1 Looking Back and Looking Forward

Milestones in Research on Early Childhood Development

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Looking Back at the History of Infant Research

Infant research has come a long way. Fewer than 100 years ago, psychologists began to express an interest in early childhood. During the first half of the 20th century, Sigmund Freud worked with adults suffering from a variety of psychological problems. Using the psychoanalytic interview technique, he realized that basic aspects of our personality as adults have deep roots in early experiences. Ethologists such as John Bowlby (1958) picked up Freud's ideas and related human development to evolution and biology, suggesting that experiences during the first years of life have enduring effects. Modern research supports the idea that early social experiences are of crucial and continuing importance (see Chapters 6 and 7, this volume). It quickly became evident that infants' interactions with the physical environment are equally meaningful, as Jean Piaget (1937) pointed out that even newborns interact with the physical world in active and constructive ways. These historical foci on infancy and early childhood have in turn prompted a set of important questions, such as how cognition begins, how young children come to represent the external world, and how first concepts develop. These questions continue to occupy developmental scientists, and they motivate the work presented in this book.

For a long period following Piaget, developmentalists failed to credit infants with much cognitive competence. We now acknowledge that the lack of methods suitable for assessing mental processes in preverbal infants circumscribed our early understanding of infants. Because the motor and language skills of infants are limited, it was hard to discern what happens inside a baby's head. The first attempts to develop methods for studying

the infant mind were published by Darwin and Baldwin, who made close observations of their own children, and by Berlyne (1958) and Fantz (1958) who were among the first to bring babies into the psychological laboratory. For example, using a stopwatch and measuring the reflection of images in the pupil of the infant's eye, Fantz ascertained that infants look at certain stimuli (e.g., faces) for longer periods of time than at other stimuli. He took looking duration to indicate visual interest of the child, and visual interest related to cognitive processes. In this way, Fantz opened the door to studying the infant mind by focusing on infant looking. Fantz's followers have since capitalized on two variants of his methodology, the preferential looking paradigm and the habituation-dishabituation paradigm. Using these and other behavioral procedures, it has been possible to learn a great deal about the abilities of infants to discriminate, remember, and categorize entities in different domains of knowledge. Furthermore, it has been possible to ask about individual differences in infant information processing. In this way, the development of methods advanced our understanding of development.

Today, the variety of methods suitable for probing cognitive capacities of infants is rather large, and the application of these methods during the past decades has revolutionized our ideas about the infant mind. It turns out that infants possess impressive knowledge about different aspects of the world and display quite advanced skills in many domains. As authors in this volume convey, concept formation, physical and numerical reasoning, and social cognition, as well as language acquisition, have roots deep in infancy.

In recent years, too, neuropsychological methods have been added to the developmentalists' armamentarium and deepened our understanding of infant cognition. Infant brain responses provide sensitive measures for certain cognitive abilities, and it is now possible to articulate developments in behavior with those in the brain. From brain research we have also learned about early plasticity. Neural networks undergo major changes in terms of growth and connectivity throughout infancy and toddlerhood, and they can be modified by experience. As will be illustrated in some chapters of this volume, developmental neuroscience has arrived as a promising new path to study mental development in the early years.

Why Is Infant Development of Special Importance?

Views of the human infant have changed dramatically in less than a century. The once helpless little creature lacking any mental abilities is now

seen as a somewhat knowledgeable partner in his or her own development. We have also learned that experiences in early childhood may be of special relevance for later development. Infancy is no longer regarded as the time before mental life starts. Rather, we have come to understand that foundations for intelligence and personality include cognitive and social skills that develop early in life. This conclusion has far-reaching practical implications: If infants come equipped with sophisticated learning abilities, if they can conceptualize experiences and acquire knowledge, and if brain development is the product of complex interactions between existing abilities and external influences, we need to think more carefully about what kinds of environments best serve children to develop their full potential.

