18

PRACTICAL REPRESENTATION[1]

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We know facts in a variety of ways. For example, one may know a fact perceptually or by mere testimony. Compare an instance of *perceptual knowledge*—e.g., the knowledge that one acquires when one sees that there is a table in front of oneself—to an instance of non-perceptual knowledge with the same content—e.g., the knowledge that one acquires by mere testimony when one is told that there is a table in front of one. It is natural to distinguish between these two types of knowledge in terms of *the modes of presentation* under which they represent the state of affairs that there is a table in front of one. In the former case (when one sees the table), one knows that there is a table in front of oneself under a visual mode of presentation, whereas in the latter case (when one is merely told that there is a table), one comes to know that proposition under a non-visual mode of presentation.

According to a prominent view of know-how—known as *intellectualism about know-how*—knowing how to perform a task is a matter of being in a propositional knowledge state about how to perform the task under a *distinctive* mode of presentation. The relevant mode of presentation is neither testimonial nor merely perceptual. Rather, it is distinctively practical. Knowing how to perform a task, and being skilled at performing a task, such as swimming, is a matter of knowing facts about how to perform a task under a practical representation of that task. As I understand it, the view is motivated by a variety of considerations coming from action theory and cognitive sciences that strongly suggest that the intentionality and intelligence of our actions is to be explained in terms of propositional knowledge about the means to achieve certain goals.[2]

This chapter will not rehearse those motivations here. Rather, it will focus on the question: what does it mean to represent a task under a practical mode of presentation? The chief challenge for proponents of intellectualism is to spell out in clear and independently motivated terms what it means to represent something practically. This chapter discusses recent attempts to clarify the notion of practical representation and its theoretical fruitfulness. The ultimate goal is not just to show that intellectualists are on good grounds when they appeal to practical representation in their theories of know-how. Rather, it is to argue that *any* plausible theory of skill and know-how has to appeal to the notion of practical representation developed here.

Section 18.1 explains the notion of a mode of presentation and introduces practical modes of presentation. Section 18.2 illustrates practical representation by discussing models of motor control in current theories of sensori-motor psychology; Section 18.3 puts forward an argument for positing practical representation. Section 18.4 goes from practical non-conceptual representations to practical *conceptual* representations—to practical concepts. Section 18.5 concludes.

18.1 What is a mode of presentation?

We are accustomed to the idea that the same individual might be represented under different *conceptual* modes of presentation. For example, one might think of Venus *as the morning star*; one might think of Venus *as the evening star*. In this case, the different modes of presentation specified by the "think of x as y" locution correspond to different *concepts* that one possesses and under which one might group individuals. Had one grouped Venus under yet different concepts, one would be in a position to think of it under yet different conceptual modes of presentation.

Many authors also argue for the existence of *perceptual* (and non-conceptual) modes of presentation (Evans 1982; Block 1990; Peacocke 1992, 2001; Bermudez 1995; Burge 2010; Neander 2017; Lande 2018). Block (1990) argues that inverted spectrum subjects with phenomenally distinct color experiences in different environments might represent the same external colors. Peacocke (1992: 73–8) argues that perceptual representations can stand in many-to-one relations to their content, as in the Mach diamond's case, where a square is perceived as a diamond instead of as a square. Burge (2010) mounts a sustained argument for perceptual modes of presentation starting from the phenomenon of *perceptual constancy*. In perceptual constancy of, say, a rectangular object, the representation of its rectangularity from different angles happens via an egocentrically anchored spatial coordinate system due to the spatial layout of light registration by retinal receptors. Differences in the spatial format of sensory cues and processing *can* determine differences in our abilities to perceive a given attribute, such as the rectangularity of an object, by affecting our accuracy and precision of representation. This is because how we represent is a function of our representational abilities which are determined by the differences in sensory cues and processing. Therefore, differences in representational abilities determine differences in modes of presentation—e.g., *rectangular at specific tilt Tn and rectangular at specific tilt Tm* may therefore represent the very same attribute (e.g. *rectangularity*).

Representations might be classified by their distinctive modes of presentation. Say that a representation is *conceptual* if it represents what it does *via* a conceptual mode of presentation; and *perceptual* if it represents what it does *via* a perceptual mode of presentation. The nature of the relevant perspective depends on the relevant *representational abilities*. In the conceptual case, the different ways in which we might conceptually represent the world depend on the *basic conceptual abilities* that we possess—i.e., the most basic abilities for thinking and reasoning (Rosch 1978; Jackendoff 1989; Laurence & Margolis 1999; Prinz 2004: Chapter 1; Machery 2009: 7–51; Margolis & Laurence 2019). Perceptual modes of presentation, on the other hand, depend on basic representational abilities that do not need to be conceptual. For example, consider the ability of the visual system to locate objects in two-dimensional space relative to a viewpoint. This ability to locate objects in two-dimensional space is not a conceptual ability—it is not an ability to think and to reason. Rather, it is a *tracking* ability because it is an ability to vary states that are two-dimensionally structured in accordance with the varying of objects and their features in three-dimensional space (Dretske 1988; Stalnaker 1999: 347; Neander 2017: 152–3).[3] The auditory and the touch systems' ways of tracking features in the environment do not need to be of the same kind as the visual system's ability to locate objects in two-dimensional space. Their modes of presentation are correspondingly different. If we have had yet different tracking abilities, such as bats' echolocation, we would perceptually represent the world under still different modes of presentation.

