

# **From Intersubjectivity to Group Cognition**

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The question of how it is possible for people to understand each other has been a controversial theme throughout the recent history of philosophy. It is a foundational issue for the social sciences, in which researchers try to understand the behaviors and statements of other people. It is of particular relevance to CSCW and CSCL, where participants have to understand, work with and learn with each other. Philosophers have posed the issue of how an individual can understand another and how a small group or community can have a joint understanding, shared intentionality or we-awareness. Studies of CSCW not only adopt insights from the philosophy of intersubjectivity to ground their methodology, they also contribute to the analysis of how intersubjectivity is established in concrete settings, including in virtual environments. Similarly, CSCL research can investigate how groups of people learn to construct intersubjective understandings in both traditional and technologically enhanced interactions. While classical phenomenology of intersubjectivity started from the cognitions of a solitary mind, the notion of intersubjectivity has subsequently shifted to a more social view. Recent studies of intersubjectivity suggest a structure of group cognition, which can provide a foundation for collaboration in work and learning that incorporates but transcends individual cognition.

While ‘intersubjectivity’ is a modern term, it points to an issue that is both as old as philosophy and as current as the lead article (Tenenber, Roth & Socha, 2015) in this journal issue. Intersubjectivity is what makes we-awareness possible. By referencing a realm between or encompassing multiple people, intersubjectivity raises the question of whether knowing, thinking or being aware are at base matters of individual humans or collectivities. The following historical review of the philosophy of intersubjectivity will trace a shift from a foundation in individual minds to one in groups or communities. It will consider the central statements concerning intersubjectivity from Husserl, Schutz, Heidegger, Merleau-Ponty, Hegel, Marx, Vygotsky and Tomasello. Implications of the philosophic conception of intersubjectivity for CSCW (computer-supported cooperative work) and CSCL (computer-supported collaborative learning)

methodology—in which the analytic foundation in individual or group cognition is currently highly contentious—will then be suggested and related to research in these fields.

The issue of intersubjectivity is paramount to our times. The major geo-political issues of the day concern how people around the shrinking globe can understand each other and relate in unity to their shared world. How can the rich and the poor see eye to eye on global ecology; how can former colonial powers and former colonies work together for peace and mutual benefit; how can populations with incompatible politics, ideology, religion and economic interests co-exist? We do not adequately grasp how people understand each other even in dyads, let alone in international communities. Researchers in CSCW and CSCL could contribute to such a comprehension, but they tend to get distracted with methodological concerns based on outmoded philosophies and approaches misappropriated from the natural sciences.

The problematic of intersubjectivity emerged in response to the growth of the social sciences a century ago. The first explicit systematic discussion was in the phenomenology of Husserl, grappling with issues in traditional philosophy. Although the historical movement from intersubjectivity to group cognition followed multiple intertwined paths, this chapter will present a single conceptual thread, aligned with facets of the lead article. It will review the core discussions of intersubjectivity in the primary philosophic texts that defined the concept. As we will see, the term ‘intersubjectivity’ is ambiguous. It can refer to the problem of how two or more minds can inter-relate: understand each other and work together from their individual cognitive positions. It can also refer to a form of joint cognition that is shared by a group and transcends, unifies or even founds the cognition of the participating individuals. This chapter will trace an evolution in philosophy from the former view to the later, and will propose a view of intersubjectivity as group cognition, appropriate to CSCW and CSCL.

## **The philosophy of subjectivity: Plato, Descartes, Kant**

Socrates was the poster child for the self-reflective individual, who radically examined his own life and thought. However, in the end he submitted to Athenian society as the collectivity to which he fundamentally belonged. Perhaps horrified by the consequence of Socrates’ refusal to break with his corrupt, irrational and unheeding community, Plato (340 BCE/1941) metaphorically left his fellow citizens behind in the dark cave of their traditions and illusions to emerge into true knowledge as an isolated individual. Thenceforth, truth, knowledge and learning were no longer matters founded in traditional society, but concerned eternal ideas discoverable through individual critical reflection.

The focus on individual thought found its ultimate formulation in Descartes (1633/1999). In his argument—popularly formulated as “I think, therefore I am”—Descartes claimed that as much as he tried to doubt the reality of everything, he could not doubt that he was thinking, because his doubt was itself an instance of him thinking. If he was thinking, then there must be a subject (namely him) who was doing the thinking. Descartes thereby established as a foundation for philosophy and all knowing that an individual thinking subject existed. This raised subsequent problems, which were much harder for Descartes and his successors to address: how can this radically doubting individual subject be certain about knowledge of any object in the physical world (the problem of epistemology) and how can this isolated individual subject be certain about knowledge of other people’s minds (the problem of intersubjectivity). How can one even know that a world or that other people exist external to the individual thinking subject (the problem of solipsism)?

There were many attempts to address the problems left in Descartes’ wake. These produced philosophies of empiricism, rationalism, materialism, idealism, etc. Some of these were adopted as foundations of scientific method and are still assumed in many contemporary research methodologies. Kant (1787/1999) came up with a synthesis of the major philosophic approaches of his time, still focusing

on the individual human mind as the seat of pure reason. He argued that the only access we have to the world is to versions of objects that we have constructed ourselves from our sense perceptions. We structure what we sense from the world that is external to our individual minds. We do so in terms of categories of time, space and causality, which we impose in constructing the world as knowable. That provides us with a view of the world that makes sense to us, with persistent, meaningful objects. Kant's solution to the problem of epistemology provides a form of constructivism that makes impossible 'objective' knowledge (other than logical deductions) in a naïve sense. Kant demonstrated that there are many questions that are meaningless to pose—often because they presume to peek behind the constructions that our understanding of the world unavoidably erects.

## The phenomenology of intersubjectivity: Husserl

While philosophy has always been concerned with the nature of subjectivity, the first major discussion of inter-subjectivity was by Husserl. He devoted his popular introduction to phenomenology to the problem of intersubjectivity. His *Cartesian Meditations* (Husserl, 1929/1960) was presented at the Sorbonne in 1929. (Merleau-Ponty was in the audience as a student.) This was a couple years after Husserl's student and assistant, Heidegger, had published *Being and Time*, but Husserl's presentation was as yet unaffected by that. Husserl was concerned with the crisis of the philosophical foundations of the sciences. Dilthey and others had differentiated the human sciences from the natural sciences. Einstein and quantum theory were shaking the physical sciences with the idea that observation was relative to the observer. The foundations of logic and mathematics were in dispute. Weber and others were formulating social sciences (linguistics, anthropology, as well as sociology) in terms of meaning and interpretation, hard to objectify.

Husserl began from Descartes' argument. It starts with the solitary subject ('I') doubting everything except its own existence. In five chapters or 'meditations,' Husserl builds toward the central problem, intersubjectivity: How can I know another person—that he<sup>1</sup> exists or what he means when he speaks? For a social science today, such as CSCW, this asks: How does one person relate to co-workers as equally human, how does one understand the meaningful actions and statements of others? Also: How does a researcher analyze the meaning created in the discourse and in the work products of cooperating workers?

After introducing Descartes' position in his first meditation, Husserl shows how minds construct meaningful objects. At first, cognition is intentional, that is, directed toward some phenomenon.<sup>2</sup> For instance, if my cognition is directed toward a six-sided die, I perceive at any instant only evidence of certain sides. However, over time my consciousness can synthesize the die as having six sides, perceptible from different perspectives. Then the die is intended by my consciousness as given with more than the immediate evidence. The meaningful die is temporally constituted by a series of perceptions and synthesizing acts in my stream of consciousness. I understand the perceived view of the die as having a horizon of possibilities, anticipations or potential remembrances that is given with the immediate perception as belonging to the meaning of the phenomenon of the observed view of the die. Husserl's third and fourth meditations outline his extensive phenomenological analyses of how the solitary subject constitutes its world and its lived temporality, starting from elementary cognitive experiences.

For Husserl, we construct or constitute our experiences of things, including other people, through sequences of cognitive acts, which are generally not conscious, but pre-reflective. Our knowledge of

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<sup>1</sup> The masculine pronoun is used throughout this paper to refer to people of all genders, in keeping with traditional English grammar and philosophic usage.

<sup>2</sup> The notion of intentionality was first developed by Husserl's teacher, Brentano (1874). As the lead article explains, it means that consciousness is always consciousness of something, always directed at something.

<sup>3</sup> Evolutionary development of mirror neurons and increased brain structure on the biological level may have accompanied and facilitated this increased sense of mutuality on the cultural level as a competitive advantage (Gallese & Lakoff, 2005), but see also (Hickok, 2014).

another person is constituted through our own processes of constructing our experience of them. We can, for instance, construct an understanding of someone else's behavior as the behavior of a person who is human like us, has a stream of consciousness like ours and has understandings like ours. We can assemble evidence for our understanding of the other person from experiences we have had—both our experiences of the other person and our own experiences that are similar or relevant. For instance, we observe our own bodies and those of others—and we see that the other is like us.

