

Understanding the influence of interpersonal factors on interactions in co-design through intersubjectivity: a systematic literature review

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Abstract

Design, like any social activity, greatly depends on human relationships for efficiency and sustainability. Collaborative design (co-design) in particular relies on strong interactions between members, as ideas and concepts become shared, going from personal (creation) to interpersonal (co-creation). There is, then, a need to understand how interpersonal factors influence interactions in co-design, and this understanding can be achieved by using the insights gleaned from research on intersubjectivity, the field of social interactions. This literature study was conducted using a systematic literature review to identify and classify the different methods used to measure intersubjectivity and see how this knowledge could explain the influence of interpersonal factors on interactions in co-design. The review identified 66 methods, out of which 4 main categories were determined. Furthermore, 115 articles were analysed and systematized in an online database, leading to a new understanding of the role of interpersonal factors in measuring the interactive levels in co-design. They reveal a positive correlation, where a rising level of interactivity is made possible by the formation and maintenance of co-creation, leading to a state of resonance where the experiences of individuals are closely related. This paper presents a state-of-the-art report on trends in the study of intersubjectivity through interpersonal factors and proposes some directions for designers and researchers interested in taking these factors into consideration for their next co-design situation.

Keywords: Interpersonal factors, Intersubjectivity, Co-design, Interactive level

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1. Introduction

1.1. Motivation

Creating something with others can allow us to reach new heights in a creative endeavor, both in terms of the members taking part in it (i.e., the experience) and the results. Pursuing this ideal, co-design aims to involve all stakeholders in the design process. However, as with any social activity, co-design is heavily dependent upon human interactions to ensure a smooth process and to make the most out of the situation (Cash, Dekoninck & Ahmed-Kristensen 2020). While current design

research focuses on either the process itself or the pursuit of outcomes from the managerial side, it tends to forget that humans are not just another resource. There is a need to focus on what causes interactions to reach high interactive levels. By defining design in the words of Taura & Nagai (2011) as “the process of composing a desired figure toward the future,” we can see how social design needs to focus on human interaction mechanisms to attain a well-being society (Matsumae, Matsumae & Nagai 2020). From that point, to challenge new social possibilities, there appears to be a need for better experiences in social interactions, even in design, that can help sustain co-design as a desirable future. This presents a viewpoint shift from the design process to the interactions happening within it, pushing for a deeper understanding of social interactions through intersubjectivity. Using recent research on intersubjectivity, we can divide an interaction into moments linked together by their intensity levels, estimated through the measure of interpersonal factors. This study will then use knowledge from intersubjectivity research to better understand the influence of interpersonal factors on interactions in co-design. We must make design more accessible for everyone, regardless of their prior experiences, to foster co-design.

1.2. Background

1.2.1. Intersubjectivity

Understanding human interactions, not as independent actions but as a web of levels connected by their intensity understood through their resulting effects, is one way to illustrate interpersonal factors. The experience of reality is a continuous and interactive flow, one that emanates between subjective subjects linked together by the concept of intersubjectivity. First conceptualized by Husserl in his Fifth Cartesian Meditation as the mechanism behind empathy, see Bower (2015), the main idea of intersubjectivity is that subjects do not constitute a world alone but jointly, together with other subjects. Serving as the main idea to fuel the dialogism shift that happens in fields studying human factors in social situations, such as cognitive science, psychology and behavioural science, this new approach prompted important steps forward in our understanding of social interactions, such as the discovery of mirror neurons explained in the study by Gallese (2003), the scaling system of intersubjectivity in child development talked about by Trevarthen & Aitken (2001) and the development of dialogism approaches in linguistics (Linell 2014). Recent neuroscience research also hints at the promising use of interpersonal factors to understand cognitive status during interactive situations by using new methodologies such as hyperbrain (Maÿe, Wang & Engel 2021). Following the socially interactive nature of collaboration and (even more so) of co-design situations that could arise between people with different design contexts, as in social design, where a shared world is needed between the members to attain the best results in co-creation, and in which the formation and maintenance of intersubjectivity was pointed out as a dynamic mechanism by Matsumae & Nagai (2018), the possibility arises of using intersubjectivity insights to understand the influence of interpersonal factors on interactions in co-design. Furthermore, previous research focuses on concepts related to intersubjectivity (i.e., interpersonal factors) by using them as a way to quantify interactions in co-design. These concepts include *shared understanding* from the study by Cash *et al.* (2020), *empathy* from the study by Ho, Ma & Lee

(2011) or *boundary objects* from the study by Star (2010). While it also focuses on the influence of human interactions on design, it only looks at it from specific viewpoints, reducing the possibilities of applying a fully integrated view of intersubjectivity. This research will then look at recent trends in human science pertaining to the concept of intersubjectivity to see how interpersonal factors as a whole influence the interactions needed in co-design.

1.2.2. Co-design

First referred to as participatory design, co-design is an approach to design that aims to involve all stakeholders in the process to attain better results in terms of usability and users' needs. Rooted in the development of a design methodology that arose during the 60s and 70s, its main contribution was to recognize the social aspects of design as an activity involving collaborations between practitioners of different backgrounds, where one of the key factors to success is human interaction (Voorberg, Bekkers & Tummers 2015). First, this approach advocated user-oriented design, meaning the user must be integrated as part of the design process. As the process became increasingly inclusive, it led to the elimination of the barrier between designer and user, going as far as user empowerment (Simonsen & Robertson 2012). In social design, for example, design methodologies were applied to tackle the social domain. Indeed, by fostering the intersubjectivity between members sharing different design contexts, in sustaining their interactions, the complexity of interpersonal factors can be deepened, allowing us to challenge complex human issues by prioritizing interactions and human factors. Recent research suggests that co-design can lead to more innovative concepts and ideas than standard design, while also enhancing the experience of the design process itself (Mitchell *et al.* 2016). Furthermore, co-design led to the blending of design research with other fields that study human behaviour, such as recent trends in design thinking research (Cross 2001). However, to achieve a more integrative experience in co-design, one that creates resonance between the creative psychological states of participants, there is a need to go further than just sharing members' creativity. One must create a shared world supported by a highly interactive flow.

Indeed, co-design includes two different types of collaborative processes. One is cooperative collaboration (i.e., cooperation), where only participation is needed to achieve a defined common goal based on each member's subjectivity. The other is co-creative collaboration (i.e., co-creation), where each member's creative participation is required, based on intersubjectivity during the socialization phase, making possible the sharing of tacit knowledge and allowing a richer experience (Matsumae & Nagai 2018; Nonaka, Toyama & Konno 2000). In other words, intersubjectivity is needed to help co-design evolve from being cooperative to co-creative and then to further sustain the interactive flow.

1.2.3. Co-creation

Co-creation is a process that occurs during co-design, where the shared world created by the members allows the creativity of all participants to expand further than it could on their own, supporting the development of more innovative creations via resonance (Trischler *et al.* 2018; Junaidy & Nagai 2013). It is a type of collaboration in the design process where each member's creative participation

is required, based on intersubjectivity during the socialization phase, meaning that both goal and design context are intersubjectively and dynamically defined during the process. To go from cooperation to co-creation, interactions need to reach greater interactive levels. The creation of value comes from a highly interactive flow leading to this shared state, where individual experiences and contexts grow closer and tighter as the process advances, finally enabling creative resonance (Matsumae & Nagai 2018). Resonance can be understood as a specific state at a high interactive level that creates a shared experience far richer than the sum of each individual's experience by allowing interpersonal factors to overlap and resonate in the intersubjective field, reducing the distance between each experience. Co-creation is a "fable-shared" state that can only happen if there is intersubjectivity that allows the highly interactive level needed for it to blossom. The possibility of attaining this state is almost non-existent if motivations and goals are not co-created between participants, because they fuel the need for it (Amabile 1983). Furthermore, co-creation is heavily dependent on other human and contextual interpersonal factors that are key to maintaining the complex dialogue needed for this shared world. For this reason, this research will use intersubjectivity as a lens to understand what kind of interactive flow is needed to create and maintain co-creation in co-design and, by this, will define the influence of interpersonal factors on interactions in co-design.

1.3. Aim

The purpose of this study is to answer these two research questions:

RQ1: What is the role of intersubjectivity in co-design?

RQ2: What methods are used to measure intersubjectivity using interpersonal factors in social interactions?

The purpose of RQ1 is to explain why intersubjectivity is essential to understanding interactions in co-design. From there, RQ2 asks how we can actually measure intersubjectivity by looking at existing research on interpersonal factors. The scope of this research is to propose an original view of social interactions in co-design as an intersubjective and interactive flow held together by its intensity (i.e., interactive level) and how interpersonal factors are used to quantify this level. It will not, however, propose an inclusive discussion of every aspect of said interactions, as such a work would require extensive knowledge of each specific factor and would be highly contextual, completely changing depending (for example) on the number of participants or the conditions in which the interaction takes place. Instead, this research aims to provide an overview made possible thanks to the dialogic approach of intersubjectivity and to show how this view can help draw links between the different dimensions of interactions and how they interact with each other.

2. Methodology

2.1. Systematic literature review

To extract and summarize knowledge from multiple research fields, the methodology chosen for this research was a systematic literature review (SLR). The SLR

methodology allows us to identify, evaluate and interpret available studies relevant to a given research question (Kitchenham 2004). Following the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines in the study by Rethlefsen *et al.* (2021), this SLR was divided into three steps: (1) planning, (2) operating and (3) analysing. This study followed 69% of PRISMA recommendations during research to ensure a responsible report, though it was not registered on the PRISMA website. Additionally, a PRISMA template flow diagram was added to help clarify the selection process for the reviewed papers (see Figure 4 in Appendixes). For the planning step, a protocol explaining the goals, scope and methods used for conducting the review was developed. In addition, the qualification criteria were specified to ensure a smooth operating phase. Following these criteria, the operating phase consisted of identifying relevant studies to prepare them for the next step. Finally, the analysing phase was where the knowledge was extracted, classified and interpreted to answer the research question. This SLR had two goals:

- Identify, classify and discuss already existing methods used to measure intersubjectivity by using interpersonal factors.
- Determine their relationships and whether the methods can be applied in co-design research.

