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Human Infancy ... and the Rest of the Lifespan

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Abstract

Human infancy has been studied as a platform for hypothesis and theory testing, as a major physiological and psychological adjustment, as an object of adults' effects as well as a source of effects on adults, for its comparative value, as a stage of life, and as a setting point for the life course. Following an orientation to infancy studies, including previous reviews and a discussion of the special challenges infants pose to research, this *Annual Review* focuses on infancy as a foundation and catalyst of human development in the balance of the life course. Studies of stability and prediction from infancy illustrate the depth and complexity of modern research on infants and provide a long-awaited reply to key philosophical and practical questions about the meaningfulness and significance of infancy.

Keywords

Infancy; infant effects; stability; prediction

HUMAN INFANCY

He who ... considers things in their first growth and origin . . . will obtain the clearest view of them.

--Aristotle (350 B.C.E.), *Politics*, Part Two

Human infancy has always offered a certain romantic and simultaneously enigmatic attraction: All of us have been infants, yet perceptions, thoughts, and feelings of our infancy are seemingly lost to us. Infants are irresistible to our senses, engaging of our intellect, and moving to our emotions. Infants are completely dependent and under our care, and the results of our actions towards them become embodied in them. Infancy represents a beginning in which much is invested theoretically, psychologically, and personally. Formal studies of infancy have largely concerned delineating the status of different characteristics (constructs, structures, functions, and processes) in early life. Focusing on characteristics so close to the start, investigators of infancy are also naturally concerned with how biological

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and experiential forces fuse to shape our origins as well as the unfolding course of future development.

Infancy encompasses only a fraction of the average person's expected life span, but infancy is characterized by remarkable physiological, physical, and psychological changes, many of which are evident even on casual observation. Within this brief period, the child's length and weight multiply, and the child changes from an immature being unable to move his or her limbs in a coordinated manner to one who can purposefully control complicated sequences of muscle contractions and flexions necessary to grasp and walk, and from an unintelligible babbling to a sentient being who can verbalize needs and wishes with abundant clarity.

As the baby grows into the child, and the child eventually into the adult, exploring and explaining what transforms as the individual develops from infancy to maturity, and what remains stable and predicts the future person have constituted challenging tasks to philosophy, biology, and psychology. A reply to them is the principal topic of this *Annual Review*.

DEFINITION, HISTORY, CHALLENGE, AND ORIENTATION

What is an infant? What were the origins of infancy studies? The period of life called infancy is somewhat ambiguous and arbitrary; however, the Latinate root of infant, *in* + *fans* (non-speaker), ties the definition to a psychosocial event, *viz.* the onset of language, rather than to physical characteristics, weaning or walking, educational requirements, or vagaries of legal opinion. For purposes of this review, infancy encompasses roughly the first year of postnatal life.

In response to a note on language acquisition by Taine (see Kessen 1965), Charles Darwin (1877) published in the English journal *Mind* "A Biographical Sketch of an Infant." The notes that constituted this account of the first years of his firstborn son William Erasmus (Doddy) had been recorded in notebooks almost 40 years earlier. Darwin's foremost roles in the origins and descent of comparative psychology generally, of developmental science specifically, and of infant studies particularly are by now legendary (Lerner et al. 2011). In the years following Darwin's publication, a plethora of "baby biographies" appeared, and infancy studies blossomed (Bornstein, Arterberry, & Lamb 2013).

Previous Reviews

Landmark reviews and integrations of the infancy literature to date include Kessen, Haith, and Salpatek's (1970) overview in Mussen's third edition of Carmichael's *Manual of Child Psychology*, entitled "Infancy: A Bibliography and Guide." Their survey approach appended more than 2,000 references to works on infants appearing to that time. Stone, Smith, and Murphy's (1973) *The Competent Infant* built on Kessen et al., excerpting important original works. Haith and Campos (1977) updated the bibliography in their "Infancy" chapter with copious additional references in the first *Annual Review* of infancy, and Hay's last *Annual Review* organized progress in infancy studies to 1986. In the roughly quarter-century since then, much has happened, and infants have grown up. Articles, essays, chapters, monographs, and books on infancy have appeared at an ever quickening pace. Notable

periodic compilations focused on academic approaches to infancy (not trade books) include Haith and Campos's (1983) *Infancy and Developmental Psychobiology*, Osofsky's (1987) *Handbook of Infant Development*, and Rosenblith's (1992) *In the Beginning*; they have been supplanted by more contemporary treatments, including, Fogel's (2007) *Infancy: Infant, Family, and Society*, Bremner and Wachs's (2010) *Handbook of Infant Development*, and Bornstein et al.'s (2013) *Development in Infancy: A Contemporary Introduction*. Several scientific journals, *Infancy*, the *Infant Mental Health Journal*, and *Infant Behavior and Development*, to name a few, are now devoted exclusively to infancy and enjoy robust publication; of course, infant studies also prominently populate a host of other academic periodicals in psychology and allied disciplines. These trends support Haith and Campos's (1977) valediction that the "allocation of the whole chapter in the *Annual Review of Psychology* to 'Infancy' is only one of many indications that the field has come into its own" (p. 251).

Thus, the literature in infancy is reviewed periodically, but not previously from the perspective that is advanced here. This *Annual Review* looks at infancy as a setting point in the life course. It has not been possible to do so before now because appropriate longitudinal data on the same participants collected in one study beginning in infancy and extending forward had not yet reached a critical mass.

Challenges of Studying Infants

How much we have learned about infant behavior and development, in approximately the last half-century, is testimony to the ingenuity, patience, and persistence of researchers in meeting and overcoming the formidable challenges posed by infants themselves. First and foremost, infants are by definition nonverbal (but not, of course, noncommunicative), and they are also, especially in the early months of life, motorically incompetent, emotionally labile, and subject to rapid fluctuations in behavioral state. Unlike adults, infants are not motivated to perform for researchers. Other problems too vex investigators like infants' like short attention spans and their limited response repertoires.

Yet, infants are also important and attractive to study, for a host of reasons spelled out immediately below, not the least of which is their role in the balance of the life span, the principal subject here. The impediments infants present have stimulated researchers to develop strategies geared to overcome various communication barriers that naturally but infelicitously separate infants from the rest of us. Through intense appeal and decades of rigorous investigation, infants have slowly divulged their many secrets. This glimpse into the heretofore private world of infancy, and what it portends for the future, constitutes one of the notable achievements of modern developmental science.

Seven Types of Infancy Studies

Infants contribute to psychological inquiry in the "magical number seven" (Miller 1956) major ways. Here, I touch on six of the seven types very briefly and then dwell on the seventh in detail. Each type merits extended treatment, which is not possible within the confines of an *Annual Review*. Amplification of one illustrates the breadth and depth of all.

First, as infancy provokes enduring philosophical, juridical, and social dispute and question, it has been the subject of continuing theoretical interest. Because infancy is a period of life that precedes the onset and influence of (much) experiences, for example, traditional nature-nurture debates have turned to infants. A principal task of infancy is radical adaptation from the secure comfort of the intrauterine environment to the kaleidoscopic extrauterine universe. Therefore, second, infancy is a major physiological and psychological adjustment. Third, adults wield extraordinary and nearly limitless control over infants in part because infancy is a period of both helplessness and plasticity. Aside from genetic bequest, caregivers exercise continuing and powerful influence over infants in their roles as ministrators, socializers, and educators. However, fourth, human infants are equally powerful stimuli to adults. Infants inspire song, poetry, literature, humor, art, and *Annual Reviews*. It is only for heuristic purposes that the otherwise inextricable mutuality between infants and adults into “effects on” and “effects of” can be separated. Transactions rule life: the level at which parents pitch the complexity of speech to their infant depends on the infant’s display of understanding, and infants’ comprehension depends on the complexity of speech addressed to them. Fifth, infancy is a natural arena for comparison of human abilities, behaviors, and development relative to newborns of other species, and, because many sorts of experimentation with human infants fall outside of ethical bounds, comparative animal models of infancy are common. Sixth, infancy appears to be a distinct stage of life, based on biological, cognitive, and social data, and so is meritorious of study in its own right. Infants do not speak, whereas children do; infants creep and crawl, whereas children walk and run. Many outstanding developmental theorists—Freud, Piaget, Erikson, and Werner—have championed stage theories of development, and all identified infancy as one. Finally, but not lastly, infancy has been studied as a basis of stability in development and prediction of the future life course.

STABILITY AND PREDICTION FROM INFANCY

The concept of development is most readily associated with change (Block & Block 2006a Kagan 1976, 1998, Wohlwill 1973). As the child rapidly grows from the infant, change in many developmental characteristics are prominent and observable. The measured values of characteristics plotted across age define their developmental functions, and the species-general developmental function of many characteristics (from height to language) is discontinuous (Emmerich 1964).

The other side of the developmental coin to change is consistency, manifest as continuity and stability. In actuality, consistency may be more parsimonious and orderly than change, and many characteristics of human development remain (more or less) consistent over time or connect in regular ways to later points in development. Consistency *qua* continuity describes maintenance of the group mean level of a characteristic over time; consistency *qua* stability describes maintenance in the ranks of individuals in a group with respect to the expression of a characteristic over time (Bornstein & Bornstein 2008, Hartmann, Pelzel, & Abbott 2011). Thus, a stable characteristic is one that some individuals demonstrate at a relatively high level at time 1 (infancy) and again at a relatively high level at time 2 (maturity). Stability has many variations and interpretations. Homotypic stability expresses maintenance of rank order status on an identical characteristic from time 1 to time 2 (e.g.,

vocabulary size at 12 months and at 12 years). Heterotypic stability or predictive validity expresses maintenance of rank order status between two related, but not identical, characteristics. The two may be related because they share the same underlying process (e.g., vocabulary size at 12 months and reading ability at 12 years both reflect language). Stability and prediction share their side of the developmental coin.

