MOTOR IMAGERY AND ACTION EXECUTION

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What triggers the execution of actions? What happens in that moment when an action is triggered? What mental state is there at the moment of action-execution that was not there a second before? My aim is to highlight the importance of a thus far largely ignored kind of mental state in the discussion of these old and much-debated questions: motor imagery. While there have been a fair amount of research in psychology and neuroscience on motor imagery in the last 30 years or so, it is only recently that we start to understand the important role motor imagery plays in action initiation. And if, as these findings suggest, motor imagery plays an important role in action initiation, we can make progress not only in understanding action initiation in general but also in understanding what goes wrong in akratic actions and in relapse actions. Finally, this new picture of action-initiation also has far-reaching consequences for the relation between motivation and causation in naturalistic action-explanations.

I. Introduction: What happens when we act?

What triggers the execution of actions? Suppose that there is a cup of tea next to your computer while you're working. You want to take a sip, you have a belief that the tea is not too hot and it would quench your thirst, you have a (distal) intention to take a sip. But you're not doing it. And suddenly, you find yourself taking a sip. What happens in that moment when this action is triggered? What mental state is there at the moment of action-execution that was not there a second before?

I take this to be the fundamental question of philosophy of action (see Brand 1978) – a question that comes up differently depending on the details of the action theory framework one is working with. If we follow Al Mele's framework, the question is how distal intentions give rise to proximal intentions (Mele 1992, 2003). In Searlean language, the

question is how we get from prior intentions to intentions-in-actions (Searle 1983), and so on.

The question about what triggers actions also has serious implications for our everyday life and wellbeing. In the case of taking a sip of tea, I wanted to do so and I formed an intention to do so. The question was just how this desire and intention gave rise to the actual bodily movement. But there are other cases where the executed action goes against our desires and even our intentions. Akratic actions are obvious examples: next to your computer is the TV's remote control, not a cup of tea. And you want to finish the grant proposal and have an all things considered intention to do so, but you nonetheless find yourself switching on the TV. How is that action triggered?

Addictions of various kinds raise the same problem (Brevers et al. 2012). Recovering addicts have very strong desire not to relapse. But when they do relapse (when their 'relapse actions', as I will call them, are triggered), what triggers these actions?

My aim is to bring a new kind of mental state into the discussion of these old and much-debated questions, namely, motor imagery. While there have been a fair amount of research in psychology and neuroscience on motor imagery in the last 30 years or so, it is only recently that we start to understand the important role motor imagery plays in action initiation. And if, as these findings suggest, motor imagery plays an important role in action initiation, we can make progress not only in understanding action initiation in general but also in understanding what goes wrong in akratic actions and in relapse actions. Finally, this new picture of action-initiation also has far-reaching consequences for the relation between motivation and causation in naturalistic action-explanations.

The plan of the paper is the following. I first introduce the concept of motor imagery (Section II) and highlight the empirical findings that suggest that motor imagery

plays an important role in action initiation (Section III). Then I examine how these findings can help us to understand how akratic actions (Section IV) and relapse actions (Section V) are triggered and what we can do about this. In the final section, I argue that the importance of motor imagery in action initiation indicates a major split between the set of motivating mental states and the set of mental states that are causally involved in bringing about an action.

II. Motor imagery

I want to introduce the concept of motor imagery with the help of a related concept: mental imagery – a concept that has been subject to much more scrutiny in philosophy, psychology and neuroscience. Many of the moves made in the mental imagery literature are directly applicable to motor imagery.

Here is an instance of mental imagery: you close your eyes and visualize an apple. It is undoubtedly an example of mental imagery, but not a particularly representative one for the following reasons.

First, visualizing an apple is a voluntary act: you count to three and visualize the apple. But mental imagery can be involuntary: we have flashbacks of unpleasant scenes and, in the auditory sense modality, we have earworms – tunes we keep on 'hearing' in the mind's ear, although we really don't want to.

Second, and more controversially, visualizing the apple is conscious, but mental imagery can also be unconscious. Some (not all) people with aphantasia (the inability to have conscious mental imagery) show all the behavioral markers (for example, reaction times) of tasks that are generally assumed to involve mental imagery (for example the mental rotation

task), while lacking any phenomenology of mental imagery (Zeman et al. 2015, Jacobs et al. 2017).

