Exploring the uncanny valley from a cognitive and social perspective: artificial intelligence, robotics and touch

The more artificial intelligence systems become embodied (e.g., through robotics), but also interactive and creative, the more prominent the puzzling phenomenon of the *uncanny valley* becomes. When a machine such as a robot acts almost like a human, but does not fully succeed, it can cause the human to feel repulsion, strangeness, or eeriness. This was characterized by Masahiro Mori more than 50 years ago as the "*uncanny valley*" (Mori, 1970[1]; Mori, MacDorman and Kageki, 2012[2]) - the term "uncanny" having been used by the German psychologist Ernst Jentsch already in 1906 (*Zur Psychologie des Unheimlichen*). The relationship between affinity and human likeness has been predicted such that affinity for an observer increases with human likeness, up to a critical point where robots appear almost, but not quite human, leading to a decrease in affinity and an increase in negative affect, followed by a further increase in affinity when human likeness is at its highest. The progressive introduction of social robots in various contexts (e.g., healthcare, education), and their acceptability or rejection by human agents, make the study of this phenomenon more timely than ever.

In the literature, there are two broad ways of tackling this phenomenon. One approach is to consider the uncanny phenomenon as a perceptual process, occurring early in perception as an automatic, stimulus-driven phenomenon. An alternative approach suggests that it involves several more general cognitive processes that occur after perceptual processing (MacDorman et al., 2009[3]). After being ignored for several decades, interest in the uncanny valley has resurfaced in recent years. Although the results are mixed, a part of the last studies tend to corroborate the original hypothesis (Wang, Lilienfeld, and Rochat, 2015[4]). The model has been refined and made more complex, and studies have been extended to other technological innovations such as prosthetic limbs (Katsyri et al., 2015[5]). There are probably several uncanny valley hypotheses, if we consider the original hypothesis to be broadly applicable guidelines. Beyond the empirical complexities, this concept raises many questions, whether physiological (e.g., the neural and bodily processes involved), social (e.g., norms, expectations, and trust in innovative technologies), or philosophical (e.g., what it is to perceive and emotionally appraise human(-like) agency, with anthropomorphic biases).

The main aim of this doctoral research would be to investigate what the uncanny valley reveals, philosophically and anthropologically, about the relations between human agents and artificial intelligence systems, in particular when these interactions are mediated by touch (robotics). Our approach articulates philosophy of mind with experimental psychology.

As suggested by the philosopher C.Aydin (2021[6]), the uncanny valley invites us to reconsider what it means to interact with another being. From an embodied and enactive philosophical perspective, in which the self is understood as dynamically shaped by its environment (Clark 2003[7]), the feeling of eeriness could be a sign of embodied reluctance to delegate relational functions to technology. The phenomenon would reveal a resistance of

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[1] Mori, M. (1970). The uncanny valley. *Energy,* vol. 7, nº 4, (in Japanese).

[2] Mori, M., MacDorman, K. F., & Kageki, N. (2012). The uncanny valley [from the field]. *IEEE Robotics & automation magazine*, *19*(2), 98-100.

[3] MacDorman, K. F., Green, R. D., Ho, C. C., & Koch, C. T. (2009). Too real for comfort? Uncanny responses to computer generated faces. *Computers in human behavior*, *25*(3), 695-710.

[4] Wang, S., Lilienfeld, S. O., & Rochat, P. (2015). The uncanny valley: Existence and explanations. *Review of General Psychology*, *19*(4), 393-407.

[5] Kätsyri, J., Förger, K., Mäkäräinen, M., & Takala, T. (2015). A review of empirical evidence on different uncanny valley hypotheses: support for perceptual mismatch as one road to the valley of eeriness. *Frontiers in Psychology*, *6*, 390.

[6] Aydin, C. (2021). The Technological Uncanny as a Permanent Dimension of Selfhood. In *The Oxford Handbook of Philosophy of Technology*, 299-317.

