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HOW MIGHT SIMULATION-BASED ACCOUNTS OF MINDREADING EXPLAIN PRAGMATIC INTERPRETATION?

abstract

This paper examines the role of simulational mindreading in pragmatic interpretation (conceived of in a Gricean manner). There are two parts to this paper. In part one, I argue that mirroring, in the form of direct or indirect simulation, underdetermines pragmatic interpretation. Nevertheless, to deliver a unique interpretation, mirroring can contribute either by reducing the number of salient interpretations or to be accompanied by theoretical considerations. This results in a hybrid view in which theory and simulation cooperate. The second part of the paper examines the imaginative or perspective-taking sense of simulation. Drawing on evidence from several clinical populations, I will show that subjects with difficulty in pragmatic interpretation often show little or no difficulty in perspective taking, and subjects with difficulty in perspective taking do not always show difficulty in pragmatic interpretation. This, I conclude, suggests that simulation in the sense of perspective taking is not necessary or plays no significant role in pragmatic interpretation.

keywords

mindreading, simulation theory, mirroring, mirror neurons, pragmatic interpretation

Phenomenology and Mind, n. 19 - 2020, pp. 226-240
DOI: https://doi.org/10.17454/pam-1914
Web: http://www.rosenbergesellier.it/elenco-libri?aaidriv=14

ISSN 2280-7853 (print) - ISSN 2239-4028 (on line)

1. Introduction

Following Grice (1989), there is a more or less general consensus that our communication does not consist of a sequence of disconnected remarks, but involves, alongside to linguistically decoding, the ability of metarepresentation, expression and recognition of intentions. Metarepresentation is present not only in implicit communication, e.g., in conversational implicatures but also in the identification of explicit content. To establish communicative intentions, a hearer must be able to disambiguate and assign a reference, fix the scope of quantifiers, resolve the interpretation of vague expressions, and resolve illocutionary indeterminacies (Sperber & Wilson, 2002; Wilson, 2005). Details of Gricean or other pragmatic theories are not our concern here. The main point for our purposes is that whether it is referential ambivalences and illocutionary indeterminacies to resolve, or metaphors, ironies and non-sentential expressions to interpret, people in a communicative context deeply engage in spontaneous metarepresentation and mental state attribution, often referred to as *mindreading*, either for what they trying to express or in recognizing what is expressed. Based on this association, pragmatic impairments are often explained by reference to mindreading impairments (Cummings, 2014). Mindreading itself, however, has been a matter of debate over the years. Several theories have been developed to account for mindreading, but the question as to which one is explanatorily adequate and more fundamental in pragmatic interpretation has remained unanswered. This is the question I will address in the present paper. First, after a brief introduction to the simulation theory, I will distinguish between *direct* and *indirect* simulation and argue that simulation in these senses underdetermines pragmatic interpretation. This, however, is not to argue that simulation plays no role in interpretation. Rather, to deliver a unique interpretation, the simulation would need to be accompanied by theoretical considerations of the sorts to which a theory-theorists might appeal. In the second part, I will examine a broader conception of simulation, the imaginative or perspective-taking sense of simulation. The evidence, I will argue, suggests that simulation in the sense of perspective taking plays no significant role in pragmatic interpretation.

2. Direct & Indirect Simulation

Questions concerning the cognitive basis of mindreading—how we engage in mental state attribution—has given rise to several theories, including the theory-theory, the simulation-theory, and, more recently, the hybrid theories that take elements of both theory and simulation. Given the fundamental role that mindreading plays in pragmatic interpretation, the question occurs as to how *simulation* or *theory* account for the mindreading exhibited in

