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Affective Mimetics, Emotional Information Space, and Metaverse

Johanna Maria Silvennoinen[1*], Pertti Saariluoma[1]

[1] Faculty of Information Technology, University of Jyväskylä, Finland.

[*] **Corresponding author:** Johanna Silvennoinen[1], johanna.silvennoinen@jyu.fi

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Abstract

Current technology design pursues applying human-like features to AI technologies. These attempts have faced many challenges due to the essential complexities of the human mind. Cognitive mimetics is a design approach to mimic human information processes in designing intelligent technologies. The focus is on mimicking cognition, human knowledge structures, and represented mental information contents which addresses a fundamental issue in technology design. However, cognition is one aspect of information processing in the human mind. Affective information processing also plays an essential role in addressing the meaningfulness of cognitive processes. This paper discusses affective mimetics (extended from cognitive mimetics with conceptual engineering) as a design approach to designing intelligent and human-like entities for AI technologies. Natural framework sources for affective mimetics are emotional information spaces referring to emotionally meaningful objects around a person. The potential of affective mimetics and emotional information spaces in directing the design of metaverse is utilised as an illustrative example.

Keywords

Cognitive Mimetics, Affective Mimetics, Emotional Information Processing, AI Technologies, Design Research Method.

Introduction

Conceptual engineering is a way to develop and evaluate conceptual foundations of design processes for constantly developing technologies (Chalmers, 2020; Eklund, 2021; Floridi, 2020; Saariluoma, 1997). Here, we shall think how to work with the emotional aspects of human action spaces. This is especially relevant in thinking human-technology interactions in modern environments such as Metaverse, in which cognitive as well as emotional dimensions are essential. One can firstly formulate such questions as how will future technologies be designed? What kind of expertise is necessary for designing artificial intelligence (AI) technologies? What will individual and meaningful totalities of the metaverse be constructed from? These questions illustrate design problem spaces we need to tackle in the near future. And essentially, we need not only tackle these issues, but we can also develop and design new ways and forms to experience realities in the conjunction of physical and virtual realms.

One important step in formulating innovation and design methods for intelligent environments is conceptual engineering (Chalmers, 2020; Eklund, 2015; Eklund, 2021; Saariluoma, 1997). This method can be seen as an evaluation analysis and design of concepts for some research domains. Here, we apply conceptual engineering to investigate the conceptual foundations of designing emotionally intelligent AI technologies.

Technological capacities, needs, contexts, and design practices are changing (Dym & Brown, 2012; Madni & Sievers, 2018). This evolvement is induced by significant societal changes, including the technologisation of work and leisure. To address these raising issues, intelligent technologies are at the core of designing modern technologies (Holmquist, 2017; Simon, 1969). AI technologies are vital as they can operate technical and technology-supported processes in which people have been necessary, thanks to their capacity for intelligent information processing. In the near future, it is possible for machines to drive cars, carry out legal procedures, and process natural languages and massive data sets (Tegmark, 2017).

Within this AI revolution, it is essential to understand emotional information processing, its essence in how people create meaning in interacting with technology, and the possibilities it offers. Novel AI technologies need to address a multitude of requirements. The focus cannot be merely on technical development but on improving human life. This necessitates a need to develop novel design methods to address complex and evolving requirements. Here, we discuss one design approach, affective mimetics. This paper is based on the cognitive scientific and psychological theories of human thinking — i.e., cognitive paradigm which is based on information processing theories; Eysenck and Keane (2015)—. These are different from information systems approaches which are based on the observation and analysis of (engineering) design processes.

An essential aspect of elevating the capacity of technologies is AI. Intelligent technological systems incorporating AI design pursue flexible and rational responses within specific contexts. Independence from a stimulus — similarly to the human mind operates— is at the core of intelligent systems (Kujala & Saariluoma, 2018; Saariluoma et al., 2018). However, current AI systems mimic the human mind only in certain restricted tasks in specific contexts. Cognitive mimetics, as a design approach, has addressed this issue by developing and designing AI technologies by imitating human information processing (Saariluoma et al., 2018; Kujala & Saariluoma, 2018). The focus is on cognitive processes, especially in mimicking human experts' thinking structures. However, cognition and emotion are intertwined in human information processing. Emotion creates meaning to cognitive processes and thus is essential to be acknowledged in design.