In his concluding fifth meditation, Husserl reaches the goal of his presentation and gives us a summary of the first major extended analysis of intersubjectivity. He departs from Descartes and argues that we can experience other people as also sentient beings who experience the world as we do. In fact, this makes the world a shared, intersubjective one. We experience the socially shared world from our own perspective and we see other people as also experiencing this same world from their positions:

I experience others in shifting experiential manifolds. On the one hand, as objects in the world. Not just as mere natural things, but also experienced as psychically active in the natural bodies to which they each belong. On the other hand, I experience them simultaneously as subjects of this world, as experiencing this world—this same world that I experience myself. They are experiencing it with me, as I experience it and as within it I experience them.

Even within my purely cognitive life, I experience the world including other people and the associated meaning not as a so-to-say private construction of synthesis, but as other than mine, as *intersubjective*, as existing for everyone, as having its objects accessible to everyone....

To the character of the world and particularly of nature as objective, there belongs its being there for everyone, as constituted by us whenever we speak of objective reality. To this belongs the objects of the experienced world having mental characteristics, which refer to human subjects by their origins and meaning—and in general refer to other subjects and their actively constituting intentionality. This includes all cultural objects (books, tools and all kinds of works, etc.), which also carry with them the experiential meaning of being there for everyone. That is, for everyone of the corresponding cultural community, such as the European or more specifically the French. (Husserl, 1929/1960, §43, my translation)

Husserl overcomes the solipsism of Descartes by showing that I experience others as fellow subjects in a shared world. However, this all takes place in my own consciousness and experiences. So it is not meaningful to ask if my understanding of the other person's behavior is identical to the other person's understanding of their own behavior. The gulf of intersubjectivity is spanned by Husserl in that we can construct an understanding of the other person as a person, with their own understandings. Nevertheless, we cannot erase the gulf and obtain direct knowledge of their understanding. Any two people construct their own understanding of the shared world (including themselves and each other) from the perspective of their own subjectivity (stream of consciousness, personality, personal history, body position).

## **The social science of intersubjectivity: Schutz**

Schutz explicitly applied Husserl's approach to the social sciences, specifically to Weber's sociology. In 1932, he published a detailed and relatively clear book on the meaning-full construction of the social world (Schutz, 1932), centered around a chapter on "Foundations of a theory of intersubjective understanding." While occasionally referencing Heidegger, Schutz remained true to Husserl's phenomenology, starting from the cognitions of an individual consciousness and constructing the intersubjective world from that basis. This was also consistent with the methodological individualism of Simmel and Weber, which held that "all concrete social phenomena should be traced back to the modes of individual behavior" (Schutz, 1932/1967, p. 4).

Schutz starts from Husserl's conclusion of the intersubjectivity of the world, namely that people take for granted the existence of other people as having the same kinds of temporal streams of consciousness

and as sharing the same social world. However, since people constitute the world from their own perspective (in terms of their own bodily location, personal history, ingrained habits, action goals and subjective experiences), “the concept of the other person’s intended meaning remains at best a limiting concept” (p. 98). We can only approach an understanding of another’s cognition to a degree and without certainty.

To understand another person takes a reflective act. The other person typically does not understand his own action in this way: he is simply acting, not reflecting on his action. Thus, it does not even make sense to ask if a researcher’s understanding of a subject’s action corresponds to the subject’s own understanding, since the subject probably does not have that kind of reflective understanding. If a researcher tries to triangulate his interpretation by asking a subject questions (in a test, a questionnaire, an interview, a focus group), then the subject may start to reflect on the relevant prior actions, but his newly constructed understanding or response was not something present at the time of the action, let alone motivating it. Nor is the subject’s retroactive self-understanding qualitatively superior to an observer’s understanding of the subject, except that the subject may have access to a richer array of information about himself and his past. Like the researcher’s analysis, the subject’s self-understanding is also a speculative reconstruction from a series of perceived experiences.

Schutz provides analyses of meaning making, sign systems and artifacts, as they enter into our understanding of other people and of their communications, actions and interactions. He also describes concepts of ‘in-order-to motives’ and ‘because motives,’ which can be used for understanding statements and actions, without attributing explicit knowledge to the actor. These feed into Schutz’ interesting discussions of the thou-orientation, the we-relationship, face-to-face situations and direct social observation.

The *thou-orientation* is a pre-reflective awareness of another person as a fellow human, who has consciousness and experiences similar in kind to my own. It thus embodies the intersubjectivity in which others are recognized as indubitable, aware, thoughtful and human. To understand another in this way is to attribute meanings, desires and plans to him. It is the first stage of intersubjectivity as a relationship between two individual subjects.

When the thou-orientation becomes reciprocal, it forms a *we-relationship*, in which another and I experience the world together as a shared world. Schutz provides this example: “Perhaps while I was following the bird’s flight I noticed out of the corner of my eye that your head was moving in the same direction as mine. I could then say that the two of us, that *we*, had watched the bird’s flight” (p. 165). Although we have experienced something together, that does not mean that we had the same subjective experience. For me to think about your experience, I have to step back from our we-relationship and reflect on evidences about your experience that are available to me. This is a second stage of intersubjectivity including reciprocity: I am aware that you are experiencing the same world as I am and we are doing it together. Schutz’ we-relationship is the foundation for the lead article’s we-awareness.

When two people are engaged *face-to-face*, they participate together in an ongoing series of acts of meaning-establishment and meaning-interpretation (such as elicitation/response pairs of discourse utterances, in which I say something and you respond, thereby establishing the meaning of my utterance through its implicit interpretation by your response). In orienting to objects of joint attention, the participants experience the objects as common to both their experiences. They are simultaneously aware of what each other experience as being experienced together. The shared intersubjective world is constituted by this experience in the face-to-face situation. Over time, I understand my partner in terms of his motives (personality, habits). Furthermore, I can check my understanding of the other by asking him questions (e.g., to jointly create meaning and to avoid or repair potential misunderstandings). This all takes place within the merged experiential streams of the face-to-face situation. Although Schutz does not discuss the face-to-face mode of intersubjectivity in any detail, he hints here at an intersubjectivity that is more than the sum of its parts, the two individual subjectivities. Meanings are created through the

interaction between the participants; there are group processes like repair of understandings; and the experience of the world is partially shared, not completely subjective. Schutz' face-to-face intersubjectivity provides a brief foretaste of group cognition.

Schutz then contrasts the face-to-face situation (e.g., of participants collaborating) with *direct social observation* (e.g., by a social-science researcher). Direct social observation is very different from the face-to-face situation. The observer is not engaged in the same undertaking as his subject, nor is he engaged with the subject in a shared context of action. Furthermore, the observer does not have the same kinds of access through interaction to check on and repair his understandings of the subject's subjective experiences, motivations or attempts. The close mutuality and reciprocal mirroring of the face-to-face situation is missing in a context of objective observation. Schutz specifies three possible indirect approaches for scientific observation of a subject's motives: An observer can interpret the subject's behavior in terms of what he imagines he himself might have done under the circumstances. Alternatively, he can take into account the customary behavior of that kind of person (e.g., applying Weber's ideal types). Finally, he can interpret the observed behavior "in terms of the effect which it actually has and assume that the effect is what was intended" (p. 175). These modes of understanding other people and of intersubjectivity appear in various methodologies of CSCW and CSCL research.

## **The being of intersubjectivity: Heidegger**

By the time Husserl's and Schutz' analyses of intersubjectivity were published, Heidegger's implicit repudiation of these theories was already widely read. Although Heidegger emerged from the Husserlian school of phenomenology and was deeply steeped in traditional philosophy, his *Being and Time* presented a radical rejection of the starting point of individual consciousness. In this sense, he left behind not only the constructivism of Kantian pure reason, but also the cognitivism of any methodological individualism. Heidegger's analysis of human existence began with the unity of being-in-the-world, where people exist through their essential involvement in the world. This involvement includes being-there-together in the shared world with other people.

Heidegger's analysis of being-there-with-others (Heidegger, 1927/1996, §§25-27) is laced with barbs against the positions of Husserl and Schutz. Heidegger refers to the enterprise of seeking a transition from the isolated individual to the other as a 'mis-understanding' and explicitly rejects the conception of the unity of the self "as the identity of the I maintaining itself in the multiplicity of its 'experiences'" (p. 122).

