Lecture 07 : Philosophical Issues in Behavioural Science

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Monday, 18th November 2024

Contents

1. Introduction

This lecture is about motor representation. We will explore what it is, and how, if at all, discoveries about motor representation might feature in objections to standard philosophical attempts to solve The Problem of Action and, separately, The Problem of Joint Action.

In this lecture we shift from thinking about the *triggers* of action to thinking about action *guidance*.

When we thought about the rat pressing a lever (in *The Minor Puzzle about Habitual Processes* in Lecture 02), we were thinking about triggers. The triggers included a desire for sugar (in the case of a goal-directed process) or a stimulus–action link (in the case of a habitual process).

Discussion about habitual and goal-directed processs is discussion about triggers.

We focussed on triggers because we were mainly concerned with how an action is selected. Our question was why one action (lever pressing) should occur rather than no action or another action (nose scratching, say).

This is all mainly about what happens before the action.

But what about the action itself?

Pressing a lever requires the precise, temporally extended coordination of limbs, torso, effectors and fingers. Although many of us are too skilled to notice the difficulty, observing babies (who require many months of practice to be able to use individual fingers) makes the difficulty of pressing a lever obvious.

As we will see, many choices are involved in the period between initiating movement and successfully having pressed a lever. The same is true of many[1] other simple actions like opening a draw or grasping a mug and drinking from it: successful execution in a continuously changing environment involves making choices throughout the action.

Our challenge is to discover why people act, individually and jointly. In attempting to meet the challenge, we need to think not only about triggers (as we have been doing) but also about guidance (the topic of this lecture). And the key to understanding guidance is something called motor representation.

[1] Of course some actions are more ballistic than others in the sense that there is a smaller role for guidance once the action has begun.

1.1. Prerequisites and What to Skip

This lecture depends on you having studied a section from a previous lecture:

- ** **ERRoR! MISSING xref FOR** $unit : philosophical_{t}heories_{h}abits$ **
- *Bratman on Shared Intentional Action* in Lecture 04

For the minimum course of study, consider only this section:

- *Motor Representation* (section §2)

2. Motor Representation

Motor representations are involved in performing and preparing actions. Not all representations represent patterns of joint displacements and bodily configurations: some represent outcomes such as the grasping of an object, which may be done in different ways in different contexts.

2.1. What Are Motor Representations?

Consider very small scale actions, such as playing a chord, dipping a brush into a can of paint, placing a book on a shelf or cracking an egg. Often enough, the early part of such an action carries information about how the action will unfold. For example, in grasping a book (or tall cylinder) you would probably hold its middle, which makes lifting it less effortful. But if you are about to place the book on a high shelf, you are more likely to grasp the book at one end, which makes lifting it more awkward now but will later make placing it easier (Cohen & Rosenbaum 2004; Meyer et al. 2013). For another illustration, imagine you are a cook who needs to take an egg from its box, crack it and put it (except for the shell) into a bowl ready for beating into a carbonara sauce. How tightly you now need to grip the egg depends, among other things, on the forces to which you will later subject the egg in lifting it. It turns out that people reliably grip objects such as eggs just tightly enough across a range of conditions in which the optimal tightness of grip varies. How tightly you initially grip the egg indicates your anticipated future hand and arm movements (compare Kawato 1999).

This anticipatory control of grasp, like several other features of action performance,[2] is not plausibly a consequence of mindless physiology. It indicates that control of action involves representations concerning how actions will

[2] More examples can be found in chapter 1 of Rosenbaum (2010).

unfold in the future. These and other representations which characteristically play a role in coordinating very small scale actions are labelled 'motor representations'.[3]

2.2. What Do Motor Representations Represent?

An initially tempting view would be that they represent sequences of bodily configurations and joint displacements only. However there is a significant body of evidence for the opposing view that some motor representations represent outcomes to which purposive actions are directed, such as the placing of a book or the breaking of an egg. These are outcomes which might, on different occasions, involve very different bodily configurations and joint displacements (see Rizzolatti & Sinigaglia 2010 for a selective review). The experiments providing such evidence typically involve a marker—such as a pattern of neuronal firings, a motor evoked potential or a behavioural performance profile—which allows sameness or difference of motor representation to be distinguished. Such markers can be exploited to show that the sameness and difference of motor representations is linked to the sameness and difference of outcomes such as the grasping of a particular object.[4]

