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. One way to get an intuitive fix on it 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 shared agency when they later walk to the metro station together. But two

[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.

people who merely happened to be walking to the metro station side by side would not be exercising shared agency (Gilbert 1990).

I'll use the term *joint action* for an exercise of shared agency, as contrasted with an *individual action* which is an exercise of individual agency.

Shared agency raises **a tangle of scientific and philosophical questions**.

1. Psychologically we want to know which mechanisms make it possible (Sebanz et al. 2006; Vesper et al. 2010).

2. 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).

3. Phenomenologically we want to characterise what (if anything) is special about experiences of action and agency when shared agency is involved (Pacherie forthcoming 2010).

4. Metaphysically we want to know what kinds of entities and structures are implied by the existence of shared agency (Gilbert 1992; Searle 1994).

5. And normatively we want to know what kinds of commitments (if any) are entailed by shared agency and how these commitments arise (Roth 2004).

In investigating these questions it is sometimes useful to have a conceptual framework which enables us to distinguish systematically between shared and individual agency. My aim in what follows is to see whether there is a constitutive role for motor representation in explaining shared agency. There is now an impressive and growing body of evidence about the role of motor representation in *enabling* joint action. But it is perhaps natural to suppose that motor representation is merely an enabling factor, so that …

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 I aim to show.

1.1. *slide

A basic question about joint action is, **What is the relation between a joint action and the outcome or outcomes to which it is directed?** Ayesha and Beatrice lift the table. ***

The standard answer to this question involves shared intention. It's hard to say exactly what a shared intention is because each philosopher seems to take a different view. But for my purposes it's enough to say that shared

intention, whatever exactly it is, stands to joint action as ordinary, individual intention stands to ordinary, individual action. Building on this parallel, we can say that when two or more agents act on a shared intention that they free they cat,

1. the shard intention involves a representation on the part of each agent of this outcome, the freeing of the cat

2. the shared intention coordinates the several agents' actions

3. and the shared intention coordinates their actions in such a way that, normally, the coordination would facilitate the occurrence of the represented outcome.

In this way we can explain the directedness of a joint action to an outcome by appeal to shared intention.

There is another feature of shared intention that should be uncontroversial on any account of it. 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.

In this talk I'm going to argue that in some cases of joint action, the directedness of the joint action to an outcome cannot be explained in terms of shared intention. In some cases, the directedness of a joint action to a goal needs to be explained in terms of a special structure of motor representation.

It would be natural to assume that motor representation plays at most an enabling role in explaining shared agency, that we need motor representation to explain how people manage to coordinate their actions in practice, but not to understand what shared agency is. But my thesis is that we need to appeal to action-guiding representations that are more primitive than intention and desire in order to explain what shared agency is: To understand shared agency we need to understand the relation between joint actions and the outcomes to which they are directed. And understanding this relation requires appeal, not only to structures of intention, commitment and knowledge, but also to structures of motor representation.

This conflicts with the view that understanding shared agency requires understanding only shared intention. So I disagree with Facundo Alonso's statement that:

> 'the key property of joint action lies in its internal component [...] in the participants' having a "collective" or "shared" intention' (Alonso 2009, pp. 444-5).

But **my disagreement is constructive**. I want to build on insights about shared intention. I'm not denying that appeal shared intention is also needed in giving an account of shared agency, and I'm not even disagreeing here with those who claim that all exercises of shared agency involve shared intentions in some way. The point is just that we can't fully understand shared agency in terms of intention, commitment and knowledge: instead, it's also necessary to invoke motor representations.

2. The theory (non-motor)

In what follows, I'm simply going to take for granted a range of empirical claims about motor representation and its role in facilitating joint action. There is a growing body of evidence in support of these claims, some of which is listed on your handout. But I'm not going to discuss the evidence. Instead I want us to do speculative philosophy, to try to tease out the broad implications of the evidence for understanding the structures of agency involved in joint action.

To this end it will be helpful to fix some terminology.

2.1. *distributive goal

Two or more agents' actions have a distributive goal just if ...

Contrast cases: don't have distributive goal.

