Uncanny Valley

Anthropomorphic forms are appealing when they are dissimilar or identical to humans, but unappealing when they are very similar to humans.

Anthropomorphic forms are generally appealing to humans. However, when a form is very close but not identical to a healthy human—as with a mannequin or computer-generated renderings of people—the form tends to become distinctly unappealing. This sharp decline in appeal is called the "uncanny valley," a reference to the large valley or dip in the now classic graph presented by Masahiro Mori in 1970.[1] Though some have disputed the existence of the effect altogether, attributing any negative affective response to a simple lack of familiarity with artificial and rendered likenesses, more recent empirical research suggests the uncanny valley is a real phenomenon. The cause likely regards innate, subconscious mechanisms evolved for pathogen avoidance—that is, detecting and avoiding people who are sick or dead.[2]

Although a full understanding of the variables required to take an anthropomorphic likeness into the uncanny valley has not yet been realized, some conditions have been identified. The strength of the negative reaction seems to correspond to the fidelity of the likeness—a highly realistic likeness that is identifiable as artificial will evoke a stronger negative reaction than a less realistic likeness. Abnormally proportioned or positioned facial features, asymmetry of facial features, subtleties of eye movement, and unnatural skin complexions are all sufficient conditions to trigger uncanny valley effects.
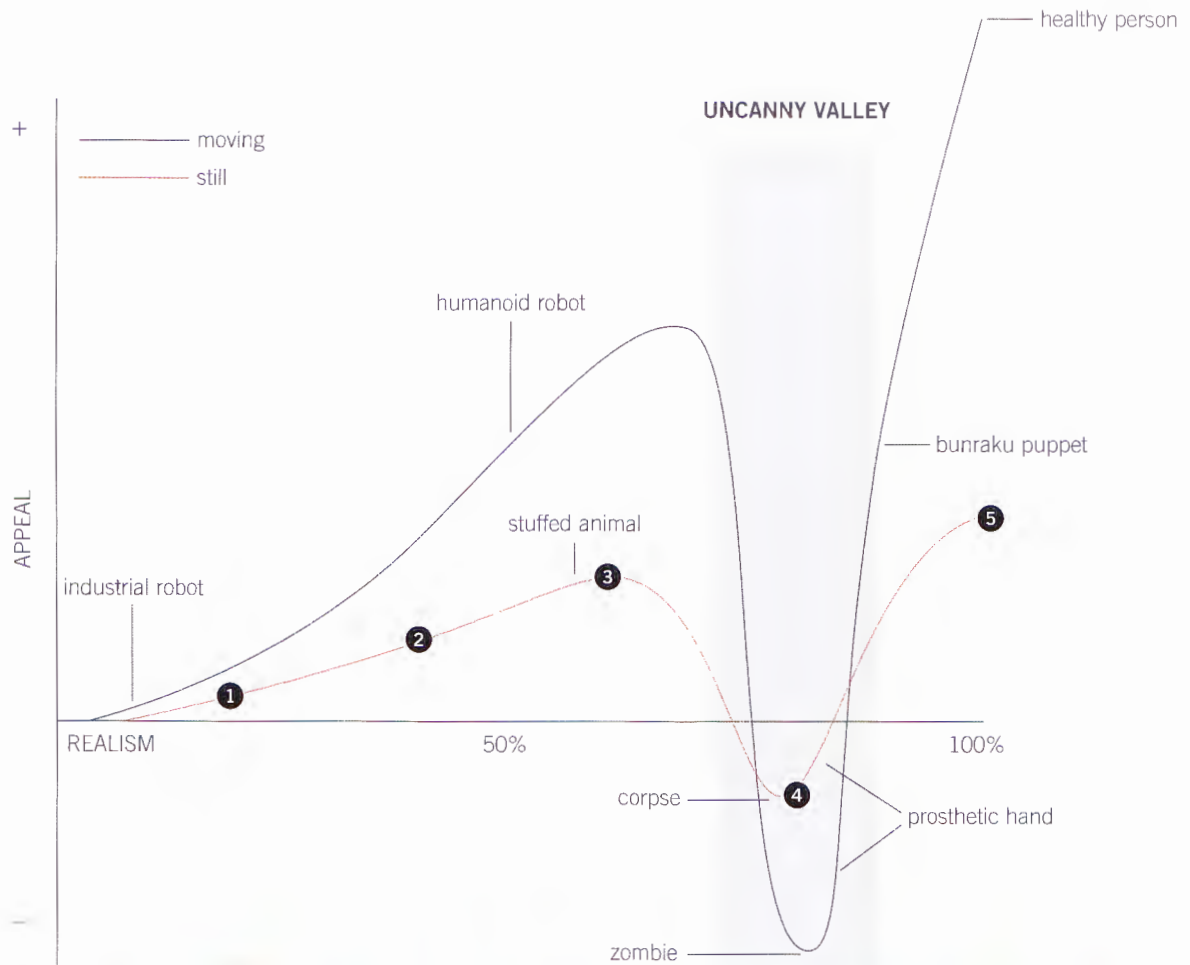
Although the uncanny valley is generally observed by animators and roboticists, there are plenty of examples where the caveats of the principle are not abided. For example, director Robert Zemeckis decided to depict computer-generated characters with a high degree of realism for the movie *The Polar Express*. The resulting effect was both impressively realistic and eerie. The movie raised awareness of what is called "dead eye syndrome," where the lack of eye movements called *saccades* made the characters look zombielike, taking the Polar Express straight through the uncanny valley. Another example is found in retail contexts. There is a general perception among retailers that the effectiveness of mannequins is a function of their realism. However, barring a mannequin that is indistinguishable from a real person, the uncanny valley suggests that retailers would be better served by more abstract versus highly realistic mannequins.

