

# Intention and Motor Representation in Joint Action

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## Abstract

On the assumption that social motor representation plays a role in explaining how effective joint action is possible, is there also a role for motor representation in explaining what joint action is? Philosophers tend to assume that motor representation is only an enabling condition for joint action and of no direct interest to narrowly philosophical theories of joint action and shared intention. In this talk I shall argue that social motor representation and shared intention have distinctive roles in explaining the purposiveness of joint action. This gives rise to a challenge. On the one hand, effective joint action—imagine two people erecting a tent in a gale together—sometimes requires both shared intentions and social motor representations plus a certain kind of harmony between the two. On the other hand, recognizing their distinctive roles precludes the existence of direct inferential links between shared intentions and social motor representations. The challenge is to explain how these two kinds of representation could sometimes harmoniously contribute to effective joint action despite the lack of inferential integration.

## 1. Introduction

Which events are joint actions? We shall argue that fully answering this question involves appeal to structures of motor representation. By contrast, most philosophers and many (but not all) psychologists appear to assume that this question can be fully answered just in terms of a special kind of

intention or structure of intention and knowledge often called a shared (or ‘collective’) intention. On this widely held view, for an event to be a joint action is for it to be appropriately related to a shared intention. For comparison, in the case of ordinary, individual action one might hold that for an event to be an action is for it to be appropriately related to an intention. This assumption immediately raises the question of what shared intention is. On this question several philosophers offer competing theories. It is striking, however, that few have challenged the assumption that for an event to be a joint action it must be appropriately related to a shared intention. This is striking because the parallel assumption about ordinary, individual action is not as widely held among leading theorists. On several leading views, there could be agents whose actions are purposive—and, in some cases, even intentional—even though the agents have no intentions. If any such view is correct, it is impossible to fully explain what it is for an event to be an action by appeal to intention alone. Our aim is to defend a parallel claim about joint action. More specifically, we shall defend these claims: first, that fully explaining which events are joint actions requires appeal to structures of motor representation and not only to shared intention; and, second, that recognising a constitutive role for motor representation in joint action makes possible an account of shared intention which is simpler and more elegant than any of the leading alternatives.

## 2. Social motor representation

We start from the premise that reciprocal agent-neutral motor representation enables some joint actions. This needs unpacking. A representation (motor or not) is *agent-neutral* if its content does not specify any agent or agents. 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 the plan itself does not specify this 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.<sup>1</sup> Two or more agents have *reciprocal* motor

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<sup>1</sup> 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 which concern actions which are partly but not entirely the agent’s own. In principle such representations could have contents which specify other agents or multiple agents. We

representations just if there is a single outcome and each agent has a motor representation of that outcome. We shall use the term *social* motor representation as an abbreviation for reciprocal agent-neutral motor representation. (Of course we cannot assume in advance of argument that reciprocal agent-neutral motor representations are social in any interesting sense; but we are using the term ‘social’ in a non-standard way as an abbreviation, one that reflects our aim.) So for two or more agents to have social motor representation is just for there to be a single outcome of which each agent has an agent-neutral motor representation.

Our premise is just that social motor representation is among the factors enabling some joint actions. It does not follow that social motor representation is involved in every joint action, nor that the existence of social motor representation would be sufficient for there to be joint action.

This premise is doubly controversial. While it is now well established both that there are motor representations of action outcomes (and not merely patterns of joint displacement, say), and also that there are motor representations of the outcomes of others’ actions rather than only of one’s own actions, less research has so far considered the conjecture that motor representations concern outcomes of actions which are partly but not entirely one’s own. There is also relatively little evidence for the further conjecture that such representations enable some joint actions. We shall not argue for either conjecture; they are empirical premises. What follows is speculative philosophy: an attempt to explain the consequences and significance of the conjecture that social motor representation enables some joint actions.

