Design Science

Under the umbrella: components of empathy in psychology and design

Álvaro M. Chang-Arana [1,2], Antti Surma-aho [2], Katja Hölttä-Otto [2,3] and Mikko Sams[4]

[1]*Department of Neuroscience and Biomedical Engineering, Aalto University, Espoo, Finland*
[2]*Department of Mechanical Engineering & Design Factory, Aalto University, Espoo, Finland*
[3]*Department of Mechanical Engineering, The University of Melbourne, Parkville, VIC, Australia*
[4]*MAGICS, Aalto Studios, Aalto University, Espoo, Finland*

Abstract

Empathy is argued to be a key factor for a successful design discussion. However, such causality cannot be empirically proven based on how empathy is currently defined in design community. Empathy is used as an umbrella construct, broad and encompassing of diverse phenomena, making it difficult to quantify. We suggest improving such a situation by introducing a definition of empathy based on psychology literature, which provides structure and guidance for studying the role of empathy in design. We first break empathy to components. Then, we review empathy as used in design. Finally, we synthetize the reviewed material. From this synthesis, we conclude that empathy in design shares several key components of empathy in psychology; particularly with state influences, top-down control process and emotional stimuli. These are present in design methods although they have not been studied using such terms. Incorporating psychological components of empathy into design can help conceptualising empathy from a different angle, thus opening interesting new avenues for future research. We hope that our treatment provides present and future designers with some useful guidance.

Key words: empathy, design research, user-centred design, psychology

Received 18 May 2021
Revised 23 May 2022
Accepted 01 June 2022

Corresponding author
Á. M. Chang-Arana
alvaro.changarana@aalto.fi

Des. Sci., vol. 8, e20
journals.cambridge.org/dsj
DOI: 10.1017/dsj.2022.13

1. Introduction

In this review, we argue that empathy in design can gain precision through the lens of psychology and neuroscience (*psychology* from now on). We have claimed (Chang-Arana *et al.*, 2020; Chang-Arana, Surma-aho *et al.*, 2020) that empathy has been proposed as an important concept behind successful businesses and projects (Brown 2009; Kramer, Agogino & Roschuni 2016; Leonard & Rayport, 1997) and has become central in design research and practice over the last two decades (Köppen & Meinel 2015). The rising interest in empathy has been influenced by studies of empathy in psychology. However, despite its relevance in design, design practitioners and researchers (*designers* from now on) have not reached a consensus on the definition or specific role of empathy in design. On a general level, designers understand empathy to mean some form of user-centric design and understanding and can therefore use it in communication (Chang-Arana *et al.*, 2020; Chang-Arana, Surma-aho *et al.*, 2020). Yet, multiple methods

and empathy-generating frameworks have been introduced as tools to foster empathy with the users. Furthermore, designers have discussed the ethical consequences and limits of empathy in design.

We suggest that design has approached the concept of empathy in such an abstract way in part due to the nature of the discipline. Design is a heavily context-based discipline, where interventions and methods may differ drastically case-by-case (Gray 2022). Thus, to achieve certain shared understanding of empathy, designers have introduced abstract and metaphorical definitions of empathy, which are easily adapted to different design contexts. Empathy in design works as an umbrella construct.

An umbrella construct is a 'broad concept or idea used loosely to encompass and account for a set of diverse phenomena' (Hirsch & Levin 1999, p. 200) for which a clear operationalization, that is, translating a concept 'into observable and testable empirical indicators, after which experimental research designs with proper sampling techniques can be applied' (Surma-aho & Hölttä-Otto 2022, p. 6), is rarely achieved. On the one hand, umbrella constructs are important tools in a healthy developing research field, balancing generalizability and specificity (Hirsch & Levin 1999). Umbrella constructs are the conceptual glue that prevents a research field from becoming disconnected and irrelevant. On the other hand, a clear definition of a concept allows rigorous measurements, comparing results across studies, establishing causation and generalising (Ball & Christensen 2019; Cash 2018) to advance or develop a proper theory (Cash 2018; Hirsch & Levin 1999) and avoid 'stagnation in research topics and methods' (Hay, Cash & McKilligan 2020, p. 1).

The life cycle of umbrella constructs follows three steps that can result in three different outcomes (Hirsch & Levin 1999). The first step is the emergence of the concept and the initial excitement it causes in a research community. This step is characterised by a prolific development of studies, the increasing collaboration between scientists and the establishment of research traditions. The second step is the validity challenge. At this stage, the limits and use of an umbrella construct are questioned. The third step synthesises these two opposing forces through typologies and more careful operationalization of the concept, or the specific criteria to delineate a concept and enable its future quantification (Kazdin 2022). If the typology results in finding the umbrella construct coherent, then the challenges are overcome. However, if the community of researchers do not agree over the concept's definition, then the construct risks collapsing into a state where researchers study solely the underlying elements of the umbrella construct.

As an umbrella construct, empathy in design faces two closely related challenges. First, empathy is assumed to impact design outcomes and ultimately improve business success. However, no clear evidence of empathy being an *a priori* condition for successful design outcomes has been provided. This limitation in establishing causality has been found in other areas of design and attributed to low methodological and theoretical rigour (Ball & Christensen 2019; Dinar *et al.* 2015). Qualitative methods have been and will be important in characterising the complex nature of design (Cash 2018). However, we believe that empathy research in design can benefit from complementing them with a quantitative approach, 'suited to robust hypothesis testing and the study of larger samples' (Hay *et al.* 2020, p. 2). Specifically, a quantitative approach allows predicting, controlling and explaining, needed to test the causality of empathy in successful design. Moreover,

https://doi.org/10.1017/dsj.2022.13 Published online by Cambridge University Press

it compels us to look at a phenomenon paying attention to conceptual details and nuances. In turn, this can uncover new research paths which otherwise would have remained unnoticed.

The second challenge is related to the metaphorical language often used to define empathy. Metaphors such as *stepping into someone else's shoes* or *merging with the user* describe some aspects of a design process well and may facilitate communication with people working in other fields. They can be inspirators, triggers of our curiosity and alternative ways of thinking from which new insights can emerge (Hayes *et al.* 2013). But metaphors are typically up for interpretation on their definition of empathy, as opposed to various subconstructs proposed by scientific study. This means that the use of metaphors in empathy research risks muddying the core concepts being investigated.

We believe that without a clear definition of empathy, one which encompasses its key subcomponents, it risks transforming into a meaningless concept. Without a clear concept we cannot understand *how*, *if*, and *why* the multiple methods and frameworks available in fact help in the design process (Surma-aho & Hölttä-Otto 2022). How do the various subcomponents of empathy, such as human-centred attitudes, user interaction tools, perspective-taking tendencies and emotional understanding contribute to the work of designers? This lack of understanding risks diminishing the prospects of the study of empathy in design as a serious scientific endeavour. Contrarily, improving our understanding of empathy may have important implications in different areas of design such as research, educating future designers, and better tuning designers' need-finding skills.

A strong theory of empathy in design will be based on thorough qualitative and quantitative research. Yet, we think qualitative studies have dominated for the most part the study of empathy in design. Therefore, in this review, we contribute with ideas for approaching empathy in design from a quantitative perspective.

Here an interdisciplinary approach to empathy can be helpful. We review how empathy has been studied in psychology, where the concept has been investigated for many more decades than in design. Psychology is not alien to the problem of defining empathy. In fact, Cuff *et al.* (2016) suggest that there are as many definitions of empathy in psychology as there are studies. Yet, we review empathy in psychology for two reasons. First, psychology in contrast to design research has reached a fuller understanding of empathy and its main components. This scaffolding can channel designers to investigate relevant or overlooked elements of empathy, as well as enabling an interdisciplinary dialogue between design and psychology. Second, psychology is familiar with the practice of breaking abstract concepts (e.g., perception, cognition, and anxiety) into observable and quantifiable entities. By showing how different components of empathy have been defined and measured, we want to inspire designers to study empathy through novel approaches.

We carry out a literature review to create a typology of empathy in design and offer a conceptual guide to build further theory on the subject. We will start by reviewing empathy in psychology and then move to empathy in design. Rather than starting the review with a design approach to empathy, which may be familiar to most the readers of this journal, we want to provide the readers with conceptual lenses from another discipline. We finalise the review with a conceptual exercise where we point at gaps and overlaps between psychology and design for further exploration.

https://doi.org/10.1017/dsj.2022.13 Published online by Cambridge University Press

2. Methodology

We used a keyword search for the review. The sources were found first through Google Scholar or searching directly on design and psychology journal websites. Keywords used for searching were *empathy*, *empathy in design*, *empathy in design thinking* and *empathy review*. We initially focused on reviews (e.g., Kouprie & Sleeswijk Visser 2009; Shamay-Tsoory 2011; Zaki & Ochsner 2012; Mattelmäki, Vaajakallio & Koskinen 2014; Clarke, DeNora & Vuoskoski 2015) and handbook chapters (e.g., Batson 2009; Shamay-Tsoory 2009; Neumann & Westbury 2011; Köppen & Meinel 2015) both in psychology and design. In addition, we followed a snowball procedure by revising the sources cited by authors. This review has been updated since 2018 following the same procedure, as well as by following the reviewers' feedback during the submission process. All sources revised were in English language and we limited the disciplines to design and psychology.

3. Empathy in psychology

The concept of empathy has been important in psychology at least since the late 1940's (Stueber 2019) and therefore there is a long history of research and methods to learn from. Certainly, recent definitions of empathy in design have been strongly influenced by psychological concepts such as cognitive and affective empathy. In this section, we will explore those concepts and others to reveal a complex nature of empathy.

Even in psychology, there is no consensus about the definition of empathy (Batson 2009). It is more of a conceptual archipelago (Scriven 1969) grouping multiple specific processes and mechanisms. A recent review listed 43 different definitions of empathy (Cuff *et al.* 2016). Below we quote the definition by Cuff *et al.* (2016, p. 150), which was formulated after scrutinising different nuances and ways of understanding empathy (italics are ours):

> Empathy is an *emotional response* (*affective*), dependent upon the interaction between *trait capacities* and *state influences.* Empathic processes are automatically elicited but are also shaped by *top-down control* processes. The resulting emotion is similar to one's perception (directly experienced or imagined) and *understanding (cognitive empathy)* of the *stimulus emotion*, with recognition that the source of the emotion *is not one's own.*

We chose Cuff *et al.*'s (2016) definition as our conceptual framework for two reasons. First, when their paper was published, it was the most updated effort to defining empathy and incorporated previous important reviews (e.g., Davis 1996, 2006; Batson 2009). Second, their definition has proven to be a useful conceptual framework to clarify empathy in other fields, such as organisational behaviour (Clark, Robertson & Young 2018).

In Sections 3.1–3.7, we discuss, in our opinion, the main elements of Cuff et al.'s definition: emotional response, trait capacities, state influences, top-down control, understanding (cognitive empathy), stimulus emotion, and the self/other distinction. Additionally, we provide concrete research examples of how the main elements in the definition have been measured before.

https://doi.org/10.1017/dsj.2022.13 Published online by Cambridge University Press

3.1. The emotional response

The emotional response is closely related to emotional or affective empathy, defined by Shamay-Tsoory (2011) as 'the capacity to experience affective reactions to the observed experiences of others or share a fellow feeling' (p. 18). This capacity is hypothesised to be based on underlying unconscious automatic processes (Cuff *et al.* 2016) such as emotional contagion (Preston & de Waal 2002), emotional recognition (Carr *et al.* 2003; Pfeifer, Lieberman & Dapretto 2007), shared experience of pain (Singer *et al.* 2004; Jackson, Meltzoff & Decety 2005) and the activation of mirror neuron systems in nonhuman primates and humans when observing actions (Iacoboni *et al.* 1999; Fogassi *et al.* 2005; Schlaug 2008). All these processes assume some kind of 'shared representation' (Zaki *et al.* 2009), that is, that perceivers have similar activity patterns in their brains as their targets. Such similar patterns have been found when observing someone else perform a motor action or when observing someone under pain (Singer *et al.* 2004; Jackson *et al.* 2005).

