Encyclopedia of Perception

Infant Perception

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Late in the 19th century, the pioneering psychologist William James in *The Principles of Psychology* famously summarized what he believed to be the infant's perceptual experience, “The baby, assailed by eyes, ears, nose, skin, and entrails at once, feels it all as one great blooming, buzzing confusion,” and suggested, “Infants must go through a long education of eye and ear before they can perceive the realities which adults perceive. *Every perception is an acquired perception*” (p. 488, emphasis original). This position was echoed by the preeminent developmental psychologist of the 20th century, Jean Piaget, who proposed that at birth, percepts across sensory modalities, such as vision and touch, are uncoordinated and that the new-born's visual world consists of an assemblage of moving colors and shapes, rather than the segregated objects experienced by adults. Perceptual organization emerges only slowly during the first two postnatal years, according to Piaget, as infants gain direct manual experience with objects and the coordination of visual, auditory, and tactile information.

Systematic investigations of infant perception were not reported until about 50 years ago, with the pioneering work of Robert Fantz. Part of this delay (relative to studies of adult perception) was caused by limitations in methodology. Fantz discovered that infants would often show visual preferences, looking longer at some patterns relative to others when the stimuli were presented sequentially. This allowed scientists to begin to chart changes in visual capacity with development. A second important contribution made by Fantz was the finding that repeated presentations of stimuli often resulted in a decrement of attention in infants. Subsequent research refined these methods and eventually led to the adoption of more sophisticated paradigms such as the habituation/dishabituation method. This and related designs capitalize on the tendency of infants to look longer at stimuli that are unusual or unexpected, and these methods have revealed a wealth of cognitive and perceptual competencies in infancy. The methodological repertoire of infant researchers in the past few decades has expanded considerably and now includes precise recordings of eye movements, brain activity, conditioning of behaviors such as head turning or reaching, and other behaviors under both controlled and naturalistic conditions.

The results of experiments that use these methods have revealed that all sensory systems in infants are functional at birth, and even coordinated to some degree. These investigations help us understand both how infants experience the world and how their knowledge develops over time as a function of the interplay of existing and developing sensory systems, actions, and physical development, including development of the brain. At birth, vision is somewhat organized, and audition, olfaction, and touch are fairly mature. Intermodal perception, coordination of information from a single event through multiple modalities, begins early, and improves across infancy.

Visual Perception

Basic Visual Function

Vision is arguably the most important sensory modality available to humans because it provides the perceiver with essential information about near and distant objects and events so that appropriate actions can be planned. Most basic visual functions are operational yet relatively immature at birth. Visual acuity, the ability to distinguish fine detail or differences in adjacent positions, is estimated at 20/200 to 20/400 for most new-borns. Acuity improves rapidly within the first few months. Contrast sensitivity, the ability to detect luminance differences between two adjacent areas such as stripes on a grating, is also reduced in newborns relative to adults and develops as infants gain visual experience. Color vision is not yet fully developed at birth, but infants are able to see colors nearly as well as adults can by age 4 to 6 months.

The ability to perceive motion is particularly helpful to infants as they begin to disambiguate the visual world. Objects and people in the environment move in many different ways (laterally, vertically, toward and away from the observer, and rotating) and at different velocities. Infants' responses to the slow and fast motion velocities differ depending on the types of motion and age, suggesting the existence of separate mechanisms for processing different types of motion. Moreover, infants' own motion also contributes to motion perception. Despite the complex nature of motion, however, nearly all types of motion perception develop by 6 months after birth.

In similar fashion, depth perception gradually develops during the first several months. Infants first become sensitive at about 2 months to kinematic, or motion-carried information for distance, as when one surface moves in front of another. Next, at about 4 months, infants are able to perceive depth via the difference in the optical projections at the two retinas to determine depth, known as stereopsis. Stereoscopic depth cues provide information about distances of objects in near space as a function of their relative horizontal positions in the visual field. Finally, at about 7 months, sensitivity to pictorial cues allows infants to perceive depth in a flat, two-dimensional picture.

Visual Attention

Infants are born with a functional oculomotor (eye movement) system. The muscles that move the eyes, and the brain-stem mechanisms that control these muscles directly, appear to be fully mature at birth, and infants make good use of these systems to scan the visual environment. Two developmental events seem to be particularly important to control of visual attention: the emergence of smooth pursuit at about 2 months, and increasing top-down control over saccadic or scanning eye movements that can take much longer. Smooth pursuit helps track moving targets in the environment and stabilize gaze, and saccades are used when inspecting visual stimuli. Both kinds of eye movement are believed to develop as specialized brain regions and networks mature, in particular systems for processing motion and objects.