Why accept the premise that social motor representation enables joint action? A direct way to test the premise would be to measure how (if at all) selective interventions on social motor representation affected agents’ performance of joint actions. As far as we know no one has done this and it may be impractical. But there are some indirect findings. We shall focus on just one, which will serve to illustrate the premise (but does not provide a decisive reason to accept it). Kourtis and colleagues report that ‘[s]imulation of another person’s action, as reflected in the activation of motor cortices, gets stronger the more the other is perceived as an interaction partner’ (Kourtis et al. 2010, p. 4). To establish this they had two subjects sit opposite each other at a table; there was also a confederate at the table, the ‘loner’. Sometimes the subjects acted alone, picking up and replacing an object. And sometimes they had to act together, passing an object between them. The loner always acted alone. EEG measurements of motor activation were recorded. The researchers compared patterns of motor activation in four conditions: when the first subject acted, when the second subject acted, when the loner acted and when there was a ‘no go’ signal so that no one

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focus on agent-neutral representations to simplify exposition.

acted. They found that when one of the subjects acted, patterns of activation in each of the two subjects were similar regardless of which was acting and which was observing. By contrast, when the loner acted the subjects' patterns of activation resembled those found in the 'no go' condition when there was no action. Since the researchers did not include a condition where there was a competitive, non-joint interaction, we cannot conclude that the effect they found is specific to joint action as opposed to other kinds of interaction. What we do take this paper to indicate, together with a body of other research on motor representation of observed action, is this. If you are engaged in a joint action with someone, one which involves moving an object by passing it between you, then each of you has motor representations of actions whose (perhaps improper) components include actions which will be performed by the other and these motor representations are functionally equivalent to motor representations of your own actions in the sense that they are just the sorts of representation that might have caused you to do what the other is doing (if you were in her position).

For each of the agents involved in a joint action to represent motorically actions whose (perhaps improper) components include the others' action is not yet for there to be social motor representation. For there to be social motor representation there must be an outcome (such as the movement of an object from one place to another) which each agent has an agent-neutral motor representation of. The experiment by Kourtis et al. (2010) was not designed to distinguish a case in which each agent represents the outcome to which the whole joint action is directed (in this case, the entire movement of the object) from a case in which each agent represents separately outcomes to which each of the individual actions comprising the joint action (in this case, the several movements of the object each of which just one agent is responsible for). However we are making a leap and assuming (without argument) that in cases like that studied by Kourtis and colleagues, there is sometimes social motor representation.

### 3. How could social motor representation enable joint action?

Suppose that social motor representation is present in some joint action contexts, and, inspired by Kourtis et al. (2010), that social motor representations are more likely to occur in joint action than when one is merely observing. It doesn't follow, of course, that social motor representation enables some joint actions. But let us consider just the possibility that it might. How could social motor representation enable joint action even in principle?

To answer this question let us take a step back and consider an individual action. Suppose an agent moves a mug from one place to another, passing

in 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 the 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 (inspired by Koutis et al's and others' findings) 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, and (iii) each agent's plans for their own action are constrained by their plans for the other agent's action. 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 (\*refs: Knoblich circles following task).

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.

## 4. Grounding the purposiveness of joint action

So far we have only been considering a possible role for social motor representation in enabling joint action. But I think the details already give us grounds for holding that motor representation has a role to play in explaining what joint action is. To see why, let's go back to individual action for a moment again.

## 5. Slide

A basic question about ordinary, individual action is: What is the relation between a purposive action and the outcome or outcomes to which it is directed?

Many ordinary purposive actions have many different outcomes. Grabbing little Isabel by the hands I swing her around, causing her to laugh and, simultaneously, breaking a vase. In fact the outcome to which this purposive action was directed might not be among its actual outcomes; after all, actions can fail.

## 6. Slide

So among all the actual and possible outcomes of my action, one or some are singled out as specially related to this action. One aspect of the question concerns what singles out the outcome or outcomes, actual or merely possible, to which a particular purposive is directed. But there is also a second aspect ...

## 7. Slide

Ordinary purposive actions are sometimes composed of more than one motor action. My swinging Isabel around starts with my reaching for her wrists, grasping them and then spinning us around ... and my action doesn't include other things which I might be doing simultaneously, like refusing a cup of tea with my eyes or trying to determine whether that smell is coming from Isabel's sister Hannah's nappy.

## 8. Slide

So another aspect of our question is what determines which activities comprise the purposive action and which do not.

## 9. Slide

The standard answer to this question involves intention. An intention (1) represents an outcome, (2) coordinates the one or several activities which comprise the action; and (3) coordinate these activities in a way that would normally facilitate the outcome's occurrence.

What binds particular component actions together into larger purposive actions? It is the fact that these actions are all parts of plans involving a single intention. What singles out an actual or possible outcome as one to which the component actions are collectively directed? It is the fact that this outcome is represented by the intention.

So the intention is what binds component actions together into purposive actions and links the action taken as a whole to the outcomes to which they are directed.