Consider the uncanny valley when representing and animating anthropomorphic forms. Opt for more abstract versus realistic anthropomorphic forms to achieve maximum acceptance. Negative reaction is more sensitive to motion than appearance, so be particularly cognizant of jerky or unnatural movements when animating anthropomorphic bodies and faces.

See also Anthropomorphic Form, Threat Detection, and Top-Down Lighting Bias.

[1] The seminal work on the uncanny valley is "Bukimi No Tani [The Uncanny Valley]" by Masahiro Mori, *Energy*, 1970, vol. 7(4), p. 33–35.

[2] See, for example, "Too Real for Comfort? Uncanny Responses to Computer Generated Faces" by Karl MacDorman, Robert Greena, Chin-Chang Hoa, et al., *Computers in Human Behavior*, May 2009, vol. 25(3), p. 695–710; and "The Uncanny Valley: Effect of Realism on the Impression of Artificial Human Faces" by Jun'ichiro Seyama and Ruth Nagayama, *Presence*, Aug. 2007, vol. 16(4), p. 337–351.

UNCANNY VALLEY

moving
still

+

APPEAL

healthy person

humanoid robot

bunraku puppet

⑤

stuffed animal

③

industrial robot

②

①

REALISM   50%   100%

corpse —— ④   prosthetic hand

zombie ——

① ② ③ ④ ⑤

Masahiro Mori's classic graph plots familiarity or appeal of an anthropomorphic form against its degree of realism. The uncanny valley resides to the right of the continuum, dipping sharply just before the likeness of a genuine healthy person. The mannequin images illustrate the benefits of abstraction and total realism in depicting human likenesses, as well as the perils of the uncanny valley.

Top-Down Lighting Bias

A tendency to interpret shaded or dark areas of an object as shadows resulting from a light source above the object.[1]

Humans are biased to interpret objects as being lit from a single light source from above. This bias is found across all age ranges and cultures, and likely results from humans evolving in an environment lit from above by the Sun. Had humans evolved in a solar system with more than one sun, the bias would be different.