To attain these goals, each method was defined by the interpersonal factor studied, together with an explanation of the situation studied and the measurement methodology proposed. Each method was classified as applicable or inapplicable to design studies, by reflecting on the possibility to actually applying it in a design situation depending on the measurements use. This combined together with further explanations on the limitations that could arise from their use, and some comments from the study to fully explain the context in which they were developed, helped answer RQ2. Before the operating phase could start, we needed to identify relevant studies. To do this, a preliminary stage was conducted in which 25 studies were selected from previous research to serve as a set of primary studies (see Figure 5 in Appendixes for a detailed list of primary studies), along with references to one of the main condensed books on the concept of intersubjectivity (Crossley 1996). This preliminary step was needed to identify research fields (as there are many approaches to intersubjectivity, depending on the background field), to recognize key authors and to facilitate the search process. This step also helped define the keywords used in the literature searches, and according to their relevancy in the primary studies, the main keywords being *intersubjectivity*, *measurement*, *methods*, *design*, *creativity* and *co-creation*. The search methodology corresponded to choosing, for each field, a representative group of articles discussing intersubjectivity and methods used to measure it. The representation was confirmed by selecting articles from a wide range of dates, authors and fields. For this SLR, two online databases were used: Scopus and Web of Science (both last consulted in January 2021), though most (95%) of the study comes from Scopus, as they were often duplicated in both databases. To further restrict the number of papers, the following qualifying criteria were applied:

- The study proposes, applies or reviews methods used to measure intersubjectivity or apply it in a given situation.

- It must come from one of these fields: *anthropology, behavioural science, child development, cognitive science, communication, design, education, linguistics, management, neuroscience, philosophy* and *psychology*.
- The article must be from a peer-reviewed journal or conference.

During the analysis, the selected papers were read, and information concerning intersubjectivity along with its possible application was extracted and classified/summarized manually in a database by the first author.

2.2. Pool of selected studies

Following the search method explained above, and after considering the qualification criteria, 115 studies were selected to be further analysed (see [Figure 6](#) in Appendixes for a detailed list of selected studies), resulting in the identification of 66 measurement methods.

[Figure 1](#) shows the repartition of the selected studies per year of publication. A clear increase in studies of intersubjectivity can be seen at the end of the 90s, corresponding to the development of social cognitive science. Following this trend, the number of publications exploded at the beginning of the century and has been growing rapidly in the last 3 years (2019, 2020 and 2021) with the most studies published overall.

In addition, if we look at the number of selected studies per research field, five dominant fields stand out: *psychology, design, neuroscience, child development* and *linguistics*. This diversity can be explained by the central role intersubjectivity plays as the mediator of human interaction: as a status (cognitive) or as a phenomenon (social). For example, in psychology, intersubjectivity is mainly understood as a cognitive state that induces social interactive behaviour, while in design, it is studied as a factor that drives interactions and could also be seen as a desirable output, such as shared understanding or shared knowledge gained from the design process.

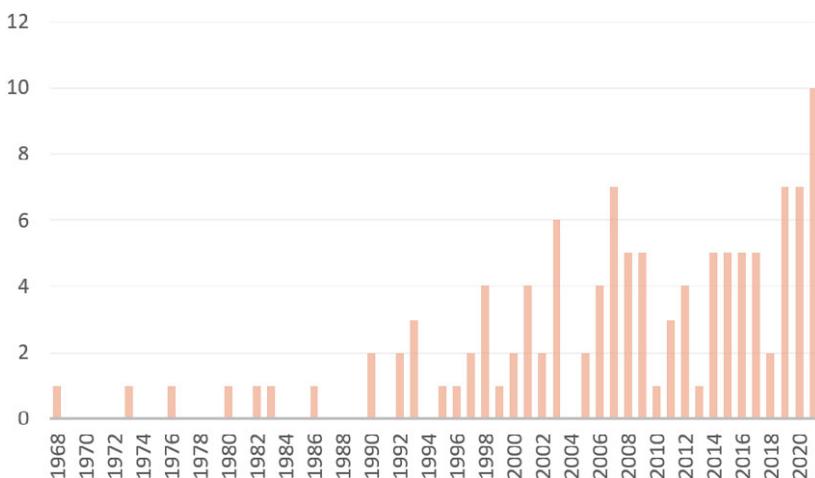


Figure 1. Repartition of selected studies per year of publication.

2.2.1. Representativity

From the pool of selected studies, 35 synonyms were identified to qualify for the phenomenon of intersubjectivity. They can be divided between:

- a synonym that specifies an aspect of the phenomenon: *innate intersubjectivity, mimetic intersubjectivity, embodied intersubjectivity, enactive intersubjectivity, open intersubjectivity, reflective intersubjectivity...*
- a synonym that adds an intersubjective aspect to an already existing concept: *intersubjective engagement, intersubjective understanding, intersubjective reciprocity, intersubjective psychobiology of human intentions...*
- and other synonyms that use it to understand similar concepts related to human interactions: *heedful interrelating, shared understanding, dialectic, motor mimicry, shared assumptions, perspective taking, connectedness, culturally shared knowledge, interpersonal perceptions, imitations, empathy, sympathy, interactional contingency, emotional contagion, open dialogical relationships, interpersonal synchrony, dyadic state...*

This large selection of approaches, together with the way the articles were selected, ensured that this pool of selected studies was representative of the current trends in each field while taking into account different viewpoints and maintaining diversity. This is supported by having 99 first authors who published in 98 different journals or conferences out of the 115 articles selected. The probability of having an article from a different first author and published in another journal or conference was then 73%.

3. Results

3.1. Understanding interactions in co-design through intersubjectivity

In the case of design, human factors have often been seen as resources that can be managed through good processes. However, it now seems evident that this view is limited and insufficient, especially in the case of co-design, where the collaboration is what leads to interesting results.

Indeed, it has often been noted in collaboration during design that failure leading to bad results arises mostly from the failure to properly manage the interaction during the process. This understanding of interactions, as being critical to limiting rifts between participants, was advocated by the development of research on boundary objects (Star 2010). In a similar vein, the need for sharedness between participants in co-design was also advanced in a study of motivation and its impact on the process itself (Amabile 1983). There is, then, a need to understand interaction beyond that in terms of a member's subjective experience of the design process, what makes it transcend this personal perspective and become interpersonal. There is a further need to study intersubjectivity to understand interactions in co-design.

Co-design is a particular process that needs specific management of its interactions and, to achieve this, a better understanding of the role of interpersonal factors in the development of co-creation (Nonaka *et al.* 2000). This clear need for interpersonal factors to understand the complex dynamics that lead during co-design to the formation of co-creation was shown in previous research as a

correlation between the formation of co-creation and the rise of intersubjectivity (Matsumae & Nagai 2018). During this study, it was explained that the co-creation process is directed by internal and external context vectors of each individual and that the contexts of each individual are altered through co-creation, meaning that the interactions were central to nurturing the process by integrating these vectors in social design with design concepts. Following this, an inverted vortex model was proposed to represent the dynamic mechanism of the formative process of intersubjectivity (as shared subjectivities) through co-creation. It then seems that intersubjectivity can be understood as a shared basis that maintains and aggregates the vectors of the different participants, leading them from co-operative collaboration to co-creative collaboration. This transition in the shared creative state of a team in co-design is made possible by the intersubjectivity formed between participants' subjectivities, raised from their experience during the design process.

Furthermore, intersubjectivity in the specific context of co-design corresponds not only to something that qualifies the interactions happening inside it but also to the outcomes. It can be used as a means of reaching a goal of an equally shared amount of knowledge or understanding between the participants, as described by Keating & Jarvenpaa (2011). It can also be used to help understand the principles that make empathy such a powerful tool in the shared design context between designers (Svanæs & Barkhuus 2020). In some cases, it is equivalent to a sharing of experience between designers to develop the overall motivations and expand the design space (Pifarré 2019). It often goes with an increase in shared artefacts in the design team, as explained by Cash, Dekoninck & Ahmed-Kristensen (2017), all while aiming for an integrative design process that can allow collaboration to reach optimal experience and performance (in design terms, from a managerial point of view). This then leads to intersubjectivity as a way to study fruitful interactions, in the sense that barriers between each member's subjectivities can be crossed, and to creation during the process of a new space where the sharing of norms and values becomes easier and more complete (Keating & Jarvenpaa 2011).

In short, intersubjectivity is essential to understanding the experience of social interactions in co-design and how these interactions can determine its success. Having a deeper understanding of intersubjectivity as a social interactive field opens the possibility of determining the influence of interpersonal factors on the experience of co-creation, leading to a better management of co-design through human factors.

3.2. Intersubjectivity as a social interactive field

Intersubjectivity is used in a variety of fields to help understand multiple phenomena all related to social interactions. (In total, 35 concepts were identified.) Each of these concepts can be classified into three main groups:

1. An integrated view of the forces behind an interaction.
2. A dialogism approach on a result out of an interaction.
3. A specific aspect/behaviour of an interaction.

