On the Very Idea of Practical Representation

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This is a draft, comments welcome.

1. Introduction

According to a standard taxonomy, there are two main ways in which the mind can represent the world: through conceptual representation — concepts and propositional attitudes — and through perceptual representation — the sort of representation that our senses afford us. This essay mounts a sustained argument for thinking that, in addition to conceptual and perceptual representation, there is a third kind of mental representation that is not (or not entirely) conceptual, nor (or not entirely) perceptual, and that is, in a sense to be clarified, distinctively *practical*.

What would it mean for the mind to represent some aspect of the world practically? And in what sense could such practically representing come apart from perceptually representing the world or conceptually representing the world? §2 introduces the notion of a distinctively practical representation starting from a reflection on the nature of conceptual and perceptual modes of presentation. §3 gives an illustration of what it would mean for a system to practically represent certain aspects of the world by looking at a simple system which makes it vivid how practical representation could come apart from conceptual and perceptual representation. §4 provides an abductive argument for thinking that the mind *must* be able to represent tasks and actions practically. §5 argues that the notion of practical representation provides a characterization of the notion of "procedural representation" often invoked by cognitive scientists. §6 compares the notion of practical representation introduced here to other recent discussions of practical modes of presentation, discusses the possibility of hybrid representations (i.e., of representations that are both practical and conceptual, or both practical and perceptual, or both perceptual and conceptual), and inquires over the possibility of practical concepts from the possibility of practical representation.

2. Variety of Modes of Presentation

The starting point of my argument for thinking that there is a distinctively practical kind of representation is the thesis that both conceptual and perceptual representation can involve modes of presentation. To say that conceptual and perceptual representation can involve modes of presentation is to say that, through them, we do not necessarily represent things *neat*: we represent the world and its parts *in some way*.[1]

If both conceptual and perceptual representation can involve modes of presentation, that means that, *if* there really is anything like a third kind of mental representation in addition to conceptual and perceptual representation, we should expect it to possibly involve modes of presentation too. And if its modes of presentation are correspondingly different, then we must be really dealing with a third kind of mental representation. Accordingly, in this section my argument will consist in reviewing reasons for thinking that both conceptual and perceptual representation can involve modes of presentation and in showing in what respect practical modes of presentation can

[1] I am not committing myself to the claim that *all* mental representation is representation-as (cfr. Burge (2009;2010) for this sort of view), although I am sympathetic to it. For the purposes of this essay, I am leaving open that there might be "singular" mental representations that represent an object directly. For the purpose of this essay, conceptual and perceptual representation might involve modes of presentation only when they are not singular —i.e., only when they are "general" or "attributive" (Cfr Burge 2009 for this use of "attributive"). On the other hand, I cannot make sense of the notion of *singular practical representation*. Practical representation, as I understand it, always involves practical modes of presentation. The claim that there is such a thing as practical representation is the claim that there is a sort of representation that is general (or attributive, non-singular), that involves modes of presentation, but whose modes of presentation are not necessarily, or not entirely, either conceptual or perceptual.

be unlike those involved in conceptual and perceptual representation.

The thesis that conceptual representation can involve modes of presentation is rather standard. 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 picked up 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 position to think of it under yet different conceptual modes of presentation.

Does it make sense to talk of modes of presentation also when it comes to *non-conceptual perceptual representation*? (Evans 1982; Peacocke 1989; Bermudez 1998; Burge 2010; Neander 2017.) There certainly is an intuitive notion of "mode of presentation" that applies uncontroversially at the level of non-conceptual perceptual content: in perception, like in thought, we perceive things *as being thus and so*. Many authors have argued for the existence of perceptual modes of presentation. For example, Block (1990) argues that inverted spectrum subjects with phenomenally distinct color experiences in different environments might represent the same external colors. And Peacocke (1995:73–78) argues that perceptual representations can stand into many-to-one relations to their content, as in the Mach diamond's case, where we perceive a square as a diamond, rather than as a square.

Although these arguments have not been completely uncontroversial (cfr. Tye 2003; Chalmers 2004; Jagnow 2012), the recent literature on perceptual representation has provided renewed support for the existence of non-conceptual perceptual modes of presentation (Burge 2010; 2014; Thompson (2010), Neander 2017; Lande forthcoming).

In the *Origins of Objectivity*, Burge (2010) mounts a sustained argument for perceptual modes of presentation (Cfr. also Burge 2014) that might be summarized as follows. Some of the relevant differences in the nature as well as in the accuracy and precision of our perceptual representational abilities relate not just to *what* is being tracked (e.g. rectangularity of an object), but *how* it is tracked (i.e. what kinds of sensory information is used and how that information is processed). For example, in perceptual constancy of shapes, we represent the rectangularity of an object while the spatial coordinates relating us and the object change, thereby representing its rectangularity as differently tilted from different angles. Here, the representation of its rectangularity from different angles happens *via* an egocentrically anchored spatial coordinate system and owes much to the spatial layout of light registration by retinal receptors. Some of this layout of pre-perceptual registration of retinal information is preserved by the perception-formation process, and thereby contributes to the different ways we represent the rectangularity of the object from different angles, as well as to the accuracy and precision of the representation. Now, Burge observes that it is implausible to think that these relevant aspects of the sensory information or processing histories are *themselves objects of genuine representation*. After all, the whole point of positing perceptual representation is that the subject is tracking something *distal*, not just states of themselves: the two-dimensional format of sensory registration, for example, is not plausibly itself object of representation. But since differences in the spatial format of sensory cues and their processing *can* determine differences in our abilities to perceive a given attribute, such as the rectangularity of an object, by affecting its accuracy and precision, and since how we represent is function of these representational abilities, these differences in sensory cues and processing, by determining differences in representational abilities, therefore determine differences in modes of presentation. The argument so concludes that different perceptual modes of presentation (which we might indicate with the complex attributes such as *rectangular at specific tilt Tn* and *rectangular at specific tilt Tm*) may therefore represent the very same attribute (e.g. *rectangularity*).

Burge (2010) is not alone in thinking that the structure and format of perceptual processes contribute to perception's distinctive modes of presentation. Neander (2017:28–48) also argues for the existence of non-conceptual visual modes of representation starting from the distinctive geometrical structure of visual representation. As she points out, vision scientists routinely take visual representations to be projection planes relative to a viewpoint (Marr 1982). The projection planes are in turn taken to be structured along imaginary Cartesian grids (Palmer 1999; McCloskey 2009) (Figure #1).

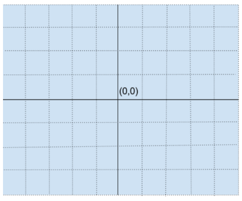

Figure #1: The Projection Plane as a Cartesian Grid.

