Design Science

Does mimicry predict or facilitate empathy: the interplay between empathic understanding and verbal mimicry during user interviews

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Abstract

Empathy is essential in understanding the user's experience. However, the relationship between the different empathy constructs, such as empathic mental processes and empathic understanding (EU), remains unclear. Therefore, in this study, we explore EU from both the designer's and the user's perspectives and how it relates to empathic mental processes. Specifically, we investigate the relationship between the user's perceived empathic understanding (PEU) and the designer's actual EU. We also examine the role of mental processes, specifically verbal mimicry, measured as Language Style Matching (LSM), in developing EU during interviews. The results show a relationship between PEU and EU, but no correlation between verbal mimicry and either perceived or actual EU. However, our results show that verbal mimicry indicates the user's expressiveness during the conversation, which may facilitate the relationship between PEU and EU. We find that when both mimicry is high and the user perceives the designer as empathic, the designer's EU is almost always high, and vice versa; however, this is less predictable in interviews with low mimicry. We conclude that treating empathic mental processes as a prerequisite for developing and attaining EU might be more useful than investigating a relationship.

Keywords: Empathic understanding, Verbal mimicry, Mental processes, Perceived understanding, User interviews

Received 15 November 2025 UTC
Revised 03 July 2026 UTC
Accepted 31 July 2026 UTC

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Des. Sci., vol. 12, e30
journals.cambridge.org/dsj
DOI: 10.1017/dsj.2026.10079

1. Introduction

User understanding is an important aspect of the design process (Sanders 2002). This extends beyond simply understanding what the user is saying or doing to encompass more implicit components, such as understanding the user's experiences, feelings and thoughts. The goal of empathic design is to gain user understanding (Sanders 2002; Surma-Aho & Hölttä-Otto 2022). Kouprie & Visser (2009) describe it as getting close to the user's lived experiences to ensure the product or service meets the user's needs. Engineering design aims to properly formulate a problem to create an appropriate solution. However, the design process begins with an ambiguously defined problem (Cross 1994). In the beginning, it is important to correctly understand the problem. Strong user focus is essential in this phase. A product's success or failure can be determined by the early stages of the design

https://doi.org/10.1017/dsj.2026.10079 Published online by Cambridge University Press

process. Therefore, user understanding is the first step in defining the design problem (Otto & Wood 2001). The development of empathy in the design process is crucial for accurately understanding users.

1.1. Empathy and design research

Empathy is a complex concept. It has been described as multidimensional without a universally agreed-upon definition or concept (Chang-Arana *et al.* 2022). The concept of empathy has been studied for over a century in various disciplines. Specifically, disciplines like psychology (Hogan 1969), psychotherapy (Rogers 1957) and neuroscience (Decety & Jackson 2004; Singer *et al.* 2004) have investigated the concept and its significance. Several researchers have presented perspectives and frameworks to understand the formation of empathy. This includes empathy as a shared representation between others and self (Decety & Sommerville 2004). This perspective describes empathy as the perception of an action automatically activating the perceiver's own mental representation of the same (Jeannerod 1999; Decety & Sommerville 2004; Singer *et al.* 2004).

The level of subjectivity and ambiguity associated with the term 'empathy' has led researchers to describe it as an 'umbrella term' (Chang-Arana *et al.* 2022). Empathy research has resulted in variations of definitions for empathy, including understanding another person's internal state (Wispé 1986; Ickes 1993; Preston & De Waal 2002), matching the observed neural response (Meltzoff & Moore 1997; Dimberg, Thunberg, & Elmehed 2000; Hoffman, 2012), feeling the same emotions (Damasio 2003; Decety & Chaminade 2003) and imagining how another person is thinking or feeling (Ruby & Decety 2004). The definition of empathy has taken various forms (Preston & De Waal 2002), and there are as many definitions as there are researchers on empathy (Sora-Domenjó 2022). This highlights the complexity connected with conceptualising empathy. To summarise the diverse concepts, previous literature classified empathy broadly into two concepts: cognitive and affective (Cuff *et al.* 2016). However, researchers still believe that these sub-classifications of empathy are interwoven and interconnected, making a clear-cut distinction difficult (Gonzalez-Liencres, Shamay-Tsoory, & Brüne 2013). The attempt to conceptualise empathy based on a streamlined design focus and user understanding, has been employed in several design areas, including design education (Hess & Fila 2016), product development (Kouprie & Visser 2009) and empathic design (Dong, Donglong, & Yuan 2018; Chang-Arana *et al.* 2022; Surma-Aho & Hölttä-Otto 2022). To better understand empathy and its relationships, Surma-Aho & Hölttä-Otto (2022) presented different constructs of empathy, their conceptualisation and operationalisation. They presented five major constructs. This includes external empathic knowledge constructs (*empathic design action [construct i] and research [construct ii]) and internal constructs (empathic mental processes [construct iii] and empathic orientation [construct iv]*). They both lead to empathic understanding [EU; *construct v*]. Figure 1 shows the relationship between the constructs, highlighting those used in this study with their operationalisation in white text. Therefore, in this study, we define empathy as EU. That is, the degree of insight accuracy (understanding of experiences, feelings and thoughts) the designer gains during a user interview.

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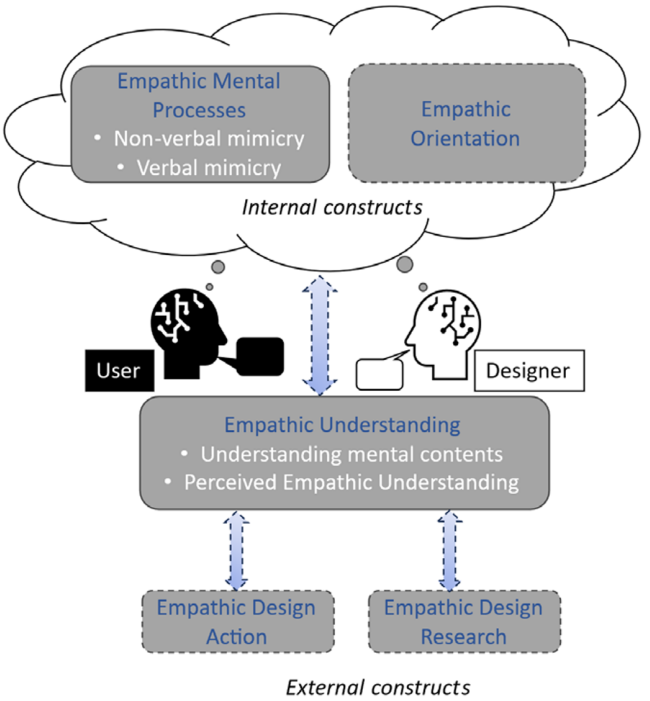


Figure 1. Different constructs of empathy with specific highlights (their operationalisation in white text) on those used in this study.

Similar to other areas of design research, there are arguments as to which is more important: theory development (Cash 2018) or pragmatic (Koskinen *et al.* 2013) research. Consequently, there is no single agreed-upon theory of empathy in design research. However, empathy in design research has been focused on understanding the user to inform the development of a product or service (Surma-Aho & Hölttä-Otto 2022). The importance of empathy in design practice and research has been shown in case studies (Postma *et al.* 2012; Drouet, Visser, & Lallemand 2023), and it has been implemented as a tool in design research via various approaches, including empathic design (Mcdonagh 2004; Van Rijn *et al.* 2011; Mcdonagh, Woodcock, & Iqbal 2018), user participation (Smeenk, Sturm, & Eggen 2018) and user simulation (Raviselvam, Hölttä-Otto, & Wood 2016). Furthermore, researchers have investigated how the different constructs relate to each other (Chang-Arana *et al.* 2020a; Salmi, Li, & Holtta-Otto 2023; Fabunmi, Halgamuge, & Holtta-Otto 2025). Specifically, how external and internal constructs relate to EU, and how empathy can be measured in design research or practice.

Research shows empathy is important to design research and practice. However, it remains unclear which empathy construct is most important for gaining accurate user understanding (EU). There is therefore a need to empirically validate the relationships among empathy constructs such as empathic mental processes, empathic orientation and EU.

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1.2. Relationship between empathic mental processes and empathic understanding

Research has explored empathic mental processes and EU constructs to investigate both automatic means to measure of empathy and the relationships among the empathy constructs. Empathic mental processes focus on what goes on inside the observer's mind when understanding another person's experience, feelings or thoughts (Surma-Aho & Hölttä-Otto 2022). This has been widely explored in neuroscience, psychology and psychotherapy to explain empathy and its processes. Several theories have been presented, such as psycholinguistic theories like the communication accommodation theory (Giles & Ogay 2007; Dragojevic, Gasiorek, & Giles 2016) and shared representation theories (Decety & Sommerville 2004; Singer *et al.* 2004) like the perception and action model theory (De Waal & Preston 2017) and theory of the mind (Premack & Woodruff 1978).

Design research on empathic mental processes (Chang-Arana *et al.* 2020a; Salmi *et al.* 2023; Fabunmi *et al.* 2025) has investigated its relationship with EU, operationalising mental processes as either non-verbal or verbal mimicry, or synchrony. Non-verbal mimicry or synchrony can be related to shared representation (De Waal & Preston 2017), while verbal mimicry is related to psycholinguistic theory (Dragojevic *et al.* 2016). Non-verbal mimicry is more commonly employed in design research, using measures such as skin conductance, electromyography and facial mimicry. For example, Chang-Arana *et al.* (2020a) investigated the relationship between physiological synchrony (skin conductance) between the designer and the user during a user interview and the designer's EU, measured as empathic accuracy (EA; Ickes 1993). Also, to implement a less instrument-heavy empathic mental process measure, Salmi *et al.* (2023) used automatic facial mimicry, a measure of non-verbal mimicry, to study the relationship between empathic mental processes and EU (EA).

Investigating verbal mimicry as an operationalisation of empathic mental processes was also explored by Fabunmi *et al.* (2025). They employed verbal mimicry, measured as language style matching (LSM), to evaluate empathic mental processes and their relationship to EU (specifically, EA). LSM is related to shared feelings, a measure of empathic mental processes (Surma-Aho & Hölttä-Otto 2022). As such, it provides insight into the degree of synchrony between speakers' psychological states. In the growing body of research, LSM is used as an approach to interpersonal coordination of language styles (Müller-Frommeyer & Kauffeld 2022). It is a dyadic construct grounded in the fact that people who align in their language styles exhibit psychological harmony (Niederhoffer & Pennebaker 2002; Ireland *et al.* 2011). Prior research also suggests that the similarity in the use of function words indicates the state of the relationship between people (Niederhoffer & Pennebaker 2002; Ireland & Henderson 2014; Kovacs & Kleinbaum 2020).

These studies assumed that the constructs of empathy are related but they did not find a significant correlation between empathic mental processes (verbal or nonverbal mimicry or synchrony) and EU. Previous literature from other disciplines has reported that empathic mental processes play a role in empathy formation (Kleinbub 2017) and may be related to understanding. Koole and Koole & Tschacher (2016) posit that movement synchrony between the therapist and patient may improve shared emotional experience and common understanding. Several researchers have also reported a relationship between skin concordance

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synchrony and patients' perceived empathic understanding (PEU; Marci & Orr 2006; Marci *et al.* 2007; Messina *et al.* 2013). It is important to note that the measures used in these studies differ from those in design research. However, the concept of empathy impacting dyad interaction outcomes is relatable to design research.

1.3. The focus of empathy in design research: designer vs user focus

Design research on empathy has predominantly focused on the designer. Previous studies (Heylighen & Dong 2019; Chang-Arana *et al.* 2022) have addressed the user only within the context of ethics. Focusing on the designer is essential in design, as empathic design aims to improve the designer's skill and understanding for better design outcomes (Kouprie & Visser 2009). Interestingly, even though the user's perspective is shown to be important in user-centred and participatory design (Steen, Manschot, & De Koning 2011; Trischler *et al.* 2018), it has been seldom investigated as part of empathy research. Specifically, how much empathy does the user perceive the designer has towards them, and how that perception impacts the designer's EU during the interview.

