities contributing to total energy expenditure in the United States: Results from the NHAPS Study. *International Journal of Behavioral Nutrition and Physical Activity*, *1*, 1–11.

Duda, M. D., De Michele, P. E., Zurawski, C., Jones, M., Yoder, J. E., Testerman, W., Lanier, A., Bissell, S. J., Wang, P., Herrick, J. B., & Marshall, J. (2003). Factors relating to hunting and fishing participation among the nation's youth. Harrisonburg, VA: Responsive Management.

Finkelhor, D., Hootaling, G., & Sedlak, A. (1992). The abduction of children by strangers and non-family members: Estimating the incidence using multiple methods. *Journal of Interpersonal Violence*, *7*, 226–243.

Fisman, L. (2005). The effects of local learning on environmental awareness in children: An empirical investigation. *The Journal of Environmental Education*, *36*, 39–50.

Flegal, K. M., Carroll, M. D., Ogden, C. L., & Johnson, C.L. (2002). Prevalence and trends in obesity among U.S. adults. (1999–2000). *Journal of the American Medical Association*, *288*, 1723–1727.

Fotheringham, M. J., Wonnacott, R. L., & Owen, N. (2000). Computer use and physical inactivity in young adults: Public health perils and potentials of new information technologies. *Annals of Behavioral Medicine*, *22*, 269–275.

Grahn, P., Mårtensson, F., Lindblad, B., Nilsson, P., & Ekman, A. (1997). Ute på dagis. Stad and Land, Nr. 145 [Outdoor daycare. City and country]. Hässleholm, Sverige: Norra Skåne Offset.

Greenough, W. T., Black, J. E., & Wallace, C. S. (1987). Experience and brain development. *Child Development*, *58*, 539–559.

Heerwagen, J. H., & Orians, G. H., (2002). The ecological world of children. In P.H. Kahn, Jr. & S. R. Keller (Eds.), *Children and nature: Psychological, sociocultural, and evolutionary investigations*. (pp. 29–64). Cambridge, MA: The MIT Press.

Hofferth, S., & Sandberg, J. (2001). Changes in American children's time, 1981–1997. In S. L. Hofferth & T. J. Owens (Eds.), *Children at the millennium: Where have we come from, where are we going?* Oxford, England: Elsevier Science.

Hüttenmoser, M. (1995). Children and their living surroundings: Empirical investigations into the significance of living surroundings for the everyday life and development of children. *Children's Environments*, *12*, 403–413.

Kahn, Jr., P. H. (1997). Developmental psychology and the biophilia hypothesis: Children's affiliation with nature. *Developmental Review*, *17*, 1–61.

Kahn, Jr., P. H. (2002). Children's affiliations with nature: structure, development, and the problem and environmental generational amnesia. In P.H. Kahn, Jr. & S. R. Keller (Eds.), *Children and nature: Psychological, sociocultural, and evolutionary investigations* (pp. 93–116). Cambridge, MA: The MIT Press.

Kellert, S. R. & Wilson, E. O. (1993). *The biophilia hypothesis*. Washington DC: Island Press.

Kellert, S. R. (2002). Experiencing nature: Affective, cognitive, and evaluative development in children. In P. H. Kahn, Jr. & S. R. Keller (Eds.), *Children and nature: Psychological, sociocultural, and evolutionary investigations*. (pp. 117–152). Cambridge, MA: The MIT Press.

Kraut, R., Lundmark, V., Patterson, M., Kiesler, S., Mukopadhyay, T., & Scherlis, W. (1998). Internet paradox: A social technology that reduces social involvement and well-being? *American Psychologist*, *53*, 1017–1031.

Levi, D., & Kocher, S. (1999). Virtual nature: The future effects of information technology on our relationship to nature. *Environment and Behavior*, *31*, 203–226.

Matthews, B. E., & Riley, C. K. (1995). *Teaching and evaluating outdoor ethics education programs*. Vienna, VA: National Wildlife Federation. (ERIC Document Reproduction Service No. ED401097)

National Park Service. (2006). The Official Website of Yellowstone National Park—The Old Faithful WebCam. Website accessed 10/23/06 at http://www.nps.gov/archive/yell/oldfaithfulcam.htm

Nie, N. H., & Hillygus, D. S. (2002a). The impact of Internet use on sociability: Time-diary findings. *IT&Society*, *1,* 1–20. Retrieved September 18, 2006, from http://www.itandsociety.org.