This discussion puts us in a position to introduce *in abstracto* the notion of *practical representation*. Suppose our minds could represent the world or some aspect thereof, in a way that is a function *not* (or not just) of our conceptual abilities, and not even (or not just) of our perceptual abilities, but rather of abilities that are neither (merely) perceptual nor (merely) conceptual and instead are practical, in some sense to be made precise. By representing (some aspect of) the world in a way that is function of their practical abilities, there would be a good sense in which our mind could represent things via a practical mode of presentation.[4] Different minds, or the same mind at different times, might even differ in their practical abilities and henceforth in how they practically represent the world. A representation is practical if it represents what it does via a practical mode of presentation, and it represents via a practical mode of presentation if it represents as a function of the representor's most basic practical abilities.

This section has provided an initial abstract characterization of practical representation. Section 18.2 discusses in some detail an example of practical representation, posited by *sensori-motor psychology*.

18.2 Sensori-motor psychology and the Casio metaphor

Suppose I form the intention to grasp a bottle of wine within my visual field. How does that intention translate into the corresponding intentional movement of grasping the bottle?

According to prominent psychological theories of motor control (e.g., Schmidt 2003; Jeannerod 1997: 11–55, 2006; Arbib 1985; Wolpert 1997; Wolpert & Kawato 1998), building on the insights of Helmholtz (1867) and Bernstein (1923, 1930, 1967), the motor system translates that intention into a *motor command*, prescribing to one's muscles and nerves the relevant movement. *Contemporary sensori-motor psychology* studies how this translation happens.[5] Figure 18.1 illustrates one prominent model of motor control, due to Wolpert (1997).

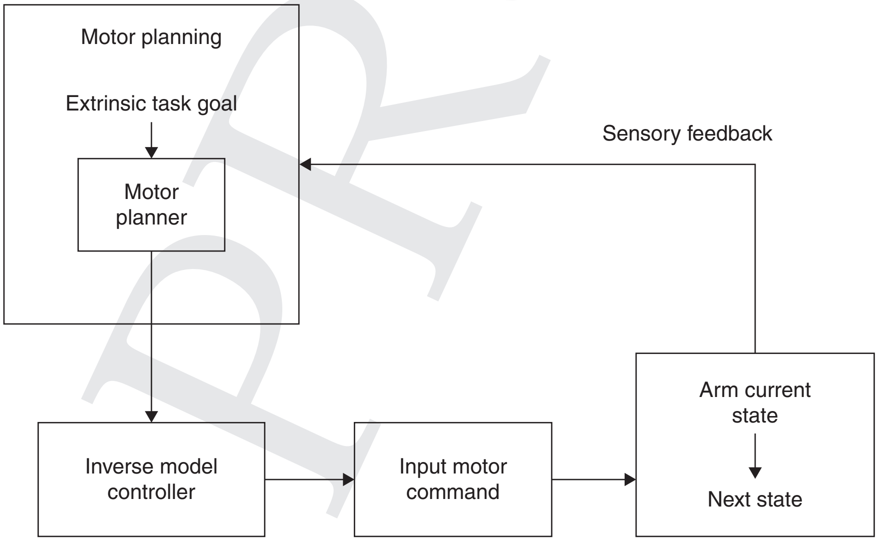

Figure 18.1 The motor system (cf. Wolpert 1997)

According to this model, the agent's intention is an input to the motor planner which uses sensory stimulations, including stimulations of the retina, the inner ear, muscle spindles and so on, to make an estimate of the environmental conditions, of the location of the goal and the relative location of the limbs. Based on these estimates, the motor planner issues a *motor command* to execute the intended task. On this model, the translation from intention to a motor command involves various sorts of representations—some merely perceptual, some more distinctively motoric. Among the motoric representations, there are motor schemas, which I will return to later. Now, I'd like to start focusing on the outputs of this model—i.e., on the motor commands. How are we to think of them?

To answer this question, it is helpful to compare the motor system to a Casio electronic keyboard (Figure 18.2). In such a keyboard, pressing each white and black piano-style key activates the switches, which triggers the electronic sensors to generate a sound—i.e., a musical note (Figure 18.3). So, each key is a *command* that, when executed, generates a note. Because each key is a command that is not made out of other commands, it is structurally simple or primitive. Let us call it an *elementary command*. A sequence or a configuration of keys is a *non-elementary command*.

Compare playing on the keyboard to executing a motor task—e.g., the task of grasping a bottle within one's visual field. And compare the music produced by means of the keyboard to the motor task executed—to having grasped the bottle.

Figure 18.2 A Casio keyboard

Figure 18.3 Key = elementary command

Figure 18.4 The matrix

The comparison runs deeper: the matrix circuits are neural paths from motor cortex to spinal cord; the wires to the speakers are the spinal cord; the speakers themselves are the efferent nerves and muscles (Figure 18.4).

Typically, a motor command issued by the motor system will be a *sequence* of instructions, like complex configurations of keys on the keyboard. This realization goes back to Lashley (1951). He noted that fast movements such as those required, for example, for playing the piano, are performed too quickly to rely on feedback about one movement shaping the next movement. The time required to receive feedback about the first movement, combined with the time needed to develop a plan for the subsequent movement and send a corresponding message to muscles, was simply too long to permit piano playing. Movements are performed as motor sequences, with one sequence being ready, while another ongoing sequence was being completed. Hence motor commands issued by the motor system will typically be *complex instructions*, like complex configurations on the keyboard.

Now, different motor systems might prescribe the same motor task in different ways, depending on the primitive abilities of the system. To see this, compare again a motor system to a Casio keyboard. A keyboard may use different sequences of keys to play the same sequence of sound. Consider the sort of commands that some keyboards possess—or *chunked commands*—which, when pressed, play at once a whole soundtrack (Figure 18.5). These commands enable

Figure 18.5 Elementary but chunked commands

to execute not just one note but a sequence of notes *at once*. Chunked commands are also not structured, just like the main white and black keys; so in this sense, they are as structurally simple as elementary commands. They differ from elementary commands as their content is complex, and therefore, the instructions they issue are complex.

