Shared Agency and Motor Representation

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Abstract

Shared agency is paradigmatically involved when two or more people paint a house together, tidy the toys away together, or lift a two-handled basket together. To characterise shared agency, some philosophers have appealed to a special kind of intention or structure of intention, knowledge or commitment often called 'shared intention'. In this paper we argue that there are forms of shared agency characterising which requires appeal to motor representation. Shared agency is not only a matter of what we intend: sometimes it constitutively involves interlocking structures of motor representation. This may have consequences for some metaphysical, normative and phenomenological questions about shared agency.

1. Introduction

Shared agency is a familiar feature of everyday life, but it's hard to get a good fix on it without assuming a big chunk of theory. I think the best available way to zoom in on shared agency is to think about contrast cases, that is pairs of cases which are as similar as possible except one involves shared agency and the other involves parallel but merely individual agency.

When members of a flash mob in the Central Cafe respond to a prearranged cue by noisily opening their newspapers, they exercise shared agency. But when someone not part of the mob just happens to noisily open her newspaper in response to the same cue, her action does not involve shared agency.[1] To give another example, two former members of the mob exercise

[1] See Searle (1990); in his example park visitors simultaneously run to a shelter, in once case as part of dancing together and in another case because of a storm. Compare Pears (1971) who uses contrast cases to argue that whether something is an ordinary, individual action depends on its antecedents.

shared agency when they later walk to the metro station together. But two people who merely happened to be walking to the metro station side by side would not be exercising shared agency (Gilbert 1990). These sorts of case invite the question, How do activities involving shared agency differ from activities involving parallel agency only?

We should be motivated to answer this question because shared agency raises a tangle of scientific and philosophical questions. Psychologically we want to know which mechanisms make it possible (Sebanz et al. 2006; Vesper et al. 2010). Developmentally we want to know when shared agency emerges, what it presupposes and whether it might somehow facilitate socio-cognitive, pragmatic or symbolic development (Moll & Tomasello 2007; Hughes & Leekam 2004; Brownell et al. 2006). Phenomenologically we want to characterise what (if anything) is special about experiences of action and agency when shared agency is involved (Pacherie forthcoming 2010). Metaphysically we want to know what kinds of entities and structures are implied by the existence of shared agency (Gilbert 1992; Searle 1994). And normatively we want to know what kinds of commitments (if any) are entailed by shared agency and how these commitments arise (Roth 2004). A philosophical account of shared agency that made it possible to systematically distinguish shared from individual agency may support investigation of these questions (as Bratman 2009 suggests).

So, to return to the contrast cases, how do activities involving shared agency differ from activities involving parallel agency only?

The first example shows that the difference between shared agency and parallel individual agency can't just be that the resulting actions have a common effect because merely parallel actions can have common effects too. And the second example shows that the difference can't just be a matter of coordination, because people who are merely happen to be walking side by side each other also need to coordinate their actions in order to avoid colliding. Apparently, then, systematically distinguishing cases of shared agency from cases of parallel but merely individual agency requires reflection on agents' mental states.

Which mental states might distinguish shared from individual agency?

***Philosophers have so far considered intentions and commitments but ignored the possibility that appeal to motor representations may also be needed. By contrast, concerning individual rather than shared agency, some have argued that motor representation may play a role in explaining agency (e.g. Pacherie 2000, 2008; Butterfill & Sinigaglia 2012). In addition, scientific research provides evidence that motor representations sometimes play a role in enabling agents to exercise shared agency, as we shall explain in detail below. So it is possible to ask whether appeal to motor representation could also play a role in distinguishing shared from individual agency. In this paper we argue that it could. Shared agency is not always only a matter of

our intentions or commitments: in some cases it also constitutively involves certain structures of motor representation. Or so we aim to show.