Emotion and affective dimensions, in broader terms, have been central in designing for humans interacting with technology for a few decades, especially in Human-centred design (HCD), but not in designing intelligent systems mimicking operations of the human mind. Research on emotion has steered its way through multiple research streams.

Different approaches and developments include, for example, affective computing (Picard, 1997; Höök, 2012), methodological — e.g., differences in emotion theories' explanatory power— and methodical developments — including physiological measurements—, relations between visual design elements and elicited emotional themes — e.g., trust; Cyr (2013)—, designing for negative emotions (Fokkinga & Desmet, 2013), and empathic and emotional design (Jumisko-Pyykkö et al., 2021; Mattelmäki et al., 2014; Norman, 2004; Saariluoma et al., 2016). In AI design, research focusing on affective aspects has been titled emotion AI. However, emotion AI (at its current state) exhibits a narrow view of emotion in human life.

All different approaches to understanding how emotions colour our interaction with technology, how we can examine emotions, and how we can design for certain emotions are importantly needed. All the different streams of emotion research share these ultimate pursuits. Still, they differ in conduction of how the human, technology, and interaction are conceptualised, and from which of these concepts emotion research is pursued towards the other concepts. For example, affective computing focuses on designing intelligent technologies that can detect the affective states of humans and act accordingly (Picard, 1997). Research on the relations between visual design and emotions strives toward understanding different designs' capabilities in inducing certain contextual emotions that can be further utilised in designing (via visual representations) for targeted affective states. The empathic design adds designers' roles to the equation for a fulfilling and pleasant interaction with technologies.

As the essence of scientific knowledge is to create understanding, research is always under criticism pursuing improvements. In the same vein, research streams on emotion have their questions. For example, empathic design is vital in HCD, but it has become more of an ideology than a design principle to be acted upon (Heylighen & Dong, 2019). Emotion theories also vary in their explanatory power. For example, basic emotion theories posit physiological correlates of emotions but do not include mental states (Ekman, 1999; Frijda, 1986; Power & Dalgleish, 1997).

In addition, a more recent term, emotion AI is an umbrella term integrating different approaches to incorporating emotion into designing AI technologies. However, emotion AI, even though stated as an umbrella term, has its deficits. Emotion AI focuses mainly on emotion detection and sentiment analysis based on data mining and automated procedures of emotion analysis (Chakriswaran et al., 2019). This line of research is important and has been utilised in a variety of domains, e.g., sports (Bartl & Füller, 2020), marketing (Paschen et al., 2019), emotional mimicry in education (Dindar et al., 2020), and for example, more recently extended to multimodal emotion detection in texts, sounds, audiovisual representations, images, and physiological signals (Marechal et al., 2019). However, the scope of emotion AI is narrow for understanding the integral role of emotion in establishing meaning and enriching human life and for designing intelligent technologies addressing emotion as driving entities in establishing meanings.

Emotion AI and affective computing are occasionally utilised interchangeably. Emotion AI is a newer term and is utilised quite loosely, whereas affective computing is a scientific field dedicated to the detection of human emotional states and to the development of systems and devices that can recognise, interpret, process, and simulate human affects. Thus, affective computing focuses on emotion detection and detection-driven actions in human-computer interaction (Picard, 1997). Both of these belong to the vast discipline of affective science (Sander & Scherer, 2009). To consider the role of emotions in a more holistic sense, it is essential to truly examine the vastness of emotions and sources of emotional design we can have in designing intelligent technologies to address current and future needs.

This paper discusses a design approach of affective mimetics in obtaining context-dependent knowledge of human cognitive and emotional information processing to be applied in designing intelligent technologies. The main focus is on extending cognitive mimetics with heteronymous conceptual re-engineering (Chalmers, 2020) to include emotional information processing in the different types of design mimetics, as emotional information processing is the key to forming meaning in cognitive processes and knowledge structures. Conceptual re-engineering means to analyse and refine or develop an existing concept, and heteronymous indicates the emergence of a different word for the re-engineered concept (Chalmers, 2020).