This separation comes from the development of the concept of intersubjectivity in research from, first, a philosophical view to answer the problem of other minds as used by Husserl (1960) to build alterity in phenomenology. From there, multiple fields applied this new view on their subject of study, be it on (1) *force* such as Bower

(2015); Matsumae & Nagai (2018); Gillespie & Cornish (2009), on (2) a *result* as for example in Keating & Jarvenpaa (2011); Martin, Sokol & Elfers (2008); Du Bois, Hobson & Hobson (2014) or (3) an *aspect* of human interactions, see (Cash *et al.* 2020; Gallese 2003; Maÿe *et al.* 2021; Ho *et al.* 2011). This separation of concepts mainly arose for historical reasons. However, recent trends see efforts to gather this fragmented knowledge into one coherent analysis of what makes human interactions possible and special.

This presents us with the need to define more precisely what the overall common ground is behind it and how it leads to considering the flow of interactive levels in a social situation as a correct approximation of its core. The definition out of a previous SLR, presented in an article titled “Intersubjectivity: Towards a Dialogical Analysis” by Gillespie & Cornish (2009), allows us to describe the current understanding on intersubjectivity as:

“the possible relations between people’s perspectives.”

From this definition, Gillespie and Cornish categorized 6 types of studies on intersubjectivity:

1. An agreement in the sense of a shared definition of an object.
2. Mutual awareness of agreement or disagreement and even the realisation of such understanding or misunderstanding.
3. Cognitive approaches that correspond to the attribution of intentionality, feelings and beliefs to others.
4. Implicit/automatic behavioural orientations towards others (embodied intersubjectivity).
5. A measure of social interactions in terms of their situational, interactional and performative nature.
6. Cultural aspects corresponding to a partially shared and largely taken-for-granted background that interlocutors assume.

This would mean that intersubjectivity corresponds to all modalities that are available to link subjectivities through social interactions. However, since this research was published, new results from cognitive science have expanded our understanding of this concept as not only a relation between perspectives but as a cognitive predisposition in humans to engage in social interaction. Ever since the discovery of mirror neurons, first in monkeys and then in humans, by Vittorio Gallese and his research team, there has been strong advocacy of the idea that we as a species have a cognitive predisposition to not only recognize other humans as being the same as us (shared perspectives) but that there is actually a shared manifold resulting from natural selection that allows smooth social interactions (Gallese 2003). This goes beyond simple relationships and affirms the intersubjective predisposition of humans to socially interact. Going in the same direction, Herrmann *et al.* (2007) presented the cultural intelligence hypothesis, explaining that humans have a tendency to outdo their nearest primate relatives (chimpanzees and orangutans) even in ontogeny, in terms of skills of social-cultural cognition such as social learning, communication and theory of mind. They hypothesised that this predisposition to engage and socially interact was partly responsible for our development as a dominant species.

Further proof of this propensity was discovered in child development, where it was observed that not only is a baby able to interact with his/her parents before birth, creating the link necessary for future feelings of attachment that will later pave the way

for the development of intersubjectivity, as explained by Kokkinaki & Markodimitraki (2019), but also that these interactions during early life have an effect on the cerebral plasticity of both the children and their partners, “calibrating” the brain to develop a specific interactive channel together, enabling the learning of social interactions on the go (Schoe 2021). All this research tends to focus on some specific cognitive status that allows human social interaction and reveals that this cognitive predisposition is made possible by an underlying mechanism created together by interactive participants, joining subjectivity through social interactions, which is what we call intersubjectivity. This is why intersubjectivity can be understood as a field that allows social interactions created jointly between participants—a *social interactive field*.

In the same way that forces in physics can be described as the results of interactions between particles and their environment (represented by a field), we can explain intersubjectivity as a field that creates and maintains social interactions by building connections upon each participant’s subjectivity. This field creates the interaction and then is influenced back by it, creating this dialogical musical flow Trondalen (2019), that, once studied at a phenomenological level, becomes a direct manifestation of it. It is the underlying phenomena that make interactions possible between individuals, as explained by Schoe (2021) and, as such, cannot be understood in its entirety but can be studied through its resulting forces, the interpersonal factors that are used to quantify the interactive level. Studying the flow of interactive levels in a social situation can produce a body of evidence for the intersubjective field. As such, measuring intersubjectivity is measuring interpersonal factors, indicating an interactive level at a given moment and then linking it with others as a flow of interactions throughout the entire situation. However, this approach presents us with a new problem: the temporality of interpersonal factors. Indeed, is the field interacting because it was first there, always present in the background, or is it because it was created once the interaction began? This is an interesting question for philosophy but has little impact in practice, as interaction is always dependent on its social context and so always starts and ends before and after the actual measurement takes place. This means that, in our case, interpersonal factors are indeed resulting from the beginning of the interaction that we consider, before the start of measurement of the interactive flow, corresponding to the context of the situation studied. This starting point is always present by nature and provides the equivalent of the initial state (referential) of the following interaction. It also means that participants are already interacting and that we must take an integrative approach from the start.

This implies that intersubjectivity measurements or, with our new understanding, measurements of interpersonal factors, focus on different aspects of the interaction following specific dimensions. Each of these dimensions is observed to quantify the interactive level and its effects on the flow of the interactions, which serves as a bundle of proof for the intersubjective field. These dimensions can then be used to categorize the measurement methods used for interpersonal factors, depending on their approach to the interaction. This classification along with the dimensions will be presented later.

3.3. Database

As a result of this SLR, 115 articles were analysed and 66 measurement methods were identified and recorded in a database created in Excel®. The creation of this

database was motivated by the need to pull together the current understanding of intersubjectivity by measurement methods of interpersonal factors and how it can be applied in specific contexts. This is why it was made available to any researcher who wishes to use it in their own field. Two categories of study were selected: one with a measurement method included and explained (type I study) and one without any method but which brings information on the use of the concept of intersubjectivity in a given field, allowing us to expand the amount of understanding and possible applications (type II study).

The information taken from each article and entered into the database can be divided into 4 main parts (see Figure 2 for details):

- The *identification* of research containing the data of *title, year of publication, authors, journal/conference name, references, DOI, research fields, keywords*
- The *definition* of measurement method and its interpersonal factor with *situation studied, intersubjectivity name, intersubjectivity definition, methodology of use*
- The *categorization* of the measurement method using *category* (of measurement method), *type of intersubjectivity* (according to Gillespie & Cornish)
- The *applicability* of the research knowledge according to *applicable to co-design, limitations, why intersubjectivity in this context, comments*

Identification									Definition			
Title	Year	Authors	Journal/conference name	References	Citation number	DOI	Fields	Keywords	Situation studied	Intersubjectivity name	Intersubjectivity def	Methodology used
Collective mind in Organizations : Heedful Interrelating on Flight Decks	1993	Karl E. Weick; Karlene H. Roberts	Administrative Science Quarterly	Administrative Science Quarterly Vol. 38, No. 3 (Sep., 1993), pp. 357-381 (25 pages)	2974	https://doi.org/10.2307/2393372	Management, organizational behavior and theory, sociology	collective mind, heedful interrelating, organizations	flight operations on aircraft carriers	heedful interrelating	interactions which outcome of training and experience that weave together thinking (shared knowledge), feeling (shared feelings) and willing (shared intentions).	Interviews in which the intersubjectivity level is defined a fortiori from the results and the comparison between the view on the situation (=finding the differences)
Category			Applicability									
Category	Type of intersubjectivity	Applicable to co-design	Limitations	Why IS(intersubjectivity) in this context	Comments							
S+C	3	yes	can only be used to study a past activity. Only study the effects of intersubjectivity on the situation. Only focus on the results. Only observations	use IS to qualify the relationships needed in difficult environment where a lot of coordination is necessary to operate. Take extreme examples to make it clear that without it, everything crumble and that the situation heavily influence the possibility to have it. Decreasing with the amount of pressure/ when difficulties arise.	easy to study when a newcomer comes in / Intersubjectivity can decreased when the activity become a routine (?)							

Figure 2. Database explanation.

However, for the type II study, as these studies did not explicitly mention them, the following data were left out (indicated by “NA” in the database): *situation studied, methodology use, category, type of intersubjectivity, applicable to co-design and limitations*.

The *identification* part is used as a reference to situate the study in its context. The research fields were defined according to the field of the journal and/or the expertise of the authors, together with a check on the keywords employed. The *definition* part is where the name and definition of intersubjectivity as given by the study are registered along with the information on the measurement method and its interpersonal factor for the type I study, according to the situation in which it was studied and with an explanation of the methodology used. For the same type I study, the *categorization* part classifies them according to their category of method (4 categories explained in the next section) and the type of intersubjectivity they studied (from 1 to 6) following the classification presented in the last section (Gillespie & Cornish 2009). Finally, the *applicability* part gives an answer to the possibility of using this method for studying its factor in co-design activities, the limitations that are likely to be encountered with its use, and for what reason it was used in this context, as well as some comments taken directly from the article to complete the understanding of the study on intersubjectivity. These comments are used to specify the context of development of the measurement methods in the study and are needed to fully enable their use as references. However, all copyrights are owned by the authors and/or publishers of the original study and do not rest with the author of this article. This database is publicly available at: <https://www.doi.org/10.13140/RG.2.2.18580.99204>.