Object Perception

Object perception is complex, involving multiple information-processing tasks, such as perceiving boundaries, shapes, sizes, and substances of objects. Understanding object boundaries first requires recognizing where one object ends and another object or surface begins. Detecting edges is critical for this process, and the intersection of edges provides information for the relative distance of object and surfaces. For example, where one edge is seen to lead into and end abruptly at another, the uninterrupted edge is usually nearer to the observer. Infants become capable of recognizing boundaries between 3 and 5 months.

Recognizing object boundaries alone does not reveal the complete shape of all objects because many objects are partly hidden by other surfaces nearer to the observer. Perception of partly occluded objects as complete is first accomplished at about 2 months, when infants view a partly occluded object moving horizontally behind an occluder. Common motion of visible parts of objects is critical for young infants' perception, although infants begin to perceive object unity in stationary displays at 6 to

7 months.

Finally, size and shape constancy supports an observer's perception of an object's true size and shape as remaining constant even when it is viewed at different distances and from different angles, which causes the size and shape within the visual field to change. Surprisingly, newborns, who have limited visual experience, appear to exhibit some sense of both size and shape constancy.

Face Perception

Studies with newborns have revealed preferences for facelike displays relative to other patterned stimuli, and consistent preferences for faces throughout infancy. Newborns' ability to recognize facelike stimuli suggests that infants may have a crude representation of faces before any experience with actual faces, or it may indicate that faces match inherent preferences for stimuli with similar spatial frequencies and arrangements of internal stimulus elements.

Under naturalistic conditions, faces exhibit multiple expressions and are seen from multiple perspectives, but infants are able to recognize familiar faces despite these variations. Infants can also discriminate gender in faces, and most infants show preferences for females. However, infants whose primary caregiver was male showed an overall preference for male faces, suggesting that experience with faces outside the lab leads infants to learn the details that define gender. Finally, infants' sensitivity to facial expressions emerges early; infants discriminate different intensities of smiling at 3 months and frowning at 6 months. By 7 months, infants can discriminate an extensive range of the facial expressions, including happiness, anger, sadness, fear, and surprise, although it is unlikely that they understand the content of this range of emotions as this age.

As noted, infants are predisposed to be sensitive to faces from birth. Some researchers have argued that this predisposition is caused by innate representation for faces, and others have suggested that it is a product of a combination of visual biases and rapid learning processes. Advances in neuroimaging and electrophysiological techniques have allowed researchers to identify areas in the brain involved in face perception. The middle fusiform gyrus in the right hemisphere has been implicated in perception of upright faces, and the amygdala appears to be involved with perception of facial expressions. Face processing in infants shows a right hemispheric advantage involving the fusiform gyrus, and experience with faces may help to sharpen the specializing of cortical areas tuned to faces. This tuning process may begin with a subcortical process involving the superior colliculus that orients infants to faces, manifest as the face preference described previously, and this can support learning about faces and the cortical sharpening process. Thus, infants' ability to perceive faces may begin as a response to a wide variety of facelike stimuli, including faces from other species; these abilities become tuned with age as a result of specific experiences with human faces.

Auditory Perception
Basic Auditory Function

Beginning with the second trimester after gestation, inner ears begin to function, which allows fetuses to have limited auditory experiences in the womb; as a consequence, fetuses show distinct responses to sounds of various intensities and frequencies.

Evidence indicates that neonates' auditory perception is influenced by prenatal experiences with sounds. For example, newborns prefer listening to their own mother's voice to another woman's voice.

Despite the physical maturity of the cochlea about two-thirds of the way through gestation, sound conduction through the external and middle ear to the inner ear is inefficient at birth, hindering the transmission of information to the auditory neural pathway. Perception of low frequencies is poor in young infants relative to high frequencies; low frequency discrimination is not yet mature even at 10 years, but discrimination of high frequencies is superior in infants relative to that of adults.

The most common measure used when testing intensity processing is the absolute threshold, the smallest intensity of sound detectable in a quiet environment. The absolute threshold improves throughout infancy and reaches adult levels by puberty, and the higher the frequency, the earlier adult levels are achieved. For example, the absolute threshold level at 4,000 and 10,000 hertz (Hz) reaches adult levels by 5 years of age, whereas the level for 1,000 Hz requires 10 years or more to reach maturity. Between 1 and 3 months, the absolute threshold improves by 15 decibels (dB), but little improvement is observed between 3 and 6 months except another 15-dB improvement in the 4,000-Hz threshold.