As a result of the top-down lighting bias, dark or shaded areas are commonly interpreted as being farthest from the light source, and light areas are interpreted as being closest to the light source. Thus, objects that are light at the top and dark at the bottom are interpreted as convex, and objects that are dark at the top and light at the bottom are interpreted as concave. In each case, the apparent depth increases as the contrast between light and dark areas increases. When objects have ambiguous shading cues the brain switches back and forth between concave and convex interpretation.[2]

The top-down lighting bias can also influence the perception of the naturalness or unnaturalness of familiar objects. Objects that are depicted with top-down lighting look natural, whereas familiar objects that are depicted with bottom-up lighting look unnatural. Designers commonly exploit this effect in order to create scary or unnatural looking images. Interestingly, there is evidence that objects look most natural and are preferred when lit from the top-left, rather than from directly above. This effect is stronger for right-handed people than left-handed people, and is a common technique of artists and graphic designers. For example, in a survey of over two hundred paintings taken from the Louvre, the Prado, and the Norton Simon Museums, more than 75 percent were lit from the top left. Top-left lighting is also commonly used in the design of icons and controls in computer software interfaces.[3]
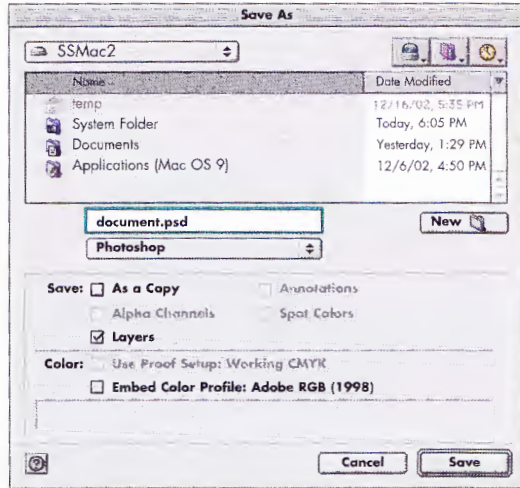
The top-down lighting bias plays a significant role in the interpretation of depth and naturalness, and can be manipulated in a variety of ways by designers. Use a single top-left light source when depicting natural-looking or functional objects or environments. Explore bottom-up light sources when depicting unnatural-looking or foreboding objects or environments. Use the level of contrast between light and dark areas to vary the appearance of depth.

See also Figure-Ground Relationship, Iconic Representation, Three-Dimensional Projection, and Uncanny Valley.

[1] Also known as *top-lighting preference* and *lit-from-above assumption*.

[2] See "Perception of Shape from Shading," *Nature*, 1988, vol. 331, p. 163–166; and "Perceiving Shape from Shading," *Scientific American*, vol. 256, p. 76–83, both by Vilayanur S. Ramachandran.

[3] "Where Is the Sun?" by Jennifer Sun and Pietro Perona, *Nature Neuroscience*, 1998, vol. 1(3), p. 183–184.

Save As

SSMac2

Name	Date Modified
temp	12/16/02, 5:35 PM
System Folder	Today, 6:05 PM
Documents	Yesterday, 1:29 PM
Applications (Mac OS 9)	12/6/02, 4:50 PM

document.psd   New

Photoshop

Save: ☐ As a Copy   ☐ Annotations
☐ Alpha Channels   ☐ Spot Colors
☑ Layers

Color: ☐ Use Proof Setup: Working CMYK
☐ Embed Color Profile: Adobe RGB (1998)

Cancel   Save

Open   ? ×

Look in: My Computer

3 ½ Floppy (A:)
Local Disk (C:)
UNTITLED (D:)
CD-RW Drive (E:)
Removable Disk (F:)
Removable Disk (G:)
Removable Disk (H:)
Removable Disk (I:)