1.3.1. User's perceived empathy

User's perceived empathy has not been directly studied in design, but studies in psychotherapy (Watson 2002; Marci *et al.* 2007; Elliott *et al.* 2011) have explored the user's perception in the context of studying therapist empathy and its relation to therapeutic outcomes (Olson 1995). Specifically, they investigated the client's or patient's perception as 'perceived empathy'. This is defined as how well the patient or client perceives the interviewer or therapist to understand them during the discussion. Previous research has investigated how perceived empathy relates to actual or expressed empathy. For example, studies (Olson 1995; Olson & Hanchett 1997) found a relationship between patients' perceived empathy and the nurse's expressed empathy. Chui, Li, & Luk (2022) also found a relationship between perceived empathy and therapist-client emotional congruence. Additionally, previous research (Chu & Tseng 2013) found that high perceived empathy improves the patient's efficiency of understanding preoperative information. Perceived empathy has been investigated in relation to other patient-interaction outcomes, beyond empathy or understanding, in several studies (Elliott *et al.* 2018).

Several instruments have been developed to measure perceived empathy in psychotherapy, including Barrett-Lennard Relationship Inventory (BLRI) (Barrett-Lennard 1962), Jefferson Scale of Patient Perceptions of Physician Empathy (Kane *et al.* 2007) and Therapist Bond Scale (Saunders, Howard, & Orlinsky 1989). The BLRI scale is the most used for clients' perceived empathy. This instrument was specifically designed for interpersonal relationships based on Rogers' theory that a client's psychological adjustment depends on the extent to which the person has had a relationship with another person who is seen as being unconditionally positive, empathic and congruent (Rogers 1957).

The above theoretical foundation for investigating PEU can be adapted to design research. Even though it was developed for therapeutic settings, the conditions are adaptable to design research, where the designer's ability to perceive the

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user's internal frame of reference (thoughts, feelings and experiences) is key to identifying latent needs (Chang-Arana *et al.* 2020b). Also, the user's perception of the designer is essential to the user's disposition during the interview. Despite studies showing that the client's PEU plays a role in the therapist's or interviewer's empathy and in the outcomes of interviews or interactions, the user's perceived empathy (PEU) has not been investigated in design research or practice.

1.3.2. Designer's empathic understanding

For the designer-focused empathy measures, previous studies have quantified empathy (EU) using both EA (the designer's accuracy in guessing the user's thoughts and feelings) (Ickes 1993; Salmi *et al.* 2023; Fabunmi *et al.* 2025) and portions of the empathy map (the user-evaluated designer's insight gained during the user interview) (Gray, Brown, & Macanufo 2010; Chang-Arana *et al.* 2020a).

EA is a behavioural empathy measure that addresses the subjective bias inherent in most empathy measures by changing how empathy is assessed. It quantifies the designer's empathy as their performance on empathic tasks (for example, inferring thoughts and feelings). This operationalisation limits its application in research and practice (Fabunmi *et al.* 2024a). Importantly, EA has equipped design research to understand what affects the designer's EU (Chang-Arana *et al.* 2020a; Li *et al.* 2021). However, the time required, the human labour involved and operationalisation limitations in practice and research are current shortcomings of the measures.

In contrast, the empathy map is a tool that helps quickly understand targets (users). It helps to easily develop concepts specific to the target (Gray *et al.* 2010), which is an essential initial stage in new product development (Sinansari *et al.* 2023). Bratsberg (2012) described empathy map as a user-centric approach that focuses on understanding a person by looking at the world or situation through their eyes. The instrument contains the see, hear, say-and-do and think-and-feel elements. The think-and-feel components specifically map onto the empathy-measure concepts in psychology and psychotherapy. This dimension is similar to Ickes (1993) EA measure, which employs the user's or client's thoughts and feelings. However, the subjective bias that accompanies the evaluation of the empathy map (user-assessed) in design research presents its own limitations.

It is important to explore what we can learn by studying the user's PEU, since we have elsewhere learned that it plays a role in empathy formation and outcomes.

1.4. Research questions

In this study, we explore the previously found lack of relationship between the two constructs of empathy, empathic mental processes and EU, by investigating three components: empathic mental processes, PEU and actual EU. Specifically, we examine whether empathic mental processes and EU are distinct but interconnected. The former may not directly correlate with the latter, but could play a crucial role in attaining it. Furthermore, building on prior psychotherapeutic studies on perceived empathy and its relationship to outcomes, we believe it would be beneficial to investigate empathy from the user's perspective, including what empathic mental processes entail and their role in achieving actual EU.

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Additionally, the investigation of the user's perceived empathy and the designer's actual EU during the user interview has not been studied. We hypothesise that the user's perceived empathy during the interview will be related to the designer's actual EU of the user's experiences, thoughts and feelings. We also hypothesise that empathic mental processes, measured as mimicry between the designer and the user during an interview, will affect the designer's understanding of the user. Additionally, building on the lack of a relationship reported in previous research on empathic mental processes and EU, we hypothesise that empathic mental processes may play a crucial role in the designer's ability to attain accurate EU, even though previous studies have shown no relationship between them.

To investigate the relationship between perceived and actual EU, and the role of empathic mental processes, such as mimicry, in such relationships, this study aims to answer the following research questions:

RQ1: Does the user's perceived empathic understanding (PEU) during the interview relate to the designer's actual empathic understanding (EU)?

RQ2: What do empathic mental processes indicate during a user interview?

RQ3: Do empathic mental processes, measured as verbal mimicry, correlate with empathic understanding (user's perceived and designer's actual understanding)?

RQ4: Do empathic mental processes mediate or moderate empathic understanding during user interviews?

2. Methodology

2.1. Experimental design

The data used in this study were obtained from a semi-structured user interview focused on designing an easily repairable cooking device to improve the cooking experience. We added repairability functionalities to the device's specifications. This is because we are also keen on understanding the user's experience with repairing products and how this can inform our design decisions. While data on specific user needs were collected during the interviews, they are outside the scope of the present analysis. The current study focuses exclusively on the relationships among empathy constructs between the designer and the user. The user-needs data were collected to support a separate, longitudinal investigation into how empathy translates into better design outcomes. A cooking device was chosen as our focus due to the complexity and differences that arise from various cooking styles, cultures and personalities. Therefore, designing a product for such a complex scenario requires the designer to understand the user's experience beyond the obvious (that is, what the user says or does). This scenario exemplifies a problem where empathic design is a good fit. This is a typical scenario for most design problems in the real world. As designers, we are expected to create a single product that caters for a diverse group of customers with varied experiences, cultures, personalities and needs.

Figure 2 shows the data analysis process carried out in this study. The data collected from the various measures administered following the interview were preprocessed prior to analysis. This is discussed in further detail in this chapter.

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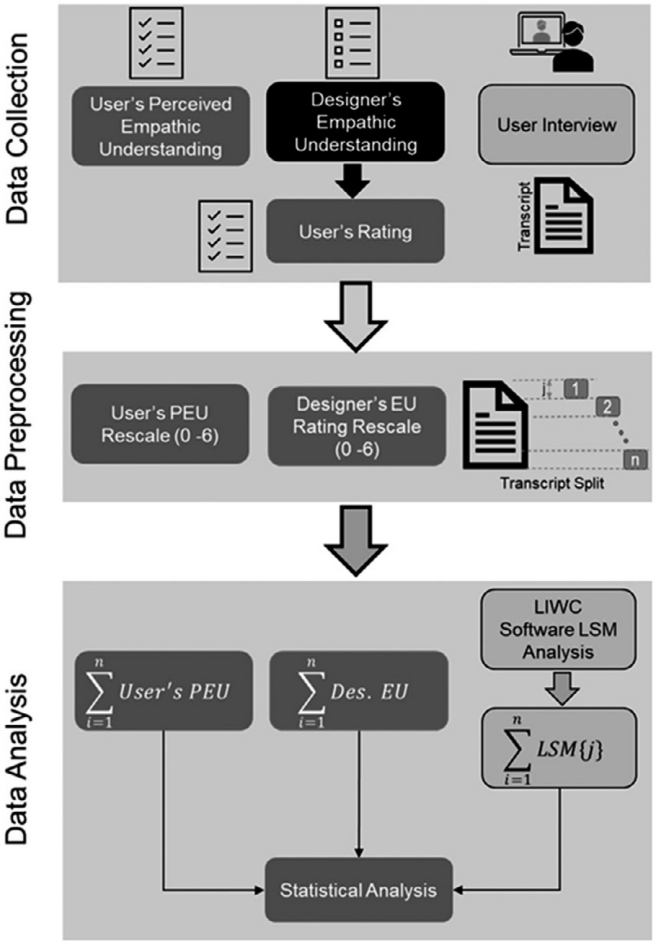


Figure 2. Data analysis flow chart used in the current study.

2.1.1. Participants

A dyadic research design was employed, with 88 user interviews conducted by four designers. Participants were required to be at least 18 years old and possess a basic level of English fluency. Aside from this, there were no other restrictions relating to gender or nationality. The participant group includes 50 females and 38 males. The study included 31 Nigerians,14 Chinese, 13 Indonesians and 7 Indian individuals, while the remaining participants were from Australia, Vietnam, Hong Kong, Singapore, Sri Lanka and other nationalities. Participants resided in Australia (67) or Nigeria (21) at the time of this study. The demographic characteristics of the participants are shown in Table 1. The reason for the difference in user base was to account for extreme variations in culture and user context in our study. The procedures followed for this study were approved by the University of Melbourne ethics committee. Each participant was also compensated for their time.

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Table 1. Demographic characteristics of participants ($N = 88$)

Demographics	Groups	n (%)
Age	18–24	31 (35.2)
	25–31	39 (44.3)
	Above 32	18 (20.5)
Gender	Female	50 (56.8)
	Male	38 (43.2)
Nationality	Nigeria	31 (35.2)
	Chinese	14 (15.9)
	Indonesia	13 (14.8)
	India	7 (8.0)
	Australian	4 (4.5)
	Vietnam	4 (4.5)
	Hong Kong	3 (3.4)
	Others	12 (13.7)
Current Location	Australia	67 (76.1)
	Nigeria	21 (23.9)

Note. 'Others' include participants from Bangladesh, Brunei Darussalam, Ethiopia, Finland, India, Iran, Malaysia, Philippines, Singapore and Sri Lanka.

2.1.2. Interview

Users were interviewed via Zoom to ensure consistency in the meeting platform, given the geographic differences among participants. Each user interview lasted about 20–30 minutes. The session began with general discussions about cooking, followed by three cooking scenarios to help the designer understand the user's experience when cooking alone, cooking with someone and using a cooking device. Finally, repair-related questions were asked to help designers understand the user's repair experiences and challenges (see Appendix A).

Immediately after the interview, as shown in Figure 2, the users were given a user-PEU questionnaire (see Section 2.2.1) to complete, evaluating their perception of the designer's EU during the interview. The designer was also given an EU task to record the thoughts and feelings quadrant of the empathy map, listing the thoughts and feelings they perceived the user had during the interview. The filled 'think-and-feel' sub-task of the empathy map was then returned to the user as a survey to evaluate how accurate each thought and feeling was about them during the interview.

2.2. Data analysis

Three participants were removed from the analysis because they did not complete the empathy map (think-and-feel) evaluation tasks. This study examined how users' PEU during the interview relates to the designer's EU after participating in the interview. We also investigated the empathic mental process construct of

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empathy, examining not only its relationship but also its role during a user interview. Investigating this will provide a broader perspective on factors that influence the designer's EU of the user, extending beyond a designer-centred view.

To answer RQ1, two different metrics were used to measure the EU during the interview. The user's PEU BLRI EU Sub-scale) and the designer's EU (empathy map (think-and-feel) sub-scale).