## 10. Slide

Now as Elisabeth Pacherie has argued (Pacherie 2008, pp. 189-90) (and I've had a go at arguing this in joint work with Corrado Sinigaglia recently too), motor representations are relevantly similar to intentions.

Of course motor representations differ from intentions in some important ways (as Pacherie also notes).

But they are similar in the respects that matter for explaining the purposiveness of action. (1) Like intentions, some motor representations represent outcomes (and not merely patterns of joint displacements, say). (2) Like intentions, some motor representations play a role in coordinating multiple component activities by virtue of their role as elements in hierarchically structured plans. (3) And, like intentions, some motor representations coordinate these activities in a way that would normally facilitate the outcome's occurrence.

So in the individual case, it seems to me quite straightforward that there is a role for motor representation to play in explaining the purposiveness of action [\*explaining the possibility of purposive action?].

The claim is not that *all* purposive actions are linked to outcomes by motor representations, just that some are. In some cases, the purposiveness of an action is grounded in a motor representation of an outcome; in other cases it is grounded in an intention. And of course in many cases it may be that both intention and motor representation are involved.

## 11. Slide

Now let's turn to joint action.

## 12. Slide

The same question we asked about ordinary, individual action also arises for joint action. What is the relation between a purposive joint action and the outcome or outcomes to which it is directed?

## 13. Slide

And again the question has two aspects. What singles out the outcome or outcomes to which a purposive joint action is directed?

## 14. Slide

And what binds together the various activities that make up the joint action? The difference in the case of joint action is, of course, that these activities are not necessarily activities of a single agent.

## 15. Slide

The answer to this question for the case of joint action is also superficially similar in the answer we gave in the case of ordinary, individual action.

A shared intention is what relates purposive joint actions to the outcomes to which they are directed. For the shared intention (1) involves a representation, on the part of each agent, of an outcome (2) coordinates the several agents' activities and (3) coordinates the several agents' activities in such a way that would normally facilitate the occurrence of the represented outcome.

It is in this sense that a shared intention can ground the purposiveness of a joint action.

## 16. Slide

But what we saw earlier, what the research by Kourti et al and others indicates, is that social motor representation can play a role similar to that of shared intention.



Return to the example of two agents moving an object in a way that involves passing it between them. Suppose that their passing involves reciprocal agent-neutral motor representations of the outcome, which is the movement of the object. These motor representations (1) represent an outcome to which the joint action is directed, (2) coordinate the several agents' activities and (3) coordinate the several agents' activities in a way that would normally facilitate the occurrence of the represented outcome. Because each agent represents the whole movement and plans all of its implementation irrespective of which parts she will actually perform, each agent plans the action in a way that should coordinate with the other agent's plans providing they use similar planning procedures

[\*What I'm saying here, in effect, is that both shared intention and social motor representation can yield a COLLECTIVE GOAL]

## 17. Slide

What I'm suggesting is very simple.

If you think that in ordinary, individual action, the purposiveness of actions can be grounded by motor representations (and you should think this because it's true), then you should also think the same about actions involving two or more agents—the purposiveness of a joint action can be grounded in motor representations as well as in shared intentions.

## 18. Slide

Let me try another way of presenting the same idea. Here are Michael Bratman's sufficient conditions for shared intention. I want to suggest that social motor representation provides a parallel

## 19. Slide

There is a direct parallel with the first condition: in the case of motor representation, each agent represents the outcome (e.g. the movement of the object). The key claim here is that some motor representations (i) represent outcomes, and (ii) represent the outcomes of actions not all of whose components will be executed by the agent whose motor representation it is.

## 20. Slide

Here there is clearly no *direct* parallel. I don't think motor representations can represent motor representations in the way that intentions can represent intentions. But I do think there is a parallel of sorts. Each agent's having a motor representation of the distributed goal of their action 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 in the case where joint action is grounded in social motor representation, what ensures meshing of subplans is two facts (i) each agent plans all of the agents' actions, and (ii) the agents rely on similar planning strategies (planning strategies that are sufficiently similar to ensure meshing subplans).

