



Alignment in social interactions



M. Gallotti^{a,*}, M.T. Fairhurst^{b,c}, C.D. Frith^{d,b}

^a School of Advanced Study, University of London, Senate House Malet Street, London WC1E 7HU, United Kingdom

^b Institute of Philosophy, School of Advanced Study, University of London, United Kingdom

^c Munich Centre for Neuroscience, Ludwig Maximilian University, Germany

^d The Wellcome Trust Centre for Neuroimaging at UCL, United Kingdom

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ABSTRACT

According to the prevailing paradigm in social-cognitive neuroscience, the mental states of individuals become shared when they adapt to each other in the pursuit of a shared goal. We challenge this view by proposing an alternative approach to the cognitive foundations of social interactions. The central claim of this paper is that social cognition concerns the graded and dynamic process of alignment of individual minds, even in the absence of a shared goal. When individuals reciprocally exchange information about each other's minds processes of alignment unfold over time and across space, creating a social interaction. Not all cases of joint action involve such reciprocal exchange of information. To understand the nature of social interactions, then, we propose that attention should be focused on the manner in which people align words and thoughts, bodily postures and movements, in order to take one another into account and to make full use of socially relevant information.

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1. Introduction

The study of how people adjust minds and bodies during online interactions is central to understanding the nature and mechanisms of social cognition. In early studies of language use in dialogue, the processes of adjustment by which the participants in a conversation integrate and process partner-specific information were presented in terms of alignment (Pickering & Garrod, 2004). The concept of alignment has since evolved and is used to describe the multi-level, dynamic, and interactive mechanisms that underpin the sharing of people's mental attitudes and representations in all kinds of social interactions (Dale, Fusaroli, & Duran, 2013).

The minds and bodies of people can be shared in several ways and, therefore, there are different types of alignment. Alignment has recently been presented as a useful conceptual resource to frame the variety of functions and processes needed for mutual understanding as people (and their brains) exchange and process information in the course of interaction (Hasson & Frith, 2016; Stolk, Verhagen, & Toni, 2016). These functions range from low-level, action-based and behavioural, forms of alignment of the kind observed when birds and fish move in perfect unison, to high-level processes involved in social judgment and evaluation. The underlying justification for subsuming all these cases under the same mechanism is that cognition and action cannot be separated. The sharing of minds and bodies can then be conceptualized in terms of an integrated system of alignment, defined as the dynamic coupling of behavioural and/or cognitive states of two people (Dumas, Laroche, & Lehmann, 2014).

* Corresponding author.

E-mail address: Mattia.Gallotti@sas.ac.uk (M. Gallotti).

Sharing goals, commitments and intentions is a prime example of a situation associated with the alignment of mental and bodily resources leading to the formation of shared intentionality (Tollefsen & Dale, 2012). Specifically, by aligning at various levels of interaction, it is assumed that a change in the way the task is represented will follow and this is taken to indicate that a joint action is occurring (Sebanz, Bekkering, & Knoblich, 2006). The question we try to probe here is whether the almost ubiquitous use of specific and well-trying experimental paradigms of joint action involving shared goals help or hinder a comprehensive description of social interaction. To answer this, we will explore the relation between joint action and alignment and its explanatory significance for thinking about the nature of social cognition. In detail, we suggest that focusing the study of the mechanisms and processes of alignment only on cases of goal-directed forms of joint action may be too narrow. Although we do not deny that the ability to adjust minds and bodies as it occurs in these interactions is perhaps the pinnacle of human sociality (Tomasello, Carpenter, Call, Behne, & Moll, 2005), we are interested in the explanatory significance of alignment for a more general theory of social interaction, not in instrumental behaviour and/or alignment *per se*.