2.2.1. Perceived empathic understanding (Barrett-Lennard Relationship Inventory (BLRI) Empathic Understanding Sub-scale)

The user's PEU was measured with the person-centred empathy measure approach using the BLRI EU Sub-scale (Barrett-Lennard 1962). BLRI is a 64-question four-themed self-report questionnaire used to measure the client's experience or perception of the relationship during therapy. The four sub-scales are, namely, Empathic Understanding, which is the therapist's ability to understand the client's experiences and feelings at the moment. The Unconditionality and Level of Regard were derived from Rogers' idea of unconditional positive regard, and Congruence, which is the therapist's genuineness, openness and authenticity during the interactions. This instrument is widely used in psychotherapy research due to several advantages, including being client-centred, easy to use and cheap to implement (Simmons *et al.* 1995; Chu & Tseng 2013). The BLRI scale has good validity and reliability (r = .64 to .92), and shows good agreement between experts and non-experts, construct validity and predictive validity (Barrett-Lennard 1962; Yu & Kirk 2009). Studies have also shown that the measure has a very good internal consistency (0.84) for empathy (Gurman 1977; Barrett-Lennard 2015). In addition to the advantages of this measure, despite the shortcomings of self-report metrics, we used the EU sub-scale in this study because its definition closely aligns with the design-specific conceptualisation of EU by Surma-Aho & Hölttä-Otto (2022). They described EU as 'a comprehensive understanding of others' experience', therefore giving it a design-specific theoretical background. In this study, the sub-scale is used to assess the user's PEU during an interview session. This is the user's subjective experience of the interaction.

This approach has been used in previous studies to measure clients' perceived empathy (Kurtz and Kurtz & Grummon 1972, Marci & Orr 2006, Mallonee, Petros, & Solomon 2022, Elliott *et al.* 2018, Olson & Hanchett 1997) and investigate the relationship with other empathy constructs (synchrony and expressed empathy) and with outcomes. The questions were rephrased with reference to the interviewer during the user interview, similar to the study by Marci & Orr (2006) investigating the impact of emotional distance on psychophysiological concordance between the dyads and patients' perceived empathy and Mallonee *et al.* (2022), who investigated how clients' perceived therapeutic alliance, empathy and coercion relate to engagement. This 16-item EU sub-scale is employed to measure the user's perception of the designer's understanding of their experiences, thoughts and feelings (see Appendix B). This is described as PEU in this study.

After the interview, the user's PEU questionnaire was administered (as shown in Figure 2). Each question was accompanied by a Likert scale ranging from +3 (strong agreement) to −3 (strong disagreement), capturing the valence and intensity of users' perceptions. The original BLRI EU sub-scale employs a forced-choice format that excludes a neutral midpoint (i.e., −3 to +3 without 0). In the

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present study, this scale was adapted to include a midpoint (0), resulting in a 7-point Likert scale. This modification was motivated by the contextual differences between psychotherapeutic and design research studies. The former involves longer, longitudinal interviews that are more person-centred and always personalised. While the latter involves shorter interviews (between 20 and 30 minutes), it is more problem-focused and may not be personalised. Therefore, we used a full Likert scale rather than forcing the user to choose between 'yes' and 'no'. There is also a high chance that the interview duration and topic discussed (product-centred) might not be sufficient for the user to answer some of the questions genuinely. Under such conditions, participants may reasonably hold neutral or uncertain perceptions and forcing a positive or negative response could introduce measurement bias.

Importantly, prior studies have adapted the BLRI response format to suit different research contexts without compromising reliability. For example, Mallonee *et al.* (2022) employed a 6-point Likert scale, while Chu & Tseng (2013) used a 5-point Likert scale including a neutral midpoint. These adaptations suggest that the BLRI EU sub-scale is flexible and can be contextually modified while preserving its measurement properties. To ensure that the inclusion of a neutral midpoint did not compromise reliability, internal consistency was assessed using Cronbach's alpha. The PEU measured by the BLRI EU sub-scale demonstrated an acceptable reliability ($\alpha = 0.75$). Additionally, analysis of response patterns showed that the midpoint was selected in a relatively small proportion of responses (approximately 13%), indicating that participants did not disproportionately rely on the neutral option. Responses remained distributed across the scale, suggesting that the inclusion of the midpoint did not introduce central tendency bias. Additionally, sensitivity analysis was conducted by removing the data with at least one midpoint entry, and the internal consistency did not improve. This shows that the midpoint entries were not random or noisy but rather represent meaningful user evaluations.

While prior studies in psychotherapeutic contexts report higher reliability values (0.80–0.91) (Gurman 1977; Mallonee *et al.* 2022), such settings typically involve longer, more personalised and longitudinal interaction designs that create opportunities for relationship dynamics to grow and mature, thereby leading to more consistent responses. In contrast, the present study reflects a shorter, task-oriented context in which greater response variability is expected. Furthermore, the study design allows the questionnaire to capture immediate and state-level relational dynamics rather than trait-level dynamics that develop over the course of enduring relationships. This difference in design structure may account for the lower reliability score relative to the longitudinal therapeutic literature. However, it accurately mirrors the ideal nature of real-world interactions between a designer and a user. Overall, these findings indicate that the modified scale maintains acceptable reliability and remains appropriate for measuring PEU in design research settings.

For analysis, the ratings for each of the 16 questions were averaged to obtain the user's PEU score. For the questions with expected positive scores, the responses were not rescaled before averaging. In contrast, for those with expected negative scores, the responses were rescaled to -3 to $+3$; a lower score means a higher perceived empathy. For example, question 6, '*Sometimes, the interviewer thinks that I feel a certain way because they feel that way*'. The designer is supposed to understand the user's feelings and not project their own. Therefore, the lower the

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score for this question, the better the user perceives the designer's EU towards them. It is essential to note that this rescaling was performed solely for the purpose of analysis. It is also important to note that, to avoid any misconception, we converted the scale to a non-negative scale for analysis only. The −3 to +3 scale was mapped to a 0–6 scale, and vice versa, for all analysis and calculations in this study.

2.2.2. Designer's empathic understanding (empathy map)

We measure the designer's understanding as the insight gained into the user's experiences, feelings and thoughts regarding the easily repairable cooking device. EA (Ickes 1993) research in design research has found that designers have a higher EA score when inferring design-related entries Chang-Arana *et al.* (2020b) rather than any thoughts or feelings. This hints that focusing on design-related thoughts and feelings could be effective in design research. We therefore build on that as it links to empathy map. Rather than requiring designers to implicitly infer user states at specific time points, empathy map directs attention to specific aspects of user behaviour, such as what they are thinking or feeling, which matches well with the idea behind EA.

Designers were required to fill the empathy map quadrants (using only the think-and-feel quadrants) with the user insight obtained during the interview. A similar approach was employed by Chang-Arana *et al.* (2020a) in their study on using physiological measures for empathy measurement. They used the empathy map's think-and-feel sub-scale to evaluate the designer's user insight gained during the interview. Designers completed a survey containing the empathy map think-and-feel sub-sections after each user interview, using the corresponding prompts *'The user thinks*' and '*The user feels'*, as shown in Table 2. The full instructional prompt provided was:

> Please complete the empathy map with how well you understand the user. Using the prompt, write down the thoughts and feelings you perceive the user had during the interview.

Subsequently, the designer's responses were sent to the user for evaluation (as shown in Figure 2). Users rated the accuracy of the mapped thoughts and feelings in relation to their experiences and challenges when cooking in the

Table 2. Example of the designer's empathic user understanding task

The user thinks ….	The user feels …
Guidance with recipe and cooking steps is important	Less satisfied when others are involved in his cooking
controlling the precise amount of ingredients is difficult	irritated when washing the vegetables and meat
the time of repair is key to determining if they will repair	more confident to repair simple devices and devices with few components
repair needs specific skills	confused about whether the parts of a device are interconnected

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kitchen and repairing devices. While involving the user in evaluating the gathered insights may introduce subjective bias, this approach aligns with the foundational tenets of user-centred design, where the user serves as the judge of design success and as the focus when gathering insights for the design requirements (Sanders & Dandavate 1999; Koskinen, Battarbee, & Mattelmeaki 2003). Consequently, EU within the design research cannot be treated as an isolated, purely cognitive state. Because the ultimate goal of empathic design is to gain accurate user insights, the user remains the final judge of whether the designer has truly comprehended their lived experiences. Operationalising actual EU through user evaluation is not just an opinion-based approach. It presents a co-constructed validation of alignment between the designer's guess and the user's actual experience. Therefore, to minimise individual bias, we used the following prompt to guide the user to perform a reflective rating task on the synthesised thoughts and feelings:

> Please rate how well this statement reflects your thoughts and feelings during the interview. The range from + 3 (strongly agree) to − 3 (strongly disagree) is how strongly you feel the statements are correct about your thoughts and feelings or how strongly they are incorrect.

This prompt was intentionally framed to guide users to reflect on their internal states (thoughts and feelings) during the interview and make comparative judgments, rather than focusing on external behaviours or evaluating the quality of the designer. The evaluation was conducted using a rating scale ranging from +3 (strong agreement) to −3 (strong disagreement). This scale was chosen to maintain consistency with the Likert scale range used in all the questionnaires in this study. For analysis, the user's ratings for each designer's mapped think-and-feel quadrants were rescaled to a 0–6 scale and then averaged.

2.2.3. Language style matching (LSM)

To answer RQ 2, we employed LSM to measure verbal mimicry between the designer and user. Unlike approaches that focus on content words, this method focuses on function words. These are described by Ireland & Henderson (2014) as 'place holders' whose meaning is unique to the dyads in conversation, and understanding the meaning of the same requires shared knowledge between the dyads. Although function words constitute a relatively small portion of the vocabulary, they account for more than half of the words used in everyday communication (Chung & Pennebaker 2011).

We refined the LSM metric. In previous design-related studies (Fabunmi *et al.* 2024b, 2025), they used the overall LSM method by Ireland & Pennebaker (2010), which is most used in psychology and psychotherapy research (Rains 2016; Cannava & Bodie 2017). This is shown in Eqs. (1) and (2). The following function words are used in this equation: preposition (prep), article, auxiliary verb (auxverb), adverb, conjunction (conj), personal pronoun (ppron), impersonal pronoun (ipron) and negation (negate) words. Equation (1) shows how the LSM for each function word is calculated using the LSM for preposition (LSM_{prep}) as an example. The LSM is then averaged as shown in Eq. (2). However, this approach measures verbal mimicry throughout the entire interview. This method may overlook important nuances and limit the study of dynamic changes in verbal mimicry, potentially obscuring insights into its role in fostering EU during the

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interview. To mitigate the shortcomings of overall LSM, the reciprocal Language Style Matching (rLSM), a turn-by-turn approach, was introduced by Müller-Frommeyer & Kauffeld (2022). Although this has been used to study who leads the conversation and fine-grained mimicry within interviews, it can be limited by low word count, particularly in design-based interviews.

$$LSM_{prep} = 1 - \frac{|prep_1 - prep_2|}{prep_1 + prep_2 + 0.0001} \quad \ldots\ldots\ldots\ldots\ldots\ldots (1)$$

$$\begin{aligned} \text{LSM} = avg\big(&LSM_{prep} + LSM_{article} + LSM_{auxverb} + LSM_{adverb} + LSM_{conj} \\ &+ LSM_{ppron} + LSM_{ipron} + LSM_{negate}\big) \end{aligned} \quad \ldots\ldots\ldots\ldots\ldots\ldots (2)$$

Additionally, we do not know if a single pair of utterances used in rLSM (Müller-Frommeyer & Kauffeld 2022) is sufficient to study verbal mimicry. To address this limitation, we combined the criteria presented by Ireland & Pennebaker (2010) with the fine-grained, turn-by-turn analytical advantages of rLSM. We chose to split the transcript into sections. Previous research in therapeutic contexts has examined LSM over time windows, such as entire sessions or 5-minute segments (Aafjes-Van Doorn & Müller-Frommeyer 2020). However, such approaches are designed for longitudinal interactions and may not be directly applicable to design research interviews, which are typically shorter. Furthermore, considering that we are using only the transcripts for this study, the 5-minute interval is not a suitable fit.