## 21. Slide

I'm less sure about a parallel to the common knowledge condition. As I see things, the justification for supposing that shared intention involves common knowledge concerns a normative link between intention and reasons. In acting on intentions, one should be acting for reasons. And a consideration can only be among your reasons if you know that consideration. So I think the need for common knowledge arises from the need to explain how another person's intentions could be among your reasons for acting. I don't think this need arises in the case of motor representation because it seems to me that the sort of planning of which motor representation is an element does not involve acting for reasons in the same sense. (In motor action, there are reasons why we do things (of course!) but these are not reasons for which we act.) What motor joint action requires is not that your motor plans provide reasons for mine. There just has to be a good chance that this is true relative to the costs and benefits of joint action and the alternatives to joint action. So I think that instead of common *knowledge*, in the case of social motor representation there is a common *background* of dispositions, habits and expectations.<sup>2</sup>

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<sup>2</sup> [\*\*\*CUT but one thing that might do the work of common knowledge is a custom or habit that would allow the agents, in their particular social context, to rely on each other's co-operation. In some countries this sort of thing works on public transport; it is reasonable to take for granted that, if you are obviously struggling with a pram or suitcase, then someone nearby will help.]

## 22. Slide

If this is right, if 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 another reason to think that motor representations can ground the purposiveness of joint action.

## 23. Slide

Recap: the question was: Does social motor representation play a role in explaining what joint is? I have just been arguing for a positive answer. My thesis is this: **Reciprocal agent-neutral motor representations coordinate multiple agents' actions around an outcome in part by virtue of representing that outcome.** That is, reciprocal social motor representations can ground the purposiveness of joint action. This is why I think that fully understanding what joint action is requires understanding the coordinating role of social motor representation and not only understanding shared intention.

I don't mean to suggest that all joint actions involve social motor representation. Surely some joint actions do not.

But, equally, *there could be purposive joint actions which do not involve shared intentions*, just as there can be purposive actions which do not involve intentions at all. Let me go slowly in explaining why I think there could be joint action without shared intention and start by returning to the case of ordinary, individual action.

## 24. Slide

So what are intentions for?

I'm going to assume that intentions are something over and above basic beliefs and desires; that an intention is not, for instance, merely a strongest desire or, as Donald Davidson held at an early stage of his thinking, merely a belief-desire pair. Intention involves more than this.

There is a temptation to assume that intention is involved in every case of purposive action. But it's hard to see what the argument for this assumption could be. In many cases it seems that beliefs, desires and motor representations are all that is needed to explain purposive action. You offer me a biscuit. I want one, and I believe I can get one by reaching out for it. So I do reach for it. As far as I can see, there's no need to suppose that, in addition to the belief and desire, it must be the case that I also intend to take a biscuit. (At least not unless we take 'intention' to mean 'strongest desire', which it does not.) Maybe I do intend this. But it's possible for an agent to take and

eat a biscuit, and to do so purposively, without having any intentions at all. Beliefs, desires and motor representations are sufficient.

So if we don't need intentions merely to perform a purposive action, what are intentions for?

## 25. Slide

This question becomes more pressing if you consider that motor representations enable quite sophisticated planning over short periods of time and sequences of action; for example, how you grasp a pointer will depend on what you are about to do with it (Zhang & Rosenbaum 2007).

This sort of planning does not need intentions at all. So (again) what are intentions for?

## 26. Slide

Michael Bratman suggests that *Intentions are for planning multiple separate actions over longer periods of time; and for planning multiple separate actions whose execution is mutually constraining where the outcomes cannot be represented motorically.*

This is a case where intentions are really needed [see figure in slide] — here one can't act on strongest desire (for the big reward) if want to maximise rewards by collecting the small and the large reward. And one can't rely on motor representation because the motor system doesn't care about things that cannot be represented in motor terms.

I don't think, of course, that intentions are only involved in actions which require planning of this sort. But I do think it's only in such actions that absolutely require intentions.

Not all purposive actions involve any planning of this sort.

Now you could imagine a two-person version of this task where we are rewarded for what we collectively achieve. In this case it's optimal if one of us goes for the small reward and the other goes for the large reward. I think it's this kind of planning that shared intention is really for.

## 27. Slide

By contrast, in many ordinary cases of joint action there is no need for planning of this sort and so no need for shared intention. Actions such as these *might* involve shared intention but they do not *necessarily* involve shared intention.

I'm suggesting that some joint actions—like the one two people move an object in a way that involves passing it between them—don't require this kind of planning and so don't necessarily involve shared intentions. In some cases, social motor representation alone is sufficient for purposive joint action.

## 28. Slide

This goes against a widely shared view in the literature

## 29. Slide

To focus on just one case, Alonso says '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)

I want to spend a bit of time on this claim because it matters for my second theme, which is a problem concerning how motor representation and shared intention interface in joint action.