pragmatic interpretation. Advocates of the theory-theory approach consider mindreading as an information-rich and thoroughly metarepresentational process which, when considered for pragmatic interpretation, is characterized either as a general theory of mind (e.g., Grice 1989) or alternatively a specialized module dedicated to utterance interpretation (e.g., Sperber & Wilson, 2002; Wilson, 2005). The theory-theory approach, however, has been challenged by an alternative view, the simulation theory, according to which mindreading is achieved by a simulational process in which, instead of using theory, we deploy our mind and its cognitive resources as a model for the other person's mental life. The basic idea of simulation has been interpreted in rather different ways: either as a basically imaginative, perspective-taking process—variously referred to as imaginative identification (Gordon, 1992), imaginative transformation (Gordon, 1996), off-line simulation (Currie, 1995; Goldman, 1989), and enactment imagination (Goldman, 2006)—or as neurological resemblance understood either as neural reuse and embodied simulation (Gallese, 2007) or mirror-based simulation (Goldman, 2006). Despite this variation, the simulational accounts all share the core idea that the same mechanism (e.g., a specific brain region) or a sub-cognitive system (e.g., the decision-making system) can be used in two modes of operation. For instance, when the same mechanism is used during action execution and action observation, or during emotion experience and emotion recognition. So, we can take all of these interpretations relatively identical or at least position them along a continuum. The question is: how might the simulation-based accounts explain the mindreading exhibited in pragmatic interpretation?

Simulation theorists have been almost silent on the question. However, a cursory glance at the literature reveals that to account for pragmatic interpretation they would probably take the same explanatory strategy they do in other domains, that is, downplaying the role of theory and insisting on simulation as an imaginative perspective-taking process. For instance, Goldman notes:

Verbal communicators commonly make assumptions...My question is: how does a communicator proceed to estimate what pieces of information will be marshaled, or made salient, in the mind of the audience...The speaker cannot appeal to any such *theoretical* knowledge to make predictions of what is likely to be derived or calculated by the hearer. Nonetheless, speakers are evidently pretty good at making such predictions, more precisely, at predicting what kinds of 'implicatures', will be appreciated by an audience. How do they do that? Again, I suggest, by simulation. (1989, p. 171-2)

Similarly, Currie & Ravenscroft (2002) remark that understanding a speaker's meaning where it differs from utterance meaning is achieved by imaginative projection, that is, by "putting yourself in the speaker's shoes and asking 'What would I have meant by that?'" (p. 146).

A potential difficulty with this approach is that simulation in this sense is often used for *predictive* cases: decision prediction (Goldman, 1989; Gordon, 1986a), figuring out solutions to arithmetic questions (Heal, 1995), inference prediction (Stich & Nichols, 1995), and predicting the grammaticality judgments (Harris, 1992). Predictions proceed by moving forward. For instance, in simulational action prediction, one proceeds by moving from imaginatively generated (pretend) mental states towards the possible effects (an action) of those states. An utterance, however, is a generated piece of action that requires *explanation*. Nevertheless, unlike predictions, explanations proceed by moving backward, from an observed action (e.g., an utterance) to the mental states that have caused that action. Can simulation processes run backward? There are two ways we can think of backward simulation: direct and indirect simulation. I will examine each for pragmatic interpretation.

The idea of direct simulation first appeared following the discovery of mirror neurons: a set of visuomotor neurons that discharge both when an individual makes a particular action (e.g., grasping an apple) and when she observes a similar action performed by others (Pellegrino,

Fadiga, Fogassi, Gallese, & Rizzolatti, 1992; Rizzolatti, Fadiga, Gallese, & Fogassi, 1996). It was argued that the similarity or overlap in neuronal discharge creates a matching mechanism that provides a direct or unmediated understanding of actions. Mirror mechanisms are simulation mechanisms because they operate in a way that one mechanism/process is used in two modes of action execution and action observation. How would this result in a direct understanding? By mapping the visual representation onto the motor representation of the observed action (Rizzolatti et al., 1996; Rizzolatti, Fogassi, & Gallese, 2001), or linking first- and third-person experiences, i.e., linking "I do and I feel" with "he does and he feels" (Gallese, Keysers, & Rizzolatti, 2004, p. 396). According to Gallese, "we can certainly 'explain' the behavior of others by using our complex and sophisticated mentalizing abilities... Most of the time, though, we do not need to do this. We have a much more direct access to the inner world of others" (2007, p. 659). It is held that all kinds of interpersonal relations, including recognition and attribution of intentions, relies on a mirror-based, or directly, shared manifold of intersubjectivity space (Gallese, 2001, 2003). Drawing on results from mirror neuron studies on monkeys (Fogassi et al., 2005) and humans (Iacoboni et al. 2005), it has been argued that mirror neurons, previously thought to be involved only in action recognition, are involved in direct recognition of intentions (Iacoboni et al., 2005, p. 533). Direct simulation is also advocated in other domains, including recognition of emotions (Goldman, 2006; Goldman & Sripada, 2005), or even language and linguistic communication. Moreover, it is argued that mirror neurons are the evolutionary precursor of language (Arbib, 2005; Rizzolatti & Arbib, 1998), that the neural structures responsible for action execution also play a role in understanding the semantic content of the same actions when verbally described (Gallese, 2007, p. 664), that the matching mechanism created by mirror neurons represents expectations that guide communication and action comprehension (Arbib & Rizzolatti, 1997), or that mirror activation creates a link between the sender of a message and its receiver in a way they can communicate without any cognitive mediation (Rizzolatti & Craighero, 2004, p. 183).[1]