Economic analysis of longitudinal studies supports this position. As demonstrated by the Nobelist in economics, James Heckman, the return on investment in high-quality educational programs is related to the age of the children participating (Heckman 2006). To put it in simpler words: Educational programs are most efficient in early childhood and pay by their greatest dividends, especially for children from low socioeconomic backgrounds or otherwise difficult starting situations. Children who participate in high-quality programs show improved cognitive performance and more motivation in school. They live healthier lives, are more likely to participate in social networks, and have their own families. Furthermore, they have better opportunities for better occupations in life. Infancy researchers may not be surprised by these findings. A supportive environment in early years leads to better adjustment in the children's brain and behavior alike that in turn facilitates knowledge and skill acquisition. Because the prosperity of contemporary culture and economy depend heavily on knowledge, children who receive a good education in early years are more likely to be successful in later life and contribute positively to civic responsibility.

A Book about Infant Development

Based on these general insights from infancy research, rapid scientific progress in the field, and the manifest importance of development in the early years, the Jacobs Foundation asked Sabina Pauen to organize a conference on "Early Childhood Education and Later Achievement." In 2008, world-leading experts in the field of infant development convened at a Marbach conference to exchange ideas and discuss implications of their work for caregivers, teachers, and policy makers. To share knowledge presented at this conference, Sabina Pauen agreed to edit a volume that briefly summarizes many of those presentations. The Jacobs Foundation and

Cambridge University Press have generously supported this project. We are thus able to offer the reader a summary of edge-cutting research on a broad range of topics from early childhood. Although it is not possible to cover all dimensions of development within the confines of a single volume, here we provide advanced students as well as scientifically interested practitioners and policy makers with some important insights into the state of the art of infancy research, placing special emphasis on mental development and social functioning.

Unique to this volume, most chapters are written as collaborations of outstanding international experts. This format was chosen to encourage researchers to interrelate their work. To structure the collection, we divided the contributions into two major parts: Part 1 deals with *Emerging Knowledge Structures and Their Impact on Child Development*, and Part 2 deals with *Internal and External Determinants of Childhood Development*. More detailed descriptions of the contents of each part follows.

Emerging Knowledge Structures and Their Impact on Child Development

All authors contributing to the first part of this volume share the basic assumption that knowledge development in infancy is domain specific. Chapter 1 deals with the general question about the nature of infants' first conceptual representations, and the remaining chapters address aspects of knowledge development in specific domains, such as physical and numerical knowledge (Chapter 2), social cognition (Chapter 3), and language acquisition (Chapter 4).

In Chapter 1, Jean Mandler and Judy DeLoache discuss the beginnings of conceptual representations. Mandler provides a theoretical framework that explains how core systems serve as building blocks for later conceptual development, and DeLoache studies errors that young children typically make when they apply newly acquired representations in everyday life. Together, these contributions provide the reader with good examples of how concept formation begins and can be understood by investigating infant success and infant mistakes.

Chapter 2 by Renee Baillargeon and Susan Carey covers the acquisition of physical and numerical knowledge. In the first half, Baillargeon asks how core knowledge in the domain of physics can best be described and how it differentiates during the first years of life. More specifically, she identifies key elements of an innate physical reasoning system and proposes how infants come to detect structure and its violations and how they develop explanations and extract critical variables from the environment based on

their experience. Along the way, Baillargeon reports studies demonstrating how systematic training can alter infants' physical representations and so offers ideas related to early childhood education. The second half of the chapter focuses on the development of numerical knowledge. Here Carey identifies two separate core systems of numerical knowledge in human infants as well as other species. These systems are not sufficient for the infants to count, however; rather, infants need to develop a new way of representing integrals and magnitude relations that is rooted in the core system but requires additional mental skills. Corresponding knowledge develops according to a Quinian bootstrapping mechanism. Carey describes in detail how infants' increasing ability to understand the nature of symbols influences this development. Chapter 2 leaves the reader with a good impression of how infant researchers attempt to explain knowledge progression in different but related domains in early childhood.