My Recent Documents
Desktop
My Documents
My Computer
My Network Places

File name   Open
Files of type: All Formats   Cancel

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Graphical user interfaces generally use top-left lighting to imply dimensionality of windows and controls.
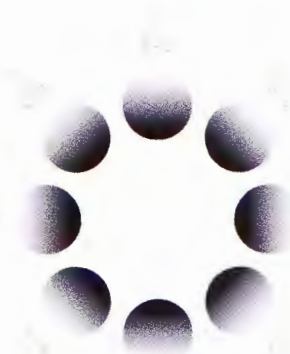
The circles lit from above appear convex, whereas the circles lit from below appear concave. As the light source moves from these positions, the depth cues become increasingly ambiguous.
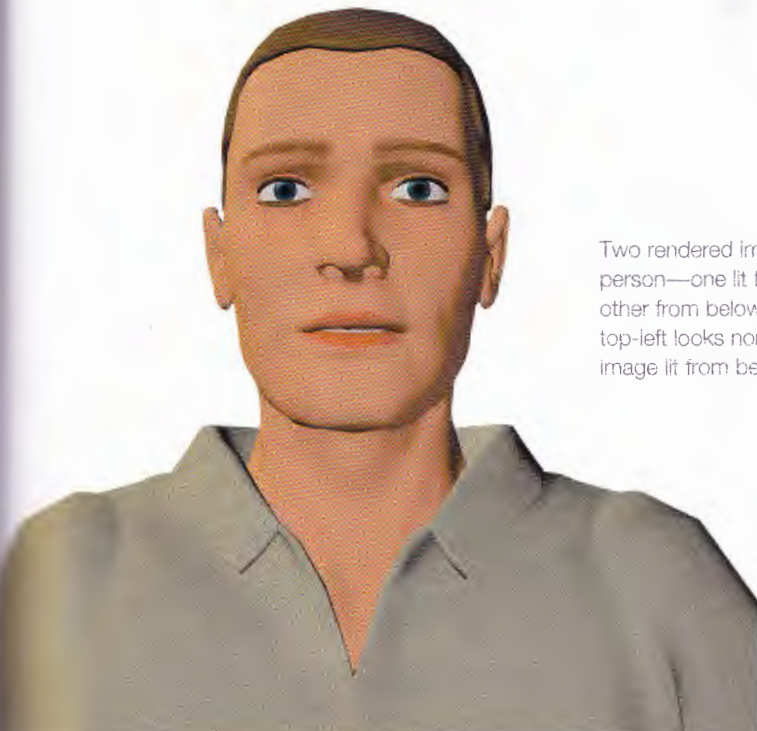
Two rendered images of the same person—one lit from top-left and other from below. The image lit from top-left looks normal, whereas the image lit from below looks scary.
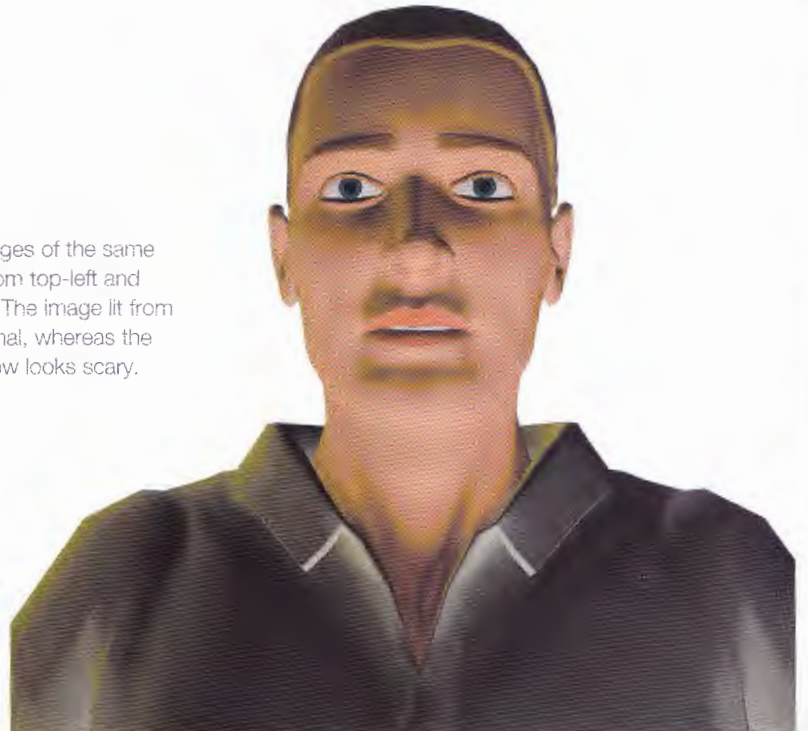
Face-ism Ratio