The notion of direct simulation, however, lays down two related requirements, both of which must be satisfied in an account of pragmatic interpretation. First, because success in simulation relies on a similarity between the simulating process and the target process (Goldman, 2006), exogenous activation of mirror neurons must have a content similar to the content represented by endogenous activation. Besides, since the direct simulation is an unmediated process without the agency of intermediary (non-simulational) mechanisms, the content represented by exogenous activation must include mental states that are represented in the target. The two requirements raise the question, also raised by Jacob and others (Goldman, 2009; Jacob, 2008; Jacob & Jeannerod, 2005), as to whether representations created by mirror neurons contain any mentalistic content.

Regarding, the type of mental states involved in pragmatic interpretation, philosophers often make a distinction between *intentions-in-action* (captured by the linguistic form *I am doing A*) and *prior intentions* (captured by the linguistic form *I will do A*) (Searle, 1983). An agent that spontaneously grasps an apple has a motor intention to grasp that apple, but she has no prior intention to do so. An intention-in-action is not temporally prior to the action. Thus, as Searle remarks, we cannot say that an agent tries to carry out her intentions-in-action. Instead, an intention-in-action is in the action and inseparable from the action (Searle, 1983, p. 84). If so, to the extent that intentions-in-action are inseparable from bodily movements,

1 For criticisms of the link between language and mirror neurons see Hickok (2010); Toni, de Lange, Noordzij, & Hagoort (2008)

there is a sense in which we can say that activation of mirror neurons in response to the observation of a motor movement represents the intentional content (intention-in-action) of that movement. However, communication seems to require more than the identification of unthinking movements or unintended but intentional actions. It also requires recognition of prior intentions, intentions that are formed prior to actions, and, during communication, are recognized as the mental cause of those actions. So, the first difficulty with direct simulation is that intentions-in-action include only impulsive actions, present even in newborn babies or non-human animals. However, there are two points to note here. First, we should note that proponents of direct simulation often claim that, in addition to intentions in actions, mirroring can deliver knowledge of prior intentions (Fogassi et al., 2005; Iacoboni et al. 2005), where this involves recognition of actions which are more than unthinking movements or unintended but intentional actions. Second, it is often the case that we figure out what we intend to say as we are saying it. In these cases, the act of uttering is obviously not performed with prior intentions but intentions that are in action and part of the action (utterance). If that is right, then, as far as unintended-but-intentional utterances are concerned, mirroring can, in principle, contribute to pragmatic interpretation. Can mirroring deliver knowledge of prior intentions? Only if it fulfills two further requirements.

First, if simulation is a direct mechanism (i.e., represents the target's mental states directly), it requires a set of distinct matching mechanisms that are associated with the recognition of different actions. For action types, say A*1*...A*n*, there must be a set of mirror mechanisms, M*1*...M*n* that respond selectively in recognition of corresponding actions, in a way that the exogenously-generated representations (visual, auditory, etc.) will directly map onto the prior intention that has caused that action. How likely is this possibility? It depends on how well it fits with experimental evidence. Second, even if we suppose that each action corresponds to a mirror mechanism that is causally implicated in recognition of that action, because there is no unique or one-to-one mapping from an agent's action to her prior intentions, in the sense that the same action is always subject to more than one interpretation, an exogenously-generated representation cannot have the relevant prior intention as part of its content. As Jacob (2008, 2009) has pointed out, unless one endorsed behaviorism, one would not be tempted to support the view that perception of an action is a sufficient basis for forming a reliable belief about the agent's prior intention (Jacob, 2009, pp. 236–237). Does it follow that mirroring could not deliver knowledge of prior intentions or alternatively would lead to a form of behaviorism? I think not. There are at least two ways in which simulation can, at least indirectly, contribute to the recognition of prior intentions. First, by reducing the number of salient interpretations of an action. Under this conception, neither the mapping needs to be one-to-one, nor mirroring is required to deliver a single and unambiguous interpretation. Instead, simulation just needs to deliver the one that is more salient than other alternative interpretations. This would be a hybrid view in which mirroring does not need mapping directly to intentions. However, another approach would be that mirroring together with non-simulational processes mediate representation of mentalistic content. Under this notion, the simulation mechanism would need to be accompanied by theoretical considerations of the sorts to which a theory-theorist might appeal. This approach also would result in a hybrid account in which elements of theory and simulation cooperate. An approach like this is advocated by Goldman in his simulational model of emotion recognition (Goldman, 2006; Goldman & Sripada, 2005). The model, labeled as the Generate and Test strategy, consists of two simulation and non-simulation processes in which, to understand an observable piece of action (e.g., an emotion facial expression), an observing agent (i) formulates hypotheses about the prior mental states that might have been the cause of the observed action (the theory-driven stage). Next, in order to test the hypotheses, (ii) a facsimile of the hypothesized state is generated and fed

