

## INFANCY

Infancy, the period between birth and eighteen to twenty-four months, has fascinated parents, philosophers, and developmental scientists perhaps more than any other period of the lifespan. The study of infants allows us to understand the origins of physical and psychological life. Furthermore, during no other period of life are physical and psychological changes more pervasive and rapid than in infancy.

Around the turn of the twentieth century, William James, an influential philosopher, psychologist, and parent, remarked that the world of the infant is a "blooming, buzzing, confusion." Throughout the twentieth century, researchers devised ingenious methods to study the infant and found that James severely underestimated the infant. We know now that infants' capacities are quite sophisticated in several domains, including perception, cognition, and emotion. Furthermore, infants' capacities in these domains and others continue to develop in infancy and beyond. Below are summaries of some of the key findings that scientists have uncovered about infants in several domains. The boundaries between these domains are somewhat artificial and arbitrary, but they nevertheless allow for an orderly arrangement of some of what is known about the human infant.

### Physical Development

The infant's physical structure and central nervous system undergo dramatic and rapid change during the first two years of life. The infant's weight doubles by five months of age, triples by twelve months of age, and quadruples by the age of twenty-four months. The infant's length does not change as rapidly as its weight, for the infant's length at birth is already 75 percent of what it will be at two years of age. Changes in length and weight are accompanied by transformations in the infant's body proportions. The head grows the fastest and matures the earliest, followed by the rest of the body downward (e.g., the neck, torso, legs). In addition, those parts that are closest to the center of the infant's body (e.g., the trunk) grow faster and mature earlier than do parts that are farther from the center (e.g., the hands). The rapid changes in infants' body proportions affect other domains of development, including perceptual, motor, cognitive, and emotional.

The physical structure of the brain develops rapidly as well. Although a human is born with almost all of the neurons that he or she will ever have, the human brain triples in weight by age three and quadruples in weight by age fourteen. Two primary reasons account for this dramatic change in the brain's weight and size. First, a fatty substance called myelin

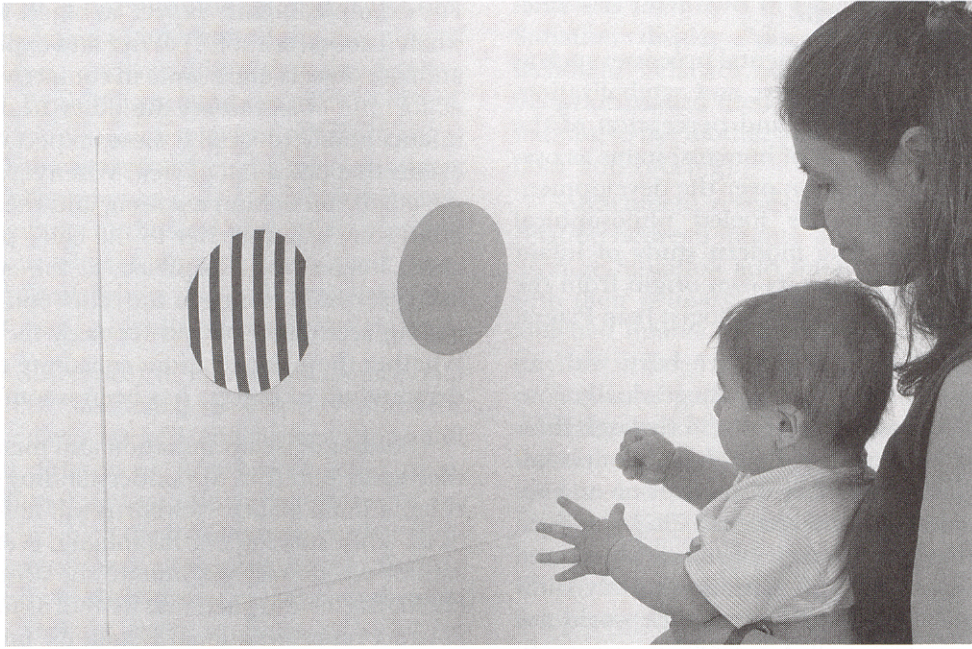
forms around a part of the neuron, causing substantial growth of the brain and increasing its neural conduction. Second, a part of the neuron called the dendrite branches multiple times, creating numerous synapses or connections with other neurons. It is for these reasons that a brain that weighs 370 grams (13 ounces) at birth will weigh 1,080 grams (38 ounces) by the age of three.

