Title: Joint task representations

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# Abstract

# Introduction

You and I are walking down a narrow pavement side by side, deep in conversation. Seeing a lamppost on your side, I anticipate that you will need to move over to my side to get around it and so I speed up to make space for you. As this illustrates, coordination often requires that people include others’ goals and actions in their planning and consider how they could respond to changing features of the environment to achieve these goals. In some cases this may require conscious deliberation and negotiation involving knowledge of, or beliefs about, others’ goals and actions. But in other cases conscious deliberation cannot explain coordination. For sometimes adjusting our plans to others’ goals and actions needs to happen too rapidly for conscious deliberation, in fractions of a second; sometimes these adjustments feel effortless or go unnoticed; and sometimes they occur without interrupting our conversation. All of this indicates that adjusting plans to others’ goals and actions can occur without conscious deliberation. To understand how people adjust their plans to others’ goals and actions, we need to identify mechanisms other than conscious deliberation, mechanisms that allow people to achieve rapid and effortless coordination even without breaking the flow of their conversation. What could these mechanisms be, and what is the evidence for their existence?

This question would make no sense if we conceived of planning as the conscious deliberative process that shape our actions. There is, however, a broader notion of planning. In general, control of action involves representations of outcomes, which generate representations of means by which these outcomes are to be realised. Not all such processes involve conscious deliberation or representations with propositional formats (\*refs: Prinz, Jeannearod, Pachiere). In fact humans could not interact with their environment at all without such non-deliberative processes. Because these processes involve representations of outcomes hierarchically structured by means to ends, we follow the psychological literature in using the term ‘planning’ to include these processes.

Our thesis is that in planning, adjustments to others’ goals and actions is sometimes achieved by including others in our planning in a special way. The familiar way of including others in our planning is to draw on our knowledge of, or beliefs about, their goals and actions. But, as we shall explain, representations of others’ goals and actions sometimes play roles in our planning that are closely related to the roles of representations of our own goals and actions. Sometimes we plan not only our own actions but others’ actions as well.

There are at least three coordination functions that including others in our planning could serve. The first function is turn taking. To return to our opening example where we are walking down a narrow street, my speeding up to make space for you depends on recognising that it is you (not me) who has to avoid the lamppost ahead. The second function is action monitoring. In terms of our example, I need to monitor your actions to know whether you are slowing down to move behind me---if instead you are also speeding up, some adjustment will be necessary. The third and last function is coordination of planning: in moving behind me to avoid the lamppost, we aim to avoid colliding with each other or the lamppost while not getting too far apart. In what follows we develop the thesis that planning others’ actions as well as our own can facilitate coordination by considering each of the three functions in turn.

These three functions are linked to three different ways in which others can be included in your planning, or so we shall argue. Before explaining this we need to introduce some background. An *actor representation* links an event to an agent and influences which events you respond to. A *task representation* links an event to an action in such a way that, normally, the event’s occurring would trigger planning for the action. Finally, a *gestalt task representation* links an event to some actions and a relation between them (for example, a push and a kick that are simultaneous) in such a way that, normally, the event’s occurring would trigger planning for the actions in such a way that the relation between them holds.

The first coordinating function that including others’ in your planning can serve, turn taking, can be facilitated by each agent having actor representations for both herself and the others. Two subjects have an *actor co-representation* just if there is a link between an event and an actor which each subject has an actor representation of. Representing who responds to which events can facilitate turn taking, as we explain below. The second coordinating function is action monitoring. This can be facilitated by including other’s tasks in your planning, which could be achieved by means of task co-representation. Two subjects have a *task co-representation* just if there is a link between an event and an action which each subject has a task representation of. We explain how representing which events require which actions, perhaps irrespective of who will perform them, can facilitate action monitoring in Section \*\*\* below. Finally, the third function is coordination of planning. Where two agents need to act in response to the same event, it may happen that their actions need to be coordinated in some way. For example, they may need to occur simultaneously. As we shall show, this can be facilitated by their each having a gestalt task representation linking the event to the relation between the actions. Such representations would comprise a *gestalt task co-representation*. This in barest outline is how planning others’ actions as well as our own can facilitate coordination. The ideas explained below are illustrated in Figure X.

# Turn Taking

Sometimes coordination involves turn taking and requires each agent to know when it is her turn to act. We claim that including others in your planning by means of actor co-representations could facilitate turn taking. How does this work?

Ayesha and Beatrice are ushers at a wedding facing a stream of guests who need to be seated. Ayesha is responsible for the groom’s party, Beatrice for the bride’s. To perform this role they each need to decide rapidly whether to act when a person approaches. So it might be helpful for Ayesha’s actions to be controlled by a representation mapping *groom party member* to *my responsibility*; and likewise for Beatrice. Now if we were to suppose that Ayesha and Beatrice were somehow acting alone, nothing more might be needed. Imagine, however, that they are acting together and know about each other’s roles. Then Ayesha may have a representation mapping *bride party member* to *other’s responsibility* and this representation may influence which events Ayesha responds to in that it makes it less likely that she will attempt to seat members of the bride’s party. That is, Ayesha and Beatrice have an actor co-representation linking appearances of bride party members to Beatrice. (Of course they may also have an actor co-representation linking appearances of groom party members to Ayesha.)

Actor co-representation carries a cost but can bring benefits in joint action. The cost is this: having an actor co-representation may make it harder to identify that it is your turn because there may be misleading cues pointing to another (as we shall see). But actor co-representation would assist you in taking your turn by preventing you from performing actions that are another’s responsibility. A further potential benefit of actor co-representation in joint action is that it would assist you in helping another in taking her turn, since it allows you to anticipate that another should act and so might induce you nudge them when they fail to act. Another potential benefit is that it would allow you to distinguish between events that one or another of you will handle and events for which none of you are yet prepared (as when a gate-crasher appears in the stream of guests). These ways in which actor co-representation could facilitate turn taking are depicted in Figure \*1.

which plays a role in your own planning that is functionally equivalent to representations of your own goals and actions.

So it is not just that Ayesha represents conditions under which Beatrice should act, but that this representation will play a role in controlling her own actions that is bound up with the role of the corresponding representation about conditions under which she herself should act.

that these representations play roles in their planning which are functionally equivalent to the first pair of representations, these would be actor co-representations.

A *co-representation* is a representations of another’s goal or action which plays a role in your own planning that is functionally equivalent to representations of your own goals and actions.

consider a situation in which you and another are presented with a sequence of stimuli, some green and others red. Your task is to press a button in response to the green stimuli,