This supports the view that some motor representations represent outcomes such as the placing of an object (so not only sequences of bodily configurations and joint displacements).[5]

2.3. Why Consider Them to Be Motoric?

If some motor representations do indeed represent such outcomes, why consider them to be motoric at all? Part of the answer concerns their role in preparing and performing actions.[6] Motor representations can trigger processes which are like planning in some respects. These processes are planning-like in that they involve starting with representations of relatively distal outcomes and gradually filling in details, resulting in motor represen-

[3] Much more could be said about what motor representations are and why they are necessary; key sources include Rosenbaum (2010), Prinz (1990), Wolpert et al. (1995), Jeannerod (1988) and Rizzolatti & Sinigaglia (2008). Related theoretical considerations have also been identified by philosophers, notably by Bach (1978) on 'executive representations'.

[4] Pioneering uses of this method include Rizzolatti et al. (1988, 2001); it has since been developed in many ways: see, for example, Hamilton & Grafton (2008); Cattaneo et al. (2009, 2010); Rochat et al. (2010); Bonini et al. (2010); Koch et al. (2010).

[5] For further supporting considerations, see Prinz (1997, pp. 143–6), Pacherie (2008) and Butterfill & Sinigaglia (2014, pp. 121–4).

[6] Another part of the answer concerns the role of motor representation of outcomes in reducing the number of kinematic parameters to be computed, which facilitates planning and control of action (see, for example, Santello et al. 2002; Tessitore et al. 2013).

tations whose contents can be hierarchically arranged by the means–end relation (Grafton & Hamilton 2007). Some processes triggered by motor representations are also planning-like in that they involve meeting constraints on the selection of means by which to bring about one outcome that arise from the need to select means by which, later, to bring about another outcome (Rosenbaum et al. 2012). So motor processes are planning-like both in that they involve computation of means–ends relations and in that they involve satisfying relational constraints on the selection of means.

3. Motor Representations Ground the Directedness of Actions to Goals

How do intentions ground the directedness of actions to outcomes? On any standard view, an intention represents an outcome, causes an action, and does so in a way that would normally facilitate the outcome's occurrence. Similarly, some motor representations represent action outcomes, play a role in generating actions, and do this in a way that normally facilitates the occurrence of the outcomes represented. Like intentions, motor representations ground the directedness of actions to outcomes which are thereby goals of the actions.

In *Goal-Directed and Habitual Processes* in Lecture 01, we encountered a basic question that any theory of action must to answer:

> What is the relation between an instrumental action and the outcome or outcomes to which it is directed?

The aim of this section is to introduce an argument for the claim that motor representations can ground the relation between an instrumental action and the outcome(s) to which it is directed.

In *Motor Representation* (section §2), we saw evidence that motor processes involve representations of action outcomes. It is only a tiny step to the further conclusion that such representations ground instrumental actions.

How do intentions ground the directedness of actions? On any standard view, an intention represents an outcome, causes an action, and does so in a way that would normally facilitate the outcome's occurrence. Similarly, motor representations of outcomes represent action outcomes, play a role in generating actions, and do this in a way that normally facilitates the occurrence of the outcomes represented.

To say that motor representations do all this is one way of making precise the metaphor involved in saying that instrumental actions are directed to outcomes. Moreover, there is a clear resemblance between the natural way

of understanding intentions as grounding outcome-directedness and the way in which motor representations ground outcome-directedness (as Pacherie 2008, pp.~189-90 has also argued, followed by Butterfill & Sinigaglia 2014, 121–124).