A fundamental conceptual issue that has framed debates in theory and research across the history of developmental science has concerned stability and prediction. What do individual differences in infants tell us about the human being's future development? The terms "seeds," "precursors," "potentials," and "Anlagen" are commonly applied to constructs, structures, functions, and processes in infants that foretell later characteristics. This *Annual Review* deliberates on questions of stability and prediction from infancy.

Why and How Developmental Science is Concerned with Stability and Prediction from Infancy

Why—The long-term significance of infancy has engendered intense dispute between two polar theoretical stances. Some authorities rail against so-called "infant determinism" and contend that infancy is not particularly important because the status of the infant or experiences in infancy have little (if any) long-term significance. That is, infant characteristics and experiences leave no irreversible signs on people's lives but are supplanted later in development. This position emphasizes discontinuities and instabilities between infancy and maturity: Infancy is disconnected from the balance of the life course, and infant characteristics and experiences are peripheral or ephemeral or inconsequential in the sense that they exert little or no enduring effect (Bruer 2002, Clarke & Clarke 2000, Kagan 1998, Lewis 1997). Empirical support for this point of view typically consists of failures to find lagged associations between the same or different characteristics in infancy and maturity, demonstrations of the recovery of functioning from early adversity or deprivation, as well as failures of early experiences or interventions to show sustained effects.

However, others theorists contend that infancy is part of a seamless and united lifeline and that characteristics and experiences in infancy are not only important in themselves but are also crucial to later life. For these theorists, biological functioning, intellectual predilections, personality inclinations, and social orientations in infancy set enduring patterns. Arguments for the specialness of infancy in these ways derive from a diverse and impressive array of theoretical starting points, including psychoanalysis, behaviorism, constructivism, ethology, neuropsychology, attachment, and systems theory. For example, Freud (1949) focused attention on infancy, suggesting that the ways babies are treated establish lifelong personality traits, and Erikson (1963) theorized that the resolution of developmental crises in infancy have implications for the way the person negotiates successive stages of development. For theorists like Watson, Skinner, and Dollard and Miller, learning in infancy is important because it occurs first and promotes easy and rapid later learning. They asserted that early and simpler behavior patterns underlie later and more complex ones. Piaget (1970) likewise opined that advanced developmental capacities build on elementary ones of very early life, all the way back to infancy. For their part, ethologists and embryologists from

Lorenz and Tinbergen to Gottlieb emphasized the lifelong legacy of infant experiences (as in sensitive periods; Bornstein 1987, 1989). Bowlby, Ainsworth, and their successors (Sroufe, Egeland, Carlson, & Collins 2005) in turn theorized that attachment experiences and classification in infancy augur future cognitive development, personality, and social relationships. Furthermore, modern systems theorists contend that development consists of hierarchically organized characteristics that incorporate earlier emerging ones (Lewontin 2005). Finally, contemporary life-course theory brackets human development as extending from the prenatal period and infancy to maturity and death. Understanding development requires examining characteristics and experiences over long periods of time to capture how later life depends on early life trajectories (Elder 1998, Elder, Shanahan, & Jennings 2015).

Infancy has therefore held a certain significance for those interested in stability and prediction, even when the characteristics and long-term effects of experiences from infancy are neither obvious nor direct. Developmental science generally carries three burdens—description, explanation, and prediction. Of these, prediction is the most thorny and problematic (as many a homespun philosopher has quipped: “prediction is difficult, especially if it’s about the future”). However, prediction from infancy has many vital purposes and benefits, its moral and ethical consequences notwithstanding. To put their ambit and value most succinctly, stability and prediction deepen psychological understanding, open the possibility of individual assessment, and lead to greater economy of decision making and more efficacious distribution of resources. These are theoretically worthy as well as highly practical goals.

Stability and prediction are also important constructs for developmental science per se. In interpreting the theoretical significance of a characteristic, it is essential to determine whether the characteristic represents something enduring in individuals or is better viewed as linked to a particular developmental time point or context, with few or no future implications. Knowledge about which characteristics are stable or predictive, beginning when, and over what periods of time, is foundational in the study of development.

Findings of stability and prediction tell us about the nature and overall ontogenetic course of a characteristic. Whether individuals maintain their order on some characteristic, or a characteristic is predictive through time, informs not only about individual variation, but contributes to understanding of the origins, nature, and future of that characteristic as well. Is past performance the best predictor of future performance? Insofar as a characteristic is stable or predictive, we know that individuals who do well or poorly with respect to that characteristic at one time are likely to do well and poorly again later. Moreover, stable and predictive early characteristics tend to shape later emerging ones. Infants who know more words at 1 year tend to know more words at 2 years, and 2-year-olds who know more words may be at a long-term advantage because knowing more words speeds learning to read, improves verbal comprehension, and eventuates in more advanced written language skills (Marchman & Fernald 2008).

Stability and prediction are also meaningful because characteristics with such attributes in childhood signal developmental status to other people, thereby affecting the child’s environment and likely his or her own development. Interactants often adjust their

expectations and behaviors to match another's consistent characteristics (as when adults modify their language to harmonize with the language of a child). On the basis of stability and prediction, infants actively contribute to their own development.

Finally, most developmental scientists believe that individuals understand the world in unique ways that reflect their unique persons, interactions, and experiences. This perspective depends (in part, at least) on stable tendencies and capacities in the individual. In a nutshell, developmentalists are broadly interested in how characteristics manifest themselves in infancy and the developmental course of those characteristics – their stability and prediction through time. Characteristics that are stable or predictive in ontogeny are informative as to the nature of those characteristics per se as well as the individuals who possess them.

How—Historically, reports of stability and prediction have relied on simple or zero-order lagged correlations and regression analyses, comparing infants' performance early in life with their performance years later as children, adolescents, or even adults. In addition, growing sophistication in the statistical armamentarium for estimating stability and prediction across time has welcomed latent growth curve modeling (Asendorpf & van Aken 1999, Boga et al. 2009, Bridgett et al. 2009, Bridgett & Mayes 2011, Hill-Soderlund & Braungart-Rieker 2008, Pasco, Fearon, & Belsky 2011), path analysis (Bornstein et al. 2006, LaBuda, DeFries, Plomin, & Fulker 1986), hierarchical linear modeling (Bada et al. 2007, Shafir, Angulo-Barroso, Calatroni, Jimenez, & Lozoff 2006), and hazard analyses (Frank et al. 2011). For temporally distal, developmental processes, moreover, tests of indirect paths between predictors and criteria are sometimes more sensitive, powerful, and theoretically appropriate than tests of simple direct relations (Shrout & Bolger 2002). A developmental cascade, for example, defines a longitudinal relation in which a characteristic at time 1 is uniquely associated with another characteristic at time 2 separate from other intrapersonal and extrapersonal factors (Masten & Cicchetti 2010). In cumulative processes, which refer to the growing implications of earlier characteristics or experiences for later outcomes, early individual differences are magnified in prediction (DiPrete & Eirich 2006). That is, in some cases the linear model may be inadequate to the task of assessing stability or prediction, and other statistical techniques may be more appropriate for multi-level longitudinal analysis (Bergman, Magnusson, & El-Khoury 2003, Collins & Sayer 2001, Little, Schnabel, & Baumert 2000).

Duncan et al. (2006) usefully described a continuum for evaluating the methodological rigor of studies such as those aimed at stability and prediction. At the popular end of the spectrum are correlational designs that analyze simple associations between measures in infancy and later outcomes, with few adjustments for confounding factors, and so this kind of research likely suffers from various biases. At the rare end are experiments in which infants are randomly assigned to treatment conditions and followed longitudinally; experiments can provide unbiased estimates of prediction (and, of course, are more appropriate to prediction than to stability). Between these extremes fall studies that employ techniques to reduce various biases (e.g., like omitted variables using fixed effects and instrumental variables regression) and natural experiments. Despite the burgeoning literature documenting stability and prediction (reviewed below), it is necessary to be cautious in drawing strong conclusions because still few studies have employed research designs or analytic methods that effectively

and comprehensively address threats to internal validity. Increasingly, however, researchers are opting for designs and analyses that seriously address biases from diverse sources.

Furthermore, empirical studies of stability and prediction usually settle for data from only two assessment waves. However, it is less than desirable to discern patterns of stability and prediction from two assessments (i.e., whether stability and prediction stabilize at a nonzero value or approach zero in the limit). Following the logic in Fraley, Roisman, and Haltigan (2013), a significant relation between measurements of some characteristic at time 1 and the same or a different characteristic at time 2 would seem to indicate that the characteristic is stable or predictive. However, conclusions about stability or prediction would vary depending on the resultant coefficient at other developmental waves. Suppose, on the one hand, that stability and prediction maintained to times 3, 4, and 5. This pattern would suggest that stability and prediction are enduring. Suppose, on the other, that stability or prediction attenuated at times 3, 4, or 5; that is, as the temporal interval increased, stability or prediction approached 0.00 in the limit. This pattern would suggest that, although the time 1 characteristic may play a role in the time 2 characteristic, the association eventually tempers, indicating that longer-term stability or prediction may be trifling. The two patterns have contrasting consequential implications (McCartney & Rosenthal 2000).