Hearing in Naturalistic Environments

The studies on auditory discrimination summarized in the previous section were conducted with pure tones. Sounds in naturalistic environments are complex, comprising multiple frequencies and various intensities. For example, perception of timbre, such as hearing differences in the way different musical instruments sound, involves comparison of different intensities across different frequencies. As early as 7 months, infants can discriminate between sounds of different timbres with the same pitch, but adult levels of competence at discriminating a series of complex timbres are not reached well into childhood.

Localization, the ability to locate the source of sounds in space, is required to accurately perceive sounds occurring in naturalistic environments. Two processes are involved in localization: (a) evaluation of spectral shape and intensity and (b) binaural comparisons of sounds reaching the left and the right ears. Under normal circumstances, spectral shape is the primary cue to position in elevation, and binaural time and intensity differences are the primary cues to position in azimuth (the plane that runs through the ears parallel to the ground). Infants appear to rely more heavily on spectral shape in sound localization than on binaural differences, perhaps because they are more sensitive to differences in sound frequency than to differences in sound intensity.

Once different types of auditory information are received, they need to be organized into perceptually meaningful elements. For example, to follow a conversation, speech produced by members of the family must be grouped together and noises from children playing outside must be filtered out. The process of grouping is partly functional in infants, but it is more easily disrupted in children than in adults. Part of this process is ignoring irrelevant sounds while attending to the relevant sound source. Infants, unlike adults, often seem to act as if they are not sure about disregarding irrelevant sounds. For example, studies with 7- to 9-month-old infants suggest that they cannot detect a pure tone when presented simultaneously with a wide-frequency noise band.

Speech Perception

Infants appear to have difficulty segregating speech from other competing sounds. Thus, when interacting with infants, adult caregivers often compensate for this difficulty by making major acoustic adjustments in their speech, such as the use of infant-directed speech, which contains exaggerated pitch contours, a higher register, repetitions, and simpler sentences.

A central question in this area concerns whether infants respond to phonetic differences in a similar manner as adults. Studies examining cross-language and native-language speech perception suggest that infants are born with universal sensitivity to the phonemes that are present in all languages. Phonemes are components of a language that distinguish words by forming the contrasting element in pairs of words, such as the /r/ and /l/ in *rake* and *lake*. There is a developmental loss of “unused” initial sensitivities. For example, a study of English-speaking adults, Hindi-speaking adults, and 6- to 8-month-old infants from English-speaking families demonstrated that infants distinguished two distinct phonemes with similar sounds in both English and Hindi, /ta/ and /da/ in English, and the retroflex /D/ and dental /d/ in Hindi, whereas adults distinguished only between different phonemes in their native language. These phonemes are all produced by placing the tongue against the alveolar ridge, just behind the teeth, and releasing it in time with voice onset. They vary with respect to the precise part of the tongue and alveolar ridge involved, and voice onset timing; as mentioned, adults often have difficulty discriminating these phonetic details when they are not part of their native language.

Infants often exhibit preferences for speech over nonspeech sounds, which can help in attending to signals in the environment necessary for language acquisition. But infants do not always prefer speech. When presented with both filtered speech, which sounds like a kind of mumble as though hearing through a wall, and nonspeech sounds, neonates did not prefer listening to filtered speech, suggesting that preference for speech is not a direct result of prenatal auditory experiences with human speech. Instead, there may be an evolutionary predisposition for sounds produced by a human vocal tract. This claim has also been extended to a finding that hearing infants show preference for watching sign language over carefully matched nonlinguistic gestures.

The patterns of rhythm and intonation in speech are known as prosody. Newborns are sensitive to prosodic properties of speech and use them to discriminate one language from another; among several components of language, prosody appears to be the primary way for young infants to perceive speech. This is especially useful in bilingual environments because it helps infants avoid a potential confusion.

Intermodal Perception

Adults do not experience the world as fragmented sensory impressions, but as integrated, multimodal experiences. Infants are capable of perceiving several types of intermodal relation. Newborns can detect “arbitrary” auditory-visual relations that were presented during a period of familiarization (a particular shape paired with a particular sound), but most intermodal relations in the world are quite specific rather than arbitrary. An example is speech, which can be simultaneously heard and seen in a talking face. Adults' phoneme perception is strongly influenced by watching faces, the so-called McGurk effect: When adults hear a syllable while looking at a face producing a different syllable, they tend to perceive the sound associated with the lip movements rather than the actual phoneme that they heard. Five-month-old infants are also susceptible to this effect.