Now, as illustrated in Figure 18.6, we might imagine different keyboards with a different repertoire of commands. For example, Keyboard #1 only possesses the main keys as commands. Keyboard #2 possesses a chunked command—a green button—that plays a sequence of two notes in addition to the main keys. Keyboard #3 possesses the main keys and a blue button, that plays a sequence of three notes. Keyboard #4 possesses the main keys and a red button that plays at once the whole sequence of four notes. The execution of these four different configurations of commands brings about the same sequence of sounds.

The motor system and motor commands are similar to a Casio keyboard and its configurations in some key respects. Similar to how Casio keyboards might differ in the set of their chunked commands, different motor systems might differ in their set of elementary commands. That might happen, for example, if two motor systems have undergone different "*chunking processes.*" A chunking process is the process through which complex operations become elementary for a system. A variety of experimental studies have demonstrated the existence of *motor* chunking (Newell 1990: 8–10; Sakai et al. 2003; Verwey 2010; Verwey et al. 2011: 407; Fridland 2019; Pavese 2019). Motor chunking is believed to occur as a result of practice and to make the execution of a task more efficient as a result. This efficiency can be explained by modeling the result of motor chunking in terms that are analogous to what I have called a "chunked command" on a keyboard. Just like Keyboard #2 has a specialized

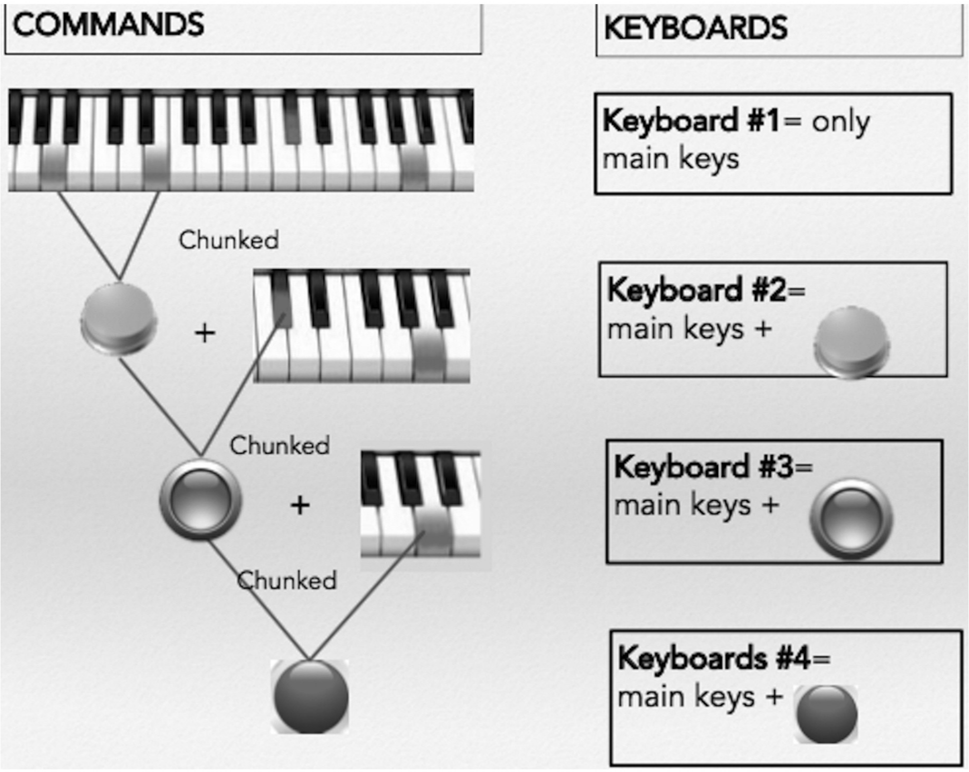

Figure 18.6 Configurations of commands

instruction (the green button) to execute a sequence of two notes, the motor system can chunk a sequence of commands to develop a specialized new elementary command that can execute that whole sequence at once.[6] Because of chunking, the set of elementary operations of a motor system can vary through time as practice occurs and can vary across motor systems at the same time.

Since motor systems can have different elementary commands, they can differ in their abilities in ways that are neither conceptual nor merely perceptual. To see this, consider again the Casio keyboard. Recall that the four keyboards differ in their elementary commands. This difference in their elementary commands corresponds to a difference in the keyboards' abilities. For example, Keyboard #1 can play a sequence of two sounds only by pressing two keys; by contrast, Keyboard #2 can execute the same sequence at once, by pressing a single command. Hence, Keyboard #2 and Keyboard #1 differ in their elementary abilities. The abilities to execute different elementary commands are neither merely perceptual nor merely conceptual abilities.[7] Imagine that we endow a Casio keyboard with a sub-system—system Perc—that tracks the frequencies of the sounds in the environment with an oscilloscope showing the result of the tracking, like a sound frequency meter (Figure 18.7). System Perc would be akin to our perceptual system because the display would represent sounds in the environment in accordance with the keyboard's tracking abilities, which are frequencies tracking. Or imagine we equipped the Casio keyboards with an additional sub-system—system Conc—that classifies sounds in the environment according to their pitch or their rhythm by mapping them