Psychologists and neuroscientists define mental imagery in a way that does not take the example of visualizing to be central. Here is a representative definition from a recent review article: "We use the term 'mental imagery' to refer to representations […] of sensory information without a direct external stimulus" (Pearson et al. 2015). This definition does not assume that mental imagery is conscious or voluntary. Whenever you have early cortical perceptual processing (for example, in the case of visual imagery, in the primary visual cortex or the secondary visual cortex or V4/V8) that is not triggered by corresponding sensory stimulation, you have mental imagery.

This way of thinking about mental imagery takes the intuitive conception of imagery seriously (as visualizing an apple will come out as an instance of mental imagery), but it widens the scope of the concept. If mental imagery is a natural kind, it is not determined by our intuitive and introspective conceptions, but rather by the functional category of early perceptual processing without sensory input (Nanay 2018, forthcoming).

What is the lesson from all this for motor imagery? Motor imagery is very different from mental imagery (and some of the early discussions of motor imagery focused on keeping it apart from mental imagery, see Jeannerod 1994, Currie and Ravenscroft 1997). But the more recent literature on mental imagery in psychology and neuroscience should help us to have a firmer grip on what motor imagery is.

Motor imagery has been traditionally understood as the feeling of imagining doing something. It is sometimes taken to be necessarily conscious, not just by philosophers (Currie and Ravenscroft 1997), sometimes even by psychologists (Jeannerod 1994, 1997, see also Brozzo 2017, esp. pp. 243-244 for an overview). And as imagining tends to be a

voluntary act, motor imagery is also often taken to be voluntary. So the paradigmatic example here is closing your eyes and imagining reaching for an apple.

But just as in the case of mental imagery, examples of this kind are not representative of motor imagery. Motor imagery, just like mental imagery, can be conscious or unconscious (see, for example, Osuagwu and Vuckovic 2014) and it can also be voluntary or involuntary. In order to understand how we can generalize to involuntary and unconscious cases, we should follow Jeannerod's methodological advice.[1]

Jeannerod writes: "Motor imagery would be related to motor physiology in the same way visual imagery is related to visual physiology" (Jeannerod 1994, p. 189). And rightly so: if visual imagery is 'early' cortical activation that is not triggered by corresponding sensory stimulation, then motor imagery is 'late' cortical activation that does not automatically trigger bodily movement.

More slowly: In the case of visual perception, light hits the retina and this retinal stimulation then triggers processing in the primary visual cortex (V1) and then in other early cortical visual areas like V2, V4/V8 or MT. When we get processing in these early cortical areas without retinal stimulation, we have mental imagery.

We get the converse picture with motor imagery. When we perform an action, before our body moves, there is processing in the primary motor cortex (M1). And before that, we get processing in the premotor cortex and in the supplementary motor area (SMA) (and before that, in the posterior parietal cortex (PPC)). So processing in PPC, SMA, the

[1] Jeannerod was also often taking it for granted that motor imagery is necessarily conscious, he even defines motor imagery as "the ability to generate a conscious image of the acting self" (Jeannerod 2006, p. 23). But when actually using this concept, he drops the assumption that motor imagery is conscious. See esp. Jeannerod 2001, Frak et al. 2001 and the discussion between Jeannerod and Rizzolatti following Rizzolatti 1994 about unconscious imagery.

premotor cortex and M1 triggers bodily movement. When we have processing in the motor cortex without bodily movement, we get motor imagery.

The paradigmatic example of imagining grasping the apple will come out as motor imagery on this definition as we have a large and growing literature on the involvement of motor cortex in conscious and voluntary motor imagery (like deliberately imagining doing something). Processing in the premotor cortex and the supplementary motor area during conscious and voluntary motor imagery has been known for a long time (Roland et al. 1980, Fox et al. 1987, Decety et al. 1990, 1994, Stephan et al. 1995, Filimon et al. 2007). The same goes for the posterior parietal cortex (Aflalo et al. 2015).

There have been more controversies about the involvement of the primary motor cortex (Roland et al. 1980, Decety et al. 1994, Stephan et al. 1995). But more recently there is converging evidence that the primary motor cortex is active during conscious and voluntary motor imagery (Gandevia and Rothwell 1987, Roth et al. 1996, Georgopoulos et al. 1989, Richter et al. 2000, Porro et al. 1996, Miller et al. 2010, Schnitzler et al. 1997, Saruco 2017, see also Dechent et al. 2004 for an error theory of why earlier studies failed to find the involvement of M1 in motor imagery).