People engage in interactions for a variety of reasons and in many different ways. For example, they might be enjoying the pleasure and smoothness of a social exchange even if there is no common goal to be jointly pursued. Or else people might compete in socially relevant ways when their own goals diverge significantly. Acting together to achieve shared goals is only one of many situations in which the minds and bodies of individual people become shared in social interaction. We therefore propose a change of perspective that will have important theoretical consequences for what we deem to be *social* in nature. When the minds of at least two agents reciprocate thoughts and experiences in a certain manner – whether cooperative or competitive, pro-social or antagonistic – they have access to information relating to each other. The central claim of this paper is that it is the nature of the information exchange between interacting agents, rather than the fact that there is a shared goal to be jointly pursued, that sets the conditions for defining an interaction as social. Furthermore, from this perspective, not all forms of joint action in which the agents align will turn out to be social interactions. Focusing on processes of alignment will allow us to distinguish social cognitive activities that are reciprocal from those that are not.

The central claim of this paper is that the alignment of minds, which emerges in social interactions, involves the reciprocal exchange of information whereby individuals adjust minds and bodies in a graded and dynamic manner. As these processes of alignment unfold, interacting partners will exchange information about each other's minds and therefore act socially, whether or not a shared goal is in place. This view of sociality differs from the prevailing paradigm in social cognitive research with regard to the scope and explanatory significance of joint actions involving shared goals, although both views give pride of place to mental alignment.

In Section 2, we emphasize the importance of studying face-to-face social interactions in real time, but suggest that common, shared goals are not needed for mutual alignment to occur. In Section 3 we suggest that the process of adjusting to one another reciprocally will not necessarily result in any degree of shared awareness, and that mutual alignment can occur even when task performance is not optimal. In Section 4 we consider the information exchange that underlies the development of mutual alignment and show that not all cases of joint action lead to reciprocal information exchange and mutual alignment. In Section 5 we conclude that reciprocal exchange of information leading to mutual adaptation should be the defining feature of social interactions.

2. Shared goals and reciprocity

For a long time, the study of social cognition was characterized by a focus on an individual mind operating in a social context (Brothers, 1990; Frith & Frith, 1999). Within the last decade, a major shift occurred which reflected the recognition that empirical studies must involve real time interactions between people (Frith & Wolpert, 2004; Hutto, 2004; Sebanz & Knoblich, 2003). Since then, research exploring the psychological mechanisms and neural correlates of social cognition has focused on forms of joint action where the participants achieve common goals as the key to understanding the processes whereby individuals exchange and integrate information in a manner that brings about a desired change in the environment. In the present discussion however, we suggest that the focus should instead be on the manner in which individuals interact rather than on shared goals as a principled component of joint action.

Typically, the unfolding of a joint action is described as bringing about a change underpinned by a cognitive architecture involving representations, processes and smooth coordination (Vesper, Butterfill, Knoblich, & Sebanz, 2010). The representations of jointly interacting subjects are standardly made intelligible under a description of their intentions and motivations as expressing the disposition to pursue a common goal together. “Shared goals” has thus become the operational basis of shared representations in research on joint action and social cognition (Sacheli, Aglioti, & Candidi, 2015). There are several reasons for taking shared goals to be the key to operationalizing joint action. Across science and philosophy, it is commonly assumed that sharing attitudes and resources is characteristic of partners interacting in a manner that is intentional and directed at common goals (Tomasello & Carpenter, 2007; Butterfill & Sebanz, 2011). As such, many different kinds of joint action are subsumed under the shared-goal umbrella, from cases of planned agency to cases of emergent and spontaneous interactions (Knoblich, Butterfill, & Sebanz, 2011). This wide range of possibilities reflects subtle differences between accounts of joint action.