Before going further, let us step back to ask why it might be useful to distinguish systematically between shared and individual agency? Shared agency raises a tangle of scientific and philosophical questions. Psychologically we want to know which mechanisms make it possible (Sebanz et al. 2006; Vesper et al. 2010). Developmentally we want to know when shared agency emerges, what it presupposes and whether it might somehow facilitate socio-cognitive, pragmatic or symbolic development (Moll & Tomasello 2007; Hughes & Leekam 2004; Brownell et al. 2006). Phenomenologically we want to characterise what (if anything) is special about experiences of action and agency when shared agency is involved (Pacherie forthcoming 2010). Metaphysically we want to know what kinds of entities and structures are implied by the existence of shared agency (Gilbert 1992; Searle 1994). And normatively we want to know what kinds of commitments (if any) are entailed by shared agency and how these commitments arise (Roth 2004). A philosophical account of shared agency that made it possible to systematically distinguish shared from individual agency may support investigation of these questions (as Bratman 2009 suggests).

As already mentioned, our aim is to show that distinguishing individual from shared agency sometimes involves appeal to certain structures of motor representation. Our first step is to review standard approaches to shared agency.

2. Shared intention

On the leading, best developed accounts of shared agency in philosophy and psychology, shared agency is explained in terms of a special kind of intention or structure of intention, knowledge and commitment often called a shared intention. For two or more agents to exercise shared agency is for them to have a shared intention and for this shared intention to be appropriately related to their actions. Such actions comprise a *shared intentional activity* (Bratman 1997, p. 142).

Explaining shared agency in terms of shared intention pushes us back to the question, What is shared intention? Here is much disagreement. Some hold that it differs from ordinary intention with respect to the attitude involved (Searle 1990). Others have explored the notion that it differs from ordinary intention with respect to its subject, which is plural (Gilbert 1992; Helm 2008), or that it differs from ordinary intention in the way it arises, namely through team reasoning (Gold & Sugden 2007), or that it involves distinctive obligations or commitments to others (Gilbert 1992; Roth 2004). Opposing all such views, Bratman (1992, 2009) argues that shared intention

can be realised by multiple ordinary individual intentions and other attitudes whose contents interlock in a distinctive way.

To avoid having to take sides on what shared intention is, let us abstract the details and focus on features that everyone should agree on. Minimally, a shared intention stands to the actions comprising a shared intentional activity in roughly the way that an ordinary, individual intention stands to an ordinary, individual action. Now an ordinary, individual intention represents an outcome, coordinates an agent's actions, and coordinates the agent's actions in such a way that, normally, this coordination would facilitate the occurrence of the represented outcome. Similarly, on almost any account, a shared intention involves there being a single outcome which each agent represents, where these representations coordinate the several agents' actions and coordinate them in such a way that, normally, the coordination would facilitate the occurrence of the represented outcome.

There is another feature of shared intention that should be uncontroversial. Shared intentions or their components feature in practical reasoning alongside ordinary, individual intentions, and there are normative requirements which apply to combinations of individual and shared intentions. To illustrate, tonight there is a party and a ceremony. It is impossible for anyone to attend both, and this is common knowledge among us. We have a shared intention that we attend the ceremony together. While having this shared intention, I also intend to go to the party. Give our common knowledge, this combination of shared and individual intentions is irrational. Its irrationality is related to that which would be involved in my individually intending to attend the ceremony while also intending to go to the party. In short, shared intentions or their components are inferentially and normatively integrated with ordinary, individual intentions.

So much for shared intention. Can we give a full account of shared agency by saying (roughly) that exercises of shared agency involve agents acting on a shared intention? Or are further ingredients necessary in systematically distinguishing shared from individual agency? Our view is that further ingredients are necessary. In giving a full account of shared agency, it is also necessary to appeal to certain structures of motor representation. Note, however, that our view is consistent with various weaker claims linking shared intention to shared agency. Our view is consistent with the claim that appeal shared intention is also needed in giving an account of shared agency, and with the claim that all exercises of shared agency involve shared intentions in some way.[2]

[2] On the latter claim, see Gilbert (2006, p. 5): 'I take a collective action to involve a collective intention.' Related claims are made by Carpenter (2009, p. 381), Call (2009, p. 369), Kutz (2000), Rakoczy (2006, p. 117), and Tollefsen (2005).