The emotional response, or affective empathy, includes several mechanisms and has been measured in many ways. Especially in neuroscience, the emotional response is measured as a physiological response, similarity of reactions or a synchrony with the target (e.g., Levenson & Ruef 1992; Singer & Lamm 2009; Bernhardt & Singer 2012). For example, Carr *et al.* (2003) showed participants a set of six basic facial expressions and asked them to either imitate and internally generate the target emotion or passively observe it. Carr *et al.* (2003) found that understanding other's emotions was associated with activation in brain areas involved in mentally representing other people's actions. In a study about empathy for pain, Lamm, Meltzoff & Decety (2010) examined the neural response to situations in which the observer is requested to empathise with a person who is not like them, as opposed to a person sharing one's own bodily experience. To test this, participants watched photographs of people being touched by a Q-tip or receiving an injection. Participants were asked to vividly imagine the pain (or nonpain) caused by the displayed situations. Lamm *et al.* (2010) found that empathising with someone else's pain recruits similar neural mechanisms, independent of the similarity with the observer's cultural background.

Recently, Smirnov *et al.* (2019) studied how synchronisation of feelings of a storyteller and a listener is reflected in brain activity using a pseudo-hyperscanning approach. Arousal related to increased synchrony in brain regions supporting attentional, auditory, somatosensory and motor processing. Valence, on the other hand, was related to increased synchronisation in regions involved in emotional processing such as amygdala, hippocampus and temporal pole. This result suggested that listeners' brains reproduce some aspects of the speaker's emotional state.

Our capacity to respond emotionally to other is so strong that one can induce moods solely through verbal means. Kramer, Guillory & Hancock (2014) manipulated exposure to positive or negative emotional expressions on Facebook users' News Feed. Researchers found that reducing the number of posts with positive emotional content had two effects: the percentage of positive words in the participants' status decreased and the percentage of negative words in their status increased when compared to a control group. Conversely, reducing the number of posts with negative content had two effects: the percentage of negative words in the participants' status decreased and the percentage of positive words in their

https://doi.org/10.1017/dsj.2022.13 Published online by Cambridge University Press

status increased when compared to a control group. Thus, exposure to emotions, even verbal affective expressions, can lead to similar emotional responses. This insight can be particularly relevant to design practice as it is common that designer's initial interactions with users are communicated to later stages of the design process through written means.

3.2. Empathy as trait capacities

People differ in how sensitive they are to the behaviour of other people. There are reported sex differences in empathy-related processes. Females are faster and more accurate than males in recognising others' facial expressions and bodily expressions of emotions (Christov-Moore *et al.* 2014). Such sex differences can be traced to the infancy. For instance, female versus male neonates are more likely to cry and for a longer time when triggered by the cry of another infant (Christov-Moore *et al.* 2014). Other studies suggest that higher empathic levels of females versus males appear early in life and appear to be stable and consistent across the life span (Michalska, Kinzler & Decety 2013; O'Brien *et al.* 2013; Christov-Moore *et al.* 2014). In older children, females were found better at guessing the cause of stress of another child (Catherine & Schonert-Reichl 2011) and outperformed males in a false-belief task (Charman, Ruffman & Clements 2002). Yet, conclusions on psychological differences due to the female-male sex binarism should be taken cautiously, as it is being empirically challenged (Fine, 2017; Joel et al., 2015). Developmental disorders have been shown to impact trait empathy. Baron-Cohen & Wheelwright (2004) found differences in self-reported global trait empathy between neurotypical adults and adults with autism-spectrum disorder (ASD). Others have found that psychopathic personality impacts empathy trait scores (Iria & Barbosa 2009; Iria, Barbosa & Paixão 2012; Ellis *et al.* 2017; Moreira, Azeredo & Barbosa 2019).

Trait empathy is most measured via self-report questionnaires. Three questionnaires have solid psychometric properties and are used extensively in research: The Interpersonal Reactivity Index (IRI, Davis 1980), the Empathic Quotient Questionnaire (EQ, Baron-Cohen & Wheelwright 2004) and the Toronto Empathy Questionnaire (TEQ, Spreng *et al.* 2009). IRI (Davis 1980) is a 28-item scale that measures four independent constructs (pp. 11–12): (a) fantasy or the 'tendency to imaginatively transpose oneself into fictional situations', (b) perspective-taking or the 'ability or proclivity to shift perspectives – to step "outside the self" – when dealing with other people', (c) empathic concern or the 'degree to which the respondent experiences feelings of warmth, compassion and concern for the observed individual', and (d) personal distress which measures the 'individual's own feelings of fear, apprehension and discomfort at witnessing the negative experiences of others'.

EQ is a 60-item trait empathy questionnaire which measures empathy as a single construct. Although the authors intended to create separate scales for the affective and cognitive components at first, they abandoned the idea because, theoretically, empathy consists of undividable affective and cognitive components. However, they did not perform any factor analysis to support this claim. It is unclear whether the EQ has a unidimensional (Allison *et al.* 2011) or multidimensional structure (Lawrence *et al.* 2004; Muncer & Ling 2006). We opt for a multidimensional understanding of empathy, where affective and cognitive

https://doi.org/10.1017/dsj.2022.13 Published online by Cambridge University Press

empathy stand as separate, yet interacting, constructs (Shamay-Tsoory & Aharon-Peretz 2007; Shamay-Tsoory 2011).

TEQ is a 16-item questionnaire which conceives empathy as a single construct, defining it as 'an emotional process or an accurate affective insight into the feeling state of another' (Spreng *et al.* 2009, p. 68). A well-thought use of any or a combination of these three questionnaires is a sound starting point for designers interested in measuring trait empathy.

3.3. Empathy as state influences

Empathic responses (e.g., matching affective states, intentions to help, and adopting someone else's perspective) are affected by the specific context and situations where the behaviour occurs. State influences can be more or less *static*. For example, one cannot change the cultural background in which one is born, but visiting or living in another culture can help gain certain insight into it. State influences can be based, for example, on shared past experiences of the participants, in-group dynamics, power, and narratives (Eklund, Andersson-Stråberg & Hansen 2009). Humans have the in-built capacity to recognise emotions in others, yet recognising the content (e.g., labelling a facial expression as happy) is context dependent. Participants can categorise a stereotypical anger facial expression as a fearful one, if they are told that the picture was taken in a frightful situation (Brosch, Pourtois & Sander 2010). Empathic responses are affected also by similarity of past experiences (Eklund *et al.* 2009). Individuals sharing the same versus different ethnic background will react stronger to the other's pain (Avenanti, Sirigu & Aglioti 2010) and are more likely to share an emotional response, although when judging more ecologically valid stimuli (i.e., videorecording of a conversation instead of posed photographs), sharing ethnical background did not result in an enhanced empathic accuracy (Soto & Levenson 2009). Power reduces accuracy in detecting someone else's emotional state, the tendency to spontaneously adopt someone else's visual perspective, and performance at a perspective-taking task even within participants of similar culture (Galinsky *et al.* 2006). Valuing the welfare of others (i.e., how a person's well-being is affected by circumstances in their life) and perceiving them in need, are antecedent conditions that motivate empathic concern (Batson *et al.* 2007). Further, being exposed to fictional narratives (e.g., a novel about a stigmatised group) influences empathic responses, particularly empathic concern (Bal & Veltkamp 2013), as well as prosocial behaviour, a spontaneous and unrequested helping behaviour, such as spontaneously helping someone who has suffered an accident (Johnson 2012).

State influence is typically measured through the effect of a specific intervention. For example, in a study exploring past shared-experiences, participants were presented with four fictional stories and asked to rate how similar these stories were to their own experience. Empathy was operationalised by asking how moved they were by the story or to what extent could they imagine an actor's feelings. Positive associations between empathy and previous similar experience were observed being stronger for female than the male participants (Eklund *et al.* 2009).

The effects of fictional stories on state empathy may not be immediate. Bal & Veltkamp (2013) found that reading fiction, but not nonfiction, can increase empathic concern of those readers who are strongly transported (Green & Brock, 2000) by the narrative. The effects of narrative on empathic concern were

https://doi.org/10.1017/dsj.2022.13 Published online by Cambridge University Press

significant not immediately but only one week after the participants read the fictional texts. This study suggests that the effects of storytelling in design could be more effective by letting designers think about the story for some days.

Narratives also influence a behaviour closely related to empathy: prosocial behaviour, or a spontaneous and unrequested helping behaviour. For instance, Johnson (2012) found that individuals who were more absorbed into the fictional story experienced high levels of affective empathy and were nearly twice as likely to pass the pen-drop task as individuals experiencing low levels of affective empathy. In the pen-drop task, an experimenter excuses to the participant and leaves the room. When the experimenter returns, they fake an accident and drop pens on the floor. It is measured whether the participant spontaneously picks up the pens thus showing a prosocial behaviour or not (Tear & Nielsen 2013).

3.4. Top-down control

People can be willingly empathic. For instance, adopting the perspective of members of stigmatised groups, such as people living with HIV or homeless people, have resulted in increased positive attitudes (Batson, Early & Salvarani 1997*a*). Adopting the perspective of elderly individuals decreases stereotypes related to age (Galinsky & Moskowitz 2000). Asking to empathise with a sad situation was found to increase the affective response to a target person (Rameson, Morelli & Lieberman 2012). In these three examples, empathy was defined as perspective-taking. We engage in a controlled empathic behaviour also in situations where we are motivated to measure the consequences of our actions on others, to manipulate someone's behaviour or to gain (or even suppress) a deeper understanding of the reasons behind someone else's behaviour (Hodges & Wegner 1997).

In top-down control experiments, participants are asked to empathise with a target. For example, in an fMRI study, participants read a contextual sentence depicting a sad situation, followed by photos of a target person in that situation. Participants who were asked to empathise showed stronger neural responses in empathy-associated brain areas (Rameson *et al.* 2012). Batson *et al.* (1997*b*) created three different instructions to elicit three different degrees of perspective-taking in listeners of a broadcast. The lowest level asked them to 'be as objective as possible about what has happened to the person interviewed and how it has affected his or her life' (p. 753), The mid-level asked subjects to 'imagine how the person being interviewed feels about what has happened and how it has affected his or her life' (p. 753). The highest level asked subjects to 'imagine how you yourself would feel if you were experiencing what has happened to the person being interviewed and how this experience would affect your life' (p. 753). Galinsky & Moskowitz (2000) asked participants to 'imagine a day in the life of this individual as if you were that person, looking at the world through his eyes and walking through the world in his shoes' (p. 711). Lastly, when Rameson *et al.* (2012) showed the contextual sentences to the participants, they were asked to 'take each target's perspective and imagine how he or she felt about the situation and how it affected his or her life' (p. 238).