By and large, these differences can be traced back to two distinct approaches. Some accounts direct attention to the enactive dimension of sharing goals in joint action. Interacting partners must actively be doing something jointly for their minds to align, rather than merely observing interactions from a detached point of view (Schilbach et al., 2013). In other words, it is

through doing, rather than what we intend to do, that interacting partners coordinate at various levels of interaction (Di Paolo & De Jaegher, 2012). In contrast, for those who focus on the skills and motivations of individual agents for sharing intentions to act together, it is the *joint* character of the goals pursued by the agents that brings about the change in performance, determined by whether the task is performed alone or with someone else (Kourtis, Knoblich, & Sebanz, 2013; Vesper, van der Wel, Knoblich, & Sebanz, 2012). The differences between these approaches run deep, and it is not our intention to try to adjudicate the debate. Instead, we focus on what we take to be a minimal list of features for which there seems to be some consensus across the board (Bohl & van den Bos, 2012).

In particular, in recent theoretical and empirical work on social cognition, reciprocity is increasingly recognized as a useful resource to capture the “jointness” of a joint action. Interpersonal understanding can be achieved by reading into one another’s mind reciprocally (Butterfill, 2013), and an explanation of the processes whereby the alignment of minds and bodies unfolds in space and time should involve an account of reciprocity (Zahavi & RoCHAT, 2015). In the process of a reciprocal exchange of information, individuals may adapt to varying degrees to one another. This is certainly the case in instances of temporal synchronisation and coordination in which physical alignment in time and space has been theorized to depend on cognitive models of adaptation (Elliott, Chua, & Wing, 2016; Hayashi & Kondo, 2013; Repp & Su, 2013) and thus on reciprocal interactions (D’Ausilio, Novembre, Fadiga, & Keller, 2015; Keller, Novembre, & Hove, 2014; Tognoli & Kelso, 2015). The behaviour of one player results in a change in behaviour of the other in a reciprocal way so as to achieve temporal synchrony. Interestingly, though not surprisingly, this reciprocal exchange of information results in physical alignment, which in turn has also been shown to result in greater degrees of affiliation and greater mental alignment (Hove & Risen, 2009; Rabinowitch & Knafo-Noam, 2015; Wiltermuth & Heath, 2009). Specifically, we suggest that, rather than a focus on the sharedness of the intended goal, we should attend to the graded exchange of information that creates alignment. The most social of interactions, in our formulation, are those in which “live” (“online”, see Schilbach, 2014) information is exchanged dynamically (*i.e.* over time, across multiple points) bidirectionally and used to adapt behaviour and align with another (Jasmin et al., 2016). However, as we will make clear later, not all “live” joint actions involve mutual and reciprocal adaptations.

There is no doubt that many examples of shared interactions involve common goals and a certain degree of cooperation. In fact, joint actions are often implicitly construed as cooperative actions, *i.e.* actions initiated and sustained by common goals; by the intentions, desires, wants, etc., of the agents to literally ‘operate together’. However, social interactions are complex and diverse, and sometimes people adapt to each other even though they are not cooperating. Indeed, it is possible to have reciprocity and thus social interaction without cooperation. This would be the case, for example, in a competitive scenario in which the minds of the subjects are aligned at the appropriate level of description, and the sharing is essential to solve social dilemmas involving antagonistic behaviour (Bratman, 2014). In these exchanges, what is needed for the minds of the agents to attune to one another is that they adapt thoughts, bodily postures and movements, to take one another into account and reason as a team, even though the team might consist of competitive actors where none is aware that they are acting from the perspective of the same group and in the pursuit of some common goal (Bacharach, 2006). These are examples of social interactions without shared goals.

3. Shared awareness and optimal performance

In the previous section, we identified paradigmatic features of joint action in the context of social cognition. While these features are often operationalized in terms of shared goals, their most fundamentally social nature has to do with the process whereby systems reciprocate thoughts and experiences, rather than with the endpoint *i.e.* the goal. It turns out that two features are often taken to be central to the process whereby interacting agents align minds and bodies. First, the interacting agents must be aware that they are doing something together with others. Second, the success of their joint performance is taken as a measure of how shared the participants’ goals are. In this section, we discuss each feature in detail and address issues which our view of reciprocity as the key to mental alignment can help to address.