3. An objection

At this point opponents sometimes attempt to dismiss our view out of hand along these lines. Philosophers are interested in shared *intentional* agency. If there are forms of shared agency other than this one, we might be right to claim that understanding these will require appeal to motor representation. But—so the objection—such forms of shared agency (if they exist at all) are not of interest to philosophers. So we are clearly wrong to claim that the philosophical project of distinguishing shared from individual agency might require appeal to ingredients other than shared intentions.

One possible response to this line of opposition would be to weaken our claim. We could become neutral on whether a full account of the sort of shared agency philosophers have focussed on can be given without appeal to motor representation, but insist that there is a form of shared agency about which parallel philosophical questions arise. This conciliatory response would preserve most of the key claims in what follows, but a stronger response is available.

As mentioned above, some have argued that fully characterising individual agency requires appeal to motor representation as well as intention (Pacherie 2000; Butterfill & Sinigaglia 2012). These arguments concern intentional action. So if (as we suppose) these arguments are not known to be defective, then, assuming a parallel between individual and shared agency, it should not be assumed at the outset that appealing to motor representation in a philosophical account of shared agency implies that the account does not apply to what opponents call 'shared intentional agency'. We do not state our position in exactly the terms used by our opponent because of doubts about the qualifier 'intentional' that are not specific to discussions of shared agency.[3] However, we do aim show in what follows that a philosophical account of the sort of shared agency that philosophers have been interested in will require appeal to structures of motor representation.

[3] We avoid using the qualifier 'intentional' for reasons not specific to questions about shared agency. (We do use the term 'shared intentional activity', but our use merely follows Bratman's stipulation that this term applies to an activity appropriately related to a shared intention.) Briefly, some philosophers offer reasons for holding that there could be agents whose actions are intentional although the agents have no intentions at all. For instance, Bratman describes a creature who 'acts on the basis of its beliefs and considered desires' only (not intentions) as doing things 'intentionally' (2000, p. 251; see Bratman 1987, pp. 137–8 for further justification). These and related considerations reveal a coherent and natural way of using the term 'intentional' on which it would apply to actions in virtue of their being appropriately related to motor representations of outcomes to which they are directed. It is not obvious to us whether using the term in this way is incorrect.

4. Shared motor representation

Our argument starts with an empirical premise about enabling conditions for shared agency: there are reciprocal, agent-neutral motor representations of outcomes whose obtaining would normally involve action on the part of each agent; moreover, these structures of motor representation sometimes facilitate coordination when agents exercise shared agency. This needs unpacking. So before considering evidence for this premise (in the next section), let us first explain it.

A *motor* representation is the sort of representation that enables agents to reach for, grasp and transfer objects in a coordinated and fluid way. Motor representations play a key role in monitoring and planning actions (e.g. Wolpert et al. 1995; Miall & Wolpert 1996; Wilson & Knoblich 2005). Unlike intentions and related mental states, motor representations are usually involved in planning actions over milliseconds rather than minutes or even years.

Some motor representations resemble intentions in representing outcomes (rather than merely kinematic or dynamic features of action), coordinating multiple component activities by virtue of their role as elements in hierarchically structured plans, and coordinating these activities in a way that would normally facilitate the represented outcome's occurrence (Hamilton & Grafton 2008; Pacherie 2008, pp. 189-90; Butterfill & Sinigaglia 2012). Despite these points of similarity, motor representations can be distinguished from intentions and other action-related intentions, as well as from perceptual representations, by their representational format (Butterfill & Sinigaglia 2012).

Motor representations lead a kind of double life. For motor representations are involved not only in producing actions but also in observing actions. Indeed there are some striking similarities between the sorts of processes and representations usually involved in performing a particular action and those which typically occur when observing someone else perform that action. In some cases it is almost as if the observer were planning the observed action, only to stop just short of performing it herself.[4] When motor representations of outcomes trigger a planning-like process in action observation, this may allow the observer to predict others' actions (Flanagan & Johansson 2003; Ambrosini et al. 2011, 2012; Costantini et al. 2012).