3.5. Understanding (cognitive empathy)

Shamay-Tsoory (2011) defined cognitive empathy as 'a cognitive role-taking ability, or the capacity to engage in the cognitive process of adoption another's

https://doi.org/10.1017/dsj.2022.13 Published online by Cambridge University Press

psychological point of view' (p. 18). A concept closely related to cognitive empathy is Theory of Mind (ToM). ToM was initially coined by Premack & Woodruff (1978) and defined as the capacity of an individual to input 'mental states to himself and to others (either to conspecifics or other species as well)'. Later, Baron-Cohen, Leslie & Frith (1985) added that ToM is a crucial social skill, which allows us to know about someone else's thoughts, desires, feelings or beliefs. ToM is an attempt to answer the question of how we can know what someone else is thinking or feeling (Batson 2009). Neuroscientific research has identified a set of brain areas associated with ToM. For example, the mental inferences of other people's goals, beliefs and desires has been attributed to the temporoparietal junction, whereas the medial prefrontal cortex is involved in attributing traits and qualities about oneself and other people, and so forth (Shamay-Tsoory & Aharon-Peretz 2007; Shamay-Tsoory 2011).

In the seminal study by Baron-Cohen *et al.* (1985), it was shown that children with ASD were unable to attribute beliefs in others or observe reality from someone else's perspective. Researchers created a false-belief task using dolls (Sally and Anne). The child sees Sally placing a marble on her basket before she leaves the scene. Anne transfers the marble into her own basket before Sally returns. The child is asked 'where will Sally look for her marble?' (p. 41). Children with ASD typically select Anne's basket, when the expected answer is Sally's basket. Another task to measure ToM is the detection of faux-pas. It occurs when 'a speaker says something without considering if it is something that the listener might not want to hear or know, and which typically has negative consequences that the speaker never intended' (Baron-Cohen *et al.* 1999, p. 408). A child is successful in the task if they recognise in the story something which should not have been said. Other studies have used these tasks and variations of them (e.g., adapting them to adults) to further explore cognitive empathy and ToM (Stone, Baron-Cohen & Knight 1998; Saxe & Wexler 2005; Shamay-Tsoory & Aharon-Peretz 2007; Schnell *et al.* 2011; Shamay-Tsoory 2011).

3.6. Stimulus emotion

The stimulus emotion is an event which triggers the complex processes described in Sections 3.1–3.5. The triggering event may be internal (e.g., imagined, remembered or inferred) or external (i.e., observing someone else, reading a story, being asked to empathise) (Cuff *et al.* 2016). The stimulus emotion can mean observing facial expressions, seeing someone in pain, reading a story, remembering one's past experiences, being asked to imagine someone else's mind-state, and so forth.

3.7. The source of emotion is not one's own (self/other distinction)

Empathy requires that the empathiser knows that the emotion they are experiencing is externally induced. For some authors, this distinction is important to differentiate empathy from emotional contagion. According to Cuff, in empathy 'the observer is aware that this feeling is a result of perceiving emotion in the other' (p. 149); while in emotional contagion 'the emotion is captured but the observer lacks this awareness, and the observer believes this feeling to be his/her own' (p. 149). A classic example of emotional contagion is infants triggered to crying after listening to another neonate cry (Sagi & Hoffman 1976; Batson 2009;

https://doi.org/10.1017/dsj.2022.13 Published online by Cambridge University Press

Christov-Moore *et al.* 2014). For proponents of the empathy-emotional contagion distinction, infants do not distinguish that the source of the emotion was induced by another infant and thus they display emotional contagion but not empathy. We agree with this distinction, but join others in seeing also emotional contagion important for empathy to occur (Jackson *et al.* 2005; Singer & Lamm 2009; Cuff *et al.* 2016).

4. Looking beneath the umbrella: empathy in design

4.1. The applied nature of empathy in design

Given that design is a heavily context-based discipline, designers have been interested in conceptualising empathy under the light of their practice. In design, empathy is seen as a design approach aiming at matching the mental contents and imagination of designers with that of end-users (Heylighen & Dong 2019) to obtain better design outcomes (Kouprie & Sleeswijk Visser 2009). However, this concept has adopted multiple forms. Early definitions such as the one by Battarbee, Baerten & Hinfelaar (2002), conceptualised empathy as an attitude adopted by designers to develop an emotional understanding of end-users. Such understanding was achieved by 'leaving the design office and becoming – if briefly – immersed in the lives, environments, attitudes, experiences and dreams of the future users' (p. 243) and enabled by the designer's use of their imagination to project into someone else's situation (Koskinen & Battarbee 2003). This exercise had the purpose of internalising users' requirements (Battarbee 2004) to obtain better design outcomes. Fila & Hess (2014), argue that developing empathic understanding towards a user supports requirements definition, and concept generation and evaluation. Thus, in addition to being an attitude, empathy is understood as an instrumental skill (Riemer 2004). Based on psychology, Kouprie & Sleeswijk Visser (2009) introduced the dichotomy of affective versus cognitive empathy into design. They write that 'having an emotional response (affective) to another's emotional state and being able to reflect on that by perspective taking (cognitive) seems to be the core mechanism of empathy' (p. 442).

More recent views have refined the concept of empathy by explicitly pointing at the thoughts and feelings of end-users as the targets of designers' empathy. Postma *et al.* (2012) conceptualised empathy as a skill necessary to solve real user problems by actively including them in the design process and understanding their circumstances, thoughts and feelings. Köppen & Meinel (2015) distilled it further and defined empathy 'in its broadest sense as perspective-taking, including both the involuntary act of feeling [*i.e., affective empathy*] with someone else as well as the conscious cognitive act of placing oneself into someone else's position and adopting their perspective [*i.e., cognitive empathy*]' (italics are ours, p. 16). Lastly, Heylighen & Dong (2019) framed empathy as an approach to design practice that aims at correctly matching end-users' mental contents and the imagination of designers.

The applied use of empathy in design has had four important implications: creating practical techniques for empathising, understanding empathising as a process of interaction and reflection, acknowledging the limitations in designer-user empathy, and cultivating ethical thinking through empathy.

https://doi.org/10.1017/dsj.2022.13 Published online by Cambridge University Press

4.1.1. Practical techniques for empathising

A first implication has been methodological advances. Multiple methods to foster empathy between designers and end-users have been introduced, opening many research paths. These differ on the level of bodily involvement of the designer with the method. Wearable simulations such as goggles, restrictive body-suits and other equipment limit body movements of the wearer to evoke the experience of completing some physical tasks under restricted conditions, thus inspiring designers to 'engage more closely with user experiences' (Kullman 2016, p. 83). The Empathic Experience Design is a method where wearable simulations are central. It is a concept generation tool based on engaging designers in empathic experiences, which simulate disabilities or situational disabilities (Johnson *et al.* 2014; Raviselvam, Hölttä-Otto & Wood 2016). Creating experience simulators such as Smeenk, Sturm & Eggen's (2017) dementia simulator as part of their Empathic Handover method (Smeenk *et al.* 2017, 2019*b*) focus on facilitating the transfer of user insights empathically to design team members who were not in contact with users. Role-playing is often used to visualise a product from the user's point of view (Medler & Magerko 2010). Spatial augmented reality in a special education school gym was implemented as a way of understanding abilities, problems, insights and strengths of students with ASD, with the goal of providing practical tools for teaching and engaging ways for students to learn (Takahashi *et al.* 2018).

More passive methods include Personas or 'abstractions of groups of real consumers who share common characteristics and needs' (Miaskiewicz & Kozar 2011, p. 418). These Personas are usually communicated as a narrative to make it sound more as a real human, and to convey vividly the needs of the person in context (Miaskiewicz & Kozar 2011). Storytelling is a 'mental story construction' (Madsen & Nielsen 2010, p. 59) used to interpret and communicate user data (Kankainen *et al.* 2012). Given that narratives are a method to communicate user knowledge in design, investigating 'the extent to which people become emotionally involved, immersed, or carried away imaginatively in a story' (Oatley 2016, p. 621) could benefit design research. Empathy map is a visual tool containing four quadrants (say, do, think, and feel) utilised to summarise and synthesise key need-finding insights from users (Both & Baggereor n.d.; Chang-Arana *et al.* 2020). All of these methods aim at understanding users' experiences, their thoughts and feelings (Köppen & Meinel 2015), creating a comprehensive user understanding and inform future design decisions that match end-users' expectations (Den Ouden *et al.* 2006). The practical techniques for empathising with the users can be understood as instantiations of state empathy (because they are contextual influences on the designers) and affective and cognitive empathy (as the techniques target embodied processes or more reflective top-down processes).

4.1.2. Empathy as a process of interaction and reflection

A second implication has been the introduction of what could be called general empathy-in-design frameworks. Perhaps the most notable is that of Kouprie & Sleeswijk Visser (2009). They proposed a framework (pp. 444–445) based on 'the principle that a designer steps into the life of the user, wanders around for a while and then steps out of the life of the user with a deeper understanding of this user'. This framework operates through four steps: discovery, immersion, connection

https://doi.org/10.1017/dsj.2022.13 Published online by Cambridge University Press

and detachment. Discovery is described as 'entering the user's world' and 'achieve willingness', immersion as 'wandering around in the user's world' and 'taking user's point of reference' and connection as 'resonating with the user, achieving emotional resonance and find meaning'. Lastly, detachment is defined as 'leaving the user's world' and then 'design with user perspective'. This metaphorical language tries to capture the complexity of understanding a user and prescribes professional practice.

More recently, Smeenk, Sturm & Eggen (2019*a*) proposed the empathic formation compass as a tool for co-design with potential utility in research, practice and education. The framework 'concerns the understanding of the formative process of becoming an empathic design professional who knows which attitude, skills and knowledge are applicable in an empathic design process' (p. 61). Through this framework, it is possible, for example, to observe how a designer engages with the different dimensions of the compass within a design case and its different stages. One can visualise if a designer is relying more on some dimensions than others, and how they could expand their understanding of a design challenge by engaging with other dimensions in the compass. The framework can be summarised in four questions: 'Is a design activity (a) more focused on self or other; (b) more affective or more cognitive; (c) taken with a more participatory or expert mindset; (d) more design- or research-led?' (p. 64). The first two questions align with affective and cognitive empathy (Sections 3.1 and 3.5), and the self/other distinction (Section 3.7); while the last two contribute with design-specific questions.

4.1.3. Limitations of designer-user empathy

As a third implication, design research acknowledges that there are limits to the empathy a designer can have towards a user, due to the differing experiences and social roles of designers and users. There is a limit to a designer's empathic horizon (McDonagh, Woodcock & Iqbal 2018). At its simplest, designers may originate from different demographics than users, be it in terms of income, age, gender, seniority at work or cultural background (Costanza-Chock 2020). Hess & Fila (2017) noted how in cross-cultural design cases empathy towards users deludes in a sort of broken phone communication as the information goes up in the decision ladder. Wearable simulators of different conditions, such as old age (Kullman 2016) and visual impairment (Raviselvam *et al.* 2022), can be used to bridge some demographic gaps, though these tools provide designers with only a brief and naïve glimpse into experiences that the users have intimately mastered in their everyday. Even if designers and users happened to have gone through similar events, their individual experiences can still significantly vary (Chamorro-Koc, Popovic & Emmison 2008). In fact, minority members designing for their in-groups tend to acknowledge the plurality of experiences even when group members share various characteristics (Taffe 2015). Perhaps the differences in the experiences of designers and users are too varied to allow complete mutual understanding, despite both sides' best efforts (Heylighen & Dong 2019). Studies of empathic accuracy in design (Chang-Arana *et al.*, 2020; Chang-Arana, Surma-aho *et al.*, 2020) seem to support the notion of empathic horizon, as well as suggesting an approach to quantify it.

https://doi.org/10.1017/dsj.2022.13 Published online by Cambridge University Press

4.1.4. Cultivating ethical thinking through empathy

A fourth implication are ethical discussions on the pragmatic implications of empathy in design. Some designers have noticed the utilitarian implications of empathy in design and argued that they are not *dehumanising* end-users by utilising empathy as a tool (Devecchi & Guerrini 2017; Walther, Miller & Sochacka 2017). Indeed, some authors may highlight the undeniably pragmatic nature of a design process. Köppen & Meinel (2015) claimed, 'the highest goal for a Design Thinker is to conceive and design something useful' (p. 19) or as Kouprie & Sleeswijk Visser (2009) claimed, the end goal of empathic design is to 'get closer to the lives and experiences of (putative, potential or future) users, in order to increase the likelihood that the product or service designed meets the user's needs' (pp. 437–438). More recent definitions of empathic design have tried to *humanise* design by not considering users as 'simply the economic bottom line of designers' (Walther *et al.* 2017, p. 132) and rather frame empathy in design as a set of skills with professional, social and ethical implications (Devecchi & Guerrini 2017; Walther *et al.* 2017; Hess *et al.* 2021). As Batson (2009) explains, 'a state of distress evoked by witnessing another's distress… does not involve feeling distressed *for* the other (see concept 8) or distressed *as* the other (concept 3). It involves feeling distressed *by* the state of the other' (pp. 7–8). Thinking back to design, if some think that empathising is to understand someone else's circumstances *so that* better products or services are consumed (thus promoting self-gains of designers), perhaps empathy is not the best word to describe such motivation.