into the mechanism that is responsible for the generation of that effect in the observing agent (the simulation-driven stage). If the generated action matches the observed action, the hypothesized mental states are attributed to the target as the cause of her action, and the action is explained. For example, an agent observing a particular facial expression hypothesizes fear as the possible cause of that expression (the non-simulational state). Next, a facsimile of fear is fed into the mechanism that is responsible for fear experience, e.g., a region in the brain, such as the amygdala. Next, amygdala activation generates a fear-related facial expression. If the generated facial expression matches the observed facial expression, fear is attributed to the target as the mental cause of that expression. By this final stage of attribution, the observing agent can make sense of the observed facial expression. The suggestion is that similar cooperation can be at work for the recognition of prior intentions.
It might be argued that this strategy, at least when used for utterance interpretation, confronts two problems. First, it faces a dilemma with two unsatisfactory horns: either (i) an action (explanandum) is unnecessarily duplicated because the observing agent needs to enact every action s/he wants to make sense of it, but this is not how we understand others (e.g., we do not re-utter every heard utterance), or the agent fails to reproduce the target action (explanandum), in which case cannot evaluate her interpretation (or hypothesized mental states) of that action, precisely because no action is produced that can be tested against the observed action. Second, the process requires trying out different (hypothesized) mental states until it generates an action that matches the observed action. So, it can be argued that while the generate and test strategy might be the mechanism of recognizing lower-level mental states (e.g., emotions), it would be cognitively too demanding and slow for recognition of higher-level states such as prior intentions because it involves generating and testing an open-ended list of hypotheses every time we make sense of an action. This requires listing all possible interpretations and then, through the agency of a highly theoretical mechanism, selecting an interpretation that seems like the most relevant explanation of the observed action. This lengthy and slow process makes indirect simulation virtually ineffective in communication.
However, I think this argument is not persuasive, firstly because it mischaracterizes the dilemma. Proponents of mirroring have consistently maintained that in simulation, actions are not duplicated. For instance, in simulational action prediction, the decision-making system is taken *off-line*, that is, because it is momentarily disengaged from behavior and motor control system, the output of the system (the decision) does not generate an action. At low-level simulational mindreading, Gallese and Goldman (1998) note that "externally generated mirror neuron activity does not normally produce motor execution of the plan in question. Externally generated plan is largely inhibited, or taken 'off-line', precisely as simulation postulates" (1998, p. 497). Similarly, for utterance interpretation, we can say the enaction of the simulation takes in an off-line, counterfactual mode, that would not lead to re-uttering every heard utterance. Besides, an off-line explanatory simulation could still generate a *plan* or *instruction* for the execution of the action. However, although the plan is not executed, it can be used to test or evaluate the interpretation of the target action. In general, the resources for offline, counterfactual reasoning that simulation theory must make use of are fairly rich and perfectly suitable for this kind of off-line retrodiction. Concerning the second objection, one way mirroring can contribute is to be seen as an element in a *stopping procedure* of the sort posited in the Relevance Theory, in which it is reasonable for the hearer to 1) follow a path of least effort and 2) stop at the interpretation that satisfies her expectations of relevance (Wilson & Sperber, 2002). Alternatively, simulationists might reply that the range of possible actions, constrained by previous experience and practicalities, facilitates the cognitively heavy load of the hypothesis testing stage. Besides, our utterances are mostly drawn from a relatively

small and often repeated subset of utterances or utterance parts. Most of the time, when we do speak, we do use utterances that others have often used in our presence, or that we ourselves have used. In that case, there seems no basis for supposing that interpretation often could have been honed by prior experience with utterances. If this is right, simulation would be slow only when we are required to process utterances from outside the familiar subset, which might be only occasionally.