A representation (motor or not) is *agent-neutral* if its content does not

[4] For reviews, see Jeannerod (2006); Rizzolatti & Sinigaglia (2008, 2010). If motor representations occur in action observation, then observing actions might sometimes facilitate performing compatible actions and interfere with performing incompatible actions. Both effects do indeed occur, as several studies have shown (Brass et al. 2000; Craighero et al. 2002; Kilner et al. 2003; Costantini et al. 2012).

specify any particular agent or agents.[5] To illustrate, agent neutral representations are sometimes found at the early stages of planning. Imagine that you and some friends are tasked with preparing a holiday. You might first write down a plan of action without specifying who will act; the plan simply describes what is to be done. The plan will eventually be implemented by you and your friends but this is not written in plan itself and so it is agent-neutral. Of course the fact that this plan is your collective plan may be represented elsewhere; this fact may also be implicit in the plan's being stapled to the door of your communal kitchen. The agent-neutrality of a representation does not require that the agents are nowhere specified, only that they are not specified in the content of the representation.[6]

Two or more agents have *reciprocal* representations (motor or not) just if there is a single outcome and each agent has a motor representation of that outcome. Reciprocal representations can occur both when one agent observes another acting alone and also when two or more agents act together. Where one agent observes another acting alone, it is possible that both have motor representations of an outcome to which the agent's action is directed. For the agent, this representation plays a role in planning and monitoring; for the observer, this representation may facilitate prediction and recognition. This is one case of reciprocal motor representation—or, as it is more usually called, mirroring. But our main interest is in a different case, one where two or more agents are acting together, there is a single outcome to which their actions are directed, and the agents each have a motor representation of this outcome. In this case of reciprocal motor representation, the agents each represent an outcome whose obtaining would normally involve not only their own actions but also those of other agents.[7] So when we act together, some of my motor representations may concern outcomes that are partly but not entirely to be realised by my actions; and likewise for you. To illustrate, suppose our task is to move an object from A to B, where you pick it up and pass it to me so that I can then place it. In this case I may represent the movement of the object from A to B and not only the component movements. I represent a collective outcome of our actions and not just outcomes

[5] Our use of the term 'agent-netural' to describe motor representations bears no relation to the use of the same term to describe reasons (on the latter, see Parfit 1984).

[6] Strictly the following argument does not hinge on the agent-neutrality of representations. It is sufficient for our purposes that there are reciprocal motor representations of outcomes whose obtaining would normally involve action on the part of each of the reciprocating agents. In principle such representations could have contents which specify particular agents. However, we focus on agent-neutral representations to show that our view is consistent with the possibility that reciprocal motor representations are agent-neutral.

[7] Note that our having reciprocal motor representations would not by itself imply that we know that the represented outcome's obtaining would normally involve actions other than our own.

to which each of our actions are individually directed.

We shall use the term *shared* motor representation as an abbreviation for the reciprocal, agent-neutral motor representation of outcomes whose obtaining would normally require action on the part of each reciprocating agent. Note that shared motor representations are shared only in the sense in which two people can share a name. (We do not mean to suggest that they are shared in the sense in which two people can share a parent: there need be no representation with two or more subjects.) Note also that a shared motor representation is not a special kind of motor representation: it is merely a structure of ordinary motor representations. At this stage we are not strictly entitled use the term 'shared motor representation' as an abbreviation. After all, we have yet to show that these structures of motor representation play a constitutive role in explaining shared agency, or even an enabling role; we have yet to review evidence that they exist. So the choice of term merely reflects our aim.

5. Interpersonal coordination and motor representation

These bits of evidence are relevant (***):

1. Kourtis et al. (2012) shows that motor planning can occur for others' actions when we are engaged in joint action with them.

2. Vesper's ESPP paper (on jumping together and imagining jumping together — jumping is published (Vesper et al. 2012), imagining jumping is about to be submitted (as of August 2012). This shows that individuals are capable of running motor simulations of multiple roughly simultaneous actions. (The important point for me is that one can simulate roughly simultaneous actions, not that the simulations are simultaneous.)