According to a venerable tradition in philosophy, agents act intentionally if they know what they are doing, in other words they are aware of their reasons to act the way they do (Anscombe, 1963). Just as individual actions are caused by reasons of which the individual is aware, so it follows that, when people engage in actions together, the target of their joint endeavors is known to each of them individually as theirs *i.e.* ‘our goal’. Along similar lines, based on the terminology used as well as the intrinsic nature of the paradigms chosen, most empirical studies of social cognition are either testing or assuming that the agent represents the structure of the task, especially the goals, as joint. Multi-person activities are jointly performed in experimental settings in which the subjects follow instructions to work together. These are given either directly or indirectly in ways designed to urge the participants to join forces. For example, perception-action experiments in which co-acting individuals observe and respond to one another implicitly require each individual to be aware of, and to act according to their observations of the other as somebody jointly acting with them.

There is currently a debate as to how to articulate the idea that jointly interacting agents must be aware of the ‘jointness’ of the task for the action to count as joint (Schmid, 2014; Zahavi, 2014). However, our suggestion is that what matters for the relevant alignment of minds and bodies to occur is the reciprocal exchange of information, *not* awareness of the reciprocal exchange of information. To be in a position to reciprocate pieces of information does not require that one take a reflective stance and think of oneself as someone who is involved in a joint action with others (*i.e.* awareness that ‘we’ are doing some-

thing together). If a system is adapting to another system reciprocally, it knows in some pre-reflective manner that it is adapting to that system, and the reciprocal adaptation over time makes it become aware that it is not alone in the world. This is the basis of research on social contingency in which the manner by which individuals become aware not only of self but of the “self” interacting with others. This is assumed to relying on reciprocal exchanges of information (assumed to rely on Tarabulsky, Tessier, & Kappas, 1996; Trevarthen, 1979). Becoming mutually aware that we are sharing attitudes, dispositions, bodily postures, perhaps goals, does not mean that the ‘jointness’ of our actions has become available to each of us for conscious report. Reciprocity of awareness is emphatically not the same as awareness of reciprocity. The process of reciprocally exchanging information and mutually adapting to one another need not necessarily result in any degree of shared awareness.

Some studies claim, not only that people perform better when they do things together, but also that task performance improves towards a point of *optimality* (Bahrami et al., 2012). There is evidence that, with the adoption of appropriate strategies, joint performance can be maximized and can approach an optimum in terms of full use of the information potentially available to the group. For example, knowing the noise associated with the signal for each individual, we can estimate how much the noise should be reduced when signals are optimally combined (Bahrami et al., 2010). In animals, a signal, for example about the source of food, that is too weak for an individual fish to follow can be followed by a group through the simple rules of bodily alignment that create shoaling behaviour (Grunbaum, 1998). Shoaling behaviour can also be observed in humans (Belz, Pyritz, & Boos, 2013), who can achieve group advantage through more complex forms of adjustment than just bodily alignment. Pairs of participants trying to detect a weak visual signal can achieve a greater group advantage when they align the terms they use to report their confidence in what they saw (Fusaroli et al., 2012). Indeed, linguistic alignment at many levels can be observed in dialogue (Pickering & Garrod, 2004) and can improve comprehension (Adank, Hagoort, & Bekkering, 2010; Fusaroli et al., 2012).

But is optimal performance necessary for mental alignment and social interaction? Although doing something together allows for some advantage, this advantage need not necessarily lead to optimal task performance. There are two problems that need to be considered. First, the interacting partners may not be maximizing what the experimenters had in mind. For example, rather than maximizing task accuracy, they might be maximizing the pleasure and smoothness of the social interaction by taking the advice of their partner even when this was not ideal. While this latter strategy might not be optimum for the task in hand, it might well be optimal for future interactions with a range of different tasks (Nowak & Sigmund, 2005). Second, there are many cases where the (reciprocal) alignment does not necessarily lead to optimal performance. There is an automatic tendency to imitate the actions of the other (Cook, Bird, Lunser, Huck, & Heyes, 2012), which has to be suppressed in joint action tasks that require participants to make complimentary rather than congruent movements (van Schie, van Waterschoot, & Bekkering, 2008). Here basic bodily alignment can interfere with successful joint action. There are also circumstances where more complex forms of alignment can interfere with successful joint action. If the members of a pair differ in the ability critical to the task being performed, joint performance may lead to a sub-optimal performance. This effect is due to inappropriate alignment of estimates of the relative competence of the members of the group (Mahmoodi et al., 2015). This alignment optimizes performance if they have equal ability, but if their ability is different this alignment over-weights the incompetent one and under-weights the competent one. These examples show that alignment can prevent the achievement of optimal performance and, conversely, that to achieve optimal performance alignment must sometimes be suppressed.

