The eyes are the window to the uncanny valley

Mind perception, autism and missing souls

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Horror movies have discovered an easy recipe for making people creepy: alter their eyes. Instead of normal eyes, zombies' eyes are vacantly white, vampires' eyes glow with the color of blood, and those possessed by demons are cavernously black. In the Academy Award winning Pan's Labyrinth, director Guillermo del Toro created the creepiest of all creatures by entirely removing its eyes from its face, placing them instead in the palms of its hands. The unease induced by altering eyes may help to explain the uncanny valley, which is the eeriness of robots that are almost—but not quite—human (Mori, 1970). Much research has explored the uncanny valley, including the research reported by MacDorman & Entezari (in press), which focuses on individual differences that might predict the eeriness of humanlike robots. In their paper, they suggest that a full understanding of this phenomenon needs to synthesize individual differences with features of the robot. One theory that links these two concepts is mind perception, which past research highlights as essential to the uncanny valley (Gray & Wegner, 2012). Mind perception is linked to both individual differences—autism—and to features of the robot—the eyes—and can provide a deeper understanding of this arresting phenomenon. In this paper, we present original data that links uncanniness to the eyes through aberrant perceptions of mind.

Keywords: robots; emotion; human-computer interaction; theory of mind

1. Mind perception and the uncanny valley

Eyes have been studied before in the uncanny valley (MacDorman, Green, Ho, & Koch, 2009; Seyama & Nagayama, 2007). For example, Seyama & Nagayama (2007) found that morphed faces of artificial and real humans evoked uncanniness when they included abnormal eyes. Although these studies suggest that there is something inherently creepy about abnormal eyes, we suggest strange eyes are broader cues to *strange minds*. Research on mind perception reveals that

we perceive minds along two broad dimensions of agency (intending, planning, doing) and experience (feeling, sensing, consciousness), and that we have fundamental expectations about who or what should have a mind (Gray, Jenkins, Heberlein, & Wegner, 2011). Adult humans are generally expected to have both agency and experience, children and animals are expected to have only experience, and robots are expected to have only agency. As they are unliving creations of metal, robots are fundamentally expected to lack abilities that are central to living creatures of flesh—the capacity to feel. Therefore, mind perception suggests that uncanniness arises not from humanlike appearances *per se*, but when these appearances lead people to ascribe experience to robots. In other words, robots are creepy when they seem to feel.

In support of this hypothesis, participants who found a humanlike robot more unsettling than a mechanical robot also ascribed it a greater ability to feel emotions and sensations (Gray & Wegner, 2012). Analyses also revealed that feelings of uncanniness were statistically mediated by perceptions of experience. Subsequent studies directly manipulated perceptions of experience in mechanical looking robots to disentangle perceived mind from appearance. As expected, they revealed that a robot described as feeling "hunger, fear and other emotions" was rated as more unnerving then a typical computer, or a computer capable of self-control and planning. Finally, these studies generalized the idea of expectations of mind, and sought to induce an uncanny valley upon humans. If humans are fundamentally expected to have the capacity for experience, then someone without these abilities should be unsettling. Consistent with this idea, participants found a man described as feeling "no pain, no pleasure, or no fear," as very unsettling.

Perceptions of experience are essential to the uncanny valley, but other minds are ultimately inaccessible (Carruthers & Smith, 1996), so how are we to know whether others have this mental capacity? How do we know that our elderly neighbor is a person with emotions and not an automaton? Research suggests that we rely on the eyes. As Shakespeare long ago noted, the eyes are the windows to the soul and play a large role in both anchoring the self (Starmans & Bloom, 2012) and communicating emotional experience. People use the eyes to identify emotions, and are remarkably accurate even without the context of the rest of the face (Baron-Cohen, Wheelwright, & Jolliffe, 1997). At a lower-level, eyes are also used to convey basic animacy, and are heavily relied upon when distinguishing a lifelike doll from a living baby (Looser & Wheatley, 2010). The centrality of eyes to mind perception suggests that they should be central to the uncanny valley, and research does find that altering the eyes can accentuate the uncanny valley (MacDorman et al., 2009). The important question, however, is whether the role of altered eyes in uncanniness is mediated by perceptions of mind.

2.   Original research: Eyes, mind perception and uncanniness

To test the link between aberrant eyes, mind perception and feelings of uncanniness, we conducted an original study for this paper. Participants rated the uncanniness of human faces, some of which were missing their eyes. We predicted that these eyeless faces should be more unnerving than other faces and that this unnervingness should be mediated by altered perceptions of experience. One-hundred and ten participants (56% female, $M_{age} = 35$) from public places around a New England university evaluated a headshot of a middle-aged man with either the nose or eyes cut out, or just a normal headshot (see Figure 1).
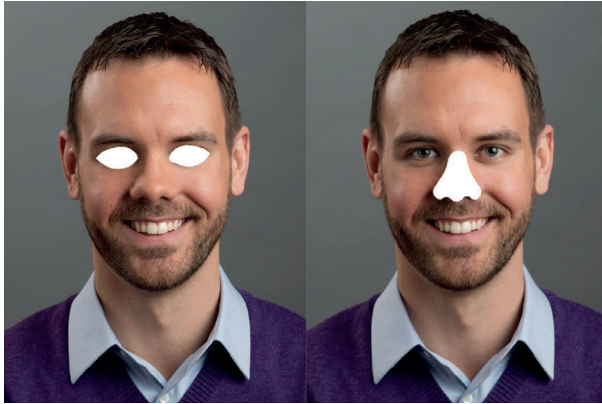