It is important that this is a functional, not a physiological way of defining motor imagery (just as the definition of mental imagery was also functional and not physiological). In the case of mental imagery, processing in V1 that is not triggered by visual input was not necessary and sufficient for mental imagery. If the V1 is silent, but there is processing in V2 or V4 that is not triggered by visual input, we still get mental imagery. What is important is that mental imagery is early processing not triggered by corresponding sensory stimulation.

Similarly, I'm not claiming that activity in M1 that does not trigger bodily movements is necessary and sufficient for motor imagery. Even if M1 is silent but the premotor cortex

or the SMA is not, and there is no overt movement, we can still talk about motor imagery (see, e.g., Gentili et al. 2004, Gandrey et al. 2013, Hanakawa et al. 2008). It is important that we do not need to resort to neuroimaging in order to find out whether the subject exercises motor imagery - we can also use behavioral methodology. One such behavioral method involves eye tracking, as motor imagery evokes very specific eye movement patterns that are very different from for example visual mental imagery and that is present both in conscious and in unconscious motor imagery (see Poiroux et al. 2015 for a summary of the research on this).

Here is a brief way of summing up how my account of motor imagery is a functional account. Just as mental imagery is no input followed by activity in what is the first stop of perceptual processing, motor imagery is the last stop of motor processing, not followed by any output.

This way of thinking about motor imagery can also help us with a notorious unclarity about the traditional, phenomenological way of zeroing in on motor imagery as the feeling of imagining doing something. As it is acknowledged by all involved in this debate, not all imaginative episodes of doing something would count as motor imagery: you somehow need to imagine doing something from a first person, and not a third person perspective. Jeannerod himself made a distinction (following the practice in sport psychology) between internal and external imagery, and only the former would count as motor imagery (Jeannerod 1994, p. 189).

These distinctions are unclear enough, but they are even more unclear in the light of some new findings about the connection between motor and sensory imagery. According to these new findings, motor imagery leads to the sensory representation (in fact, in our terminology, sensory imagery) of the outcome of the imagined action (Kilteni et al. 2018).

Given that neither this sensory representation nor the motor imagery in question need to be conscious, keeping motor imagery of doing something and sensory imagery of the performance of this action apart will be very difficult if all we can use is phenomenology and intuitions. But using the functional definition instead of relying on slippery intuitive and introspective markers like 'first person' or 'internal' would help us to have a more precise way of understanding motor imagery.

III. Motor imagery and action-initiation

The question of action initiation is widely studied in neuroscience and psychology. Neuroscientists of action make a (not very surprising) distinction between the preparation for a movement and the execution of that movement. The set of findings I want to focus on here is about one major difference between these two phases of action execution: the inhibition of action during the preparation for a movement and the lifting of this inhibition shortly before the execution begins (see Porter and Lemon 1993 for an overview). This difference is at the segmental spinal level. There is a sharp decrease of spinal reflexes[2] during preparation for a movement (which prevents motor neurons from spontaneous firing) and increase again shortly before execution. (Bonnet and Requin 1982, Requin et al. 1977, Fourkas et al. 2006, see also Kyriakatos et al. 2011).

[2] More precisely, this decrease in action preparation and increase in action execution is only true of T-reflexes, that is, Tendonal reflexes, reflexes induced by a blow on the muscle tendon, as in the case of the knee-jerk reflex), not H-reflexes (that is, Hoffmann reflexes, reflexes induced by an electric charge). See Porter and Lemon 1993 on a good overview of the literature on this. H-reflexes bypass the muscular spindle and does not track the activity of the specific muscles involved in the action. It is also influenced by various factors, including, among others, caffeine (see Kalmar et al. 2006). T-reflexes, in contrast, track the activity of the specific muscles involved in the action via the gamma motor neurons in the muscular spindle.

It is important to be clear about what these studies show and what they don't show. They do show that the increase in spinal excitability is necessary for the initiation of action – if the spinal excitability is decreased, there is no bodily movement. But what they do not show is that the increase in spinal excitability is sufficient for action initiation. It is not, as the following set of findings about spinal excitability and motor imagery demonstrate.