Affective mimetics can utilise emotional information spaces as the sources for design. Here, we discuss the potential of affective mimetics and emotional information space in directing the design of the metaverse as an example of a complex cognitive and emotional human-technology interaction domain.

The rest of the paper is structured as follows. First, cognitive mimetics are described, followed by a section explicating emotional information processing. Then, affective mimetics are presented and discussed with the concept of emotional information space, Metaverse as an example. And lastly, discussion and conclusions are presented.

Cognitive Mimetics

Design mimetics has been a vital source for design practice for several decades and utilised in numerous contexts. Design mimetics can be presented as a three-level conceptual model (Kujala & Saariluoma, 2018; Table 1). Biomimetics utilises physical structures as the source of imitation. Sensory-motor mimetics perception and motor functions — e.g., in designing robotics—, and cognitive mimetics' imitation source for design are higher cognitive processes.

Table 1: *A three-level conceptual model of design mimetics (Kujala & Saariluoma, 2018).*

Level	Source of imitation in nature
Cognitive mimetics	Higher cognitive processes
Sensory-motor mimetics	Perception and motor functions
Biomimetics	Physical structure

The biomimetic design imitates biological and physical systems, structures, and forms found in nature to be applied to technology designs (Bar-Cohen, 2006). Biomimetics is also called biomimicry or bionics (Vincent et al., 2006). However, biomimetics is an insufficient source of design for intelligent technologies that operate within the domain of information. Thus, biomimetics cannot serve as an adequate method for AI design; for example, thinking about machines to design tools for creative processes. To enable such processes, it is essential to understand how people process information, relevant knowledge structures, mental content, and how they create new information (Myllylä & Saariluoma, 2022; Saariluoma, 1995; Saariluoma et al., 2021).

In cognitive mimetics, instead of imitating structures of nature, human information processing and knowledge structures are the sources of design mimicry (Kujala & Saariluoma, 2018; Saariluoma et al., 2018). Therefore, cognitive mimetics is a unique approach to design mimetics by focusing on knowledge structures and represented mental information content. This also necessitates specific research methods. For example, observation and ethnographic approaches are not solely sufficient research approaches to obtain data to be analysed to understand these internal processes (Grahn et al., 2020). Multimethod approaches, including, thinking aloud, prospective thinking aloud, self-reports, observations, interviews, and phenomenological and other qualitative techniques, are applicable methods in cognitive mimetics — see collections by Breakwell et al. (1995), Denzin and Lincoln (2011)—.

The core idea of cognitive mimetics is to explicate human information processes, for example, by methods developed for human thinking and expertise (Ericsson & Simon, 1984; Saariluoma, 1995). The processes can be modelled by cognitive simulation and explicated for further AI development. The models can be called human digital twins (HDT) (Saariluoma et al., 2020). Cognitive mimetics have been utilised in studying ship simulator driving (Saariluoma et al., 2019) and in automated driving technologies (Grahn et al., 2020).

However, human information processing is not only cognitive. It has essential emotional aspects. Therefore, it makes sense to think about how to analyse human emotional information processing in constructing human digital twins for AI developers.

Emotional Information Processing

In early cognitive science, emotions were not a focal problem. The main thing was to study the human mind from Turing's (1936) point of view and model how people in different domains think. Turing machines were models of human mathematicians' information processing (Newell & Simon, 1972; Turing 1936; 1950). However, emotions and cognitive processes are so closely linked that it would be an error to keep them separate in research (Frijda, 1986).

Emotional information processing in decision-making has been referred to as irrational and intuitional and conscious, cognitive, and analytical as rational behaviour (Kahnemann, 2011; Simon, 1987). Information processing theories have not focused on the interaction of cognition with affect, even though, in actual human behaviour, affect significantly influences cognitive processes. Understanding the human mind requires understanding both (Simon, 1967). The importance of affect in human information processing has slowly started to be acknowledged in different domains. Current research stresses the intertwined nature of cognition and affect (Eysenck & Keane, 2015). However, in regard to AI and the design of intelligent systems, cognitive approaches still play a significant role.

