Wolfgang Metzger: Laws of Seeing

Chapter 11. The Wandering Moon

Speaker: Hsin-Yueh Hsu (Moon)

December 8, 2009

Figure 171

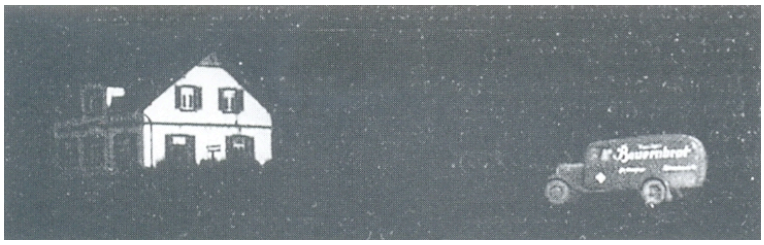


Figure 174

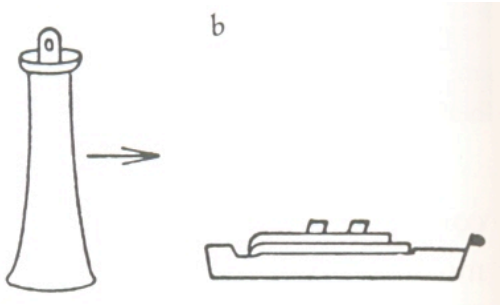


Figure 175b

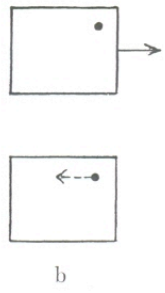


Figure 177b

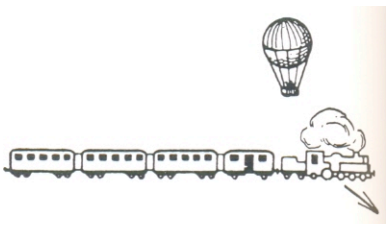


Figure 178

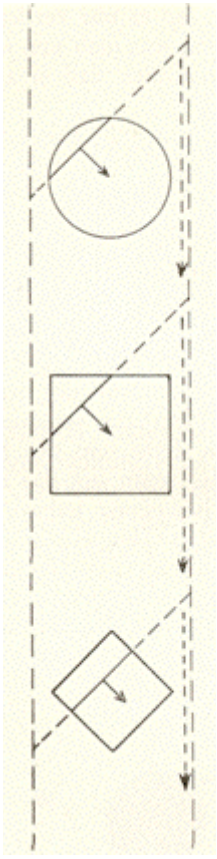


Figure 465

Wolfgang Metzger: Laws of Seeing

Chapter 11. The Wandering Moon

Speaker: Hsin-Yueh Hsu (Moon) December 8, 2009

Motion is the most powerful stimulus in vision. As soon as a moving stimulus occurs in our peripheral visual field, we turn around, to look at it with foveal vision. This dissociation between peripheral and central vision has been called the "*Where and the What system*". The two systems project to the parietal and temporal lobe, respectively.

Metzger describes a number of findings in motion perception, which were obtained using everyday observations and toy stimuli. While some observations speak for the influence of experience, others speak against it. An example is the wandering moon, which we see in motion relative to the wind-swept clouds, although it is completely motionless (Figure 171). This is called *induced motion*. Another example is the haunted swing, where the observer sits stationary in his chair, while the house turns around him. This induces a strong sense of self-rotation in the observer and produces nausea, as houses do not normally rotate.

Figure 174 shows a house and a truck against a black background. When the house is set into motion, it is the truck that appears to move - in the opposite direction. This demonstration works only in complete darkness without any external reference. Here again the motion percept is governed by experience. The same conclusion holds for Figure 175b, when the lighthouse is moved, but the ship appears to move instead; and the train in Figure 178, imparting its downward movement to the balloon, which appears to rise to the left. In Figure 177b, motion perception is studied using experience-free stimuli. Here, a rectangle actually moves to the right, but the dot in the upper right corner appears to move in the opposite direction.

A particularly compelling illusion can be experienced by looking through the window of a train, when another train stops nearby. As soon as the other train starts moving again, one's own train appears to move against better knowledge. Metzger attributes this illusion to the law of *enclosedness*. (More experiments should be done to find out about the boundary conditions for this illusion.)