3.1. Limit

The outcomes motor representations can represent are probably limited in various ways. After all, motor processes are concerned with the present and immediate future and, unlike intentions, do not seem to be concerned with arbitrary future times; nor with outcomes to be brought about at some as-yet unspecified time. They may also be limited to very small scale actions such as grasping a mug, eating a biscuit or getting into bed.

For this reason, there are many instrumental action where it would be implausible to suggest that their directedness is grounded in motor representation. Cooking carbonera sauce on the weekend or visiting Milan next summer, for example.

4. Motor Representations Aren't Intentions

Explains why motor representations aren't intentions.

4.1. What are intentions?

Goal-Directed and Habitual Processes in Lecture 01 introduced two minimally controversial assumptions about intention

> Intentions are the upshot of beliefs and desires (or are identical to one or both of these).
>
> Intentions specify outcomes and (when things go well) coordinate actions around those outcomes, thereby binding together components of the action.

This section, we rely on a further minimally controversial assumption:

> Intentions are propositional attitudes and inferentially integrated with beliefs, desires and other propositional attitudes. This inferential integration allows them to play a characteristic role in practical reasoning (see, for example, Bratman 1987).

4.2. Why Motor Representations Are Not Intentions

Motor representations cannot be intentions because motor representations differ from intentions with respect to their representational format.

To support this claim, we first need to understand the notion of representational format (see below); we then need evidence that the claim is true (see the recording or Butterfill & Sinigaglia 2014, §3 on pp. 124ff).

4.3. Representational 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*. 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*.[7]

The format of a representation constrains its possible contents. For example, a representation with a cartographic format cannot represent what is represented by sentences such as 'There could not be a mountain whose summit is inaccessible.'

The distinction between content and format is necessary because, as the illustration shows, each can be varied independently of the other.

5. Motor Representation and The Problem of Action

What justifies claiming that events are actions in virtue of their relations to your intentions rather than in virtue of their relations to motor representations?

The Problem of Action is, What distinguishes your actions from things that merely happen to you?

According to the Standard Solution, actions are those events which stand in an appropriate causal relation to an intention. (See ** **ERRoR! MISSING xref FOR** $unit : philosophical_{t}heories_{h}abits$ **.)

We have seen that motor representations can ground the directedness of actions to outcomes (*Motor Representations Ground the Directedness of Actions to Goals* (section §3)).

[7] Note that the distinction between content and format is orthogonal to issues about representational medium. The maps in our illustration may be paper map or electronic maps, and the instructions may be spoken, signed or written. This difference is one of medium.

How might this give rise to an objection to the Standard Solution?

5.1. Background: The Structure of Action

When researchers focus on the contrast between goal-directed processs and habitual processs (see *Goal-Directed and Habitual Processes* in Lecture 01), they typically treat actions as unitary and ignore their structure.

What does this mean? Actions are individuated by outcomes—the question 'What is she doing?' can often be answer by specifying an outcome like 'opening the bottle' or 'washing their hair'. Similarly when characterising habitual and goal-directed processes, we individuate possible actions by outcomes such as the operating of a lever or the eating of popcorn. We give no consideration to the structure of these actions.

What do we know about their structure? Operating a lever involves performing several actions such as reaching for, grasping and then moving it (as we saw in *Motor Representation* (section §2)). These component actions are related to the main action as means to ends. And a component action may itself have component actions also related as means to ends. So even an apparently, small-scale simple action like operating a lever involves a hierachy of component actions. Further, the component actions often overlap in time, and, when things go well, are minutely coordinated to meet both relational constraints (how many fingers you will grasp with constrains, and is constrained by, how you reach, for instance) and also background requirements such as the need not to topple over when reaching.[8] All this involves sustained coordination of many rapidly moving body part in response to a changing environment, which is very difficult to acheive, as we know from studies of how the skills needed to perform mundane actions develop.[9]