Nie, N. H., & Hillygus, D. S. (2002b). Where does Internet time come from? A reconnaissance. *IT&Society*, *2*, 1–20. Retrieved September 18, 2006, from http://www.itandsociety.org.

Pergams, O. R. W., Czech, B., Haney, J. C., & Nyberg. D. (2004). Linkage of conservation activity to trends in the U.S. economy. *Conservation Biology*, *18*, 1617–1623.

Pergams, O. R. W., & Zaradic, P. A. (2006a). [Decline of *per capita* visits to national parks in period 1987–2005] Unpublished raw data.

Pergams, O. R. W., & Zaradic, P. A. (2006b). Is love of nature in the United States becoming love of electronic media? 16-year downtrend in national park visits explained by watching movies, playing video games, Internet use, and oil prices. *Journal of Environmental Management*, 80, 387–393.

Pyle, R. M. (2002). Eden in a vacant lot: Special places, species and kids in the neighborhood of life. In P.H. Kahn, Jr. & S. R. Keller (Eds.), *Children and nature: Psychological, sociocultural, and evolutionary investigations.* (pp. 305–328). Cambridge, MA: The MIT Press.

Rideout, V. J., Vandewater, E. A., & Wartella, E. A. (2003). Zero to six: Electronic media in the lives of infants, toddlers, and preschoolers. (Publication No. 3378). Menlo Park, CA: Kaiser Family Foundation.

Sebba, R. (1991). The landscapes of childhood: The reflection of childhood's environment in adult memories and in children's attitudes. *Environment and Behavior*, *232*, 395–422.

Skidmore, P. M. L., & Yarnell, J. W. G. (2004). The obesity epidemic: Prospects for prevention. *QJM: An International Journal of Medicine*, *97*, 817–825.

Taylor, A. F., Kuo, F. E., & Sullivan, W. C. (2001). Coping with ADD: The surprising connection to green play settings. *Environment and Behavior*, *33*, 54–77.

Taylor, A. F., Kuo, F. E., & Sullivan, W. C., (2002). Views of nature and self-discipline: Evidence from inner city children. *Journal of Environmental Psychology*, *22*, 49–63.

Turner, A. M., & Greenough, W. T., (1985). Differential rearing effects on rat visual cortex synapses. I. Synaptic and neuronal density and synapses per neuron. *Brain Research*, *329*, 195–203.

Ulrich, R. S., (1993). Biophilia, biophobia, and natural landscapes. In S. R. Kellert & E. O. Wilson (Eds.), *The biophilia hypothesis*. Washington, D.C.: Island Press.

Utter, J., Neumark-Sztainer, D., Jeffery, R., & Story, M. (2003). Couch potatoes or French fries: Are sedentary behaviors associated with body mass index, physical activity, and dietary behaviors among adolescents? *Journal of the American Dietetic Association*. *103*, 298–1305.

Vaske, J. J. and Kobrin, K. C. (2001). Place attachment and environmentally responsible behavior. *The Journal of Environmental Education*, *32*, 16–21.

Verbeek, J. H., & de Waal, F. B. M. (2002). The primate relationship with nature: Biophilia as a general pattern. In P. H. Kahn, Jr. & S. R. Keller (Eds.), *Children and nature: Psychological, sociocultural, and evolutionary investigations.* (pp. 1–28). Cambridge, MA: The MIT Press.

Wallace, C. S., Kilman, V. L., Withers, G. S., & Greenough, W. T. (1992). Increases in dendritic length in occipital cortex after 4 days of differential housing in weanling rats. *Behavioral Neural Biology*, *58*, 64–68.

Wells, N. M. (2000). At home with nature: The effects of nearby nature on children's cognitive functioning. *Environment & Behavior*, *32*, 775–795.

Wells, N. M., & Evans, G. W. (2003). Nearby nature: A buffer of life stress among rural children. *Environment and Behavior*, *3,* 311–330.