But some actions involving parallel but merely individual agency do involve distributive goals. One dark night two people each independently intend to paint a large bridge red. More exactly, each intends that her painting grounds or partially grounds the bridge's being painted red.[2] (These intentions ensure that it is possible for both people to succeed in painting the bridge, as well as for either of them to succeed alone.) Because the bridge is large and they start from different ends, the two people have no idea of each other's involvement until they meet in the middle. Nor did they expect that

[2] Event D *partially grounds* event E if there are events including D which ground E. (So any event which grounds E thereby also partially grounds E; we nevertheless describe actions as 'grounding or partially grounding' events for emphasis.) See the definition of *plural grounding* *.

anyone else would be involved in painting the bridge red. On almost any account, this implies that they were not acting on a shared intention. Despite this, they both succeed in painting the bridge red. As this illustration suggests, it is possible for two or more agents' actions to have a distributive goal without them thereby exercising shared agency. So distributive goals are not shared intentions.

2.2. *collective goal

Let an outcome, possible or actual, be a *collective goal* of a joint action, or of any collection of goal-directed actions, where three conditions are met: (a) this outcome is a distributive goal of the actions; (b) the actions are coordinated; and (c) coordination of this type would normally facilitate occurrences of outcomes of this type. Examples of actions that typically have collective goals include two people jointly sawing a log with a two-handled saw and three people jointly lifting a heavy table. The bridge painters (from section *) are different: their actions do not have a collective goal because they are not coordinated.

Where two or more agents' actions have a collective goal there is a sense in which, taken together, their actions are directed to the collective goal. It is not just that each agent individually pursues the collective goal; in addition, there is coordination among their actions which plays a role in bringing about the collective goal. We can put this in terms of the direction metaphor. Any structure or mechanism providing this coordination is directing the agents' actions to the collective goal. So the notion of a collective goal provides **a schematic answer** to the question about the relation between joint actions and the goals to which they are directed.

The notion of a collective goal assumes that of coordination. This should be understood in a broad sense. When two agents between them lift a heavy block by means of each agent pulling on either end of a rope connected to the block via a system of pulleys, their pullings count as coordinated in this broad sense. In this case, the agents' actions are coordinated by a mechanism in their environment, the rope, and not necessarily by any psychological mechanism. By invoking a broad notion of coordination and invoking coordination of actions rather than of agents, the definition of collective goal avoids direct appeal to psychological states.

To make a conjecture based on work with bees and ants, in some cases the coordination needed for a collective goal may even be supplied by behavioural patterns (Seeley 2010) and pheromonal signals (Hölldobler & Wilson 2009, pp. 178-83, 206-21).

This is not to say that collective goals never involve psychological states. In fact, one way for several actions to have a collective goal is for their agents to be acting on a shared intention; a shared intention supplies the required

coordination.

But the possibility we are interested in is that the coordination required for a collective goal involves structures of motor representation rather than shared intention. How could this work in principle?

2.3. Agent-neutral

First we need to introduce the notion of an agent-neutral plan. By saying that something is *agent-neutral* I mean just that it does not involve identifying any particular agents.

Agent-neutral planning for outcomes whose realisation would normally involve action on the part of several agents is also quite common. [*Change example so that can vary parameters: we have decided to make a pizza …] For example, some housemates who have decided to take on an allotment to grow vegetables might sit down together to plan what needs doing without yet assigning roles to particular individuals. In so planning, each housemate is thinking about what is to be done and not what she herself will do. At some point the housemates stop planning. (This does not necessarily mean that they have a fully worked out plan; like any other plans, agent-neutral plans can have gaps that may need filling in later.) They now divide up the roles in a way that everyone is prepared to go along with, and that each implements her part in the plan.

In the above example of agent-neutral planning, the housemates **plan together** and **agree** on a common plan. But an individual can construct an agent-neutral plan by herself, even if its eventual execution will involve others. In fact, two or more individuals who are assigned a task might each individually engage in agent-neutral planning in parallel.

Suppose that the housemates each sit alone in their rooms and plan the trip to Balaton.

Of course, for us to engage in reciprocal, parallel agent-neutral planning concerning a particular outcome only makes sense if the plans we construct will be identical or similar enough that differences don't matter. And, of course, we must also all assign the same or similar roles to ourselves and each other. So reciprocal, parallel agent-neutral planning only makes sense where:

1. we have relevantly similar planning strategies and expertise
2. there is one salient way for us to achieve the outcome; and
3. there is one salient way for us to assign roles to each other.