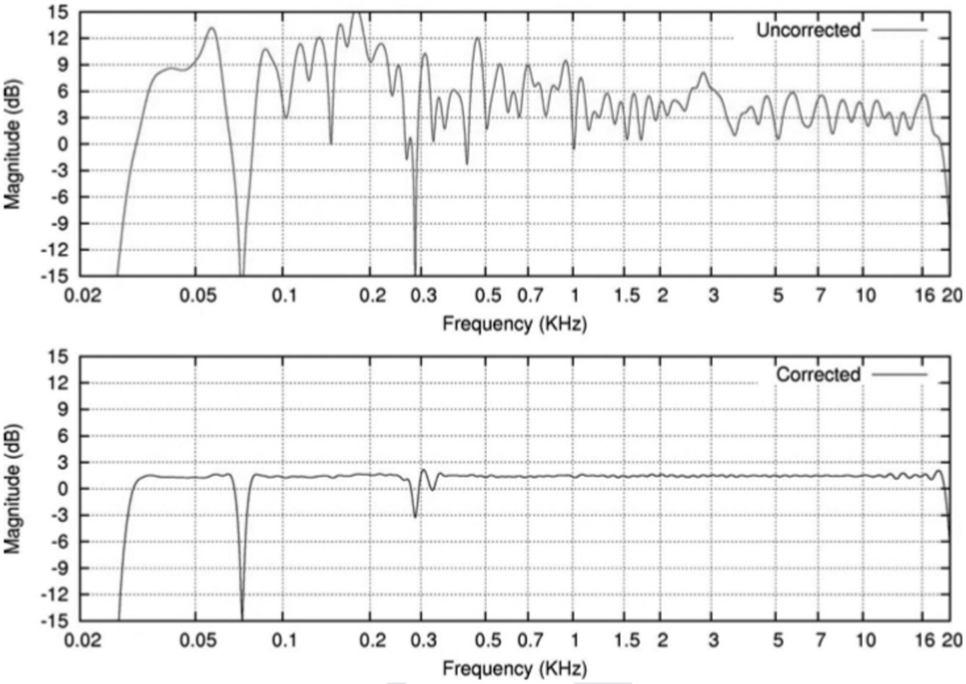

Figure 18.7 Sound frequency meter

into the label of the corresponding musical note, in a way analogous to *a note recognition device or app*. Imagine the system is sophisticated enough that it can draw simple inferences—e.g., from the fact that the note is a C to its not being a D. System Conc would be akin to our conceptual system because it would represent in accordance with the keyboard's classificatory, reasoning, and thinking abilities (e.g., which sounds it can not only tell apart but also label and reason about).

The main keyboard's system, including both black and white keys and chunked commands, is distinct from both system Perc and system Conc, because the main keyboard's abilities include neither system Conc's conceptual abilities nor system Perc's perceptual abilities, and differ from both in their direction of fit (Platts 1979: 257; Anscombe 1957: 56). Conceptual abilities are abilities to conceive—i.e., to be in a certain conceptual state, to output conceptual representations; perceptual abilities are abilities to perceive—i.e., to output perceptual representations. Practical abilities are abilities to execute instructions. In conclusion, the different configurations of commands in the four keyboards above stand for the same sequence of sounds but in different *ways* that depend on the elementary practical abilities of the relevant keyboards.

A configuration on a Casio keyboard is a metaphor for practical representation (Figure 18.8). We can think of each key, and each configuration of keys, to *stand* for (and in this sense, *to represent*) the note, or the sequence of notes, that pressing that key will result in playing. In this sense, those different configurations of keys stand for the same sequence of sounds in different *practical* ways, in terms of different primitive commands and abilities to execute those commands.[8] In the same way, different motor systems that have undergone different chunking processes will differ in their primitive commands and in their practical abilities.

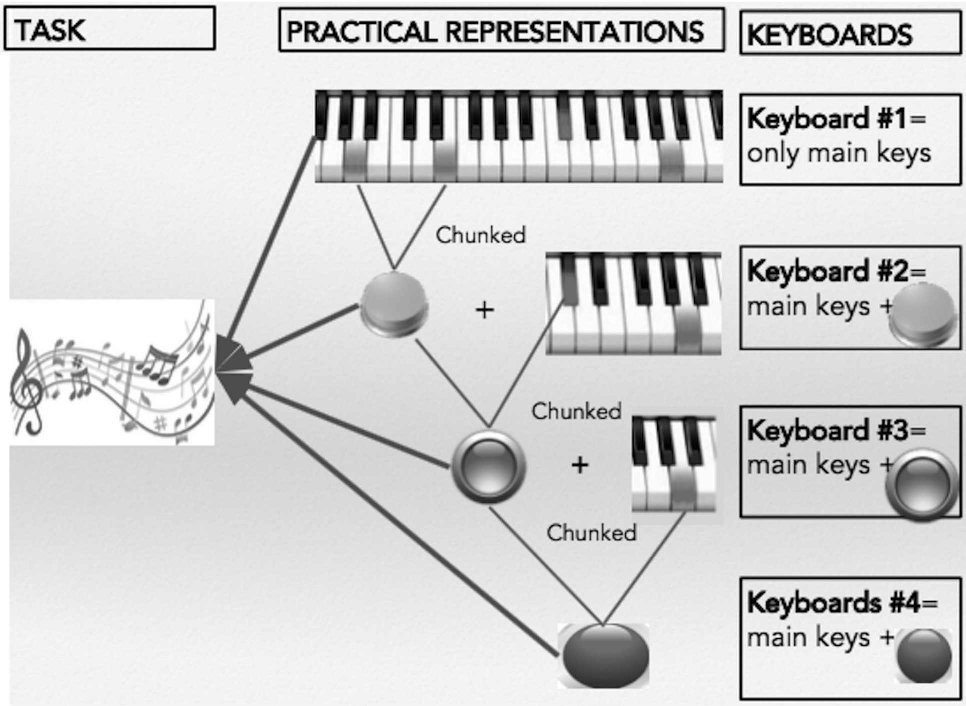

Figure 18.8 Different practical representations

Similar to configurations of keys on different keyboards, motor systems that have undergone different practice and therefore have different chunking processes, might differ in their set of primitive abilities. Because the set of a system's primitives can vary through time, a motor system might prescribe the same task in different ways at different times. They will break down the task into a different set of elementary commands depending on the set of their primitive abilities at that time.