To determine the most appropriate splitting approach, we evaluated six configurations consisting of 3, 4, 5, 6, 7 and 8 utterance pairs per split. In each configuration, the transcript was segmented into consecutive units, where each unit (split) contained *j* designer–user utterance pairs (See Figure 2). For example, in the 3-pair configuration, each split consisted of three consecutive designer–user pairs. The overall LSM score for a transcript was then computed by averaging the LSM values across all splits, as shown in Eq. (3).

$$\frac{1}{n}\sum_{i=1}^{n} LSM\{j\}, LSM_j \quad \ldots\ldots\ldots\ldots\ldots\ldots (3)$$

where LSM_j is calculated using Eqs. (1) and (2), and n is the total number of splits.

The choice of split size was guided by three criteria:

(a) Number of data points (split-size):

For the data points, we investigated the data size of the different split approaches. For example, if the transcript is split using the 3-split-size approach (that is, each split should have three designer-user pairs), the data point is the total number of splits.

(b) Word count per split

Prior work suggests that LSM requires a minimum of approximately 50 words per segment to produce reliable estimates (Pennebaker, Mehl, & Niederhoffer 2003; Tausczik & Pennebaker 2010; Kory-Westlund & Breazeal 2019). This is added to our selection criteria.

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(c) Association with established LSM measures:

To assess the validity of each splitting approach, we examined the correlation between split-based LSM scores and two established LSM measures: the LSM formula for the whole transcript (Ireland & Pennebaker 2010) as used in a previous study (Fabunmi *et al.* 2025) and the rLSM (Müller-Frommeyer & Kauffeld 2022), which is an utterance-level adaptation of LSM.

These criteria introduce a trade-off: a smaller split size increases the number of observations but may fail to meet the minimum word count requirement, while a larger split size is more likely to satisfy the word count constraint but reduces the number of data points. Therefore, the optimal split size is the one that balances these competing constraints and correlates with the established LSM measures across the different transcripts.

To ensure robustness, this evaluation was conducted on two distinct datasets: a cooking-focused interview dataset (current study) and a driving-focused dataset Salmi *et al.* (2023). Although the datasets differ in domain, participants and context, both were collected via Zoom, allowing for a consistent conversation condition.

Across both datasets, Figure 3 shows that smaller split sizes (e.g., 3-split-size) yielded more segments (e.g., 9–29 splits for the cooking dataset), enabling finer-grained analysis. In contrast, larger split sizes (e.g., 8-split-size) resulted in fewer segments (e.g., 3–11 splits) but higher word counts per segment. Importantly, the 4-split and 5-split size configurations provided the most balance between sufficient word count and adequate data points across both datasets. These configurations were also the smallest split sizes that consistently met the minimum word count requirement.

Further correlational analysis revealed that the 4-split-size approach (denoted as LSM_4 in Figure 4) exhibits higher average correlations with both LSM and rLSM for the cooking and driving transcripts than the 5-split-size approach (LSM_5). Additionally, considering the intercorrelation among all split-size approaches, as shown in Figure 4 and the column chart in Figure 5, the 4-split-size approach appears to have the highest correlation and the smallest differences across interview transcripts.

Therefore, in this study, we employed the 4-split-size approach and Eq. (3) to compute the overall LSM score. It is also important to note that we explored the use of overlapping splits during transcript segmentation. However, no significant differences were observed between the overlapping and non-overlapping approaches; as such, the non-overlapping method was retained for simplicity and consistency.

2.2.4. User's reported openness

In this study, we also operationalised user's expressiveness as their reported openness. Specifically, their self-reported willingness to engage with the designer or to express themselves during the interview. The users rated their openness on a Likert scale ranging from 0 to 10, in response to the prompt: 'On a scale of 0 to 10, could you rate how well you expressed yourself in the interview?'

2.2.5. Statistical analysis

For the statistical analysis in this study, Spearman's correlation analysis was used because the data were non-parametric. The generalised linear model (GLM) with

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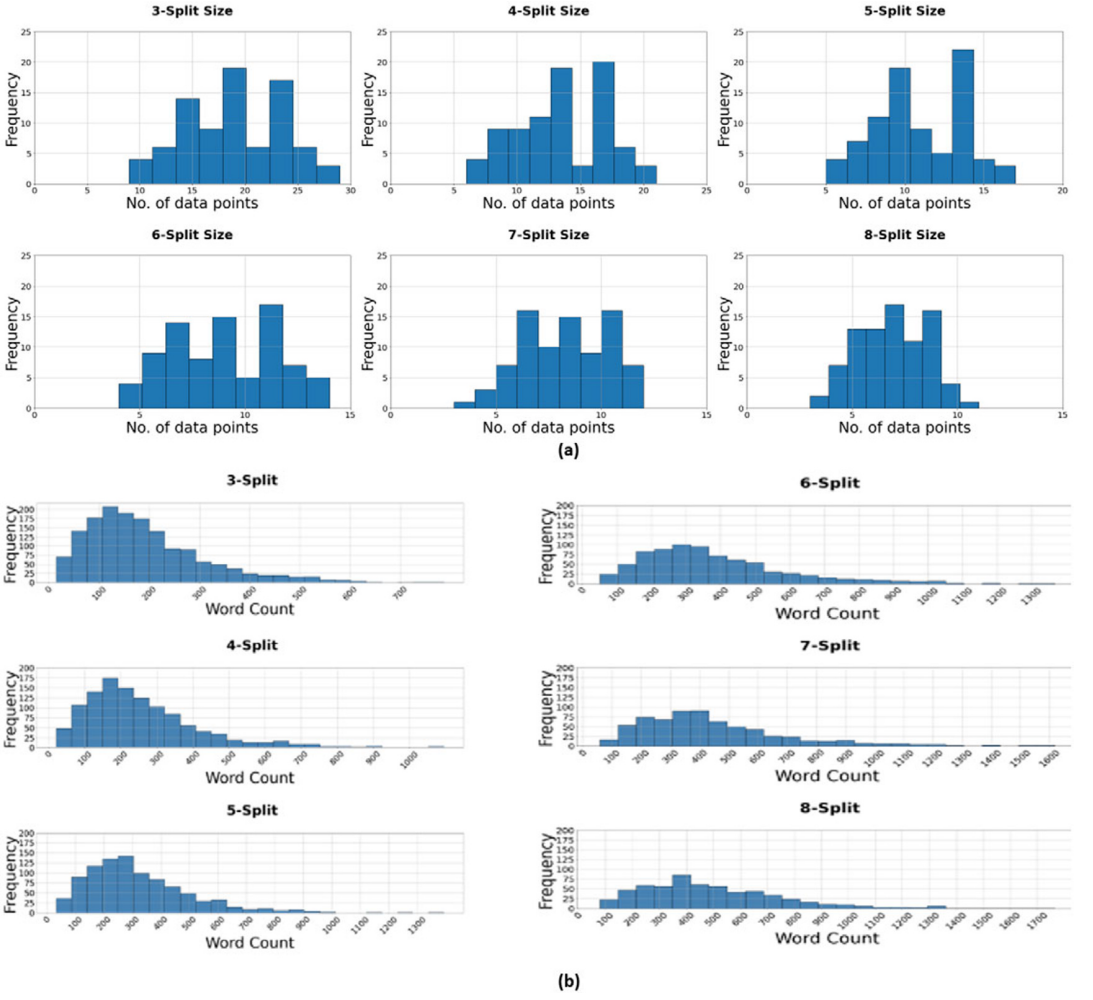


Figure 3. Cooking dataset splitting exploration: (a) Word count and (b) No. of data points (Splits).

the gamma function and a log link was used for the moderation analysis, as the data were non-parametric, skewed, continuous and positive. The bootstrapping method was used to evaluate the mediation analysis because the data is non-parametric. Krippendorff's alpha was used to calculate the inter-rater reliability (IRR).

3. Results

3.1. User's perceived empathic understanding (PEU) correlates with the designer's empathic understanding (EU)

In RQ1, we investigated whether there is a relationship between the user's PEU of the designer (PEU) (M = 4.266, SD = 0.709) and the designer's actual EU (EU) of the user (M = 5.105, SD = 0.708). The user's PEU scores were parametric (S-W test;

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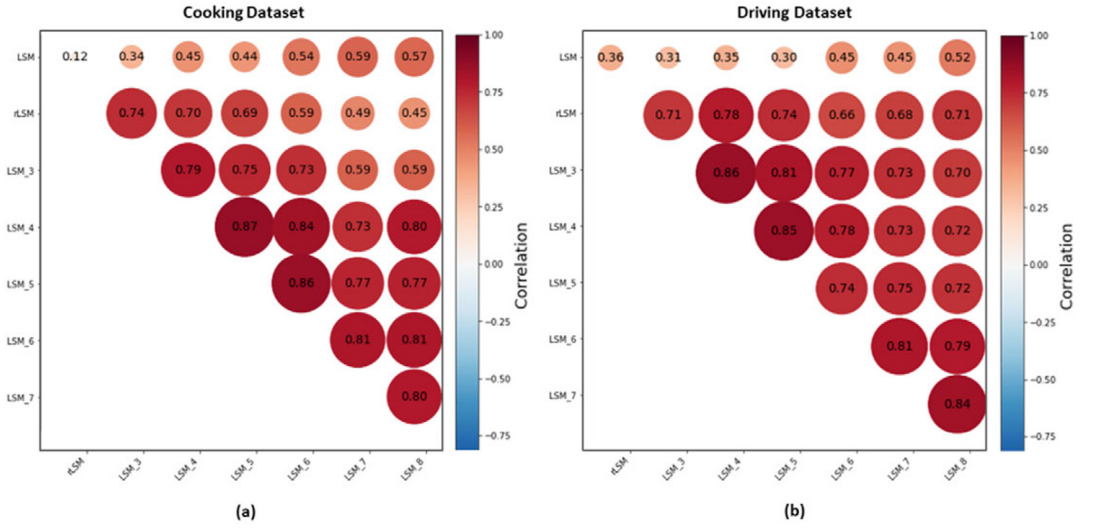


Figure 4. Correlation analysis.

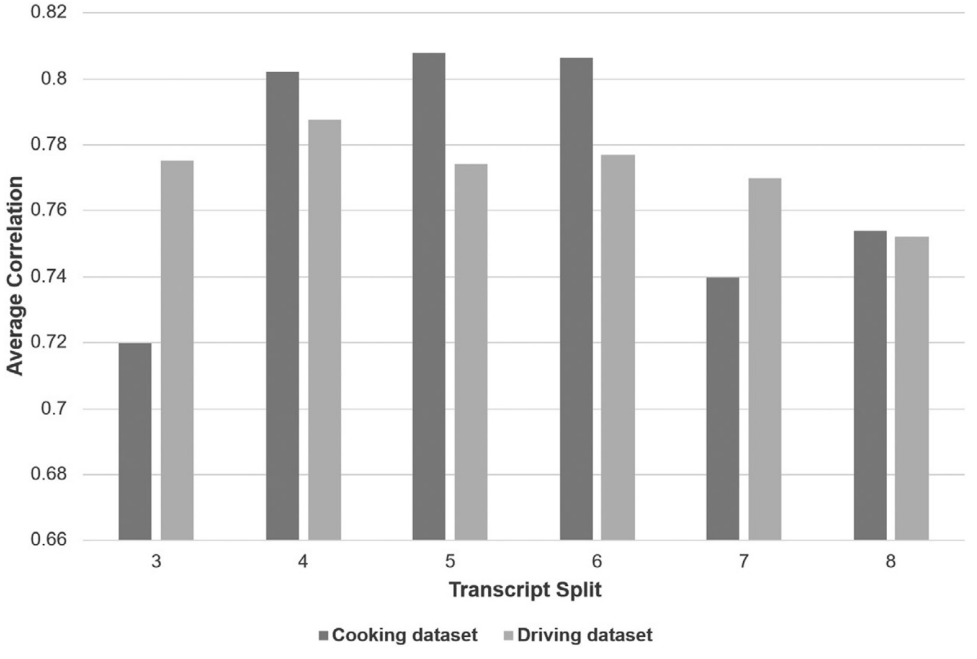


Figure 5. Average correlation comparison between the split size approaches.

p = .178), whereas the designer's EU scores were non-parametric (S-W test; p < .001).