Infants can use the duration of events to integrate information across modalities. In one study, infants were familiarized with pairs of checkerboards that flashed at the same rate but for different durations. These checkerboards were presented in silence. During test, infants were again presented with pairs of checkerboards, accompanied by sounds whose duration, onset, and offset corresponded to only one of the checkerboards. Infants older than 6 months (but not younger) exhibited a looking preference for the matching checkerboard. However, if onset and offset of the sound and flash were not synchronized (but maintained identical absolute duration), the preference disappeared, indicating that accurate responding to amodal duration information depends on synchronization of onset and offset. (*Amodal* refers to a single event that is specified by more than one modality.) Infants also may be capable of abstracting amodal rhythmic structure from auditory-visual pairings. At 5 months of age, infants can detect changes in regularly or irregularly occurring rhythmic auditory or visual sequences regardless of whether the modality of presentation is changed.

Another example of developments in intermodal perception involves matching a shape that is perceived both visually and haptically (i.e., by touch). This ability does not appear functional in very young infants, but some studies indicate that, by 4 to 5 months, infants recognize and discriminate objects cross-modally—that is, visual exposure leads to haptic recognition and vice versa.

In sum, many studies suggest that at an early age, infants are sensitive to some intermodal relations. Other findings suggest that intermodal perception for amodal pairings emerges only after 6 months or older, suggesting that at least some intermodal relations are learned through experience, or at least come on line only after particular modalities reach certain developmental levels.

- infants
- phonemes
- intermodal perception
- infant perception
- motion
- ears
- face perception

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See also

- Amodal Perception
- Attention: Theories of
- Audition
- Binding Problem
- Color Perception
- Constancy
- Cross-Modal Transfer
- Eye Movements: Behavioral

- Face Perception
- Infant Perception: Methods of Testing
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- Multimodal Interactions: Color-Chemical
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- Multimodal Interactions: Visual-Auditory
- Multimodal Interactions: Visual-Haptic
- Nature and Nurture in Perception
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- Perceptual Development: Intermodal Perception
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- Perceptual Development: Taste and Olfaction
- Perceptual Development: Touch and Pain
- Perceptual Development: Visual Acuity
- Perceptual Development: Visually Guided Reaching
- Perceptual Development: Visual Object Permanence and Identity
- Perceptual Organization: Vision
- Speech Perception
- Statistical Learning
- Vision

Further Readings

Gottlieb, G., & Krasnegor, N. A. (1985). Measurement of audition and vision in the first year of postnatal life: A methodological overview. Norwood, NJ: Ablex.

James, W. (1890). The principles of psychology (Vol. I). New York: Dover.

Johnson, S. P., (2005). Building knowledge from perception in infancy. In L. Gershkoff-Stowe, & D. Rakison (Eds.), Building object categories in developmental time: 32nd Carnegie symposium on cognition (pp. 33–62). Mahwah, NJ: Lawrence Erlbaum.

Jusczyk, P. W. (1997). The discovery of spoken language. Cambridge: MIT Press.

Kellman, P. J., & Arterberry, M. E. (1998). The cradle of knowledge: Development of perception in infancy. Cambridge: MIT Press.

Kuhl, P. K. Human adults and human infants show a “perceptual magnet effect” for the prototypes of speech categories, monkeys do not Perception & Psychophysics 50 (1991) 93–107 http://dx.doi.org/10.3758/BF03212211

Lewkowicz, D. J. The development of intersensory temporal perception: An epigenetic systems/limitations view Psychological Bulletin 126 (2000) 281–308 http://dx.doi.org/10.1037/0033-2909.126.2.281

Lickliter, R., and Bahrick, L. E. The development of infant intersensory perception: Advantages of a comparative convergent-operations approach Psychological Bulletin 126 (2000) 260–280 http://dx.doi.org/10.1037/0033-2909.126.2.260

Saffran, J. R., Werker, J., & Werner, L. (2006). The infant's auditory world: Hearing, speech, and the beginnings of language. In R. Siegler, & D. Kuhn (Eds.), Handbook of child development (pp. 58–108). New York: Wiley.
Teller, D. Y., and Movshon, J. A. Visual development Vision Research 26 (1986) 1483–1506 http://dx.doi.org/10.1016/0042-6989%2886%2990169-0
Werker, J. F., & Tees, R. C. (1999). Experiential influences on infant speech processing: Toward a new synthesis. In J. T. Spence (Ed.), J. M. Darley, & D. J. Foss (Associate Eds.), Annual review of psychology (Vol. 50, pp. 509–535). Palo Alto, CA: Annual Reviews.