In conclusion, the analogy between the motor system and the Casio keyboard is instructive for it highlights in what ways motor commands are functions of the practical abilities of their system. Predictably, the analogy is not perfect. Let me highlight two important differences. First, motor commands (though not merely perceptual) are perceptual because they are the output of perceptual processes and take into account the environment's features where the task takes place. Hence, if motor commands count as representations, they must be *hybrid* representations, both perceptual and practical. Second, although configurations on a keyboard are played one after the other, they are in an important sense *static*: they "stay there" waiting to be executed. By contrast, motor representations are *dynamic* because they are issued in furtherance of the task goal as the task unfolds (cf. Rescorla 2018).

A final difference between configurations on a Casio keyboard and motor commands is the following. The status of Casio configurations as representations is questionable, because it is not clear that we *need* to think of those configurations as representations. When explaining the functioning of the keyboard, representation-talk is dispensable. By contrast, as I argue in the next section, it is explanatorily helpful to think of motor commands, as well as other motoric prescriptive representations to be discussed later, as *bona fide* representations.

18.3 Why posit practical representation?

Cognitive scientists definitely speak of motor instructions as if they are *bona fide* representations (e.g., Winograd 1975; Tulving 1985; Anderson 1982; Stevens 2005; Knowlton & Foerde 2008; Tankus & Fried 2012). More generally, it is common to find cognitive scientists talking as if procedural systems such as the motor system are representation-based. For example, Tulving tells us that "[t]he representation of acquired information in the procedural system is prescriptive rather than descriptive" (Tulving 1985: 387–8). Many philosophers follow motor scientists in allowing these sorts of unconscious representations that are not necessarily available at the personal level (e.g., Butterfill & Sinigaglia 2014; Mylopoulos & Pacherie 2017; Rescorla 2016; Pavese 2017; Levy 2017; Fridland 2017).

There are, indeed, excellent empirical reasons for thinking that the procedural system encodes information about the task to be performed. However, as Dretske (1988) teaches us, carrying information and representing are a different matter. For example, tree rings carry information about the tree's age, without representing it. So, why think that we are dealing with *bona fide* representations when we are dealing with practical representations?[9] Following a recent argument by Ramsey (2007: section 2.2), some might argue that talk of practical representation is *dispensable* (see also Shea 2018).[10] Consider a rifle that responds to a finger movement by discharging a bullet from the muzzle. There is an internal mechanism whereby the movement of the trigger causes the movement of the firing pin, which causes the ignition of the primer in the cartridge, which causes the explosion of the propellant, which causes the bullet to travel down the barrel and exit at speed. This explanation of the behavior of the rifle does not need to appeal to *any* representation: the description of the mechanism of the trigger will satisfactorily explain the rifle's firing. Motor commands are not *that* different from the command issued when pulling the trigger. If so, why think of motor commands in representational terms and of the motor system as a representational system? Doing so might seem explanatorily idle. Call this the *objection from the rifle*.

Skepticism about positing practical and procedural representation is often voiced even by those philosophers who are convinced that representation-talk in cognitive science can sometimes be explanatorily helpful. Because what is at stake here is whether practical representation is real, as opposed to whether *any* representation is real, I will assume that representation-talk is explanatorily helpful *at least in some cases*. In particular, I will assume that there are personal-level representations such as intentions and beliefs. Then, the question becomes: Why think that, when explaining motor behavior, we need to posit motor and procedural representation in addition to intentions, beliefs, and desires?

In order to show that positing practical representation is not explanatorily idle, what has to be shown is that the constitutive aspect of representation—what distinguishes representation from information carrying, for example—enters essentially in our explanations of motor behavior. What is distinctive of representation is that it is normatively assessable as accurate or inaccurate: a representation can *misrepresent* (e.g., Brentano 1874; Dretske 1988; Neander 2017). What has to be shown is that this normative aspect of representation is explanatorily helpful when it comes to explaining motor behavior.

The normative aspect of representation is helpfully modeled by the so-called "content-target" model (Cummins 1996; Greenberg 2019). According to this model, a representation *aims at its target*—a representation that is meant as a representation of Obama *aims* at Obama—and *expresses/denotes its content*—the set of properties that the representation ascribes to Obama (Figure 18.9). For example, the picture of Obama aims at Obama if that is what the painter wanted to paint; and the picture expresses certain properties if it portrays Obama as having

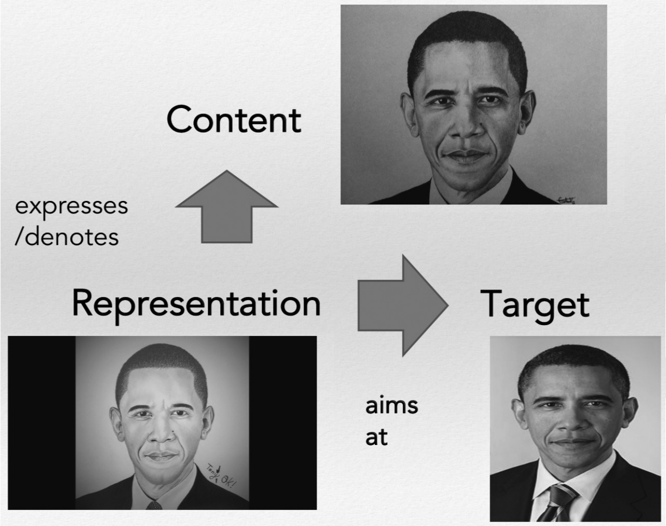

Figure 18.9 The content-target model of representation
Source: Cummins 1996; Greenberg 2019

certain properties. A representation is *correct* when the content matches its target—if the properties expressed match those that Obama actually has—and incorrect otherwise.