Emotional information processing can be understood from at least two levels. Firstly, emotional information processing can be explained from the viewpoint of basic survival and emotion regulation. We need to react and act quickly to situations that present the possibility of harm. On the other hand, many situations require deliberate and careful emotional processes affecting, for example, decision-making in difficult circumstances.

One research stream of emotional information processing focuses on observable cues. This line of research is based on Frijda's (1986) notion that emotions are closely connected to tendencies to act. Thus, to examine emotional processing, the focus should be placed, instead of emotion and cognition, on studying actions representing cognition and emotion (Frijda et al., 1989). However, observable — bodily, including facial movements— actions do not necessarily always indicate emotional mechanisms and cannot be utilised in explicating the mental content of mental representations. This might be more straightforward when discussing subliminal actions (such as pupil sizes) than explicating higher cognitive-affective processes with actions. Our bodily representatives of our inner states can be misleading due to covert attention. Gaze can be focused on a specific location, but *the contents of the mind are elsewhere* (Posner, 1980).

Emotional information processing in higher-level cognition plays an essential role as the meaning maker of cognitive processes. For example, we can make decisions (boundedly) rationally, but if the affective dimension is missing, we cannot be consistent with our decisions (Kahneman, 2011; Simon 1987).

The examples from decision-making illustrate how important roles emotions have in human information processing. Another example could be ethics, which is based on how people feel about the consequences of their actions (Saariluoma & Rousi, 2020). Therefore, it makes sense to think of conceptual foundations of affective mimetics and human digital twinning.

Affective Mimetics, Emotional Information Space and Metaverse

Here we describe affective mimetics as a design approach, emotional information space as a holistic source for design, and metaverse as a timely example for affective mimetics and emotional information space in designing emotionally intelligent AI technologies.

1. *Affective Mimetics*

Current research on information processing within a modernistic view of human cognition posits affect and cognition to be intertwined in actions. Thus, much research is placed on understanding the interaction between affect and cognition (Sander & Scherer, 2009; Kret & Bocanegra, 2016). As a result of conceptual engineering (Chalmers, 2020; Eklund, 2015; 2021), cognitive mimetics is extended to include emotional information processing and is titled affective mimetics.

Table 2 presents an extended conceptual model of design mimetics, including affective mimetics and techno-mimetics. Cognitive and affective mimetics are supportive of each other as cognition and emotion are intertwined. Thus, if the focus of the design is to mimic human information processing, the term cognitive-affective mimetics can be utilised. Here we conceptually extend cognitive mimetics to include affective mimetics as the focus is on emotional information processing. Affective mimetics is placed after cognitive mimetics — but only separated with a dashed line to illustrate their intertwined relation— as cognitive evaluations of the significance of certain events to an individual give rise to affect (c.f., Scherer, 2009; Smith & Kirby, 2001).

In addition, techno-mimesis (Dörrenbächer et al., 2020) as a novel design approach is included in the conceptual model. Techno-mimesis is placed last as it is the furthest part of mimicking nature or human information processing. The focus of techno-mimesis is to design experiences from a technology point of view for humans. This can be actualized by experiencing the world through prostheses — e.g., seeing the world with a distance sensor instead of eyes—. Thus, the focus is on designing abilities for robots that extend human capabilities (Dörrenbächer et al., 2020).

Table 2: *A three-level conceptual model of design mimetics (Kujala & Saariluoma, 2018).*

Level	Source of imitation in nature
Cognitive mimetics	Higher cognitive processes
Affective mimetics	Higher affective processes
Sensory-motor mimetics	Perception and motor functions
Biomimetics	Physical structure
Techno-mimesis	Technological devices (e.g., sensors)

To develop affective mimetics or mimetics based on emotional information processes, it is essential to develop basic concepts of this approach. One critical insight is that human actions generate emotional values for objects, people, and thoughts (Lazarus & Lazarus, 1994). One can thus see the action environment of a person as a system of emotionally coloured objects. This system of emotionally coloured objects can be called emotional information space (Silvennoinen & Saariluoma, 2022).