At one time, scientists assumed that the newborn's brain was "hard-wired" and that the environment played little, if any, role in its development. Researchers studying human and nonhuman species have provided overwhelming evidence that experience does, in fact, play a powerful and enduring role in the infant's brain development. The infant's experiences "mold" the brain by preserving active synapses and pruning less active or inactive ones. Interestingly, researchers have found sensitive periods in which the brain is affected by experience more so than at other times.

### Perceptual and Motor Development

At birth, infants' sensory systems are available for processing perceptual information from the world and from their own bodies, but each system operates, for the most part, within a more limited range than later in infancy. Newborns' senses of taste and smell are particularly well established; in the first two weeks of life, infants can discriminate among sweet, sour, and bitter tastes, and can recognize the smell of their mother's milk. Infants' hearing is also relatively mature at birth, although the loudness threshold for detecting sound is ten to twenty decibels higher in newborns than in adults. Young infants are highly attuned to human voices, especially their mother's. In addition, infants localize sounds, and by the end of their first month, if not sooner, they differentiate speech sounds in a manner comparable to adults. In fact, one-month-olds across cultures differentiate speech sounds not evident in their particular native languages. Thus, young infants demonstrate a wider range of speech sound sensitivity than adults; by ten to twelve months, however, infants' sensitivity to speech sounds narrows and conforms to their native language.

From birth, infants demonstrate distinct preferences for the human face and are especially attuned to moving rather than static stimuli. By two months, infants' color vision is well established. At the same time, infants can process depth information by some cues, a capacity that continues to develop into the middle of the first year. Infants' overall visual acuity, however, is much more limited than that of adults. In the first two to three months, infants cannot discrimi-



*In a visual acuity test, an infant sits on his mother's lap and looks at gray and striped circles. Of all the sensory systems, infants' visual capabilities have been the most thoroughly investigated. (Laura Dwight/Corbis)*

nate fine visual detail and tend to focus on areas of a stimulus where the contrast between light and dark is greatest, such as the hairline or the eyes of a face. By six to eight months, however, visual acuity nears adultlike maturity.

Infants' perceptual development is inextricably linked to their motor, or action, development. Like adults, infants' action in the world guides their perception of the world, just as their perception of the world guides their action in it. For example, the ability to perceive through touch the size, texture, and hardness of objects develops over the first six to nine months of life in parallel with changes in how infants manually explore objects. At birth, infant action is limited, rather inflexible, and reflexive, largely because they lack control of their heads and trunks. When provided with postural support, however, newborns demonstrate rudimentary reaching abilities, directing their arms in the general direction of objects. Within the first weeks of life, infants are able to support their own heads, facilitating gaze and the scanning of the environment. By three to four months, infants begin using vision to guide their reaching efforts, resulting in successful contact with objects. With experience in visually guided reaching, infants increasingly coordinate their grasping of an object with the movement of their arm toward the object. Between five and seven months, infants develop sufficient trunk control to support their independent

sitting, which in turn provides a solid position for head and arm activity.

Infants around seven to nine months begin to move themselves in the environment by means of crawling, which opens up a whole new world of exploration for them. Between eight and twelve months, infants begin to stand, first by using furniture or other objects to support themselves and then by establishing postural control to support independent standing. Walking soon follows as infants move into their second year. With each new motor transition, infants gain new means of perceptually apprehending the world. At the same time, infants rely on their perceptual development to establish more efficient means of acting on the world. For example, infants must rely on what they see and feel when crawling or walking over surfaces in order to continuously update their action and make their action fit the ever-changing demands of the environment.

Enormous individual differences mark the timing of developmental changes in both perceptual and motor development. Increasingly, developmental psychologists have shifted their focus away from simply documenting infants' perceptual and motor milestones toward understanding how these changes occur and how the domains of perception and action constantly and seamlessly interact to produce unique, individual pathways of development.