3.4. Classification of measurement methods

As explained previously, to simplify the interactive flow composing an interaction and quantify the interactive levels associated with it, the measurement method of interpersonal factors focuses on different dimensions. We can define these dimensions of interactions in the following 6 aspects:

- Temporality: *static/dynamic*
- Perspective: *subjective/intersubjective/objective*
- Cognition data observations: *direct/indirect*
- Role: *process/outcome*
- Placement: *internal/external*
- Intensity: *stable/unstable*

By applying a measurement method to each of these dimensions, we can determine what aspect of the interaction the interpersonal factor seeks to understand and how it can be linked with other interpersonal factors to approximate the interactive flow through an integrative approach. This categorization allows the authors to specify whether the measurement method has used mostly *subjective* (as in asking for the perspective of one of the participants), *intersubjective* (as in asking for the interpersonal perspective) or *objective* (as in taking an external point of view such as video or specific measurement) data to understand the interaction, mixed with a *static* (from the moment) or *dynamic* (from the flow) approach from *direct* (from the phenomena) or *indirect* (as results of the phenomena) cognition data observations to grasp the intensity of the interactive level. Its relationship with other

factors is then defined by the role it plays in the interactive flow, as a *process* (part of) or an *outcome* (results afterward), by its placement inside the interaction as an *internal* (coming within the interaction) or *external* (coming from outside) force, and by whether its intensity is *stable* (maintaining the same level) until the next situation or *unstable* (changes the level), leading to a change in the interaction level. By observing these dimensions, it became apparent that some measurement methods of interpersonal factors could be separated into four categories according to their perspective and their temporality: for each interactive moment of static data, there is *subjective feedback*, objective *behaviour observation*, including *measurements from biosignals* and, to link these moments as dynamic data, the *dynamic context*. The link between dimensions and these categories is developed later in a summarized manner in Table 1 (see Table 1).

This conceptual classification is used to simplify the study of interaction as a dynamic phenomenon through the separation of static and dynamic data corresponding to the actual measurement methodology used, meaning that this separation comes from the way the data from the measurement methodology are integrated during an interaction: as a group of independent measurements for static data and as a function of these moments put together for dynamic data. It is not a separation of the interpersonal factors studying a specific aspect of the interactions, much less a distinction of the integrative aspect of them, such as advocated by the body of mind theory. If we follow the definition of intersubjectivity as a social interactive field, it seems important not to forget that interpersonal factors always influence each other. This is why the classification is only of the measurement method itself and not of the phenomenon behind it.

For example, in the case of subjective feedback, we can say that these methods focus on a *static* approach to *subjective* data by *direct* observations. These factors are then understood as an *internal outcome* of the interactive moment with mostly a *stable* intensity for the next moment. To simplify this categorization process, we coded them as follow:

S: Subjective feedback/**B:** Objective behaviour observation/**M:** Measurements from biosignals/**C:** Dynamic Context / +: method uses both categories of approaches

For example, S+C means that the method uses both subjective feedback and dynamic context to measure intersubjectivity.

The classification was done by the first author and then verified by an independent assistant, with an interrater match of 100% for the 66 methods classified after discussions with the latter. Most of the measurement methods identified were already a mix of different categories used to grasp, as much as possible, the entirety of the interactive flow, and some trends can be identified.

All methods included dynamic context (coded C) in their study to integrate the interactive moment in a flow of interaction. This category can be divided into two sub-categories for easier comprehension: one gathering the internal integrated into external and unstable dynamic forces transiting behind the interactions, called *driving forces*, and one that considers the internal unstable effect of the output of one interactive moment on the next, called *interactional context*. This sub-division is a theoretical one. While, in reality, it is almost impossible to distinguish between these two sub-categories, it was still important to divide them to completely represent the impact of the interpersonal factors on each moment of the interactive

flow. It was the one the most studied, as it provides the opportunity to use the results of the interaction as study material in an integrated approach. These results agree with the current understanding of intersubjectivity as shared perspectives, where the outcomes can be measured by looking at the application of these perspectives in the situation. In other respects, measurements from biosignals (coded M) make up the category with the fewest methods (only eight), as it remains a new approach used mainly in neuroscience and needs heavy equipment and processing of data to be used compared to the others. It can also be noted that this category is, in reality, a sub-category of objective behaviour observations (coded B). However, it was separated as a focused category to underline the difference in approaches between the two: direct cognition data observations in the case of B, as, for example, a study of motor mimicry via video and pose comparison, compared to indirect measurements in the case of M, such as hyperbrain studies. Subjective feedback (coded S) is the only way to access the personal subjective experience of the interaction. It is not often mixed with objective data as that creates a difficulty in defining the relationships between the datasets. Instead, a specific methodology would need to be developed to use it in combination with other approaches. There is still a gap existing between the perception of a phenomenon and its cognitive mechanism. However, the study proposing these combinations seems to have the most integrated and complete understanding of the interaction and its flow in a given situation. For example, in the research done by Jackson, Meltzoff & Decety (2005), the authors tried to measure the empathy level (interpersonal factor of the study) of participants by using subjective reports of feeling of pain (S) while looking at an image together with a visual analog rating (B + C), all while comparing to data coming from a fMRI(M). This study then concluded with the deeply intersubjective aspect of pain perception and how empathy contributes to it. By linking together measurement from all the categories, it was possible to go beyond just understanding an individualistic biologic aspect of social behaviour.

This categorization, and a repartition of the method according to these categories, along with a few examples of interpersonal factors for each category, is presented in [Table 1](#).

By using this categorization along with the database presented in the previous section, we can better understand the role of each interpersonal factor on the interactive flow and how this role can be applied in a specific context. For example, one of the most studied interpersonal factors from the *driving forces* category is motivation. Motivation is essential to understanding the reason for the interaction (intersubjective) and in what direction each participant wants to lead it (internal/external). It corresponds to a cognitive phenomenon that is observed directly from data such as feelings from participants and agency data (direct). It serves as a driving force for a dynamic context (process) that pushes the interactions in one direction or another (dynamic) depending on the state of the interactive flow (unstable). This is why motivation must be understood from a dialogic point of view, as not only a result coming from one interactive moment but as something integrated throughout the interactive flow, participating in its dynamic. One study that supported this approach on motivation is the study by Matusov (2001). In this study, motivation was defined as human agency:

“Agency involves processes of developing and prioritizing goals, problems and choices, problem solving, and making and realizing solutions (including moral ones).”

Table 1. Full categorization with interpersonal factors

Category	Code	Number of method	Dimensions						Interpersonal factors	
			Temporality	Perspective	Cognition data observations	Role	Placement	Intensity		
Subjective feedback	S	26	Static	Subjective	Direct	Outcome	Internal	Stable	Feelings, perceptions, assumptions, sympathy, representations, empathy	
Objective behaviour observation	B	39	Static	Objective	Direct	Outcome	Internal	Stable	Emotive behaviour, verbal and non-verbal communicative behaviour, motor mimicry, synchrony, empathic behaviour	
	M	8	Static	Objective	Indirect	Outcome	Internal	Stable	Try to capture one behaviour but at a biological level (ex: fEMG for shared behaviour)	
Dynamic Context	Driving forces	C	66	Dynamic	Intersubjective	Direct	Process	Internal External	Unstable	Meaning (context vector), coordination, co-creation, motivation, collaboration
	Interactional context			Dynamic	Intersubjective	Direct	Process	Internal	Unstable	Partial understanding, partial knowledge, partial agreements, media, vision, communication

This view of motivation as unstable and always fluctuating, heavily dependent on the current state of the interactive flow and participating in its sustainment or its decay, is then reflected on the method used to measure it, including feedback, behavioural analysis and results from the activity (S + B + C). This mix of methods can be explained by the fact that motivation was not the only factor studied in this research but was a part of three factors used to study intersubjectivity, together with communicative behaviour and perceptions. As is evident, each measurement method of interpersonal factors is dependent on the context of the study in which it is realized and should be used as a reference only along with the information presented in the database, as it is essential to understanding its role in the interaction’s simplification. This is why the database was made public and this categorization is useful as a guide to help researchers navigate through it, making it available for any researcher who wants to use these factors in their own context.

As explained before, what are referred to here as interpersonal factors are the actual phenomena that quantify the interactive level, as they are showing the interaction’s dimensions. By measuring these interpersonal factors, we can develop a good approximation of the interactive flow by linking interactive moments through their interactive level. There is also a need to specify that these factors are all linked through the interaction and not independent. If the measurement method of the factor itself can be categorized, it would be naive to assume the phenomenon behind the factor, then maintains its current measurement. That is why this categorization is mainly useful to understand which aspect of the interaction is focused on by each interpersonal factor and how these factors interact to form an integrated intersubjective understanding of a social interaction. Furthermore, this table is incomplete by design, and future research might use different interpersonal factors to study interactions. However, their dimensions

and their measurement methodologies should still be able to be defined following this categorization and then included as another method. If alone they are not sufficient to explain the interactive flow as a whole, they can be collected together and serve as hints for the intersubjective field behind this flow. There is, then, a necessity to integrate as much data as possible from different methods coming from different categories to quantify the interactive level.