Neander (2017: 34–8) points out that ascriptions of non-conceptual visual representations can create inten*s*ional contexts. For example, while it might true that Mary's visual system represents the moon *as located at 4,2.8*, it might not be true that Mary's visual system represents the moon *as located at the place mentioned above for illustrative purposes*. Because of the intensionality of these reports, it makes sense to talk of modes of presentation also for the visual system's representations, regardless of whether those representations are introspectively accessible to the subject and whether or not those representations are conceptual. Arguably, moreover, these are genuine *modes of presentation*, rather than differences in the properties that are being represented, as the visual system does not plausibly represent the Cartesian grid.[2]

These considerations are, of course, not unique to visual representation and extend to many sorts of perceptual representations. Like visual perception, tactile perception and spatial hearing for example are also egocentrically anchored, spatial-coordinate systems (Burge 2014:492). This spatial structure contributes to their corresponding modes of presentation. Plausibly, moreover, different sense modalities are associated with different modes of presentation: the visual representation of something as a body is different from a tactile representation of something as a body, or from its olfactory or auditory representation. Finally, intermodal systems mediating between different perceptual modalities represent in a way different from any of the perceptual modalities (Burge 2010: 13).

For my purposes, Burge's (2010; 2014) and Neander's (2017) considerations in favor of perceptual modes of presentation will do: both conceptual representation and non-conceptual perceptual representation can involve modes of presentation. What can be said about the differential nature of perceptual and conceptual modes of presentation?

In both conceptual and perceptual representations, modes of presentation constitute, as Burge (2010: 37) puts it, the *perspective* from which an animal or a person's representation steers. As Burge (2009:251) observes, the nature of the relevant perspective depends on the relevant *representational abilities*:

Representation in both perception and propositional thought is type-identified to

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[2] Cfr. Lande (forthcoming) for a similar argument.

> reflect representational abilities. [...] Since perspectives are ways of perceiving or conceiving, the perspectives are limited by the finite, partial, fallible abilities that they mark or help type-identify.

Burge's point here is that how we represent perceptually or conceptually depends on the *basic representational abilities* of the representing subject. And although conceptual and perceptual representation both can involve modes of presentation and perspectives, the relevant perspective and mode of presentation differ precisely because the relevant representational abilities differ.

In the conceptual case, the different ways in which we might conceptually represent the world depend on the *basic conceptual abilities* that we possess and that we can acquire. What is a conceptual ability? A widely held view of concepts, one that seems prevailing both in psychology and in philosophy (Rosch 1978; Rosch & Mervis 1975; Jackendoff 1989; Laurence & Margolis 1999; Prinz 2004: Chapter 1; Machery 2009: 7-51; Margolis & Laurence 2014), takes a concept to be a representation that is combinatorial and underlies high-order cognitive capacities of thinking and reasoning.[3] In this sense of "conceptual," conceptual modes of presentation are functions of the mind's most basic abilities for thinking and reasoning.

Perceptual modes of presentation, on the other hand, depend on basic representational abilities that do not need to be conceptual. For illustration, consider

[3] On this conception of concepts, that I will assume in what follows, many representations that underlie low-level cognitive abilities, such as perceptual or motor abilities, do not count as concepts, even if they are combinatorial. Many seem to take the ability to categorize to be a conceptual ability. However, some talk also of *perceptual categorization* (Cfr Philiastides, Ratcliff & Sajda, P. (2006); Ashby, Ennis & Spiering (2007); Burge 2010:31-4). Because I want to leave open that there is such a thing as perceptual categorization, in the main text I am characterizing conceptual abilities as abilities to think and to reason, rather than abilities to think, to categorize and to reason.

again the sort of visual modes of presentation discussed by Neander (2017: 27–48). These visual modes of presentation depend on a basic representational ability that our visual system possesses — i.e., the ability 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 of some sort, for it is an ability to vary states which are two-dimensionally structured in accordance with the varying of objects and their features in three-dimensional space (Dretske 1986, 1988; Stalnaker 1999:347; Neander 2017:152-3).[4]

Nor is the sort of tracking abilities involved in visual perception the only sort of tracking ability that we do possess or that we *could* possess. The auditory system, the smell system, and the touch system also track features of the environment but their ways of tracking features in the environment do not need to be of the same kind as the visual ability to locate objects in two-dimensional space. Their modes of presentation are correspondingly different. Finally, if we have had yet different tracking abilities, such as bats' echolocation, we would perceptually represent the world under still different modes of presentation.

In this sense, while the modes of presentation distinctive to conceptual representation vary with our abilities to think and to reason, the modes of presentation distinctive to perceptual representation vary with the specific sort of tracking abilities that perceivers possess.

This discussion puts us in a position to introduce the notion of *practical*

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[4] Not everybody thinks of perception in terms of tracking. Cfr. Lupyan and Clark (2015) defend a view of perception as a *predictive process*. I cannot discuss here how substantially different these views of perception are. Thinking of perception as a predictive process will not affect my main argument, also on Lupyan and Clark's view (2015), just like on the tracking view, perception has a world-to-mind direction of it and this direction of fit is what matters for my argument.

representation. Suppose our minds could represent the world, or some aspect thereof, in a way that is a function *not* (or not entirely) of our conceptual abilities, and not even (or not entirely) of our perceptual abilities, but rather of abilities that are neither perceptual nor conceptual. In particular, suppose these abilities differ from perceptual abilities and conceptual abilities in *their direction of fit* (Platts 1979: 257; Anscombe 1957: 56; Searle 1979:79). Perceptual and conceptual abilities have a world-to-mind direction of fit. They are, respectively, abilities to *perceive* and abilities to *think*; and perceptual states and thoughts are mental states with a world-to-mind direction of fit. Now suppose our minds could represent the world in a way that is a function of abilities that have a *mind-to-world* direction of fit.[5] In virtue of their different direction of fit, these abilities would be *practical* abilities. 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 *practically.*

The hypothesis of practical representation is, then, the hypothesis that practical abilities can also constitute the perspective from which we can represent the world, just in the way perceptual abilities can constitute the perspective from which we can perceptually represent the world and in the way conceptual abilities can constitute the perspective from which we can conceptually represent the world. When we represent the

[5] As Searle (1979) uses the notion of *direction of fit*, beliefs count as having a different direction of fit than desires because beliefs' truth or satisfaction conditions are satisfied when the belief fits the world; whereas a desire's fulfilment or satisfaction conditions are satisfied when the world *fits it*. Abilities (conceptual, perceptual, or practical) do not have satisfaction conditions in the same sense as intentional states do. However, we can think of them as deriving their direction of fit from their output. 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 — to output perceptual representations. And both conceptual and perceptual representations have a world-to-mind direction of fit. Often, the notion of direction of fit is defined in such a way to also capture a further difference in the normativity of beliefs versus desires (cfr. Anscombe 1957: 56; Platts 1979: 257; Humberstone 1992), i.e., the fact that false beliefs are defective in a way that unfulfilled desires are not. In the text, I am mostly following Searle's (1979) notion of direction of fit, but I will return to the latter distinction in the next section.

world from the perspective afforded to us by our practical abilities, we represent it *practically*.[6]

This discussion gives us an initial gloss on practical representation. The next section provides an illustration of what it would mean for a system to practically represent (some aspect of) the world.

3. An Example of Practical Representation

Consider a Casio electronic keyboard (Figure #2):

Figure #2: A Casio Keyboard

In a Casio 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 #3).

