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Anamorphosis

The Ames demonstrations were not unprecedented, in the sense that they have much in common with an historic artistic distortion technique called *anamorphosis*, and to other perspective illusions employed in the design of theatrical sets.

In anamorphic constructions, the image looks distorted when viewed frontally (as is customary) but correctly proportioned when seen from the side (often indicated by a peephole). For example, Ames was well acquainted with the work of scientist and philosopher Hermann von Helmholtz, who more than 50 years before had noted that an infinite variety of distorted rooms could be devised that, from a monocular peephole, would nonetheless seem to be normal.

Far in advance of Helmholtz, this same kind of visual distortion was used as early as 1485 by Leonardo da Vinci (and probably even earlier by Chinese artists) as an offshoot of perspective. As early as the 16th century, a group of Dutch artists made anamorphic "peepshows" called *perspectyfkas* or perspective cabinets, a few of which still exist and are now on display in museums. These artistic constructions have much in common with the Ames distorted room, the chair demonstration, and the rotating trapezoid window. In fact, many of the Ames demonstrations make use of trapezoids that appear rectangular, tilted surfaces that appear to be flat, or flat surfaces that appear tilted.

Most of the Ames demonstrations require (or at least work optimally with) a monocular peephole. This is because they rely on the fact that any number of external constructions could produce the same retinal image. Ames explicitly stated that (as Helmholtz had noted) he could have constructed an infinite number of distorted rooms, no two of which would have the same physical shape, yet each would appear to be normal. In the end, he only constructed a few.

Implications

The Ames demonstrations might never have become well known had they not been embraced and promoted by other people who saw them as palpable evidence of their own convictions. They were of particular value to proponents of transactional psychology (not to be confused with transactional analysis), a 1950s spin-off of pragmatism that was partly inspired by the "transactional approach" of philosopher John Dewey (who first saw the demonstrations in 1946, and then corresponded with Ames until 1951). Ames believed, as Dewey did, that we are not passive recipients of a given reality, but instead are active participants in a give-and-take exchange (a "transaction") in which split-second assumptions are made about the nature of reality.

The demonstrations have also had lasting effects on other aspects of culture. Even today, one or more of the demonstrations are invariably mentioned in textbooks on perception, and it is not uncommon for one or more to appear in television documentaries, video clips, cinematic special effects, or advertising commercials.

Roy R. Behrens

See also Magic and Perception; Object Perception; Pictorial Depiction and Perception

Further Readings

Behrens, R. R. (1994). Adelbert Ames and the cockeyed room. *Print, 48,* 92–97.

Behrens, R. R. (1998). The artistic and scientific collaboration of Blanche Ames Ames and Adelbert Ames II. *Leonardo, 31,* 47–54.

Behrens, R. R. (1999). Adelbert Ames, Fritz Heider, and the chair demonstration. *Gestalt Theory, 21,* 184–190.

Cantril, H. (Ed.). (1960). *The morning notes of Adelbert Ames, Jr.* New Brunswick, NJ: Rutgers University Press.

Ittelson, W. H. (1968). *The Ames demonstrations in perception.* New York: Hafner.

Kilpatrick, F. P. (Ed.). (1961). *Explorations in transactional psychology.* New York: New York University Press.

Amodal Perception

Amodal (meaning "without" modality) *perception* is perception of information that is common or redundant across multiple senses (e.g., auditory, visual, tactile). Amodal information includes changes along three basic parameters of stimulation—time, space, and intensity. Properties of objects and events such as temporal synchrony, rhythm, tempo, duration, intensity, and co-location are common across auditory, visual, and proprioceptive stimulation. Properties

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such as shape, substance, and texture are common across visual and tactile stimulation. For example, the same rhythm and tempo can be detected by seeing or hearing the pianist strike the notes of the keyboard, and the same size, shape, and texture can be detected by seeing or feeling an apple.

Virtually all events occur across time, are distributed across space, and have a characteristic intensity pattern, so virtually all events provide amodal information. For example, speech comprises changes in audiovisual synchrony, tempo, rhythm, and intonation (intensity changes) that are common to the movements of the face and the sounds of the voice. Self-motion produces proprioceptive feedback (information from the muscles, joints, and vestibular system) that is synchronized and shares temporal and intensity changes with the sight of self-motion (e.g., seeing and feeling one's hand move). Perceiving amodal information is critically important for organizing early perceptual and cognitive development and for accurate perception of everyday events in children and adults alike.

The term *amodal* has also been used in a different sense—to refer to perception in the absence of direct information from a specific sense modality. For example, in visual perception, *amodal completion* describes how we perceive a unitary shape (e.g., a ball), even when part of the object or shape is occluded (hidden) behind another object (e.g., a block). Even infants can accurately perceive a partially hidden shape if the occluder is moved back and forth, progressively revealing and then hiding the object's contours. Scientists propose that we perceive unitary shape by detecting visual invariants (patterns that remain constant across change) through object motion, whereas others maintain that we must fill in the missing information by inference or cognitive processes. Whatever the process, the term *amodal* referring to incomplete information is not consistent with the previous definition (which refers to information that is fully available and can be directly perceived through more than one sense) and, thus, will not be discussed further. This entry describes the history, theory, and development of amodal perception.