4. Discussion

4.1. Measure of the interactive level

Using the classification presented in the last section as a reference, and the separation between static data coming from analysis of a moment and dynamic data linking these moments together, a new integrated view of an interactive situation can be created by linking interactive moments through their interactive levels. We can then formulate the measure of an interactive level $P(n)$ as an incremental series following this equation (see Eq. 1 below for details):

$$P(n + 1) = P(n) + \Delta P \quad (1)$$

Next static state = Current static state + Dynamic context

$P(n + 1)$, the next interactive level, is a function of the previous one $P(n)$ and is understood from the static data coming from the interpersonal factors from subjective feedback, behaviour observations and measurements from biosignals and ΔP represents the dynamic data coming from the interpersonal factors coming out of the driving forces and the interactional context. This new understanding of interactions as a flow of interactive moment joined together by their intensity level can be used as a way to link both objective and subjective data from the same situation to not only see the cognitive status of the members but to illuminate how this different status influences the interaction itself and is changed back at the same time in a dialogical manner, indicating the intersubjective phenomenon. This is supported by possible new outcomes from interdisciplinary studies taking this approach (Jackson *et al.* 2005; Ehkirch *et al.* 2021). This means not only that new methodologies need to be developed to integrate the different categories in a coherent manner but also that these methodologies need to be interdisciplinary in their approach to measurement, using different datasets on different dimensions, such as sometimes objective and sometimes subjective, while working on different temporalities. Some promising methodologies have recently been proposed in neuroscience that apply data analysis sciences such as the hyperbrain method that link data from the brain activity of interactive members to see if synchronization in data can be linked to the ability of social cognition (Barraza, Pérez & Rodríguez 2020). Another is the recent advancement in machine learning that enables the study of integrated data of different dimensions to study social behaviour (Van Olmen & Tantucci 2022). These approaches are still new and being tested, and there is a lot of theoretical work left before designing appropriate analysis models that can integrate all these data. Indeed, each categorization of the measurement methods studies a specific aspect of the interaction, as we discussed earlier when talking about dimensions. This separation of approaches is needed to simplify and approximate the interactive flow and can also help us talk about the influence of each category on the intensity level of each interactive moment. For

each categorization, there are common aspects of the method and the interpersonal factors they represent, and how these aspects influence the interaction intensity level:

- *Subjective feedback* methods focus on the cognitive perspective and the effect of the interaction at a personal level. They can indicate the intensity of the interaction based on *quantity* (how much effect the interaction had) and *quality* (how much the participant reflected on the effect).
- *Objective behaviour observation* methods focus on external interactive behaviour. They can indicate the intensity of the interaction based on *quantity* (how much the interaction provoked this behaviour) and *quality* (how much effect this behaviour had).
- *Measurements from biosignal* methods focus on the internal measurement link to interactive behaviour. They can indicate the intensity of the interaction based on *quantity* (how much the interaction provoked these biosignals compared to normal) and *synchrony* (how much resonance this behaviour had with other participants' behaviour).
- *Driving force* methods focus on the external and unstable dynamic forces that made transition possible at the interactive level. They can indicate the intensity of the interaction based on *presence* (how much the interaction induced this force) and by their *quality* (how much effect this force had).
- *Interactional context* methods focus on the internal dynamic stable effect of one moment to another. They can indicate the intensity of the interaction based on *presence* (how much the interaction induced this context) and *sharedness* (how much this context is shared between participants).

This categorization of measurement methods is a conceptual model used to understand the possible relationships between interpersonal factors and the intensity of an interactive level. It can be used as a bridge to connect interactive moments in an interactive flow and, by this, approximate the intersubjective field. However, as discussed in the Results section, intersubjectivity is ungraspable by its nature. This means that the interactive flow is, by design, an approximate version and that interpersonal factors will always be limited in comprehension by their measurement method. This is why the authors decided to limit the actual discussion of the interactive level to its formulation and to an overview of the common aspects of interpersonal factors represented in the same category of measurement method. Doing otherwise would have required a full understanding of all contextual uses of each interpersonal factor in a specific situation to expand on its actual implications. Not all factors are of the same importance, nor should all be studied and integrated at the same level all the time. Depending on the situation, some factors should be studied first, as they gather key data thanks to the way the interaction is constructed. By using the database as a reference to understand the contextual use of each factor, they should be identified by a specialist in each field before attempting to analyse the whole situation. Beyond understanding factors, relationships need to be defined for each given social interaction, allowing researchers to calibrate measurement methods and their analysis. This opens a world of possibilities for the researcher who wants to study interaction by looking at interpersonal factors and can bring an understanding of social cognition and its influence on specific social situations.

4.2. Influence on interactions in co-design

As described in the last section, measuring the interactive level in a given social situation can explain not only interactions but also how they influence and participate in the experience of the situation itself. This means that studying interpersonal factors is key to understanding how the situation evolves and what makes a good interaction. After adding our new understanding of intersubjectivity as an integrated flow of interactive moments linked by their interactive levels on top of the previous view of intersubjectivity as a mediator for sharing design context in co-creation, the influence of the interactive level on co-creation can be described as a positive correlation, where the rising of the interactive level is rendered possible by the formation and maintenance of co-creation, leading to a state of resonance where the experiences of individuals are closely related (Junaidy & Nagai 2013). This creates a shared experience far richer than the sum of each individual’s experience by allowing the perspectives to overlap and develop in the intersubjective field and reducing the distance between each experience (see Figure 3 below for details).

For example, in a co-design situation, each individual designer will at each moment influence the designers’ own and other designers’ experiences, which they will then enter in interaction through collaboration with each other as the interactive level rises, pushed forward by the motivation that was created by the sharing of experiences (Matsumae *et al.* 2020). This will, in return, create the possibility of shared results out of the interactive moment by pushing for the emergence of new interactional context, such as shared understanding, shared knowledge and shared perceptions. Further, by following the formulation of the interactive level presented in the previous section, we can see how this will help to create a vortex that will raise the interactive level until it reaches resonance. Indeed, both co-creation and motivation are driving forces that help the transition of the interactive level by altering its intensity. Furthermore, multiple research results support the

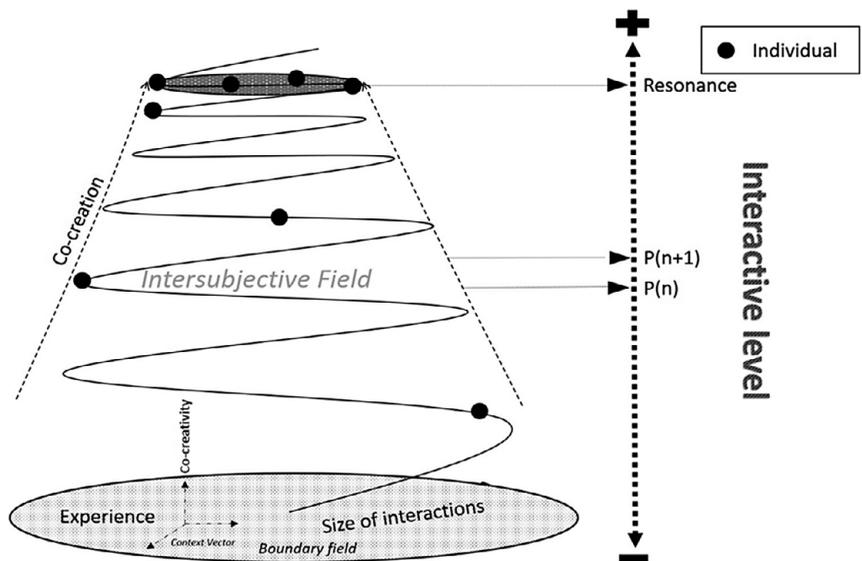


Figure 3. Inverted vortex model for interaction dynamics.

importance of specific interpersonal factors in co-design, as explained before, such as *empathy* from Ho *et al.* (2011), *shared understanding* as detailed by Cash *et al.* (2020), *shared perceptions* by Matsumae *et al.* (2020) and *shared behaviours/shared cognitive status* (Ehkirch *et al.* 2021).

In a state of resonance born from co-creation, individuals participating in the interactive process should have a high interactive level, which means a greater possibility of creative emulation thanks to the intensity of the interactions created. This state can further expand not only the experience of creation and design in general but can also allow the collaboration to reach new heights, leading to smooth interactions during the design process. Designers and design researchers should work to better integrate these interpersonal factors to foster new possibilities for co-design as a whole. This knowledge may help design practitioners and researchers take into account the human factors, leading to a better experience with the process, where everyone can easily enjoy design and use it more often in their daily life.

4.3. Limitations and future research

One of this study's limitations was that it was conducted inside our research group, implying that there is possible viewpoint bias behind the selection of the article and their systematization. That is why it was decided to make the database accessible to everyone, so that they could use this research's results for themselves. Each researcher can access the database and easily choose which measurement method to use, while understanding where this method came from and what the possible limitations are, as well as discussions raised by it. However, by the nature of this research, it was impossible from the start to integrate all existing methods used for measuring intersubjectivity, leaving the possibility that this database is too restrictive with only 115 articles and 66 measurement methods.

Furthermore, it needs to be mentioned that the current understanding of intersubjectivity is divided into two approaches to the concept: the subjective approach (personal) and interactive approach (interpersonal). Each approach has disadvantages and advantages but they are mostly separated, resulting in clearly different methodologies for the handling and processing of data. This gap can lead to some theoretical misinterpretations that are reflected in the results of the study. This is why it was decided to be as precise as possible regarding the intentions of the authors behind each method recorded in the database and how they reflected on its limitations. (See the Limitations and Comments row in the applicability part).

After having defined the current state of knowledge on intersubjectivity and how it influences co-creation, the next step of this research is to use this knowledge to determine the best measurement methods and the relationship between the interpersonal factors to apply them to a co-creative situation during an experiment to test new analysing methodologies. Then, the relationship between co-creation and the interactive level can be further explained, while creating new integrative methodologies for analysis.

5. Conclusion

This study presented the state-of-the-art in measurement methods currently used to indicate intersubjectivity. To do this, a SLR was followed to analyse 115 articles

published between 1968 and 2021, after which they were systemized in an online database.

Of these studies, 66 measurement methods were identified and classified into 4 categories according to their perspective (subjective or objective) and temporality (static or dynamic): subjective feedback, behaviour observations, measurements from biosignals and dynamic context (which itself can be further divided into driving forces and interactional context).