4.2. Empathy in design is an umbrella construct

Empathy in design has been under constant change. If we would ask the reader to define empathy in design based on what we have written thus far, we are sure some confusion would arise. This is due to the concept being an umbrella term. Umbrella terms are broad and loose concepts, which encompass and account diverse phenomena (Hirsch & Levin 1999). We observe the looseness in terms such as *immersing, internalising, understanding, placing oneself into someone else' s position* and *matching mental contents.* The set of diverse phenomena include *lives, environments, attitudes, experiences, emotional response, perspective-taking, thoughts, feelings, adopting someone else's perspective, mental contents* and *imagination.*

What do we mean by these loose terms and diverse phenomena? What does it mean to immerse into the user's life? How is it done? How do we know if we have matching mental contents? How exactly could we define *lives, environment, thoughts, feelings, imagination*? How can we translate these concepts into measurable ones? More efforts should be directed towards translating these concept 'into observable and testable empirical indicators, after which [*observational and*] experimental research designs with proper sampling techniques can be applied' (italics are ours, Surma-aho & Hölttä-Otto 2022, p. 6).

This development has been driven by the relatively recent emergence of the concept and the excitement it has caused in the design community. We have seen how the study of empathy in design has branched into something larger than a conceptual discussion. There are discussions of epistemological and ethical limits, tools and frameworks created and implemented based on the current understandings of empathy in design. In terms of the evolution of umbrella terms, we suggest

https://doi.org/10.1017/dsj.2022.13 Published online by Cambridge University Press

that empathy in design is in its first developmental state. It is characterised by a prolific development of studies, the interdisciplinary collaboration between scientists and the establishment of research traditions.

Current understanding of empathy, both in psychology and in design, consists of several elements. This presents a challenge to clarifying the conceptual validity of empathy in design that we and others (Heylighen & Dong 2019; Surma-aho & Hölttä-Otto 2022) have recently raised. Figure 1 aims to depict this challenge. We indicate how each component of Cuff *et al.*'s (2016) definition of empathy in psychology relates to the topics discussed in Section 4.1. The outcome is a complex and tangled scenario, where nearly every empathy concept in psychology connects to several empathy concepts in design. The practical nature of design may explain the many overlaps with psychology and why it is difficult both to find clean one-to-one connections between and compare both disciplines. In addition, Figure 1 points out that the limitations and designer-user empathy (section 'Limitations of designer-user empathy'), and cultivating ethical thinking through empathy (section 'Cultivating ethical thinking through empathy') remain to be explored.

5. Towards a psychology-informed understanding of empathy in design

We introduce a conceptual exercise where we take Cuff *et al.*'s (2016) definition of empathy in psychology as a framework to illuminate our understanding of empathy in design. Psychology also struggles to define empathy. Yet, psychology's more mature understanding of empathy and its main components can channel designers to investigate relevant or overlooked elements of empathy and facilitate interdisciplinary dialogue. By showing how different components of empathy have been defined and measured, we want to inspire designers to study empathy through novel approaches.

5.1. 'Empathy is an emotional response (affective)…'

The emotional response involves unconscious automatic processes such as emotional contagion (Preston & de Waal 2002), and the activation of mirror neuron systems when observing actions executed by others (Iacoboni *et al.* 1999; Fogassi *et al.* 2005; Schlaug 2008). Emotional responses, reflected in emotional synchrony, are thought to increase one's liking and general goodwill towards the target other while also positively contributing to empathic accuracy (Davis 2006). Here, people who resonate stronger when viewing others in pain tend to engage more in helping behaviour, such as comforting the other (Rieffe *et al.* 2021). In creating accurate understanding, synchrony can be seen as a prerequisite: individuals incapable of *feeling into* others may also struggle in accurately making sense of the others' experiences (Stueber 2019).

Likewise, design literature speaks of the importance of emotionally connecting and resonating with users to truly understand them (Battarbee *et al.* 2002; Kouprie & Sleeswijk Visser 2009) as well as humanising users instead of perceiving them as means to achieve something (see section 'Cultivating ethical thinking through empathy'). While some data indicates that facial synchrony might be indicative of empathic accuracy at least for positive thoughts and feelings (Salmi, Li & Hölttä-Otto 2022), no direct connection between synchrony of facial expressions of a

https://doi.org/10.1017/dsj.2022.13 Published online by Cambridge University Press

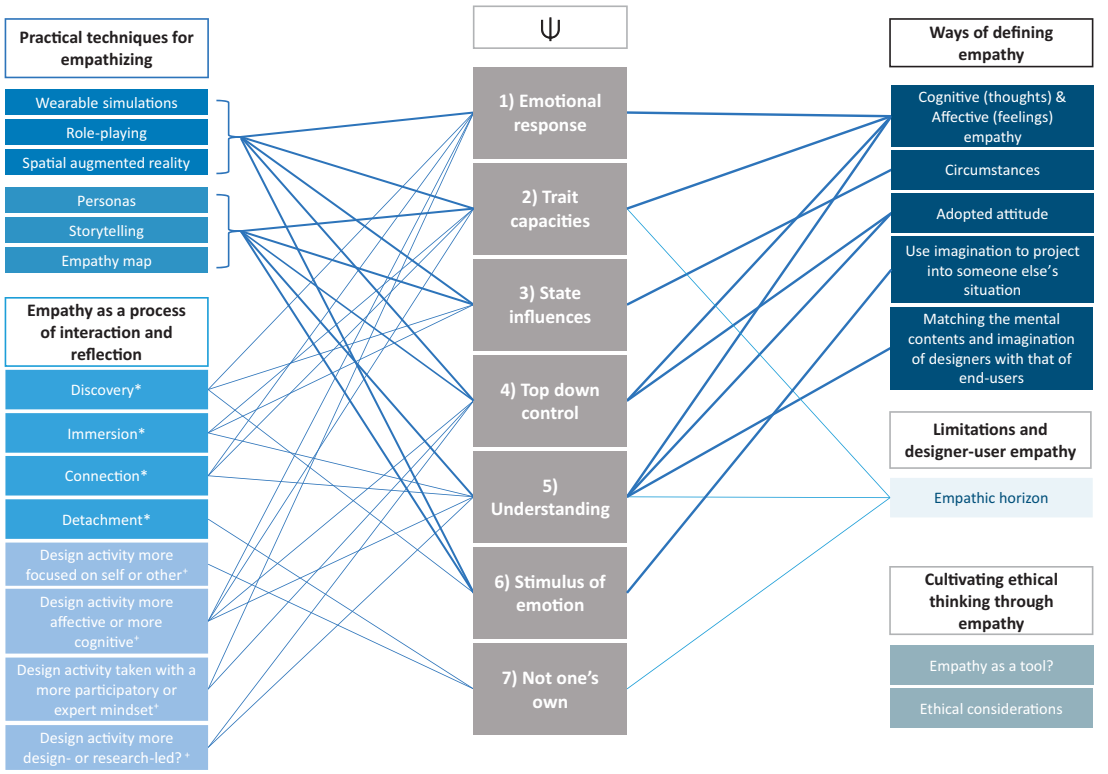

Figure 1. Overlaps of the components of the concept 'empathy' in psychology (⟱) and in design (on left and right sides of the figure). Under 'practical techniques for empathising' we grouped the six elements under two groups. The first one (darker blue) are techniques which have a higher embodied nature and are close to affective empathy. The second one (lighter blue) are less embodied techniques and closer related to top down control and understanding (cognitive empathy). Regarding 'cultivating ethical thinking through empathy', this implication is closely related to the behavioural outcomes of empathising. Thus, we did not established connections to Cuff *et al.* (2016) because they declined to incorporate behavioural outcomes into their definition: 'Although it is to be noted that empathy may lead to behavioural outcomes, this definition of empathy purposefully avoids behavioural implications' (p. 150). Yet, we think that 'cultivating ethical thinking through empathy' could be explored from other psychological perspectives on empathy (e.g., see Davis 2006). *Kouprie & Sleeswijk Visser (2009). +Smeenk *et al.* (2019*a*).

designer interviewer and a user interviewee and accuracy of understanding has been found (Chang-Arana *et al.* 2020), leaving open the possibility of its moderating role. Also, while ethical perceptions of users have not directly been connected to emotional responses, this possibility has not been eliminated either. In fact, Hess, Strobel & Brightman (2017*a*) found that design students showed increased consideration for others' points of view after experiencing challenges with ethical dilemmas, where emotional responses would be likely to have occurred.

In summary, the emotional response might support designers' capability to accurately understand others, as well as encourage designers to view users as humans instead of purely utilitarian entities. But the direct link remains unestablished.

https://doi.org/10.1017/dsj.2022.13 Published online by Cambridge University Press

5.2. '…dependent upon the interaction between trait capacities and state influences'

Research on trait empathy suggests that people differ on their general tendency to respond empathically to others. The degree of trait empathy depends on gender (Charman *et al.* 2002; Catherine & Schonert-Reichl 2011; Michalska *et al.* 2013; O'Brien *et al.* 2013; Christov-Moore *et al.* 2014; but see Joel *et al.* 2015, and Fine, 2017), having or not having ASD (Baron-Cohen & Wheelwright 2004; Bird & Viding 2014), or amount of psychopathic personality features (Iria & Barbosa 2009; Iria *et al.* 2012; Ellis *et al.* 2017; Moreira *et al.* 2019).

Recent studies are starting to pay attention to trait empathy in design (e.g., Surma-aho, Björklund & Hölttä-Otto 2018; Alzayed *et al.* 2021; Apfelbaum, Sharp & Dong 2021). Hess *et al.* (2017*b*) introduced the Empathy and Care Questionnaire (ECQ), which explores how practicing engineers evaluate 'the importance and existence of empathy and care within the engineering practice' (p. 1132). They concluded that the more experience an engineer has, the more they will perceive the importance and awareness of empathy and care in engineering practice. This result might be explained by failures in engineering education.

The IRI has been used in design research. Designers working in engineering education have measured students' trait empathy aiming at interventions for increasing it. Rasoal, Danielsson & Jungert (2012) compared the four factors of the IRI (Davis 1980) between students from two engineering and four health care profession programmes. When compared to health care students, engineering students tended to have significantly lower scores on the IRI's subscales. As the authors note, this study was based on a self-report questionnaire, thus self-perceived empathic skills could have been overestimated (see Levenson & Ruef 1992; Stueber 2019). No effect sizes were reported, limiting our understanding of the exact magnitude of the differences on the IRI four subscales between the different groups of students. Surma-aho *et al.* (2018) found that students' trait perspective-taking (using the IRI) increased after completing a design thinking course. Contrarily, Alzayed *et al.* (2021) report that students' IRI scores did not change after an 8-week project. Hess *et al.* (2021) explored the effects of an ethics assignment in the ethics-related skills of students of an introductory biomedical engineering course. The students' IRI scores did not differ on their pre–post measures. Others have used simpler approaches such as a 5-point Likert empathic self-efficacy (Raviselvam *et al.* 2017) and looking at innovation categories, and specifically user related innovation (Saunders, Seepersad & Hölttä-Otto 2011).