So far, I have distinguished between two senses of simulation and discussed the role of each in pragmatic interpretation. Direct simulation involves mere mirroring, and indirect simulation involves mirroring plus non-simulational processes, such as inferential processes of attribution. Our discussion thus far suggests that whereas mirroring alone underdetermines pragmatic interpretation, mirroring in cooperation with non-simulational processes, such as inferential mental state attribution, can play significant roles in pragmatic interpretation. At this point, however, we should distinguish between high- and low-level simulational mindreading. Although, as Goldman notes, a strict definition of high- versus low-level mindreading is lacking, the two are often differentiated in terms of two different prototypes. Whereas low-level prototype is the automatic and mirroring type of simulation, a high-level prototype is a kind that uses mental pretense, perspective taking, and imagination (Goldman, 2006, p. 147). Given the distinction, advocates of simulation theory might argue that our discussion thus far characterizes simulation in a way that is too narrow and constraining. So, the argument goes, although the low-level and mirroring type of simulation that we discussed might not be sufficient for interpretation, the more general sense of simulation, associated with the high-level prototype, is sufficient for delivering unique pragmatic interpretations. Simulation, in this sense, mainly consists of perspective taking, enactment imagination, and mental pretense. Indeed, it is this perspective-taking sense of simulation, which is often intended in simulational accounts of action and intention prediction. For instance, Gordon (1986) holds that we simulate by imaginative projecting into the other's situation in the same way that chess players, while transported in imagination, visualize the board form the other side. Currie & Ravenscroft maintain that it is only the perspective-taking part that is, properly speaking, essential for simulation (Currie & Ravenscroft, 2002, p. 54). Goldman (2006), by insisting on the role of enactment imagination.

A considerable feature of simulation in this broader sense is that it relies on first-order representations only. Perspective taking, as Baron-Cohen (1988) remarks, can be performed by using the strategy of mental rotation on first-order representations (Baron-Cohen, 1988, p. 394). In general, unlike the theory-theory approach in which metarepresentations of the form *I think he thinks* play a crucial role, a distinguishing feature of simulation is that by perspective taking an agent attributes one of her own generated (first-order) representations to the target (Goldman, 2006, p. 40) This is how simulation constitutes a competitor to theory-driven accounts of mindreading. To illustrate this type of simulation, Goldman notes:

> [Simulation] contends that E-imagination is often employed for mindreading. To determine whether my wife, seated elsewhere in the room, can see the bird in the birdfeeder, I might visualize how things look from her perspective. Such perspective taking could lead me to mindread both her visual state and any consequent beliefs about the bird. Analogously, many nonvisual specimens of E-imagining might be utilized for mindreading purposes. In general, E-imagining isn't confined to the production of imagery, visual or otherwise. (2006, p. 149)

The quote illustrates how level-1 and level-2 perspective taking concern the ability to imaginatively slip into the role of another person and imagine how s/he would think in the targeted situation. According to Flavell and his co-workers (Flavell, 1977; Flavell et al. 1981), there are two levels of visual perspective taking. Level-1 is the ability to understand non-egocentrically what object another person does and does not see, and that other people have

a different line of sight than ourselves. Level-2 perspective taking is the ability to understand that different people viewing the same item may see different things or have different representations of the same item if their viewing conditions differ. With this distinction in mind, the rest of this paper examines the significance of this broader sense of simulation in utterance interpretation. If simulation underpins pragmatic interpretation, we should expect an association between pragmatic and perspective taking impairments. One could, of course, fail at pragmatic interpretation by being poor at things independent of perspective taking, e.g., poor linguistic comprehension. However, all other things being equal, if simulation is sufficient for the mindreading required for interpretation, we should expect that (i) subjects with no serious difficulty in perspective taking experience no difficulty in pragmatic interpretation, and (ii) subjects with no considerable difficulty in pragmatic interpretation show no difficulty in perspective taking. Drawing on empirical evidence, I will argue that the relationship between simulation and interpretation is not the way simulationists might expect. Specifically, I will show that subjects which are known as having difficulty in pragmatic interpretation often show little difficulty in perspective taking, and subjects with difficulty in perspective taking do not necessarily experience difficulty in pragmatic interpretation. The evidence, I think, suggests that simulation in this sense probably plays no significant role in pragmatic interpretation.

