Uncanny valley—why we find human-like robots and dolls so creepy

10 November 2015, by Stephanie Lay

No danger but creepy as hell. Credit: Rain Rabbit, CC BY-NC

The "uncanny valley" is a characteristic dip in emotional response that happens when we encounter an entity that is almost, but not quite, human. It was first hypothesised in 1970 by Japanese roboticist Masahiro Mori who identified that as robots became more human-like, people would find them to be more acceptable and appealing than their mechanical counterparts. But this only held true to up a point. When they were close to, but not quite, human, people developed a sense of unease and discomfort. If human-likeness increased beyond this point, and the became very close to human, the emotional response returned to being positive. It is this distinctive dip in the relationship between human-likeness and emotional response that is called the uncanny valley.

Anything with a highly human-like appearance can be subject to the uncanny valley effect, but the most common examples are androids, computer game characters and life-like dolls.

However, not all near-human robots are eerie, and the perception of eeriness varies from person to person. So what evidence exists for the effect and what properties of near-humans might make us feel so uncomfortable?

Still debated

Since 1970, the uncanny valley effect has been explored from many perspectives, from the practical interest of roboticists to theoretical approaches from philosophers and experimental studies conducted by psychologists. Research started in earnest from 2005, when Karl MacDorman and Takashi Minato translated Mori's original paper into English. Interest in the area has since expanded quickly: so far, 510 academic papers reference the effect in 2015, compared to just 35 in 2004.

Although the effect is easy to describe, and feels intuitively "right" when looking at some examples of human-like agents such as reborn dolls or game characters, it is notoriously difficult to research such a circular and subjective concept. Academics are even engaged in an active debate as to whether the uncanny valley exists at all – Jari Kätsyri and colleagues recently reviewed the evidence and drew the conclusion that the effect remains elusive.

Either way, the debate has not yet been won – although perhaps the most compelling evidence for the existence of the uncanny valley has just been published. Maya Mathur and David Reichling studied 80 real-world robots and found a clear valley effect in how much people liked and were willing to trust them.

Their data showed the classic rise-dip-rise that Mori originally predicted. This was found with the original robots and also with CGI images built to systematically vary in human likeness. The challenge now is to explain just why this might be happening. I have been researching in this area

since 2006, and my own review of the literature found at least seven explanations – but at the moment there are three theories that seem particularly promising.

Top three theories

First, the uncanny valley might occur at the boundary where something moves from one category to another, in this case, between non-human and human. Christine Looser and Thalia Wheatley looked at mannequin faces that were morphed into human faces and found a valley at the point where the inanimate face started to look alive.

Second, the presence of a valley may hinge on whether we're able to believe that near-human entities possess a mind like we do. A study by Kurt Gray and Daniel Wegner found that robots were only unnerving when people thought that they had the ability to sense and experience things, and robots that did not seem to posses a mind were not frightening.

A final compelling area for future research is that the uncanny valley occurs because of mismatches between aspects of the robot's appearance and/or behaviour. Angela Tinwell's work has looked at many types of mismatch, including speech synchronisation, speech speed and facial expressions. In one 2013 study, near-human agents that reacted to a startling noise by showing surprise in the lower part of their face (not the upper part) were found to be particularly eerie. This study suggested that this may be even be reminiscent of the pattern of expressive behaviour exhibited by humans with psychopathic traits.

My latest research has built on Tinwell's findings and looked at responses to faces with different emotional expressions shown in the eyes and the rest of the face. I found that the eeriest combinations were those where happy faces were paired with fearful or angry eyes, possibly suggesting the agent was trying to suppress an unpleasant emotion.

Android science progresses rapidly, and is creating increasingly more realistic robots. The uncanny valley would not exist if a robot was indistinguishable from a human, because there would no longer be a relative dip in emotional response.

One theory, that of an uncanny wall, suggests that it will always be possible to tell artificial from human because as robots become more realistic, we will also become more sensitive and will always be able to tell that something is not right.

However, we're certainly not there yet, and we could eventually find that the uncanny valley effect was an artefact of this particular period in the history of artificial humans, when representations were clearly distinguishable from human. For some, not being able to distinguish between robots and humans, for example, may throw up problems beyond being creepy. Speaking as a researcher of the uncanny valley, I plan to enjoy its sense of subtle eeriness while it lasts.

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