Long-Term Stability and Prediction from Infancy

The infancy literature is replete with studies of stability and prediction assessments confined *within* the first year of life (e.g., Artzi et al. 2011, Beebe et al. 2010, Bridgett et al. 2009, Fish 2001), and developmental science more generally abounds with studies that evaluate and substantiate stability and prediction *after* infancy (e.g., Asendorpf & van Aken 2003, Gao et al. 2010a, Casey et al. 2011, Caspi 2000, Dennissen, Asendorpf, & van Aken 2007, Guerin, Gottfried, & Thomas 1997, Martinez-Torteya, Bogat, von Eye, & Levendosky 2009, Reese, Jack, & White 2010). Notably, Bloom (1964) suggested that 50% of an adult intelligence is developed by 4 years of age, basing this conclusion on the strong statistical correlation between IQ at 4 years and IQ at 17 years. The Fels longitudinal study reported that IQ at 3 years predicted attained education and occupational status after 26 years (McCall 1977). Block and Block (2006b) observed that preschool children who were relatively more anxious, indecisive, and prone to guilt were more likely to endorse conservative values when they were 23 years. Many reports now extend from childhood or adolescence well into late life (Ashby & Schoon 2012, Benson & Elder 2011, Casey et al. 2011, Gao et al. 2010b, Kell, Lubinski, & Benbow 2013). Among the oldest, active longitudinal studies, with birth years extending from 1903 to the 1920s, was Terman's on a sample of talented children: by the 1990s, investigators who continued this project had completed 13 waves of data spanning 70 years (Crosnoe & Elder, 2004, Holahan & Sears, 1995, Shanahan & Elder, 2002). Notably, however, past long-term longitudinal studies typically began in adolescence and often assumed that what transpired before—in the first years of life—was little consequential.

Because long-term longitudinal research generally was rare, and research beginning in infancy almost absent, it was not possible previously to answer questions about stability and prediction from infancy. This is unfortunate, because knowing more about which aspects of

humanity are stable or predictive is (as argued above) vital to a full understanding of the nature and process of development. Now, however, examples from multiple domains have begun to populate the life course literature, and they reveal pervasive stabilities and predictions from the first year of life (or even before) to childhood, adolescence, and adulthood. To animate the discussion and broaden generalizations, the following sections illustrate stability and prediction from biological, physical, and motor domains of development, from perceptual, cognitive, and communicative domains of development, and from emotion, temperament, and social domains of development. Infant experiences are also considered. Most are recent efforts, but where available, each section begins with reference to classical studies from the 1960s–1970s. In which domains of development are characteristics preserved from infancy? Several, it turns out.

Biological, Physical, and Motor Development

Interest in stability and prediction in biology was reinvigorated when events occurring in early postnatal (or even prenatal) life were traced and found to have long-lasting effects on behavior and health. Barker and his colleagues in the 1980s unearthed an association between low birth weight (LBW) and ischemic heart disease in adulthood (Barker & Osmond 1986). The so-called Barker Hypothesis identified the general importance of early determinants of adult disease. A wealth of data has been published since showing an inverse association between infant size at birth and adult blood pressure, type 2 diabetes, heart disease, and enhanced response to stress (Barker, Eriksson, Forsén, & Osmond 2002, Huxley, Shiell, & Law 2000, Jones et al. 2006, Hales et al. 1991, Phillips et al. 2005). More generally, this line of research has led to articulation of the developmental origins of health and disease paradigm (DOHaD; Barker 1998, Bateson et al. 2004, Gluckman & Hanson 2006).

A frequent design encountered in the biological literature consists of between-group comparisons of “treatment” children, adolescents, or adults versus controls where the treatment (preterms vs. fullterms, toxin exposed vs. nonexposed) happened in the first year of life, or sometimes earlier. Publications appear periodically as successive waves of data collection are completed (Corapci, Radan, & Lozoff 2006, Gahagan, Yu, Kaciroti, Casillo, & Lozoff 2009, Geva et al. 2009, Hane, Henderson, Reeb-Sutherland, & Fox 2010, Lorenz et al. 2009, McAnulty et al. 2010, Paradise et al. 2007, van Baar, Ultee, Gunning, Soepatmi, & de Leeuw 2006). The deduction is that any mature differences between the groups are ascribable to continuing infancy (or prenatal) characteristics or experiences (rather than any intervening factor or experience). These studies concern themselves with an eclectic variety of outcomes, linking different biological, physical, or motor characteristics in the first year of life to many different later criteria. For example, preterm infants, relative to term infants, later in life show anatomical differences in the brain structure, are at increased risk of diabetes and heart disease, more likely display impaired motor skills, higher heart rate, attention and cognition problems, delayed language, low IQs, and developmental and learning disabilities, and they experience increased problems in social and academic functioning (Aziz, Schlindwein, Wailoo, Biala, & Rocha 2012, Bhutta, Cleves, Casey, Craddock, & Anand 2002, Caravale, Tozzi, Albino, & Vicari 2005, Foster-Cohen, Edgin, Champion, & Woodward 2007, Gayraud & Kern 2007, Kerkhof, Breukhoven, Leunissen,

Willemsen, & Hokken-Koelega 2012, Mewes et al. 2006, Phillips & Barker 1997, Saigal 2000, Saigal, Hoult, Streiner, Stoskopf, & Rosenbaum 2000, Salt & Redshaw 2006, Sansavini et al. 2006, Schothorst & Egeland 1996, Shenkin, Starr, & Deary 2004, Spassov et al. 1994, Taylor, Klein, & Hack 2000 Taylor, Klein, Minich, & Hack 2000, van de Weijer-Bergsma, Wijnroks, & Jongmans 2008, Woodward, Mogridge, Wells, & Inder 2004). Children born before 26 weeks gestation and followed until 6 years report higher rates of cognitive impairment compared their classmates (Marlow, Wolke, Bracewell, & Samara 2005). Smaller babies also grow up to be sadder adults: Birth weight has been linked to both depression and anxiety over 40 years (Colman, Ploubidis, Wadsworth, Jones, & Croudace 2007). Long-term follow-up studies show preterm infants (even those without medical disabilities) have as adults lower educational attainment and income, are less likely to establish a family, and are more likely to receive Social Security benefits (Moster, Lie, & Markestad 2008). Infancy is also a particularly vulnerable period, for example to malnutrition, and growth problems forecast poor cognitive and social functioning in middle childhood and adolescence (Grantham-McGregor & Fernald 1997, Guerrant et al 1999, Kar, Rao, & Chandramouli 2008). Postnatal exposure to various toxins, like PCBs, has also shown adverse behavioral and emotional effects as, for example, in decreased sustained activity and high-level play and increased withdrawn and depressed behavior, aggression, and emotional reactivity (Lai et al. 2002, Perera et al. 2012, Rogan & Gladen 1991, Vreugdenhil, Slijper, Mulder, & Weisglas-Kuperus 2002).

A more straightforward approach in these domains has been to assess an hormonal or autonomic or central nervous system characteristic in infancy and relate it directly to the same or another (related) characteristic later in development. The diversity is striking. Higher levels of testosterone at 3 months of age predict greater penile growth in early childhood (Boas et al. 2006). Heart rate (HR), heart rate variability (HRV), and parasympathetic control measured in the first year of life are stable up to 5 years (Bar-Haim, Marshall, & Fox 2000, Bornstein & Suess 2000, Calkins & Keane 2004). Skin conductance activity in typically developing 1-year-olds predicts mother-rated aggressive behavior problems at 3 years (Baker, Shelton, Baibazarova, Hay, & van Goozen 2013). Thus, hormones and measures of autonomic function during infancy carry through to multiple measures of physical, autonomic, and behavior in childhood and later. Together, these results provide evidence of early postnatal origins of more mature development.

Likewise, evoked response potentials (ERP) in the first year of life predict children's later language, cognitive, and socioemotional development (van der Feest 2010). Infants who show less neural activity to non-native contrasts at 7.5 months have larger vocabularies at 24 months, suggesting that infants who are more attuned to the sounds in their language are better at learning words (Kuhl 2009); auditory ERPs of English-exposed American infants in response to both Spanish and English voicing contrasts at 11 months of age predict the number of words children produce at 18 through 30 months of age (Kuhl & Rivera-Gaxiola 2008; see also Garcia-Sierra et al. 2011, Rivera-Gaxiola et al. 2005); cortical auditory ERPs at 6 and 9 months predict language at 3 and 4 years (Choudhury & Benasich 2011); a discriminant function analysis of the brain waves of newborns predicts the classification of 8-year-old children into normal- and low-language performance groups with about 80% accuracy (Molfese 2000). Brain electrical activity at 8 months also predicts working memory

at 4.5 years (Wolfe & Bell 2007). Stability in frontal brain activity asymmetry at 10 months predicts higher externalizing and internalizing behaviors as rated by mothers at 2.5 years (Smith & Bell 2010), and infants with right frontal EEG asymmetry show higher levels of anxiety and less ability to regulate their emotions in middle childhood (Hannesdottir, Doxie, Bell, Ollendick, & Wolfe 2010).

MRI can be used to measure the sizes of brain structures, and these measures in young infants also predict later language abilities (Ortiz-Mantilla, Choe, Flax, Grant, & Benasich 2010). fMRI studies allow precise localization of brain activity and show remarkable similarity in the structures responsive to language in infants and adults (Dehaene-Lambertz, Dehaene, & Hertz-Pannier 2002, Dehaene-Lambertz & Hertz-Pannier 2006).

A related characteristic shown to be predictive in the long-term is physical status of the infant. Low birth weight (LBW; < 2kg) is predictive of motor problems at 16 years (Whitaker et al. 2006); height and head circumference at 1 year predict IQ and neurodevelopmental outcomes at 9 and 10 years (Fattal-Valevski et al. 2009); and being small for gestational age has an independent effect on 16-year full-scale IQ, controlling for other pre- and postnatal risk factors (Lorenz et al. 2009). Small for gestational age newborns have higher HR and lower HRV than newborns adequate for gestational age; babies born with low birth weight have lower HRV in childhood and adulthood as compared to babies born with normal weight; and those born preterm have higher HR at 18 to 24 years, as compared to normal controls (Aziz et al. 2012, Kerkhof et al. 2012, Phillips & Barker 1997, Spassov et al. 1994).

Even infantile colic (excessive crying in an otherwise healthy baby classically defined by Wessel criteria as at least 3 hours of crying at least 3 days a week for 3 weeks; Wessel, Cobb, Jackson, Harris, & Detwiler 1954) appears to be associated with migraines in children aged 6 to 18 years (Gelfand, Thomas, & Goadsby 2012, Guidetti, Ottaviano, & Pagliarini 1984). Other early childhood periodic syndromes (benign paroxysmal vertigo or benign paroxysmal torticollis) are thought to be expressions of genes that later in life also manifest as migraine (Giffin, Benton, & Goadsby 2002).