Human being as our openness to the world is defined according to Heidegger, first and foremost, by the collectivity of other people, with whom we are concerned and with whom we share a joint world, filled with meaningful artifacts and natural objects that we deal with together. However, this collectivity is described abstractly by Heidegger—not in terms of our family, friends, colleagues, neighbors, community or society. In fact, it is portrayed in rather dark tones, as an oppressive or at least obscuring view of the world through the outlook of an unenlightened mass culture.

Heidegger argues that because we are caught up in this distracting and obscuring culture and are constantly busy with other people, with the objects in the world of our concern and our projects involving them, we cannot see our own true nature as being-there-with-others. Rather, we see things—including other people and even ourselves—in terms of an ontology of physical objects and mental ideas (à la Plato, Descartes and the common sense of the collective). Unfortunately, after his brief but central and pivotal analysis of being-there-with-others, Heidegger shifts from the social basis of human existence, which he had finally uncovered, to a focus on the individual self as a secondary ontological mode, which supposedly provides greater understanding of human being than the collective view. He values this derived mode as more 'authentic,' although ironically it is close to the individualistic reflective mode of Husserl. Heidegger, thus, retreats from the social foundation he briefly established. By not elaborating

this more concretely through contact with the other mainstream of German philosophy developed by Hegel and Marx, Heidegger remains at the level of politically conservative cultural criticism (Adorno, 1964/1973) and heads toward his fateful political error (Stahl, 1975).

## **The corporeality of intersubjectivity: Merleau-Ponty**

Merleau-Ponty studied both Husserl and Heidegger carefully, including their responses to Descartes' problem of intersubjectivity. Merleau-Ponty (1945/2002) fleshed out their analyses with an in-depth analysis of the role of the body and of embodied perception in human being and thinking. His chapter on other people and the human world comes as the culmination of his phenomenological description of human existence. He argues that the experience of another person—such as my sense of the other's grief or anger—is given immediately in my perception of his bodily contact and expression, not mediated through some form of my reflection on what his inner experiences must be like based on remembrances of similar experiences of my own (p. 356). We thus strive to project a shared world, in which we can communicate, for instance about our grief or anger. We each do so from our own bodies, as corporeal actors.

Intersubjectivity is given with our being embodied in a shared world and forms a basis for our subjectivity. Intersubjectivity could not be 'constituted' subsequently by isolated individual consciousnesses. As Merleau-Ponty says, "My greatest attempt at impartiality would never enable me to prevail over my subjectivity (as Descartes so well expresses it by the hypothesis of the malignant demon), if I had not, underlying my judgments, the primordial certainty of being in contact with being itself, if, before any voluntary adoption of a position, I were not already situated in an intersubjective world" (p. 355). Merleau-Ponty adopts Heidegger's view of being-there-with-others as fundamental to the human condition. However, he does so more concretely and persistently. He refers to the perception of the other's body as material, meaningful and expressive. He cites evidence from child development that infants exist in a shared world without even differentiating themselves from others—so that subjectivity is seen to be a derived and learned phenomenon, not a Cartesian starting point.

In addition, Merleau-Ponty looks at the role of language in the perception of other people. Language is essentially social; it transcends the individual and it merges the perspectives of multiple speakers. He describes eloquently how dialogue can establish a shared thinking in the verbal interaction of two people:

My thought and his are interwoven into a single fabric, my words and those of my interlocutor are called forth by the state of the discussion, and they are inserted into a shared operation of which neither of us is the creator. We have here a dual being, where the other is for me no longer a mere bit of behavior in my transcendental field, nor I in his; we are collaborators for each other in consummate reciprocity. Our perspectives merge into each other, and we co-exist through a common world. In the present dialogue, I am freed from myself, for the other person's thoughts are certainly his; they are not of my making, though I do grasp them the moment they come into being, or even anticipate them. And indeed, the objection which my interlocutor raises to what I say draws from me thoughts which I had no idea I possessed, so that at the same time that I lend him thoughts, he reciprocates by making me think too. It is only retrospectively, when I have withdrawn from the dialogue and am recalling it that I am able to reintegrate it into my life and make of it an episode in my private history. (p. 354)

Through elicitation and response, the utterances of people in dialog produce a cognitive stream that is not attributable to either speaker individually, but is a group process that only makes sense as such. This is a description of collaboration as an intersubjective form of cognition. There is a common world, in which the two personal perspectives are integrated in a single process of meaning making—a 'shared fabric.' The view of an individual's contribution to the dialog is a retroactive view, the result of subsequent reflection and appropriation.

Merleau-Ponty's description of the intersubjective source of my own creativity is particularly striking. The other draws from me thoughts "which I had no idea I possessed." Of course, I did not 'possess' such thoughts ahead of time—they emerged from the discourse. Nevertheless, they were understood by everyone as being my thoughts, from my perspective and due to my agency. Here we get a glimpse of the power of intersubjective collaboration.

This model of intersubjectivity goes beyond Husserl's and Schutz' analyses of the individual's 'transcendental field.' It also escapes Heidegger's version of intersubjectivity as an obfuscating mass culture. Merleau-Ponty agrees that one can step back from intersubjective engagement to reflect on one's personal life, but now with positive insights about one's own thinking that would not otherwise have occurred. Finally, we have a conception of intersubjectivity that values the potential of collaboration and of our concrete joint life in a shared world. Here, intersubjectivity can be a primordial experience, which provides a foundation for individual consciousness.

In recent decades, followers of phenomenology have adopted the shift of starting point from the individual to the shared world, pioneered in Heidegger's being-there-with-others, the later Husserl's life-world and Merleau-Ponty's intersubjectivity. For instance, Schegloff (1991, p. 168) writes, "In Western tradition, it is the single, embodied, minded individual who constitutes the autonomous reality." He then contrasts the view of phenomenologically inspired ethnomethodology and conversation analysis to this earlier dominant cognitivist tradition: "Interaction and talk-in-interaction are structured environments for action and cognition, and they shape both the constitution of the actions and utterances needing to be 'cognized' and the contingencies for solving them." As their names suggest, ethnomethodology describes the pervasive methods that people use for creating social order during their interactions, and conversation analysis describes the patterns of talk that people use to support intersubjective understanding of the public meaning that is thereby created in the shared world. This approach details the rich and orderly variety of mechanisms that are used in human interaction to constitute and maintain intersubjectivity.

In addition to his phenomenological roots, Merleau-Ponty appreciated the other major philosophic tradition in twentieth-century European thought, that of Hegel and Marx, to which we turn next.

## **The dialectic of intersubjectivity: Hegel and Marx**

When the movement of social history became conspicuous with the American and French revolutions, the march of Napoleon and the early stirrings of the industrial working class, Hegel captured the nature of his dynamic times in his philosophy. His early lectures in particular defined a break with Kantian methodological individualism and described the social nature of man (Habermas, 1971; Hegel, 1807/1967). This led to a philosophic approach to subjectivity contrasting to that of Husserlian phenomenology, which had remained neo-Kantian (see Figure 1).



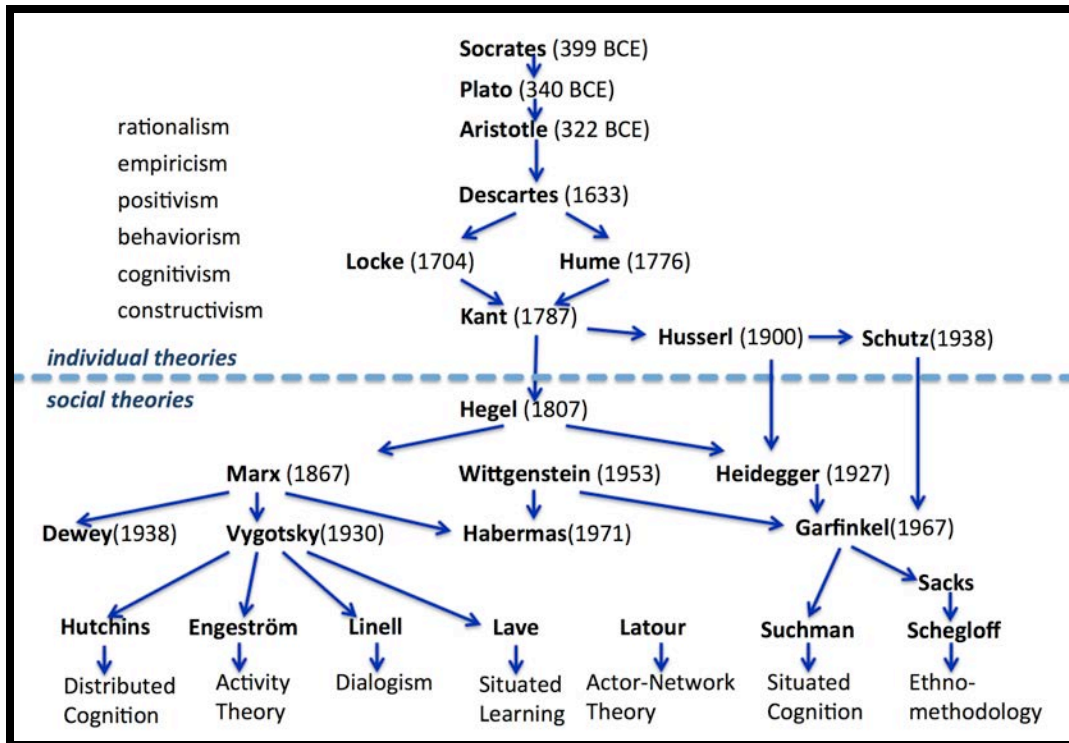


Figure 1. The transition from individualistic to social theories in philosophy and social science.