- An integrative understanding of intersubjectivity as a way to understand and qualify the interaction in co-design was given together with a summary of previous research on the influence of these social interactions on collaboration in the design process, to answer RQ1.
- The identification of the methods, with their interpersonal factors measured, and their classification were added to the database so that any researcher or practitioner wanting to measure intersubjectivity could access them accordingly. Furthermore, the applicability of each method for design was determined according to its use in the context of the study and its transferability. This was done along with a clear presentation of the study and method intents and the method's contextual usage to ensure a full understanding of the priority given to each approach and of what the relationship was between the interpersonal factors according to the study. This database can serve as a basis for understanding the current method used to measure intersubjectivity, answering RQ2.
- Following these results, a new definition of the concept of intersubjectivity as a social interactive field was given, leading to the development of an incremental equation to formulate the measurement of an interactive level, along with an update of the inverted vortex model to schematize the influence of interpersonal factors on interaction in co-design. It had what can be described as a positive correlation, where the rising of the interactive level is rendered possible by the formation and maintenance of co-creation, leading to a state of resonance where the experiences of individuals are closely related.

This study is part of broader research that will propose new integrated methodologies to analyse data coming from some methods presented, to be able to modelize the interaction flow of a co-creative situation by measuring the interactive level through interpersonal factors. This research is built upon the knowledge accumulated throughout this study and on the author's previous lab experiments, where hints of a bond between objective indicators and subjective feedback of an interaction were found.

We hope that this research will contribute to the understanding of human factors in design and lead to the development of smoother interactive flows in co-creation and co-design in general, creating a better experience in the design process and allowing more people to participate in future design.

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Appendixes

Glossary

- *Design*: The process of composing a desired figure toward the future. (Ref: Taura & Nagai 2011). It can be seen as either a process with a clear goal from the start or as a generative process where the goal is found through the process itself.
- *Social design*: Social design is the application of design methodologies to tackle the social domain, especially in this research: complex human issues, making interactions and human factors the priority. In social design, there are two types of designers: *meta-designers* who manage the direction of the design and *designers* who participate in the design process.
- *Participatory design*: Requires participation between all actors. Rooted in the development of a methodology for design that arose during the 60s and 70s. First, it advocated user-oriented design, meaning that the user must be integrated as part of the design process, but it became increasingly inclusive, leading to the elimination of the barrier between designer and user. It also advocates using design methodology in different contexts (e.g., social design).
- *Co-design*: Collaborative design was born from participatory design and has since become a more inclusive approach to design. It enforces the need for cooperative and/or co-creative collaboration in the design process, which leads to a dependence on human interactions to ensure a smooth process and to make the most out of the situation (ref: Cash *et al.* 2020).
- *Cooperation*: Joint action toward one's goal.
- *Collaboration*: Joint action toward a shared goal. In this research, collaboration can be categorized into cooperative or co-creative collaboration, depending on whether the process includes the sharing of tacit knowledge among participants.
- *Cooperative collaboration*: A type of collaboration in the design process where cooperation is needed to achieve a defined common goal based on each member's subjectivity and the defined roles assigned. Contrary to co-creation, there is

no need for intersubjective sharing of goal and design contexts in cooperative collaboration.

- *Co-creation*: Also called co-creative collaboration. A type of collaboration in the design process where each member's creative participation is required based on intersubjectivity during the socialization phase, meaning that both goal and design context are intersubjectively and dynamically defined during the process. Co-creation is a process that occurs during co-design, where the shared world created by the participants allows everyone's creativity to expand further than it could if they were working alone, supporting the development of more innovative creations. To go from cooperative collaboration to co-creative collaboration (co-creation), interactions must reach a highly interactive level.
- *Intersubjectivity*: The main idea of intersubjectivity is that subjects do not constitute a world alone but jointly, along with other subjects. (Ref: Bower 2015)

Also refers to the possible relations between people's perspectives (Ref: Gillespie & Cornish 2009) or a cognitive predisposition among humans to engage in social interaction.

Intersubjectivity can be understood as a field that allows social interactions created jointly between the participants: *the social interactive field*. In the same way that forces in physics arise from interactions between particles and their environment (represented by a field), we can explain intersubjectivity as a field that creates and maintains social interactions by building connections upon each participant's subjectivity. It is the underlying phenomena that make interactions possible between individuals and, as such, it cannot be understood in its entirety but can be studied at the phenomenological level through its resulting forces, the interpersonal factors that are used to quantify the interactive level. Studying the flow of interactive levels in a social situation can produce a body of evidence for the intersubjective field. From this point, measuring intersubjectivity is measuring the interpersonal factors, indicating an interactive level at a given moment and then linking it with others as a flow of interactions throughout the entire situation.

- *Interactive moment*: A given moment and (static) conceptual separation of an interaction.
- *Interactive flow*: A dynamic understanding of an interaction acquired by linking interactive moments through their interactive levels.
- *External forces*: These direct the interactive flow from an external perspective and are used in social design to manage the direction of the design. In social design, the meta-designer uses these forces to push the process forward.
- *Internal forces*: These direct the interactive flow from inside and link to the participant's behaviour. In social design, it is dependent on the design context.
- *Forces behind an interaction*: Contextual elements that fuel/drive an interaction.
- *Interpersonal factors*: Phenomenological factors used to study social interactions that can be measured and quantified. Adding them together allows one to estimate the interactive level depending on different dimensions.
- *Dimensions of interpersonal factors*:
 - *Static/dynamic*: Corresponding to the temporality of value of the interpersonal factor.
 - *Subjective/intersubjective/objective*: Corresponding to the perspective of value of the interpersonal factor.

- *Direct/indirect*: Corresponding to the observations of value of the interpersonal factor.
- *Process/outcome*: Corresponding to the role of value of the interpersonal factor.
- *Internal/external*: Corresponding to the placement of value of the interpersonal factor.
- *Stable/unstable*: Corresponding to the intensity of value of the interpersonal factor.
- *Interactive level*: A measure of the intensity of an interaction at a given moment coming via an assessment of interpersonal factors. A high interactive level means a strong interaction where the intersubjectivity field is tighter, meaning an increase in the number of shared subjectivities between participants.
- *Resonance*: A specific state at a high interactive level that creates a shared experience far richer than the sum of each individual's experience by allowing the interpersonal factors to overlap and resonate in the intersubjective field, reducing the distance between each experience. It can be understood from a subjective point of view as a specific creative psychological state or as the interactive state that led to this personal state.
- *Measurement methods*: Methods used to measure interpersonal factors coming from the systematic literature review.
- *Subjective feedback*: Category of measurement methods that use subjective data collected directly from the participants in an interaction (*static/subjective/direct/outcome/internal/stable*).
- *Objective behaviour observation*: Category of measurement methods that use objective (observed) data of interactive direct behaviours (*static/objective/direct/outcome/internal/ stable*).
- *Measurement from biosignals*: Category of measurement methods that use objective (observed) data of interactive indirect behaviours. Included under objective behaviour observation (*static/objective/indirect/outcome/internal/ stable*).
- *Dynamic context*: Category of measurement methods that use the contextual data of an interaction. Can be divided into two sub-categories: driving forces and interactional context.
- *Driving forces*: Sub-category of dynamic context. Gathering the dynamic forces behind the interactions (*dynamic/intersubjective/direct/process/internal and external/unstable*).
- *Interactional context*: Sub-category of dynamic context. Takes into account the effect of the output of one interactive moment on the next (*dynamic/intersubjective/direct/process/internal/unstable*).

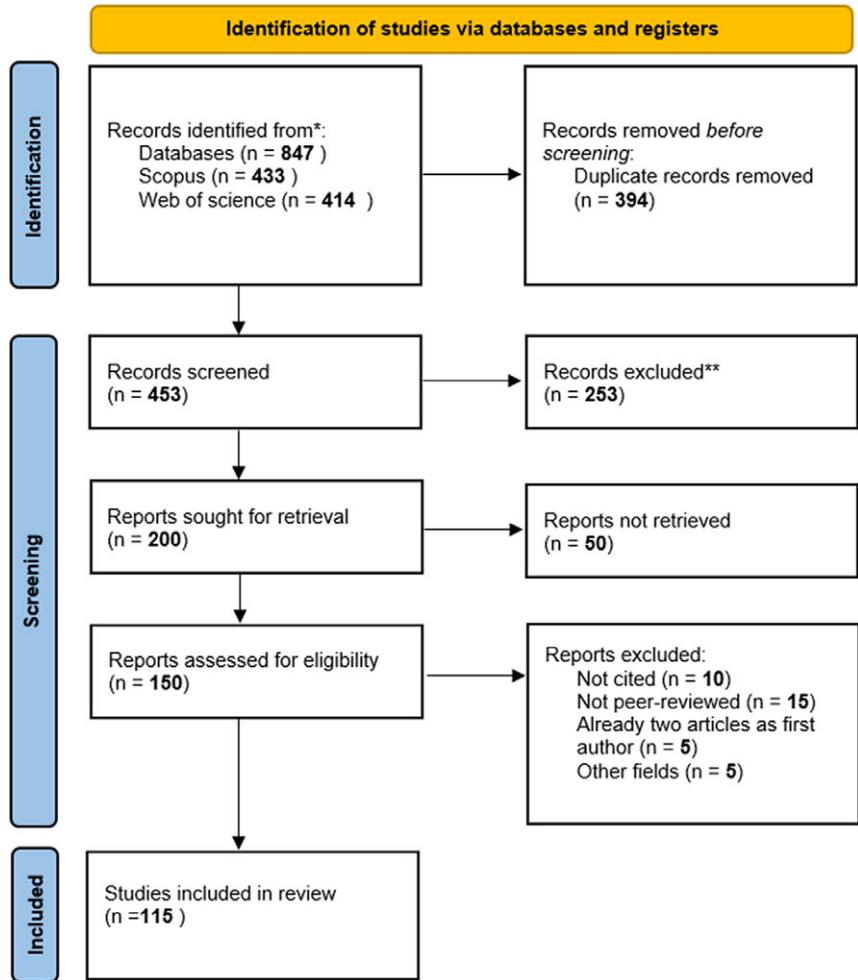


Figure 4. PRISMA flow diagram.