3. Dissociation Between Simulation and Pragmatic Interpretation

Communication impairments are among the typical symptoms of autism spectrum disorder (ASD). Subjects with autism often experience a severely impaired functioning on most pragmatic aspects, including difficulties in using speech acts (Ziatas, Durkin, & Pratt, 2003), comprehending irony and metaphor (Gold, Faust, & Goldstein, 2010; Martin & McDonald, 2004), detecting violations of Gricean Maxims[2] (Surian, Baron-Cohen, & Van der Lely, 1996) and using features of the context in utterance interpretation (Loukusa et al., 2007) (cited in Cummings, 2013, 2014). Besides, the evidence demonstrates that ASD subjects face considerable difficulty in mental state attribution (Baron-Cohen, Leslie, & Frith, 1985; Golan, Baron-Cohen, & Golan, 2008; Leslie & Frith, 1988; Williams & Happé, 2009; Williams & Happé, 2010b). If simulation plays a significant role in utterance interpretation, it is expected that autistic subjects, who are severely impaired in pragmatic interpretation, show serious difficulty when taking others' perspectives. Several studies, however, speak against this expectation.

In an early study on perspective taking by Hobson (1984), autistic subjects were presented a display in which a miniature figure was said to be wishing to hide from one or two other seekers. The task required the subjects to point out where the figure should stand in order to hide from the seekers. In a second task, the Cube test, Hobson asked the subjects to infer the perspective of a dull that faced a cube. Successful performance needed the subjects to visualize points of view very different from their own. The results revealed that autistic subjects, in comparison to controls, had no difficulty in identifying the other figure's visuospatial perspective, nor any difficulty in coordination of different perspectives in the Cube task. In a subsequent study by Leslie & Frith (1988), a plastic board was placed on a table in a way that a doll could be on either side of the board (visible to the child). Then a counter was placed on the board, and, depending on the position of the counter in relation to the doll, the subject was asked whether the doll could see the counter. In several trials, the experimenter varied the position of the doll while the child was asked to change the position of the counter where the doll could or could not see the counter. The results show that autistic subjects, regardless of whether they could recognize mental states or not, had no difficulty in visualizing others' perspectives.