Until Hegel, human nature and human cognition were conceived as based in the individual person, as fully determined from birth ahistorically or universally—not dependent on one’s biography or social context. The theories that minds develop (Freud), that social relations transform (Marx) or that humanity evolves (Darwin) all came after Hegel—in process-oriented sciences inspired by his philosophy. For Freud, Marx and Darwin, to understand a psyche, a social formation or a species requires understanding the history of its development, complete with its conflicts and resolutions.

Hegel outlined a dynamic view, in which mind develops all the way from primitive sense perception to sophisticated self-consciousness and cultural worldview. In the methodological Preface to his most influential presentation of the development of mind, Hegel (1807/1967) wrote that one must analyze a phenomenon by looking at its unity as the result of its clashing temporal appearances:

The bud, the blossom and the fruit’s fluid nature make them into moments of an organic unity within which ... one is equally as necessary as the other.... The subject matter is not exhausted in its ends; rather, it is exhaustively treated while it is worked out. Nor is the result that is reached the actual whole itself; rather, *the whole is the result together with the way the result comes to be....* What is the most difficult of all is to grasp both what unites the process and the result, and to give a full exposition of what that is. (§2 & 3, my translation and italics)

Let us see how Hegel treated interaction between two people in his famous master/slave dialectic. A person first becomes aware of himself as a particular individual at this developmental stage within Hegel’s system. The analysis focuses on the interaction of people and involves them working with objects in the world. The cognitive effect (self-consciousness) is a result of the whole dynamic of the interaction, not a pre-existing causal agent within the interaction. The prototypical interaction is here that of a worker creating an artifact; the worker recognizes himself as reflected in the product that he created to meet the needs of another person:

Work *gives form* to its object. The worker’s transforming relationship toward the object is transformed into the object’s form and becomes something *persisting*, because for the worker the object gains self-

sufficiency. This transforming mediation—the *activity* of forming—is also the *individuality* of consciousness or the pure being-for-itself of consciousness, which in the work process now steps out of consciousness and takes on the character of persistence. The consciousness of the worker thereby arrives at a perception of the self-sufficient artifact as a perception *of his self*. (Hegel, 1807/1967, p. 238, my translation)

Hegel shows how human consciousness emerges through productive activity in the intersubjective and physical world. The worker and the master (for whom the object is produced) are formed as such (i.e., as self-conscious individuals) through the interaction with each other and with artifacts (tools and products of work) in the world. Hegel describes the emergence of self-consciousness from within the process of mutual recognition of self, world and other. In particular, it is the worker, who produces an artifact in the physical world at the bidding of an other, who is then able to perceive his labor as externalized and made persistent in the artifact. The worker's self-consciousness emerges through his activity in the shared world, where he comes to see himself as objectified in his artifacts and through the eyes of others.

Marx (1867/1976) builds on this analysis of social interaction. He situates Hegel's idealist analysis in the historical context of early capitalism. The artifact that is produced by the worker's labor and that externalizes his self within its social relations to other people is specified within settings of capitalist production into a commodity (an artifact produced for sale on the open market). The worker's self-consciousness is reified, alienated and fetishized because the commodity that reflects his identity is no longer his (but the capitalist's, who sells it) and because his social relations to potential users of the artifact are transformed into the abstract monetary value of the commodity. The meaning of the labor that went into forming the product's use-value undergoes multiple complex transformations: it is externalized into an artifact, the artifact enters commodity relations and the commodity is reflected back to the worker as monetary exchange-value belonging to his boss. For Marx, individuals in capitalist society are analyzed as results of their interactions as wage laborers, owners of the means of production or consumers of commodities. He critiques the traditional notion of the abstract individual consciousness as an ideology of individualism that obscures concrete, historically specific human reality.

In his methodological *Grundrisse*, Marx (1858/1939) identifies the interaction in which the worker exchanges his labor time for the capitalist's wages as the 'cell form' for analysis. His analysis in *Capital* (1867/1976) starts out from the simple dyadic interaction of a worker exchanging the product of his labor with another person. As his inquiry into social production in the capitalist era develops, this elemental intersubjective relation of production is mediated by its dialectical relationship to technology as the social means of production (e.g., the factory system and machinery in their historical development).

Intersubjectivity in this approach of Hegel and Marx is a concrete social and historical product of human labor with material artifacts. The subjectivity of individuals is a subsequent by-product of their interactions within the shared social world. The Kantian view of the individual mind producing the world is stood on its head. Mind is seen as a social product and individualism is characterized as an ideology serving competitive capitalism.

In a contemporary extension of this tradition, Habermas (1971/2001) has argued for viewing communicative action as the basis for intersubjectivity and social theory. He starts by explicitly rejecting the individualism of Kant and Husserl, which do not allow escaping from monadic subjectivity. Incorporating the linguistic turn of Wittgenstein (1953), Habermas reconstructs the possibility of moral behavior and social science from the interpersonal relationship between people engaged in communicative action. The dialectical tradition takes as its starting point the social interaction among people in place of Descartes' isolated subject. It focuses on the dynamic and conflictual mediations of this interaction within the concrete, historical world.

## The mediation of intersubjectivity: Vygotsky

Vygotsky provides a psychology of human cognition appropriate to Marx's methodology of social science. He adopts Marx' analytic cell form: the interaction among people mediated by artifacts. Artifacts are both physically present in the world and meaningful to people. For Vygotsky, the notion of artifact encompasses both tools and language. Their meaning is not projected from individual minds, but is intersubjectively emergent from social interactions, as in the dialectical presentations of Hegel and Marx.

Consider Vygotsky's programmatic effort to show how the individual human mind is grounded in activity within the physical and social world. His description of the genesis of the pointing gesture illustrates a typical early experience of meaning for a small child; it shows how the meaning of this ubiquitous symbolic artifact is created in the intersubjective world and only subsequently incorporated (internalized) in the child's own sense-making repertoire:

We call the internal reconstruction of an external operation *internalization*. A good example of this process may be found in the development of pointing. Initially, this gesture is nothing more than an unsuccessful attempt to grasp something, a movement aimed at a certain object, which designates forthcoming activity.... When the mother comes to the child's aid and realizes this movement indicates something, the situation changes fundamentally. Pointing becomes a gesture for others. The child's unsuccessful attempt engenders a reaction not from the object he seeks but from another person. Consequently, *the primary meaning* of that unsuccessful grasping movement *is established by others*.... The grasping movement changes to the act of pointing. As a result of this change, the movement itself is then physically simplified, and what results is the form of pointing that we may call a true gesture. (Vygotsky, 1930/1978, p. 56, italics added)

Here we see the intersubjective genesis of the meaning of a pointing gesture. The recognized, practical and formalized gesture becomes an artifact: it embodies meaning in the physical world. The meaning of the pointing gesture is its reference to that which is pointed at. The baby and the mother intended some object together in their shared world. Their intersubjective gesture entails that the baby and the mother recognize each other as people who can have intentions and who can recognize intentions of other people. This is a first glimmer of intersubjectivity, in which the baby becomes aware of his own and other people's intentionality. (Of course, the baby cannot yet express this awareness in any verbal or conceptual sense, but only behaviorally.) The key point is Vygotsky's analysis of this gesture artifact as a product of two people interacting, recognizing each other as subjects and together intending something in their shared world. This pointing gesture is a ubiquitous form of reference or deixis, used throughout the human world to support joint attention. In the origin of the infant's first gesture, we already see a model of intersubjective, shared understanding of meaning. The subsequent usage of this pointing gesture is premised upon the mutual recognition of an underlying intention, which emerged within the intersubjective mother-child interaction.

This view of intention as co-constructed in the world stands in sharp contrast to the rationalist assumption that individuals 'have' aims—stored mental contents produced by logical calculations of self-interest as though by a homunculus in their heads—which they then express in speech or action. Marx, Wittgenstein and Heidegger (the primary founders of twentieth-century theory)—and their followers—soundly reject this cognitive picture of agency (see, e.g., Dennett, 1991; Dourish, 2001; Dreyfus, 1992; Ehn, 1988; Suchman, 2007).