Wells, N. M., & Lekies, K. S. (2006). Nature and the life course: Pathways from childhood nature experiences to adult environmentalism. *Children, Youth and Environments*, *16*, 1–24.

Wilson, E. O. (1984). *Biophilia*. Cambridge, MA: Harvard University Press.

Comment on "Videophilia"

Ellen Dissanayake
School of Music, Music Education Division
University of Washington
edissana@seanet.com

We who grew up in earlier decades, who played outdoors with friends after school, lay on the grass and identified shapes in clouds, slept under the stars in the back yard, walked to school, read books for pleasure, made things for play without the use of kits, waded in nearby creeks in summer and ice-skated on local lakes in winter, may sometimes wonder whether our misgivings about children's pastimes today are perhaps just old fogeyish or simple nostalgia for our own lost youth. However, Zaradic and Pergams, like others, provide empirical evidence that the sedentary, indoor, electronic-centered occupations of most children today have physical, social, and environmental consequences that are not in the best interests of young people or the societies they will one day inherit.

Although not quantitative, my ethological studies of the origin and functions of the arts in human evolution provide a perhaps unfamiliar but interesting perspective on the effects of videophilia in children. Ethologists tell us that the behavior and psychology of an animal are as much a product of its environment and way of life as its anatomy and physiology. For example, caribou and reindeer live on open plains, are exposed to predators, and have evolved to graze in large herds. Forest-dwelling roe deer, however, move around alone and browse inconspicuously in well-spaced, defended territories (Eisenberg, 1981, pp. 200–201). As a result of millions of generations of biological adaptations for a particular ecological niche and way of life, caribou psychology is as ill-equipped for solitude as is the roe deer's for togetherness.

If we think of ourselves as animals whose psychology evolved to operate in a particular way of life, what might this fact contribute to a discussion of the consequences of videophilia on the young human mind? Whether we think of human evolution as beginning with the first upright hominids of five million years ago, the earliest representatives of our genus *Homo* some two million years ago, or behaviorally modern humans who lived after 100 thousand years ago, it is clear that twenty-first century human life *style* differs enormously in most respects from that of our ancestors and is unprecedented. Yet human *psychology* is arguably little changed.

Even though hominids left Africa and settled in widely diverse habitats that required diverse material cultures, they did not relinquish the emotional needs and psychological satisfactions of their hunter-gatherer (or "small-scale") way of life. Human psychology evolved over hundreds of thousands of generations to find such a life satisfying. Being carried around as infants on our mothers' bodies; growing up in a small

group of like-minded others of all ages; learning to make the artifacts necessary for subsistence (from tools to shelter to clothing) and to do what was needful (hunt, trap, fish, prepare food, make and keep fire) with our own hands and bodies, using the materials of the natural world; socializing with our fellows and demonstrating with them in participative ceremonies a shared system of beliefs—these are the behaviors that an ethologist from Mars would have recorded as characteristic of our species until the invention of agriculture made possible much larger, stratified, settled societies.

Surely these are behaviors that our cognition and emotions have evolved to find appealing, satisfying, and meaningful. I have no doubt that such lives would have seemed full and rewarding. Had our ancestors not felt that way, had they all been depressed and alienated, we would not be here today. And I think it is fair to say that humans today still have a Pleistocene psychology. Looking at a timeline of life on earth, on which five million years of human evolution is only a few seconds before midnight of a 24-hour day (Potts, 1996, p. 6), modern (post-agricultural or post-Enlightenment) life is itself only a nanosecond of those few seconds. There simply has not been enough time for the fundamental emotional needs and predilections acquired during our lives as hunter-gatherers to have changed very significantly.

To be sure, adaptability is in itself one of humankind's prominent adaptations. Wherever children grow up and in whatever time period, their dexterous hands want to handle and manipulate—whether mud, fibers, and rocks or dials, knobs, and electronic buttons. Curious young minds, ready to participate and learn, are sure to be attracted by fast-moving colorful action, excitement, adventure, violence, and competition— whether in stories told or read aloud by elders or on a computer or TV screen. Can't we say that the toys of twenty-first century life are just a new variation on the old "let's have fun and learn" theme?