2 Principles which, according to Grice, people follow in effective communication.

Baron-Cohen (1989) examined visual perspective taking in autistic subjects compared to normal subjects and subjects with Down's Syndrome. Small toys were placed around the subject and, from the orientation of an experimenter's eyes alone, the subject had to identify which toy the experimenter is attending to. Baron-Cohen found no significant differences within or between the three groups: 92.5% of autistic subjects, 94.4% of normal subjects and 89.3% of subjects with Down Syndrome passed the test. The results by Baron-Cohen are replicated in a study by Leekam et al. (Leekam, Baron-Cohen, Perrett, Milders, & Brown, 1997). Using the same procedure, Leekam and colleagues report no significant group differences in the performance of normal subjects, autistic subjects, and subjects with down syndrome.
The evidence reviewed thus far points to an intact ability of level-1 perspective taking in autism, showing that individuals with autism can imaginatively grasp that others might have a different line of sight and what things others do and do not see at any given moment. Following Flavell (1977), this is called level-1 visual perspective taking. Besides level-1 perspective taking, understanding by simulation requires level-2 perspective taking (1977): recognizing that others may represent the same thing a bit differently and have a different perspective on the same thing than we do. Do subjects with autism are capable of level-2 perspective taking?
To answer the question, Reed & Peterson (1990) examined autistic subjects in understanding the contrasting perspectives of individuals viewing the same object from different vantage points. The subjects sat in front of a turntable, and an object (a plastic tiger or a teddy bear) was placed on the table. Reed & Peterson asked participants to "turn it round so I can see the ----" the last word being "nose," "tail," "back," depending on the object presented (1990, p. 460). The results revealed a uniformly high-level performance by all participants in both level-1 and level-2 perspective-taking tasks, with no significant difference in performance between autistic and control groups. Similarly, Tan & Harris (1991) reported no significant difference between autistic and control subjects in level-1 and level-2 perspective-taking tasks. More recently, David et al. (2010) examined visuospatial perspective taking in a task required to detect an elevated object from a virtual character's perspective. Interestingly, David et al. instructed participants to answer questions by using imagination, for instance, by telling "imagine yourself standing in the position of the virtual character," or "it is important to imagine your change in position!" (p. 294). Results by David et al. revealed no significant group differences. In a more demanding task presented by Zwickel and colleagues (Zwickel, White, Coniston, Senju, & Frith, 2011), a dot appeared next to a triangle protagonist and participants were asked to press either the left or right button to indicate on which side of the screen the dot appeared relative to the triangle. In some trials, the dot appeared on the same side from the viewpoint of both the triangle and the observer. In other trials, the dot occurred while the triangle was pointing downwards, so a dot on the participant's right fell on the left of the triangle or vice versa. The results, according to Zwickel et al., were clear cut, revealed no significant differences in group performance.
However, it should be noted that results from perspective taking studies on autism have not always been consistent. Yirmiya et al. (Yirmiya, Sigman, & Zacks, 1994) presented autistic subjects with items on a rotating table and asked them to turn the table until they can see an item in the exact same way that the experimenter can see the item from where she is standing. The majority of the subjects had a good perspective-taking ability, but as a group, they performed less well than controls. A study by Hamilton et al. (Hamilton, Brindley, & Frith, 2009) suggests that low-functioning children with autism have difficulty on level-2 perspective taking in the mental rotation task (compared to their performance on the spatial rotation task). Hobson (1999) shows that subjects with autism have specific limitations in imitating the *style* of another person's actions. Two points about the contradictory evidence are in order.

First, poor performance does not always demonstrate difficulty in perspective taking. It might be the result of a heavy memory load or a difficulty in executive function than perspective taking. Reed (2002) shows that, at least in some cases, deficits in executive function can cause poor performance in perspective taking. Second, if perspective taking is impaired in autism, then, as Carruthers (2006) has pointed out, on the assumption that introspective faculty is intact in autism, autistic subjects must experience no severe difficulty in reading their own minds. Several studies, however, have demonstrated that subjects with autism have difficulty in discriminating between their intended and non-intended actions (Phillips, Baron-Cohen, & Rutter, 1998), are less able to recognize their mistaken action as unintended (Williams & Happé, 2010a), hardly can think and talk about their inner experience (Hurlburt, Happé, & Frith, 1994), and have problems in reporting their false beliefs (Perner, Frith, Leslie, & Leekam, 1989; Williams & Happé, 2009).

In general, it may be true that subjects with autism, despite communication deficits, do not suffer from limited imagination or difficulty in perspective taking; however, given the contradictory evidence, this interpretation is not wholly straightforward. More explicit evidence for the absence of a relationship between simulation and pragmatic interpretation comes from other resources, specifically, from studies on subjects with schizophrenia and fragile X syndrome. Evidence shows that individuals with schizophrenia exhibit a high degree of pragmatic impairments, including difficulties in proverb comprehension (Brüne & Bodenstein, 2005), processing contextual information (Bazin, Perruchet, Hardy-Bayle, & Feline, 2000; Sitnikova, Salisbury, Kuperberg, & Holcomb, 2002), and decoding of violation of conversational implicatures (Tényi, Herold, Szili, & Trixler, 2002). Moreover, several studies demonstrate to impaired mental state attribution in schizophrenic patients (Bora, Yucel, & Pantelis, 2009; Brüne & Bodenstein, 2005; Corcoran, Cahill, & Frith, 1997; Frith & Corcoran, 1996; Langdon et al., 1997). For instance, difficulties in understanding jokes that require inferring mental states (Corcoran et al., 1997) or making inferences about others' thoughts and intentions (Frith & Corcoran, 1996). Despite this, subjects with schizophrenia do not seem to have any difficulty in perspective taking. Results by Langdon et al. (Langdon, Coltheart, Ward, & Catts, 2001) shows that schizophrenic subjects perform equally capable as controls in judging the location of a block in an array relative to a change of perspective, or in judging what an array would look like if the array rotated while the patients stayed fixed (perspective change judgment). Similarly, subjects with fragile X syndrome suffer from specific pragmatic deficiencies, including the use of repetitive language: utterance repetition, topic repetition, and conversational device repetition (Ferrier, Bashir, Meryash, Johnston, & Wolff, 1991; Murphy & Abbeduto, 2007), and failure to signal non-comprehension language—signaling non-comprehension requires the listener continuously monitor her understanding and formulate responses that make clear to the speaker what aspect are problematic (Abbeduto et al., 2008). In addition, similar to autism and schizophrenia, subjects with fragile X syndrome are impaired in mental state attribution (Cornish et al., 2005; Garner, Callias, & Turk, 1999; Grant, Apperly, & Oliver, 2007). Despite these problems, however, no difficulty arises when the subjects take others' perspective (Mazzocco, Pennington, & Hagerman, 1994; Mazzocco & Reiss, 1999) or during emotion understanding, which is often considered as simulational (Bouras, Turk, & Cornish, 1998; Shaw & Porter, 2013; Simon & Finucane, 1996).