In Chapter 3, Amanda Woodward and Tricia Striano pursue a similar general goal when discussing the development of social cognition. As pointed out by the authors, learning from social partners is a two-way street, requiring social-cognitive capacities in the learner as well as a supportive social context. First, Striano explains how infants come to interpret social signals and engage in social interactions that can either be dyadic (infant-partner) or triadic (infant and interactive partner focusing jointly on something else). She uses both behavior and neuropsychological methods in service of her goal. Next, Woodward explores how social experience helps infants to increase their understanding about other humans. More specifically, she describes her research on the development of intentional understanding, highlighting the change from conceptualizing goal-directed action to representing intentional actions as part of an enriched folk psychology that later develops into an elaborated theory of mind. The chapter concludes with an illustration of how motor experience with successful goal-directed reaching helps infants to conceptualize goal-directed actions, thus indicating how interactive experiences with the nonsocial world influence cognitive development in the social domain.

Concluding Part I of this volume, Sandra Waxman and Usha Goswami (Chapter 4) look more closely at later years of early development, asking how children come to acquire spoken and written language. As pointed out by Waxman, world learning is intimately entwined with cognitive development, because infants can only understand the meaning of a spoken word if they have previously acquired some kind of conceptual understanding. Not only do infants need to identify individual words in the stream of spoken language, they have to identify individual entities

(object, events) in the stream of experience before they can map words onto meanings. As Waxman illustrates, an additional challenge consists in the fact that not all words signify objects; for example, some words correspond to features or actions rather than entities. Hence, the infant needs to learn how to discriminate between different kinds of words using knowledge about the world as well as knowledge about language. How phonological development is related to later reading acquisition is explained by Goswami in the second part of the chapter. She proposes a detailed theory that addresses developmental progress and offers information about why some children experience difficulties in learning to read and write. In sum, Waxman and Goswami's contributions complement one another by showing how young children come to master the challenges of language acquisition in different formats of hearing, understanding, reading, and writing.

Internal and External Determinants of Childhood Development

As illustrated in different chapters of Part 1 of this volume, knowledge acquisition can be profitably approached through a domain-specific orientation. Infants come equipped with elaborated information-processing abilities (e.g., to perceive, to remember, to combine, and to conceptualize) that help them to form representations of objects (Chapter 1), physical events and magnitudes (Chapter 2), social relationships (Chapter 3), and language (Chapter 4). However, early stimulation seems to have considerable effects on infant learning, a consideration that raises issues of internal and external determinants of individual differences. Do all infants come equipped with the same mental abilities?

In Chapter 5, the first contribution to Part II of this volume, Marc H. Bornstein and John Colombo provide the reader with an overview of infant studies that bear on the prediction of mental development based on assessments of infants' basic information-processing capacities. The authors focus on the most prominent paradigm to measure visual attention: habituation-dishabituation. They ask how stable individual differences in performance can be assessed with this paradigm, and how well measures of visual attention based on it predict later intelligence and achievement, thereby, highlighting the role of internal determinants of child development.

Chapter 6 adopts a complementary approach, asking about the role of early experiences on brain maturation and later functioning. Charles Nelson and Nathan Fox report results of a longitudinal study designed to test aspects of development in Romanian orphan children who either stayed

in the orphanage throughout their early childhood or were put into foster care very soon. One virtue of this study is that it used a matched-control design, ensuring that the children in the two groups were comparable with respect to their physical health and family background before they were exposed to different environments. Furthermore, the study controlled for the quality of foster care and tested children on a frequent basis, gathering both behavioral and neurological data. The authors point to striking differences in brain, mental, and social development between these groups, suggesting that high-quality care, a secure environment, and adequate cognitive and emotional stimulation during the first years of life are requisite to wholesome child development.

Raising the issue of benefits and dangers related to child-care institutions in Western cultures, Michael Lamb discusses the impact of nonparental care on emotional development in Chapter 7. Lamb first gives a brief overview of the history of nonparental care, highlighting that institutionalized child-care has always been a part of normal life. Based on this general insight, he then reviews empirical studies asking how this kind of child-care influences development, and he arrives at the conclusion that both the quality of child-care and the quality of parent-child relationships predict developmental outcomes. This work suggests that investment in high-quality daycare is necessary for all children to develop their full potential.