The traditional conception of individual agency—in which human actions are caused by mental representations, cognitive schemas or prior plans—contributes to the difficulty of overcoming cognitivist habits of thought. Drawing on contemporary philosophy and social science, Emirbayer and Mische (1998, p. 962) conceptualize agency in Heideggerian temporal terms (with hints of Bourdieu, Giddens and Habermas). They define agency as: “a temporally embedded process of social engagement, informed by the past (in its ‘iterational’ or habitual aspect) but also oriented toward the future (as a ‘projective’ capacity to imagine alternative possibilities) and toward the present (as a ‘practical-evaluative’ capacity to

contextualize past habits and future projects within the contingencies of the moment).” Such a post-cognitive concept of agency could be applied at the group unit of analysis, forming a concept of ‘group agency,’ potentially driving collaboration. This could inform CSCW and CSCL theories. In developing a post-cognitive view of intentionality, it is important to reconsider the notions of agency and causality—as Latour (1990; 1992; 2013) does by extending them to collectivities and to artifacts in actor networks.

A paradigm shift from the traditional focus on individual consciousness to a foundation in intersubjectivity can be motivated by noting anomalies in the established views (Kuhn, 1972). Consider an anomaly in the educational-psychology paradigm of measuring learning outcomes as uncovered by Vygotsky’s analysis of learners’ *zones of proximal development*. In a formulation evoking Hegel, he writes of the need to analyze developmental processes, not just outcomes: “The zone of proximal development defines those functions that have not yet matured but are in the process of maturation, functions that will mature tomorrow but are currently in an embryonic state. These functions could be termed the ‘buds’ or ‘flowers’ of development rather than the ‘fruits’ of development.” He then cites a study in which children “could do only under guidance, in collaboration and in groups at the age of three-to-five years what they could do independently when they reached the age of five-to-seven years” (Vygotsky, 1930/1978, pp. 86, 87). CSCL can be seen precisely as such an effort to stimulate students within their zones of proximal development under guidance, in collaboration and in groups. If the desired results do not show up as learning outcomes measurable in individuals (outside of their group context) for several years, then the key effect will be systematically missed by traditional methods of testing individuals. The failure of the cognitive paradigm of instructional research to account for processes in the zone of proximal development—so central to learning—should be considered an anomaly, suggesting the need for a paradigm shift.

In his less quoted section on “Problems of Method,” Vygotsky (1930/1978, pp. 58-75) called for a new paradigm of educational research almost a century ago. Arguing that one cannot simply look at visible post-test results of an experiment, he approvingly quoted Marx: “if the essence of objects coincided with the form of their outer manifestations, then every science would be superfluous.” He then emphasized, “*To study something historically means to study it in the process of change*; that is the dialectical method’s basic demand. To encompass in research the process of a given thing’s development in all its phases and changes—from birth to death—fundamentally means to discover its nature, its essence.” In Vygotsky’s proposed method of ‘double stimulation,’ a child is confronted by both an object to work on and an artifact to support that work; she learns to mediate her understanding with the use of the artifact. However, Vygotsky does not call for a controlled experiment that compares learning outcomes with and without a furnished artifact. “The experiment is equally valid,” he points out, “if, instead of giving the children artificial means, the experimenter waits until they spontaneously apply some new auxiliary method or symbol that they then incorporate into their operations.” That kind of approach requires an analysis of the children’s situated meaning-making processes and their consequences throughout the interaction trajectory. It requires an attention to the children’s interaction that is oriented to observing and analyzing the sense making that is involved in creative, unanticipated collaborative accomplishments. It involves the unique trajectories of student groups, which cannot be coded and statistically aggregated or sorted into standardized categories.

Vygotsky (1930/1978) outlines an intersubjective conception of the development of human cognition and collaborative learning, which treats the interaction, development and learning of groups with artifacts in the shared world as foundational. We shall see a concrete example of this approach toward the end of this paper. One’s understanding of oneself, of artifacts (including representations, gestures, signs, symbols, language) and of the meaningful world are constructed primarily and originally intersubjectively, socially and culturally. The individual is a result of subsequent processes of internalization, including the transformation by young children of speech as intersubjective communication into self-talk and then silent verbal rehearsal or thinking.

## The evolution of intersubjectivity: Tomasello

Tomasello (2014) complements Vygotsky's dialectical psychology with a corresponding evolutionary anthropology. He offers us a theory of intersubjective intentionality based on an analysis of human evolution and how human intentionality diverged from that of other primates throughout pre-history. Under environmental pressures, humans developed increasingly complex forms of cooperative sociality (see also Seddon, 2014). Tomasello describes a two-step evolutionary sequence: *joint intentionality* followed by *collective intentionality*. At both of these transitions, a similar process took place. "A change of ecology led to some new forms of collaboration, which required for their coordination some new forms of cooperative communication, and then together these created the possibility that, during ontogeny, individuals could construct through their social interactions with others some new forms of cognitive representation, inference, and self-monitoring for use in their thinking" (p. 31).

Perhaps the first step took place in the context of collaborative foraging. Early human individuals—in response to a changing feeding ecology—began to join other individuals in pairs in pursuit of shared goals, and they jointly attended to situations relevant to their common goals.<sup>3</sup> "Each participant in the collaboration had her own individual role and her own individual perspective on the situation as part of the interactive unit" (p. 78). Tomasello highlights this dual-level structure—*simultaneous joint participation and perspectival individuality*—as a defining structure of what he calls joint intentionality. For him, it is foundational for all subsequent manifestations of human shared intentionality. Of course, early humans had always lived in family units and small tribes (like other primates), but now they began to carry out tasks like strategic hunting in small teams as an 'interactive unit.'

The second step took place more recently, as agriculture and domestication of animals led to the founding of the first great civilizations. Modern humans became predominantly cultural beings by identifying with their specific cultural group and collectively creating various kinds of cultural conventions, norms and institutions (p. 80). They thus became thoroughly group-minded individuals. Tomasello argues that the development of joint and collective intentionality provided a necessary foundation for the development of human language and culture, which allowed for the escalating evolutionary emergence of modern human cognition and thinking (p. 128). This rapid form of evolution took place through historically transmitted culture (Donald, 1991; 2001), rather than as biological adaptation. Increasingly, our individual cognition became mediated by and derivative of group, collective, cultural and now even global cognition.

Intersubjectivity—as the recognition of other people as having the same kinds of comprehension capabilities as we do (so-called "theory of mind")—involves perspective taking, being able to view from the other person's position. For instance, to understand what someone says to me, I have to be able to understand the utterance as coming from the other person, as he might have understood it in articulating it. I also have to understand it as having been designed for me to understand it ("recipient design"). So I have to recognize the speaker as someone who understands meaning and can create it, as well as someone who knows how I might understand what he says. This mutual or reciprocal recognition is a precondition for distinctively human communication (e.g., as evolved beyond animal vocal signaling). Intersubjectivity is a foundation for—a condition for the possibility of—modern human interaction (Duranti, 2010).

Of course, our understanding of each other is only tentative and partial. There is no possibility of absolute knowledge of other minds or of identity of mental contents, as Husserl and Schutz argued. Shared understanding is, rather, taken-for-granted, not objective. Furthermore, the sharing is generally developed only to the point necessary to maintain communication (Linell, 2014). In general,

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<sup>3</sup> Evolutionary development of mirror neurons and increased brain structure on the biological level may have accompanied and facilitated this increased sense of mutuality on the cultural level as a competitive advantage (Gallese & Lakoff, 2005), but see also (Hickok, 2014).

understanding is always partial and pragmatic; I only understand even my own thoughts enough to continue engaging in the current activity that involves those thoughts.

As Heidegger (1927/1996) put it, understanding is an aspect of our being-in-the-world, of situated activity rather than of mental cognition. We understand something *as* something to the extent necessary for our dealings with it. Accordingly, our shared understanding with other people should be seen as an aspect of our being-there-with-others in the same world. We share understandings because we share one world; and we do so to the extent necessary for our care for things in the world and our concern for other people as part of our existence in the social world (with our background, our plans, our situation).

The discussion of intersubjectivity in twentieth-century philosophy and social-science theory has moved decisively away from the rationalism of Descartes and its focus on the reasoning of an individual mind. We are embodied in a shared world and we understand ourselves, each other and our world through social interaction, gradual cognitive development and cultural transmission. Intersubjectivity can be more than just the confrontation of independent individuals. It can include the collaborative production of joint meaning in a shared world, where the interaction can result in a unity that is more than a simple aggregate of the inputs of the individuals.