Appealing to the content-target model of representation, we can reframe the question of whether positing practical representation is explanatorily helpful in the following terms. Motor commands (and motor schemas) are genuine representations if they can be explanatorily helpful to appeal to the content-target model of representation with respect to motor commands and, in particular, to talk as if motor commands misrepresented their target.

At first, one might reasonably wonder whether talk of misrepresentation applies to motor commands. After all, imperatives do not represent accurately or not, they are not true or false. However, note that there is an important sense in which motor commands *can* be correct or incorrect: a motor command can prescribe the execution of a certain task correctly or incorrectly *with respect to the original intention of the agent*. The standards of correctness here are imposed by the intentions of the agent, which fix the target task to be executed.

Appealing to the agent's intention in fixing the target of the motor commands enables the extension of this three-part model to the notion of practical representation. On this model, a practical representation (say, a motor command) *aims at its target* (the task that the agent intends to execute) and *expresses its content* (the set of properties that the command prescribes the task to be executed to have). Thus, if an agent wants to dance, *ceteris paribus*, the motor system will produce a motor representation that aims at the task of dancing and represents it as having certain properties. The representation is correct if it represents the task that the agent wanted to execute—i.e., when its content matches the target (Figure 18.10). When the motor commands incorrectly prescribe the target task that the agent intends to execute, the three-part model licenses us to say that the motor command misrepresents that task.

So, it does make sense to talk of misrepresentation for motor commands. But is it ever explanatorily helpful to talk of *mis*representation when it comes to motor behavior? As a case study, consider Ideomotor Apraxia (henceforth, "IA") (Geschwind 1965a, 1965b; Heilman & Rothi 1993; Macauley & Handley 2005; Jeannerod 2006; Wheaton & Hallett 2007; Krakauer

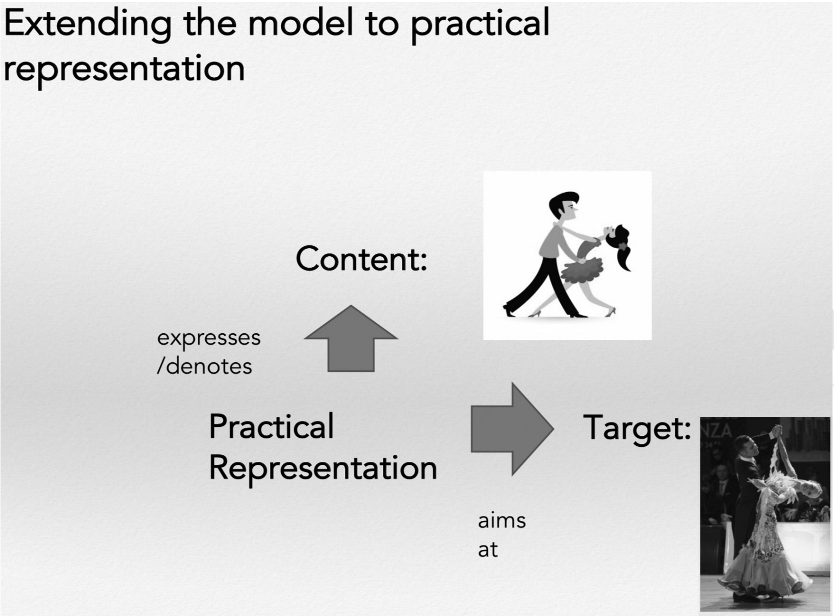

Figure 18.10 The content-target model of practical representation

& Shadmehr 2007; Gross & Grossman 2008; Vanbellingen & Bohlhalter 2011; Sathian et al. 2011). IA is a motor deficit that is not due to paralysis, muscle weakness, or even sensory loss.[11] Rather, it is a deficit in the ability to *plan* motor actions in the following sense. Patients affected by it are perfectly able to explain how a certain task is performed. However, strikingly, they are unable to imagine, act out, or pantomime the correspondent movement on demand, such as "pretend to brush your teeth" or "pucker as though you bit into a sour lemon" or "pick up a phone." Often their pantomime reflects improper orientation of their limbs and impaired spatio-temporal organization. Remarkably, however, they are often able to perform an action when environmentally cued. For example, while they may not be able to pick up the phone when asked to do so, they might be able to perform the action when the phone rings. Although, for a while, IA has been thought to be due to a deficit in semantic knowledge, recent findings suggest otherwise. Some patients affected by IA might perform well when it comes to correctly identifying the correct hand postures in observational tasks or to verbally describing how to use the tool and to position their limb (Hayakawa et al. 2015). This suggests that the deficit is not due to defective semantic understanding of what subjects are asked to do.