Early on, Gesell (1937) reported patterns of individuality and consistency in motor behavior from the first to the fifth year of life. Movement and coordination at between 1.5 and 4.5 months are consistent with the later female advantage in finer motor skill and male advantage in gross motor activity (Piek, Gasson, Barrett, & Case 2002). Movement at 4 months predicts motor and cognitive status at 2 years (Rose-Jacobs, Cabral, Beeghly, Brown, & Frank 2004); motor control at 3 months, parent-reported attention problems at 8 years (Friedman, Watamura, & Robertson 2005); manipulative skill at 4 months (Kohen-Raz 1967), the Beery Developmental Test of Visual Motor Integration (VMI; eye-hand coordination) at 5 years (Siegel 1983a); activity at 5 months, attention and play after 1 year (Tamis-LeMonda & Bornstein 1993); psychomotor status at 6 months, developmental profiles at 2 years (McCall, Hogarty, & Hurlburt 1972); and motor control at 3 months, attention at 8 years (Friedman et al. 2005). A large-scale ($N = 374$) normative prospective 14-year longitudinal multivariate multisource controlled study showed that infants who were more motorically mature and who explored more actively at 5 months achieved higher levels

of academic achievement at 14 years through conceptually related and age-appropriate measures of psychometric intelligence at 4 and 10 years and academic achievement at 10 years. This developmental cascade applied equally to girls and boys and was independent of children's behavioral adjustment and social competence, mothers' supportive caregiving, verbal intelligence, education, and parenting knowledge, and the material home environment (Bornstein, Hahn, & Suwalsky 2014).

Similarly, the Bayley Scales Psychomotor Development Index (PDI) in the first year of life predicts expressive language at 2 years (Siegel, 1981), 3 years (Siegel, 1979), and 4 years (Siegel, 1982) and the McCarthy GCI at 6 years (Siegel, 1983a); 4-month PDI, 6-year VMI (Siegel 1989); and 8-month PDI and 1-year motor development, 7-year intellectual level (Broman, 1989).

Perceptual, Cognitive, and Communicative Development

A second developmental domain in which long-term stabilities and predictions are being documented includes perception, cognition, and communicative functions in the first year of life. Neonatal look duration relates to selective attention at age 12 years (Sigman, Cohen, Beckwith, Asarnow, & Parmelee 1991), and ocular reaction time (RT) to targets in a visual expectation paradigm at age 3.5 months relates to ocular RT at age 4.5 years (Dougherty & Haith 1997). Perceiving a unique face in an anomalous social experience (still-face) at 5 months predicts face recognition at 1.5 years (Bornstein, Arterberry, & Mash 2004). Despite years of visual input being available to both hemispheres following corrective surgery for congenital cataracts that blocked all patterned input to both the left and right eyes in infancy, people later show impaired face processing in the right but not the left hemisphere (Le Grand, Mondloch, Maurer, & Brent 2003). Long-term perceptual effects are not restricted to vision: Infants who nursed for 6 weeks from mothers who placed a balm with a distinctive odor on their nipples retained a representation of the odor for at least 18 months after they had stopped nursing (Allam, Soussignan, Patris, Marlier, & Schaal 2010), and 6.5-month-olds sitting in a dark room who reached out on hearing a sound from the space in front of them reached out when they returned to the lab and were played the sound 2 years later (Keen & Berthier 2004); in both instances, infants without the experience did not react.

Studies of stability in cognition have demonstrated consistencies as well. 6-month-olds' performance in an action interpretation task predicts their performance on theory of mind tasks at 4 years (Aschersleben, Hofer, & Jovanovic 2008). Infant information processing abilities in the first 6 months of life in three domains (attention, speed, and memory) relate to language and executive functions (working memory, inhibition, and shifting) at age 1.8 (Dixon & Smith 2008), age 4 (Cuevas & Bell 2013, Courage, Howe, & Squires 2004), and age 11 years (Rose, Feldman, & Jankowski 2012), academic achievement at age 14 years (Bornstein et al. 2012), span of apprehension and intelligence at age 18 years (Sigman, Cohen, & Beckwith 1997), and IQ and academic achievement at age 21 years (Fagan, Holland, & Wheeler 2007), even after contributions of biological and psychological third variables have been partialled (Bornstein et al. 2012, Laucht, Esser, & Schmidt 1994).

The Bayley Scales are often interpreted as a general measure of infant cognition. The Bayley Scales Mental Development Index (MDI) at 4 to 12 months predicts the Reynell

Developmental Language Scales (RDLS) performance at 2, 3, and 4 years (Siegel, 1979, 1981, 1982, 1983a, b, 1985a, b), the Bayley MDI administered at 3 months predicts the Stanford-Binet at 3 years, the McCarthy Scales of Children's Abilities (MSCA) at 4 years, and the Wechsler Preschool and Primary Scale of Intelligence (WPPSI) at 4, 5, and 6 years (Wilson 1978).

Infants in the first year of life do not command much in the way of verbal abilities per se; however, some speaking patterns we acquire early appear to last a lifetime (Flege 1991). Longitudinal studies demonstrate stability and prediction from a variety of early preverbal skills to measures of later language. Indian infants adopted by American families and only exposed to English relearn Indian-dialect phonemes more quickly than American children who had never heard the Indian phonemes (Singh, Liederman, Mierzejewski, Barnes 2011); speech perception at 6 months predicts language acquisition (word understanding, word production, and phrase understanding) at 2 years (Tsao, Liu, & Kuhl 2004) and Fernald, Perfors, & Marchman 2006), and speech discrimination at 6 months predicts phonemic awareness scores at age 5 years (Cardillo 2010); speech processing performance (segmenting words from fluent speech) before 12 months predicts language assessed at 6 years (Newman, Ratner, Jusczyk, Jusczyk, & Dow 2006). The trajectory of learning to discriminate vowels between 7 and 11 months predicts children's language abilities and pre-literacy skills at age 5 years, an association that holds regardless of SES as well as the level of children's language skills at 18 and 24 months of age (Cardillo Lebedeva & Kuhl 2009). Infants' early phonetic perception (Kuhl et al. 2008, Kuhl, Conboy, Padden, Nelson, & Pruitt 2005, Rivera-Gaxiola, Silva-Pereyra, & Kuhl 2005, Tsao et al. 2004), their pattern-detection skills for speech (Newman et al. 2006), mismatch responses to native-language sounds (Kuhl et al. 2008), and processing efficiency for words (Fernald et al. 2006) have all been linked to advanced later language abilities. Studies of communication skills and expressive vocabulary at 8 and 12 months also show predictive relations to mother-reported child symbolic use of objects at 2 years (Reilly et al. 2009); and 12-month-olds' vocabulary as measured by the CDI predicts their 4-year verbal IQ (Blaga et al. 2009, Domsch et al. 2009). Finally, 3-month-old boys' differential vocalizations to their mothers versus a stranger predicts cognitive and academic functioning at 12 years, high-school grade point average and SAT scores, and education completed by 28 years (Roe, 2001).

Emotions, Temperament, and Social Development

A third developmental domain of long-term study includes evaluations of emotions, temperament, and social interactions in the first year as predictive of child, adolescent, or adult criteria. Emotions are normally thought to be transient and fleeting. In consequence, emotions per se might not be expected to cast a long shadow. Nonetheless, low approach behaviors and poor inhibitory control at 4 months have been linked to internalizing behaviors at 4 years (He et al. 2010), and 3- to 4-month-olds who cry during experiments are more likely to be fearful and anxious adolescents (Ohr, Feingold, & Fagen 2006). Institutionalized care beyond 1 year appears undermine emotion identification and labeling in 4- to 5-year-olds (Camras et al. 2006).

Chess followed children at regular intervals from infancy to young adulthood to try to understand the temperamental origins of later behavioral disorders. Their findings suggest that some aspects of early temperament had long-term consequences. For example, the majority (70%) of difficult infants in their sample manifest behavior problems later in life (Thomas, Chess, & Birch 1970). Temperamental difficultness, irritability, and negativity themselves appear to be stable from the first year (Rothbart & Bates 2006). Four-month behavioral inhibition, an infant temperamental style characterized by distress to novelty, predicts social wariness at 7 years (as moderated by maternal negative personality; Degnan, Calkins, Keane, & Hill-Soderlund 2008). In more normal bands of temperament, mother as well as father reports of activity level, smiling and laughter, distress to limitations, and fear at 6 months foretell behavioral adjustment at 5.5 years (Komsí et al. 2006), and temperamental exuberance in 4-month-olds predicts 5-year-olds' externalizing and surgency (Degnan et al. 2011).

In one longitudinal study, 4-month-olds were classified as either high or low in reactivity (depending on levels of motor activity and distress in response auditory, olfactory, and visual stimuli) and were then examined at 14 and 21 months (Kagan & Arcus, 1994), 4.5 years (Kagan, Snidman, & Arcus 1998), and 7 years of age (Kagan, Snidman, Zentner, & Peterson 1999). Temperamental reactivity was stable over time. Moreover, children classified as highly reactive in infancy were more likely to react fearfully to novel stimuli at 14 and 21 months than were children classified as unreactive; by 4.5 years, highly reactive children showed less spontaneity and sociability with adults; and by 7 years, highly reactive children were more likely to behave anxiously than were non-reactive children. In adolescence at 15 years of age, highly reactive infants had become shy and anxious (Kagan 2013), and fMRI examinations at 21 years in the same sample revealed that previously inhibited children showed more amygdala activity than did previously uninhibited children when looking at novel, as opposed to familiar, faces (Schwartz, Wright, Shin, Kagan, & Rauch 2003).