3. The GROOP effect shows that there are representations which specify each agent's task in relation to the other (so they are not simple representing the outcomes to which each of their actions are directed; they are representing an outcome to which their actions taken together are directed.)

4. Vesper says forthcoming EEG paper using piano playing paradigm on agent-neutral identification of error: one brain wave signals whether there is an error, and a different brain wave signals whose error it is (also tells you whether the overall harmonics are affected)

It is hardly controversial that reciprocal motor representations exist, for their existence is suggested by by a large body of research on motor cognition in action observation. [***Rest of this paragraph belongs in the evidence section? Should be clearer about transition: (a) I am observing and we reciprocally represent an outcome of your action (mirroring). (b) We are interacting and reciprocally represent an outcome of your action (mirroring in joint action). (c) We are interacting and reciprocally represent an outcome to which our actions are distributively directed.] It is more controversial that reciprocal motor representation occurs in joint action, but there is some evidence for this claim too.[8]

What follows is speculative philosophy: we now take for granted that social motor representation sometimes facilitates the exercise of shared agency and ask whether this matters for a philosophical account of shared agency. As a first step, we shall ask how social motor representation might facilitate agents in coordinating their actions. Note that answering this question does not directly commit us to any view about shared agency. After all, social motor representation might sometimes facilitate coordination while being extraneous to a philosophical account of shared agency.

6. How could social motor representation coordinate actions?

Suppose that social motor representation is sometimes present when two or more agents act together. It doesn't follow, of course, that social motor representation will play any role in coordinating the agents' actions. But let us consider just the possibility that it might. How could this happen? How could social motor representation play a role in coordinating action when two or more agents act together?

As a first step towards answering this question let us illustrate a general principle about planning by scaling up from motor action all the way to corporate action.

In small city state, Aravinda organises the trams and Gerhard the busses. Each is responsible for devising and updating the timetable for the service. Let us stipulate that the extent to which the tram and bus services are coordinated is to be measured by the sum of all passengers' total journey times. So a change to the timetables would result in better coordination just if it would decrease the sum of passengers' total journey times. To illustrate, improving coordination might involve having trams arrive at a stop shortly

[8] See Kourtis et al. (2012): 'the partner's expected action is simulated at the motor level, which probably facilitates effective performance of the joint action.' Kourtis et al. (2010) show that reciprocal motor representation is more likely to occur in joint action than is mere observation. See also Knoblich & Jordan (2003).

before, rather than shortly after, busses depart from there. Now Aravinda and Gerhard each intend they, Aravinda and Gerhard, coordinate the trams with the busses to the greatest extent possible given other constraints; and they intend to do this by way of these intentions and meshing subplans of them, and this is common knowledge between them. Aravinda and Gerhard thus meet Bratman's sufficient conditions for them to have a shared intention. Acting on this intention, every January Aravinda updates the tram timetables and sends Gerhard the changes. Likewise, Gerhard updates the bus timetables every June and sends Aravinda the changes. In this way each is responsive to the other's intentions and subplans of these. Indeed, each may even try to predict changes in the other's subplans and modify their own accordingly. But from each individual's point of view, the other's plans are merely a constraint.

This approach to planning suffers from two defects. First, it is unlikely to be optimal in the sense of resulting, eventually, in a combination of plans such that no other combination of plans would have been better for at least one service and no worse for either service. Second, it is unlikely to be efficient in the sense of allowing Gerhard and Aravinda to arrive at an optimal combination of plans for the two services, trams and buses, with the fewest iterations.

How could they do better? One possibility may be to have a single person planning the busses and trams—perhaps, for example, Aravinda could buy Gerhard's franchise. But suppose that this is not possible, and that there are limits on how much information Aravinda and Gerhard can share. Then another way that might improve things would be to have Aravinda and Gerhard each plan everything. So Aravinda would plan the best timetable for all the trams and busses, and Gerhard would do the same. Since Aravinda only controls the trams, she can only implement the tram-related part of this master timetable. Likewise, Gerhard can only implement the bus part of his master timetable. But if Aravinda's and Gerhard's separate planning processes are sufficiently similar, this process may result in coordinated services. In this new case, Aravinda and Gerhard coordinate their actions not by knowing or predicting each others' plans but by thinking about the best overall plan. Instead of each viewing the others' plans and actions as constraint on their own, in planning actions they absorb the others' actions.