Much research has been driven, so far, by the implicit goal of identifying optimal group performance as a proxy for mental alignment (Fusaroli et al., 2012), however, there is conceptual room and empirical evidence for arguing that optimal task performance is not a good index of mental alignment or ‘optimal sociality’. In other words, taking achievement of a shared goal as the paradigm of a social interaction leads to the binary conception of sociality according to which an interaction is either (optimally) social, or it is not. Instead we should be investigating the nature of the corresponding state. In the next section, we will suggest a different definition of social interaction. This approach takes alignment to refer to the process by which systems exchange information by adjusting bodily and mental states dynamically to varying degrees.

4. Types of alignment

Two systems can interact when they have access to information relating to each other (Bilek et al., 2015). There are different ways of exchanging information between systems and hence different types of interaction (Liu & Pelowski, 2014), but in every case some kind of alignment occurs (Coey, Varlet, & Richardson, 2012; Huygens, 1673). In the previous sections we have analysed the prevailing paradigms in research on social cognition, showing how the implicit assumptions underlying current theoretical and empirical studies of joint action imply a certain picture of the nature and mechanism of social interactions. In this section we propose an alternative approach to research on the cognitive foundations of sociality and are particularly concerned with the characterisation of alignment. On the premise that social interaction occurs when people align their mental attitudes and bodily postures at various levels of coordination, then different types of interaction can be classified in terms of types of alignment. In order to motivate our discussion of the way in which social interaction should be empirically investigated and theorized about, we will pay particular attention to the requirement for reciprocity.

In Section 2 we pointed out that it has become customary in the literature to consider shared goals as the paradigm case of social interaction and to identify reciprocity as an important consequence of joint action (Knoblich & Sebanz, 2008). In

contrast to this approach we will take reciprocity to be the primary requirement for social interactions. We suggest that reciprocity can be identified with a special kind of alignment, *mutual* alignment, involving adjustment in both parties to the interaction. However, not all cases of joint action lead to mutual alignment. It is important to distinguish this mutual alignment from other types of alignment, which do not involve a reciprocal exchange of information between the agents. Such types are characteristic of many previous studies of social cognition in which participants were frequently tested in the context of observational, ‘offline’ social interactions. For example, there have been many studies in which behaviour and brain activity were measured when one participant observed the actions of another (Iacoboni et al., 2004). Such offline social cognition involves interaction between two systems, an actor and an observer. However, while one system (the observer) can align with the actor, the other system (the actor) cannot align with the observer, since the actor receives no information about the observer (see Fig. 1). The exchange of information goes in one direction only. There is alignment, even in an observational scenario, but it is not mutual. This justifies the critique that the social cognition in observational scenarios is not sufficiently ‘social’ since it amounts to individual-level cognitive processes tested in a social setting (Hutto, 2004).