In the second edition of the *Laws of Seeing*, Metzger describes the perceived direction of a motion stimulus traversing an aperture. Figure 465 shows a diagonal line moving downward. There are three windows: a circle, a square, and a diamond. In each of these cases, the line appears to move from the upper left to the lower right

at right angles to its orientation. This is called the *aperture problem*. However, the

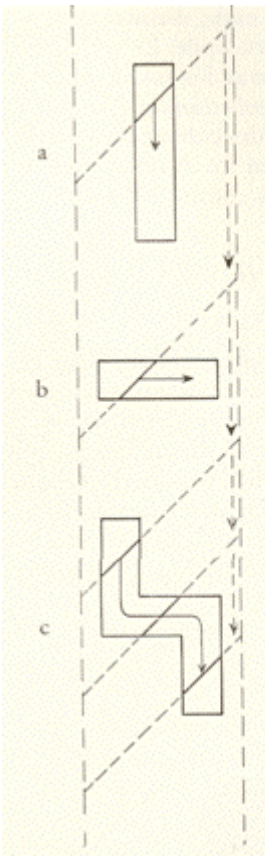


Figure 466

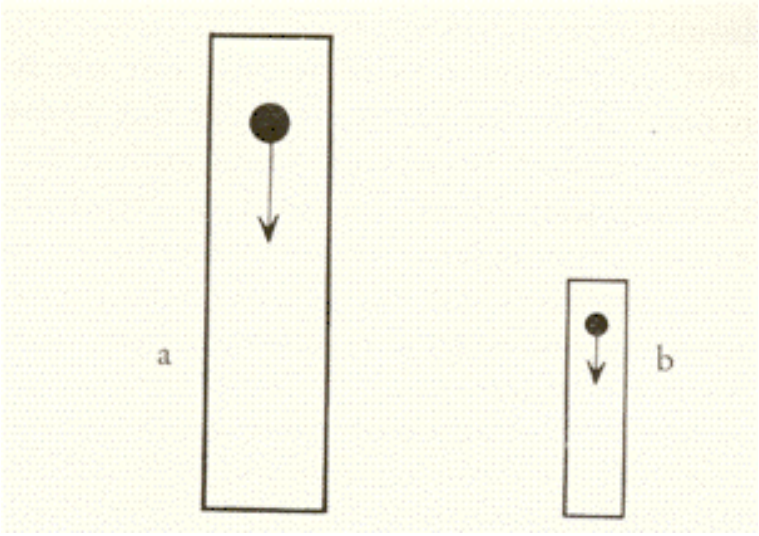


Figure 469

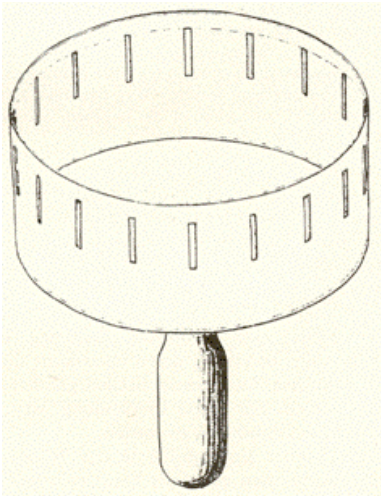
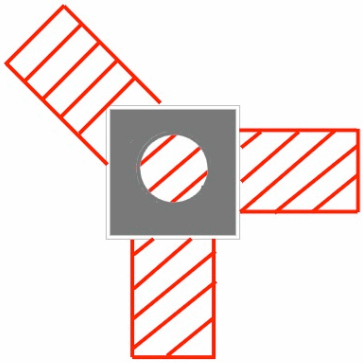


Figure 474

same is no longer true in Figure 466, where the windows are narrow. In *a,* the line appears to move downward, in *b* to the right, and in *c* first down, then to the right, and down again. In other words, the perceived direction of motion conforms to the shape of the window, regardless of the actual direction of motion. This kind of motion is mediated by the local motion cues at the edges of the window, which determine the direction of the global motion. The *barber pole* illusion obeys the same principle.



This takes us to motion perceived in plaids. Here a diagonal grating moving to the upper right and a diagonal grating moving to the lower right are spatially superimposed. As a result, one perceives motion in the direction of the vector sum (horizontal and to the right). It has been shown that after adaptation to such a stimulus, one perceives a *negative motion aftereffect* in the opposite direction. This is an example of perceived motion without a change of location. Neurophysiological experiments have studied the mechanisms underlying plaid motion and motion transparency, i.e., when the lower grating is seen through the upper grating.