IA is an example of dissociation between the declarative knowledge system and the procedural system. But it also provides an exemplary illustration of the explanatory advantage of practical representation. For how do we go about explaining IA? Talking simply about the motor system not functioning, as when the rifle fails to shoot despite the shooter wanting it to, would not distinguish apraxic patients from subjects who simply lack the ability to perform the relevant motor task. As mentioned, many apraxic patients *can* perform the relevant tasks at least in some circumstances. Rather, what is distinctive to the IA patients is that the motor system is not "hooked up" to the high-level personal representation of the task command *in the right way* and the motor behavior ends up diverging from the request that the agent intends to execute. Note that it is not simply that the intention does not succeed at causing the motor behavior. The motor behavior *is* issued in this case. Moreover, the motor behavior issued by apraxic subjects is not random, as if it resulted from *some* sort of planning. What is distinctive about IA is that there seems to be a mismatch between the task the agent represents as being required and the task that is prescribed by the motor system: the task that the motor commands prescribe does not match the task that the agent intended to perform upon request. This description of apraxic behavior essentially appeals to the *content* of the motor commands and essentially appeals to the fact that the target of the motor representation (in this case, what task the agent is asked to perform) does not match the actual content of the motor representation.

Hence, talk of practical representation gains us the most natural and empirically supported psychological description of what goes distinctively wrong in patients with IA and in other similar dissociations between one's personal-level intentions and one's motor system.[12] The *objection from the rifle* fails to establish that practical representation is explanatorily dispensable. Although the behavior of the motor system, like the mechanism of the rifle, might be described without representation-talk, as soon as we aim at describing how the motor system interacts with the agent's intentions and at explaining in what ways the motor system fulfills them, we are led back to talking as if the motor system correctly represented or misrepresented those intentions—i.e., we are back to exploiting the normative dimension of representation.

18.4 From practical representations to practical concepts: the hierarchy of practical representation

In the literature on action and know-how, practical modes of presentation are discussed as pertaining in the first instance to *conceptual representation*. Peacocke (1986: 49–50) talks of "action-based ways of thinking." Stanley and Williamson (2001) draw an analogy between practical modes of presentation and *first personal* modes of presentation (Perry 1993). Stanley (2011: 98–110) identifies practical modes of presentations with practical ways of *thinking*. Bengson and Moffett (2007) talk of "ability-entailing concepts." Pavese (2015a) talks of "practical concepts." Pavese (2015b) talks about *practical senses* and Fregean senses are typically assimilated to concepts. Mylopoulos and Pacherie (2017) talk of "action-executable concepts."

Prima facie, the discussion in this chapter might seem to substantially diverge from these discussions of practical modes of presentation in that practical modes of presentation have been defined by contrast to conceptual modes of presentation and ways of thinking. Despite this apparent discrepancy, the current discussion is compatible with and a desirable development of those earlier views of practical modes of presentation.

First, some practical representations are, like perceptual representations, non-conceptual: for example, motor commands are non-conceptual practical representations. But the present proposal is compatible with there being hybrid representations, for it is compatible with there being representations that represent both as a function of practical abilities and as a function of conceptual and perceptual abilities. So, it is compatible with there being practical representations that are also conceptual or even both conceptual and perceptual.

Now, consider the sort of motoric representations involved in the translation of intentions into motor commands: motor schemas (Bernstein 1967; Schmidt 1975, 2003; Arbib 1985; Jeannerod 1997). Motor schemas are less context-specific and more enduring motor representations that mediate between intentions and motor commands. For example, Arbib (1985) talks of motor schemas as a predetermined set of commands, often characterized as a "control program." This suggests that like motor commands, motor schemas are also prescriptive representations, only more general and less context-dependent. They are supposed to be

Non-practical concept	Non-observational concept
Motor schema (or practical concept)	Observational concept
Motor command	Percept

Figure 18.11 The hierarchy of practical representation

revisable through trial and error and able to store information about the invariant aspects of an action (Arbib 1992; Jeannerod 1997: 51–5). There seems to be some evidence for thinking that motor schemas can be refined through focus and mental rehearsing of the motor task, which would suggest that they are accessible to the personal level (e.g., Feltz & Landers 1983; Sherwood & Lee 2003).

Motor schemas are better candidates for being a conceptual, albeit practical, sort of representation. For they are akin to "object schemas" that some identify with conceptual representation of objects. They interface between motor commands and the semantic representations of an action, in a way similar to how, in the theory of perceptual representations, *observational concepts* are supposed to mediate between percepts and non-perceptual conceptual representations (Weiskopf 2015; Pavese 2020b).[13] These representations can be modeled by Pavese's (2015b) practical senses. Like a program, a practical sense breaks down a task into a different sequence of instructions, depending on the system's most basic practical abilities. For example, if multiplying is an elementary operation for the system, it does not break down the task of multiplying into subtasks. But if multiplying is not elementary, then it might break it into subtasks that include adding. So, a practical sense can play the role of interfacing between semantic concepts of a task and a motor command by mapping the semantic representation of a task into different motor commands, depending on the basic abilities of the system. In this sense motor schemas can be modeled as practical senses (Figure 18.11).