Looking Forward into Future Infant Research

At this point, the circle closes. Child development research increases our understanding of early childhood development. This work provides the basis for advice to parents, to health-care professionals, and to policy makers for designing high-quality educational programs. Investments in early childhood pay dividends for the individual as well as for society. Thus, we have learned that infants are capable of acquiring knowledge from early on. To do so effectively and efficiently, they need an emotionally secure and cognitively stimulating environment that offers adequate support to develop those skills that help them become healthy and successful members of their culture. The present volume addresses this complete process by offering a collection of contributions that describe advances in a diversity of vital aspects of early childhood development. Reading this volume will yield an impression that developmental science has come a long way and that we now know quite a lot about infancy and early development. However, we are still far from knowing exactly how best to help people achieve their full potential. The challenges to future researchers are to advance knowledge

and the science of infant development further, and to create settings that promote human development.

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2 The Beginnings of Conceptual Representation

Jean M. Mandler and Judy DeLoache

This chapter deals with a fundamental question that developmental psychologists have been trying to answer for more than 100 years: How do we come to represent objects and events in terms of concepts – the basic building blocks of human thinking and reasoning? Even though we are still far from knowing all the answers to this question, much progress has been made during the past several decades. One promising approach is to integrate recent findings on preverbal understanding of objects and events within a theoretical framework that describes how concept formation begins, what the core conceptual system consists of, and how it develops over time. Yet another promising approach is to study errors that young children make when they apply their newly acquired conceptual representations in everyday life. The present chapter provides the reader with one prominent example for each approach. In the first section, Jean Mandler describes how a process of *Perceptual Meaning Analysis* creates concepts from spatial information and how they become enriched in various ways. In the second section, Judy DeLoache presents her work on *scale errors* and explains how such errors inform us about the difficulty of aligning conceptual and motor representations in young children.

Creating Concepts from Spatial Information

The First Concepts

One of the things we have learned about infant development in recent years is that along with the sensorimotor skills of recognizing and acting on objects that Piaget described, infants are also learning to interpret what they observe conceptually. Even before they begin to act on objects, they

show attentional biases that help create their first interpretations of events. In particular they attend to motion through space (Haith 1980; Kellman 1993). They attend to whether objects start moving by themselves (Leslie 1982), whether they interact with other objects (Frye et al. 1983), and the kinds of paths they take (Rochat, Morgan, & Carpenter 1997).

One of the results of this bias is that at least until 6 months, infants attend to and remember more about what objects do than about what they look like. For example, 5-month-olds are better at remembering where an object has been hidden than what the object looks like (Newcombe, Huttenlocher, & Learmonth 1999). They are also better at remembering the action an object took (such as brushing hair) than what the object was (for example, a brush or a bubble wand) (Bahrick, Gogate, & Ruiz 2002; see also Perone et al. 2008). Lack of attention to object detail is one of the reasons so-called basic-level concepts, such as *dog* and *cup*, are not the first kinds of concepts to be formed. Instead, early object concepts tend to be more global with less detail – that is, sketchy "superordinate" notions such as *animal*, *vehicle*, and *container* rather than notions such as *dog* or *cup*. Action on objects helps infants attend to the details that will eventually carve out basic-level concepts from more global ones. For example, by 11 to 12 months, infants have begun to pay attention to parts of objects that produce interesting results, and they begin to categorize objects on that basis (Träuble & Pauen 2007).

The early global concepts, which for objects are known to be formed by 7 months (Mandler & McDonough 1993) and probably as early as 3 months ground the later basic-level concepts. Young infants see a dog or a cat but think of them both as *animal*. (However, *animal* is an adult linguistic construal; as discussed later in this section, the infant concept is probably something more like *self-moving interactor*.) Similarly, a cup or a pan is understood as *a container*. For example, when 14-month-olds are asked to imitate an event in which a person drinks from a teacup, and they are provided with various objects they might use, they are as likely to choose a frying pan for their imitation as they are a mug (Mandler & McDonough 1998).

Only gradually do infants subdivide global concepts. Although as early as 3 months of age, infants are able to categorize various animals on the basis of differences in their perceptual appearance (Eimas & Quinn 1994), generalized imitation studies such as the one just mentioned show that conceptual differentiation is a slower process. For example, in Mandler and McDonough (1998, 2000) we showed that infants conceptually differentiate land animals and birds by 14 months, but do not definitively differentiate land animals such as dogs and rabbits until some time between 20 and 24