In practice, designers must perform their tasks irrespective of their trait empathy. However, by knowing the degree of trait empathy an individual designer possesses, we could further explore the success of interventions to 'adjust' their empathy levels at different points in the design process. Additionally, we could investigate which aspects of trait empathy are more relevant for design interventions and accordingly focus on developing such aspects in designers as best as possible.

Even though individuals differ on their trait empathy, state influences suggest that empathic responses can also be affected by specific contexts and situations. These include differences in the interacting individuals' ethnic backgrounds (Avenanti *et al.* 2010), power dynamics (Galinsky *et al.* 2006), and even exposure to fictional narratives (Oatley 2016). State factors have been discussed in design

https://doi.org/10.1017/dsj.2022.13 Published online by Cambridge University Press

literature as well (McDonagh *et al.* 2018). For example, Li & Hölttä-Otto (2020) and Li, Surma-aho & Hölttä-Otto (2021) found that national culture impacts the accuracy of user understanding. We note that state influences can be more or less static. For example, one cannot change the cultural background in which one is born but visiting or living in another culture can help gain certain insight into it (Li *et al.* 2021).

Both trait and state influences on empathy influence the expression of the emotional response. It is interesting that in design the distinction between trait and state empathy is not as prominent as the affective-cognitive empathy distinction. Yet, in practice and implicitly, designers are very familiar with state empathy. Different user-centred and empathy-generating methods aim at bringing the designers' and users' states closer to one another, for example by helping the designer think with similar logic as the user (see sections 'Practical techniques for empathising' and 'Empathy as a process of interaction and reflection'). Such state similarity enables more influential outcomes of empathy, including less stereotypical understanding of users, concern for users, motivation to help the users, and motivation for other mutually beneficial social behaviours towards/with users. Thus, it can be said that design methods create the context through which designers and users attempt at bridging their empathic horizon (McDonagh *et al.* 2018).

In existing literature, designers have not yet investigated methods and frameworks through the lens of state influences, that is, the ways in which specific design methods might support *aligning* aspects of designers' and users' contexts, situations, and values. Doing so could help designers observe their work under a different light and further test the effectiveness of these tools informed by state empathy studies in psychology.

In summary, the awareness of the role of trait empathy is increasing in design. Designers have developed many state interventions, even though the use of the term *state empathy* has not been explicitly used. Incorporating this concept into their practice could open new research possibilities.

5.3. 'Empathic processes are automatically elicited but are also shaped by top-down control processes'

People can be empathic when asked to be. One can adopt the perspective of stigmatised groups (Batson *et al.* 1997*b*; Galinsky & Moskowitz 2000) or to empathise with a person in a sad situation (Rameson *et al.* 2012). Personal motivation influences how empathically one responds to stimuli (Hodges & Wegner 1997). Empathy is under top-down control.

In design, the specific steps for implementing and instructions for using techniques and frameworks that promote empathy are a means for top-down control of empathy, in addition of being means to creating state influences (see Section 5.2). These tools tell the designer what they must do to be empathic. With design processes also involving other forms of thinking, doing, and reasoning, the tools serve as a request for designers to *turn on* their empathic mode. The contextual inquiry method makes a designer 'expand the limits of his or her personal focus and see more in the participant's world' (Hanington & Martin 2019, p. 179), which can be interpreted as a direct request to engage in cognitive empathy to understand users' thoughts. Similarly, cultural probes ask designers to use users' reports as 'inspirational pieces identifying key patterns and themes that

https://doi.org/10.1017/dsj.2022.13 Published online by Cambridge University Press

might emerge from a participant group' (Hanington & Martin 2019, p. 218), again requesting cognitive empathy.

In addition, we propose that designers' purposeful empathising processes of interaction and reflection (i.e., empathy-generating frameworks) aim to bring the designers' and users' states closer to one another through a set of steps and indicators which must be consciously implemented by the designer. This empathy-requesting nature of user-centred design methods and empathy-generating frameworks can further explain how user-centred design methods encourage empathic responses.

In summary, top-down processes are reflected in the instructions and steps that direct the attention of designers towards understanding users (by fostering designers' cognitive and affective empathy). Designers could consider the psychological literature presented in Section 3.4 to explore how to further frame top-down control in empathy in design research.

5.4. 'The resulting emotion is similar to one's perception (directly experienced or imagined) and understanding (cognitive empathy) …'

Cognitive empathy is defined by Shamay-Tsoory (2011) as 'a cognitive role-taking ability, or the capacity to engage in the cognitive process of adoption another's psychological point of view' (p. 18). This capacity is based on conscious processes, where perceivers strive to know what someone else is thinking or feeling (Batson 2009). This can mean, for example, correctly observing reality from someone else's perspective (Baron-Cohen *et al.* 1985), and detecting accidental faux pas (Baron-Cohen *et al.* 1999).

Cognitive empathy in design has been studied using a method called *empathic accuracy* (Levenson & Gottman 1983; Levenson & Gottman 1985; Levenson & Ruef 1992; Ickes 1993; Ickes 2001; Chang-Arana *et al.* 2020; Chang-Arana, Surma-aho *et al.* 2020). Chang-Arana *et al.* (2020) measured empathic accuracy in contextual interviews with five professional musicians. After each interview, musicians were asked to rewatch the interview and report the thoughts and feelings they remembered having had, the exact time when this occurred and whether the thoughts and feelings were positive, neutral or negative. Designers then watched the same interview videos watched by the musicians, which were stopped at the times indicated by the musicians. Designers mean empathic accuracy was 50%. In another study (Chang-Arana, Surma-aho *et al.*, 2020), designers' empathic accuracy was higher when inferring users' mental contents that were design-related in contrast to nondesign-related ones in three different design cases. A later study by Li *et al.* (2021) replicated design relatedness results. In contrast to self-rating questionnaires, empathic accuracy provides a real-time measurement of mutual understanding between two people in a specific context. It avoids social desirability biases of respondents and measures their performance under the influence of a specific context (Ross & Nisbett 2011). However, a link between empathic accuracy and design outcomes has not been found yet.

Empathic understanding (Surma-aho & Hölttä-Otto 2022) is a common goal of empathic methods. This understanding is often cognitive and can result from either experienced (such as those with an embodied component) or imagined user

https://doi.org/10.1017/dsj.2022.13 Published online by Cambridge University Press

experiences. Several methods highlight focus on conscious understanding processes. For example, the Triading method (Hanington & Martin 2019) intends to 'elicit what is important and meaningful to them [*participants*]' (italics are ours, p. 750), and the guidelines to analysing focus group data ask designers to 'revisit the logic participants use' as well as to 'pay particular attention to stories they tell, the metaphors and analogies they use, and how they describe their experiences, preferences, and memories' (p. 380). Since the methods are embedded with world views and epistemologies which influence how designers perform their practice Gray (2022), more attention should be focused to the differences between methods as well as the process of creating them.

In summary, psychology and design agree that understanding from another person's point of view is a key objective of empathising with others.

5.5. '… of the stimulus emotion…'

The triggering event for the empathic process can be any kind of emotional stimulus. These stimuli may be internal, such as imagined, remembered, or inferred; or external to the individual, such as observing someone else, reading a story, or being asked to empathise (Cuff *et al.* 2016). Intervention studies of empathy use a wide range of stimuli, such as dolls acting out fictional scenarios (Baron-Cohen *et al.* 1985), textual descriptions of fictional scenarios (Oatley 2016), photographs of faces depicting emotions (Carr *et al.* 2003; Pfeifer *et al.* 2007), observing actions (Iacoboni *et al.* 1999; Fogassi *et al.* 2005; Schlaug 2008) and pain (Singer *et al.* 2004; Jackson *et al.* 2005). While these stimuli vary in terms of realism and the strength of emotion depicted, such characteristics do not explain the type of empathic response elicited. Even simple photographs of faces can cause both emotions and attempts at understanding in the observer.

User-centred design methods, too, provide several types of emotional stimuli, from direct observation of others' experiences to embodied experiences and prompts for reflection. Embodied experiences include wearable simulations that limit the abilities of the wearer. These methods evoke the experience of completing some physical tasks under restricted conditions, thus inspiring designers to 'engage more closely with user experiences' (Kullman 2016, p. 83), potentially eliciting both emotions and purposeful reflection of the experience. Raviselvam *et al.* (2022) compared designers going through an actual simulation of visual impairment or only being told about the users. The former was better for empathy (and creativity) metrics. This suggests that the form or modality of the stimulus emotion should be considered. Even role-playing a product or service from a user's point of view without wearables can provide designers with emotional stimuli (Medler & Magerko 2010). On the other hand, reflection prompts are provided by various analysis-oriented methods, such as constructing user personas or empathy maps. Persona construction demands designers to describe user groups with similar needs (Miaskiewicz & Kozar 2011), with empathy maps asking designers to describe individual users' mental contents (Both & Baggereor n.d.; Chang-Arana *et al.* 2020), both of which are triggers to think about others' experiences. As such, we can use the concept of emotional stimuli to explain the connection between user-centred design methods and empathic responses.

In summary, the emotional stimuli provided by user-centred design methods partly explain how they encourage empathic responses in designers.

https://doi.org/10.1017/dsj.2022.13 Published online by Cambridge University Press

5.6. '…with recognition that the source of the emotion is not one's own'

The self/other distinction is important in psychology particularly to differentiate empathy from emotional contagion (Sagi & Hoffman 1976; Batson 2009; Christov-Moore *et al.* 2014). In design, recognising that one's emotional response is different from someone else's is well understood (Heylighen & Dong 2019). In practice, we think it reminds designers to differentiate their attitudes towards a product or service from the user's attitudes. The self/other distinction in design requires from the designers to be aware of differences in state influences such as power, cultural background, and demographics, as well as other epistemic distances between users and them.

In summary, the self/other distinction reminds designers to differentiate their attitudes towards a product or service from the user's attitudes.

6. Conclusions, limitations and future work

Empathy is deemed key to obtaining better design outcomes. However, such causality cannot be established as empathy is currently defined. Empathy in design is an umbrella construct, broad and encompassing of diverse phenomena, yet risking becoming an empty concept. To avoid the latter, we looked at empathy in more depth through the lens of psychology. This intersection can provide fruitful research topics and methods that help add rigour to the umbrella concept. We draw the following conclusions:

Research and practice of empathy in design overlaps with key components of empathy. However, design research does not appear to be fully aware of this coincidence. For example, designers are quite experienced with state influences, top-down control processes, and emotional stimuli. These seem to be present in design methods although they have not been studied in such terms. We observe that while design research is well aware of some psychological concepts such as cognitive and affective empathy, some of these others are ignored. These can open interesting avenues for future research. For example, using the understanding from psychology of how to influence and use the state influences could help designers bring the designers' and users' mental states closer together. Further, many empathic design methods incorporate several of the identified concepts, but it is not clear which one(s) of these are the factors that make the method work. For example how much of doing empathic design is due to the top-down control effect of knowingly trying to be empathic and how much of it depends on the other factors such as the type of stimuli or the trait or state influences?