The question was how social motor representation might play a role in coordinating action. We propose that it might do so in the way illustrated by Aravinda and Gerhard's final attempt at coordination, where each plans everything despite only being in a position to execute half of the plan.

To see how this might work, let us step down to motor action but first consider only an individual action. Suppose an agent moves a mug from one place to another, passing it from her left hand to her right hand half way. It is a familiar idea that motor planning, like planning generally, involves

starting with relatively abstract representations of outcomes and gradually filling in details. We can capture this by supposing that motor representations for planning and monitoring action involve a hierarchical structure of representations. At the top we might find a relatively abstract representation of an outcome, in this case of the movement of the object from one location to another. Action-relevant details are progressively filled in by representations at lower stages of the hierarchy. Now in the action we are considering there is a need, even for the single agent, to coordinate the exchange between her two hands. How is this achieved? We suppose that part of the answer involves the fact that planning for the movements of each hand is not done entirely independently. Rather there is a plan for the whole action and plans for the movements of each hand are components of this larger plan. It is in part because they are parts of a larger plan that the plan for one hand constrains and is constrained by the plan for the other hand.

How is this relevant to the case of joint action? In joint action the agents have the same goal, to move the object from one place to another. They also face a similar coordination problem, requiring a precisely timed swap from one hand to another. Now suppose, that the same planning is involved in the individual case (where one agent performs the whole action) and in the joint action case (where the action is distributed between two agents). The planning is the same almost up to the actual muscle contractions.

How could this be helpful? Suppose the agents' planning processes are similar enough that, for a given context and problem, they will produce approximately the same plans. Then having each agent plan the whole joint action means that (i) each agent plans the other agent's action, (ii) each agent's plan for the other agent's action is approximately the same as that agent's plan for her own action [***AMBIGUOUS: 'that agent's plan' must refer to the other agent, not 'each agent', and (iii) each agent's plans for their own action are constrained by the plans for the other agent's action.

[***TODO: (a) contrast this case with a team of experts, each with different motor expertise (e.g. musicians playing together). They can't plan each others' actions. (b) Discuss in how much detail each others' actions should be planned so as to enable coordination.]

So what enables the two agents' plans to mesh is not that they represent each other's plans but more simply that they plan each other's actions as well as their own actions as if they were each about to do the whole thing themselves.

Each agent is planning (and monitoring) both their actions almost as if a single agent were going to execute the whole action. And of course this is exactly what we want for small-scale joint action—we want two or more agents to act as one. This may be why the performance of dyads in joint actions often resembles the performance of individuals tasked with performing the whole action alone (Knoblich & Jordan 2003).

So what is the difference between the individual and the joint case? From the point of view of motor representation, the primary difference may be that in joint action there is a need to prevent execution of the parts of the action which are not one's own.

7. Grounding the purposiveness of joint action

So far we have only been considering a possible role for social motor representation in enabling joint action. How does any of this bear on our main question about shared agency? The details of how social motor representation enables joint action already give us grounds for holding that motor representation has a role to play in explaining shared agency.

Here are two basic question about joint action are. What singles out the outcome or outcomes to which a purposive joint action is directed? And what binds together the various activities (of several agents) that make up the joint action?

If we appeal to a notion of shared intention, we can answer these questions about joint action. A shared intention is what relates purposive joint actions to the outcomes to which they are directed. For the shared intention involves a representation, on the part of each agent, of an outcome, coordinates the several agents' activities and coordinates the several agents' activities in such a way that would normally facilitate the occurrence of the represented outcome. This is how a shared intention can bind together the activities comprising a joint action and link them to an outcome.