[6] As this informal gloss gives out, the notion of practical representation introduced in this essay is very different from Nanay's (2014) notion of "pragmatic representation." For Nanay, pragmatic representation is defined as a sort of nonconscious perceptual representation (Nanay 2014: 4–5). By contrast, although some practical representation might also be perceptual, not every example of practical representation needs to be a perceptual representation. Cfr. [reference to forthcoming paper blind for peer review] for a more detailed comparison with Nanay (2014).

Figure #3: key=elementary command

In this sense, each key is a *command* whose execution generates a note. Because each key is a command which is not made out of other commands, let us call it an *elementary command*. A sequence or a configuration of keys is a *non-elementary command* (Figure #4).

Figure#4: A Configuration of keys = a non − elementary command

In this section, I will argue for the following two main claims:

(1) a configuration of keys on a Casio keyboard is a *representation* of sort — i.e., it is a "prescriptive" representation.[7]

(2) a configuration of keys on a Casio keyboard prescriptively represents a sequence of sounds in *a distinctively practical way*.

[7] Millikan 1996 talks of *directive* representations to include desires, intentions as well as prescriptions. I take it that prescriptive representations, to include commands and imperatives, are a subset of directive representations.

Let us start with (1). It is rather intuitive to take 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. My argument for this claim draws on metasemantic considerations — broadly of teleosemantic nature — about the content of commands. Plausibly, the content of a prescription is the effect that that prescription has the function (goal) of bringing about (Millikan 1984; Papineau 1984).[8] Extending the teleosemantic approach to the content of the commands of a Casio keyboard, we get that each key represents a musical note and that a configuration of keys represents a sequence of notes.

Now, one might object to this claim on the ground that representations must have accuracy conditions. Because commands cannot be true or false, one might object that they are *not* representations at all.

In response, representations can be susceptible of semantic evaluations without being evaluable for truth and falsity. Desires, for example, are not true or false. What makes desires *representations* is that there is a perfectly good sense under which they too can be subject to semantic evaluation: they can go fulfilled or unfulfilled (cfr. Neander 2017:18). Similarly, a command might or might not be complied; an instruction might be followed correctly or incorrectly (Burge 2010: 39).

One might still object that there is an importantly relevant disanalogy between desires and commands, on one hand, and beliefs on the other: false beliefs are defective in a way in which unfulfilled desires or commands are not. Hence, fulfilment and compliance are not normative in the same sense as truth and falsity are. On this basis, one

[8] Do the key represent the switches that produce the sound or the sound itself? For a satisfactory response to this sort of indeterminacy worries that affect teleosemantic theories of content, see Neander 2017 and Shulte 2017.

might worry whether a configuration of keys on a Casio keyboard really represents.[9]

Even if the disanalogy between desires/commands and beliefs on the other is there, my particular claim that a configuration of keys in a Casio keyboard are representations of sort still stands. Just like in the case of false beliefs, if pressing the key on the keyboard did not result in a sound or resulted in a sound different from the one that that key is supposed to play, there would be something defective with the key or with the keyboard. Here, and in contrast with the case of desires or other prescriptions, the fact that the key's function is not fulfilled *is* a sign of defectiveness. Moreover, on a broadly teleosemantic picture of representation, representations by a system S misrepresent *when S malfunctions*. And it is true that there might not be any malfunctioning when a desire goes unfulfilled. In contrast, if pressing the key did not issue the production of the relevant note, then the Casio keyboard *would* be malfunctioning. Moreover, if the Casio malfunctioned in certain ways, the configuration of keys *would* misrepresent. For example, if the main matrix of the Casio keyboard malfunctioned so that some interference with the electric sensors caused a white key (say, a C key) to play, say, what a black key is instead supposed to play (say a C#), then there would be a good sense in which that white key would *misrepresent* the note C.[10]

Hence, there is surely a sense in which the Casio commands *can* be susceptible of semantic evaluations. These remarks get us to the first claim of this section ((1)) — i.e., that a configuration of keys on a Casio keyboard prescriptively represents a sequence of sounds.

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[9] Cfr. Anscombe (1957:56). Millikan (1986: 68) explicitly articulates this worry, although Millikan (1996) is happy to take prescriptions to be representations of sort.

[10] In further support, suppose the keyboard were half step down off tune. Then I could play a certain song by playing the same score for half-step up on the keyboard. In this case a configuration of keys that is half step up will correctly prescriptively represent that song.

The second claim, (2), is that the keyboard can prescriptively represent that sequence of sounds in *a distinctively practical way* — that is, as a function of the keyboard's practical abilities. In order to appreciate the difference between claim (1) and claim (2), consider an ordinary prescription in a public language, such as "Dance!" According to a prominent semantic theory for imperatives, imperatives denote the tasks they prescribe (Lascarides and Asher 2003; Barker 2010). On this theory, imperatives *prescriptively* represent a task. It does not follow from that that in natural languages imperatives *practically* represent tasks, in the relevant sense, for they do not necessarily prescriptively represent that task differently depending on the speaker's or the addressee's practical abilities. For example, when issuing an order with an imperative such as "Dance!," I might order you to perform a task that it turns out neither I nor you have the ability to execute.[11] Hence, imperatives in natural languages do not represent practically,[12] although they do represent prescriptively.

In order to see that a configuration of keys prescriptively represents a sequence of sounds *in a distinctively practical way* — that is, in a way that depends on the most basic practical abilities of the keyboard, start by considering a keyboard that, like many Casio keyboards, possesses, in addition to the main keys, a few further commands. In particular, consider the sort of commands that some keyboards possess — or *chunked commands* — which, when pressed, play at once a whole soundtrack (Figure #5). These commands enable 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

[11] "Ability" here is to be understood not as circumstantial ability, but in terms of robust counterfactual success in favorable conditions. See Hawley 2003; Pavese 2015b.

[12] The same is true for other sorts of "directive" representations. Intentions or desires do not need to represent practically: they do not necessarily represent what is desired or what intentions in terms of operations that the subject has the ability to perform — i.e., as when I desire to become a tap dancer.

sense, they are also elementary.

Figure #5: Elementary but chunked commands

Now, as illustrated in Figure #6, we might imagine different keyboards with a different repertoire of commands. Keyboard #1 only possesses the main keys as commands. Keyboard #2 in addition possesses a chunked command — a green button — that plays a sequence of two notes. 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.

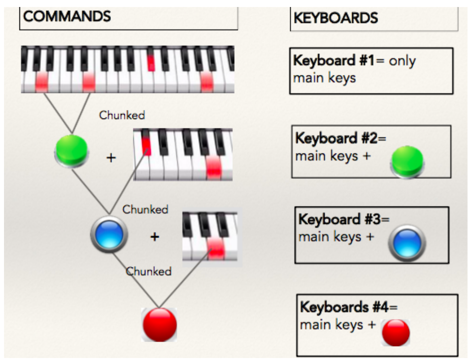

Figure #6: Configurations of commands

The execution of these four different configurations of commands brings about the same sequence of sounds. If we think of these keys as representing the sounds or sequence of sounds that they have the function to bring about, as suggested earlier, then we have that the same sequence of sounds can be represented by different configurations of commands.