## Cognitive Development

Cognition, comprised of mental processes such as conceiving, reasoning, memory, and symbolization, organizes humans' action in and perception of the world and is the foundation of humans' status as psychological beings. Speculation over the developmental origin of cognition has fueled philosophical inquiry for millennia. The modern study of infant cognitive development takes its own origin from the theory and research of Swiss psychologist Jean Piaget.

According to Piaget, infants are born with no mental framework in place and only gradually construct a conceptualization of the world through their experience with it. The experience of the infant is initially bound by the immediacy of perception and action, a "sensorimotor intelligence." Piaget argued that newborns have no concept of self or object and simply experience a wash of sensations. Only rudimentary schemas for interacting with the world are available to them. They will, for example, grasp objects placed in their hands, suck on objects that contact their mouths, and visually track moving objects. As infants apply these and other basic perception-action schemas to different objects and situations, they gradually adjust their action to the vast complexity of the world, increasingly accounting for specific objects and events. In the process, a more generalized and abstract sense of the world and infants' place in it emerges. By the end of infancy, the child has built a primitive understanding of objects and events as independently existing in time and space. For Piaget, a consequence of the infant period is an emerging representational ability, captured in the consolidation by eighteen to twenty-four months of an "object concept," which allows the child to conceive of an object's existence even when it is no longer available to the senses (e.g., out of view).

The study of representation in general—and the object concept in particular—has remained at the forefront of research in infant cognition. Examining infant search behavior, Piaget established six developmental stages through which infants pass before establishing a mature object concept. For example, during the third stage, around four to eight months, infants will search out a partially covered toy. But if the toy is completely hidden, infants will not search for it, as if it no longer exists. By the fourth stage, around eight to twelve months, infants will search for a completely covered toy, but when the toy is then hidden in another location, infants search exclusively at the initial hiding site, as if the toy's existence coincided with that particular location in space. More recent studies, using infant looking behavior, suggest that even younger infants have formed certain expectations about objects and their physical properties.

For example, infants expect an object to stop moving when it contacts a solid barrier and expect that two inanimate objects must come in contact with one another for one object to set the other in motion. Young infants seem to apply these expectations even to events that occur out of view. When three-month-olds see a ball roll behind a screen, and then the screen is lifted to reveal a barrier to the ball's path, they look much longer, as if surprised, at the event when the ball is revealed resting at the other end of the barrier, having seemingly moved through the solid barrier. Whether these expectations constitute conceptual understanding of objects has been a source of debate.

Studies of infant imitation and memory have further contributed to the understanding of infant representational ability. Newborns will imitate the action of an adult sticking out his tongue, even though they cannot see themselves imitate the action. Some psychologists have argued that newborns must possess an abstract representational system for linking their unseen facial movements with what they see the adult doing. Around nine months, representation is clearly in place as infants, having only observed an adult play with a toy in a particular way, will imitate the adult when given a chance twenty-four hours later to play with the toy. In this deferred imitation, infants must represent what they have seen twenty-four hours earlier and must recall from memory the representation. Prior to nine months, infants can retain memories for weeks or even months, but they retrieve those memories only if sufficient cues are present to allow them to recognize the familiarity of an event.

## Socioemotional Development

Emotions pervade infants' daily lives in that they are the means by which infants accomplish their goals, as well as the primary medium through which communication occurs. Newborns display general patterns of distress and excitement. Later in the first year, other emotional expressions develop such as joy, surprise, sadness, disgust, anger, and fear. For example, infants begin to smile at others around six to eight weeks of age and begin to show wariness of strangers, as well as separation distress, between seven to nine months of age. More complex emotions, including embarrassment, pride, shame, and guilt, become evident in the last half of the second year.

Emotional expressions are displayed not only by the infant but also by the caregiver. Developmentalists have found that infants begin to detect adults' emotional displays (vocal and facial) by the age of two months. For example, young infants are able to distinguish between a smiling face and one that appears

to be frowning. It is not until the middle of the first year that infants begin to understand the meaning of facial displays (i.e., understanding that the displays are emotional). Beginning around ten months of age, infants use the emotional displays of others to regulate their own behavior toward events they encounter in the world, a phenomenon called social referencing. For example, infants at the end of the first year will avoid ambiguous objects toward which their caregivers act disgusted, while they will approach and touch objects toward which their caregivers smile.