The ratio of face to body in an image that influences the way the person in the image is perceived.[1]

Images depicting a person with a high face-ism ratio—the face takes up most of the image—focus attention on the person's intellectual and personality attributes. Images depicting a person in a low face-ism ratio—the body takes up most of the image—focus attention on the physical and sensual attributes of the person. The face-ism ratio is calculated by dividing the distance from the top of the head to the bottom of the chin (head height) by the distance from the top of the head to the lowest visible part of the body (total visible height). An image without a face would have a face-ism ratio of 0.00, and an image with only a face would have a face-ism ratio of 1.00. Irrespective of gender, people rate individuals in high face-ism images as being more intelligent, dominant, and ambitious than individuals in low face-ism images.

The term *face-ism* originated from research on gender bias in the media. It was found that images of men in magazines, movies, and other media have significantly higher face-ism ratios than images of women. This appears true across most cultures, and is thought to reflect gender-stereotypical beliefs regarding the characteristics of men and women. While there is little consensus as to why this is the case, it is likely the result of unconscious processes resulting from a mix of biological and cultural factors. In one experiment, for example, male and female college students were randomly assigned a task to draw either a man or a woman. The students were told they would be evaluated on their drawing skills, and were given no additional instructions. Both genders drew men with prominent and detailed faces, and drew women with full bodies and minimally detailed faces.[2]

Consider face-ism in the representation of people in photographs and drawings. When the design objective requires more thoughtful interpretations or associations, use images with high face-ism ratios. When the design objective requires more ornamental interpretations or associations, use images with low-face-ism ratios. Note that the interpretations of the images will be the same irrespective of the subject's or viewer's gender.

See also Attractiveness Bias, Baby-Face Bias, Classical Conditioning, Framing, and Waist-to-Hip Ratio.

[1] The term *face-ism* is used by some researchers to refer to the tendency of the media to represent men in high face-ism images, and women in low face-ism images—also referred to as *body-ism*.

[2] The seminal work on face-ism is "Face-ism" by Dane Archer, Debra D. Kimes, and Michael Barrios, *Psychology Today*, 1978, p. 65–66; and "Face-ism: 5 Studies of Sex-Differences in Facial Prominence" by Dane Archer, Bonita Iritani, Debra D. Kimes, and Michael Barrios, *Journal of Personality and Social Psychology*, 1983, vol. 45, p. 725–735.
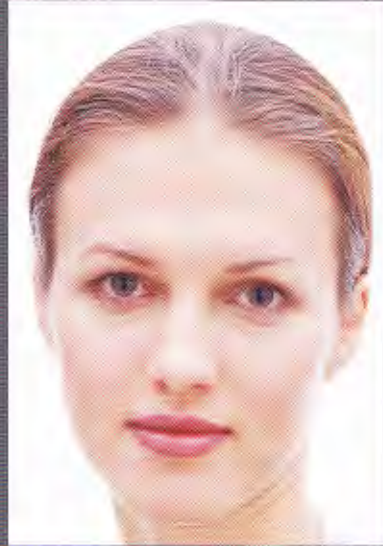
Face-ism Ratio = .96   Face-ism Ratio = .55   Face-ism Ratio = .37

The effect of face-ism is evident in these photographs. The high face-ism photograph emphasizes more cerebral or personality-related attributes like intelligence and ambition. The lower face-ism photographs emphasize more physical attributes like sensuality and physical attractiveness.

Waist-to-Hip Ratio

A preference for a particular ratio of waist size to hip size in men and women.