In this sense, these four configurations represent the same sequence of sounds through different *modes of presentation*. These different modes of representing the same sequence of sounds do not correspond to different ways of classifying the sounds; nor to different ways of tracking the sounds. Rather, they correspond to differences in the *practical abilities* that the keyboards have. To see this, 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 through pressing two keys; by contrast, Keyboard #2 can execute the same sequence at once, through pressing a single command. Hence, Keyboard #2 and Keyboard #1 differ in their elementary abilities. These abilities to execute different elementary commands are neither perceptual nor conceptual abilities, for they differ from those in their direction of fit. An ability to execute a command has a mind-to-world direction of fit, rather than a world-to-mind direction of fit.[13] Hence, the sort of abilities of the keyboards that are relevant for these sorts of representation are neither conceptual nor perceptual. In this sense, the different configurations considered above are different *practical* representations of the same sounds.

The claim that keyboards have practical abilities might sound bizarre. It is tempting to object that it is *not* the keyboards but rather it is the *piano players* that might

[13] 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.

have the relevant practical abilities — i.e., ability to execute some piece of music. My argument goes as before, however, if we consider *special* kinds of keyboards which, just like *player pianos,* can play themselves. These special keyboards have practical abilities in a *less* derivative sense.

To emphasize the point that a configuration of keys on a Casio keyboard is a practical representation, rather than a perceptual or conceptual representation, imagine we endow a Casio keyboard with a sub-system — system P — that tracks the frequencies of the sounds in the environment with an oscilloscope showing the result of the tracking. We can imagine this system P to operate in the way similar to a sound frequency meter (Figure #7).

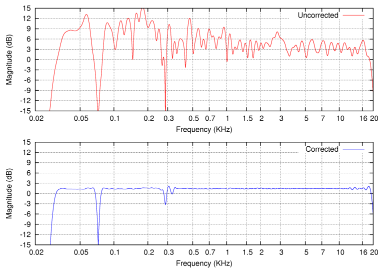

Figure # 7: Sound frequency meter

System P would be akin to our perceptual system, for the display would represent sounds in the environment in accordance with the keyboard's tracking abilities, which are frequencies tracking. In addition, imagine we equipped the Casio keyboards with an additional sub-system — system C — that classifies sounds in the environment according to their pitch or their rhythm by mapping them 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 — i.e., from the fact that the note is a C to its not being a D. System C would be akin to our conceptual system, for it would represent in accordance with the keyboard's classificatory, reasoning, and thinking abilities (which sounds it can tell apart and label).

The main keyboard's system, including both black and white keys and chunked commands, is distinct from both system P and system C, for the main keyboard's abilities include neither system C's conceptual abilities nor system P's its perceptual abilities and differ from both in their direction of fit. Hence, the keyboard's practical representations are neither conceptual nor perceptual.

In conclusion, the different configurations of commands in the 4 keyboards above represent the same sequence of sounds but in different *ways*, depending on the elementary practical abilities of the relevant keyboards. In this sense, they represent the same sequence of sounds in different *practical* ways. The 4 different configurations of commands are therefore different practical representations of the same sequence of sounds.[14] Moreover, I have argued that they are neither perceptual representations nor conceptual representations. Hence, they are examples of practical representations that are neither perceptual nor conceptual.

[14] 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. In this section, I have been working with 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 1986; Neander 2017). In this case, the relevant function is the function to activate the switches to generate the production of the sounds. But my overall argument is *not* committed to this view of representation. If one favours a more demanding view of representation of the sort defended by Burge 2010, one should take the goal of this section to have given an illustration of *what sort of things* would count as practical representations, were the necessary conditions on there being a representation to be in play.

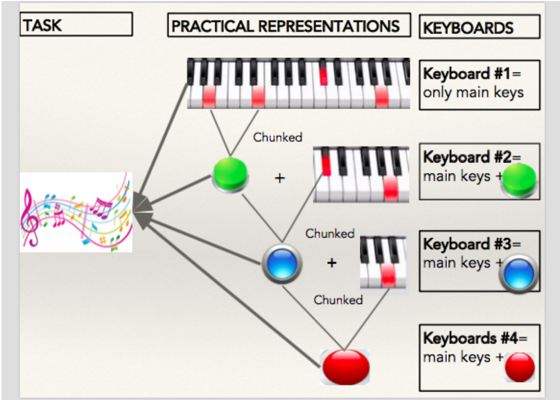

Figure #8: Different Practical Representations

4. Towards An Abductive Argument for the Existence of Practical Representation

Why think that, just like a Casio keyboard, the human mind can also represent practically?

Elsewhere [reference to published paper blind for peer review; reference to forthcoming paper blind for peer review], I have put forward an argument for thinking that the sort of motor representations that figure in control theories of motor behavior (motor commands and motor schemas) represent practically.[15] The former part of this section reviews the argument. As we will see, this argument demonstrates the psychological reality of practical representations only on the assumption that motor representation is psychologically real. A more principled argument for the existence of practical representation is given in the latter part of this section.

Here is a summary of the argument for thinking that motor commands and motor schemas represent practically. Through motor commands and motor schemas, the motor system prescriptively represents a task, in a similar way to how, through its keys, a Casio

[15] Cfr. Bernstein 1967; Schmidt 1975, 2003; Jeannerod 1997:11-55, 2006; Arbib 1981, 1985; Wolpert 1997; Wolpert & Kawato 1998; Rescorla 2016.

keyboard prescriptively represents a sequence of notes. The same arguments I have given for the claim that a configuration of keys on a Casio keyboard represents, although prescriptively, extends to motor commands and to the motor system. Just like a Casio keyboard through a configuration of keys, through a motor command the motor system prescriptively represents moving one's hand towards the glass or one's bending the bottle to pour the wine into the glass. If a motor system malfunctioned, and the motor movements produced did not correctly follow the motor instructions, there would be a good sense in which the motor instructions would misrepresent those very same motor movements which the execution of those motor instructions was supposed to bring about but did not.

Hence, motor commands and motor schemas prescriptively represent the task they prescribe. Moreover, they represent it *as to be performed in accordance with a method*, which breaks down the task into the most elementary operations that the system can perform. For example, a motor command prescriptively represents moving one's hand to the glass by breaking down this movement into a sequence of elementary commands, prescribing the contractions of the muscles, the orientation of the movement, its velocity, etc. A method can be thought of as a tree that branches out down to terminal nodes, in analogy with how procedures are represented by computer scientists (Abelson & al. 1996). The structure of this branching tree is a mode of presentation of the task to be performed through it [reference to published paper blinded for peer review; reference to forthcoming paper blinded for peer review].[16]

Why think of this sort of mode of presentation as distinctively practical? Here is

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[16] In [reference blinded], I argue that motor commands must fully specify a method to perform a motor task from the fact that they are the output of *motor planning*, which is the process by which the motor system plans how the task is to be performed (cfr. Wolpert 1997).

the argument given in [reference to published paper blinded for peer review; reference to forthcoming paper blinded for peer review]. The set of elementary operations for a motor system can vary through time, as illustrated by the process that psychologists call "chunking" through which complex operations become elementary for a system (Newell 1990: 8–10; Sakai & Kitaguchi & Hikosaka 2003; Verwey 2010; Verwey and al. 2011:407). The result of chunking is analogous to what I have called a "chunked command" on a keyboard: through chunking a sequence of commands, the motor system comes to have a specialized new elementary command that can execute the whole sequence at once, just like, for example, keyboard #2 has a specialized instruction (the green button) to execute a sequence of two notes.[17] Because of chunking, the set of elementary operations of a motor system can vary through time and can vary across motor systems at the same time.

