Danger Avoidance: An Evolutionary Explanation of Uncanny Valley

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From common sense one might be lured to think that as the appearance of synthetic agents, such as robots and computer-animated characters, approaches near to human appearance, they tend to be more interesting and likeable by humans. Although this intuition stands up to a point, it is not always the case. The concept of "Uncanny Valley," a hypothesis put forth by the famous roboticist Masahiro Mori in 1970, gives an outline regarding human reaction toward human-like synthetic agents. It states that although with increasing human-like attributes in appearance and motion, synthetic agents get more positive response from humans, after a certain point the emotional response becomes negative. The negative trend continues as long as the appearance and motion become indistinguishable from human beings; then the emotional reaction becomes similar to that toward the natural agents, i.e., human beings (Mori 1970). The presence of Uncanny Valley is visible in the plot of degree of familiarity/likeability of synthetic agent against anthropomorphism (Figure 1).

Although the initial support for Uncanny Valley came anecdotally from mass media (e.g., negative audience response of computer-animated movies such as *The Polar Express* and *The Final Fantasy: The Spirits Within*), its presence was later supported by several experimental studies (Bartneck et al. 2007; Seyama and Nagayama 2007; MacDorman et al. 2009).

Despite being an accepted psychological phenomenon, the precise reason behind this response is not well understood. Different theories have been proposed, such as mortality salience (MacDorman 2005), pathogen avoidance (Rozin and Fallon 1987), and cognitive dissonance related to facial aesthetics (Rhodes et al. 2001; MacDorman et al. 2009). Nevertheless, none of these theories explain the evolutionary basis of the presence of Uncanny Valley in spite of the phenomenon being conserved in other primates (Steckenfinger and Ghazanfar 2009).

Even though the concept of pathogen avoidance (Rozin and Fallon 1987) can explain Uncanny Valley in an evolutionary sense to some extent, it cannot explain why a seemingly healthy human corpse, even a fresh one, generates strong negative emotions. Thus, we hypothesize the presence of Uncanny Valley as a general mechanism of danger avoidance instead of specific pathogen avoidance. We put forth the following arguments supporting our explanation.

Many species are known to bury, hide, or otherwise isolate their dead members. Dead rodents are often found to be buried by their conspecifics (Misslin 2003). Similar behavior is also observed in social insects, such as ants (Wilson et al. 1958) and honeybees (Visscher 1983). These defensive responses are considered as a survival function in commensal species (Misslin and Ropartz 1981; Misslin 1982). Being cohabiting social animals, primates have also developed burial as a mechanism of separating the dead from the living (Spennemann 2007). This is thought to be one of the reasons that people find human-like response more important than appearance in robots (Dautenhahn et al. 2005).

Necrophobia is deemed to be one of the reasons behind human burial practices at least since the early Iron Age (Saponetti et al. 2007). In prehistoric times, humans had an expected lifetime of around 25 years (Simon 1995). Thus, most deaths

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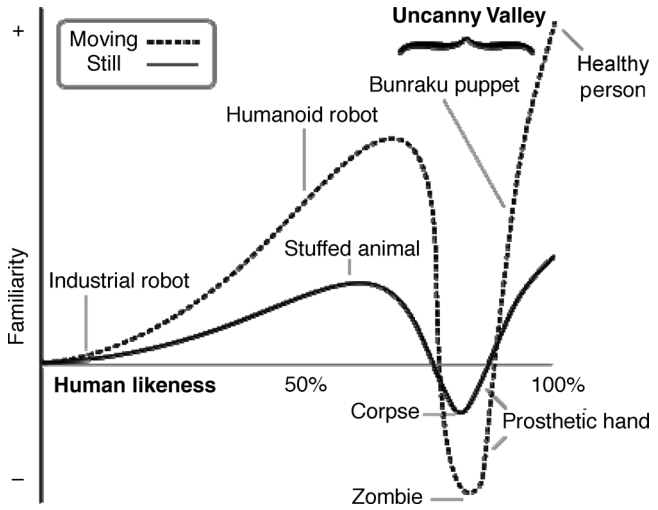

Figure 1.
Plot of familiarity/likeability against human likeness of synthetic agent. Taken from Wikipedia article "Uncanny Valley" (http://en.wikipedia.org/wiki/Uncanny_valley) published under Creative Commons ShareAlike 3.0 License.

were premature, and caused by predators, invaders, disaster, or disease. Many of these fatal agents were localized near freshly dead conspecifics. For example, many predators used to stay close to the carcass of their preys; dead bodies of individuals killed by toxic gas release, mudslide, or other accidents were found at the very site of the disaster. Consequently, dead bodies were considered as indications of potentially fatal danger. Individuals avoiding a fresh corpse were more likely to avoid these threats. Hence, avoidance of corpses was positively selected for. Similar avoidance responses have also been observed in insects. It has been found that necromone secretion is a phylogenetically conserved pathway in several insect species (Yao et al. 2009). These necromones are secreted from dead insects, and act as an alarm signal to conspecifics (Yao et al. 2009). It is possible that similar chemical pathways of danger signal cross-link with visual pathways during the evolution of cognition in higher animals, leading to our proposed danger avoidance reaction.

From our everyday experience, we can arrange dead, synthetic agents, and corpses into the following order of negative emotion (the first one being the least negative emotion-provoking, the last one the most negative emotion-provoking):

1. Dead insect—as a matter of fact, many of us kill insects (e.g., mosquitoes, cockroaches, etc.) without even having the feeling of regret
2. Decomposing insect body
3. Dead small animal
4. Decomposing small animal
5. Dead large animal
6. Decomposing large animal
7. Human corpse
8. Decomposing/freshly dead mutilated corpse
9. Freshly dead mutilated corpse with sudden movements

This order is clearly suggestive of a mechanism of danger avoidance. Conditions that result in the death of insects have little significance in the survival possibility of higher animals. Threats to small animals (e.g. mouse) or even larger animals are not suggestive of human danger, although the larger the animal is, the greater the chance of danger and negative emotion. The hypothesis is further supported by the fact that a large number of dead insects or small animals may also create a fear response. It is most probably due to the fact that a large number of dead animals, though small, suggests environmental disaster and/or potential widespread toxicity. Following similar logic, it can be inferred that a human corpse will elicit strong negative emotions because it clearly suggests danger. At the extreme end of the spectrum is a fresh, dead corpse with sudden movement, which is indicative of the greatest degree of danger because it clearly suggests that the death-causing agent might be in close vicinity. It has been found that moving synthetic agents appear to be uncannier than the static ones (Minato et al. 2004).

Although the hypothesis of danger avoidance successfully explains the order of preference mentioned above, it cannot explain cross-cultural difference toward dead bodies (Field et al. 1997) and the carrying of decomposing children by feral baboons even two days after death (Nash 1974). Explanations of these phenomena might lie on the level of the higher cognitive skills, which can modulate innate responses through cultural adaptation and maternal empathy, respectively. It is likely that along with danger avoidance, other factors such as mortality salience and cognitive dissonance related to facial aesthetics collectively contribute toward the Uncanny Valley.

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