The waist-to-hip ratio is a primary factor for determining attractiveness for men and women. It is calculated by dividing the circumference of the waist (narrowest portion of the midsection) by the circumference of the hips (area of greatest protrusion around the buttocks). Men prefer women with a waist-to-hip ratio between .67 and .80. Women prefer men with a waist-to-hip ratio between 0.85 and 0.95.[1]

The waist-to-hip ratio is primarily a function of testosterone and estrogen levels, and their effect on fat distribution in the body. High estrogen levels result in low waist-to-hip ratios, and high testosterone levels result in high waist-to-hip ratios. Human mate selection preferences likely evolved to favor visible indicators of these hormone levels (i.e., waist-to-hip ratios), as they are reasonably indicative of health and reproductive potential.[2]

For men, attraction is primarily a function of physical appearance. Women who are underweight or overweight are generally perceived as less attractive, but in all cases women with waist-to-hip ratios approximating 0.70 are perceived as the most attractive for their respective weight group. For women, attraction is a function of both physical appearance and financial status. Financial status is biologically important because it ensures a woman of security and status for herself and her children. However, as women become increasingly independent with resources of their own, the strength of financial status as a factor in attraction diminishes. Similarly, women of modest resources may be attracted to men of low financial status when their physical characteristics indicate strong male features like dominance and masculinity (e.g., tall stature), but men with both high waist-to-hip ratios and high financial status are perceived as the most desirable.

The waist-to-hip ratio has design implications for the depiction of the human form. When the presentation of attractive women is a key element of a design, use renderings or images of women with waist-to-hip ratios of approximately 0.70. When the presentation of attractive men is a key element of a design, use renderings or images of men with waist-to-hip ratios of approximately 0.90, strong male features, and visible indicators of wealth or status (e.g., expensive clothing).

See also Anthromorphic Form, Attractiveness Bias, Baby-Face Bias, and Golden Ratio.

[1] The seminal work on the waist-to-hip ratio is "Adaptive Significance of Female Physical Attractiveness: Role of Waist-to-Hip Ratio," *Journal of Personality and Social Psychology*, 1993, vol. 65, p. 293–307; and "Female Judgment of Male Attractiveness and Desirability for Relationships: Role of Waist-to-Hip Ratio and Financial Status," *Journal of Personality and Social Psychology*, 1995, vol. 69, p. 1089–1101, both by Devendra Singh.

[2] While preferences for particular features like body weight or breast size have changed over time, the preferred waist-to-hip ratios have remained stable. For example, in analyzing the measurements of *Playboy* centerfolds since the 1950s and Miss America winners since the 1920s, researchers discovered that the waist-to-hip ratios remained between 0.68 and 0.72 despite a downward trend in body weight.

When asked to select the most attractive figures from renderings of men and women of varying weights and body types, people favored *male C* and *female A*, corresponding to waist-to-hip ratios of 0.90 and 0.70, respectively.
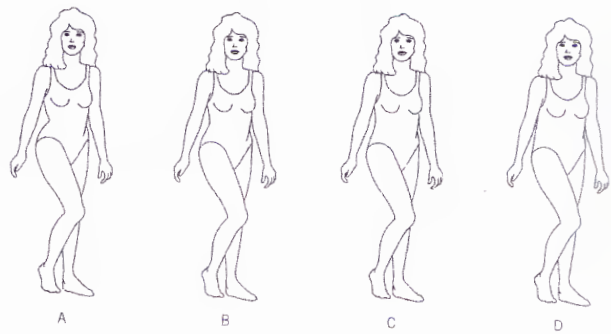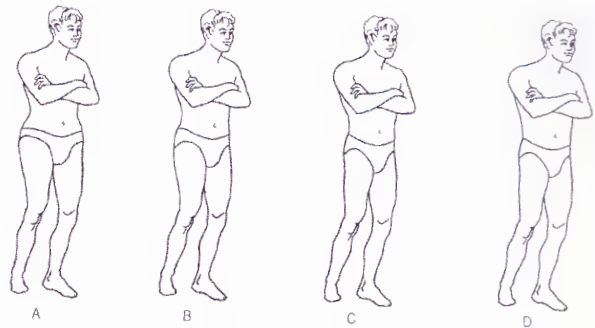
The world famous Adel Rootstein mannequins have changed to match the ideal look and body type of men and women for over five decades (1960s - 2000s). The waist-to-hip ratios of the mannequins, however, have not changed—they have remained constant at around 0.90 for men, and 0.70 for women.

A   B   C   D

A   B   C   D