The speed of perceived motion depends on eye movements. A moving object seen with your eyes kept still appears to move twice as fast as the same object seen with ocular pursuit. The reason is the difference in retinal image displacement. Furthermore, a large object appears to move more slowly than a small object, even if both have the same velocity (Figure 469).

An important discovery was made by Max Wertheimer, when he observed that two stimuli presented in alternation produced a percept of *apparent motion*. This was an example of an emergent property that could not be derived from the individual stimuli. It gave rise to Gestalt psychology. The statement that *the whole is different from the sum of its part* is based on this and other observations. Using apparent (or stroboscopic) motion, it was shown that many of the Gestalt factors which we have come to know from static stimuli (chapters 1-10) also apply to dynamic stimuli. There are three stages of stroboscopic motion depending on the duration of the time interval between the two stimuli: simultaneity, optimal motion, and succession. Optimal

motion refers to an object seen to move across the unstimulated space between the

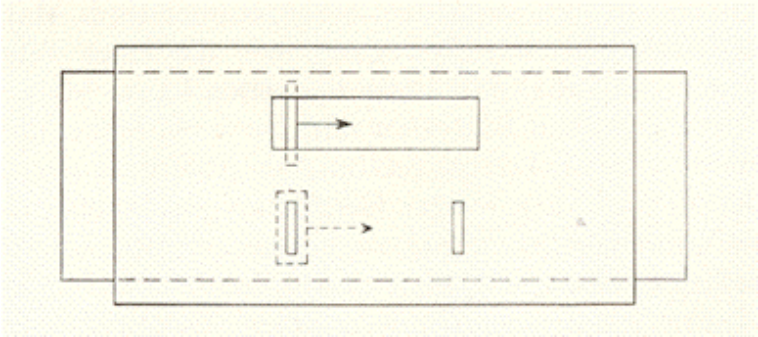


Figure 476

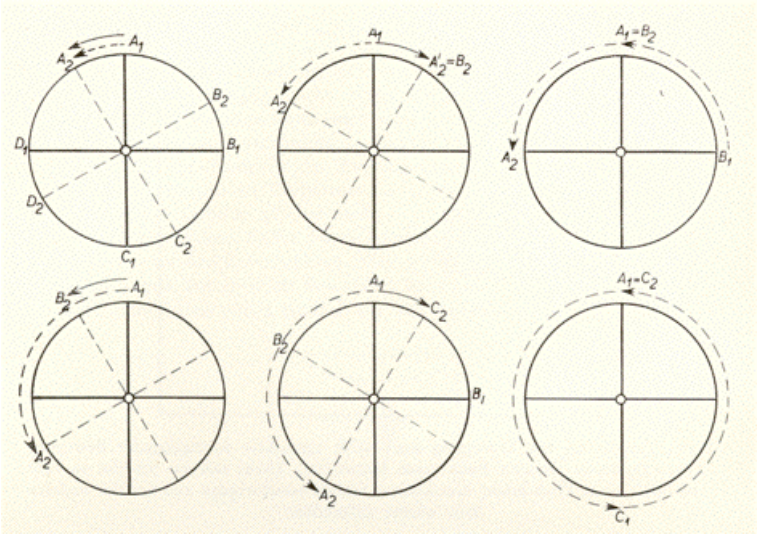


Figure 481

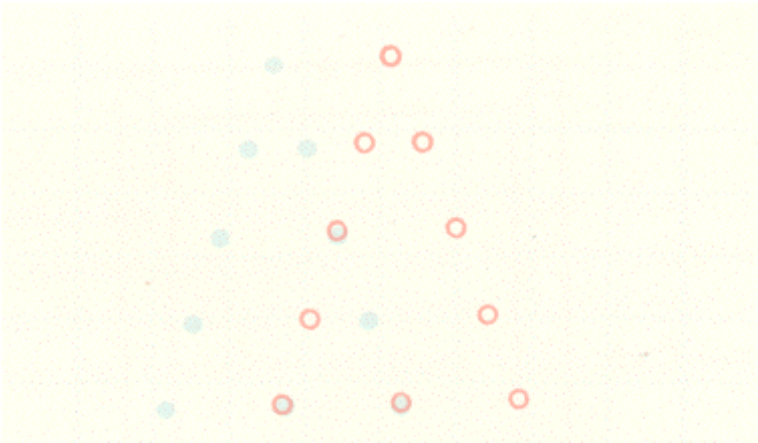


Figure 489

two stimuli, while motion without an object is called *pure or phi-motion*. Wertheimer attributed stroboscopic motion to an electrical short circuit in the brain. Perceptive fields for motion can be measured using the maximum distance over which optimal or phi motion is seen. They are 20 larger than perceptive fields for static contrast stimuli.