There was a weak, positive and significant correlation (r = 0.292, p = 0.007) between the user's PEU and the designer's EU (Figure 6). While this relationship is

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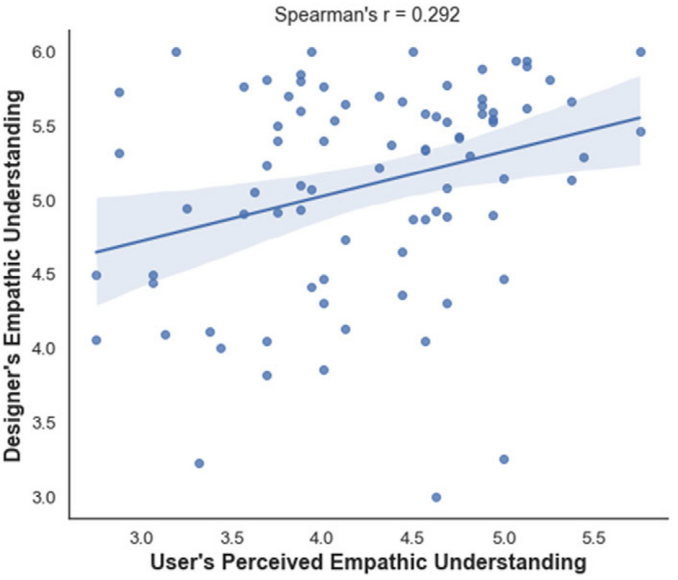


Figure 6. Scatterplot of the user's PEU and the designer's EU (empathy map (think and feel)). Confidence interval = .95.

statistically significant, the coefficient of determination (r^2 = .085) indicates that the user's PEU accounts for only 8.5% of the variance in the designer's actual EU. This suggests that while there is a relationship between the variables, the user's perception is a limited predictor of the designer's EU. It indicates that a designer's actual EU is also influenced by unobserved factors. Furthermore, we employed the Linear Mixed-Effects Model (LMM) to examine the relationship between the two measures of EU while controlling for individual differences across designers. The analysis showed that the designer group effect has a low intraclass correlation coefficient (14.2%), and a significant positive correlation still exists between perceived and actual EU (r = 0.240, p = 0.027) after controlling for individual differences. This suggests that the observed relationship is not a secondary effect of designer-specific traits but is interaction-driven.

3.2. Empathic mental processes (verbal mimicry) indicate the user's expressiveness

To investigate what verbal mimicry indicates during the user interview, we analysed the transcripts and their LSM scores for the different splits during the user interview. Figure 7 shows a user interview with both high and low LSM (verbal mimicry) scores during the discussion.

To better interpret the LSM results across different sections of the interview, we examined the sections for conversational differences. We observed that segments with higher LSM scores appear to be associated with more conversational exchanges, where both dyad members contribute actively to the discussion. Specifically, when the LSM score is high, the users are more engaged during the discussion. In these instances, users tend to provide more elaborate responses, and

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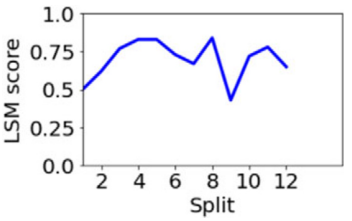


Figure 7. Example of LSM (verbal mimicry) pattern during a user interview.

the interaction reflects a more extended back-and-forth dialogue. In contrast, segments with lower LSM scores tend to be characterised by brief question–answer patterns with limited elaboration.

In this context, expressiveness refers to the extent to which the user provides detailed or personalised responses. These patterns are consistent with prior work suggesting that LSM reflects alignment within a dyad's psychological world (Niederhoffer & Pennebaker 2002), although the present analysis does not directly measure psychological states or engagement. We expect that if there is harmony between the designer's and the user's psychological world, then the user ought to be elaborate (share personal experiences), the discussion will be highly conversational, and there is expected to be reflection on each other's utterances (responding to a previous utterance to gain deeper insight).

To assess the generalizability of the coding scheme, a randomly selected subset comprising 5% of the overall dataset ($N = 60$) was independently coded by a second rater. The indicators for high and low expressiveness, along with an example of each, were provided to the raters as a guide. Transcripts were classified as high or low expressiveness based on predefined criteria, including the user's elaboration (how well the user shares personal experiences, even without specific prompting during the interview), as well as the degree of conversational engagement (how much the user contributes to the discussion) and reflection (how well they respond to the other's previous statement to gain more depth). IRR was assessed using Krippendorff's alpha (nominal), yielding a value of $\alpha = 0.86$, indicating strong agreement. An illustrative example is presented in Figure 8, with additional examples provided in Appendix C.

In splits with a lower LSM score (Figure 8a and d), the interview section consists solely of questions and answers. For instance, in Figure 8a, although the designer asked exploratory questions that could have led to better user understanding (for example, how often the user cooks and whether they enjoy cooking), the user's responses were just brief answers with little or no expressiveness. Similarly, in Figure 8d, a communication disruption (e.g., due to network issues) coincides with low LSM. The low LSM in such an event is expected because the user is unlikely to be expressive in that situation. This further supports the authenticity of the mimicry measure in revealing the dyads' mentalisation distance (harmony or disharmony) during the user interview.

In contrast, in splits with higher LSM scores (Figure 8b and c), the user was more engaged and expressive. The user shares personalised experiences, and the section is conversational. In addition, the designer reflects on the user's statements to engage the user more deeply, gain a deeper understanding of the experience and

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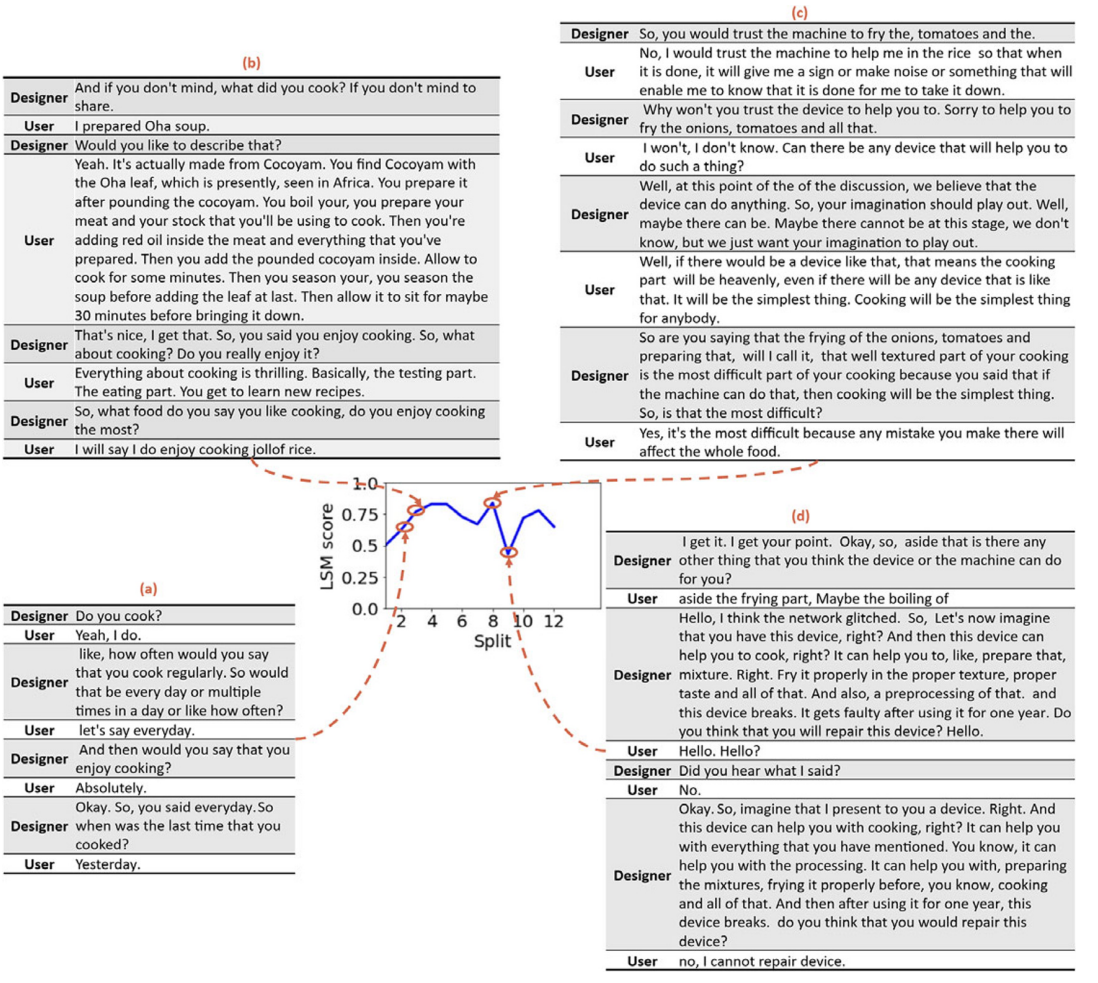


Figure 8. Verbal mimicry investigation using the cooking dataset transcript.

potentially better comprehend it. For example, in Figure 8b, the user, while describing *oha* (a traditional Nigerian soup), expresses themselves in detail. We also see that when the designer asks the user whether they enjoy cooking, the user responds, 'Everything about cooking is thrilling…', then goes on to describe the phases of cooking and explains why they enjoy it. This highlights the user's interest in the topic and expressiveness, as they provide more details about cooking that relate to their emotions. In Figure 8c, the designer asks 'why the user will not trust the device to fry onions and tomatoes', following up on the previous statement of the user on trusting the cooking device when it comes to cooking rice, but not frying onions and tomatoes. We also see the designer prompting the user to use their imagination, further demonstrating a deeper level of harmony. The designer also reflects on the user's statements, asking a follow up question in the last utterance pair, 'So are you saying that the frying of the onions, tomatoes and preparing that, will I call it, that well textured part of your cooking is the most

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difficult part of your cooking because you said that if the machine can do that, then cooking will be the simplest thing. So, is that the most difficult?'

From the examples, we can see a clear difference between the discussions in different splits in the same interview. This was also shown in the LSM scores (a measure of verbal mimicry and harmony in the dyads' psychological world) and was repeated across other interview samples.

Additionally, we investigated the correlation between LSM and the users' reported openness and freedom to express themselves during the interview. The user's reported openness (M = 8.233, SD = 1.155) was not normally distributed (S-W test; $p < 0.001$); therefore, Spearman's correlation was used. In this analysis, the user's reported expressiveness is treated as ordinal data. There was a weak positive correlation between the user's reported openness and LSM ($r = .285$, $p = .009$).

3.3. Empathic mental processes, measured as verbal mimicry, do not correlate with empathic understanding

In RQ3, we further investigated whether there is a relationship between empathic mental processes, measured by verbal mimicry and EU. Specifically, the relationship between the LSM, a measure of the user's expressiveness during the interview and the user's PEU, as well as the designer's actual EU, was investigated. There was neither a correlation between LSM and EU, measured as the 'think' and 'feel' sections of the empathy map ($p = 0.338$), nor between LSM and the user's PEU ($p = 0.353$).

3.4. Empathic mental processes may moderate empathic understanding during the user interview, but not mediate

In RQ4, we investigated whether empathic mental processes (measured via verbal mimicry) play a role in the development of EU during user interviews. We employed an extreme groups design (EGD) based on LSM scores. The interviews were grouped into two: high mimicry (top 40th percentile, M = 0.781, SD = 0.022) and Low mimicry (bottom 40th percentile, M = 0.714, SD = 0.029), with an experimental effect size of Cohen's d = 2.65. This 40% threshold was selected to maximise the contrast between the mimicry extremes while ensuring a robust sample size ($n = 34$ per group) for group comparisons. By excluding the middle 20% of the distribution (the centre scores), we reduced the noise inherent in moderate mimicry levels, thereby increasing the sensitivity of our analysis. Post hoc power analysis with an alpha of 0.05 indicates that the sample size provides a statistical power of 90.2% to detect a large effect (Cohen's $d = .80$).