History and Theory

For centuries, philosophers and scientists have been intrigued by how we perceive unified objects and events even though our senses provide specific information through separate sensory channels. How are these different sources of stimulation bound together? Further, why do our senses provide overlapping and redundant information for many qualities of objects? The concept of amodal perception addresses these important questions and dates back more than 2,000 years to the time of Aristotle. Aristotle proposed a *sensus communis* (an amodal or common sense) that detected qualities that were common to several senses. These common sensibles included number, form, rest, movement, magnitude, and unity—information that today is considered amodal.

Centuries later, philosophers such as John Locke and George Berkeley took a different approach to the question of perceiving object and event unity. They proposed that sensations had to be interpreted and integrated across the senses before a person could perceive meaningful objects and events. Until recently, developmental psychologists, including Jean Piaget, thought this process of integration developed gradually through experience with objects. By coordinating and associating what one sees with what one feels and hears, one could construct a coherent, three-dimensional world of objects and events.

This constructivist view was not seriously questioned until James J. Gibson's ecological view of perception emerged in the 1960s, and a view more consistent with that of Aristotle's reemerged. Gibson proposed that the different forms of stimulation from the senses were not a problem for perception, but rather provided an important basis for perceiving unitary objects and events. Our senses, he proposed, work together as a unified perceptual system to pick up information that is invariant or common across the senses—that is, amodal information. If we attend to amodal information, then there is no need to learn to integrate stimulation across the senses to perceive unified objects. Temporal synchrony (the most basic form of amodal information) has been described as the glue that binds stimulation across the senses. For example, by attending to synchrony, the sounds and sights of a single person speaking would be perceived as united. Sights and sounds that are perfectly synchronized belong together and constitute unitary events. Detecting this information prevents the accidental association of unrelated but concurrent sensory stimulation.

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Development

Researchers now know that even very young infants are skilled at detecting amodal information, including temporal synchrony, tempo, rhythm, intensity changes, shape, texture, substance, and prosody in speech. Amodal information is highly salient and directs attentional selectivity, for both humans and animals, especially during early development. When videos of two different events are superimposed, playing a synchronous soundtrack to one of them allows even infants to selectively attend to the synchronous event while effectively ignoring the asynchronous one. This attentional salience may be partly the result of the enhanced neural responsiveness generated by redundantly presented amodal information compared with that observed for each modality alone.

The development of a surprising variety of skills depends on the detection of amodal information. Shortly after birth, infants move their eyes in the direction of a sound, coordinating audible and visible space. This provides a basis for detecting further amodal information common to the sight and sound. By 2 to 5 months, infants detect a variety of amodal aspects of objects and events. For example, they detect temporal synchrony, rhythm, and tempo uniting the sights and sounds of objects banging against a surface, as well as more refined temporal information revealing the substance (rigid and elastic) and composition of objects. Infants detect voice-face synchrony in speech by 2 months and later can use it to separate one speech stream from another concurrent one. Even information for emotion is detected by 5 months and is largely amodal, deriving from differences in the timing and intensity of movement and sound. Learning about the self also depends on detecting amodal information for self-motion. By 3 to 5 months, infants detect the congruence between the proprioceptive feedback from their own motion and the visual experience of that motion (e.g., by feeling and seeing their own legs move), and this provides an important basis for separating the self from other individuals. Even maintaining an upright posture requires detecting amodal information common to the visual flow and proprioceptive feedback from body motions. Young infants also detect the common shape, texture, and substance across tactile and visual exploration, allowing them to visually select an object they have previously explored only tactually. Amodal information can also be used to create the illusion of unity as in the *ventriloquism effect*. The ventriloquist creates amodal information by moving the puppet's mouth in time with his own speech sounds and can therefore fool the audience into perceiving that the puppet is speaking. Thus, amodal information simplifies and organizes incoming stimulation, providing a basis for perceiving unitary, multimodal events rather than a "blooming, buzzing confusion" of unrelated sights, sounds and tactile impressions.

Lorraine E. Bahrick

See also Attention: Cross-Modal; Cross-Modal Transfer; Multimodal Interactions: Tactile–Auditory; Multimodal Interactions: Visual–Auditory; Multimodal Interactions: Visual–Haptic; Object Perception; Perceptual Development: Intermodal Perception; Vision

Further Readings

Bahrick, L. E., & Lickliter, R. (2002). Intersensory redundancy guides early perceptual and cognitive development. In R. Kail (Ed.), *Advances in child development and behavior* (Vol. 30, pp. 153–187). New York: Academic Press.

Gibson, E. J., & Pick, A. D. (2000). *An ecological approach to perceptual learning and development.* New York: Oxford University Press.

Gibson, J. J. (1966). *The senses considered as perceptual systems.* Boston: Houghton Mifflin.

Lewkowicz, D. J. (2000). The development of intersensory temporal perception: An epigenetic systems/limitations view. *Psychological Bulletin, 126,* 281–308.

Lewkowicz, D. J., & Lickliter, R. (1994). *The development of intersensory perception: Comparative perspectives.* Hillsdale, NJ: Lawrence Erlbaum.

Animal Chemical Sensitivity

Humans use their chemical senses in many facets of their lives, yet their abilities pale in comparison with those of most animals. Everyday demonstrations of the chemosensory prowess of animals include dogs tracking invisible chemical trails,