Because the set of a system's operations can vary through time, a motor system might prescriptively represent the same task in different ways at different times. Different motor systems might prescriptively represent the same task in different ways at the same time, because they will break down the task into a different set of elementary commands depending on the set of their elementary abilities at that time. In this sense, motor systems represent a task *practically*.

As noted, however, this argument concludes that practical representation is psychologically real *only* on the assumption that cognitive scientists are on good grounds when they posit motor representations. The rest of this section is devoted to providing a

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[17] 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. As far as I can see, however, this difference though important does not affect the claim that both the motor system and a Casio keyboard can practically represent.

more principled argument for the psychological reality of practical representation.[18] The argument I propose is *abductive*: it argues for the existence of practical representation from the fact that practical representation explains the *productivity of skillful behavior* better than its non-representational alternative.

We are able to perform an arbitrary, in principle infinite, number of complex novel tasks. Consider all the dance sequences a dancer can learn; all the music pieces that a piano player can learn to play; and all the different ways in which a basketball player can learn to sink the basket. Cognitive scientists such as Newell (1990) see in this sort of productivity the defining feature of human cognition in general (cfr. also Lewis, Vara & Howes 2004).

As finite beings, we are doomed to learn to perform this arbitrary number of complex novel tasks only starting from a finite number of abilities. But a finite number of abilities can explain the ability to perform an arbitrary number of complex tasks only provided that those abilities are *combinable* in the right way to make up an arbitrary infinite number of complex abilities.

This recombinability is itself a remarkable fact that calls for an explanation. For abilities are *not* necessarily recombinable. For example, consider cases in which a subject can perform parts of a task without being able to perform the whole task. We might think of a process that has several stages (maybe a video game boss fight) and the agent is able to complete all the stages on their own but fails to execute the sequence of stages as a whole. Or one might think of a piano score, of which one can play each key, and many combinations of them, without being able to play the whole combination. Finally, a

[18] The argument resembles very closely the standard argument for the compositionality of thought starting from its productivity, that many attribute to Frege ([c. 1914] 1980: 79).

dancer might be able to perform each step of a sequence and fail to be able to put them together. These are all examples in which the subjects might have the abilities to perform many, if not all subparts of the score, but those abilities do not sum up to the desired complex ability.

So it is *not* generally true that the abilities to perform parts of a task are recombinable in such a way to make the ability to perform the whole task. If the ability to execute an arbitrarily complex task is to be explained in terms of a finite set of abilities, call such a set S, the recombinality (or *compositionality*) of the abilities in S calls for some explanation.

It seems that in order for the composing abilities in S to be recombinable in the right way, they must not only be *elementary* — i.e., not composed out of other abilities. They must also be combinable with each other in such a way to guarantee that, if *a*1 and *a*2 are two different elementary abilities for a system, there be a composition of them that is also an ability for the relevant system. Say that a mode of combination of two abilities is *primitive* for a system if the result of combining two elementary abilities in accordance with such a mode of combination is itself an ability for that system. We have seen that abilities do not necessarily satisfy this constraint of being recombinable to make up complex abilities. Hence, the issue arises: *what sort of abilities could satisfy this constraint?*

Suppose the most elementary operations that a system can perform are prescriptively represented by elementary commands, where an elementary command is (i) a most basic command that the system has the ability to execute and (ii) that can be combined with other basic commands in accordance with some of the system's modes of combination in such a way that, if the system has the ability to perform c1 and the ability to perform c2 then the system has the ability to perform c1 & c2.[19] If elementary abilities were abilities to execute elementary commands, because these elementary commands are by definition composable in accordance with the system's primitive modes of combination, that would explain how the ability to perform arbitrarily complex tasks arises from a finite set of elementary abilities. The argument concludes that in a variety of skill domains, the productivity of human behavior is best explained in terms of a finite set of elementary abilities to execute commands that are primitively combinable.

On this account, one acquires the ability to perform a complex task when one forms a *practical representation* of that task — i.e., where the complex task is broken down into elementary commands structured in accordance with primitive modes of combination. Forming a practical representation amounts to "proceduralizing" the ability to perform that task. Because, as we have seen, the subject might have different primitive abilities at different times, proceduralizing the relevant ability might amount to forming different practical representations of the same task at different times.

The hypothesis of practical representation explains better than the nonrepresentational alternative how a system might be able to perform an arbitrary number of complex tasks starting from a finite set of abilities, for it explains how the relevant abilities could be composable in the way desired by the *explanandum*, by explaining what it is that these abilities are abilities to do — i.e., to execute elementary commands — and in terms of the recombinable nature of these elementary commands. Because the productivity of skillful behavior *is* real, an inference to the best explanation concludes that practical representation must also be psychologically real.

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[19] For computers, for example, sequencing is one such mode of combination.

5. Procedural presentation as practical representation

A number of authors (cfr. Rizzolatti, Fogassi, & Gallese 2000; Pacherie 2011; Nanay 2014; Butterfill & Sinigaglia 2014; Mylopoulos & Pacherie 2016, among others) have discussed and emphasized the central role of motor representation in the production of motor actions. The current discussion differs from these contributions in two crucial ways.

First, my claim is that motor representation is just one example of practical representation. With the example of a Casio keyboard, I have argued that practical representation can come apart from the paradigmatic cases of perceptual and conceptual representation. By contrast, current discussions of motor representation explicitly classify motor representation as perceptual without explicitly addressing the question of how motor representation might differ, if at all, from paradigmatic cases of perceptual representation.[20]

Secondly, practical representation is helpfully more general than the notion of motor representation and because of that it affords us a characterization of the sort of *procedural representation* routinely posited by cognitive scientists. It is common for cognitive scientists to talk of procedural memory systems as *representation-based*, and to describe these representations as "prescriptive."[21] For example, neuroscientist Tulving (1985: 387–8) points out that "the representation of acquired information in the

[20] Cfr. Nanay 2014:4–5. As I will explain in the next section, in my view, motor commands are representations that are both practical and perceptual.