The task demands and their planning strategies may conspire to ensure that they each come up with the same agent-neutral plan. The task demands

and manifest properties of the agents, such as their distribution in space, may also ensure that each agent also assigns the same roles to the same individuals. (Strictly speaking it is not necessary for the plans and role assignments to be identical; it is enough if the resulting agent-specifying plans are, in a special sense, compatible.[3]) Finally, each agent may know enough about herself and the others to be able to determine, without communicating, whether the plan and role assignments will be acceptable to everyone. And all of this—that they engage in parallel, agent-neutral planning resulting in identical (or compatible) plans and role assignments, which are acceptable to all—may be common knowledge to the agents. So it is possible, in principle at least, that several agents might each individually engage in agent-neutral planning and rationally perform their part in the resulting plan, knowing that the others will do likewise. Parallel, agent-neutral planning can rationally result in coordinated action without presupposing shared agency.[4]

2.4. *Motor

To see how there might be agent-neutral motor planning for outcomes realising which will involve the agent and another's or others' actions, let us return to a case involving a single agent.

Consider 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

[3] Suppose that, for some outcome, two or more agents each have a plan for the realisation of that outcome. (These plans may, but need not, specify roles for all of the agents; but the plans must be agent-specific, not agent-neutral.) By saying that these plans are *compatible* we mean that: (i) no agent would normally be prevented from performing the role she is assigned in her own plan by other agents performing the roles they are assigned in their plans; and (ii) if all facts about which agents have which roles in which plans were common knowledge to the agents, this would not affect the rationality of their each acting on the intention that they realise the outcome by performing the role she is assigned in her own plan. To illustrate, suppose that our task is to press a button simultaneously. If your plan is that each of us will to start to move in exactly 60 seconds and press the button 5 seconds later whereas my plan specifies that you are the leader and we are each to press the button 5 seconds after you start moving, then our plans are compatible.

[4] Note that we are claiming only that shared agency is not presupposed. Our view is consistent with (but does not depend on) the claim that if some agents each engage in parallel, agent-neutral planning and then rationally perform their part in the resulting plan, the upshot would be an exercise of shared agency.

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.

3. [*cut] Shared motor representation

Our argument starts with an empirical premise about enabling conditions for joint action: 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.

*** **explain motor representation in terms of passing object from one hand to the other**

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.[5] 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).

[5] 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).

A representation (motor or not) is *agent-neutral* if its content does not specify any particular agent or agents.[6] 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.[7]

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.[8] 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 move-

[6] 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).

[7] 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.

[8] 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.

ments. I represent a collective outcome of our actions and not just outcomes 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.

4. [*cut] 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?

5. 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 inten-

tion 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' 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.

6. 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

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

[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.'

> '2. I intend that we J in accordance with and because of la, lb, and meshing subplans of la and lb; you intend that we J in accordance with and because of la, lb, and meshing subplans of la and lb
>
> '3. 1 and 2 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, (1), 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, (1). 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, (2), there is clearly no direct parallel. Whereas one intention can be about another intention, we assume that one 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

[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.

[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.

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.

7. 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.

[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).

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.

8. *Interface Problem

[*Include this?]

I think we can see a possible solution to this challenge by considering another problem. In constructing realisers of shared intention from ordinary individual intention, we need intentions *that we J*. As has been much discussed, 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.

9. Conclusion

In conclusion, I have been arguing that in order to fully understand the relation between joint actions and the goals to which they are directed we need to invoke shared motor representations. This is because shared motor representations involve a representation, on the part of each agent, of a single outcome, and coordinate the agents' actions in such a way that, normally,

the occurrence of the represented outcome will be facilitated. In this respect shared motor representation resembles shared intention.

But there are also differences. Shared motor representation and shared intention have **distinctive roles in explaining shared agency**. And, relatedly, shared motor representation is **unlike shared intention** in that its constituent representations are non-propositional in format and so it doesn't inferentially integrate with ordinary intentions and knowledge states.

This has two consequences. One is that we cannot fully understand shared agency is if we focus only on shared intention. The other is that we face a challenge. The challenge is to explain how these two kinds of representation could sometimes harmoniously contribute to effective shared agency despite not being inferentially integrated in practical reasoning.

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