[7] Clark, A. (2003). *Natural-Born Cyborgs. Minds, Technologies, and The Future of Human Intelligence.* Oxford University Press.

the self to the substitution of interactions between humans and interactions with technology. This primary hypothesis needs to be considered and discussed from philosophy of mind and cognitive science, but also needs to be supported by empirical research. Indeed, given the inconsistent findings in the empirical literature, the diversity of hypotheses derived from Mori's seminal article, and the various methodologies employed, it is difficult to determine whether any one of the current cognitive explanations and philosophical interpretations provide a sufficient understanding for the phenomenon on its own. Researchers face many difficulties, in particular the difficulty of operationalizing the multifaceted construct of "human likeness", the absence of a systematic definition of the term "likability" or "affinity" and a valid measurement of it, the presence of confounding factors, the absence of a clear mathematical model depicting the assumption, or even the unclearness of the term "uncanny" itself (Wang, Lilienfeld, and Rochat, 2015[4]).

From a scientific and operational perspective, we propose to approach this phenomenon based on its existence in a well-defined sensory modality, which is touch. The concept of "uncanny valley" has been extended beyond vision to other sensory domains. For instance, Berger and colleagues (2018[8]) noted that when the fidelity of haptic sensation increases on its own, without correspondence with other sensory feedback, it induces a worse subjective impression of realism. They named this phenomenon the "*uncanny valley of haptic*." To our knowledge, the haptic dimension of the uncanny valley has been relatively little studied, which contrasts with the importance of touch in human life. Touch is central to emotional regulation, social bounding, or the constitution of self-experience. It is a complex sense, intrinsically linked to other senses, movements and emotions. Norms relating to touch vary according to region, cultural norms, and time periods (Classen, 2012[9]). For example, how affective touch is processed and whether it is beneficial to individuals seems to depend on culture, with the topographies of tactile comfort or the context in which certain forms of touch are acceptable varying between Western and Eastern cultures (Schirmer et al., 2023[10]). This hypothesis that the uncanny valley has its roots in social, cultural, and historical domains has been relatively unexplored. Articulated with the philosophical investigation mentioned above, the second objective of this doctoral work is therefore to assess this latter hypothesis empirically. Is sensitivity to the uncanny valley in the haptic domain influenced by social and cultural norms? This can be addressed through a series of psychophysical experiments involving behavioral (e.g., questionnaires, response delays, eye tracking) and physiological measurements (e.g., EEG).

This project will be therefore based on an articulation between philosophy and psychology. The successful candidate will have dual training in these disciplines: for example, a bachelor's degree in psychology or cognitive science, and a master's degree in philosophy. The thesis will be supervised by two senior researchers, Pierre Steiner and Malika Auvray. Pierre Steiner is a University Professor of philosophy at the Université de technologie de Compiègne, and Malika Auvray is a CNRS Research Director in psychology at ISIR, Sorbonne Université. They both conduct their research in the field of cognitive science, including artificial intelligence[11], in full adequation with the ambitions of SCAI. The COSTECH laboratory at UTC has a strong tradition in philosophy of technology and philosophy of cognitive science, and also includes an experimental platform devoted to the study of tactile interactions. The ISIR laboratory has an expertise on the study of multisensory experience and its relations to technology.

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[8] Berger, C. C., Gonzalez-Franco, M., Ofek, E., & Hinckley, K. (2018). The uncanny valley of haptics. *Science Robotics*, 3(17), eaar7010.

[9] Classen, C. (2012). *The deepest sense: A cultural history of touch*. University of Illinois Press.

[10] Schirmer, A., Cham, C., Zhao, Z., & Croy, I. (2023). What makes touch comfortable? An examination of touch giving and receiving in two cultures. *Personality and Social Psychology Bulletin*, *49*(9), 1392-1407.

[11] In relation with the object of this proposal: Poivet, R., Pelachaud, C., & Auvray, M. (2025). Breaking expectations: the role of non-player characters' coherence and consistency. *IEEE Transactions on Affective Computing*, 16, 2946-2958. Poivet, R., de Lagarde, A., Pelachaud, C., & Auvray, M. (2024). Evaluation of Virtual Agents' Hostility in Video Games. *IEEE Transactions on Affective Computing*, 15, 1949-1961. Steiner, P. (2025). The structure of intentionality: insights and challenges for enactivism. *Inquiry*, 68(10), 3509–3540. Steiner, P. (2023). An aftertaste of Cartesian salad? Pre-reflective self-consciousness, Peirce, and the study of cognition in the wild. *Adaptive Behavior* 31 (2), 169-173.