Pioneer art therapist Edith Kramer reports that in her long career of working with hospitalized children, the use of art materials with a real person easily out-competed television for their interest (Williams, Kramer, Henley, & Gerity, 1997). But she found that with the availability of video games, children no longer preferred art making. She describes an important psychological as well as physical difference between the two. Although video games may satisfy a need for mastery, they do so without the benefits of the lessons of *real* hands-on play, action, and adventure in an actual social and natural environment. Pressing keys or clicking a mouse is not like building or making real things. Real materials, says Kramer, may resist as well as obey. Handling them generates a kind of body-mind interaction that is not found in computer art.

Zaradic and Pergams mention that videophilia easily fosters a reduction in physical activity. Equally detrimental is the loss of human *inter*activity, which is a vital psychological and emotional need from birth. Human infants, born "natural," immediately show their preparedness to become cultural beings. Newborns are ready to interact socially, preferring human faces and voices to any other sight or sound. Babies are imitative, ready to copy what others do—from early facial expressions and the sounds of language to the gestures and actions of the people around them. Through play and watching what other children and adults do, they acquire the manipulative, physical, cognitive, and social skills that their lives will eventually require. They wish to please others and be accepted by them.

In his landmark work, building on studies by Daniel Stern, Colwyn Trevarthen, and others, Allan Schore presents evidence from many disciplines that caretaker-infant interaction, based on face-to-face visual-vocal communication with mutual gaze, critically influences the development of the infant brain (Schore, 1994). Such interaction is essential to the child's future capacity to self-regulate emotions, to appraise others' emotional states, and to manage stress. Later social interaction with family and peers builds on infant interactivity and intersubjectivity and helps them to develop. Electronic communication, although interactive, remains cognitive and disembodied—the opposite of two people face-to-face. Studies of mother-infant interactions have shown that as early as 8 weeks of age, infants expect their mothers to respond to their own visual, vocal, and kinetic behaviors contingently—that is, in fractions of a second (Beebe, 1982; Murray & Trevarthen, 1985; Nadel et al., 1999). An electronic image may respond to a finger click but not to a small change in facial musculature, vocal sound, or head movement. Coordinating body movements and vocalizations with others has been a time-honored way of building emotional rapport and one-heartedness—from mother-infant play to the ritual ceremonies of the Pleistocene to folk dances and gospel choirs of today. Understanding that humans evolved with the readiness—nay, the emotional need—to interact face-to-face with other people, to handle natural materials, to make and use things for their lives, and to sing and dance in groups is further indication that it is not only the natural environment but the natural human social world that is in danger of virtualization from videophilia.

References

Beebe, B. (1982). Micro-timing in mother-infant communication. In M. R. Key (Ed.), *Nonverbal communication today* (pp. 169–195). The Hague: Mouton.

Eisenberg, John F. (1981). *The mammalian radiations: An analysis of trends in evolution, adaptation, and behavior.* Chicago: University of Chicago Press.

Murray, L., & Trevarthen, C. (1985). Emotional regulation between two-month-olds and their mothers. In T. Field & N. Fox (Eds.), *Social Perception in Infants* (pp. 177–197). Norwood, NJ: Ablex.

Nadel, J., Carchon, I., Kervella, C., Marcelli, D., & Réserbet-Plantey, D. (1999). Expectancies for social contingency in 2-month-olds. *Developmental Science, 2*, 164–173.

Potts, Rick (1996). *Humanity's descent: The consequences of ecological stability*. New York: William Morrow.

Schore, A. N. (1994). *Affect regulation and the origin of the self: The neurobiology of emotional development*. Hillsdale, NJ: Lawrence Erlbaum Associates.

Williams, K., Kramer, E., Henley, D., & Gerity, L. (1997). Art therapy and the seductive environment. *American Journal of Art Therapy, 35*, 106–117.

Author Note

Ellen Dissanayake is the author of *What Is Art For?* (1988), *Homo Aestheticus: Where Art Comes From and Why* (1992), and *Art and Intimacy: How the Arts Began (*2000), all published by the University of Washington Press, Seattle.