The refined conceptions of shared understanding in our intersubjective world that emerge from the preceding review are suggestive for research in CSCW and CSCL. We turn now to examples of empirical studies from these fields.

## **Intersubjectivity in CSCW**

The lead article documents an instance of intersubjectivity, in which there is joint attention and mutual recognition. Many of the characterizations of forms of intersubjectivity summarized above can be related to the recorded actions of Hank and Danny and to the analysis of the data by the authors.

All of the sources considered above discussed the importance of one person seeing the other and being able to observe that they were attending to the same objects. This was a central theme in the lead article. The pair-programming work environment was carefully structured so that the participants could see each other and could track each other's general gaze. This environment was an interesting hybrid of face-to-face and computer-mediated. In fully online alternative systems discussed in the article, the awareness of joint attention was either supported with specific functionalities or seen to be problematic.

The article explicitly focused on the initial alignment phase of Hank and Danny working together. Consequently, we do not get to observe much of how they subsequently proceed in accomplishing their shared work in a fully intersubjective mode. The data presented gives a glimpse into a very narrow—but critical—slice of the intersubjective experience. As the authors note, Hank and Danny are very much at home in their specific work world and only need to align around the particular task at hand. These programmers are experienced at working together in this paired manner. The physical and technical environment has been carefully set up to support their closely coupled cooperative work, and they move around within it skillfully, without displaying explicitly much of the understanding or practices that contribute to such being-there-with-others.

Paired programming—like intersubjectivity itself—can be viewed in two ways. In one, there is cooperation between two subjectivities, who coordinate their actions and reciprocal understandings of each other in two parallel streams of individual cognition. Excerpts 1 and 2 include division of labor, for instance where Danny will write a list on paper while Hank operates the computer. In this view, one programmer may bring in resources (knowledge, skills, processes, artifacts) that the first does not have, or the second programmer can provide an immediate check on the work accomplished by the first.

In the alternative view, the pair collaborates in a single cognitive process of jointly accomplishing the programming task. For instance, excerpt 3 can be seen as the pair narrowing in on a relevant object together through their joint attention to a list on the screen and their interactive construction of an increasingly narrow focus within that list.

- 3.1 Danny: ((Just before he starts talking, Danny moves left hand that is holding a pen so that the pen points to a specific item on a dropdown menu on the left monitor))  
I bet you if
- 3.2 ((at apex of point, with pen tapped on screen))
- 3.3 ((Hank selects item on list that is four items below Danny's point, which is highlighted on the display))
- 3.4 Danny: you (go?) ((starts to withdraw hand))
- 3.5 Hank: ((Hank uses mouse to move cursor two elements higher on the list))
- 3.6 Danny: bidoni
- 3.7 Hank: ((Hank moves up two additional elements on list, stays there))
- 3.8 Danny: m-t-m black

The authors first describe the actions of the programmers: “Danny uses physical gestures and speech that complement and complete one another to direct Hank to a specific location. Hank uses the mouse for placing the cursor preparatory to acting with it, which, in its visibility to Danny takes a role in the ‘conversation’ that the two are having concerning the specific location of the next operation.” Then the authors nicely summarize the interaction as follows: “They thus combine a variety of semiotic resources to give this fragment its orderly, sequential character.” What they call the programmers’ ‘conversation’ (including words, cursor movements, pointing gestures and mutual bodily visibility) is in fact a single, well-ordered achievement. It is irrelevant which programmer introduced which resource. All the resources received their meaning from the unfolding joint process of locating the cursor on a particular font name so that the team could work on that object. The actions of the two programmers form a single orderly sequence.

In the analysis of this work as a collaboration, the two programmers are seen to be checking—or grounding (Clark & Brennan, 1991)—their understanding of each other through their utterances, repairs, gestures and gazes. This reciprocal testing of interlocutors’ understandings corresponds to the mutual reciprocity of knowledge in some of the theories of intersubjectivity reviewed above. Certainly, Husserl and Schutz, with their orientation to individual consciousnesses, relied heavily on one subject’s knowledge that the other knows that the first knows that.... Even Tomasello focuses on the recursive recognition of other minds as sentient and perspectival. While Tomasello is persuasive that the evolution of this capability of recursive recognition to arbitrary levels was a necessary evolutionary precondition for modern human cognition and collaboration, that does not mean that we must always engage in some sort of mental recognition that you understand that I understand, etc. There may be occasions when this is indeed necessary, but only then does it actually have to be carried out. Furthermore, we have the ability to respond to questioning by making retroactive statements of mutual recognition to arbitrary levels of recursion. However, this need not enter into most activities of joint understanding. Such mutual recognition is already implicit in the fact of joint understanding. It is taken for granted in Heidegger’s being-there-with-others, in which we care for each other as human, or in Merleau-Ponty’s gaze, in which we see the body of the other as another human perspective on our shared world.

In his recommendations for social-science analysis, Garfinkel (1967) noted that common ground is established by the methodical ways in which things are said, not by a process of verifying agreement of the sets of presumed mental contents stored in the heads of the speaker and of the hearer:

For the conduct of their everyday affairs, persons take for granted that what is said will be made out according to methods that the parties use to make out what they are saying for its clear, consistent, coherent, understandable, or planful character, i.e., as subject to some rule’s jurisdiction—in a word as rational. To see the “sense” of what is said is to accord to what was said its character “as a rule.” “Shared

agreement” refers to various social methods for accomplishing the member’s recognition that something was said-according-to-a-rule and not the demonstrable matching of substantive matters. The appropriate image of a common understanding is therefore an operation rather than a common intersection of overlapping sets. (p. 30)

The authors of the lead article have gone to pains to avoid mentalist explanations. They formulate their discussion of aligning visual fields in terms of the methodical ways of establishing joint attention to a shared object rather than as checking that one subject knows that the other is looking at the object and the other knows that the first knows that, etc. The establishment of joint attention—so necessary for collaboration—entails that the people involved are looking at the same object *together*. They do not just happen to be individually oriented to the object, but are oriented toward it in a coordinated way. They do not have to be separately aware of the assumed recursive mutuality of this relationship—unless there is some kind of breakdown that needs to be repaired by checking verbally on the mutuality of gaze to some recursive depth. A contribution of the lead article analysis is to explicate the need to support the participants’ operations of maintaining awareness of the mutuality of their joint attention and to describe their methods of doing so in their hybrid environment.

Just as there is an ambiguity to the method of paired programming between cooperation (with division of labor) and collaboration (working together on each step, although possibly from different perspectives or with different resources), so there is an ambiguity to excerpt 3. While we have viewed the interaction there as a single, coherent, meaningful achievement, it could also be viewed in terms of the distinct actions of two individual subjects. One could argue that Danny had himself identified the item in the list on the computer screen from the start by tapping on it with his pen. Then Hank followed Danny’s guiding gestures to eventually recognize the same item by highlighting it with his cursor. This is a pervasive ambiguity in the analysis of CSCW data. To decide in favor of an analysis that treats the group as the primary agent or one that focuses on the contributions of individuals generally requires detailed interactional data, which is rarely available to researchers. For instance, if excerpt 3 did not include Danny’s bodily gestures and Hank’s computer actions in addition to the spoken discourse, it would be impossible to analyze the identification of the font as a joint achievement.

The alignment phase involves a transition from individual cognition to intersubjective cognition. It therefore contains elements of each and can be analyzed at either the individual or group unit of analysis. At the individual level, it appears that subjects are monitoring each other’s gaze or focus of attention. Here is where the reciprocal and recursive recognition come in and the conception of communicative signals being exchanged. Especially in the case of dyads, it is tempting to analyze individual intentionality and agency in a traditional, individualistic way; in somewhat larger groups, the interaction is often harder to attribute to individuals as the discussion builds on individual utterances in complex ways and takes turns that no one participant planned. At the group level of description, the group is beginning to act as a unity, creating social order and joint meaning in a shared world—not through independent acts of the individual participants, but through the interaction of the group.

The ambiguity is important. The point is not so much to always opt for an individual or a group focus, but to recognize their intertwining: that the individual is a social product, but also that the intersubjective has the individual at its poles. Sometimes one unit of analysis is more useful than the other. Efforts at alignment, in particular, involve a transition from multiple individual cognitions to a unified group cognition. Philosophies of dialogicality have long tried to maintain this balance of what Tomasello calls joint intentionality with individual perspectives, which is not well supported by our inherited conceptualizations (Rommetveit, 2003; Wertsch, 1991). Interaction analysis—as carried out in the lead article—has shown us how to analyze the displayed utterances of individuals as part of intersubjective processes of group meaning making and social-order construction, without hypothesizing hidden mental phenomena (Schegloff, 1991).