[21] The distinction between declarative and procedural systems is foundational in cognitive sciences and goes back to pioneering experiments by Milner is the late 50s on amnesiacs. Since Milner (1965) and Cohen and Squire (1980), the distinction between procedural knowledge and declarative knowledge has been foundational in psychology and neuroscience (cfr. Squire 1992; Cohen & Eichenbaum 1993; Squire 2009; Squire & Wixted 2011, 2016; Squire & Zola-Morgan 1988; Bayley & Franscino & Squire 2005; Roy & Park 2010). Although it has no shortage of detractors, even those challenging it end up relying on some version of it (Dew & Cabeza 2011; Henke 2010).

procedural system is *prescriptive* rather than descriptive." (See also cfr. Singley & Anderson 1989:190-1; Knowlton and Karin Foerde 2011: 107 and Taatgen 2013.)[22] When cognitive scientists posit "procedural" representations, little is said about the nature of these procedural representations, except for the fact that these representations are generally thought of as *prescriptive* and that they need be neither conceptual nor perceptual. We are told that they need not be conceptual, as they are distinct from the sort of representations on which declarative systems are based and because they need not be accessible at personal level; we are told that they need not be perceptual either, as when procedural representations are invoked to explain highly abstract tasks, such as abstract mathematical tasks.

The notion of practical representation introduced here helps elucidate an aspect that is common to *all* procedural representations (whether or not motor). According to my proposal, *a task is represented procedurally by a system only if it is represented practically by that system* — where a task is represented practically by a system provided that it is prescriptively represented by a command that breaks the task down into subcommands that are elementary for the system, and does so in accordance with a structure that respects the system's primitive modes of combination.

6. From Practical Representations to Practical Concepts

The idea that there might be a distinctively practical way of representing the world has been around in the literature for some time, mostly in connection with the debate on the nature of know-how. In this literature, however, practical modes of presentation are

22 For a more detailed survey of talk of procedural representation in cognitive scientists, see [Reference to forthcoming paper blinded for peer review].

discussed as pertaining in the first instance to *conceptual representation*. That is evident from the fact that practical modes of presentations are often identified with practical ways of *thinking.* For example, Peacocke (1986: 49–50) talks of "action-based ways of thinking." Bengson & Moffett (2007) and Mylopoulos & Pacherie (2016) talk of "ability-entailing concepts." Stanley (2011: 98–110) talks of "practical ways of thinking." Pavese (2015a) talks of "practical concepts." Pavese (2015b) thinks of practical modes of presentations as "practical senses."

Prima facie, the discussion in this essay 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 to ways of thinking. Just like perceptual modes of presentation are not themselves conceptual nor ways of thinking,[23] I have suggested that practical modes of presentation are not necessarily conceptual nor ways of thinking.

Despite this apparent discrepancy, the current proposal should be seen as fully compatible with and indeed a desirable development of these views of practical modes of presentation. For example, consider Pavese's (2015b) practical senses, understood as *operational semantic values* of program texts. Practical senses so understood qualify as practical representations, because operational semantic values in effect break down a task, such as *multiplying*, in different ways depending on the elementary abilities of the system (Pavese 2015b:6–7). For instance, a practical sense might break down the task of multiplying into no subtasks, if multiplying is an elementary operation for the system, or might break it into subtasks that include adding, if multiplying is not elementary. In this sense, practical senses qualify as practical representations (cfr. also Pavese 2017b).

[23] Cfr. Kulvicki (2007:214).

Are practical senses conceptual? An answer to this question depends on what concepts are. At the outset, I have assumed a *robust* notion of concepts, according to which only combinatorial representations that underlie higher-order cognitive abilities of reasoning and thinking count as concepts (see §2). Whether practical senses can play this role in reasoning and thinking is not something I have space to argue for here. But practical senses definitely count as "conceptual" on a minimalist notion of concepts, of the sort defended by Fodor 1975, 1998, Gallistel 1990, and Camp 2009, on which a concept is *any* mental representation that is combinatorial. On this minimalist sense, practical senses count as conceptual because they are fully compositional (Pavese 2015b:14–16).

There is a second, more substantial, sense in which the notion of practical representation introduced here is compatible with there being practical concepts. In this essay, practical modes of presentation have been characterized as ways of prescriptively representing a task as a function of abilities that are neither (or not entirely) conceptual nor (or not entirely) perceptual. As pointed out, this way of characterizing practical representation is compatible with there being practical representations that are *neither conceptual nor perceptual*, as in the case of a configuration of keys on a Casio keyboard. However, the present proposal is also compatible with there being *hybrid representations* — i.e., in particular, with there being representations that represent *both as a function of practical abilities and as a function of conceptual and perceptual abilities.*[24] For

[24] It is worth noting that what I call "hybrid representations" are related but different from Millikan's (1996) *pushmi-pullyu representations*. The latter are individuated in terms of their function: they have both a descriptive function and a directive function. The former are individuated in terms of their modes of presentation: they have both a perceptual (or conceptual) mode of presentation and a practical mode of presentation. Many examples Millikan gives of *pushmi-pullyu representations* are not practical representations nor hybrid representations in my sense. For example, consider strict orders delivered with a declarative pattern, such as "You will not leave the house today, Johnny, until your room is clean."

example, plausibly sensory-motor representations such as motor commands and motor schemas can represent *both* as a function of practical abilities and as a function of perceptual abilities, as motor commands are the outputs of a process — i.e., motor planning — which takes perceptual feedback as input (cfr. Wolpert 1997). If so, motor commands are *hybrid* representations, both perceptual and practical. If there can be representations that are both perceptual and practical, then it seems to me that it cannot be ruled out that there might be practical representations that are also conceptual in a robust sense.[25] Hence, it cannot be ruled out that, for instance, the mind can *think* of tasks practically, through representations that are both practical, in the sense of practical specified here, and conceptual. And if we were to model the contents of these thoughts, they would be closely resembling Pavese's (2015b) practical senses.

Here is a third respect under which the taxonomy given in this essay is compatible with there being practical concepts. Some identify perceptual concepts with sensory or perceptual representations (cfr. Barsalou 2008; Prinz 2004). Others take at least certain perceptual concepts to be distinct from, but especially linked to perceptual representations, so that entertaining a perceptual concept might require activating a corresponding perceptual representation (Machery 2016). We might expect something analogous to be true in the case of practical representation. Just like there might be perceptual concepts one possesses only by virtue of possessing a corresponding perceptual representation, there might be concepts that are practical in the sense that are

This order has both directions of fit but represents what it does independently of the speakers' or of the recipients' elementary practical abilities. In this sense, it is not a practical representation, or a hybrid representation, in my sense.

[25] In fact, although we might envisage simple systems like the Casio Keyboard described in section 3 in which subsystems represent independently, in complex systems like the human mind representations are much more likely to be hybrid.

possessed *only* by virtue of possessing a corresponding practical representation.[26]

Finally, and relatedly, the current framework makes room for the possibility, analogous to that contemplated by a moderate form of embodied cognition (cfr. Anderson 2007; Barsalou 2008; Goldman 2012), that practical representation might be *redeployable* as conceptual representation. Consider again a Casio keyboard: although a particular configuration of the black and white keys on the main keyboard is primarily used to play a sequence of notes (in their mind-to-world direction of fit), it could also be used by a music teacher to teach students the musical notes, for example, by mapping a note or a sequence of notes to the corresponding keys. In this case, the teacher would be using the configurations of keys not with a mind-to-world direction of fit (for bringing about sonic changes in the world) but with a world-to-mind direction of fit (for classifying sounds in the environment). In the two cases, the same representation[27] can be used *with a different function*. By being used with a different function, it acquires a different mode of presentation — a conceptual one — while retaining the same content that it has acquired in virtue of its original function. In this sense, the current proposal is not just compatible but is even congenial to the idea that practical representation, or some transformation thereof, can be redeployed as conceptual representation.