Infants' expressions of smiling and laughter predict their anticipatory eagerness about upcoming positive events at the age 7 (Rothbart 1988, Rothbart, Derryberry, & Hershey 2000). Parent-reported infant reactivity to sensory stimulation at 10 months is related to social inhibition at 2 years (Andersson, Bohlin, & Hagekull 1999); fear (distress to novelty) in infancy is associated with increased latency to approach later in childhood (Rothbart & Mauro 1990). In early adopted children followed from infancy to adolescence, temperament was found to be stable over time (Jaffari-Bimmel, Juffer, van IJzendoorn, Bakermans-Kranenburg, & Mooijaaart 2006); and physical aggression, as reported by mothers and fathers, in a sample of children initially recruited at 12 months was moderately stable 1 year later (Alink et al. 2006). Infant activity level predicts positive emotionality, and higher anger/frustration and low soothability-falling reactivity at age 7; and infants who show a short latency to grasp objects at 6.5, 10, and 13.5 months show high levels of positive anticipation and impulsivity as well as high anger-frustration and aggression at age 7 (Rothbart et al. 2000). Putnam, Rothbart, and Gartstein (2008) reported stability for fine-grained scales and factor-level temperamental dimensions from the Infant Behavior Questionnaire-Revised to the Early Childhood Behavior Questionnaire to the Children's Behavior Questionnaire.

Temperamentally difficult 1 year olds who experience negative and intrusive mothering show externalizing behavior at 3 years (Belsky, Hsieh, & Crnic 1998); similarly, infants who are temperamentally difficult and experience harsh parental reactions as 4-year-olds show externalizing behavior in adolescence (Bates et al. 1995).

Social Anxiety Disorder (SAD) causes the experience of intense fear and distress in social situations. Chronis-Tuscano and her colleagues (2009) investigated whether behavioral inhibition, a temperamental disposition to withdraw from unfamiliar social interactions, was an early sign of SAD. They measured temperament at ages 4 months, 24 months, 4 years, and 7 years. When the children were between the ages of 14 and 16 years, they were assessed for SAD. Onset for SAD was normally after 7 years. Temperament proved relatively stable from infancy to adolescence, and infants who showed early stable and high maternal-reported behavioral inhibition were most likely to show SAD by 14 to 16 years at age.

Across domains, temperament at 8 months predicts working memory at 4.5 years (Wolfe & Bell 2007); exuberance in infancy (vigorous motor activity, babbling, and smiling) predicts sociability and risk taking at 5 years (Lahat et al. 2012); hyperreactivity in the first months of life predicts periodic syndromes at 10-11 years (Guidetti et al. 1984); and reactivity at 4 months correlates with ventromedial prefrontal structural brain differences at 18 years (Schwartz et al. 2010).

The social status and social interaction style of infants have also been found to predict later development. In this area, infants' attachment status (usually measured around or just after the child is 1 year) has been the focus of many follow-on longitudinal investigations. Developmentalists have been drawn to infant attachment especially out of reasoning that the security of the infant's early relationships influences the ways in which the person relates to others during life after infancy (Bowlby 1969; van IJzendoorn 2005). Main and Cassidy (1988) reported a high degree of stability between 12-month attachment assessments in the Strange Situation and 6-year assessments, and meta-analysis confirms that attachment status is moderately stable across (at least) the first 19 years of life (Fraley 2002).

Expectations of its developmental spreading effects are borne out in studies that show that quality of infant attachment predicts later social relationships with siblings and peers (Furman & Lanthier 2002, Garner 2006, Ladd & Pettit 2002, Volling 2003, Zimmermann, Maier, Winter, & Grossmann 2001). Indeed, different attachment types predict a variety of developmental outcomes. Secure infant-mother attachments at 12 months are associated with more accurate perception of emotion in faces (Steele, Steele, & Croft 2008) and superior problem-solving abilities in diverse stressful and challenging contexts into the preschool years (Sroufe et al. 2005). Babies with secure (Type B) attachments to their mothers are later more cooperatively playful when interacting with a friendly stranger and more popular and socially competent in their peer group in elementary school (Sroufe et al. 2005). The quality of infant attachments also predicts school children's perceptions of their relationships with teachers, underscoring both the long-lasting and broad impact of infant attachment status (Howes, Hamilton, & Phillipsen 1998, NICHD Early Child Care Research Network 2005, 2006). For its part, insecure attachment in infancy and, in particular the disorganized/

disoriented classification, predicts antisocial behavior in childhood (Jafferi-Bimmel et al. 2006), PTSD symptoms at 8.5 years (McDonald et al. 2008), externalizing behaviors at 12 years (Pasco Fearon & Belsky 2011), and compromised parent-adolescent relationships and increased likelihood of deviant behavior among youth (Allen, More, Kuperminc, & Bell 1998). A core assumption of attachment theory is that individual differences in adult attachment styles emerge from individuals' developmental histories (Hazan & Shaver 1987, Mikulincer & Shaver 2007). An age 18 follow-up of the NICHD SECCYD, a longitudinal investigation that tracked a cohort of children and their parents from birth, reported that individual differences in adult attachment styles could be traced to variations in infants' caregiving environments in combination with other factors (Booth-LaForce & Roisman 2012, Fraley, Booth-LaForce, Roisman, Owen, & Holland 2013). Infant attachment security is associated with the security of participants' romantic relationships in young adulthood (Roisman, Collins, Sroufe, & Egeland 2005). Adults who classify themselves as secure are more likely to describe their early experiences with their parents as being affectionate, caring, and loving (Hazan & Shaver 1987), whereas adults who classify themselves as insecure are more likely to describe their parents as cold or rejecting (Collins & Read 1990).

Attachment classification is not the only long-term social style predictor from infancy. It has been recognized for some time that early (3-month) infant participation in interactions with their mothers predicts their later (6-year) intelligence (Coates & Lewis 1984). Other socioemotional factors in infants appear to predict as well. For example, differences in infants' perception of intentional agency at 12 months predicts their understanding of others' theory of mind, mental states, and beliefs as 4-year-olds (Yamaguchi, Kuhlmeier, Wynn, & vanMarle 2009). Infants' interactions at 7 months predict their expressive and productive vocabulary at 14 months (Lunden & Silven 2011). Infants whose mothers show positive responses at 12 months have higher WPPSI IQ at 4 years (Pearson et al. 2011); and fathers' diverse vocabulary in interactions with their infants at 6 months predicts children's communication skills at 15 months, after adjusting for infant developmental level at 6 months and other confounders (Pancsofar & Vernon-Feagans 2010). Noll and Harding (2003) found that, when mothers respond to their 12- to 47-month-olds' object play in an "options-promoting" manner (encouraging, affirming, and/or expanding on the child's activities), their children later engaged in higher levels of symbolic play. Socially at-risk mothers who received nurse visitations prenatally and postnatally had 15-year-olds who were relatively protected on a host of criminal and antisocial behaviors (Olds et al 1998). Parents who endorse more egalitarian parenting attitudes at 1 month are more likely to have children who are liberal in their ideologies at age 18 years (Fraley, Griffin, Roisman, & Belsky 2012).

Infants' extrafamilial social experiences are likewise predictive of later development. Infants who experience longer hours of child care, based on average hours/week since 1 month of age, are rated by caregivers at 4.5 years as showing more problem behaviors, even when extensive family covariates and other child care dimensions are included as covariates (NICHD ECCRN 1998, 2003a, b). Infant child care hours continue to predict outcomes through high school, showing modest associations with self-reports of risk taking and impulsivity (Belsky et al. 2007), and the effects of early child care on cognitive and social functioning appear to persist through age 15 (Vandell et al. 2010). Similar patterns of

associations between hours of infant care and child problem behaviors have been reported in other studies conducted in the United States (Loeb et al. 2007) as well as Canada (Côté, Borge, Geoffroy, & Rutter 2008) and the United Kingdom (Neighbourhood Nurseries Initiative Research Team 2007).

Reciprocally, clinical levels of maternal depression, when children are between 3 months and 3 years of age, are associated with aggression and antisocial behaviors at 5 to 8 years of age (Wright, George, Burke, Gelfand, & Teti 2000). Indeed, as pointed out earlier, more severe social deprivation in infancy appears to exert untoward effects on later development. Beckett and colleagues (2006) and Kreppner and colleagues (2007) compared multiple cognitive and socioemotional outcomes in 11-year-olds initially reared in Romanian socially depriving institutions but adopted out of Romania into the United Kingdom (U.K.) prior to 2 years of age with comparison samples of noninstitutionalized children adopted from Romania and nondeprived within-U.K. early (before the age of 6 months) adoptees. By the age of 11 years, Romanian children adopted in the U.K. before 6 months of age largely caught up when compared to within-country U.K. adoptees, and more so than Romanian children placed into adoptive homes after 6 months. For example, their mean IQ score at 11 years exceeded 90. Children adopted before 12 months of age are as securely attached as their non-adopted peers, whereas children adopted after their first birthday show less attachment security than non-adopted children (van den Dries, Juffer, van IJzendoorn, & Bakermans-Kranenburg 2009), and the sequelae of deprivation in infancy are still present in some children at age 11, as evidenced in their quasi-autism (problems in social reciprocity and communication, unusual and circumscribed interests), disinhibited attachment (lack of clear differentiation between familiar and unfamiliar adults), inattention/overactivity (both at home and at school, many ADHD diagnoses), and cognitive impairment (poor academic achievement). Sheridan, Fox, Zeanah, McLaughlin, and Nelson (2012) used structural MRI and EEG to examine brain structure and function in typically developing children in Romania exposed to institutional rearing and children previously exposed to institutional rearing but then randomized to a high-quality foster care intervention to evaluate whether placement in an improved environment mitigates the effects of institutional rearing on neural structure. Children with histories of institutional rearing had smaller cortical gray matter volume than never-institutionalized children. Cortical white matter did not differ for children placed in foster care than never-institutionalized children but was smaller for children not randomized to foster care. Other complementary research shows that institutionalized children possess larger amygdalae than noninstitutionalized children (Tottenham et al. 2010).