As far as I know, this claim is not explicitly argued for. From conversation with philosophers I think the central argument hinges on contrast cases. Contrast cases are pairs of actions which are similar in terms of behaviour and coordination but where one is joint but the other isn't....

## 30. Slide

[nothing]

## 31. Slide

[Gilbert's Jack and Sue walking together case]

## 32. Slide

[Searle's park visitor contrast case]

These sorts of contrast case invite the question, How do joint actions differ from individual actions which may occur in parallel? What is the difference between Jack and Sue walking together and their walking side-by-side? Gilbert's example shows that the difference can't just be a matter of coordination, because people merely walking alongside each other also need to

coordinate their actions in order to avoid colliding with each other. And Searle's example shows that the difference between joint action and parallel individual action can't just be that the actions have a common effect because merely parallel actions can have common effects too.

How might this lead someone to think that all joint action involves shared intention? I think the idea is supposed to be this. One difference between the genuinely joint actions and their merely parallel counterparts is that the genuinely joint actions involve shared intentions. And there is no further difference that enables one systematically to distinguish the two cases.

I think this argument is mistaken for two reasons.

### 33. Slide

First because there are contrast cases in which the joint action does not involve shared intention. For instance, contrast our lifting a sofa together with us each individually raising either end of the sofa, coincidentally at the same time. The former is a joint action whereas the latter is arguably not. But I don't think it's right to assume that lifting a sofa together necessarily involves shared intention (although our *buying* a sofa together might). So it seems to me that the contrast cases give us no reason at all to suppose that all joint actions involve shared intention.

In fact the existence of cases like the sofa indicate that appeal to shared intention does not provide a sufficiently general way of explaining the difference illustrated by the contrast cases.

This brings me to a second consideration. There is a more general notion appeal to which enables us to distinguish the contrast cases. Genuine joint action differs from merely parallel action because the former involves each agent's representing an outcome to which all of their actions are directed where these outcome representations coordinate their actions in a way that would normally facilitate their collective success in bring about this outcome.

### 34. Slide

(Actually I don't think this is quite general enough because I think some joint actions involve non-representational coordinative structures only; I am also doubtful that there is a sharp distinction between merely parallel and genuinely joint action and I think it is possible to see the difference as a matter of degree. But I don't want to get into that here. It's sufficient that we have moved away from the bare shared intention account. [\*WHAT WE REALLY NEED IS A COLLECTIVE OR SHARED GOAL, and the possibility of gradual construction shows that there's no magic moment separating joint from parallel action.]

To sum up so far, I reject the claim that reflection on the contrast cases provides any support for the idea that all joint action involves shared intention.

## 35. Slide

So far I have been assuming that there is an inconsistency between two claims: (1) my claim that reciprocal agent-neutral motor representation can ground purposive joint action (2) many philosophers' claim that all joint actions involve shared intention.

But maybe it is a mistake to think that these are inconsistent. Why not suppose that some social motor representations are shared intentions?

## 36. Slide

If some reciprocal agent-neutral motor representations are shared intentions, then there is no inconsistency. And what I've just been arguing is that agent-neutral motor representations resemble shared intentions in that both play a role in coordinating agents' actions by virtue of representing outcomes. Isn't that enough to justify identifying them as 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, on most accounts shared intentions are neither shared nor intentions so we would hardly be doing more violence to the term than is already being done. So insofar as labeling some social motor representations shared intentions might help to avoid unnecessarily philosophical discussion, I'm all in favour. However, there is an important difference between the states normally regarded as shared intentions and any motor representations. And this difference matters for understanding the interface between shared intention and motor representation.

[\*PLAN for what follows:\*

Difference in format. Leads to the interface problem. Shared intentions can be inferentially integrated with other shared intentions; but not they cannot be inferentially integrated with social motor intentions (two disjoint planning processes). Elisabeth Pacherie's proposal: shared intentions set outcomes to be achieved by social motor representations. I borrow this idea from her, but it raises a further problem. The problem is how the one sets outcomes for the other given the difference in representational format.

## 37. Slide

In what respects do reciprocal agent-neutral motor representations differ from shared intentions?

## 38. Slide

As background we first need a generic distinction between content and format. Imagine you are in an unfamiliar city and are trying to get to the central station. A stranger offers you two routes. Each route could be represented by a distinct line on a paper map. The difference between the two lines is a difference in content.

