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Infant Perception

Scott P. Johnson¹

¹University of California, Los Angeles

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Perception is the set of processes by which organisms interpret and organize sensory information to understand the world and plan appropriate actions across different scenarios. This involves receiving input through the sensory systems (including vision, audition, touch, taste, and smell) and making sense of it based on prior knowledge and context. Innovative studies have revealed that sensory systems begin to develop before birth. Vision in newborns is partially organized, and coordinated perception-action systems, such as hearing and head turning, show early functionality. Basic functions of audition, olfaction, and touch are operational at birth. More complex processes such as intermodal perception—integrating information from multiple senses, such as vision and audition—are less functional at birth and improve rapidly during infancy.

History

William [James's \(1890\)](#) seminal work *The Principles of Psychology* described an infant's sensory experience as a “blooming, buzzing confusion,” an unorganized stream of sights, sounds, and tactile sensations without distinct objects or order [see [Attention](#)]. The brain's inherent structure provides a foundation for perceptual development, but organized perception unfolds through interaction with the world [see [Cognitive Development](#)].

In contrast, the Gestalt psychologists Kurt [Koffka \(1935\)](#) and Wolfgang [Köhler \(1947\)](#) proposed that perception is innately organized, favoring simple, cohesive patterns because of the brain's tendency to minimize processing effort (the *minimum principle*), supported by evidence such as organized newborn brain activity ([Hebb, 1949](#)). Unlike James, Gestalt theory posited that even infants see unified wholes, not fragmented sensations ([Zuckerman & Rock, 1957](#)).

Jean [Piaget \(1937/1954\)](#) offered a third perspective, arguing that infants' understanding of objects and spatial relations develops together through hands-on exploration [see [Action](#)]. Initially, newborns experience fleeting sensory impressions without depth or coherence, but by the end of the second postnatal year, they understand *object permanence* (i.e., objects are perceived as persisting when hidden). However, later studies analyzing looking behavior (which does not require skilled manual activity) suggested that even young infants show early object permanence, challenging Piaget's timeline by removing the need for extensive learning from manual experience ([Baillargeon et al., 1985](#)).

Core concepts

Visual perception

Studies of visual development in infancy provide some support for all three theoretical perspectives outlined in the previous section. Vision is at least somewhat organized at birth and undergoes rapid improvements as sensory and cortical systems mature and as the infant gains experience integrating vision with other senses.

At birth, most visual functions are operational but immature. Visual acuity, the ability to discern fine details, is estimated at 20/200 to 20/400 in newborns (meaning they see at 20 feet what a typical adult sees at 200 to 400 feet), improving rapidly in the first few months. Contrast sensitivity, color vision, and motion perception approach adult levels by 4 to 6 months. Depth perception, however, emerges in a steplike fashion; at 2 months, infants detect kinematic (motion-based) depth cues; at 4 months, stereopsis (depth from the disparities in the inputs to the brain from left and right eyes) develops; and by 7 months, sensitivity to pictorial cues enables depth perception in flat images ([Banks & Salapatek, 1983](#)).

Visual attention

Newborns possess a functional oculomotor system (i.e., musculature and brainstem control) to control eye movements, allowing them to scan their environment [see [Visual Search](#)]. Smooth pursuit emerges at 2 months to track moving objects. Top-down (cognitive) control of eye movements matures more slowly, enabling infants to stabilize gaze and inspect stimuli effectively ([van Renswoude et al., 2019](#)).

Object and face perception

Infants begin identifying object boundaries between 3 to 5 months by detecting edges and their intersections, which indicate relative distances. Perceiving partly occluded objects as complete starts at 2 months for moving objects with aligned edges, and by 6 to 7 months, infants perceive unity in stationary displays ([Johnson et al., 2023](#)). Remarkably, newborns show some size and shape constancy, perceiving an object's true size and shape despite changes in distance or angle, even with limited visual experience ([Slater, 1995](#)).

Newborns (and late-term fetuses) are drawn to faces and face-like stimuli [see [Face Perception](#)]. Within months, infants recognize familiar faces under varying expressions and perspectives, discriminate gender (often preferring females), and show sensitivity to facial expressions—detecting smiling at 3 months, frowning at 6 months, and a range of emotions by 7 months ([Walker-Andrews, 1997](#)). Differentiation of race (e.g., same- vs. other-race faces) also develops across the first year after birth ([Quinn et al., 2019](#)).

Auditory perception

Auditory perception begins in the womb [see [Hearing](#)]. Newborns prefer their mother's voice, reflecting prenatal hearing experience and memory for familiar sounds. However, sound conduction is inefficient at birth, impacting low-frequency perception in particular. Absolute thresholds reach adult levels earlier for higher frequencies (e.g., 4,000 Hz by 5 years) than lower ones (1,000 Hz by 10 years). Infants discriminate the spectral “shape” of sounds (e.g., the ratio of low, mid, and high frequencies) and localize sounds by 7 months but reach adult-level competence later. Grouping sounds into meaningful units, like following a conversation, is functional but fragile in infants, owing in part to difficulty filtering out irrelevant sounds ([Johnson & Hannon, 2015](#)).