Within an adopted sample, current executive functioning (EF) is associated with measures of early deprivation after controlling for IQ, with less time spent in the birth family before placement in an institution and lower quality of physical/social care in institutions predicting poorer EF performance (Hostinar et al. 2012).

In Bronfenbrenner's bioecological model, the macrosystem is acknowledged to exert effects on development (Bronfenbrenner & Morris 2006). Infancy is apparently vulnerable to macrosystem forces. For example, economic conditions in early life (such as business cycles) have far-reaching consequences for individual mortality rates (van den Berg,

Lindeboom, & Lopez 2009): Being born during a recession is associated with an increase in the mortality rate after the first year of life. Birth-year (but not subsequent) family income is negatively associated with adult Body Mass Index among low-income families (Ziol-Guest et al. 2009); likewise, immune-mediated chronic diseases play a role in associations between poverty in the prenatal year through age 2 (but not between ages 3 and 5 years or between ages 6 and 15 years) and limitations on activities of daily living, hypertension, and arthritis and on adult productivity between ages 30 and 41 (Ziol-Guest et al. 2012). Duncan et al. (2015) learned that family income in the period age 0 to 2 years had larger beneficial effects on adolescents' completed schooling and adults' college attendance than later family income. Generally speaking, economic disadvantage in very early childhood is linked to worse overall health status and higher rates of mortality in adulthood (Case, Fertig, & Paxson 2005), and early family indigence is linked to heightened risk for several chronic diseases in adulthood (Johnson & Schoeni 2007 as reported in Duncan et al. 2015): By age 50, individuals who experienced poverty in early childhood were 46% more likely to have asthma, 75% more likely to be diagnosed with hypertension, 83% more likely to have been diagnosed with diabetes, 2.25 times more likely to have experienced a stroke or heart attack, and 40% more likely to have been diagnosed with heart disease, in comparison to individuals whose family incomes were 200% of the poverty line or greater.

Illustrative Long-Term Longitudinal Epidemiological Projects

The foregoing summaries recount stability and prediction literatures from infancy which have developed around specific topics in specific studies. A number of large-scale multivariate epidemiological longitudinal efforts have also been initiated that have or will adventitiously address issues in stability and prediction from infancy. Among the most notable is the Dutch "hunger winter" study. Near the end of World War II, western (but not northern or eastern) Holland endured a food blockade which provided an unhappy but significant natural experiment in infant development and long-term public health. Unlike other famines, the Dutch Hunger Winter struck during a precisely circumscribed time and place and in a society that keeps comprehensive and meticulous health records of its population. As a result, researchers could identify children who were malnourished during different specific ontogenetic periods and follow their development periodically well into adulthood. Relative to those children who received proper nutrition, malnourished fetuses and infants suffered more nervous system congenital abnormalities as well as increased risk of schizophrenia in maturity (Hoek, Brown, & Susser 1998, 1999).

Other notable long-term longitudinal multivariate epidemiological investigations from infancy include the Helsinki Birth Cohort 1934-1944 Study in men now reaching old age (Tuovinen et al. 2012); cohorts in the United Kingdom, marked by birthdates of 1946, 1958, 1970, and (the Millennium National Longitudinal Study) 2000, all scheduled to be followed into the later years of life (Ferri, Bynner, & Wadsworth 2002); the National Longitudinal Survey of Youth that has followed a sample of individuals born in the 1950s and 1960s and their offspring (Blau 1999); the Panel Study of Income Dynamics that has followed a nationally representative sample of U.S. children since 1968 (Duncan et al. 2010); the Dunedin Study from New Zealand that has continuously observed children born in 1972–1973; the Carolina Abecedarian Project in the United States that began in the 1970s with

predominantly African American families with 3-month-olds; the Cebu Longitudinal Health and Nutrition Survey in the Philippines that began with a cohort of Filipino women who gave birth between 1983 and 1984; the Avon Longitudinal Study of Parents and Children in the United Kingdom that followed all 1991 – 1992 births in that district; and the NICHD SECCYD that recruited families in 1991 from research sites around the United States. Table 1 presents a representative sampling of such studies.

Desiderata

Stability and prediction from infancy are compelling and long-standing topics of philosophical, biological, psychological, and clinical interest. Should we take these emerging long-term stability and predictive validity data from infancy at face value? In evaluating their merit as well as designing the studies of tomorrow and assessing reports that appear in the future, several considerations warrant attention.

Baby biographies of the late 19th and early 20th centuries that followed on Darwin provided a wealth of ideas about infants, and the evidence developed from those baby biographies had two important implications. First, they showed that infants of different ages were competent at different tasks, and, second, they revealed considerable individual variation among infants. The question that naturally arose was whether individual differences on different tasks were transient or consequential. Stability and prediction alike intimate their meaningfulness. Among the perennial and far-reaching questions about human ontogeny, the issue looms large of what connections (if any) obtain between early individual differences and later life.

In practice, stability and prediction effects and their sizes depend on what variables are considered, the way they are measured and when, the length of time between initial and criterion measurements, which analyses are used, which kinds of infants or families living in which circumstances are studied, whether background variables are statistically controlled, and so forth. The penultimate section of this *Annual Review* explores some of these critical desiderata.

Longitudinal methodology—In the past, cross-sectional designs prevailed in developmental study, and investigations that followed individuals over their lives were rare, essentially excluding longitudinal data. In consequence, life course study has been late arriving to the scholarly developmental literature (Elder et al. 2015). The fortuitous expansion of long-term longitudinal studies, coupled with conceptual and methodological advances, have generated new knowledge about ontogenetic stability and prediction. There is today, moreover, substantial appreciation of the benefits of longitudinal data (Ferri, Bynner, & Wadsworth 2003, Hauser 2009, Phelps, Furstenberg, & Colby 2002), which Butz and Torrey (2006) referred to as one of the greatest innovations of 20th century social science. Even still, most of this growing literature is correlational, and there are far fewer studies that rely on quasi-experimental designs or use rigorous analysis of longitudinal ones.

Cause, source, and covariates—An association between the same characteristic early and late, or between a different early and late characteristics, forges a lagged link which is suggestive but not determinative of a causal connection between the two. Moreover, stability

and prediction presuppose, but do not prove, that the stable or predictive characteristic is in the individual. It could be that other endogenous or even exogenous variables theoretically carry or mediate lagged associations.

Stability between infancy and maturity might depend, in part or in whole, on stability in the child's environment: stability in how significant people interact with the child or in the physical surroundings they provide. For example, one characteristic (easy temperament) at time 1 in infancy could relate to the same or to another characteristic (open personality) at time 2 in maturity because of stability in the individual characteristic *or* because some environmental characteristic (parents who support well-being) is stable. Individuals inherit a species-typical genome and a species-typical environment. Species-universal conditions constrain development – they limit the contexts in which genes will be expressed – and thus an individual's life course. For the most part naturalistic circumstances favor environmental stability, and children are reared in stable material and social environments (Holden & Miller 1999), so that consistent experiences across (at least) early development are likely. For example, observer ratings of maternal sensitivity in parent–child relationships correlate across multiple assessment waves ranging from early infancy to age 15 (Fraley, Roisman, & Haltigan 2012). The likelihood of stability and predictive validity is enhanced when environmental contexts remain relatively stable. Of importance to the interpretation of stability and prediction, beyond temporal ordering, is therefore the control of continuing environmental supports to stability and prediction.

Similarly, inclusion and elimination of other third variable common causes that could mediate observed links is requisite to apt interpretation. If third variables mediate stability or prediction, once the contribution of the common cause is removed, individual stability or prediction should attenuate. For this reason, third variables are increasingly being taken into account through the application of partial correlations (Lozoff, Jimenez, & Wolf 1991), hierarchical regression approaches (Rose-Jacobs et al. 2009), or other statistical maneuvers. Path analysis modeling makes it possible to reduce the influence of key confounds and initial covariances, as it allows control for spurious effects related to covariances between infant and other exogenous factors. Structural equation modeling is often also employed to assess stabilities and predictions controlling for other variables, and here the use of latent variables capitalizes on the shared contributions of different approaches, allows for measurement of a characteristic to vary (appropriately) across time while retaining comparability, and permits purer representations of characteristics because variance arising from sources unique to particular indicators that is not accounted for by the factor is relegated to its error term (Bentler 1995, Bentler & Wu 1995, Bollen 1989, Kline, 1998).

Prediction failures—Bell, Taylor, and Dockrell (1965) examined relations between low birth weight and incidence of disease or deformity at 10 years; they found no relation. Kagan, Lapidus, and Moore (1978) showed 2-year-olds distinctive and unusual pictures which they failed to recognize as 10-year-olds. Some studies produce mixed or inconclusive stability or prediction. In essence, it could be that there actually is little or no stability or prediction from infancy. However, it would be invalid to accept this null hypothesis about human development before examining measures that redress a raft of alternative explanations for null results. The want of a connection between a characteristic in infancy

and later life could be attributable to several different possibilities (such as the measurement instrument or the measure) or correlations may be misleading (if development follows a progression of discrete stages) or if the range of scores at either anchor age is truncated (Smolak & Levine 1984) or if the experience is brief, unimportant or not meaningful (Kagan 2013).

Of course, some development may seem discontinuous. New abilities emerge that often qualitatively differ from anything preceding. Do all early attainments qualify as precursors to later ones? Are nonverbal gestures precursors to language? Is the newborn stepping reflex a precursor to walking?

Moreover, there are many reasons to expect null or small associations between infancy and maturity. One reason is that individual differences in maturity are influenced by concurrent experiences. For example, daily-diary study indicates that variation in adult attachment patterns reflects contemporaneous experiences in interpersonal relationships (La Guardia, Ryan, Couchman, & Deci 2000, Pierce & Lydon 2001). The likelihood that early status or experience plays a role in shaping later individual differences has to be judged in the context of understanding that later variance can result from more proximate cause. Likewise, environments are subject to change. Furthermore, all mature characteristics are likely a function of a number of factors. To the extent that multiple factors contribute to variation in the mature phenotype, the explanatory power of any one relative to the rest is diminished (Ahadi & Diener 1989, Strube, 1991).