Throughout this article, we propose a myriad of specific ways empathy in design could be thought of. These include design methods as state empathy enhancing techniques, design methods being a form of top-down control, as well as designers' emotional responses supporting their capability to accurately understand others and to view others as humans instead of purely utilitarian entities. However, these should be treated as propositions where the direct link remains unestablished.

Next, we address limitations. Even though we aimed at a thorough revision of relevant literature, it is unfeasible to cover all sources of empathy both in design and psychology. In addition, the selection of our sources, although wide, did not

https://doi.org/10.1017/dsj.2022.13 Published online by Cambridge University Press

follow random sampling. This prevents generalising our conclusions to the empathy literature both in design and psychology.

Our approach to empathy is closer to a positivistic view of science. Thus, we acknowledge that our approach could be criticised from other ways of understanding scientific practice. Yet, we think our attempt to clarify empathy can also inform other epistemologies in design, by inviting us to think of empathy from a different angle.

No perfect match can be made between empathy in design and Cuff et al.'s definition. It is understandable given that these are two different disciplines. Ours is an attempt to create a dialogue between them. However, other readings of our ideas are possible and so drawing different conclusions from ours.

Future works could be more precise on the components they intend to study. The accumulated effort of well-defined empathy studies will build a clearer definition of empathy in design. We hope this piece provides designers and newcomers in the study of empathy some guidance in such a vast task.

Acknowledgment

We would like to thank Jie Li for helping us improve the design of Figure 1.

References

Allison, C., **Baron-Cohen, S.**, **Wheelwright, S. J.**, **Stone, M. H.** & **Muncer, S. J.** 2011 Psychometric analysis of the empathy quotient (EQ). *Personality and Individual Differences* **51** (7), 829–835; doi:10.1016/j.paid.2011.07.005.

Alzayed, M. A., **McComb, C.**, **Menold, J.**, **Huff, J.** & **Miller, S. R.** 2021 Are you feeling me? An exploration of empathy development in engineering design education. . *ASME. Journal of Mechanical Design* **143** (11), 112301; doi:10.1115/1.4048624.

Apfelbaum, M., **Sharp, K.** & **Dong, A.** 2021 Exploring empathy in student design teams. In *International Design Engineering Technical Conferences and Computers and Information in Engineering Conference (Vol. 85406)*, p. V004T04A002. American Society of Mechanical Engineers.

Avenanti, A., **Sirigu, A.** & **Aglioti, S. M.** 2010 Racial bias reduces empathic sensorimotor resonance with other-race pain. *Current Biology* **20**, 1018–1022.

Bal, P. M. & **Veltkamp, M.** 2013 How does fiction reading influence empathy? An experimental investigation on the role of emotional transportation. *PLoS One* **8** (1), e55341; doi:10.1371/journal.pone.0055341.

Ball, L. J. & **Christensen, B. T.** 2019 Advancing an understanding of design cognition and design metacognition: progress and prospects. *Design Studies* **65**, 35–59; doi:10.1016/j.destud.2019.10.003.

Baron-Cohen, S., **Leslie, A. M.** & **Frith, U.** 1985 Does the autistic child have a "theory of mind"? *Cognition* **21** (1), 37–46; doi:10.1016/0010-0277(85)90022-8.

Baron-Cohen, S., **O'Riordan, M.**, **Stone, V.**, **Jones, R.** & **Plaisted, K.** 1999 Recognition of faux pas by normally developing children with Asperger syndrome or high-functioning autism. *Journal of Autism and Developmental Disorders* **29** (5), 407–418; doi:10.1023/A:1023035012436.

Baron-Cohen, S. & **Wheelwright, S.** 2004 The empathy quotient: an investigation of adults with Asperger syndrome or high functioning autism, and normal sex differences. *Journal of Autism and Developmental Disorders* **34**, 163–175.

https://doi.org/10.1017/dsj.2022.13 Published online by Cambridge University Press

Batson, C. D. 2009 These things called empathy: eight related but distinct phenomena. In *The Social Neuroscience of Empathy* (ed. W. J. Ickes & J. D. Jean), pp. 3–15. The MIT Press; doi:10.7551/mitpress/9780262012973.003.0002.

Batson, C. D., **Early, S.** & **Salvarani, G.** 1997a Perspective taking: imagining how another feels versus imagining how you would feel. *Personality and Social Psychology Bulletin* **23**, 751–758.

Batson, C. D., **Eklund, J. H.**, **Chermok, V. L.**, **Hoyt, J. L.** & **Ortiz, B. G.** 2007 An additional antecedent of empathic concern: valuing the welfare of the person in need. *Journal of Personality and Social Psychology* **93**, 65–74; doi:10.1037/0022–3514.93.1.65.

Batson, C. D., **Polycarpou, M. R.**, **Harmon-Jones, E.**, **Imhoff, H. J.**, **Mitchener, E. C.**, **Bednar, L. L.**, **Klein, T. R.** & **Highberger, L.** 1997b Empathy and attitudes: can feeling for a member of a stigmatized group improve feelings toward the group? *Journal of Personality and Social Psychology* **72** (1), 105–118; doi:10.1037/0022-3514.72.1.105.

Battarbee, K. 2004 *Co-experience: understanding user experiences in interaction.* Doctoral Thesis Dissertation, Aalto University, online document, Accessed July 8, 2022 https://aaltodoc.aalto.fi/handle/123456789/11462.

Battarbee, K., **Baerten, N.** & **Hinfelaar, M.** 2002 Pools and satellites: intimacy in the city. In *Proceedings of the Conference on Designing Interactive Systems DIS'00*, pp. 237–245. ACM Press.

Bernhardt B. C. & **Singer, T.** 2012 The neural basis of empathy. *The Annual Review of Neuroscience* **35**, 1–23.

Bird, G. & **Viding, E.** 2014 The self to other model of empathy: providing a new framework for understanding empathy impairments in psychopathy, autism, and alexithymia. *Neuroscience and Biobehavioral Reviews* **47**, 520–532; doi:10.1016/j.neubiorev.2014.09.021.

Both, T. & **Baggereor, D.** (n.d.) *Bootcamp Bootleg* [Online], online document (downloadable on July 15th 2019) https://dschool.stanford.edu/resources/the-bootcamp-bootleg.

Brosch, T. **Pourtois, G.** & **Sander, D.** 2010 The perception and categorisation of emotional stimuli: a review. *Cognition and Emotion* **24** (3), 377–400; doi:10.1080/02699930902975754.

Brown, T. 2009 *Change by Design: How Design Thinking Transforms Organizations and Inspires Innovation*. Harper Business.

Carr, L., **Iacoboni, M.**, **Dubeau, M. C.**, **Mazziotta, J. C.** & **Lenzi, G. L.** 2003 Neural mechanisms of empathy in humans: a relay from neural systems for imitation to limbic areas. *Proceedings of the National Academy of Sciences* **100** (9), 5497–5502; doi:10.1073/pnas.0935845100.

Cash, P. J. 2018 Developing theory-driven design research. *Design Studies* **56**, 84–119; doi:10.1016/j.destud.2018.03.002.

Catherine, N. L. & **Schonert-Reichl, K. A.** 2011 Children's perceptions and comforting strategies to infant crying: relations to age, sex, and empathy-related responding. *The British Journal of Developmental Psychology* **29** (3), 524–551; doi:10.1348/026151010X521475.

Chamorro-Koc, M., **Popovic, V.** & **Emmison, M.** 2008 Using visual representation of concepts to explore users and designers' concepts of everyday products. *Design Studies* **29** (2), 142–159; doi:10.1016/j.destud.2007.12.005.

Chang-Arana, Á.M., **Piispanen, M.**, **Himberg, T.**, **Surma-aho, A.**, **Alho, J.**, **Sams, M.** & **Hölttä-Otto, K**. 2020 Empathic accuracy in design: exploring design outcomes through empathic performance and physiology. *Design Science* **6**, E16; doi:10.1017/dsj.2020.14.

https://doi.org/10.1017/dsj.2022.13 Published online by Cambridge University Press

Chang-Arana, Á. M., **Surma-aho, A.**, **Li, J.**, **Yang, M. C.** & **Hölttä-Otto, K.** 2020 Reading the user's mind: designers show high accuracy in inferring design-related thoughts and feelings. In *ASME 2020 International Design Engineering Technical Conferences IDETC/CIE 2020*. ASME.

Charman, T., **Ruffman, T.** & **Clements, W.** 2002 Is there a gender difference in false belief development? *Social Development* **11** (1), 1–10; doi:10.1111/1467-9507.00183.

Christov-Moore, L., **Sipmson, E. A.**, **Coudé, G.**, **Grigaityte, K.**, **Iacoboni, M.** & **Ferrari, P. F.** 2014 Empathy: gender effects in brain and behaviour. *Neuroscience and Biobehavioral Reviews* **46**, 604–627; doi:10.1016/j.neubiorev.2014.09.001.

Clark, M. A., **Robertson, M. M.** & **Young, S.** 2018 "I feel your pain": a critical review of organizational research on empathy. *Journal of Organizational Behavior* **40**, 166–192; doi:10.1002/job.2348.

Clarke, E., **DeNora, T.** & **Vuoskoski, J.** 2015 Music, empathy and cultural understanding. *Physics of Life Reviews* **15**, 61–88; doi:10.1016/j.plrev.2015.09.001.

Costanza-Chock, S. 2020 *Design Justice*. The MIT Press.

Cuff, B. M. P., **Brown, S. J.**, **Taylor, L.** & **Gowat, D. J.** 2016 Empathy: a review of the concept. *Emotion Review* **8** (2), 144–153; doi: 10.1177/1754073914558466.

Davis, M. H. 1980 A multidimensional approach to individual differences in empathy. *JSAS Catalog of Selected Documents in Psychology* **10**, 85, online document, Accessed July 8, 2022 https://www.uv.es/~friasnav/Davis_1980.pdf.

Davis, M. H. 1996 *Empathy. A Social Psychological Approach*. Westview Press.

Davis, M. H. 2006 Empathy. In *Handbook of the Sociology of Emotions* (ed. J. E. Sets & J. H. Turner), pp. 443–466. Springer.

Den Ouden, E., **Yuan, L.**, **Sonnemans, P. J. M.** & **Brombacher, A. C.** 2006 Quality and reliability problems from a consumer's perspective: an increasing problem overlooked by businesses? *Quality and Reliability Engineering International* **22** (7), 821–838.

Devecchi, A. & **Guerrini, L.** 2017 Empathy and design. a new perspective. *The Design Journal* **20** (1), S4357–S4364; doi:10.1080/14606925.2017.1352932.

Dinar, M., **Shah, J. J.**, **Cagan, J.**, **Leifer, L.**, **Linsey, J.**, **Smith, S. M.** & **Hernandez, N. V.** 2015 Empirical studies of designer thinking: past, present, and future. *Journal of Mechanical Design* **137**, 1–13; doi:10.1115/1.4029025.

Eklund, J., **Andersson-Stråberg, T.** & **Hansen, E. M.** 2009 "I've also experienced loss and fear": effects of prior similar experience on empathy. . *Scandinavian Journal of Psychology* **50**, 65–69.

Ellis, J., **Schroder, H.**, **Patrick, C.** & **Moser, J.** 2017 Emotional reactivity and regulation in individuals with psychopathic traits: evidence for a disconnect between neurophysiology and self-report. *Psychophysiology* **54** (10), 1–12; doi:10.1111/psyp.12903.

Fila, N. D. & **Hess, J. L.** 2014 Exploring the role of empathy in a service-learning design project. *Design Thinking Research Symposium* **10**, 1–22; doi:10.5703/1288284315952.

Fine, C. (2017). Testosterone rex: Myths of sex, science, and society. W. W. *Norton & Company*.