By no means does this discussion exhaust all the interesting issues surrounding the notion of practical representation. I have not tried to defend the claim that every mental representation is either conceptual, perceptual, or practical, or a combination thereof. My essay leaves open that also this trichotomy might not be exhaustive. Nor have I tried to argue that every practical representation is a procedural representation, as

[26] Mylopolous & Pacherie (2016) seems to think of action-based concepts as being practical in this derivative sense.

[27] Where "representation" is typed by its content but not by its mode of presentation.

this notion is understood in cognitive sciences. So-called procedural representations are supposed to be implicit and not available at a personal level. Can practical representation encompass personal-level representations or does it share the same alleged boundaries of procedural representation? If the former, can intentions involve practical representation? Can there be practical representations of something other than *tasks*? For example, can *objects* be represented practically?[28] I have to leave these and other important issues for future research.

8. Conclusions

This essay has explored and defended the hypothesis that the usual taxonomy of mental representation — encompassing conceptual and perceptual representation — should be augmented to include a third kind of representation, which is distinctively practical. The notion of practical representation has been characterized in terms of its distinctive modes of presentation, which in turn depend on abilities that are not (or not entirely) perceptual or conceptual (§2). I have illustrated the idea of practical representation with the example of a simple system (§3). I reviewed some reasons for thinking that practical representation is psychologically real by looking at control theories of motor behavior and I outlined a more principled argument for the existence of practical representation (§4). Further, I claimed that the notion of practical representation sheds light on some constitutive features of so-called procedural representations (§5). I ended by emphasizing the continuity of the current proposal with recent discussions of practical modes of presentation, by discussing the possibility of hybrid representations and the possibility of practical concepts from that of practical representations.

[28] Cfr Gibson 1954.

Practical representation is both intelligible and enters center stage in prominent psychological and neuroscientific explanations of skillful behavior. The possibility for practical representation also provides the best explanation for the productivity of skills. If so, then, the mind does not just represent the world conceptually and perceptually. It can represent the world practically too.

References

Author. (2017).

———. (forthcoming).

Abelson, H. and G. Sussman (1996). *Structure and interpretation of computer programs*. MIT Press.

Anderson, J. (1982). “Acquisition of cognitive skill.” *Psychological Review* 89.4:369.

———. & J. Douglass, D. (1997). “The Role of Examples and Rules in the acquisition of a cognitive skill.” *Journal of Experimental Psychology: Learning, Memory, and Cognition*, 23(4): 932–945.

Anderson, M.L. (2007). The massive redeployment hypothesis and the functional topography of the brain. *Philosophical Psychology* 21(2): 143–174.

Anscombe, G.E.M. (1957). *Intentions*. Oxford: Basil Blackwell.

Arbib, M.A. (1985) Schemas for the temporal organization of behavior. *Human Neurobiology*, 4: 63–72.

Ashby, F. G., Ennis, J. M., & Spiering, B. J. (2007). “A neurobiological theory of automaticity in perceptual categorization.” *Psychological review*, *114*(3), 632.

Barsalou, L.W. (2008). Grounding cognition. *Annual Review of Psychology* 59: 617–645.

Bengson J. and M. Moffett. “Know-How and Concept Possession.” *Philosophical Studies*, 136(1):21–57, 2007.

Bernstein, N. (1967). *The Coordination and Regulation of Movements*. Pergamon Press, Oxford.

Bermúdez, J. L. (1995). “Nonconceptual content: From perceptual experience to subpersonal computational states.” *Mind & Language* 10.4: 333–369.

Block, N. 1990. “Inverted earth.” *Philosophical Perspectives* 4:53–79.

Burge, T. (2009). “Five theses on *de re* states and attitudes.” *The Philosophy of David Kaplan:* 246–324.

———. (2010). *Origins of objectivity*. Oxford University Press.

———. (2014). “Reply to Rescorla and Peacocke: Perceptual content in light of perceptual constancies and biological constraints.” *Philosophy and Phenomenological Research*, *88*(2), 485–501.

Butterfill, S. A., & Sinigaglia, C. (2014). “Intention and motor representation in purposive action.” *Philosophy and Phenomenological Research 88*, 119–145.

Camp, E. (2009). “Putting thoughts to work: Concepts, Systematicity, and Stimulus-Independence.” *Philosophy and Phenomenological Research* 78.2: 275–311.

Chalmers, D. (2004). “The Representational Character of Experience.” *The future for philosophy*: 153–181.

Carey, S. (2009). *The origin of concepts*. Oxford University Press.

Cohen, N. J. & Squire, L. (1980). “Preserved Learning and Retention of Pattern-Analyzing Skill in Amnesia: Dissociation of Knowing How and Knowing that”, *Science* 210(4466), pp. 207–210.

Corkin, S. (1968). “Acquisition of Motor Skill After Bilateral Medial Temporal-Lobe Excision,” *Neuropsychologia*, Vol. 6, pp. 255–265.

Dretske, F. I. (1986). *Explaining behavior: Reasons in a world of causes*. MIT press.

Evans, G. (1982). *The Variety of Reference.* Oxford: Clarendon Press.

Fodor, J. A. (1998). *Concepts: Where cognitive science went wrong*. Oxford University Press.

Frege, G. ([c. 1914] 1980). “Letter to Jourdain”, translated in *Philosophical and Mathematical Correspondence*, Hans Kaal (trans.), Gottfried Gabriel et al. (eds.), Chicago: Chicago University Press, pp. 78–80.

Gallistel, R. (1990). *The Organization of Learning* (Cambridge MA: MIT Press).

Gibson, J. J. (1954). The visual perception of objective motion and subjective movement. *Psychological Review, 61,* 304–314.

Goldman, A. I. (2012). “A moderate approach to embodied cognitive science.” *Review of Philosophy and Psychology* 3.1: 71–88.

Hawley, K. (2003). “Success and knowledge-how.” *American Philosophical Quarterly*, *40*(1), 19–31.

Humberstone, I. L. (1992). Direction of fit. *Mind*, *101*(401), 59–83.

Knowlton, B. J. & Foerde, K. (2008). "Neural Representations of nondeclarative Memories." *Current Directions in Psychological Science* 17, 62–67.

Kulvicki, J. (2007). "What is what it's like? Introducing perceptual modes of presentation." *Synthese* 156.2: 205–229.

Jackendoff, R. (1989). "What is a concept, that a person may grasp it?" *Mind & Language*, 4:1-2, 68–102.

Jagnow, R. (2012). "Representationalism and the Perspectival Character of Perceptual Experience," *Philosophical Studies* 157, no. 2 (2012): 227–249.

Jeannerod, M. (1997). *The cognitive neuroscience of action*. Oxford, UK: Blackwell Publishers, Inc.