Motor imagery, like action execution, but unlike action preparation, increases spinal excitability (Bonnet et al. 1997, Li et al. 2004, Bakker et al. 1996, Guillot et al. 2007, Aoyama and Kaneko 2011).[3] So whatever increases spinal excitability is there both in motor imagery and in action execution. This means that the increase in spinal excitability is not sufficient for triggering the action: in the case of motor imagery, we have an increase in spinal excitability, but no action performance.

Given that both motor imagery and action-initiation increase spinal excitability – and therefore the 'readiness' to perform an action, one should ask how motor imagery might contribute to the triggering of the bodily movement.

The relation between motor imagery and actual action performance has been investigated for a long time (see especially Marc Jeannerod's work: Jeannerod 1994, 1997, 2006, see also McCormick et al. 2013). It has been known for decades that there is a substantial overlap between the brain regions involved in motor imagery and in motor representations (see Miller et al. 2010 for a summary). But the main emphasis of the research on the connection between motor imagery and action performance has been on how motor imagery can help us to make our action performance more accurate (see the vast amount of

[3] Further, motor imagery training increases spinal plasticity (Grospretre et al. in press). Note that the so-called 'emulator theory of motor imagery' (Grush 2004) could be seen as anticipating this point. The emulator theory opposes the more mainstream simulator theory (of Jeannerod 1994 and Currie and Ravenscroft 1997) and it emphasizes the importance of the activation in the motor cortex driving a skeletomuscular 'emulator' – this claim could be seen as activation in the motor cortex increasing spinal excitability.

research in sport psychology on this (Feltz and Landers 1983 is a classic summary)). What I want to focus on is a much more recent body of findings, which is not about how motor imagery can modify the content of our motor representations, but about how it can help trigger action execution.

And there are some important recent results that suggest that motor imagery can make it more likely that the bodily movement is triggered (the findings at the moment seem to be limited to some simple bodily movements only, see Rodrigues et al. 2010, Stins et al. 2015, see also Fourkas et al. 2006). Further, incongruent motor imagery interferes with action execution (Ramsey et al. 2010).[4]

These findings suggest that the initiation of actions is made more probable by having motor imagery of the performance of this action and it is made less probable by having motor imagery of some other actions (see also Nanay 2017).

Nothing in these empirical results suggests that motor imagery reliably lead to action execution. All it follows is that it makes the triggering of action execution more likely by pushing the spinal excitability further and further up. But the mere fact that motor imagery is a factor in what triggers actions is something that could have a significant impact on understanding the mechanism of action initiation.[5]

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[4] Further, congruent hand posture during motor imagery facilitates spinal excitability, whereas incongruent hand posture makes spinal excitability less likely (Vargas et al. 2004).

[5] It is important to distinguish this view of the involvement of motor imagery in action initiation from ideomotor theory (see Knuf et al. 2001 for a good summary of the growing literature on ideomotor theory). The ideomotor theory is not new. William James famously summarized the view as "We think the act, and it is done" (James 1890, vol. ii, p.522). But a clearer (and earlier) formulation of the view comes from Johannes Muller: "The idea of a particular motion determines a current of nervous action towards the necessary muscles, and gives rise to the motion independently of the will" (Müller 1838, p. 944). See also Lotze: "As soon as an idea of an accessible goal surfaces into memory, the unfolding action appears as directed to that goal, seeking to approach it." (Lotze 1851, p. 298). More recent incarnations of ideomotor theory aim to clarify what this 'anticipatory image' (James 1890, vol 2: 501) or

IV. Akratic actions

Thinking about the role of motor imagery in action initiation helps us to understand how akratic actions are triggered. Few of us have the distal intention to perform akratic actions. Nonetheless, these actions are initiated somehow. The question is: how?

You are working on your computer and suddenly the idea of watching TV instead pops into your head. And then you find yourself reaching for the remote. My claim is that one of the mental states that has contributed to the triggering of the action of reaching for the remote is motor imagery. As a result, one thing we can do if we want to resist the temptation of watching TV would be to manipulate your motor imagery (see Papies and Barsalou 2015, Cornil and Chandon in press for (modest) steps in this direction).

The link between motor imagery and akratic actions is even more straightforward in cases we might call 'obsessive procrastination'. You know that you need to work on a grant proposal that is due tomorrow, but you are instead playing a video game. You know you need to stop, but you keep on playing. If we understand the role of motor imagery in action initiation, this is not surprising at all. When playing a video game, you already have your motor imagery engaged in the video game and this leads to the initiation of the action of playing another level, rather than getting up and going to your computer to work on the grant proposal.