Fogassi, L., **Ferrari, P. F.**, **Gesierich, B.**, **Rozzi, S.**, **Chersi, F.** & **Rizzolatti, G.** 2005 Parietal lobe: from action organization to intention understanding. *Science* **308** (5722), 662–667; doi:10.1126/science.1106138.

Galinsky, A. D., **Magee, J. C.**, **Inesi, M. E.** & **Gruenfeld, D. H.** 2006 Power and perspectives not taken. *Psychological Science* **17** (12), 1068–1074; doi:10.1111/j.1467-9280.2006.01824.x.

https://doi.org/10.1017/dsj.2022.13 Published online by Cambridge University Press

Galinsky, A. D. & **Moskowitz, G. B.** 2000 Perspective-taking: decreasing stereotype expression, stereotype accessibility, and in-group favoritism. *Journal of Personality and Social Psychology* **78** (4), 708–724.

Gray, C. 2022 Languaging design methods. *Design Studies* **78**, 101076; doi:10.1016/j.destud.2021.101076.

Green, M. & **Brock, T. C.** 2000 The role of transportation in the pervasiveness of public narratives. *Journal of Personality and Social Psychology* **79** (5), 701–721; doi:10.1037//0022-3514.79.5.701.

Hanington, B. & **Martin, B.** 2019 *Universal Methods of Design: 125 Ways to Research Complex Problems, Develop Innovative Ideas, and Design Effective Solutions*. Rockport.

Hay, L., **Cash, P.** & **McKilligan, S.** 2020 The future of design cognition analysis. *Design Science* **6**, 1–26; doi:10.1017/dsj.2020.20.

Hayes, S. C., **Levin, M. E.**, **Plumb-Vilardaga, J.**, **Villatte, J. L.** & **Pistorello, J.** 2013 Acceptance and commitment therapy and contextual behavioral science: examining the progress of a distinctive model of behavioral and cognitive therapy. *Behavior Therapy* **44** (2), 180–198; doi:10.1016/j.beth.2009.08.002.

Hess, J. L. & **Fila, N. D.** 2017 Empathy in design: a discourse analysis of industrial co-creation practices. In *Analysing Design Thinking: Studies of Cross-Cultural co-Creation* (ed. B. T. Christensen, L. J. Ball & K. Halskov), pp. 483–498. Taylor & Francis Group.

Hess, J. L., **Miller, S.**, **Higbee, S.**, **Fore, G. A.** & **Wallace, J.** 2021 Empathy and ethical becoming in biomedical engineering education: a mixed methods study of an animal tissue harvesting laboratory. . *Australasian Journal of Engineering Education* **26** (1), 127–137; doi:10.1080/22054952.2020.1796045.

Hess, J. L., **Strobel, J.** & **Brightman, A. O.** (2017a) The development of empathic perspective-taking in an engineering ethics course. *Journal of Engineering Education* **106** (4), 534–563; doi:10.1002/jee.20175.

Hess, J. L., **Strobel, J.**, **Pan, R.** & **Wachter Morris, C. A.** (2017b) Insights from industry: a quantitative analysis of engineers' perceptions of empathy and care within their practice. *European Journal of Engineering Education* **42** (2), 1128–1153; doi:10.1080/03043797.2016.1267717.

Heylighen, A. & **Dong, A.** 2019 To empathise or not to empathise? Empathy and its limits in design. *Design Studies* **65**, 107–124; doi:10.1016/j.destud.2019.10.007.

Hirsch, P. M. & **Levin, D. Z.** 1999 Umbrella advocates versus validity police: a life-cycle model. *Organization Science* **10** (2), 199–212; doi:10.1287/orsc.10.2.199.

Hodges, S. D. & **Wegner, D. M.** 1997 Automatic and controlled empathy. In *Empathic Accuracy* (ed. W. Ickes), pp. 311–340. Guildford Press.

Iacoboni M., **Woods, R. P.**, **Brass, M.**, **Bekkering, H.**, **Mazziotta, J. C.** & **Rizzolatti, G.** 1999 Cortical mechanisms of human imitation. *Science* **286**, 2526–2528; doi:10.1126/science.286.5449.2526.

Ickes, W. (1993). Empathic accuracy. *Journal of Personality*, **61**(4), 587–610. https://doi.org/10.1111/j.1467-6494.1993.tb00783.x.

Ickes, W. 2001 Measuring empathic accuracy. In *Interpersonal Sensitivity: Theory and Measurement* (ed. J. A. Hall & F. J. Bernieri), pp. 219–241. Erlbaum.

Iria, C. & **Barbosa, F.** 2009 Perception of facial expressions of fear: comparative research with criminal and non-criminal psychopaths. *The Journal of Forensic Psychiatry & Psychology* **20** (1), 66–73; doi:10.1080/14789940802214218.

Iria, C., **Barbosa, F.** & **Paixão, R.** 2012 The identification of negative emotions through a go/no-go task comparative research in criminal and non-criminal psychopaths. . *European Psychologist* **17** (4), 291–299; doi:10.1027/1016-9040/a000101.

https://doi.org/10.1017/dsj.2022.13 Published online by Cambridge University Press

Jackson, P. L., **Meltzoff, A. N.** & **Decety, J.** 2005 How do we perceive the pain of others? A window into the neural processes involved in empathy. *NeuroImage* **24**, 771–779; doi: 10.1016/j.neuroimage.2004.09.006.

Joel, D., **Berman, Z.**, **Tavor, I.**, **Wexler, N.**, **Gaber, O.**, **Stein, Y.**, … & **Assaf, Y**. (2015). Sex beyond the genitalia: The human brain mosaic. *Proceedings of the National Academy of Sciences of the United States of America* **112** (50), 15468–15473. https://doi.org/10.1073/pnas.1509654112

Johnson, D. R. 2012 Transportation into a story increases empathy, prosocial behaviour, and perceptual bias toward fearful expressions. *Personality and Individual Differences* **52**, 150–155; doi:10.1016/j.paid.2011.10.005.

Johnson, D. G., **Genco, N.**, **Saunders, M. N.**, **Williams, P.**, **Seepersad, C. C.** & **Hölttä-Otto, K.** 2014 An experimental investigation of the effectiveness of empathic experience design for innovative concept generation. *Journal of Mechanical Design* **136** (5), 051009; doi:10.1115/1.4026951.

Kankainen, A., **Vaajakallio, K. Vesa Kantola, V.** & **Mattelmäki, T.** 2012 Storytelling group – a co-design method for service design. . *Behaviour and Information Technology* **31** (3), 221–230; doi:10.1080/0144929X.2011.563794.

Kazdin, A. E. 2022 *Research Design in Clinical Psychology* (5th ed.). Pearson.

Köppen, E. & **Meinel, C.** 2015 Empathy via design thinking: creation of sense and knowledge. In *Design Thinking Research* (ed. H. Plattner, C. Meinel & L. Leifer), pp. 15–28; doi:10.1007/978-3-319-06823-7_2.

Koskinen, I. & **Battarbee, K.** 2003 Introduction to user experience and empathic design. In *Empathic Design, User Experience in Product Design* (ed. I. Koskinen, K. Battarbee & T. Mattelmkäi), pp. 37–50. IT Press.

Kouprie, M. & **Sleeswijk Visser, F.** 2009 A framework for empathy in design: stepping into and out of the user's life. *Journal of Engineering Design* **20** (5), 437–448; doi: 10.1080/09544820902875033.

Kramer, J., **Agogino, A. M.** & **Roschuni, C.** (2016) Characterizing competencies for human-centered design. In *Proceedings of the ASME 2016 IDETC/CIE*. ASME; doi: 10.1115/DETC2016-60085.

Kramer, A. D. I., **Guillory, J. E.** & **Hancock, J. T.** 2014 Experimental evidence of massive-scale emotional contagion through social networks. *PNAS* **111** (24), 8788–8790; doi: 10.1073/pnas.1320040111.

Kullman, K. 2016 Prototyping bodies: a post-phenomenology of wearable simulations. *Design Studies* **47**, 73–90; doi:10.1016/j.destud.2016.08.004.

Lamm, C., **Meltzoff, A. N.** & **Decety, J.** 2010 How do we empathize with someone who is not like us? A functional magnetic resonance imaging study. *Journal of Cognitive Neuroscience* **22**, 362–376.

Lawrence, E. J., **Shaw, P.**, **Baker, D.**, **Baron-Cohen, S.** & **David, A. S.** 2004 Measuring empathy: reliability and validity of the empathy quotient. *Psychological Medicine* **34**, 911–924; doi:10.1017/S0033291703001624.

Leonard, D. & **Rayport, J. F.** 1997 Spark innovation through empathic design. *Harvard Business Review* **75** (6), 102–113.

Levenson, R. W. & **Gottman, J. M.** (1983) Marital interaction: physiological linkage and affective exchange. *Journal of Personality and Social Psychology* **45** (3), 587–597; doi: 10.1037//0022-3514.45.3.587.

Levenson, R. W. & **Gottman, J. M.** 1985 Physiological and affective predictors of change in relationship satisfaction. *Journal of Personality and Social Psychology* **49** (1), 85–94; doi: 10.1037/0022-3514.49.1.85.

https://doi.org/10.1017/dsj.2022.13 Published online by Cambridge University Press

Levenson, R. W. & **Ruef, A. M.** 1992 Empathy: a physiological substrate. *Journal of Personality and Social Psychology* **63** (2), 234–246; doi: 10.1037//0022-3514.63.2.234.

Li, J. & **Hölttä-Otto, K.** 2020 The influence of designers' cultural differences on the empathic accuracy of user understanding. *The Design Journal* **23** (5), 779–796.

Li, J., **Surma-aho, A.** & **Hölttä-Otto, K.** 2021 Measuring designers' empathic understanding of users by a quick empathic accuracy (QEA). In *International Design Engineering Technical Conferences and Computers and Information in Engineering Conference (Vol. 85420)*, p. V006T06A027. American Society of Mechanical Engineers.

Madsen, S. & **Nielsen, L.** 2010 Exploring persona-scenarios – using storytelling to create design ideas. In *Human Work Interaction Design: Usability in Social, Cultural and Organizational Contexts - Second IFIP WG 13.6 Conference, HWID 2009 Pune, India, October 7–8, 2009*. (ed. D. Kater, R. Orngreen, P. Yammiyavar & T. Clemmensen), pp. 57–66; doi: 10.1007/978-3-642-11762-6_5.

Mattelmäki, T., **Vaajakallio, K.** & **Koskinen, I.** 2014 What happened to empathic design?. *Design Issues* **30** (1), 67–77; doi:10.1162/DESI_a_00249.

McDonagh, D., **Woodcock, A.** & **Iqbal, S.** 2018 *Experience + Experience + Experience = Empathy Design for Health*. Sheffield Hallam University.

Medler, B. & **Magerko, B.** 2010 The implications of improvisational acting and role-playing on design methodologies. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems (CHI '10). Association for Computing Machinery*, pp. 483–492. ACM; doi:10.1145/1753326.1753398.

Miaskiewicz, T. & **Kozar, K. A.** 2011 Personas and user-centered design: how can personas benefit product design processes?. *Design Studies* **32**, 417–430; doi:10.1016/j.destud.2011.03.003.

Michalska, K. J., **Kinzler, K. D.** & **Decety, J.** 2013 Age-related sex differences in explicit measures of empathy do not predict brain responses across childhood and adolescence. *Developmental Cognitive Neuroscience* **3**, 22–32; doi:10.1016/j.dcn.2012.08.001.

Moreira, D., **Azeredo, A.** & **Barbosa, F.** 2019 Neurobiological findings of the psychopathic personality in adults: one century of history. *Aggression and Violent Behavior* **47**, 137–159; doi:10.1016/j.avb.2019.03.005.