We compared the correlation between the user's PEU and the actual designer's EU when the mimicry is low and high. We found a significant, medium positive correlation ($r = 0.44$, $p = 0.008$) for the high mimicry group compared to the low mimicry group, which was weakly correlated but not significant ($r = 0.29$, $p = 0.094$). This is also shown in the scatter plot in Figure 9. The red circles are for the high mimicry, while the blue crosses are for the low mimicry. The correlation for the high mimicry group is stronger than that of the overall transcripts. This highlights the possible role of mental processes (mimicry) in fostering EU.

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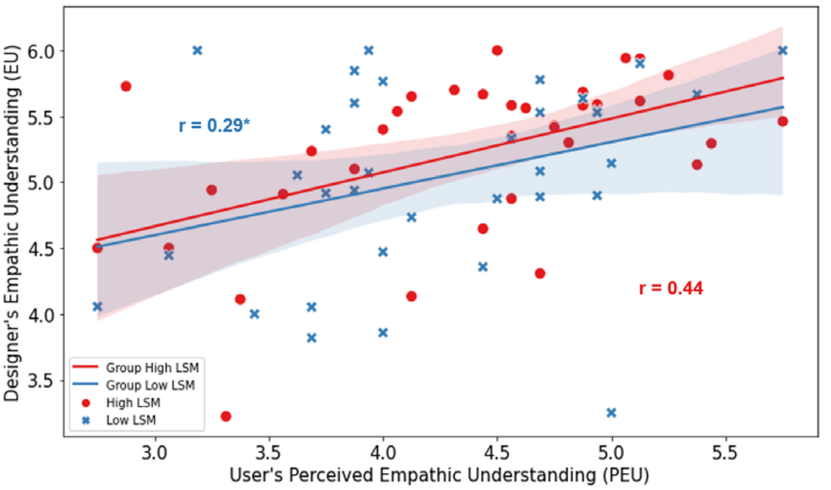


Figure 9. Scatter plot showing the correlation between the user's PEU and designer's EU between the verbal mimicry groups (High and Low LSM).

Based on previous studies and our findings on the correlation between users' PEU and the designer's actual EU, we expect that a higher perception of empathy during the interview leads to greater understanding by the designer. Accordingly, we examined this expectation across the verbal mimicry groups (High LSM and Low LSM). As shown in Figure 10, we found that high mimicry was associated with about 60% (21/35) of interviews in which both variables exceeded the mean – that is, when the user's PEU surpasses the overall user mean, the designer's actual EU is

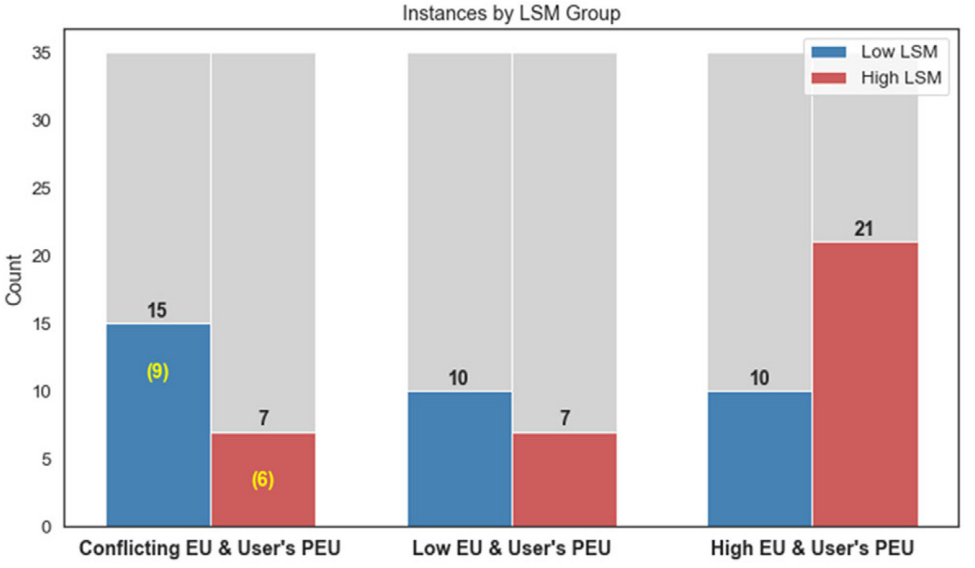


Figure 10. LSM group analysis with high, low and conflicting user's PEU and designer's EU values.

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also above its mean. Additionally, 20% (7/35) of interviews had both variables below their respective means – that is, when the user's PEU is below the overall user mean, the designer's actual EU is also below its mean. The remaining 20% (7/35) represented cases of non-alignment – that is, when the user's PEU is above the mean, but the designer's actual EU is below the mean, or vice versa.

However, in the low mimicry group, there are more conflicting scores – about 42% (15/35). We observe more interviews in which the user PEU as high, but the actual understanding was low, or vice versa. These findings further support the idea that mimicry may influence empathy, particularly in how the user's PEU relates to actual EU, or how the designer gains empathic insight during the user interview. It is also worth noting that there were more interviews with high users' PEU and actual designers' understanding in the high LSM group compared to the low LSM group. This further indicates that mental processes measured as mimicry (user's expressiveness) may play a role in how the user perceives the designer's empathic ability, which correlates with the actual designer's understanding gained.

We found that a large percentage of the conflicting variables are interviews with low user's PEU and high actual designer's EU (See the yellow text in Figure 10). This suggests that there are other factors contributing to the high actual designer's EU beyond the user's PEU. When the designer has a low understanding, the user's PEU is also mostly low, meaning that high perception will almost always lead to high EU, especially in high mimicry interviews. However, for a low user's PEU, it may not be the case. This does not mean the designer has not gained understanding. Uncertainties like this are what design research aims to eliminate, helping to identify clear and more certain user insights.

To further investigate the role of empathic mental processes (measured as mimicry) in gaining EU during user interviews, we conducted both mediation and moderation analyses. This was to determine whether mental processes (measured as mimicry) mediate or moderate the relationship between the user's PEU and the actual designer's EU.

The mediation analysis is described in Table 3. For the high mimicry group, the predictor, the user's PEU, has a significant direct effect on the outcome (the designer's EU). However, the mediated path (indirect) using verbal mimicry (LSM) is not significant. For the low mimicry group, none of the paths is significant. This suggests that the mediation effect does not vary significantly across the groups; only the association between the variables is observed.

For the moderation analysis, the GLM showed a significant main effect ($\beta = 0.0802$, SE = 0.029, z = 2.81, p = .024), indicating that the user's PEU is a predictor of the designer's EU. This confirms that a higher user's PEU is associated with a greater designer's EU. However, the interaction between the user's PEU and the group (high and low mimicry) ($\beta = -0.0103$, $SE = 0.045$, $z = -0.23$, $p = .818$) was not statistically significant, but it had a negative slope. This indicates that the slope in the low mimicry group is slightly weaker than that of the high mimicry group; however, the difference was not statistically significant.

Although we previously noted potential patterns in the data, it must be emphasised that the interaction term was non-significant; thus, we cannot establish a definitive moderation effect. However, a descriptive comparison shows a marginal difference in the influence of the user's PDE on the designer's EU for low mimicry groups ($\beta = -0.0103$, representing a 1.02% decrease). While this trend is directionally interesting, it remains statistically inconclusive. This suggests that

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Table 3. Mediation analysis of user's PEU and designer's EU using LSM across the high and low groups

Group	Effect type	β (Estimate)	95% CI	p-value
High LSM	Total	0.410	[0.160, 0.660]	.001
	Direct	0.400	[0.150, 0.650]	.002
	Indirect	0.009	[−0.024, 0.109]	.748
Low LSM	Total	0.330	[−0.030, 0.610]	.098
	Direct	0.320	[−0.040, 0.690]	.082
	Indirect	0.011	[−0.021, 0.145]	.708

while mimicry is a relevant factor, designers' EU is likely influenced by a complex interplay of variables not examined in this study.

4. Discussion

In this study, we examined the correlation between a user's perception of the designer's EU and the designer's EU gained through user interviews. Our findings suggest that the user's PEU can affect the designer's EU of the user's thoughts and feelings during the interview. Also, empathic mental processes are a potential indicator of the user's expressiveness during the interview, which, in turn, can help determine the likelihood that interactions will lead to EU. Figure 11 summarises the findings, with solid arrows indicating the explored constructs and dashed arrows indicating the unexplored constructs.

4.1. The user's perception of the designer's empathy is related to the designer's empathic understanding of the user's thoughts and feelings

Our study shows a statistically significant but weak relationship between PEU and the actual designer's EU. The weak relationship and low explanatory power suggest that some relationships exist between the user's subjective feeling of being understood during the interview and the designer's empathy measured as EU, which is the goal of empathy in design research and practice. However, there are most likely other variables that mediate or moderate the relationship.

Our findings are similar to previous studies in other fields that show the relationship between PEU and other measures of empathy, such as physiological measures (Marci & Orr 2006) or trait measures (Olson 1995). Extending this to the design research, this study confirms that the user's PEU is not an isolated subjective experience but relates to the designer's actual understanding in some way.

However, the weak correlation warrants critical investigation. This weak correlation is similar to previous findings on perceived empathy and therapy outcomes (Watson 2002; Elliott *et al.* 2011). Elliott *et al.* (2011) explain that this weak correlation likely arises because the metrics capture different aspects of the multidimensional concept of empathy that are also related. Furthermore, this may be due to several factors, such as the complexity of human behaviour, where

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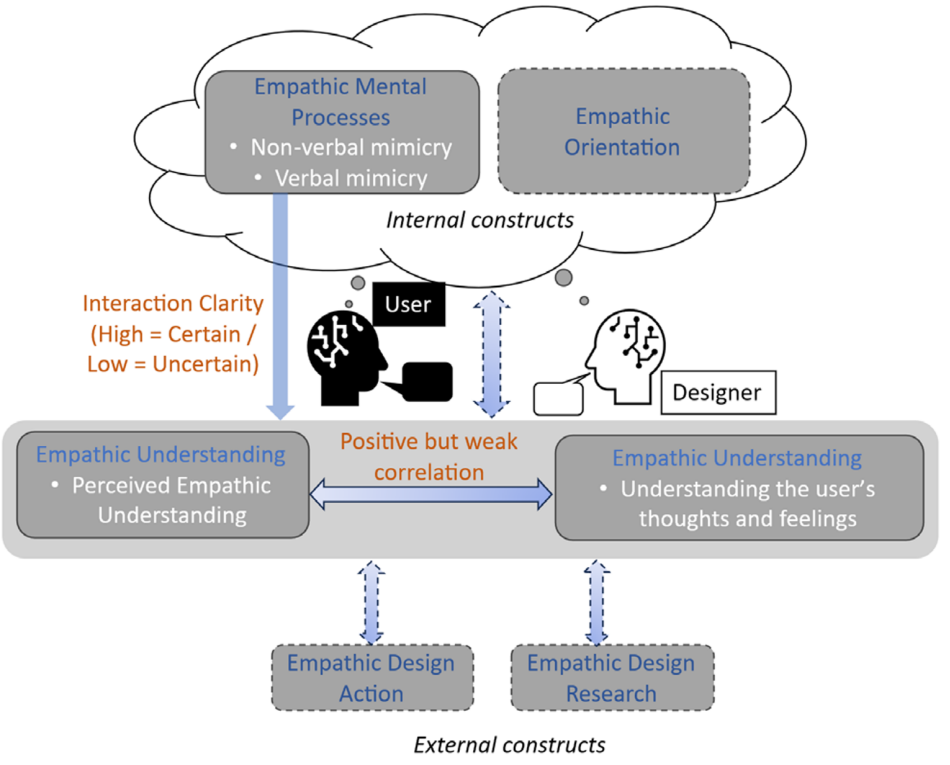


Figure 11. Summary of the study's findings.

multiple factors, including personality, environment and culture, interact with human behaviour and vary across populations and contexts. Consequently, our findings suggest that while the user's PEU is a valuable indicator in a design interview, it is an insufficient proxy for the designer's actual understanding. This underscores the need to investigate unobserved moderators.