Individual differences in infants' socioemotional development have fascinated developmentalists for decades, particularly infants' attachment styles and temperamental differences. Attachment refers to an enduring emotional tie that one person forms to another. It is a tie in which the infant takes another (typically the caregiver) as a protective figure, finding increased security in their presence, missing them in their absence, seeking them in times of stress or alarm, and using them as a secure base from which to explore. According to John Bowlby, the tendency for infants to form attachments is evolutionarily based, being evident across cultures and in other mammalian species. All human infants, even those who have been mistreated and abused, form attachments to others.

The attachment behaviors that infants display change with development. The very young infant can only cry when distressed, look to the caregiver if he or she is nearby, and be attractive to adults. In time, however, infants take on an increasingly active role. Older infants can deliberately signal to the attachment figure by, perhaps, calling for the caregiver. Furthermore, infants acquire the ability to remain in close proximity to their attachment figure with the onset of crawling between seven and nine months.

While all infants form attachments, there are individual differences in infants' attachments that have enduring socioemotional consequences. Mary Ainsworth devised a laboratory procedure (called "strange situation") consisting of a series of maternal separations and reunions designed to categorize twelve-month-old infants' attachment styles to their caregivers. According to this research, infants can be categorized into three groups depending on the attachment behaviors they display: (1) "securely attached" infants seek comfort from the caregiver during reunions and, once comforted, play with toys; (2) "insecurely attached-avoidant" infants avoid their mothers during reunion and focus their attention on their play; and (3) "insecurely attached-resistant" infants are ambivalent during reunion, first approaching the caregiver and then pushing her away. Through subsequent research a fourth category of in-

fants was identified in which infants in the Strange Situation display "disorganized-disorganizing" attachment behavior, characterized by contradictory behavior toward their mothers during reunion (e.g., walking to the mother and then abruptly falling to the floor and rocking).

Attachment researchers have found a consistent relation between infants' attachment behaviors in the Strange Situation and infants' history of interaction with their primary caregivers. Mothers of "securely" attached infants tend to be sensitive and responsive to their infants' emotional signals, whereas mothers of "insecure" infants tend to ignore or to respond inconsistently to their infants' emotional signals. Infants who are classified as "disorganized-disoriented" tend to have caregivers who are frightening to, or frightened of, their infants. In sum, infants' history of interaction influences their quality of attachment, which, in turn, is related to their socioemotional development later in life.

In contrast to the individual differences in attachment thought to arise because of varying interactional histories, temperament researchers study enduring differences in emotionality, and behavioral responses to stimuli, that are due to constitutional factors. Various researchers have identified various temperamental attributes, but most researchers agree that the following are important components of temperament:

- Activity level—the typical pace or vigor of one's activities
- Irritability/negative emotionality—how easily or intensely upset one becomes over negative events
- Soothability—the ease with which one calms after becoming upset
- Fearfulness—one's wariness of intense or highly unusual stimulation
- Sociability—one's receptiveness to social stimulation

Behavioral genetic studies comparing identical twins to fraternal twins indicate that the components of temperament are moderately heritable. In addition, infants' temperament, particularly activity level, irritability, sociability, and shyness, endures to some extent into childhood and adulthood. One important point, however, is that temperament does not determine personality in later life. The study of temperament thus highlights a significant principle that cuts across all developmental phenomena; biology dynamically interacts with environment in the development of humans.

When taken together, some of the key findings in infants' physical, perceptual, motor, cognitive, and

socioemotional development indicate that infants are qualitatively different from adults; infants are not simply miniature adults. Furthermore, development is characterized by several reorganizations both within and between domains, thereby precipitating changes in infants' perceptions of the world, as well as the way in which they act upon it. The period of infancy is likely to continue to generate fundamental and important questions that challenge scientists.

*See also:* STAGES OF DEVELOPMENT

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