BOOK REVIEW

Ljiljana Radenovic

Science in the Service of Children: 1893–1935
by Alice Boardman Smuts, Yale University Press, 2006

Throughout the early and the mid-19th century in the United States, there was neither scientific interest in the study of children nor social institutions that would support such interest. By the mid-20th century, however, the situation had dramatically changed. A number of research stations, institutes, and bureaus had been established for the study of child development and child guidance. Also, by that time, psychologists had agreed that the mental life of adults could be understood only if one had a better understanding of the development of a child's mind, an idea that was entirely foreign to earlier researchers like Wilhelm Wundt, who said that experiments on very young children were "wholly untrustworthy."

Alice Boardman Smuts' book, *Science in the Service of Children, 1893–1935,* is about this revolutionary transition in thinking. In order to understand all the contributing factors in the development of the science of children, both social trends and scientific ideas need to be examined, and in this valuable book, Smuts traces the origins of both. Thus, the book is partly history of science and partly social history. In order to write such a comprehensive book, Smuts, being an historian by vocation, had to venture into the field of child development. *Science in the Service of Children* proves that her venture was successful.

Science in the Service of Children is divided into three parts, each of which lays out in chronological order the main social developments and scientific ideas, carefully including the ideological and theoretical motives behind them. In the process, Smuts covers most of the factors that contributed to the increasing interest in child studies in the United States in the late 19th and early 20th centuries.

The first part of the book ("Preparing the Way") covers the period from 1893 to 1910. The first chapter in this section deals with the social movements of the period, such as social feminism and the settlement house movement. Smuts notes that at this time, middle-class women (unlike women abolitionists or suffragists before the Civil War) chose to use the role of mother to justify their fight for social reforms. Their main concern was the harmful effects of urban-industrial life on women and children. Concerned about the poor conditions in which many children had to live, these women reformers asked for more political rights so that they could influence social policies and achieve child welfare reform. As the need for the social reform grew, so too did the need for empirical investigation and scientific research. Accordingly, during this period, the first social surveys were undertaken; their aim was to reveal connections between the industrial environment and poverty, child labour, and the like.

In Chapter 2, Smuts looks at the origins of the scientific study of children. The chapter is mainly devoted to Stanley Hall and the Child Study Movement. Smuts ably relates Hall's evolutionary theory and genetic psychology to the importance that he accords the study of the contents of children's minds. Chapter 3 deals with the ways in which the evolution of scientific and philosophical ideas about the nature of child development shaped the understanding of childrearing practices. While Chapter 4 continues to look at the interconnection between growing scientific interest in the study of the child and certain social issues, its focus is on how scientists and social reformers became united in a desire to achieve child welfare reform.

In this initial section of the volume, Smuts is particularly good at revealing how certain philosophical ideas brought about some very concrete government-funded actions. For instance, in Chapter 4, she points out that investments in playgrounds and places for children's recreational activities came from changed attitudes about the value of play in children's lives. In an earlier era, John Locke's idea that only hard work can properly form a child's character, as well as the so-called "Protestant work ethic," dominated American society. Therefore, no effort was made to provide such things as playgrounds or children's centres. As Smuts makes clear, the movement to establish public playgrounds throughout the country in the late 19th century derived, at least in part, from the appearance of new psychological theories asserting that play is essential for healthy development.

The second part of the book ("Creating the Models") covers the period between 1910 and 1921. Chapter 5 deals with the continuing efforts of social reformers to establish a government-funded Children's Bureau. This finally happened in 1912. Smuts devotes some attention to a description of the bureau and its first president, Julia Lathrop. At the time of her appointment, Lathrop already had 22 years of experience as a settlement worker, so her belief that the main goal of such a bureau was to improve children's lives is not surprising. However, what is interesting is that in Lathrop's view, the bureau's recommendations should be objectively and scientifically justified. This boosted research in several areas, such as infant mortality, maternal mortality, child labor, dependency, and delinquency. Besides advancing research that would eventually improve child welfare, Lathrop insisted that the bureau should provide advice on parental care and child rearing. As a result, the bureau inaugurated two advice manuals, *Parental Care* and *Infant Care*.