Such offline interaction can be contrasted with the case of online social interactions, where both participants act. The distinction between offline and online social interaction tasks is now acknowledged as crucial for advancing our understanding of the cognition processes underlying social interaction (Schilbach, 2014). However, not every case of online interaction involves a reciprocal social interaction based on mutual alignment. There are tasks where adjustment of the minds and bodies of participants are linked, but not by the reciprocal exchange of information. Consider, for example, the case of salsa. Salsa is indeed a case of joint action. The participants engage in a common task where they have to accomplish something together by coordinating their behaviour, and by cooperating in the pursuit of the shared goal, i.e. performing the dance. In salsa, dancers interact by performing a series of predefined movement patterns (Renta, 2004). As a result, coordination relies primarily on synchronisation with the music, rather than adaptation to each other (Koehne, Schmidt, & Dziobek, 2015). As such, Fig. 2 shows, there need be no binary exchange of information of the kind required by cases of mutual alignment. In other words, the participants do not rely on each other because they rely instead on information from a third system, i.e. music with a predictable pulse.¹ If each actor coordinates with the predictable pulse dictated by the music, then they will become temporally aligned. Although temporal coordination does create a degree of alignment between the agents, it does not amount to a mutual exchange of information. Notice that the explanatory advantage of defining the type of interaction involved in salsa from the point of view of what is required for the agents to adjust, at various levels of interaction, is to shed light on minimal aspects of sociality that would otherwise be left out of a joint-action picture of social interaction.

Indeed, if the music were heard by one of the actors, while the second actor only had access to the behaviour of the first actor, this would be a case of *offline* social cognition. Here the first actor becomes the leader while the second actor is the follower. Leader and follower are still doing something together as the synchronisation task requires the subjects to adjust behaviourally to each other. But although the agents interact as if they were cooperating and synchronizing, the adjustment only appears so from an observer’s point of view. It should be emphasized that the leader receives no information from the follower hence there is no reciprocal interaction (see Fig. 3).

Notice that we are *not* saying that synchronisation tasks are not reciprocal in nature. Quite the opposite, they could well be. Rather, the point is that, although the literature has now moved towards a more interactionist approach, empirical studies continue to be limited to tasks that require agents to interact together in time in the pursuit of joint goals. Since behavioural synchronisation is typically observed in such studies, there is a tendency to argue that the task being undertaken – in the present discussion, an online task of synchronisation – is sufficient to capture the socially relevant component of a social interaction. We contend that, if we want a richer and more exhaustive account of sociality, then observation of synchronised behaviour is not sufficient, or necessary, to define social interaction. It is the nature of the exchange of information, *whatever* this nature may be, that sets the conditions for the individuation of an interaction as social.

The change of perspective prompted by our definition of social interaction suggests that reciprocity may be necessary though not sufficient to define the nature of online social cognition. If the exchange of information between two systems is bidirectional, then the interaction is likely to be reciprocal and dynamic (Fig. 4). In contrast to salsa, consider the case of tango in which movements are improvised and as such require constant, mutual adaptation (Koehne et al., 2015; Tateo, 2014). Tango dancers have access to information relating to each other and, by virtue of the task, they exchange information with one another across time in a reciprocal and bidirectional fashion. The juxtaposition of tango with salsa highlights a spectrum of degrees of mutual reciprocity, with a richer form of interaction and greater need for alignment in tango compared with salsa.

We will explain what we mean by reciprocity with an example concerning the division of labour and the degree of give-and-take that can occur within an interacting partnership. In any exchange, one can expect that, due to individual differences, such as differences in skill or personality, co-actors may choose different roles within the interaction. Consider the very simple task in which two partners hear a rhythm and then have to continue this rhythm, without an external signal, by tapping together in synchrony. Although very simple, this task has two components, first, to maintain the rhythm and, second, to stay in synchrony. When this task is performed, a division of labour develops spontaneously. One partner concentrates on maintaining the rhythm, while the other concentrates on keeping in synchrony (Konvalinka, Vuust, Roepstorff, & Frith, 2010; Konvalinka et al., 2014). In this example the second partner must adapt more than the first and, in this sense

¹ We admit that this is a rather idealist view of Salsa. In ‘real life’ partners no doubt do adapt to each other’s movements.