To understand we-awareness or intersubjectivity once a team has come into alignment and is working smoothly together, it would be useful to analyze excerpts of interaction in later phases with the



same kind of detail provided for the alignment phase in the lead article. Fuller examples of completely online group work would also be relevant to CSCW. The authors note a paucity of appropriate, detailed data about computer-mediated CSCW interactions on work like paired programming using different mediating technologies. In addition, we might add, there is little data reported about how people first learn to interact skillfully within such contexts. For a suggestion of how intersubjectivity might be analyzed and supported in more contexts, we turn to CSCL.

## Intersubjectivity in CSCL

The relation of CSCW to CSCL has not been widely noted or clearly articulated. Both involve computer support for people interacting. While CSCW has the advantage of studying people who are expert at their work and experienced at working together, CSCL has the advantage of observing how such expertise and such interaction between people is originally constituted and learned. CSCL education can prepare students for careers in CSCW workplaces, and CSCW can display domain-related practices for adoption in CSCL curricula. The two fields share an interest in how individual and intersubjective cognition complement each other and how computer-support artifacts or environments mediate between them.

This section of the paper will review a specific research agenda that explored the nature of intersubjectivity in a variety of small-group math-education settings. It will present examples of intersubjective knowledge building under several diverse, but typical learning conditions, involving computer mediation.

Based on research in CSCW and CSCL, Stahl (2006) proposed a form of intersubjectivity called *group cognition*. Group cognition can be thought of as a form of intersubjectivity that goes beyond the mutual recognition of individual minds in Husserl and the recursive thou-relationship of Schutz to a being-there-with-others that Heidegger and Merleau-Ponty briefly hint at. Its analysis is based on the social-historical-cultural approach of Hegel, Marx and Vygotsky. It is a developed form of Tomasello's joint intentionality with individual perspectives. Group cognition is a vision of intersubjectivity for CSCW and CSCL, which goes beyond the accomplishments of individual cognition within group efforts.

In group cognition, multiple people participate in coherent interactions that achieve cognitive accomplishments that are best analyzed at least in part at the group unit, rather than attributing contributions and agency entirely to individual minds. When a number of people are involved in group-cognitive processes or activities, their individual utterances or actions are taken as merged in a single cognitive system, which is distributed across the people and the artifacts that are involved (Hutchins, 1996). Ideas, practices, habits and traditions from the larger culture are also brought in, so that the group cognition mediates between individual and community units of analysis (Stahl, 2013, Ch. 8).

The original elaboration of the notion of group cognition arose within a series of studies of software environments to support perspectives, negotiation and group formation in specific workplace and school settings (Stahl, 2006, e.g., Ch. 3, 6, 8). It provided, for instance, a detailed example of group cognition, in which a face-to-face student group co-constructed the meaning of a scientific representational artifact in an educational computer simulation in 1998 (Ch. 12 & 13). However, the collection of studies also acknowledged that the vision of group cognition as an effective form of collaborative learning is rarely achieved in practice. Furthermore, it noted the difficulty of finding or collecting data that is adequate for establishing and analyzing group cognition, let alone for observing the mediation across levels of analysis.

Later (from 2002-2015), the Virtual Math Teams (VMT) system was developed as a test ground for studying group cognition. VMT is a collaboration environment for mathematical problem solving by online small groups of students. Reports on pedagogical and methodological issues in VMT (Stahl, 2009)

included analysis of a text chat in which several online students solved a challenging word problem collaboratively that none could solve individually (Ch. 5). The analysis argued that their chat could be viewed as a group-cognitive accomplishment, integrating a chain of interactive responses similar to a solution that could have been stated by one person but here involving the whole group as the problem-solving agent. Another case study (Ch. 7) discussed how three students working online in VMT with a shared graphics whiteboard maintained joint attention to geometric details and organized their graphical, symbolic and narrative interactions to solve an intricate problem in combinatorics collaboratively.

More recently, the VMT environment was extended with a custom multi-user version of GeoGebra, an application for dynamic geometry. A stimulating problem often given to people once they become comfortable with dynamic geometry is that of constructing inscribed triangles that behave like a given pair of inscribed triangles. (See the instructions and inscribed triangles ABC/DEF in Figure 2.) This is a difficult task even for adults who enjoy mathematics. The VMT research team has been looking closely at the logs of a group of three 14-year-old girls who succeeded with this problem in less than an hour. None of the students had studied geometry before joining an after-school math club as part of our research project; they had spent four hours working together on collaborative dynamic geometry before this session.

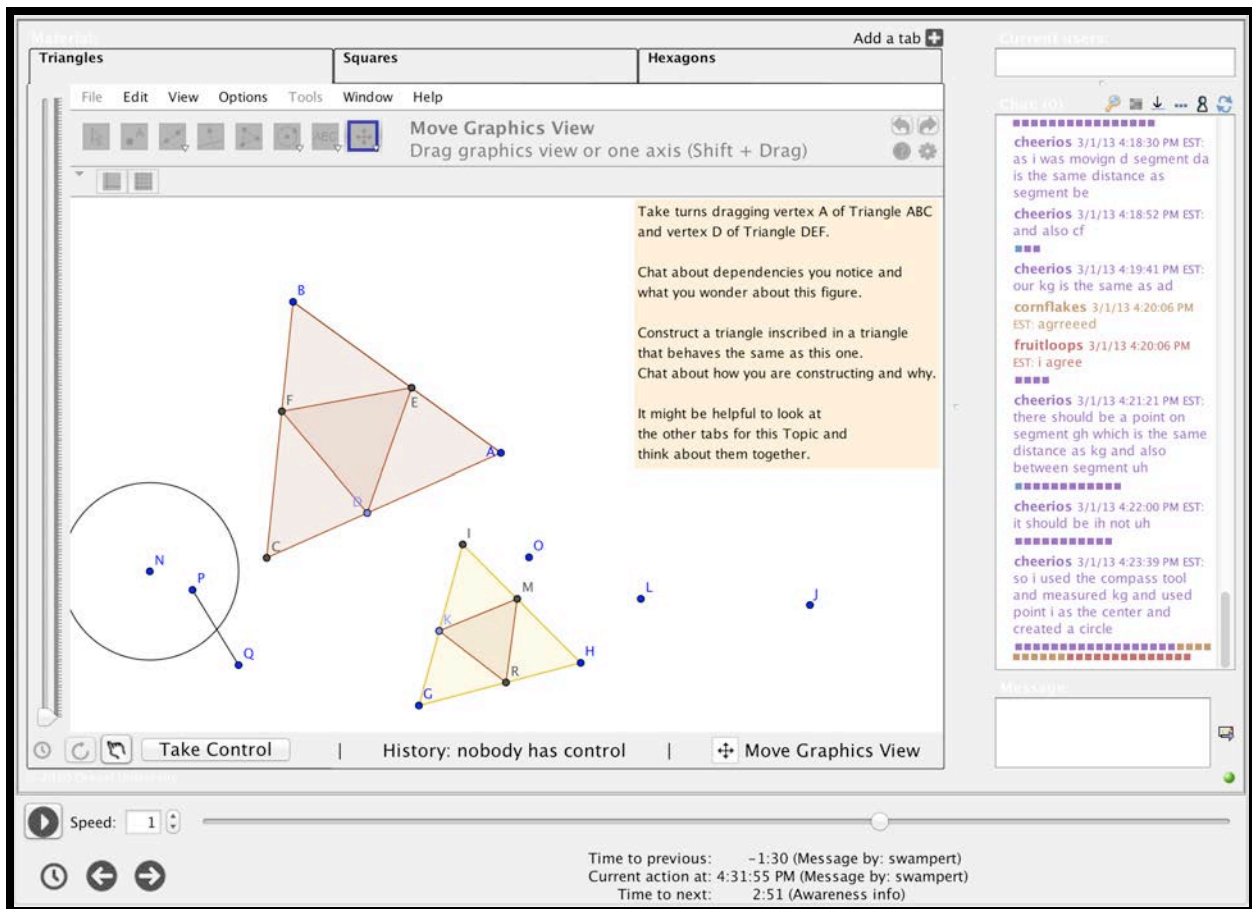


Figure 2. The state of the inscribed-triangles construction after Fruitloops finished triangle KMR inscribed in GHI.

The analysis of the team's work concluded that the students' success was an instance of group cognition (Stahl, 2013, Ch. 7.3). None of the students could construct the triangle configuration themselves and the process of construction involved all three exploring, planning and carrying out the construction. Each of the three girls displays a different characteristic behavior pattern throughout their

work in the eight hour-long sessions of our study. Yet, the team is impressively collaborative. This illustrates nicely the notion of individual perspectives within intersubjective group interaction.