'response image' (Greenwald 1970) that initiates action amounts to. This 'image' is a representation of the effect of the action (thus the label 'ideomotor'). Whether this representation should be understood as a sensory representation is not clear (see Knuf et al. 2001 for discussion), but what is certain is that it is not the kind of representation that would involve cortical motor processing, let alone processing in M1. Whatever triggers action according to the ideomotor theory is not motor imagery.

I should emphasize that these are supposed to be partial explanations. There are many mental states that are involved in performing akratic actions and I do not want to pretend that I can explain all of them. My aim was to highlight an important mental antecedent of akratic action that we may have more control over than other, less clearly understood motives of akratic actions.

On a pragmatic note, it seems to follow from this that if you feel the temptation to reach for that remote control, not imagining doing so (or imagining performing other actions) may help you to resist this temptation, whereas imagining doing so will increase the probability that you succumb to the temptation.

And here we can plug in one of the most celebrated results of sport psychology about motor imagery. It has been found that the precision and even the strength of complex motor actions is increased merely by the subject looking at the object these actions are performed with or on. The explanation of this is that the mere perception of this object triggers motor imagery and this repeatedly triggered motor imagery contributes to the better (more accurate, more forceful) performance of this action (Feltz and Landers 1983, Bakker et al. 1996).

What is relevant from these findings for our purposes is that merely perceiving an object with which we are used to performing an action triggers motor imagery of this action. So seeing a remote control will trigger motor imagery of grasping it and pushing the on button. And merely seeing a glass of wine will induce motor imagery of lifting it up and taking a sip.

So one, simple and not always available, way of reducing the chance of performing an action we do not want to perform is to make the objects that are required for performing this action perceptually unavailable (that is, to hide that remote or not to have Facebook

open in your browser, for example). Or, if this is not an option, the same can be achieved by making these objects inaccessible by a well-trained motor routine. If we don't perceive this object, the motor imagery is less likely to be activated. And if we do perceive it, but the motor routine is not well-trained, the motor imagery is, again, less likely to be activated.

This proposal could also be taken to be continuous with some influential philosophical accounts of resisting temptations (that is, resisting the initiation of the tempting action). Richard Holton argues that it can be detrimental of our determination to resist temptation to think about the tempting action (Holton 2009, pp 126ff.). The present proposal could be thought of as extending this general approach. Rather than focusing on thinking about one's options in general, the aim here is to identify just what kind of mental processes would be needed to push us over the threshold of action-initiation. And my answer is that this mental process is motor imagery.

V. Relapse actions

One advantage of this view of the role of motor imagery in action initiation is that it can help us to explain some empirical findings about addiction treatment. The study I want to focus on is about alcoholics who were trained to use a joystick when presented with pictures of alcohol and of non-alcoholic beverages (Wiers et al. 2011, see also Palfai 2006, Wiers et al. 2010).

Subjects in this experiment had to move the joystick away from themselves when presented with pictures of alcohol and they had to move the joystick towards themselves when they saw a picture of non-alcoholic beverages. The control group was either not

trained in any ways, or were trained to respond to some other, not alcohol-related feature of the picture.

The result was that those who were trained to make avoidance movements in response to pictures of alcohol showed significantly more progress at recovery in a year's time (Wiers et al. 2011). In some cases, even a single training session had a significant positive effect (see esp. Wiers et al. 2010).

It is not clear how we can explain this effect – it was not clear to the experimenters who conducted these studies either. Wiers et al. 2011 hypothesizes, very tentatively, that maybe emotions are involved (roughly, retraining the action-tendencies lead to emotional change). But it is not clear how this connection would work and how such change in emotions would lead to such drastic improvement in recovery.

If we accept that motor imagery plays an important role in action initiation, we get a much more straightforward explanation. As we have seen, incongruent motor imagery interferes with action execution (Ramsey et al. 2010). And the joystick exercise these subjects perform train them to have motor imagery in response to pictures of alcohol that is incongruent with approach behavior. As a result, their action execution (of reaching for alcohol in relapse situations) is less likely to be triggered.