## 39. Slide

Each of the routes could alternatively have been represented by a distinct series of instructions written on the same piece of paper; these cartographic and propositional representations differ in format.

Format matters because only where two representations have the same format can they be straightforwardly inferentially integrated.

## 40. Slide

To illustrate, let's stay with representations of routes. Suppose you are given some verbal instructions describing a route. You are then shown a representation of a route on a map and asked whether this is the same route that was verbally described. You are not allowed to find out by following the routes or by imagining following them. Special cases aside, answering the question will involve a process of translation because two distinct representational formats are involved, propositional and cartographic. It is not enough that you could follow either representation of the route. You will also need to be able to translate from at least one representational format into at least one other format.

## 41. Slide

This brings me to the argument ...

1. Only representations with a common format can be inferentially integrated.



2. Any two intentions can be inferentially integrated in practical reasoning.
3. My intention that I visit Paris on Friday is a propositional attitude.

## 42. Slide

It follows that All intentions are propositional attitudes

## 43. Slide

But it is also widely agreed that: No motor representations are propositional attitudes.

## 44. Slide

So we can conclude that: No motor representations are intentions

## 45. Slide

This step—Any two intentions can be inferentially integrated in practical reasoning—is questionable. I don't have an argument for this and I'm not sure it isn't terminological. What I care about is that we distinguish attitudes according to the processes in which they feature. So if you like we could distinguish two kinds of intention, one propositional the other motor. As long as we distinguish representations of different formats I don't see that it matters too much whether we call them all intentions or whether we use that term for only some of them.

## 46. Slide

So where does this leave us? The question was whether reciprocal agent-neutral motor intentions could count as shared intentions.

## 47. Slide

In answer to that question, I think this: (a) IF you agree motor representations are not intentions, THEN reciprocal agent-neutral motor representations are not shared intentions.

And (b) IF motor representations are a non-propositional variety of intention, THEN reciprocal agent-neutral motor representations are a non-standard variety of shared intentions.

The key thing is that, either way, reciprocal agent-neutral motor representations cannot be inferentially integrated with shared intentions in practical reasoning. This leads to what I'll call 'The Interface Problem'

## 48. Slide

It will take me a moment to explain what the problem is.

## 49. Slide

The first step is to note that: Some joint actions involve both shared intention and reciprocal agent-neutral motor representation. Imagine two people setting up a tent in a gale together, for example. It seems success will often require many ingredients including shared intention for the large-scale planning and reciprocal agent-neutral motor representation for passing objects and bending the poles together.

## 50. Slide

Earlier I argued that reciprocal agent-neutral motor representations:

- represent outcomes;
- ground the purposiveness of some joint actions; and

## 51. Slide

This means, I think, that in at least some cases of effective joint action there will be a certain kind of harmony between the contents of reciprocal agent-neutral motor representations and the contents of shared intentions. Further, I think it's probable that, in some cases, the harmony is non-accidental.

To be clearer about what 'harmony' means, we need the notion of matching:

Two outcomes, A and B, *match* in a particular context just if, in that context, either the occurrence of A would normally constitute or cause, at least partially, the occurrence of B or vice versa.

In some cases of joint action, the outcomes each kind of representation specifies non-accidentally match.

## 52. Slide

This leads to a question: how are non-accidental matches between the outcomes specified by shared intentions and by reciprocal agent-neutral motor representations possible?

A natural suggestion is that matching is achieved through practical reasoning. It is in this way that the contents of shared intentions could partially determine the contents of reciprocal agent-neutral motor representations. But there is an **obstacle** to this idea.

## 53. Slide

For as we saw earlier, reciprocal agent-neutral motor representations

- differ in format from (the constituent attitudes of) shared intentions.

Given that only representations with a common format can be inferentially integrated in practical reasoning, we cannot appeal to reasoning to explain how the outcomes specified by shared intentions match the outcomes specified by reciprocal agent-neutral motor representations. This is why the interface problem is a problem.

## 54. Slide

In conclusion, I have suggested that reciprocal agent-neutral motor representations can ground purposive joint action for they can coordinate two or more agents' actions in virtue of representing a single outcome to which each agent's actions are directed.

I also suggested, further, that reciprocal agent-neutral motor representation and shared intention have distinctive roles in explaining the purposiveness of joint action.

And this suggestion has two consequences. One is that we cannot properly understand what joint action 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 joint action despite not being inferentially integrated in practical reasoning.

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