Are there cases in which we find the opposite pattern? That is, are there individuals whose perspective taking is impaired, but whose pragmatic interpretation abilities are spared? Evidence from psychopathic individuals supports the opposite pattern of dissociation. A recent study by Drayton et al. (Drayton, Santos, & Baskin-Sommers, 2018) has examined psychopathic individuals in a dot-perspective task in which the subjects were presented with pictures of a human avatar who were facing either the right or left wall of a room, where

up to three red dots could appear on the walls. The task required the subjects to verify the number of dots either they or the avatar could see. The results revealed an impaired ability to think from another's perspective, an impairment which, according to Drayton et al., maybe the cognitive root of the subjects' deficits in social functioning and moral behavior. Despite the impaired ability of perspective taking, psychopathic subjects do not have any difficulty neither in pragmatic interpretation nor in the classic theory of mind tests (Blair et al., 1996; Dolan & Fullam, 2004; Jones, Happé, Gilbert, Burnett, & Viding, 2010). For instance, the subjects show good performance on first- and second-order false-belief tests which, respectively, involves reasoning about what another person might mistakenly think and what one mistakenly thinks another person thinks (Jones et al., 2010). Does the Drayton et al. study show that perspective taking in psychopaths can be impaired without corresponding deficits in pragmatic interpretation? This may, but the interpretation of the findings must be made with caution. First, precisely what the dot perspective tasks tell us is still a matter of dispute, and there are in particular important differences in task design across different studies, making direct comparisons difficult. Second, whereas psychopaths tended to be seen as having somewhat intact cognitive perspective-taking skills, they are generally seen as having a deficit in affective empathy, particularly in recognition of fearful vocal affect (Blair et al., 2002; Blair et al., 2005). So, any interpretation of the findings about psychopaths' abilities is at best speculative and must remain tentative.

4. Concluding Remarks

Mindreading or the ability to represent others' mental representations is involved in different cognitive domains, including pragmatic interpretation, which requires expression and recognition of intentions. The connection between the two is so close that difficulties in interpretation are often explained by reference to mindreading impairments. However, mindreading itself and the question as to how it is executed has been a subject of long-standing debate in the literature. This has given rise to the development of several positions, but the question of which one is explanatorily adequate and more fundamental in pragmatic interpretation has remained unanswered so far. In this paper, I examined the explanatory value of the simulation hypothesis, as one of the most prominent accounts of our mindreading ability, regarding pragmatic interpretation. In the first part of the paper, I argued that low-level mirror-based simulation is not sufficient for the recognition of prior communicative intentions. However, mirroring plus non-simulational processes, such as theoretical and inferential considerations or processes that reduce the number of salient interpretations, can play a significant role in the process of pragmatic interpretation. Next, we examined a more general sense of simulation, high-level simulation, which is characterized in terms of mental pretense, perspective taking, and enactment imagination. To this end, we evaluated level-1 and level-2 perspective taking in several clinical populations, and found no necessary connection between this sense of simulation and pragmatic interpretations. The evidence we reviewed points to a dissociation between the two: individuals with considerable difficulty in pragmatic interpretation show little or no difficulty in perspective taking, and individuals with deficits in perspective taking do not always show difficulty in pragmatic interpretation. This strongly suggests that simulation in this sense plays no significant role in the process of pragmatic interpretation.

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