IVs and DVs—Stability and prediction depend crucially on the infant variable, the criterion variable, and the fit between the two. This admonition has several constituents. First, to be valuable and meaningful, a characteristic observed in an infant needs to be reliable, meaning that observed one day it ought to be similar how it is that observed in the same infant a short time later. Otherwise, the characteristic would not constitute a reliable index of the infant. Statistically speaking, as Spearman noted, unreliability places inexorable limits on predictive validity (Cohen, Cohen, West, & Aiken 2003). (Similarly, it is unreasonable to expect an early experience to predict later to a greater degree than it predicts subsequent assessments of itself.) Additionally, a characteristic may not be stable at one point in the life course, but stabilize at a later age.

Second, use of a single IV may underestimate the true effect on a mature criterion. Generally, the less information that is available, the lower the stability estimate (Hartmann et al. 2011). Colombo (Colombo, Mitchell, & Horowitz 1988, Colombo, Shaddy, Richman, Maikranz, & Blaga 2004) showed that the predictive validity of infant performance is improved by combining or aggregating items or tasks. Because the effects of individual differences can be expected to accumulate across development, focus on a single predictive index measured at a single point in time may underestimate its true contribution. Focus on a single outcome variable measured at a single point in time may likewise underestimate stability and prediction in development (Caspi, Bem, & Elder 1989, Rutter & Rutter 1993).

In considering IVs, third, it may be critical to distinguish between performance and competence, because one may predict better than the other. Relatively rapid development

also makes it difficult to determine which performance is more representative of the baby and therefore predictive: optimal performance, average performance, or minimal performance.

Last, across time the same measures (that assess homotypic stability) are (usually) more highly related than are different measures (that assess heterotypic stability or prediction). Thus, homotypic stability may represent liberal (upper bound) estimates which are augmented because of shared source and method variance, practice effects, and the like, whereas heterotypic stability may represent conservative (lower bound) estimates because of the variance introduced by differences in assessment instruments and procedures used at different times. Greater stability might be expected between variables that conceptually relate than between those which do not. (Similarly, whether assessments are made across consistent or inconsistent contexts may make a difference: the former enhance stability and the latter attenuate stability; Bornstein, Tamis-LeMonda, & Haynes 1999.) Finally, although surface manifestations of characteristics change over the life course, some latent variable of surface variables might reflect an enduring individual difference (Bornstein & Putnick 2012).

Timing—Different patterns of stability and prediction could emerge depending on the ages at which individuals are initially and terminally assessed, and concomitantly longitudinal effects are a complex function of the interval between assessments. Measures taken early in development are (usually) less highly predictive than are measures taken later in development (Asendorpf 1992, McGrew & Knopik 1993), as people are thought to become increasingly consistent in relation to one another as they age (Roberts & DelVecchio 2000), and so stabilities tend to increase with increasing age. Furthermore, the shorter the inter-assessment interval, normally the higher the stability estimate, a phenomenon sometimes called the Guttman (1954) “simplex” (Conley 1984).

Both catch-up and sleeper effects moderate stability and prediction. Catch-up effects define situations where a relation between time 1 and time 2 may hold, but not between time 1 and time 3 (Wilson 1978). For example, compared to infants born at term very low birth weight infants show deficits in reading comprehension at 9 years that no longer obtain at 15 years (Samuelsson et al. 2006). Reciprocally, sleeper effects define situations where a relation between time 1 and time 2 may not hold, but may emerge between time 1 and time 3 (Betancourt et al. 2011, Bridgett & Mayes 2011). For example, infants who were born during the Dutch hunger winter and experienced chronic malnutrition in their first trimester *in utero* manifest elevated rates of schizophrenia, which did not emerge until late in development (Hoek et al. 1999, Roseboom, de Rooij, & Painter 2006).

Developmental research has primarily focused attention on micro timescales to assess normative ontogenetic patterning. Less attention has been focused on longer timescales to explore stability and prediction, and even less has been done to explore development in terms of very long timescales (our concern here). Comprehensive explanations in development need to consider all timescale perspectives.

Sample—Sample size and composition moderate stability and prediction. Small samples may lack the power to detect existing associations that large samples possess. Homogenous samples may harbor associations that are masked by diverse samples (Bornstein, Jager, & Putnick 2013). In some subsamples stability and prediction may be smaller, in other subsamples larger. Loss of follow-up over time (attrition) may introduce bias, as stability and prediction apply only to those individuals who survive longitudinal study.

Effect size—Effect size (like the correlation coefficient which is often the main statistic used to authenticate the relation between infant scores and mature scores) quantifies stability or prediction. Stability and prediction effect sizes tend to be small to modest. However, judgments of the importance of an effect are subjective. As many theoreticians and empiricists have emphasized, small effect sizes can be meaningful, as for example from a public health perspective (Abelson 1985, Ahadi & Diener 1989, Cortina & Landis 2009, Prentice & Miller 1992, Rosenthal & Rubin 1982, 1983, Vacha-Haase & Thompson 2004, Yeaton & Sechrest 1981). The correlation coefficient, moreover, is subject to the nature of the distribution and does not necessarily provide useful information about individual cases. Lack of heterogeneity in the distribution of scores (restriction of range) at either anchor age can attenuate correlation, and failure to examine individual patterns may account for the apparent lack of stability or predictability.

Theory—Stability and prediction need to be interpreted taking into consideration assumptions of a field. Background theory, classical research, and even the temporal distance of the relation can create a situation in which any non-zero effect reasonably supports conclusions about stability and prediction. That is, importance is at least partly a function of whether stability or prediction is expected at all. Theory and empiricism once established the strong expectation of no stability or predictive validity of mental development from infancy (Bayley 1949), and the implications of this position were far-reaching for the nature of infancy and conceptions of mental development. To be meaningful new predictive data may need only fail to disconfirm such expectations. In the field of stability and prediction from infancy, small effects can represent impressive support, and showing that stability or prediction holds under unlikely and unexpected circumstances can be as striking as (or, in some cases, more striking than) showing that one or the other accounts for a great deal of variance. The fact that an effect survives a stringent test, as in the inclusion of multiple controls, is additionally probative.

Direct and Indirect Effects—Some stability or prediction effects are direct, others indirect. Direct effects may be evidenced by associations between IVs and DVs. Indirect effects play theoretically appealing and essential roles, as in developmental cascades, but may be more elusive and challenging to detect than direct effects. They are also destined to be small mathematically due to the statistical fact that, as the number of intervening variables in an indirect effect increases, the magnitude of the overall indirect effect decreases. (The indirect effect is the product of path coefficients leading from an independent variable through intervening variable(s) to a criterion variable.)

Weaknesses and Strengths of the Literature—On the one hand, longitudinal study is subject to design flaws. Reusing the same measures, a good thing for strict assessments of stability, can capitalize on practice effects and shared method variance, a bad thing *re* conclusions. Similarly, the use of the same reporters or testers at different ages capitalizes on shared source variance that may inflate stability correlations, and staff who are familiar with participants may carry over their familiarity from one testing session to another. Most stability and prediction reports do not indicate whether testers are masked (but see Rose-Jacobs et al. 2004, Rose-Jacobs et al. 2011). On the other hand, the stability and prediction literature doubtlessly suffers the “file drawer” problem, it being unlikely that nonsignificant findings have been published (Rosenthal 1979).

Mechanisms—Considerations of stability and prediction often do not speak to the specific mechanisms through which each occurs, but they should. The assessment and demonstration stability or prediction constitute the (important) descriptive phase of investigation, and either may obtain even if specific developmental processes remain unspecified. However, clarifying mechanisms of stability and prediction will constitute an important next wave in future research. Ultimate criteria for success in developmental science turn on how well we can explain and understand processes underlying individual functioning and development *and* on how well we can predict.

Overview

On first observation, newborns and infants often appear disorganized and erratic. At a given moment, babies seem to be constantly moving their eyes, hands, and feet without apparent purpose. Over longer periods, they appear to shift randomly and unpredictably between sleep and alertness. However, infants are not quite so irregular and unpredictable. Close and consistent inspection reveals that infants are regular in many ways and their systems cycle in detectable patterns. Indeed, infant activity is organized at fast, medium, and slow rhythms. Some actions regularly cycle at high frequencies, perhaps once or more every second. Heartbeats, breathing, and sucking exemplify fast biological rhythms that maintain life, and kicking and rocking illustrate other fast-cycling behaviors. General movements of the body cycle at intermediate rates, on the order of once every minute or two. States of waking, quiet sleep, and active sleep cycle at low frequencies in periods of up to 24 hours. By observing activity over extended times and carefully decomposing it, it is possible to detect regularity underlying infants’ seeming randomness. A snapshot of the infant at any one time captures the simultaneous and independent cycling of several complex rhythms. In short, apparent irregularity is only just that, apparent, and much infant behavior is characterized by underlying regularity.

Macken and Burton (1979) wished to know how infants acquire the voicing contrast in American English word-initial stop consonants, and so they recorded the speech of four monolingual children at 2-week intervals, beginning in infancy. They then submitted recordings of infants’ spontaneous speech to two kinds of analyses: transcriptions by trained phoneticians and instrumental analysis. The human judges divided infant data into three general stages: (1) the child has no contrast; (2) the child has a contrast but one that falls within the adult perceptual boundaries and thus is presumably not perceptible to adults; and

(3) the child has a contrast that resembles the adult contrast. Some Stage 2 contrasts which children maintained went unnoticed by the transcribers and were presumably not perceptible to adults. However, spectrograms with high temporal resolution and scale magnification revealed a statistically significant number of distinct phonemically voiceless stop productions. In short, judgments of adults did not capture significant facts about the child's language production where spectrographic analysis provided insight. Speech contrasts that infants had learned and were maintaining would not have been detected by parents or other adults, and it might have taken up to another year before the children's productions improved to the point where the contrasts that the infants were making were perceived by adults. These two homilies impart pointed lessons for understanding stability and prediction from infancy. Not the least, methods and measures applied today that fail to substantiate preservation in development leave open the possibility that methods and measures applied tomorrow may reverse current conclusions.