Because infants may have difficulty segregating speech from competing sounds, caregivers often employ *infant-directed speech* with exaggerated pitch and simpler structures [see [Infant-Directed Speech](#)]. Infants are born with universal phoneme sensitivity, distinguishing sounds like /ta/ and /da/ across languages, but lose sensitivity to nonnative phonemes with age. They prefer speech over nonspeech but not filtered speech, suggesting an evolutionary bias for human vocal sounds. Prosody (rhythm and intonation) helps newborns discriminate languages, aiding speech perception, especially in bilingual settings ([Werker & Yeung, 2005](#)) [see [Language Acquisition](#)].

Intermodal perception

Multisensory events convey amodal properties shared across auditory and visual inputs, such as synchrony, rhythm, and tempo, as well as modality-specific properties unique to one sense, such as pitch, timbre, and visual patterns. Amodal properties, redundantly specified across sensory inputs, are highly salient. Infants detect mouth–vocalization synchrony within 1 to 3 days and face–voice synchrony in speech by 3 to 7 months. By 7 months, infants perceive affect (happy, sad, angry, neutral) across faces and voices and even across genders. In nonsocial events, infants detect sight–sound synchrony by 3 to 4 weeks and by 7 months detect nested synchrony, rhythm, and tempo within visual–auditory events ([Bahrick & Lickliter, 2000](#)).

Chemosensory perception

Research on chemosensory development (smell and taste) reveals that olfactory and gustatory systems are functional in fetuses and newborns and scaffold early adaptation and social bonding [see [Smell](#) and [Taste](#)]. For example, fetuses respond to odorants in amniotic fluid by 28 to 30 weeks gestation, and newborns distinguish maternal breast odors and milk from those of strangers within hours of birth. These innate preferences for familiar scents likely promote breastfeeding and attachment ([Browne, 2008](#)). Olfaction continues to mature across childhood, guiding flavor perception and food preferences and supporting emotional regulation and peer interactions into adolescence ([Schaal et al., 2020](#)).

Touch

Tactile perception, likewise, develops prenatally [see [Touch](#)]. Mechanoreceptors within skin and limbs are functional by 14 weeks after gestation, enabling fetuses to explore the intrauterine environment and newborns to discriminate textures, temperatures, and light pressure via oral and manual touch. In infants, touch integrates with chemosensory cues for multisensory flavor experiences as new foods are introduced ([Bremner & Spence, 2017](#)). The role of touch in exploring the world becomes increasingly important as manual dexterity improves during the first year after birth ([Bremner & Spence, 2017](#)).

Questions, controversies, and new developments

Debates in infant perception often concern the early competencies observed in face perception: whether they stem from innate, dedicated cognitive skills or from the interaction of perceptual skills and experience. Some

have proposed an unlearned representation for face-like patterns that governs preferences ([Johnson et al., 2015](#)), whereas others argue such preferences arise from general visual biases, such as favoring stimuli with specific spatial frequencies or visual configurations with relatively more elements or higher contrast in the upper half of a shape (e.g., in a face, eyes and brows vs. the mouth; [Turati et al., 2002](#)).

A second interesting debate centers on the nature of *critical periods* in development: a specific time window during which a child is particularly sensitive to certain environmental stimuli, and exposure to these stimuli is necessary for normal development of specific abilities or functions. If the required experience is absent or inadequate during this period, it can lead to irreversible or long-lasting deficits, even if the stimuli are provided later. Critical period effects can be disentangled from other developmental processes by observing speech perception in children born deaf who had cochlear implants ([Houston, 2005](#)) and object perception in children born blind who underwent cataract replacement ([Sinha, 2013](#)).

Broader connections

Understanding how infants process sensory information reveals how early experiences shape learning and brain development. For example, social perception underpins social cognition skills like joint attention, empathy, and theory of mind (understanding others' intentions). Infants later diagnosed with autism spectrum disorders (ASDs) often show atypical social perception, such as reduced preference for faces or gaze following by 6 to 12 months [see [Autism](#)]. Such early disruptions in face processing may contribute to later social deficits in ASD ([Jones & Klin, 2013](#)). Interventions such as parent-mediated social engagement before 12 months can leverage plasticity for face perception to enhance social attention, potentially mitigating ASD symptoms ([Green et al., 2017](#)).

In addition, typically developing newborns' preferences for face-like patterns and native-language sounds quickly become attuned to culturally specific inputs, for example, recognizing own-race faces more accurately (the other-race effect) and discriminating native phonemes. Interestingly, 9- to 12-month-old infants from racially diverse U.S. communities were found to better recognize other-race faces relative to infants from less diverse areas, highlighting the role of experience in face recognition abilities ([Bauer et al., 2023](#)) and implying that varied social exposure in early life can broaden perceptual tuning and support more flexible learning. Additionally, cultural differences in caregiver interaction, such as the amount of eye contact or object-focused speech, modulate attention allocation and word learning, showing that perception and culture jointly scaffold cognitive development ([Senju & Csibra, 2008](#)).

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