[8] This is a much simplified picture. Pezzulo et al. (2018, p. 294) provide, in a single paragraph, a bit more of the picture: 'Motivated control, and the coordination of behaviour to achieve affectively meaningful outcomes or goals, poses a multidimensional drive-to-goal decision problem. It requires arbitration among multiple drives and goals that may be in play at the same (e.g., securing food versus water) or different levels of behavioural organization (e.g., indulging in a dessert versus dieting)—as well as the selection and control of appropriate action plans; for example, searching, reaching and consuming food. Previous research has highlighted two dimensions of motivated control: one concerns the distinction between a control or 'cold' domain (e.g., choice probabilities, plans, action sequences or policies) and a motivational or 'hot' domain (e.g., homeostatic drives, incentive values, rewards), where both are essential for learning, planning and behaviour. The other dimension concerns the complexity of the decision problem. In relation to control, it differentiates sensorimotor control (choosing among current affordances) from cognitive or executive control (the temporal coordination of thoughts or actions related to internal goals). In terms of motivation, it distinguishes visceral drives (e.g., eating) from higher-order objectives (e.g., dieting).'

[9] To illustrate the difficulties involved, consider Witherington et al. (2002) on how antic-

More background on how actions are individuated and the hierarchical structure of action is covered in another course, Mind & Reality, here: `https://mind-and-reality.butterfill.com/lecture_10_tube.html#action_basic_principles`

When thinking about the contrast between goal-directed processs and habitual processs, we focus on the question

> How are relatively large-scale action goals selected?

This question involves treaing actions as unitary and ignoring their structure. When thinking about motor processes, we focus on questions about structure such as:

> Given that a relatively large-scale action goal has been selected, how is the action to be prepared, performed and monitored? And, in particular (for us), how are component action goals selected?

These questions capture complementary perspectives. Treating them separately has proven productive. Eventually both are needed to understand the story of action.

5.2. Objection to the Standard Solution

Consider an alternative to the Standard Solution:

> Actions are those events which stand in an appropriate causal relation to a motor representation.

The Objection is then:

1. This solution to The Problem of Action is not worse than the Standard Solution.
2. Therefore we should accept both or neither, as things stand.

The justification for (1) is three-fold. First, the role of motor representations overlaps with that of intentions (see *Motor Representations Ground the Directedness of Actions to Goals* (section §3)). Second, as far as bodily actions are concerned, intention without motor represention is not sufficient. Third, no explicit justification has yet been published for giving priority to intentions over motor representations.

ipatory postural adjustment (to maintain balance) develops, or Witherington (2005) on developments in how skillfully infants' graping actions anticipate contact with an object.

5.3. Responses to the Objection

One response to this Objection would be to abandon the Standard Solution as the unique answer to The Problem of Action in favour of an alternative. The simplest (but not necessarily correct) alternative might be to allow that the Standard Solution is just one among several ways to answer The Problem of Action.

Another response to this Objection would be to defend the Standard Solution by identifying considerations that favour adopting it over the above alternative. This might (but need not) involve appealing to the idea that actions are done for reasons. In developing a response along these lines, it is important not to change the question by switching The Problem of Action for an alternative. (It's almost trivial that there is *some* question to which the Standard Solution is the correct answer; our concern, of course, is with whether it is the correct answer to The Problem of Action.) Would invoking the idea that actions are done for reasons amount to changing the question? Insofar as our source is Davidson (1963), it seems reasonable to hold that this idea was implicit all along. If relying on Frankfurt (1978), things are less clear because he sees the problem as applying to a very broad range of agents, including some in which learning and cognition play at most a limited role.[10]

5.4. Contrast with Other Objection to the Standard Solution

Another objection to the Standard Solution hinges on the ideas that actions can be dominated by habitual processs and run counter to any intentions the agent has (see *The Problem of Action meets Habitual Processes* in Lecture 02).

On that objection, the key idea is that, in some cases, intentions are not involved at all (or at least are not appropriately related to actions). A common line of objection to this objection is to attempt to distinguish the bad actions (as 'merely purposive activities', perhaps) from the good actions (as 'autonomous actions', perhaps; Velleman 2000.