Development is governed by genetic and biological factors in combination with experiences and environmental influences. Thus, developmental stability and prediction of any characteristic are attributable to endogenous factors that transact exogenous ones. Biological forces generally tend to reinforce homeostasis in the individual. Moreover, the consistent social network in which development normally transpires also contributes to stability and prediction. Thus, individual $\longleftrightarrow$ environmental relational processes actually tilt to promote stability and prediction in development. Contrary to first blush, stability and prediction in development are expectable.

That said, even the strongest stability or prediction coefficient one could practicably expect to see, say $r = .90$, leaves substantial common variance unaccounted for, $\approx 20\%$. Here, theoretical perspective comes into play. Focusing on instability and prediction failures would lead to the singular but limited view that development is disorderly; focusing on stability and prediction risks overlooking necessary adaptability and change in the developing organism. Despite stability and prediction, children can and do alter over time in their status relative to one another. The life-span perspective in developmental science specifies that human beings are open systems, and the plastic nature of psychological functioning ensures both stability and instability across the life course. Both confer advantage. Many developmental processes are Janus-like with both stable and unstable, continuous and discontinuous aspects. Infant status does not fix a child's health or height, perceptiveness or personality. To be stable or predictable does not mean to be immutable or impervious to experience or adaptation. Like stability, adoption is an identifying characteristic of development, and children change in both their relative standing and mean level on every characteristic as they grow.

The mature status of each aspect of a person is influenced by contemporary circumstances and by expectations of the future, but it is also affected by prenatal and infancy status and experiences and, in some instances, by circumstances of prior generations (Elder et al. 2015). Interdisciplinary life-course study, coupled with the arrival of long-term longitudinal research, is occupying increasing attention, as the precursors to mature status are explored among early sensitive periods, cascades, cumulative effects, and other temporal associations that extend over decades (Bauldry, Shanahan, Boardman, Miech, & Macmillan 2012, Bornstein 1989, Kuh & Ben-Schlomo 2004).

Long-term studies of stability and prediction are identifying relations between late-life adaptation and the earliest phases of life-span development. Although this *Annual Review* has documented links between early and later life, those links require reinforcement as much as reassessment, and there is much more to learn. Important efforts should start with refinement, replication, and reflection.

CONCLUSIONS

...The childhood shews the man ...

--John Milton (1671), *Paradise Regained*, Book 4, line
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A key goal of contemporary developmental science is mapping temporal trajectories from early characteristics to mature phenotypes. Many developmentalists have maintained that different stages of life vary qualitatively, that infancy stands apart from the balance of the life course, and that development from infancy is unstable and noncontinuous. However, the “blooming, buzzing confusion” of infancy cloaks order. Some relations between infancy and maturity may be obscured because they are displaced in time, and others may go unnoticed because surface manifestations of different characteristics at different developmental periods appear unrelated. We now know too that much of development consists of hierarchically organized abilities that subsume one another. An implication of contemporary relational systems perspectives is that earlier emerging characteristics in development lay foundations for and so likely exert impact on later appearing characteristics.

A central issue in developmental study is evaluation of forces bound up in ontogenetic advance. Central to understanding developmental advance is recognizing the contributions of the individual, experience, and their transactions. Individuals contribute to their own development, and we are increasingly aware that people are agents in their own lives. The emerging literature in stability and prediction indicates that infants bring substantial variation in their individuality to their own long-term development.

Stability and predictive validity in development from infancy have several noteworthy implications. First, they have meaning for developmental science in terms of more adequately describing the growth of individuals. Second, they have implications for more completely understanding the nature of diverse biological and psychological phenomena. Through elucidation of stability and prediction, infancy studies can lead to insights that have significance for psychology as a whole. Studies of stability and prediction between infancy and maturity are therefore important to theory building; they are equally important to understanding clinical populations. Because there are threads of stability and prediction from infancy, third, measures in infancy might one day serve as screening tools for early detection of later (risk) status and so infancy has implications for the identification, prevention, and treatment of disorders. The emerging critical mass of data on stability and prediction overturn the argument that infancy is not meaningful in itself and that it is unrelated to later life. Early childhood exposure to microorganisms that are common in the natural environment adjusts the immune system so that even disadvantaged adults living under unhealthy conditions in low and middle income countries have lower blood

concentrations of proteins that signal inflammations that portend cancer, diabetes, and heart disease (McDade 2012). The contemporary life-course perspective on human development supports some stability and prediction, even from the prenatal period.

The developmental changes that take place during the first year of life are as or more dramatic than any others in the human lifespan. The most remarkable involve the changing shape and capacity of the body, the complexity of the nervous system, the dawning of sensory and perceptual capacities, the increasing abilities to make sense of, understand, and master things in the world, the achievement of communication, the emergence of characteristic personal styles, and the formation of specific social bonds. At no other time is development so fast-paced or thoroughgoing in so many different spheres of life. Yet, at the core of the infant, and later the toddler, child, adolescent, and adult, is the same individual, and some stability and predictability from infancy – whatever their dynamic endogenous and exogenous origins – is expectable.

Deconstructing infancy studies in this way contributes to elaborating and to explaining infancy *qua* a dimension of human fascination and intellectual significance. The ineffable romance of infancy may haunt us in many ways, but in other ways we now see more clearly that infancy contributes concretely to our understanding ourselves. The fact that infants are unvolitional, uncooperative, unstable, nonverbal, and motorically inept once ward off all but philosophical speculation about them. Developmental scientists have finally overcome infants' formidable and intractable posture to extract information of all sorts from and about them. In recent years, a revolution has taken place in infancy studies, fueled by technological and methodological advances. We now know a great deal about babies' perceptions, thoughts, and feelings. Taken together, longitudinal studies are coming to bind infancy more tightly to the tapestry of life span development. Longitudinality is a social science Hubble telescope (Butz & Torrey 2006).

Infancy is the first phase of life lived outside the womb, and the characteristics developed and acquired then help to forge a foundation for the balance of the life course; some individual differences in infancy may endure, at least in part, and they are certainly those that later experiences build on or modify. Infancy is only one phase in the lifespan, however, and so our physical development, nervous system maturity, motor capacities, perceptual abilities, cognitive competencies, and personalities and social styles are also shaped by development and experiences after infancy. Living is to experience consequential and life-altering events. The start does not fix the course or outcome of development, but it clearly exerts an impact on both. Ascribing certain prospects to the future may be unachievable, but the longitudinal literature from infancy is starting to reveal enduring effects that we should not ignore or dismiss. The future may not be an utterly random bet. "*At first the infant...*" Shakespeare has Jacques recite in *As You Like It*. Infancy introduces the part and also sets the stage for the unfolding drama that is to follow.

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Table 1

Longitudinal Epidemiological Studies from Infancy to Maturity

Name	Enrollment		Country/Topic	URL
	Year	N		
Some General Studies				
Kaui ^a	1955	600	Hawaii, USA	https://www.ncjrs.gov/App/publications/Abstract.aspx?id=122798
Solna ^b	~1955	212	Sweden	http://www.oru.se/English/Research/Old-research-pages/Research-projects/project/School-of-Law-Psychology-and-Social-work/The-Solna-study/
Dunedin ^c	1972-3	>1000	New Zealand	http://dunedinstudy.otago.ac.nz/studies/main-study/description
Minnesota ^d	1975	267	USA	http://www.cehd.umn.edu/ICD/Parent-Child/default.html
CFRS, NICHD ^e	1988	400+ xxxx	USA + cross-cultural	http://www.cfr.nichd.nih.gov/index.html
ALSPAC ^f	1991-2	>14000	UK	http://www.bristol.ac.uk/alspac/
ECLS-B ^g	1998-9	14000	USA	http://nces.ed.gov/eccls/birth.asp
LSAC ^h	1999-20000	>10000	Australia	http://flosse.fahcsia.gov.au/fahcsia-help/doku.php?id=the_surveys#hilda
Gen R ⁱ	2002-6	9778	The Netherlands	http://www.generationr.nl/index.php?option=com_content&task=view&id=3
Some Specific Studies				
ATP ^j	1982-3	2443	temperament	http://www.aifs.gov.au/atp/about/about.html
LLAS ^k	1987	160	adoption	http://www.socialsciences.leiden.edu/educationandchildstudies/childandfamilystudies/
SEECYD ^l	1991	1364	child care	http://www.nichd.nih.gov/research/supported/seccyd/overview.cfm#participants
Jyväskylä ^m	1993-6	410	dyslexia	https://www.jyu.fi/ytk/latokset/psykologia/huippututkimus/en/research/JLD_main/JLD
MSU ⁿ	1998	206	domestic violence	https://www.msu.edu/~mis/

General studies are multivariate epidemiological efforts; specific studies are designed to examine a specific topic.

^aThe Children of Kauai.

^bThe Solna Study.

^cThe Dunedin Multidisciplinary Health and Development Study.

^dMinnesota Longitudinal Study of Risk and Adaptation.

^eChild and Family Research.

^fAvon Longitudinal Study of Parents and Children (Children of the 90s).

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^gThe Early Childhood Longitudinal Study.
^hLongitudinal Study of Australian Children.
ⁱThe Generation R Study.
^jAustralian Temperament Project.
^kLeiden Longitudinal Adoption Study.
^lThe NICHD Study of Early Child Care and Youth Development.
^mThe Jyväskylä Longitudinal Study of Dyslexia.
ⁿThe MSU Mother Infant Study.

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