2. *Emotional Information Space*

Emotional information space incorporates all issues within a certain environment with cognitively appraised affective meanings and the ability to encode these information contents into designing emotionally intelligent AI technologies (Silvennoinen & Saariluoma, 2022). Let's use a story adapted from Power and Dalgleish (1997) to concretise this abstract notion.

Think that you are walking in a forest with your little son. A bear is approaching you and your son, but fortunately, a forest guard can shoot the bear with a sleeping bullet. The beast falls asleep, and the threat disappears. During the event, numerous emotional attributes can be attached to different actors in different stages of the process to the actors. Bear is a threat though it does not attack. Your son is marked with pity, you with fear and rage. The forest guard with his gun raises safe, and after the beast has slept, comport. Even the bear may feel cute after falling asleep. Thus, the action narrative demonstrates how people mentally represent various action environments and evens emotionally in their minds (Power & Dalgleish, 1997).

AI technologies ideally operate in environments in which components make sense to the system. These components can have emotional aspects. For example, one can be afraid of animals and avoid them when walking in a forest or meeting a barking dog on the street. The attributed components of an event can be verbal messages or pictures, but there is no obstacle for them to be any kind of emotionally meaningful and sense-making semiotic objects. Moreover, AI technologies do not operate only in space and time, but they can also be actively and intelligently involved in human information space.

This space has cognitive and emotional dimensions in human information processing, and such spaces require effective encoding of these dimensions to be incorporated into AI design. In any situation, emotions can be activated on the ground of cognitive analysis. Some people, objects or events are negative; some are positive. Thus, in human mental representations or machine situational representations, components and their combinations have emotional values. The system of emotional values can be seen as emotional maps in action space, in which affective elements can be seen as attributes of situations.

Emotional information spaces can also function as a source of socially shared designs. Social media and mobile internet enable us to acquire several different kinds of virtual possessions. These possessions can be material things no longer with material characteristics (e.g., e-books, photos, music) and objects that have not ever had a physical material form — e.g., avatars, games— (Seok et al., 2013). These possessions have individual meanings but can also have social meanings that are socially constructed and valued. These possessions and social interactions in social media moods and emotional shifts are transmitted and co-created (Coyne, 2016). In a metaverse, virtual possessions can have strict ownerships via non-fungible tokens (Wang et al., 2021). Thus, virtual possessions, such as unique, unreplaceable band t-shirts worn by avatars in different contexts, e.g., in virtual concerts, can be bought, owned, and sold forward.

3. *Metaverse – An Example*

A modern example could be provided by metaverse. It is a set of virtual spaces that can be created and explored with others that are in different physical spaces. The term metaverse originates from Neal Stephenson's cyberpunk novel Snow Crash in 1992. Here metaverse is presented as an imaginary virtual place, in which artefacts can be created — and not only artefacts from our physical reality, but artefacts that do not exist yet—, and larger infrastructures, such as unique neighbourhoods where rules of three-dimensional spacetime do not apply.

The development of the metaverse is based on recent technological advancements, e.g., extended reality, artificial intelligence, internet of things, computer vision, mobile networks, and robotics. One example of metaverse design is a bodily metaverse of Lisbon presented on a social virtual reality platform as an immersive artistic virtual world (Gebrian et al., 2021). We argue that at the core of meta-design space for metaverse are meaningful entities. The question, then, is how to gain knowledge of components of such meaningful totalities. Emotional information space can be utilised as a holistic design source informing the constructing elements of meaningful metaverses and designed with affective mimetics.

At its most modest pursuits, metaverse can be conceptualised as an extension of the mobile internet. It can be stated that many metaverses already exist, such as Second Life and Fortnite — but not always with AR and VR solutions—. However, the current metaverse under discussion strives toward sociality as a realistic society with enhanced interactions, accessibility, and equality (Duan et al., 2021). In broader terms, a metaverse can be discussed as a new form of infrastructure and as a meta-design space enabling immersive experiences that are thematically interconnected (Seidel et al., 2022). Thus, the metaverse can be seen as a world where reality and virtuality intertwine in various ways. Metaverse as a meta-design space integrates various interconnected design spaces in which dimensions of human experience (time, space, artefacts, and actors) play important roles in transitions between spaces, whether physical, virtual or a mixture (Seidel et al., 2022). The metaverse is planned to be everything you can imagine; it is so broad that it is almost meaningless, Meta (formerly Facebook) CEO Mark Zuckerberg stated in his Facebook Connect keynote (Arstechnica, 2021). At its current ideation phase — as an entity of embodied multiple distinct online spaces—, it is thought to be constructed from the following components:

1. A shared social space with personalisable avatars to represent users
2. A persistent realm for the avatars to live and interact with each other
3. Possibility to own virtual property (similarly as physical property)
4. Ability to create your own virtual property (and to exchange and sell it)
5. A shared universe of intellectual properties from major companies
6. A 3D telepresence via VR or AR glasses.

There are a plethora of questions to ask and address concerning the development of metaverse. How will it be defined, and by whom? Who or whom are in control of it? From what will it be consisted of? How are human dimensions in technology design addressed, for example, ethics? Do we even want to have a metaverse? And, if systems that we currently use are integrated into the metaverse, are we forced to move along?

Discussion and Conclusion

Understanding operations of the human mind is at the core to encode emotional aspects of information for machines to process (Kerruish, 2021; Saariluoma, 2020; Jokinen & Silvennoinen, 2020). This information can have any physical meaning source, such as pictures, sounds, and verbal messages. We call this emotional information space. A simple example would be avoiding and pursuing behaviours. Machines can pursue towards the target people experience valuable and avoid target people see dangerous. Thus, mimicking human emotional analysis of emotional space can give information about what to do and why to do so. In this paper, we presented a design method to mimic human information processing: affective mimetics. Affective mimetics is extended via conceptual engineering from cognitive mimetics.

As presented in this paper, emotion in AI and designing intelligent systems has many research streams and many challenges to overcome. We propose that emotion AI needs to be extended to address other dimensions of affect within technology interaction besides emotion detection and sentiment analysis to incorporate the variety emotion plays in human life. The knowledge of how attributed emotions direct human actions can be used in developing technologies, which in the same action environments also utilise emotional information. Designing with affective mimetics can be utilised for several contexts where humans interact with technology and emotionally meaningful entities are to be incorporated to the design. The design contexts can be, such as care-robots for the elderly, domestic multisensory technological ecosystems for relaxation purposes, and personalised digital learning environments.

The role of the concepts presented in this paper can be summarised with the example of metaverse with the following structure. Emotional information space as the holistic framework for emotionally intelligent technology design — context can be, for example, metaverse—, incorporating cultural artefacts — such as virtual possessions, images, and music—, subtle enlightening meanings — personally apperceived meanings of the objects—, created forms for experiences in conjunction of realities — physical and virtual mixture—, can be seen as the starting point to map out what to design for and why. Affective mimetics as a design approach informs us to understand what and how to include. Affective computing can be seen as a source for automating emotion-detectable constructs to make the interaction towards socially intelligent interaction and co-experience — possibly also enabling co-creation— fluent. Affective computing can be utilised with emotion detection in the metaverse and aiding others in obtaining knowledge of the affective states of the others. Empathic design incorporated designers' approach to address and incorporate the aforementioned issues into being.

Conceptual engineering can outline key concepts and their systems for future work. However, it cannot replace empirical analysis. New concepts allow setting problems for empirical work and make it possible to design research questions and operationalise research for design. New systems of concepts make it also possible to guide design processes on the ground of empirically analysed environments.

In the present case, this means that researchers should empirically construct emotional information spaces and networks as the sources for affective mimetics. They should ask subjects in different environments under different instructions emotional association of systems of objects, for example, in a social media environment, such as metaverse. Thus, future research focus is to be placed in empirical examinations of emotional information spaces implementing affective design, and also, to empirically validate the benefits of affective mimetics as a design method for emotionally intelligent technologies. Moreover, as seen so far, different mimesis-based design methods are emerging.

Therefore, future research could also focus on examining this landscape in further elaborating the possibilities of the existing methods and to create novel design methods to address the evolving possibilities that future technologies enable and, especially, to design technologies from the human perspective.

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