The conceptual nature of motor schemas is, however, debatable. Whether or not motor schemas are best thought of as conceptual sort of representations, it is nonetheless true that distinctively practical and person-level conceptual representations mediating between semantic representations of a task and motor representations might be needed, in order to overcome some puzzles that arise when understanding the relation between intentions and motor representations (cf. Pacherie 2000; Sinigaglia & Butterfill 2014; Mylopoulos & Pacherie 2017) and in order to provide a complete explanation of IA. Indeed, the best explanation of what goes on with IA might be that the subjects affected by this deficit cannot think of the task practically—that is, they cannot engage in a distinctively *productive* kind of reasoning—and because of that, are incapable of forming the correct motor representations (Pavese 2020b, manuscript).[14]

18.5 Conclusions

Intellectualists have first introduced the notion of a practical mode of presentation in the debate about know-how (Stanley & Williamson 2001; Stanley 2011; Pavese 2015b, 2017). Earlier discussions of intellectualism have assumed that practical modes of presentation ought to be *conceptual* modes of presentation. In this chapter, I have presented a taxonomy of modes of presentation according to which modes of presentation can be conceptual, perceptual, practical, or a combination thereof (Section 18.2). The notion of practical representation has been illustrated with the case of motor commands and motor schemas in sensori-motor psychology and its distinctive practical dimension has been explained via the Casio keyboard metaphor (Section 18.3). Although the notion of a practical mode of presentation has faced a lot of criticisms (Schiffer 2002; Noe 2005; Glick 2015), it is perfectly intelligible, as it is a matter of representing as a function of one's practical abilities. Moreover, practical representation is psychologically real: a variety of representations posited by cognitive scientists when explaining motor skillful behavior represent practically. In Section 18.4, I have reviewed some reasons for thinking that the existence of practical representation is motivated not by mere reliance on the current scientific practice but by a more principled argument for the explanatory helpfulness of this notion when it comes to describing the interplay of the motor system with the agent's intentions. This picture is not meant to rule out the possibility of *practical concepts*—i.e., concepts that one comes to possess by virtue of practically representing the world in a certain way, just like one comes to possess observational concepts in virtue of perceptually representing the world a certain way. In fact, a complete theory of know-how and skill might ultimately have to appeal to practical concepts (Section 18.5).

If that is right, practical representation—whether conceptual practical representation or nonconceptual practical representation—is not an unwelcome commitment that intellectualists about know-how face; it is a necessary posit for any theory of know-how and skills.

Notes

1 For discussion that helped me with this material, I am particularly grateful to Todd Ganson, Gabriel Greenberg, and John Krakauer.

2 See e.g., Pavese (2013, 2018, 2020a). For the role of propositional knowledge in skillful action, see also Stanley & Krakauer (2013), Christensen et al. (2019), and see Wu, Chapter 16 in this volume.

3 Not everybody thinks of perception in terms of tracking. Cf. Lupyan and Clark (2015) who defend a view of perception as a *predictive process*.

4 As this informal gloss gives out, the notion of practical representation introduced in this essay is very different from Nanay's (2013) notion of "pragmatic representation" (cf. Pavese 2019: 801–3 for extended comparison). For a different notion of practical modes of presentation, one according to which practically representing something is a matter of representing it in terms of one's practical interests, see Weiskopf (2020).

5 See Rescorla (2016) for a helpful review of this literature.

6 An important difference between the motor system and a normal Casio keyboard is that once a motor system has chunked a sequence [A][B][C] into [A, B, C], the motor system will not be able to execute the very same sequence by executing the commands [A][B][C] sequentially. By contrast, Keyboard #2, for instance, can still play the first two notes by using instead of the green button the two original black and white keys.

7 There are two distinguishable senses in which the Casio keyboard's ability to execute a command has a mind-to-world direction of fit. In the first sense, it has a mind-to-world direction of fit because executing a primitive command results in a change in the world. In the second sense, it has a mind-to-world direction of fit because it enables the keyboard to represent a note with a single command, and a command has a mind-to-world direction of fit.

8 It is worth noting that on a view on which representation requires agency, of the sort defended by Burge (2010: chapters 8–9), there is no sense in which a Casio keyboard can represent perceptually, conceptually, let alone practically. By contrast, on a more permissive notion of representation, broadly teleosemantic, on which any system that has been assigned a certain function is in position to represent in virtue of being assigned that function (Dretske 1988; Neander 2017), a configuration on a Casio keyboard could be a representation. In this case, the relevant function is the function to activate the switches to generate the production of the sounds. Here, I wish not to take a stance on this thorny issue.

9 As many scholars have emphasized, there are many "intra-theoretical" reasons for positing motor representations. As Sinigaglia & Butterfill (2014: 122–13) and Pavese (2017) notice, the *functional*

role of motor representations within computational models of motor behavior seems to be that of a representation: motor representations are the outputs of a computational process, motor planning. Motor planning takes a representation as input (an intention) and returns a representation as output. Moreover, they are inputs to monitoring, which are internal predictive models that estimate likely effects of actions (Miall & Wolpert 1996). And, as Fodor (1998) would put it, no computation without representation! This argument for positing representation, however, requires granting a lot: that certain computational models of motor behavior are correct, for example, in describing the motor system as planning an action or monitoring it. The "intentionality" of this way of speaking already presupposes that it makes sense to posit representations for the motor system. But this is exactly what is at stake.

10 I am grateful to Ganson for discussion here.

11 Neuroscientists routinely describe IA as a defect in "motor programming" or in "selecting the right motor program." Cf. Macauley & Handley (2005: 30–1). Jeannerod (2006: 12) describes the phenomenon as the consequence of a "disruption of the normal mechanisms for action representations."

12 Another example of the explanatory helpfulness of practical representations is the case of motor adaptations, (e.g. Mazzoni & Krakauer 2006), where the motor system adapts to a strategy that does not necessarily align with the agent intentions. Cf. also Gallistel (1999). See Pavese (2020b) for more discussion.

13 With respect to these sorts of motor schemas, also Pacherie (2006) talks of "executable concepts," that one can possess only by virtue of possessing the lower level motor representation.

14 Pacherie (2006) makes a similar point about IA. Pavese (2020b) develops it and extends by looking at the most recent findings concerning IA.

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