4.2. Empathic mental processes (verbal mimicry) point to the user's expressiveness during the interview

Our findings suggest that empathic mental processes, measured as verbal mimicry (specifically, LSM), serve as an indicator of the user's expressiveness during an interview. By analysing mimicry in the use of function words, we show that higher LSM is associated with the user's expressiveness during the interview, and vice versa. The correlation between LSM and the user's reported openness and freedom to express themselves further supports this relationship.

This aligns with the description of LSM by Niederhoffer & Pennebaker (2002). They described LSM as a phenomenon in which people matching in their language styles indicate harmony in their psychological worlds. The conversation between the dyads can indicate the degree of harmony in their mental processes. Specifically, in design research, the state of the conversation is closely tied to how much of their experiences the user shares during the interview. This further corroborates

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Babcock, Ta, & Ickes (2014) and Niederhoffer & Pennebaker (2002) description of LSM as an 'engagement index' which might occur when dyads are in 'grip of strong emotions, rather than a direct measure of rapport'.

Within the design research context, this finding corroborates studies that describe mental processes as a proxy of an engaging conversation during the interview; however, mimicry was used to measure the dyads' mentalisation. For example, Chang-Arana *et al.* (2020a) reported this in their study on measuring EA in design using physiological measures. They found that when the user and the designer shared similar arousal states during the interview session (either they were relaxed or aroused together or almost together), the conversation between the user and the designer was very engaging.

These results support the early claim by Pennebaker & King (1999) that 'mimicking someone's linguistic style shows a momentary adoption of the person's way of thinking'. Consequently, we argue that LSM does not directly measure the rapport between the designer and the user, but rather the user's expressiveness, how much of personal experiences the user shares during the interview, which, by extension, can affect how attuned the designer is to the user's cognitive frame.

4.3 Empathic mental processes measured as verbal mimicry (LSM) do not correlate with any measure of empathy during the user interview

We did not find a correlation between empathic mental processes measured as verbal mimicry (LSM) and either measure of EU (perceived or actual). This lack of a relationship suggests that while verbal mimicry may relate to the user's expressiveness, it does not serve as a direct indicator of EU.

This finding mirrors the debate over whether mental processes lead to EU, as found in previous studies investigating the relationship between empathic mental processes, such as mimicry, and EU. While studies in therapy found relationships between empathic mental processes measured as mimicry and PEU (Marci & Orr 2006; Marci *et al.* 2007), a few studies have also reported the lack of such relationships Messina *et al.* (2013). Our findings align more closely with the latter, as well as with recent design research studies (Chang-Arana *et al.* 2020a; Salmi *et al.* 2023), which found no relationship between non-verbal mimicry (such as electromyographs and facial mimicry) and EA. Furthermore, our findings are consistent with studies (Fabunmi *et al.* 2024b, 2025), which also showed no relationship between verbal mimicry (measured as LSM) and EA.

We posit that this discrepancy in findings could be attributed to differences in the interaction design. The studies that found a significant correlation involved real therapist-client interaction and a well-established therapeutic relationship (after 10 therapy sessions). But the study by Messina *et al.* (2013), which reported no relationship, used pseudo-patients and was based on a 20-minute interview. Similarly, our study and others in design research employed brief (20- to 30-minute), one-off interactions with no prior relationship. Variations in the experimental design may have led to differences in the results. This suggests that a relationship may exist between empathic mental processes (an indicator for user expressiveness and reported openness or freedom to express themselves during an interview) and EU (specifically, PEU) following several interaction sessions.

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Previous studies in psychotherapy (Karvonen 2017) and design research (Fabunmi *et al.* 2025) have also shown that mental processes increase through sections of interaction between dyads. This suggests that empathic processes may only begin to correlate with outcomes once a certain threshold is surpassed. This peak could be worth investigating in future research.

4.4 Empathic mental processes do not mediate or moderate empathic understanding during the user interview

Mentalisation has been described in neuroscience as a crucial part of empathy building. Also, studies have highlighted that empathic mental processes like synchrony and mimicry have an important role in empathy development (Marci & Orr 2006; Kleinbub 2017). However, the role they play is not clear. In answering RQ3, we found that empathic mental processes, operationalised as verbal mimicry (LSM), do not mediate the relationship between perceived and actual EU. Furthermore, the interaction term evaluating the moderation was not significant, indicating that empathic mental processes cannot be empirically established as a moderator either. However, the directionally consistent patterns observed in the study suggest that when verbal mimicry is high, the correlation between the user's PEU and the designer's actual understanding is stronger. Conversely, as shown in Figure 10, lower verbal mimicry was associated with more uncertainty and conflicted relationships.

Previous studies on mental processes and empathy have also highlighted mechanisms such as synchrony and mimicry to promote harmony and connection between dyads, thereby influencing likeness, empathy and social interaction. Van Baaren *et al.* (2004) showed that people who were mimicked were more helpful to others compared to those who were not. They report that mimicry is not merely a consequence of likeness; rather, it results from prosocial behaviour. That is the willingness to engage in activities that benefit others. This suggests that when there is high mimicry, the user is more likely to engage with the designer during the interview, resulting in the designer better understanding the user. The expressiveness of the user will make it easier for the designer to be empathic, and this will impact how the user perceives the designer's empathy, leading to higher user's perception of EU and actual EU. Koole and Koole & Tschacher (2016) highlighted that patient-therapist synchrony might enhance mutual understanding and emotional experience sharing. These findings in previous literature emphasise the role of empathic mental processes as a potential indicator of the user's expressiveness, engagement during the interview and empathic interactions.

Consequently, we see pointers suggesting that, even though empathic mental processes, operationalised as verbal mimicry, do not significantly mediate or moderate EU, our work suggests that it remains a valuable indicator and is critical for design research. The slight difference observed between the low and high mimicry interviews could be noticeable when deciding which customer insight the designer should use to make design decisions, and whether the design process will lead to a successful or unsuccessful outcome.

5. Conclusion

This study investigates the complex interplay between EU (user perception and designer understanding) and empathic mental processes, operationalised as verbal

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mimicry (LSM). Our findings showed a positive but weak correlation between how well the user feels they are understood and how well they are actually understood during the interview. Design research can explore the user's PEU beyond social outcomes and treat it as a proxy for the reliability of the insights being gathered.

This study presents LSM as a metric for the user's expressiveness during an interview. While LSM did not directly correlate with empathy measures, we found that, even though verbal mimicry does not mediate or moderate the relationship between the user's PEU and the designer's EU, when it is high, the relationship is stronger, with more certain high perceived and actual EU, and vice versa. Therefore, empathic mental processes (such as verbal mimicry) should be considered a baseline for empathy measures. In high-mimicry interviews, the precursor to empathy is clearer, reducing uncertainty.

For design research and practice, these findings provide additional insight into the role that empathic mental processes play in attaining EU during user interviews. Furthermore, the understanding that users' expressiveness may facilitate EU could help designers better evaluate the likelihood of accurately gathering insights during a user interview, using the transcripts.

6. Limitations and future study

This study investigated the EU gained during a user interview, based solely on the user's perception. Considering the multidimensional nature of empathy, it is certain that a single measure is not sufficient to measure understanding. It will be more insightful to explore a combination of methods in measuring the designer's EU.

Also, this study investigated the correlation between verbal mimicry, measured as LSM and EU (perceived and actual). However, the study was based on a 20- to 30-minute interview, which might have affected the relationship between mimicry and EU, given findings from psychotherapy research. Future studies should investigate a longitudinal experimental design to examine its impact on empathic mental processes and EU.

Also, the study included four designers, with both designers and users from diverse cultural backgrounds. Given that each designer conducted multiple interviews, the observations possess an inherent dependency structure. While our results show that the designer-specific characteristics have a low effect in this study, the small number of designers and the varying interview counts per designer may be a limitation. Future research could investigate how designer or cultural differences affect the findings with more designers and an equal number of interviews per designer.

Furthermore, the measure of the user's perception used in this study is questionnaire-based and may be subjective. The approach may also introduce the risk of agreement bias. Although it has been widely used for similar purposes in other disciplines, such as psychotherapy, a structured prompt was also employed to ensure objective reflection. Future research could incorporate objective outcome-based metrics to cross-verify the user's self-reported validation. Future research could also investigate empathic mental processes by combining both verbal and non-verbal unconscious mimicry. This approach will help further prevent the inherent subjectivity in textual analysis and complement any limitations in each dimension (verbal or non-verbal).

https://doi.org/10.1017/dsj.2026.10079 Published online by Cambridge University Press

Acknowledgements

This study would not be possible without the graduate research funding from the University of Melbourne, Australia. We would also like to thank the participating designers for their support during the data collection.

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Appendix A: Interview template

(Expected Duration: 20–30 mins)

- Introduction
  - Hello, how are you?
- Discussion about cooking (warm-up discussion)
  - Do you cook?
  - How often do you cook?
  - What is the last food you cooked?
  - What kind of food do you enjoy cooking the most?
  - What food will you most likely cook if you are tired and hungry?
  - What food will you most likely cook if you are cooking for friends and family?
- Scenario 1 (Pain point)
  - Imagine you are cooking **yourself** in these situations, what part of cooking would you like help with?
  - What would you like help with the most?
- Scenario 2 (Human help)
  - Imagine you can get the help of another **person** while cooking, how would you like the person to help you?
- Scenario 3 (cooking device help)
  - Imagine there is a **device** in your kitchen that can help you while cooking, how would you like the device to help you?
  - What else would you like from the device apart from the help you mentioned earlier? (referring to scenario 1)
- Scenario 4 (How the device can be repairable)
  - Let us imagine you used the device for a year, and it always helped you cook tasty meals without any disappointments. Now, imagine one day the device stops working. Do you think you will **repair** it?
    - If No, why (barriers)
      - What would make it easy for you to repair it? (enablers)
    - If yes, why (enablers)
      - What will make it difficult for you to repair it? (barriers)
- Any other needs for the device

Thank you.
End

(***Comment:*** *The template above is a guideline for the semi-structured interview. This will help ensure that all the interviews follow the same guide, but the discussion in the interviews is not restricted to this, as the designer can follow the direction of the user's conversation, but all interviews will remain in the scope described above.)*

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Appendix B: User's perceived empathic understanding (PEU) questionnaire

Thank you for your time. This phase of the study is the EU phase. This is the first of the two tasks in this section.