Our earlier discussion of how social motor representation might enable joint action already shows that social motor representation resembles shared intention in this respect. Return to the example of two agents moving an object in a way that involves passing it between them. Suppose that their passing involves a social motor representation of the outcome, which is the movement of the object. Then there are motor representations, one for each agent, of an outcome to which the joint action is directed. And these representations coordinate the several agents' activities, and do so in ways that would normally facilitate the occurrence of the outcome represented.[9] So social motor representation can bind together the activities comprising a joint action and link them to an outcome in much the way that shared intention can.

What we are suggesting is very simple. Given the correctness of a standard view about shared intention in joint action, and given that in ordinary, individual action, motor representations bind together activities and link them to outcomes, it is plausible that in joint action, several agents'

[9] This implies that social motor representation and the associated processes underwrite what Butterfill (submitted) calls *collective goals*.

activities can be bound together and linked to an outcome by social motor representation. That is, the purposiveness of a joint action can be grounded not only in shared intention, but also in social motor representation. This is why we suppose that an account of shared agency must appeal not only to shared intention but also to social motor representation.

8. How social motor representation resembles shared intention

It may be helpful to compare and contrast the notion of social motor representation with a notion of shared intention. We shall use Bratman's account of shared intention as it is the best developed. Here are Bratman's collectively sufficient[10] conditions for you and I to have a shared intention that we J:

> 'I. (a) I intend that we J and (b) you intend that we J
>
> 'II. I intend that we J in accordance with and because of Ia, Ib, and meshing subplans of Ia and Ib; you intend that we J in accordance with and because of Ia, Ib, and meshing subplans of Ia and Ib
>
> 'III. I and II are common knowledge between us' (Bratman 1993, p. View 4)

Let us take each of these three conditions in turn.

To see a parallel with the first condition, (I), recall two (empirical) claims on which the notion of social motor representation is based. First, some motor representations represent outcomes. Second, some motor representations represent the outcomes of actions not all of whose components will be executed by the agent whose motor representation it is. Given these claims, there is a direct parallel with Bratman's first condition, (I). Where some agents have either a shared intention or a social motor representation, there is an outcome to which their actions are directed and each agent represents this outcome. Of course there is also a difference: In the case of social motor representation, the outcome is represented motorically and need not feature in the content of any intention.[11]

Concerning the second condition, (II), there is clearly no direct parallel. Whereas one intention can be about another intention, we assume that one

[10] In Bratman (1992), the following were offered as jointly sufficient *and individually necessary* conditions; the retreat to sufficient conditions occurs in Bratman (1997, pp. 143-4) where he notes that 'for all that I have said, shared intention might be multiply realizable.'

[11] Here and below were are assuming that no motor representations are intentions. If this assumption is wrong (as Pacherie 2008 suggests), social motor representation may be even more closely related to shared intention that we suggest here.

motor representation cannot be about another motor representation. But there is a parallel of sorts. A function of the second condition, (2), is to ensure meshing of subplans. Each agent's having a motor representation of the outcome to which all their actions are together directed does ensure meshing of subplans. What ensures this meshing is not the fact that each agent represents the other's plans as the other's plans. Rather what ensures meshing of subplans is this: Each agent plans all of the agents' actions, and the agents rely on planning strategies that are sufficiently similar to ensure meshing subplans.

The third condition, (3), concerns common knowledge. Why is this condition needed? Bratman himself says little.[12] One possible justification for supposing that shared intention involves common knowledge concerns a normative link between intention and reasons. In acting on an intention, there should be reasons for which the agent acts. And, arguably, a consideration can only be among the reasons for which an agent acts if she knows that consideration (or at least is in a position to know it). So the need for common knowledge may arise from the need to explain how reasons for which an agent acts could include facts about others' intentions. This need does not arise in the case of social motor representation (at least not in the same way). For, arguably, where actions involve motor representations, it is not true that there should be reasons for which the agent acts. (Of course there are reasons which explain why motor actions happen; but these need not be reasons for which agents act.) So motor joint action does not require that one agent's motor representations provide reasons for which another agent acts. Instead, what is required is this. There should be a good chance—good relative to the potential costs and benefits of attempting this particular joint action now—that social motor representation will provide the necessary coordination. Of course this could be guaranteed by common knowledge. But common knowledge is not required. Alternatively it can be ensured by common planning processes and a common background of dispositions, habits and expectations.[13]

If, as we have just argued, social motor representations play a role analogous to the structure of intentions and knowledge which Bratman identifies as sufficient for shared intention, then this is a (non-decisive) reason to think that motor representation is also needed in characterising shared agency.