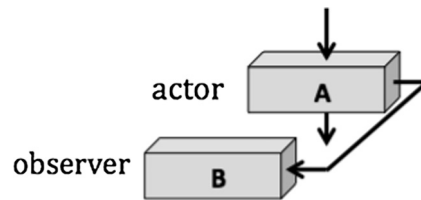


Fig. 1. Off-line social cognition: B observes, but A receives no information from B.

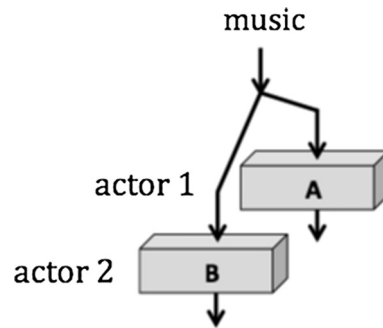


Fig. 2. Coordination without mutual alignment (e.g. Salsa): There is no, or minimal, exchange of information. Both A and B are driven by the same external signal.

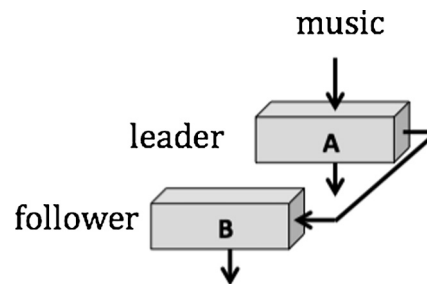


Fig. 3. On-line social cognition without mutual alignment: B aligns to A, but A receives no information from B.

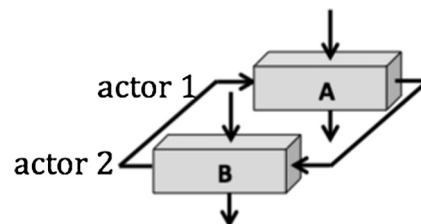


Fig. 4. On-line social cognition with mutual alignment (e.g. Tango): A and B exchange information reciprocally and adapt to each other.

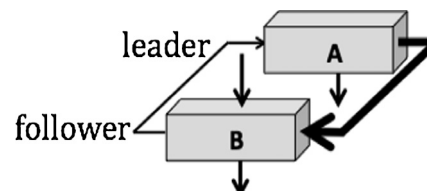


Fig. 5. On-line social cognition with mutual alignment: the follower adapts more than the leader.

becomes a follower, while the first becomes a leader (illustrated by the thickness of the arrows in Fig. 5). In such cases there will be a degree of give and take that not only varies across individuals but may also vary across time. For example, a follower will adapt more or less depending on the variability of the signal from the leader (Fairhurst, Janata, & Keller, 2013). Another example is where one partner in a joint action will take up a follower role when the other partner has a more difficult task to perform (Vesper et al., 2013).

This suggests that a binary, in-or-out view of synchronised behaviour will almost certainly miss interesting information relating to the precise nature of the exchange and interdependence of the two signals. An interaction is not about discreet points of, for example, synchronisation or coordination in space and time, but rather it is about the dynamic process of alignment that leads to those observed behaviours that we deem *social* in nature. Perhaps the degree of synchronisation achieved in a rhythmical joint action task is less important than the exchange that allowed this synchronisation to occur. It is the predictive and adaptive behaviours of the interacting partners that allows, not only for greater physical coordination, but also for mental alignment.

Future experimental work should aim to explore the nature of the exchange. This could be achieved by modelling the dynamic time-course of both behavioural (e.g. tapping behaviour and other measures of temporal coordination) and neural activity of the interacting individuals. This would take us beyond binary correlations and simple comparisons of being in or out of synchrony. In particular, it will be important to consider the kind of synchronisation of behaviour and neural activity that occurs when partners mutually adapt and to contrast this with that occurring when partners are being driven by the same external signal without mutual exchange of information. We might also expect to see a spectrum of synchronisation forms relating to the extent to which leader-follower distinctions emerge.