The present objection from discoveries about motor control is consistent with the view that all actions are appropriately related to intentions.[11] There

[10] According to Frankfurt (1978), 'the contrast between actions and mere happenings can readily be discerned elsewhere than in the lives of people. There are numerous agents besides ourselves, who may be active as well as passive with respect to the movements of their bodies.' Further, on his view explications of the distinction between actions and events that merely happen to an agent cannot rely 'upon concepts which are inapplicable to spiders' (Frankfurt 1978, p. 162).

[11] There may also be other objections to the Standard Solution based on discoveries about motor representation, and some of these other objections may be inconsistent with the claim that all actions are appropriately related to intentions.

is no way to reply to this objection by distinguishing good from bad actions.

The two objections to the Standard Solution are therefore complementary in the sense that different strategies are probably needed to reply to them.

6. Conclusion

Motor representations specify outcomes and ground the directedness of instrumental actions to outcomes. The case for invoking intention to solve The Problem of Action does not appear stronger than the case for invoking motor representation. Yet again, philosophical and psychological theories appear incompatible.

Glossary

directedness (of an action to an outcome) Where an action happens in order to bring about an outcome, the action is thereby *directed* to that outcome. (See also instrumental action.) 5, 6

goal-directed process A process which involves 'a representation of the causal relationship between the action and outcome and a representation of the current incentive value, or utility, of the outcome' and which influences an action 'in a way that rationalizes the action as instrumental for attaining the goal' (Dickinson 2016, p. 177). 2, 8, 9

habitual process A process underpinning some instrumental actions which obeys *Thorndyke's Law of Effect*: 'The presentation of an effective [=rewarding] outcome following an action [...] reinforces a connection between the stimuli present when the action is performed and the action itself so that subsequent presentations of these stimuli elicit the [...] action as a response' (Dickinson 1994, p.48). (Interesting complication which you can safely ignore: there is probably much more to say about under what conditions the stimulus–action connection is strengthened; e.g. Thrailkill et al. 2018.) 2, 8–10

inferential integration For states to be *inferentially integrated* means that: (a) they can come to be nonaccidentally related in ways that are approximately rational thanks to processes of inference and practical reasoning; and (b) in the absence of obstacles such as time pressure, distraction, motivations to be irrational, self-deception or exhaustion, approximately rational harmony will characteristically emerge, eventually, among those states. 6

instrumental action An action is *instrumental* if it happens in order to bring about an outcome, as when you press a lever in order to obtain food. (In this case, obtaining food is the outcome, lever pressing is the action, and the action is instrumental because it occurs in order to bring it about that you obtain food.) You may encounter variations on this definition of *instrumental* in the literature. For instance, Dickinson (2016, p. 177) characterises instrumental actions differently: in place of the teleological 'in order to bring about an outcome', he stipulates that an instrumental action is one that is 'controlled by the contingency between' the action and an outcome. And de Wit & Dickinson (2009, p. 464) stipulate that 'instrumental actions are *learned*'. 5, 6, 11

motor representation The kind of representation characteristically involved in preparing, performing and monitoring sequences of small-scale actions such as grasping, transporting and placing an object. They represent actual, possible, imagined or observed actions and their effects. 2, 5–7, 9–11

representational format Format is an aspect of representation distinct from content (and from vehicle). Consider that a line on a map and a list of verbal instructions can both represent the same route through a city. They differ in format: one is cartographic, the other linguistic. 7

Standard Solution (to The Problem of Action). Actions are those events which stand in an appropriate causal relation to an intention. 7–11

The Problem of Action What distinguishes your actions from things that merely happen to you? (According to Frankfurt (1978, p. 157), 'The problem of action is to explicate the contrast between what an agent does and what merely happens to him.') 2, 7, 9–12

The Problem of Joint Action What distinguishes doing something jointly with another person from acting in parallel with them but merely side by side? 2

very small scale action An action that is typically distantly related as a descendent by the means-ends relation to the actions which are sometimes described as 'small scale' actions, such as playing a sonata, cooking a meal or painting a house (e.g. Bratman 2014, p. 8; Gilbert 1990, p. 178). 3, 6

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