Figure 474 shows a stroboscope, which enables the observer to see, for example, a rider on horseback. This was the beginning of motion pictures. In old Chaplin movies, the apparent motion was jerky, because the frame rate was too low (60 Hz); today it is 24Hz. Nevertheless, every movement in the cinema still is an apparent movement elicited by stimuli that are sequentially presented in slightly different positions. When real motion and apparent motion are shown simultaneously, one above the other (Figure 476), they cannot be distinguished from each other. Metzger writes (p. 14): "This is a fundamental datum for the theory of perceived movement, since it forces us to explain real and apparent movement on the same basis. It follows that everything discovered in the study of apparent movement contributes also to our understanding of the ability to perceive actual movement." O.-J. Gruesser showed in the frog that motion-sensitive neurons responded equally to both types of movement.

Apparent motion in a movie occasionally produces puzzling results. The rotating wheel of a car will appear to move forward, a moment later come to a stop, and then move backward, before resuming its forward motion. This is because of the Gestalt factor of *proximity* (Figure 481). When the rotation in the next frame has proceeded by 45 degrees relative to the previous one, the perceived motion direction will be ambiguous. When the rotation has proceeded by exactly 90 degrees, the wheel will appear to be stationary.

A fascinating example of apparent motion is the *motion quartet*, where four dots are arranged at the corners of a hypothetical square. Because the distances between pair members are identical, two-stroke apparent motion can be perceived either along the vertical or horizontal axis. If, however, the square is changed to a rectangle, apparent motion should now be seen preferably in the direction of the shorter axis, according to the Gestalt factor of *proximity*. Curiously, the change in motion direction will not immediately occur because of hysteresis (Anstis & Ramachandran: inertia). The Gestaltists called this "*objective set,*" based on the law of *minimum change*.

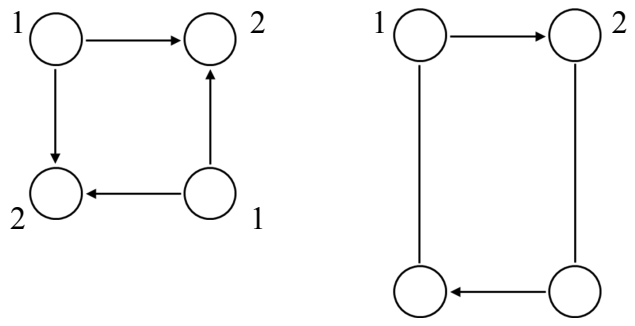


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Figure 489 demonstrates long-range motion in the so-called *Ternus display*. Although the two stimuli share several elements, local motion between them will not be seen, because "nothing must be destroyed and nothing newly created except what is already present" (Metzger, p. 27). For the same reason, a bird in a cage becomes perceptually a fish in an aquarium, or *Moon* turns into *Chia Yao*.

A type of motion which we normally do not see occurs in a cycloid. Every point on a rolling wheel describes a half circle with the amplitude corresponding to the radius of the wheel. This motion can be made visible only by a luminous bulb attached to the rim of the wheel and viewed in darkness (without the hub).

Michotte demonstrated that apparent causality can be perceived when two visual events are shown in the appropriate temporal and spatial relationship. Using specially designed tracks moving behind a cardboard window, he found five kinds of apparent causality. These are: push or launching, shoving, pick-up or entrainment, repulsion, and overtaking. Experiments on apparent causality have recently been done by Guilia Parovel and Clara Casco in Padua who kindly sent us their files with animations.

▲ Examples of some of Michotte's basic demonstrations of perceptual causality (Scholl & Tremoulet, 2000)

Sarina mentioned developmental studies on apparent causality in young children.