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[12] See Bratman (1993, p. 117): 'it seems reasonable to suppose that in shared intention the fact that each has the relevant attitudes is itself out in the open, is public.' In other words, common knowledge is needed because it is.

[13] Another possible line of justification for the claim that common knowledge is involved in shared intention might start from a natural generalisation of Davidson's claim that '[a]ction does require … that what the agent does is known to him under some description' (Davidson 1971, p. 50).

9. Are social motor representations shared intentions?

We have been arguing that an account of shared agency cannot appeal to shared intention only but must also appeal to social motor representation (and perhaps to other ingredients besides). Our argument rests on the premise that social motor representations are not shared intentions. But since we have just bee pointing to broad similarities between shared intention and social motor representation in that both play a role in coordinating agents' actions by virtue of representing outcomes, it may be tempting to suppose that some social motor representations are shared intentions.

This issue might easily seem narrowly conceptual or terminological. At the end of the day it doesn't much matter if we want to call some motor representations 'shared intentions'. After all, as already noted, on some accounts shared intentions are neither shared nor intentions so we would hardly be doing more violence to the term than is already being done.

However exactly one decides to use the term 'shared intention', at least three substantive issues remain. The first concerns conceptual demands. Whereas having a shared intention arguably demands an ability to represent others' intentions (pp. * Butterfill 2012), social motor representation imposes no such demands. The second concerns planning. Whereas shared intentions are elements in long-term plans and function in part to enable agents to coordinate their plans, social motor representation is incapable of playing this role. A third, and related substantive issue is that social motor representations are structures of representations with a non-propositional format and so cannot be inferentially integrated with ordinary intentions and knowledge (pp. * Butterfill & Sinigaglia 2012), whereas shared intentions can.

While prefer (for narrowly terminological reasons) to state our claim by saying that explaining shared agency requires ingredients other than shared intention, the claim could alternatively be formulated by saying that explaining shared agency requires importantly different (in the ways described) varieties of shared intention.

10. Conclusion

We have been considering how to provide an account of shared agency that might contribute to investigating a tangle philosophical and scientific questions.

Whereas some have claimed that shared agency can be fully explained in terms of a notion of shared intention, we have argued that some events are joint actions by virtue of being appropriately related to a structure of

motor representations we call social motor representation. We don't mean to suggest that all joint actions involve social motor representation. The view we are aiming to establish is rather this: Some events are joint actions in virtue of being appropriately related to social motor representations which bind their components together and ensure that there is a single outcome to which these components are collectively directed. This is why understanding shared agency requires understanding not only shared intention but also the coordinating role of social motor representation.

None of this is to deny that shared intention is among the ingredients needed to characterise shared agency. Indeed, it may be that the notion of social motor representation has a role to play in explaining what shared intention is. In constructing realisers of shared intention from ordinary individual intention, we need intentions *that we J*. As has been much discussed (e.g. Petersson 2007), the contents of these intentions cannot all refer to actions involving shared intentions. For this reason Michael Bratman suggests that things we intend are cooperatively neutral activities. It is then necessary to add further intentions in order to transform cooperatively neutral activities into joint actions. But it also seems possible that in some cases, what we intend when we intend that we J is not a cooperatively neutral activity but instead a joint action of the sort which involves social motor representation.

So perhaps harmony between shared intention and social motor representation is sometimes achieved in this way: what we intend when we share an intention is the sort of joint action that involves social motor representation.

In conclusion, two things. First, some events are joint actions in virtue of being appropriately related to social motor representations which bind their components together and ensure that there is a single outcome to which these components are collectively directed. Second, and much more tentatively, in some cases social motor representation may be among the ingredients that realise a shared intention.

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