Title	Year	Authors
The Function of co-creation in dynamic mechanism of intersubjectivity formation among individuals	2018	A. Matsumae; Y. Nagai
Dynamic relationship design of knowledge co-creating cluster: traditional Japanese architectural industry	2020	Akane Matsumae; Susumu Matsumae; Yukari Nagai
The chameleon effect: the perception-behavior link and social interaction	1999	Chartrand, T.L., Bargh, J.A.
Infant Intersubjectivity : Research, Theory, and Clinical Applications	2001	Colwyn Trevarthen; Kenneth J. Aitken
Repair After Next Turn: The Last Structurally Provided Defense of Intersubjectivity in Conversation	1992	Emanuel A. Schegloff
Intersubjectivity as a way of informing teaching design for a community of learners classroom	2001	Eugene Matusov
Amédée or How to Get Rid of It: Social Representations from a Dialogical Perspective	2000	Ivana Marková
Development of design collaboration skills	2012	Kleinsmann, M., Deken, F., Dong, A., Lauche, K.
Analytic impasse and the third: Clinical implications of intersubjectivity theory	2006	Lewis Aron
Rethinking Language, Mind, and World Dialogically	2009	Linell, P.
The Relational Habitus: Intersubjective Processes in Learning Settings	2012	Lynda D. Stone; Charles Underwood; Jacqueline Hotchkiss
Socio-cognitive Functions of L1 Collaborative Interaction in the L2 Classroom	1998	Marta Antón; Frederick DiCamilla
Developing open intersubjectivity: On the interpersonal shaping of experience	2015	Matt Bower
Cultural learning	1993	Michael Tomasello; Ann Cale Kruger; Hilary Horn Ratner
Nonverbal communication, affective sharing, and intersubjectivity	1992	Mundy, P., Kasari, C., Sigman, M.
Dialogicality in languages, minds and brains: is there a convergence between dialogism and neuro-biology?	2007	Per Linell
Nonverbal Communication, Affective Sharing, and Intersubjectivity	1992	Peter Mundy; Connie Kasari; Marian Sigman
Supporting the development of shared understanding in distributed design teams	2017	Philip Cash; Elies A Dekoninck; Saeema Ahmed-Kristensen
An Attempt to Understand Social Relationships Using Facial Expression Electromyography Analysis	2021	Quentin Ehkirch; Saya Kakiuchi; Yuki Motomura; Susumu Matsumae; Akane Matsumae
An experimental method for inquiring into communication	1973	Rolv Mikkel Blakar
The relational habitus: Intersubjective processes in learning settings	2012	Stone, L.D., Underwood, C., Hotchkiss, J.
Enactive intersubjectivity: Participatory sense-making and mutual incorporation	2009	Thomas Fuchs; Hanne De Jaegher
The extended body: a case study in the neurophenomenology of social interaction	2012	Tom Froese; Thomas Fuchs
The Roots of Empathy: The Shared Manifold Hypothesis and the Neural Basis of Intersubjectivity	2003	Vittorio Gallese
Husserl and Transcendental Intersubjectivity	2001	Zahavi, D.

Figure 5. List of primary studies.

Title	Year	Authors
Collective mind in Organizations: Heedful Interrelating on Flight Decks	1993	Karl E. Weick; Karlene H. Roberts
Activity Settings as the Unit of Analysis: A Theoretical Basis for Community Intervention and Development	1993	Clifford R. O'Donnell; Roland G. Tharp; Kathleen Wilson
On Intersubjective Engagement in Autism: A Controlled Study of Nonverbal Aspects of Conversation	2007	Rosa M. Garcí'a-Pe'rez, Anthony Lee; R. Peter Hobson
Moving Beyond Computational Cognitivism: Understanding Intentionality, Intersubjectivity and Ecology of Mind	2008	Agustín Ibáñez; Diego Cosmelli
Work with the beat: How dynamic patterns in team processes effect shared understanding	2020	Philip Cash; Elies Dekoninck; Saeema Ahmed-Kristensen
Using interactive technologies to promote a dialogic space for creating collaboratively: A study in secondary education	2019	Manoli Pifarré
Baby feeding and body sway: an experiment in george herbert mead's "taking the role of the other"	1968	O'Toole Richard; Dubin Robert
Developmental trajectory of intersubjectivity in the second and third year of life: Study of fixed-population and randomindividual effects	2014	Marc Pérez Burriela; Marta Sadurni Bruguéa
The Designer's Body as Resource in Design: Exploring Combinations of Point-of-view and Tense	2020	Dag Svanaes; Louise Barkhuus
The Role of Intersubjectivity in Animal and Human Cooperation	2008	Peter Gärdenfors
Amédée or How to Get Rid of It: Social Representations from a Dialogical Perspective	2000	Ivana Marková
Patterns of Intersubjectivity in the Constitution of Subjectivity: Dimensions of Otherness	2003	Nelson Ernesto Coelho, Jr.; Luis Claudio Figueiredo
Constitution of the Self: Intersubjectivity and Dialogicality	2003	Ivana Marková
Measuring common knowledge: Latent semantic analysis, linguistic synchrony, and common knowledge in international relations	2020	A Burcu Bayram; Vivian Ta
Socio-cognitive Functions of L1 Collaborative Interaction in the L2 Classroom	1998	Marta Antón; Frederick DiCamilla
Spontaneous emotional coordination of first-born dizygotic twins and singletons with their mothers in early infancy	2017	Theano Kokkinaki; Maria Markodimitraki
A Cultural Psychological Reflection on Collaborative Research	2007	Flora Cornish; Tania Zittoun; Alex Gillespie
Framing Design: A Social Process View of Information System Development	1998	Susan Gasson
Analytic impasse and the third: Clinical Implications of intersubjectivity theory	2006	Lewis Aron
Experimental methods for studying "elementary motor mimicry"	1986	Janet Beavin Bavelas; Alex Black; Charles R. Lemery; Scott MacInnis; Jennifer Mullett
An Outline of Intersubjectivity: The Development of Recognition	1990	Jessica Benjamin
An experimental method for inquiring into communication	1973	Rolv Mikkel Blakar
Father–newborn vocal interaction: A contribution to the theory of innate intersubjectivity	2021	Caroline Boiteau; Theano Kokkinaki; Carol Sankey; Aude Bul; Maya Gratier; Emmanuel Devouche
Perspective Making and Perspective Taking in Communities of Knowing	1995	Richard J. Boland; Jr.;Ramkrishnan V. Tenkasi
Developing open intersubjectivity: On the interpersonal shaping of experience	2015	Matt Bower
Bodily Connectedness: Designing Affective, Movement-based Communication Media	2019	Yulia Brazauskayte
Identity and interaction: a sociocultural linguistic approach	2005	Mary Bucholtz; Kira Hall
Supporting the development of shared understanding in distributed design teams	2017	Philip Cash; Elies A Dekoninck; Saeema Ahmed-Kristensen
Interaction between impaired and unimpaired speakers : Inter-subjectivity and the interplay of culturally shared and situation specific knowledge	1999	Sarah Collins; Ivana Markova
Interpersonal Perceptions and Metaperceptions Psychotherapeutic Practice in the Interexperiential Realm	2009	Mick Cooper
Human Cognition in Context: On the Biologic, Cognitive and Social Reconsideration of Meaning as Making Sense of Action	2008	Diego Cosmelli; Agustín Ibáñez
Communication between Children with Deafness, Blindness and Deafblindness and their Social Partners: An Intersubjective Developmental Perspective	2015	Saskia Damen; Marleen J. Janssen; Wied A. J. J. M. Ruijsseenaars; Carlo Schuengeld
A PET Exploration of the Neural Mechanisms Involved in Reciprocal Imitation	2002	J. Decety; T. Chaminade; J. Grèzes; A.N. Meltzoff
Neural correlates of feeling sympathy	2003	Jean Decety; Thierry Chaminade
Human Empathy Through the Lens of Social Neuroscience	2006	Jean Decety; Claus Lamm
Grasping intersubjectivity: an invitation to embody social interaction research	2017	Hanne De Jaegher; Barbara Pieper; Daniel Clénin; Thomas Fuchs
Intersubjectivity and other grounds for action-coordination in an environment of restricted interaction: Coordinating with oncoming traffic when passing an obstacle.	2019	Arnulf Deppermann
Dialogue About Dialogue - Investigating Intersubjectivity in Interview Research	2008	DeTurk, S.; Foster, E
Developing intersubjectivity and teamwork skills through learning circles on clinical placement: A mixed methods study	2021	Thea van de Mortel; Stephen Billett; Lyn Armit; Valda Frommolt; Creina Mitchell; Marion Mitchell; Julie Shaw; Laurie Grealish
The Personal and the Social: Mead's Theory of the 'Generalized Other'	1997	Dodds AE; Lawrence JA; Valsiner J
Getting the point: The role of gesture in managing intersubjectivity in a design activity	2011	Jared Donovan; Trine Heinemann; Ben Matthews; Jacob Buur
The Function of co-creation in dynamic mechanism of intersubjectivity formation among individuals	2018	A. Matsumae; Y. Nagai
Dialogic resonance and intersubjective engagement in autism	2014	John W. Du Bois; R. Peter Hobson; Jessica A. Hobson
Effects of experience and social context on prospective caching strategies by scrub jays.	2001	N. J. Emery; N. S. Clayton
Parent-Infant Synchrony: Biological Foundations and Developmental Outcomes	2007	Ruth Feldman
What if We Look at the Body? An Embodied Perspective of Collaborative Learning	2021	Juliene Madureira Ferreira
Neuronal Oscillatory Signatures of Joint Attention and Intersubjectivity in Arrhythmic Coaction	2021	Alexander Maÿe; Tiezhi Wang; Andreas K. Engel
Mimetic Self-Reflexivity and Intersubjectivity in Complementary and Alternative Medicine Practices: The Mirror Neuron System in Breast Cancer Survivorship	2021	Vinita Agarwal
The Interpersonal Neurobiology of Intersubjectivity	2021	Allan N. Schore
Comparison of Japanese and Scottish Mother–Infant Intersubjectivity: Resonance of Timing, Anticipation, and Empathy During Feeding	2021	Koichi Negayama; Jonathan T. Delafield-Butt; Keiko Momose; Konomi Ishijima; Noriko Kawahara
The extended body: a case study in the neurophenomenology of social interaction	2012	Tom Froese; Thomas Fuchs
Enactive intersubjectivity: Participatory sense-making and mutual incorporation	2009	Thomas Fuchs; Hanne De Jaegher
Delusion, Reality, and Intersubjectivity: A Phenomenological and Enactive Analysis	2020	Thomas Fuchs
On seeing ourselves as others see us: Self-other agreement and discrepancy in personality ratings	1980	David C. Funder
Designing for intersubjectivity and dialogicality in museum interactive installations about migration	2020	Areti Galani; Abigail Durrant; David Chating; Rebecca Farley
The role of embodiment and intersubjectivity in clinical reasoning	2015	Shaun Gallagher; Helen Payne