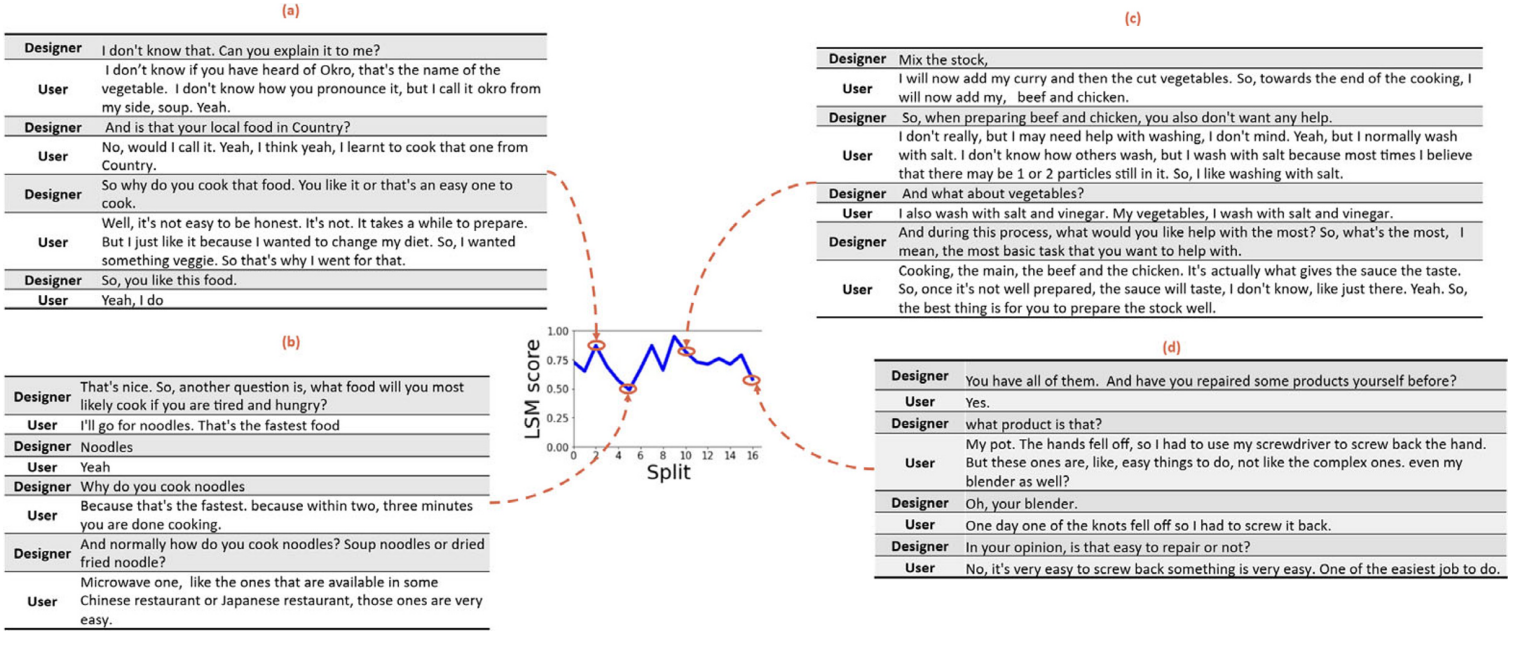
Kindly rate how you feel about the following statements. The options range from +3 (strong agreement) to −3 (strong disagreement), signifying a strong feeling of agreement to a strong feeling of disagreement.

1. The interviewer tries to see things through my eyes.
2. The interviewer understands my words but not the way I feel.
3. The interviewer is interested in knowing what my experiences mean to me.
4. The interviewer nearly always knows exactly what I mean.
5. At times, the interviewer jumps to the conclusion that I feel more strongly or more concerned about something than I actually do.
6. Sometimes, the interviewer thinks that I feel a certain way because they feel that way.
7. The interviewer understands me.
8. The interviewer's attitude towards some of the things I say or do stops the interviewer from really understanding me.
9. The interviewer understands what I say from a detached, objective point of view.
10. The interviewer appreciates what my experiences feel like to me.
11. The interviewer does not realise how strongly I feel about some of the things we discuss.
12. The interviewer responds to me mechanically.
13. The interviewer usually understands all of what I say.
14. Even when I do not clearly state what I mean, the interviewer still understands me.
15. The interviewer tries to understand me from their own point of view.
16. The interviewer can be deeply and fully aware of my most painful feelings without being distressed or burdened by them.

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Appendix C: Other illustrative examples of user's expressiveness in low and high LSM scores



(a)

Designer	I don't know that. Can you explain it to me?
User	I don't know if you have heard of Okro, that's the name of the vegetable. I don't know how you pronounce it, but I call it okro from my side, soup. Yeah.
Designer	And is that your local food in Country?
User	No, would I call it. Yeah, I think yeah, I learnt to cook that one from Country.
Designer	So why do you cook that food. You like it or that's an easy one to cook.
User	Well, it's not easy to be honest. It's not. It takes a while to prepare. But I just like it because I wanted to change my diet. So, I wanted something veggie. So that's why I went for that.
Designer	So, you like this food.
User	Yeah, I do

(b)

Designer	That's nice. So, another question is, what food will you most likely cook if you are tired and hungry?
User	I'll go for noodles. That's the fastest food
Designer	Noodles
User	Yeah
Designer	Why do you cook noodles
User	Because that's the fastest. because within two, three minutes you are done cooking.
Designer	And normally how do you cook noodles? Soup noodles or dried fried noodle?
User	Microwave one, like the ones that are available in some Chinese restaurant or Japanese restaurant, those ones are very easy.

(c)

Designer	Mix the stock,
User	I will now add my curry and then the cut vegetables. So, towards the end of the cooking, I will now add my, beef and chicken.
Designer	So, when preparing beef and chicken, you also don't want any help.
User	I don't really, but I may need help with washing, I don't mind. Yeah, but I normally wash with salt. I don't know how others wash, but I wash with salt because most times I believe that there may be 1 or 2 particles still in it. So, I like washing with salt.
Designer	And what about vegetables?
User	I also wash with salt and vinegar. My vegetables, I wash with salt and vinegar.
Designer	And during this process, what would you like help with the most? So, what's the most, I mean, the most basic task that you want to help with.
User	Cooking, the main, the beef and the chicken. It's actually what gives the sauce the taste. So, once it's not well prepared, the sauce will taste, I don't know, like just there. Yeah. So, the best thing is for you to prepare the stock well.

(d)

Designer	You have all of them. And have you repaired some products yourself before?
User	Yes.
Designer	what product is that?
User	My pot. The hands fell off, so I had to use my screwdriver to screw back the hand. But these ones are, like, easy things to do, not like the complex ones. even my blender as well?
Designer	Oh, your blender.
User	One day one of the knots fell off so I had to screw it back.
Designer	In your opinion, is that easy to repair or not?
User	No, it's very easy to screw back something is very easy. One of the easiest job to do.

Figure C1. Verbal mimicry investigation (Additional Example 1).

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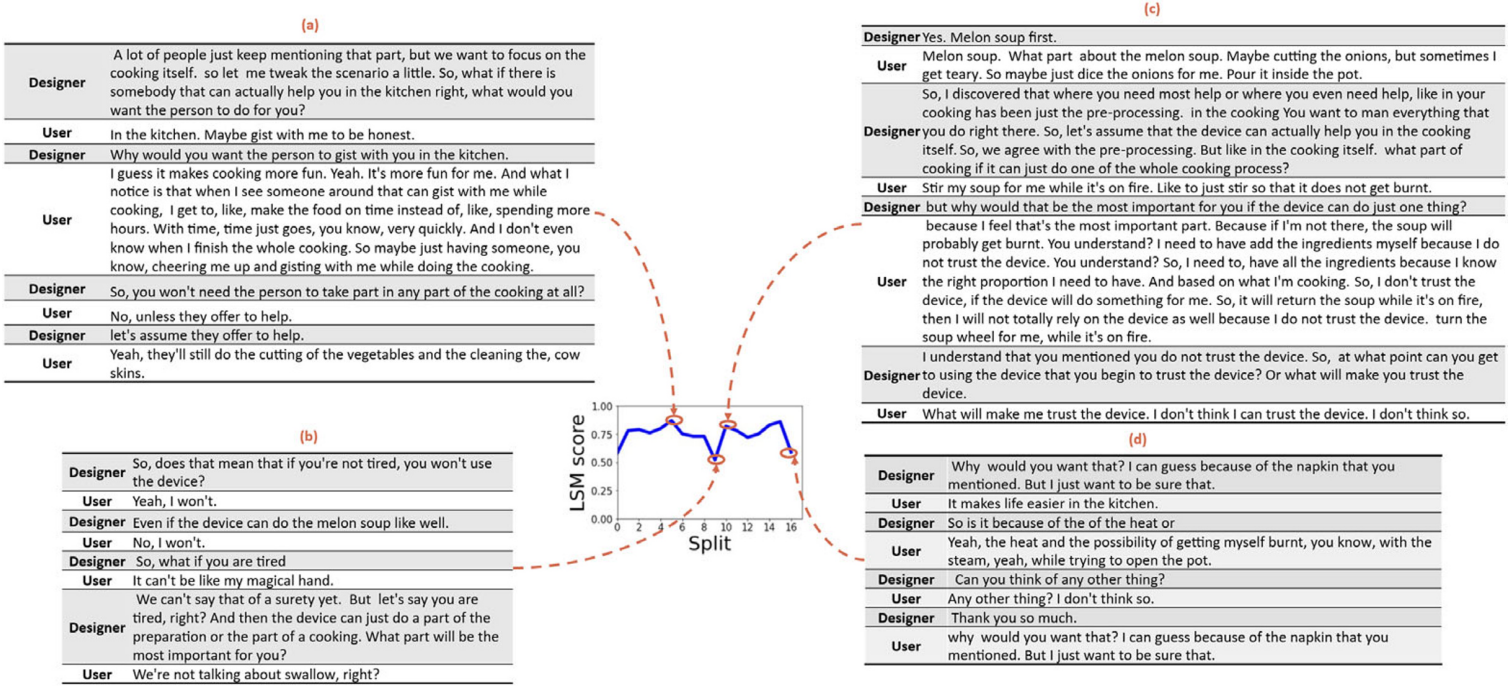


Figure C2. Verbal mimicry investigation (Additional Example 2).

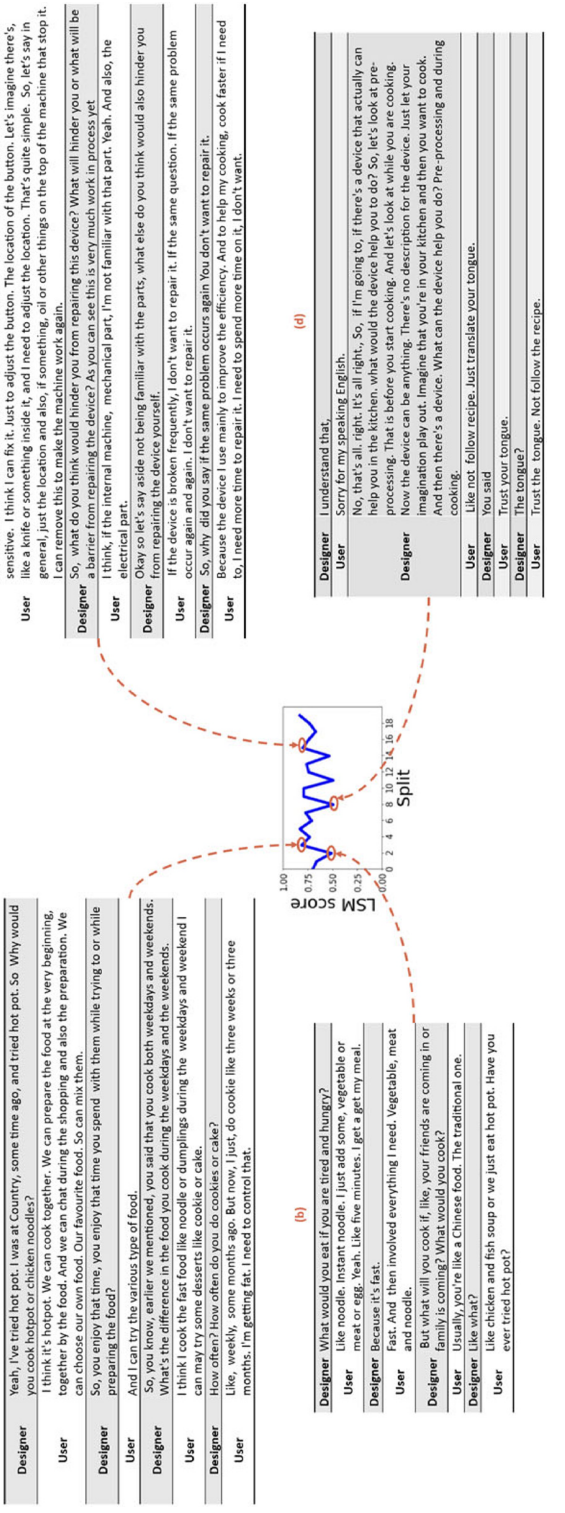


Figure C3. Verbal mimicry investigation (Additional Example 3).

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