What was particularly striking in the team's successful construction of the inscribed triangles was that on first appearance it seemed like the team's insightful and skilled work was actually done primarily by the student who until then had seemed the least insightful and skilled. If one just looks at the chat postings (see panel in the right side of Figure 2), Cheerios does all the talking and Fruitloops (who is usually the most reflective and insightful) and Cornflakes (who explores the technology and often shows the others how to create geometric objects) simply register passive agreement. However, the actual GeoGebra construction actions tell a far more nuanced story. First, for almost an hour each of the three students in the 'Cereal Team' took extended turns exploring the given example of inscribed triangles by dragging the vertices to discover dependencies in the construction that dynamically maintained the invariances of equilateral triangles. The dragging of figures is displayed simultaneously on each student's computer. Only one person at a time can create or drag geometric objects, in order to maintain joint attention by everyone to a single, shared sequence of actions.

Cheerios observes Fruitloops experimenting with the use of the GeoGebra compass tool just before Cheerios takes control and makes her discovery. Cheerios continues to manipulate Fruitloops' construction, involving a circle whose radius was constructed with the compass tool to be dependent on the length of a line segment. Then Cheerios very carefully drags points on the original inscribed-triangle figure to discover how segments BE and CF are dependent upon the length of segment AD, refining prior movements by the other students. The dynamic relationship between the side lengths becomes visually salient as she increases the size of the triangles or their orientation and as she drags point D along side AC.

Cheerios has a sense that the compass tool should be used to measure segment KG, but she does not quite understand how to make use of that tool. Following Fruitloops' example, Cheerios uses the compass to draw a circle around point I, whose radius equals length GK (see Figure 3, left). However, she is unable to further implement the plan she has already projected in chat.

Next, Cornflakes takes control of the construction, places a point, M, where Cheerios' circle intersects side HI and then repeats the process with the compass to construct another point, R, on the third side of the exterior triangle (see Figure 3, right).

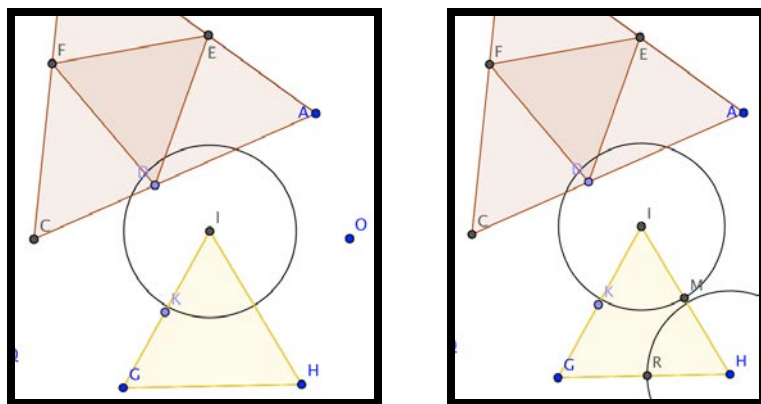


Figure 3. The state of the construction after Cheerios finished (left) and after Cornflakes finished (right).

Fruitloops then takes control and uses the polygon tool to construct a shaded interior triangle, KMR, connecting Cornflakes' three points on the sides of the exterior triangle (see Figure 2). She then conducts a drag test, dragging points on each of the new triangles to confirm that they remain equilateral and inscribed dynamically, just like the example figure. At that point, the students have been working in the room for over an hour and end their session, having succeeded as a team.

The VMT software is fully instrumented, so that researchers can obtain detailed logs and even replay the sessions (as shown in Figure 2, a screen image from the replayer) to see precisely what the students all saw on their screens. Of course, as Schutz pointed out, researchers have a reflective relationship to the interaction, which is quite different from the engagement of the students. The intersubjectivity of the students, when things are functioning optimally, can be that of group cognition, where they act as one subject, constructing shared meaning through their interaction. The intersubjectivity of the researchers with the students involves systematic (methodical, self-conscious, research-driven, theory-laden) efforts to understand the meanings previously created by the students, based on a culture and world partially shared by the researchers.

## **Intersubjectivity as group cognition**

The kind of data generated by teams of students using VMT can support detailed research into the nature of interaction and intersubjectivity in CSCW and CSCL situations. For instance, the VMT research team has now analyzed all eight hours of the Cereal Team's interaction (Stahl, 2015). In particular, we track their enactment and acquisition of various member methods or group practices. We see how the students form into an effective team and how they align and develop joint attention. By adopting specific sequences of group practices, the team learns how to collaborate, to manipulate technological affordances, to engage in collaborative dynamic-geometry problem solving and to enter into mathematical discourse. Displayed in the team interaction, we can see group cognition in action as a specific form of intersubjectivity.

We see the potential productivity of collaboration in the way that the three students, participating from within their personal zones of proximal development, bring different resources to the interaction. Further, the interaction itself elicits—as Merleau-Ponty put it—“thoughts which I had no idea I possessed.” Ideas, skills and approaches from different sources mix and spontaneously generate new, shared knowledge through the interaction itself and its internal logic or implicit connotations. Collaborative learning may be guided through reflection by the participants and through feedback from the problem-solving process itself. For instance, observation of the results of various people's attempts at geometric manipulations and constructions may lead to the discovery of solutions that cannot be attributed to any one of the participant's minds or even to a simple aggregation of their individual contributions. The dynamic behavior of their joint geometric-construction moves in their shared online world contributes to the unfolding of a solution path as well.

In the Cereal Team's work, we see multiple instances of one student contributing a skill or insight from their individual perspective or developmental zone into the group work—usually in response to what another student did or tried to do. The other students learn from this—often from just one occurrence, where the contribution is discussed and consequently adopted by the team as a group practice. Subsequently, another student brings the newly learned skill into the group work, and it is accepted without comment. In this way, first, the group learns a skill or insight and through that, each of the other individuals learns it. For instance, in the session just described, it took each of the three students doing some of the necessary actions to construct the inscribed triangles. However, in their next session, all three students very clearly knew how to carry out all those actions when the group worked on a related challenge of constructing inscribed squares.

In the longitudinal developmental trajectory of the Cereal Team (followed in detail in Stahl, 2015), as the team first learns to collaborate online and to engage in dynamic geometry, we can observe the reciprocal interpenetration of individual and collective understanding in the group-cognition form of intersubjectivity. We see what our review of theories of intersubjectivity characterized as simultaneous

joint participation and perspectival individuality, as well as joint attention, shared meaning making, group agency and being-there-with-others in a shared world.

The Cereal Team took up in their discourse mathematical terms like “constraint” and “dependency,” which were introduced in their session instructions. The choice of classical geometry problems and the wording of their presentation to the students guided the student exploration and discourse, mediating the interaction with resources from the mathematical community. By responding to the cues in the instructions and incorporating these technical terms in their discourse with each other, the students gradually developed new conceptions. At first not understanding the terms at all, they passed through everyday uses of them to more rigorous mathematical statements—in a process recalling Vygotsky (1934/1986). The transitions in individual and group understanding of the role of dependencies in dynamic geometry can be tracked in the logs of their interaction (Stahl, 2015).

While all the reviewed theories of intersubjectivity noted the important role of language, Vygotsky was especially clear about the mediation of language—both spoken and thought—in how we understand each other and our shared world. Heidegger’s later work (e.g., 1959/1971) also emphasized how language can be seen as a source of meaning making—most visibly in poetry. For him, “speech speaks” (through us) and we live in language as the “house of being.” As Tomasello (2014) notes, the cultural richness of spoken languages incorporates eons of human shared experiences. In the mixing pot of group discourse, phrases evoke each other and thereby generate creative ideas.

Of course, competent language users are needed to speak and understand the phrases. However, the source of the creative generation and the deductive flow can be analyzed in terms of the meanings sedimented in the phrases, rather than being attributed to rational motives in the minds of individual participants. Group cognition and its associated intersubjectivity can be conceived in primarily linguistic, rather than mental, terms (as recommended by Habermas, 1971/2001). Its intentionality is not that of some kind of group mind or even primarily of the minds of the individual participants, but of the intersubjectively shared discourse and the historically mediated referred intentionality of a culture, expressed in its passed-down meanings. That is why a goal of math education is to involve students in math discourse and collaborative exploration.

Group cognition is a form of intersubjectivity, in which the words and actions of group members are aligned in a coherent unity, which can be analyzed as a semantic (meaning-making) or cognitive (symbol-manipulating) system in its own right. This vision of a potentially powerful form of group intersubjectivity can inspire and guide the design of supportive technology and pedagogy in CSCW and CSCL, as it has done in the VMT project (Stahl, 2006; 2009; 2013; 2015).

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