Figure 6. List of selected studies.

Title	Year	Authors
Theory, practice and performance	2016	Shaun Gallagher
The Roots of Empathy: The Shared Manifold Hypothesis and the Neural Basis of Intersubjectivity	2003	Vittorio Gallese
Intersubjectivity as a Measure of Social Competence Among Children Attending Head Start: Assessing the Measure's Validity and Relation to Context	2015	Rebecca R. Garte
A sociocultural, activity-based account of preschooler intersubjectivity	2016	Rebecca R. Garte
Being other: Intersubjectivity, allocentrism and the possible	2019	Vlad Petre Glaveanu
Constructing intersubjectivity in representational design activities	2000	Rafael Granados
Establishing Second-Person Forms of Contemplative Education: An Inquiry into Four Conceptions of Intersubjectivity	2009	Olen Gunnlaugson
Discourse as an interactional achievement: Some uses of 'uh huh' and other things that come between sentences	1982	Emanuel A. Schegloff
Halting aphasic interaction: Creation of intersubjectivity and spousal relationship in situ	2010	Tarja Aaltonen; Minna Laakso
The Special Challenges of Psychotherapy with Persons with Psychosis: Intersubjective Metacognitive Model of Agreement and Shared Meaning	2017	Ilanit Hasson-Ohayon; Shlomo Kravetz; Paul H. Lysaker
Metacognition and Intersubjectivity: Reconsidering Their Relationship Following Advances From the Study of Persons With Psychosis	2020	Ilanit Hasson-Ohayon; Andrew Gumley; Hamish McLeod; Paul H. Lysaker
New Perspectives on Emotional Contagion: A Review of Classic and Recent Research on Facial Mimicry and Contagion	2014	Elaine Hatfield; Lisamarie Bensman; Paul D. Thornton; Richard L. Rapson
Beyond intersubjectivity: Task orientation and first language use in foreign language discussions	2013	Eric Hauser
Neurodivergent intersubjectivity: Distinctive features of how autistic people create shared understanding	2019	Brett Heasman; Alex Gillespie
Self, Identity, and Globalization in Times of Uncertainty: A Dialogical Analysis	2007	Hubert J. M. Hermans; Giancarlo Dimaggio
The Quality of Design Participation: Intersubjectivity in Design Practice	2012	Denny K. L. Ho; Yanki C. Lee
Empathy @ design research: a phenomenological study on young people experiencing participatory design for social inclusion	2011	Denny Kwok-leung Ho; Jin Ma; Yanki Lee
Imitation, Empathy, and Mirror Neurons	2009	Marco Iacoboni
Identity in whose eyes?: the role of representations in identity construction	2002	Caroline Howarth
Intersubjectivity and the domains of social interaction: proposal of a cross-sectional approach	2018	Melisa Stevanovic; Sonja E. Koski
How do we perceive the pain of others? A window into the neural processes involved in empathy	2005	Philip L. Jackson; Andrew N. Meltzoff; Jean Decety
The Room of Opportunity: understanding phases of creative knowledge processes in innovation	2014	Ingunn Johanne Ness; Gunn Elisabeth Søreide
The Third Figure: The Creation of Intersubjectivity in Ethnographic Drawing	2021	Jasamin Kashiropour
Interspatial subjectivities: engineering in virtual environments	2011	Elizabeth Keating; Sirkka L. Jarvenpaa
Fixing the mirrors: A feasibility study of the effects of dance movement therapy on young adults with autism spectrum disorder	2015	Sabine C Koch; Laura Mehl; Esther Sobanski; Maik Sieber; Thomas Fuchs
Paternal questioning as a component of innate intersubjectivity in early infancy	2019	Theano Kokkinaki
Convention and Intersubjectivity: New Developments in French Economics	2006	John Latsis
Scaffolding wiki-supported collaborative learning for small-group projects and whole-class collaborative knowledge building	2016	C-Y. Lin; C.M. Reigeluth
Dialogicality in languages, minds and brains: is there a convergence between dialogism and neuro-biology?	2007	Per Linell
Interactivities, intersubjectivities and language: On dialogism and phenomenology	2014	Per Linell
Partial intersubjectivity and sufficient understandings for current practical purposes: On a specialized practice in Swedish conversation	2016	Per Linell; Jan Lindström
Interpersonal perception in a social context	1990	Thomas E. Malloy; Linda Albright
Taking and Coordinating Perspectives: From Prereflective Interactivity, through Reflective Intersubjectivity, to Metareflective Sociality	2008	Jack Martin; Bryan W. Sokol; Theo Elfers
Dynamic relationship design of knowledge co-creating cluster: traditional Japanese architectural industry	2020	Akane Matsumae; Susumu Matsumae; Yukari Nagai
Intersubjectivity Without Agreement	1996	Eugene Matusov
Intersubjectivity as a way of informing teaching design for a community of learners classroom	2001	Eugene Matusov
Measuring Responses to Nonverbal Social Signals: Research on Affect Receiving Ability	2017	Ross Buck; Mike Miller; Stacie Renfro Powers
The Achievement of Intersubjectivity through Embodied Completions: A Study of Interactions Between First and Second Language Speakers	2006	Junko Mori; Makoto Hayashi
Nonverbal Communication, Affective Sharing, and Intersubjectivity	1992	Peter Mundy; Connie Kasari; Marian Sigman
On Studying Ethnology (Not Just People, Societies in Miniature): The Necessities of Ethnography, History, and Comparative Analysis	2007	Robert Prus
Repair After Next Turn: The Last Structurally Provided Defense of Intersubjectivity in Conversation	1992	Emanuel A. Schegloff
On the Architecture of Intersubjectivity	1976	Ragnar Rommetveit
Effect of subjective perspective taking during simulation of action: a PET investigation of agency	2001	Perrine Ruby; Jean Decety
What you believe versus what you think they believe: a neuroimaging study of conceptual perspective-taking	2003	Perrine Ruby; Jean Decety
Building intersubjectivity in blended problem-solving tasks	2021	Rossana Beraldo; Susanna Annesse; Neil Schwartz; M. Beatrice Ligorio
Humans Have Evolved Specialized Skills of Social Cognition: The Cultural Intelligence Hypothesis	2007	Esther Herrmann; Josep Call; Maria Victoria Hernández-Lloreda; Brian Hare; Michael Tomasello
Consensus and collaboration: norm-regulated behaviour in industrial marketing relationships	1997	Robert E. Spekman; Deborah J. Salmond; C. Jay Lambe
From Intersubjectivity to Group Cognition	2016	Gerry Stahl
The Relational Habitus: Intersubjective Processes in Learning Settings	2012	Lynda D. Stone; Charles Underwood; Jacqueline Hotchkiss
Cultural learning	1993	Michael Tomasello; Ann Cale Kruger; Hilary Horn Ratner
Chimpanzees understand psychological states – the question is which ones and to what extent	2003	Michael Tomasello; Josep Call; Brian Hare
Infant intersubjectivity : Research, Theory, and Clinical Applications	2001	Colwyn Trevarthen; Kenneth J. Aitken
Embodied Human Intersubjectivity: Imaginative Agency, To Share Meaning	2012	Colwyn Trevarthen
Musical Intersubjectivity	2019	Gro Trondalen
Dyadically expanded states of consciousness and the process of therapeutic change	1998	Edward Z. Tronick; Nadia Bruscbweiler-Stern; Alexandra M. Harrison; Karlen Lyons-Ruth; Alexander C. Morgan; Jeremy P. Nahum; Louis Sander; Daniel N. Stern
Positioning and interpretative repertoires: Conversation analysis and post-structuralism in dialogue	1998	Margaret Wetherell
Creating intersubjectivity during socio-dramatic play at an Australian kindergarten	2009	Victoria Whittington; Irene Floyd
Beliefs about beliefs: Representation and constraining function of wrong beliefs in young children's understanding of deception	1983	Heinz Wimmer; Josef Perner
An Attempt to Understand Social Relationships Using Facial Expression Electromyography Analysis	2021	Quentin Ekhkirch; Saya Kakiuchi; Yuki Motomura; Susumu Matsumae; Akane Matsumae

Figure 6. Continued.