Muncer, S. J. & **Ling, J.** 2006 Psychometric analysis of the empathy quotient (EQ) scale. *Personality and Individual Differences* **40** (6), 1111–1119; doi:10.1016/j.paid.2005.09.020.

Neumann, D. L. & **Westbury, H. R.** 2011 The psychophysiological measurement of empathy. In *Psychology of Empathy*, pp. 119–142. Completar.

O'Brien, E., **Konrath, S. H.**, **Grühn, D.** & **Hagen, A. L.** 2013 Empathic concern and perspective taking: linear and quadratic effects of age across the adult life span. *Journals of Gerontology Series B: Psychological Sciences and Social Sciences* **68** (2), 168–175; doi: 10.1093/geronb/gbs055.

Oatley, K. 2016 Fiction: simulation of social worlds. *Trends in Cognitive Sciences* **20** (8), 618–628; doi:10.1016/j.tics.2016.06.002.

Pfeifer, J., **Lieberman, M.** & **Dapretto, M.** 2007 "I know you are but what am I?": neural bases of self-and social knowledge retrieval in children and adults. *Journal of Cognitive Neuroscience* **19** (8), 1323–1337; doi:10.1162/jocn.2007.19.8.1323.

Postma, C. E., **Zwartkruis-Pelgrim, E.**, **Daemen, E.** & **Du, J.** 2012 Challenges of doing empathic design: experiences from industry. *International Journal of Design* **6** (1), 59–70.

Premack, D. & **Woodruff, G.** 1978 Does the chimpanzee have a theory of mind?. *Behavioral and Brain Sciences* **1** (4), 515–526; doi:10.1017/S0140525X00076512.

https://doi.org/10.1017/dsj.2022.13 Published online by Cambridge University Press

Preston, S. D. & **de Waal, F. B. M.** 2002 Empathy: its ultimate and proximate bases. *Behavioral and Brain Sciences* **25**, 1–72; doi:10.1017/S0140525X02000018.

Rameson, L. T., **Morelli, S. A.** & **Lieberman, M. D.** 2012 The neural correlates of empathy: experience, automaticity, and prosocial behaviour. *Journal of Cognitive Neuroscience* **24** (1), 235–245; doi:10.1162/jocn_a_00130.

Rasoal, C., **Danielsson, H.** & **Jungert, T.** 2012 Empathy among students in engineering programmes. *European Journal of Engineering Education* **37** (5), 427–435; doi: 10.1080/03043797.2012.708720.

Raviselvam, S., **Hölttä-Otto, K.** & **Wood, K. L.** 2016 User extreme conditions to enhance designer empathy and creativity: applications using visual impairment. In *International Design Engineering Technical Conferences, August 21–24*. American Society of Mechanical Engineers; doi:10.1115/DETC2016-59602.

Raviselvam, S., **Hwang, D.**, **Camburn, B.**, **Sng, K.**, **Hölttä-Otto, K.** & **Wood, K. L.** 2022 Extreme-user conditions to enhance design creativity and empathy-application using visual impairment. *International Journal of Design Creativity and Innovation* **10**, 1–26; doi:10.1080/21650349.2021.2024093.

Raviselvam, S., **Sanaei, R.**, **Blessing, L.**, **Hölttä-Otto, K.** & **Wood, K. L.** (2017) Demographic factors and their influence on designer creativity and empathy evoked through user extreme conditions. In *Proceedings of the ASME 2017 IDETC/CIE*. ASME; doi: 10.1115/DETC2017-68380.

Rieffe, C., **O'Connor, R.**, **Bülow, A.**, **Willems, D.**, **Hull, L.**, **Sedgewick, F.**, **Stockmann, L.** & **Blijd-Hoogewys, E.** 2021 Quantity and quality of empathic responding by autistic and non-autistic adolescent girls and boys. *Autism* **25** (1), 199–209.

Riemer, M. J. 2004 Incorporating emotional intelligence (EQ) skills into the engineering curriculum to facilitate communication competences. . *World Transactions on Engineering and Technology Education* **3** (2), 231–234; online document, Accessed July 8, 2022 https://www.researchgate.net/profile/Marc_Riemer2/publication/299566551_Incorporating_emotional_intelligence_EQ_skills_into_the_engineering_curriculum_to_facilitate_communication_competences/links/56ffbe6808aee995dde817cd/Incorporating-emotional-intelligence-EQ-skills-into-the-engineering-curriculum-to-facilitate-communication-competences.pdf.

Ross, L. & **Nisbett, R. E.** (2011). The person and the situation: Perspectives of social psychology. U.K.: Pinter & Martin Ltd.

Sagi, A. & **Hoffman, M. L.** 1976 Empathic distress in the newborn. *Developmental Psychology* **12**, 175–176; doi:10.1037/0012-1649.12.2.175.

Salmi, A., **Li, J.** & **Hölttä-Otto, K.** 2022 Facial expression recognition as a measure of user-designer empathy. In *International Design Engineering Technical Conferences and Computers and Information in Engineering Conference IDETC/CIE2022, St. Louis, Missouri*. ASME.

Saunders, M. N., **Seepersad, C. C.** & **Hölttä-Otto, K.** 2011 The characteristics of innovative, mechanical products. *Journal of Mechanical Design* **133** (2), 021009.

Saxe, R. & **Wexler, A.** 2005 Making sense of another mind: the role of the right temporo-parietal junction. *Neuropsychologia* **43**, 1391–1399.

Schlaug, G. 2008 Music, musicians, and brain plasticity. In *Oxford Handbook of Music Psychology* (ed. S. Hallam, I. Cross & M. Thaut), pp. 1–19. Oxford Handbooks Online; doi:10.1093/oxfordhb/9780199298457.013.0018.

Schnell, K., **Bluschke, S.**, **Konradt, B.** & **Walter, H.** 2011 Functional relations of empathy and mentalizing: an fMRI study on the neural basis of cognitive empathy. *NeuroImage* **54**, 1743–1754.

https://doi.org/10.1017/dsj.2022.13 Published online by Cambridge University Press

Scriven, M. 1969 Psychology without a paradigm. In *Clinical-Cognitive Psychology: Models and Integrations* (ed. L. Breger), pp. 9–24. Prentice-Hall.

Shamay-Tsoory, S. G. 2009 Empathic processing: its cognitive and affective dimensions and neuroanatomical basis. In *The Social Neuroscience of Empathy* (ed. J. Decety & W. Ickes), pp. 215–232. MIT Press; doi:10.7551/mitpress/9780262012973.003.0017.

Shamay-Tsoory, S. G. 2011 The neural bases for empathy. *The Neuroscientist* **17** (1), 18–24; doi:10.1177/1073858410379268.

Shamay-Tsoory, S. G. & **Aharon-Peretz, J.** 2007 Dissociable prefrontal networks for cognitive and affective theory of mind: a lesion study. *Neuropsychologia* **45**, 3054–3067; doi:10.1016/j.neuropsychologia.2007.05.02.

Singer, T. & **Lamm, C.** 2009 The social neuroscience of empathy. The year in Cognitive Neuroscience 2009. *Annals of the New York Academy of Sciences* **1156** (200), 81–96.

Singer, T., **Seymour, B.**, **O'doherty, J.**, **Kaube, H.**, **Dolan, R. J.** & **Frith, C. D.** 2004 Empathy for pain involves the affective but not sensory components of pain. *Science* **303** (5661), 1157–1162.

Smeenk, W., **Sturm, J.** & **Eggen, B.** 2017 Empathic handover: how would you feel? handing over dementia experiences and feelings in empathic co-design. *CoDesign* **14**, 259–274; doi:10.1080/15710882.2017.1301960.

Smeenk, W., **Sturm, J.** & **Eggen, B.** (2019a) A comparison of existing frameworks leading to an empathic formation compass for co-design. *International Journal of Design* **13** (3), 53–68, online document, Accessed July 8, 2022 http://www.ijdesign.org/index.php/IJDesign/article/view/3406.

Smeenk, W., **Sturm, J.**, **Terken, J.** & **Eggen, B.** (2019b) A systematic validation of the empathic handover approach guided by five factors that foster empathy in design. *CoDesign* **15** (4), 308–328; doi:10.1080/15710882.2018.1484490.

Smirnov, D., **Saarimkäi, H.**, **Glerean, E. R.**, **Hari, R.**, **Sams, M.** & **Nummenmaa, L.** 2019 Emotions amplify speaker-listener neural alignment. *Human Brain Mapping* **40** (16), 4777–4788; doi:10.1002/hbm.24736.

Soto, J. A. & **Levenson, R. W.** 2009 Emotion recognition across cultures: the influence of ethnicity on empathic accuracy and physiological linkage. *Emotion* **9** (6), 874–884; doi: 10.1037/a0017399.

Spreng, R. N., **McKinnon, M. C.**, **Mar, R. A.** & **Levine, B.** 2009 The Toronto empathy questionnaire: scale development and initial validation of a factor-analytic solution to multiple empathy measures. *Journal of Personality Assessment* **91** (1), 62–71; doi: 10.1080/00223890802484381.

Stone, V. E., **Baron-Cohen, S.** & **Knight, R. T.** 1998 Frontal lobe contributions to theory of mind. *Journal of Cognitive Neuroscience* **10** (5), 640–656; doi:10.1162/089892998562942.

Stueber, K. 2019 Empathy. In *The Stanford Encyclopedia of Philosophy* (ed. E. N. Zalta) [Online], online document, Accessed July 8, 2022 https://plato.stanford.edu/archives/fall2019/entries/empathy/.

Surma-aho, A., **Björklund, T.** & **Hölttä-Otto, K.**. (2018) Assessing the development of empathy and innovation attitudes in a project-based design thinking course. In *Research Presented at the ASEE Annual Conference and Exposition, Salt Lake City, Utah*. ASEE, online document, Accessed July 8, 2022 https://www.asee.org/public/conferences/106/papers/21511/view.

Surma-aho, A. & **Hölttä-Otto, K.** 2022 Conceptualization and operationalization of empathy in design research. *Design Studies* **78**, 101075; doi:10.1016/j.destud.2021.101075.

https://doi.org/10.1017/dsj.2022.13 Published online by Cambridge University Press

Taffe, S. 2015 The hybrid designer/end-user: revealing paradoxes in co-design. *Design Studies* **40**, 39–59; doi:10.1016/j.destud.2015.06.003.

Takahashi, I., **Oki, M.**, **Bourreau, B.**, **Kitahara, I.** & **Suzuki, K.** 2018 An empathic design approach to an augmented gymnasium in a special needs school setting. *International Journal of Design* **12** (3), 111–125.

Tear, M. J. & **Nielsen, M.** 2013 Failure to demonstrate that playing violent video games diminishes prosocial behavior. . *PLoS One* **8** (7), e68682; doi:10.1371/journal.pone.0068382.

Walther, J., **Miller, S. E.** & **Sochacka, N. W.** 2017 A model of empathy in engineering as a core skill, practice orientation, and professional way of being. *Journal of Engineering Education* **106** (1), 123–148; doi:10.1002/jee.20159.

Zaki, J. & **Ochsner, K.** 2012 The neuroscience of empathy: progress, pitfalls and promise. *Nature Neuroscience* **15**, 675–680; doi:10.1038/nn.3085.

Zaki, J., **Weber, J.**, **Bolger, N.** & **Ochsner, K. N.** 2009 The neural basis of empathic accuracy. *Proceedings of the National Academy of Sciences of the United States of America* **106** (27), 11382–11387; doi:10.1073/pnas.0902666106.

https://doi.org/10.1017/dsj.2022.13 Published online by Cambridge University Press