Figure 1. Example headshots for eyeless and noseless manipulations. (Photo Credit: Amy Stern)

Compared to the nose-less and the normal headshot, the eyeless headshot was seen as significantly more uncanny (creepy, unsettling, unnerved, uneasy, disgusting), $F(2,106) = 7.85$, $p = .001$, more likely to be missing the capacity for emotional experience of pain and fear, $F(2,106) = 7.85$, $p = .001$, and more likely to be soulless $F(2,104) = 7.59$, $p = .001$ (see Figure 2). The eye-less condition did not differ significantly from the nose-less condition in perceived lack of agency ($p = .12$), though it was rated as higher than the normal condition ($p = .006$). The nose-less and normal conditions did not differ significantly from each other on any of these traits, ps > .22. A mediation analysis revealed that the impact of eyelessness on uncanniness was was partially mediated by perceived emotional experience. Eyeless people were seen as more likely to lack emotional experience, which in turn significantly predicted uncanniness ratings (see Figure 3).
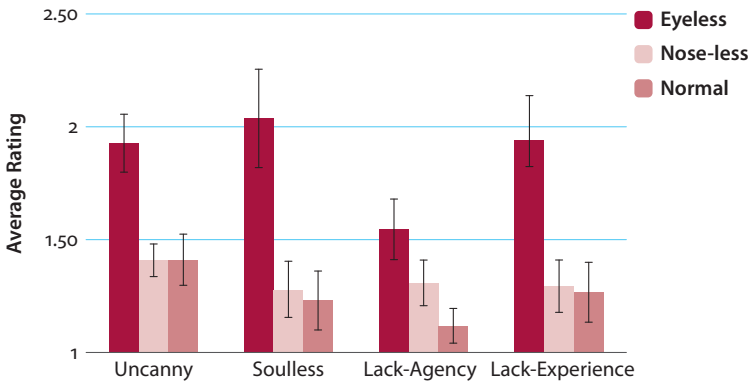
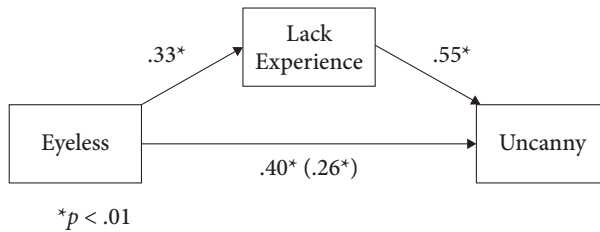**Figure 2.** Average ratings for headshots across conditions

Figure 3. The link between eyelessness and uncanniness is partially mediated by perceived mind (standardized regression coefficients)

3.   Autism and the uncanny valley

The role of mind perception in feelings of uncanniness points to an important individual difference variable: autism. Autism is a developmental disorder categorized by social impairments, difficulties in emotion recognition and classification (Uljarevic & Hamilton, 2013) and "mind-blindness" (Baron-Cohen, 1995). Although most people can typically infer mental states solely from glances at the eyes, individuals with autism struggle with this task (Baron-Cohen, Wheelwright, & Jolliffe, 1997). Those with autism also often display abnormalities in eye-contact (Senju & Johnson, 2009) and disordered perceptions of mind (Gray, Jenkins, Heberlein, & Wegner, 2011). As mind perception and the eyes are important factors in the uncanny valley, this then suggests that people with autism—with reduced eye-contact and mind perception—should be less susceptible to its effect.

Initial evidence suggests that the uncanny valley effect is indeed mitigated in individuals with autism, and even that otherwise-uncanny humanoid robots can be effective as both a diagnostic tool and as therapy for those with autism (Scassellati,

2007). For example, although normal humans may find the humanlike robot KAS-PAR somewhat uncanny, research has revealed its effectiveness in treating those with autism (Dautenhahn et al., 2009). Indeed, children with autism often prefer social interactions with robots such as KASPAR, or Robota, a small humanoid robot, than other humans (Robins, Dautenhahn, & Dubowski, 2006). Contrary to general predictions from the uncanny valley, these children also respond well to humanlike faces in robots, which have taught them to better understand emotions (Pioggia et al., 2004). Speaking most directly to the uncanny valley, pilot data reveals that increasing humanness leads to decreased attractiveness—i.e. the typical uncanny valley—in most people, but not in those with autism, who rated humanlike robots as *more* attractive (Destephe, Zecca, Hashimoto, & Takanishi, under review).

4. Conclusion

In his discussion of the uncanny, Freud argued that the experience of the uncanny emerges when a being is "robbed of one's eyes" (Freud, 1919, p. 7). Empirical research suggests that losing one's eyes is tantamount to losing one's soul—at least from the perspective of the perceiver. Without eyes, humans are perceived to lack experience, violating a fundamental expectation of mind and inducing uncanniness. Conversely, it seems that robots *with* eyes convey the capacity for experience, also violating a fundamental expectation of mind and inducing uncanniness. This suggests two ways around the uncanny valley. The first is to design robots without eyes that express depths of feeling, but this might be uncanny in itself. The second is to extend the circle of experience beyond flesh and blood, by believing that robots are also entitled to feel and sense. To banish uncanniness, we must simply give robots their souls.

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