As we said earlier, the consensus view is that reciprocity is a necessary condition for sociality in the sense of a joint action. By stressing the importance of the nature of the exchange of information, we are not challenging this consensus view. We agree that some social interactions must be reciprocal and involve a mutual exchange of information. Our claim is that the type of social interaction at stake at any given time depends on the nature of the exchange of information rather than the fact that the subjects might be engaged in performing joint action tasks. By thinking about the conditions for the formation and persistence of acts of sociality in terms of the nature of information exchange, we can generate a definition of social interaction that is simpler yet more encompassing than the picture painted by the prevailing paradigm.

The moral is that focusing on online tasks that appear social if not mutual from an outside point of view leads to a limited definition of what counts as social in a social interaction. This is the case even though they involve subjects who are, more or less explicitly, instructed to undertake actions together in the pursuit of shared goals. In contrast, focus on the types of information exchange between agents during a social interaction allows for a broader range of interactions to be considered. A bidirectional and mutual exchange of information can be seen as the pinnacle of social interaction. But such interactions are not exclusive to joint actions where participants have a common goal. There are more ways for individual people to reciprocate thoughts and experiences than acting together in the pursuit of joint goals. Furthermore, not all joint actions elicit the bidirectional and mutual exchange of information.

5. Concluding remarks

The biggest challenge currently facing philosophers and scientists of social cognition is to understand social interactions. We suggest that this problem is best approached at the level of processes of mental alignment rather than through joint action tasks based on shared goals, and we propose that the key process is one of reciprocal, dynamic and graded adaptation between the participants in the interaction. Defining social interactions in terms of reciprocal patterns of alignment shows that not all joint actions involve reciprocity and also that social interactions can occur in the absence of shared goals. This approach has two particular advantages. First, it emphasises the key point that interactions can only be fully understood at the level of the group, rather than the individual. The pooling together of individual mental resources generates results that exceed the sum of the individual contributions. But, second, our approach points towards the mechanisms of adaptation that must be occurring within each individual in order to create the interaction (Friston & Frith, 2015).

This picture of social interaction in terms of mental alignment suggests two important theoretical developments. One is about a possible way to characterize the idea that types of social interaction lie on a continuum of possible solutions. If we focus on the task or the shared goal being pursued by agents jointly, as the current literature suggests, then only limited subdivisions of types of interaction will emerge. If, however, our focus extends so as to integrate the nature of the interaction, conceived of in terms of information exchange, then we can arrive at a higher degree of resolution of the space in which social interaction lie. This will define a spectrum of types of interaction (not just offline *versus* online social cognition), suggesting a dimensional rather than a discrete picture. After all, alignment comes in degrees and a spectrum-like definition of sociality implies that there is a variety of forms of alignment and hence of interactions. The lesson is that interacting socially is a matter of 'less or more' social understanding, rather than a binary *i.e.* all-or-none scenario.

The second theoretical consequence of our model follows directly from this view of the graded nature of mental alignment and concerns the definition of what counts as social in a social interaction. We leave aside any consideration of the specific task involved and concentrate solely on the nature of the interaction and the extent to which it is dynamic. The key feature of this definition is that people engaged in a social interaction exchange information dynamically, through

give-and-take, and not that they must entertain representational states of a certain type² allowing them to share plans and goals, as the prevailing definition of a social interaction in terms of shared intentionality would have it. By doing so, we avoid making assumptions about the representational configuration of the intentional states that enable and sustain acts of interaction. Of course, this hardly amounts to rejection of representationalism, or any classic assumption in social-cognitive research about the conditions of existence and identity of mental states. The point is rather that we can articulate a view of sociality that does not necessarily involve appeal to assumptions about the shared nature of individual-level mental states, which have proven difficult to articulate and operationalize beyond intuition.

We believe that this approach opens up exciting possibilities for new experimental paradigms, outlined in the previous section, and also for theoretical reflection on the nature of the social mind.

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² This should be understood loosely as referring to both the intentional type and the content of mental representations, as well as to the psychological 'mode' in which they are entertained by the parties to a social interaction, for example the second or the first-person plural.

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