Chapter 6 describes the establishment of the first child guidance clinic. Here, Smuts explains how social reformers (such as Ethel Sturges Dummer), scientists who studied juvenile delinquency (such as William Healy and Bernard Glueck), as well as psychiatrists (such as Adolph Meyer) made child guidance clinics possible. Despite some inevitable differences in their approach to the subject, they were united in the belief that all conduct disorders were more or less treatable, whether these disorders were caused by multiple genetic or social factors.

Chapter 7 describes the establishment of the first child development research institute, the Iowa Child Welfare Research Station. A motto for this drive was coined by Cora Bussey Hillis, who used to say that if agricultural research could help farmers grow better crops and livestock, then research on children's development could help

people grow better sons and daughters. Hillis' campaign for a child study laboratory finally succeeded in 1914, when the State University of Iowa decided to pursue her idea, assigning Carl Emil Seashore to run the laboratory. The focus of the laboratory was the study of normal children; this included the study of very young children. The main goal was to establish norms of child development and a range of deviation. Until this was determined, Seashore argued, neither pediatricians nor parents could judge the progress of a child. It is important to note (and Smuts emphasizes this point) that the underlying idea of the Hillis and Seashore research program was that human behaviour is mainly shaped by environmental influences. This puts them on the nurture side of the nature-nurture controversy of the era.

The third part of the book ("Breaking Through") covers 1922 to 1940. Here, Smuts looks at the continuing efforts of social reformers and scientists to expand the fields of child guidance and child development, as well as the increasing involvement of the federal government in child study. Chapter 8 describes new developments in the American society in the "New Era" that began after World War I. By this time, trust in the value of applied social sciences, including psychology, had grown. Private endowments for scientific research (such as The Laura Spelman Rockefeller Memorial) had multiplied, and the focus of study had shifted from adults' to children's programs. However, an environmental bias (i.e., the nurture side of the nature-nurture debate) continued to dominate the scientific community. The idea was particularly endorsed by behaviorists, who held, as Watson put it, that "children are made, not born." This attitude was extremely important to social reformers, who believed that they could change society by changing child-rearing practices.

In Chapter 9, Smuts moves on to discuss the first major institutes for the study of child development and the initial studies pursed by these institutes. These early studies focused on children's physical development and worked to establish the norms for such development (this was the era of normative research in psychology). In this chapter, Smuts describes the tension between the scientists who were interested in child research in order to help children and those who were interested in a scientific understanding of childhood. Clearly, a proper relationship between research and practice was yet to be found. In 1934, The Committee on Child Development (founded in 1920) finally agreed that research and its applications were equally important. Even so, for the next several decades, research was number one on the Committee's priority list. This chapter also deals with how these newly-established institutions functioned during the Great Depression and how the child development and early education movements influenced federal nursery schools and child-rearing literature.

Chapter 10 is devoted to Arnold Gasell and the Yale clinic. Then, in Chapters 11 and 12, Smuts follows the origins and development of child psychiatry. This includes a detailed outline of the increasing number of clinics and the growing funds available for child guidance programs, as well as the change in the approach to successful clinical treatments (from behaviorism to dynamic psychiatry). The final chapter describes projects on psychological guidance and research projects undertaken by the Children's Bureau between 1922 and 1940. This includes studies on unemployment and its effects on families, studies on maternal and child health, child labour, delinquency, and

the like. In the Epilogue, Smuts briefly outlines how the science of children continued to develop after the World War II.

Smuts' book is a rare and extremely valuable source for anyone interested in the origins of the scientific study of children. The book is unique in the sense that it tackles both history of ideas and social history. Moreover, it successfully elucidates how social development and scientific development are intrinsically interwoven. Although the book does not endorse any particular view on psychological development, it shows how interactionist approaches to development (as opposed to more nativist approaches) connected well with the ideas of social reformers who believed that changes in childrearing practices might improve society in general. The only problem is the book's occasionally dry and overly academic style that can prevent the reader from fully appreciating the early years of social reformers and psychologists. Nevertheless, it deserves to be on the shelves of all those who are in the field of child study, regardless of their critical orientation.

To purchase a copy of the *Journal of Developmental Processes*
or to subscribe to future issues,
please visit www.icdl.com
or call 301-656-2667 for information