Lande, K. (forthcoming). "The Perspectival Character of Perception." *The Journal of Philosophy*.

Laurence, S., and E. Margolis. (1999). "Concepts and cognitive science." *Concepts: core readings*: 3–81.

Lewis, R. L., A. H. Vera, and A. Howes. (2004). "A Constraint-Based Approach to Understanding the Composition of Skill." *ICCM*.

Machery, E. (2009). *Doing without concepts*. Oxford University Press.

———. (2016). The amodal brain and the offloading hypothesis. *Psychonomic bulletin & review*, *23*(4), 1090–1095.

Marr, D. (1982) "Vision: A Computational Investigation" Into. WH Freeman.

Milner, B. (1962). "Physiologie de l'hippocampe." Paris: Cen. Natl. Rech. Sci; *Les troubles de la memoire acompagnant des lesions hippocampiques bilaterales*; pp. 257–272.

McCloskey, M. (2009). *Visual reflections: A perceptual deficit and its implications*. Oxford University Press.

Millikan, R. G. (1986). "Thoughts without laws; cognitive science with content." *The Philosophical Review* 95.1 (1986): 47–80.

———. (1996). "Pushmi-pullyu representations." *Philosophical Perspectives*, 9, 185–200.

Mylopoulos, M. & E. Pacherie. (2016). "Intentions and motor representations: The interface challenge." *Review of Philosophy and Psychology*: 1–20.

Nanay, B. (2013). *Between Perception and Action*. Oxford University Press.

Neander, K. (2017). *A Mark of the Mental: In Defense of Informational Teleosemantics*. Cambridge, Massachusetts; London, England, MIT Press.

Newell, A. (1990). *Unified Theories of Cognition*. Cambridge, Massachusetts: Harvard University Press.

No ̈e, A. (2004). *Action In Perception* (Cambridge, MA: MIT Press).

Palmer, S. E. (1999). *Vision science: Photons to phenomenology*. MIT press.

Pavese, C. (2015). "Practical Senses," *Philosophers' Imprint* 15.29: 1–25.

———. (2017b). "A Theory of Practical Meaning," *Philosophical Topics*, vol. 45 no 2 (45.2), Fall 2017, pp. 85–116.

Peacocke, C. (1983). *Sense and Content: Experience, Thought, and Their relations.* OUP.

———. (1987). "Depiction." *The Philosophical Review* 96.3: 383–410.

———. (1995). *A Study of Concepts*. Cambridge, MIT Press.

———. (2001). "Does perception have a nonconceptual content?" *The Journal of Philosophy* 98.5: 239–264.

———. (2014). *The mirror of the world: subjects, consciousness, and self-consciousness*. Oxford University Press.

Platts, M. (1979). *Ways of Meaning.* London: Routledge and Kegan Paul.

Philiastides, M. G., Ratcliff, R., & Sajda, P. (2006). "Neural representation of task difficulty and decision making during perceptual categorization: a timing diagram." *Journal of Neuroscience*, *26*(35), 8965–8975.

Prinz, J. J. (2004). *Furnishing the mind: Concepts and their perceptual basis*. MIT press.

Reder, L. M. H. P., and Kieffaber, P. D. (2009). "Memory systems do not divide on consciousness: Reinterpreting memory in terms of activation and binding." *Psychological Bulletin 135.1,* 23–49.

Rescorla, M. (2016). "Bayesian sensorimotor psychology." *Mind & Language* 31.1: 3–36.

Rizzolatti, G. & Sinigaglia, C. (2008). *Mirrors in the brain: How our minds share actions, emotions*. Oxford: Oxford University Press.

Rosch, E. (1978). "Principles of Categorization," in E. Rosch & B. Lloyd (eds.), *Cognition and Categorization*, Hillsdale, NJ: Lawrence Erlbaum Associates, pp. 27–48.

Roy, S. & N.W. Park. (2010). "Dissociating the memory systems mediating complex tool knowledge and skills." *Neuropsychologia* 48.10: 3026–3036.

Schmidt, R. A. (2003). "Motor schema theory after 27 years: Reflections and implications for a new theory." *Research quarterly for exercise and sport*, *74*(4), 366–375.

Schulte, P. (forthcoming): "Perceiving the World Outside: How to Solve the Distality Problem for Informational Teleosemantics", *Philosophical Quarterly*.

Squire, L.R., & Zola, S.M. (1997). "Amnesia, memory & brain systems." Philosophical Transactions of the Royal Society of London, B: Biological Sciences, 352, 1663–1673.

Singley, M. K. & J. Anderson. (1989). *The transfer of cognitive skill*. No. 9. Harvard University Press.

Smith, E., & Medin, D. (1981). *Categories and Concepts*, Cambridge, MA: Harvard University Press.

Squire, L. R. (1992). "Memory and the hippocampus: a synthesis from findings with rats, monkeys, and humans." *Psychological review* 99.2:195.

———. (2009). "Memory and Brain Systems: 1969–2009", *Journal of Neuroscience*, 29(41), pp. 12711–12716.

Stanley, J. (2011). *Know How* Oxford U.P.

———. and Williamson, T. (2001). "Knowing How", *Journal of Philosophy*, 98:8, pp. 411–444.

Stevens, J. A. (2005). "Interference effects demonstrate distinct roles for visual and motor imagery during the mental representation of human action." *Cognition* 95 (3):329–350.

Taatgen, N. A. (2013). "The nature and transfer of cognitive skills." *Psychological review* 120.3: 439.

Tankus, A., and I. Fried. "Visuomotor coordination and motor representation by human temporal lobe neurons." *Journal of cognitive neuroscience* 24.3 (2012): 600–610.

Thompson, B. (2010). "The spatial content of experience." *Philosophy and Phenomenological Research*, *81*(1), 146–184.

Tye, M. (1996). "Perceptual experience is a many-layered thing." *Philosophical issues*, *7*, 117–126.

Tulving, E. (1985). "How many memory systems are there?" *American psychologist* 40.4 : 385.

Verwey, W. B., Abrahamse, E. L., Ruitenberg, M. F., Jiménez, L., & de Kleine, E. (2011). Motor skill learning in the middle-aged: limited development of motor chunks and explicit sequence knowledge. *Psychological research*, *75*(5), 406–422.

———. (2010). Diminished motor skill development in elderly: indications for limited motor chunk use. *Acta Psychologica* 134, 206–214.

Warrington, E. & Weizkrantz L. (1970). "Amnesic Syndrome: Consolidation or

Retrieval?", *Nature* 14, pp. 628–630.

Winograd, T. (1975). "Frame representations and the declarative/procedural controversy" in Bobrow, Daniel and Collins, Allan Eds. *Representation and Understanding: Studies in Cognitive Science*, New York, N.Y.: Academic Press Inc., 185–210.

Wolpert, D. M. (1997). Computational approaches to motor control. *Trends in cognitive sciences* 1(6): 209–216.

——— & Kawato, M. (1998). Multiple paired forward and inverse models for motor control. *Neural Networks* 11, 1317–1329.