This is a very promising way of treating addictions. One important marker of addiction is that addicts' attention is captured by addiction-relevant stimuli (see Brevers et al. 2011 for a summary of the vast literature on this, see also Anderson and Yantis 2013 for how this fits into long term value-driven attentional effects). And 'addiction-relevant stimuli' here does not merely mean stimuli that is directly connected to the addiction (in the case of gambling addiction: the roulette table), but a much wider range of stimuli that would be somehow very distantly related to the addictive behavior (for example, the shirt you once

wore in the casino, and so on). It is not an option to hide all possible addiction-relevant stimuli (because they are everywhere).

So addicts perceptually encounter addiction-relevant stimuli all the time and their attention is captured by these stimuli. And the intense capture of the addict's attention makes the triggering of motor imagery also more intense. So the only available option seems to be to reprogram the motor imagery itself, which, as we have seen, is not an impossible task.

VI. Motivation vs. causation

One salient feature of the relation between motor imagery and action initiation I argued for above is that the set of mental states that cause action are not the same as the set of mental states that motivate the action.

This constitutes a major departure from the standard causal theories of action, where the mental states that cause us to act are also the ones that motivate us to act.[6] This is true of the original Davidsonian picture (where these motivating and also causing mental states would be beliefs and desires, see Davidson 1980), but also on the later intention-centered and dual intention accounts (where they would be (proximal) intentions, see Mele 1992,[7] Bratman 1987, Searle 1983).

[6] This move needs to be distinguished from one in the vicinity that got more attention in the contemporary philosophy of action literature, namely, the distinction between what one intends to do and what one is motivated to do (see Mele 1992, Holton 2009). My distinction is between what intention we have (which may or may not also be the motivation we have) to act and what causes us to act, that is, what actually triggers our action.

[7] Again, see the previous footnote on how Mele's way of resisting the equation of motivation and causation is different from mine.

A consequence of the general picture of action initiation I argued for is that these two sets of mental states can come apart: motor imagery clearly plays an important causal role in triggering action initiation, but it is not a motivating state by any account of motivation.[8]

Motor imagery is not a reason for action (a concept often brought in when talking about motivation). And it is not (normally) available to conscious introspection (which seems to be an important feature of motivating mental state types). Motor imagery is not a motivational mental state, but it is causally involved in triggering action initiation. It shows that causation and motivation of action needs to be kept apart.

Does this move of severing the ties between motivation and causation of action need to worry the proponents of a causal theory of action? I don't think so. The entire process of action initiation I described is a causal process. Depending on what version of the causal theory of action one accepts, this would lead to different pictures. If, for example, we go with Al Mele's (Mele 1992) account, the links between distal intention, motor imagery and proximal intention and the bodily movements are all causal links. The only difference is that my account adds an extra causal ingredient to the standard causal picture, that of motor imagery.

A last worry about this way of tweaking the causal theory would be the following. One alleged advantage of the original causal theories of action is that all the causally efficacious mental states are mental states we have access to: mental states that we are aware of. This is, again, true of Davidson's original account, where we are very much aware of our

[8] While motor imagery is not a motivating state, it can and does interact with motivation in the sense that motor imagery can make it more likely that we have a desire or intention to do something. The role of mental (that is, sensory) imagery in desires has been widely discussed in psychology by the 'elaborated thought theory of desire', for example. But the imagery that influences (or elaborates) our desires could also be thought to be motor imagery. See Nanay forthcoming. Thanks to an anonymous referee for helping me clarify this point.

beliefs and desires that cause and motivate us to act. And it is also true of the dual intention theories where we are aware of our proximal (and if they are present, also our distal) intentions.

But the worry would be that this is not so when it comes to motor imagery. So one could argue that motor imagery is something that we merely postulate theoretically in order to explain some odd phenomena – it could be thought to be a theoretical entity, opening the door for various versions of antirealism about theoretical entities.

My response is threefold. First, we often are aware of motor imagery. As we have seen, motor imagery may or may not be conscious. If it is conscious, it can be subject to introspection. This response addresses a potential pushback from a causal theorist, namely, that they should take into consideration a merely subpersonal state that causally contributes to action execution (after all, there are many of these, along the motor nerve). The answer is that motor imagery is not a merely subpersonal state. Even if we accept the personal/subpersonal distinction as unproblematic (I myself don't think we should), a state that can become conscious, if attention is allocated to it, is not a subpersonal state. In other words, motor imagery, although it can be unconscious, is a bona fide mental state (an analogy: perceptual states can also be, and are often, unconscious, nonetheless, it would be odd to deny that perceptual states are bona fide mental states).

Second, I don't see any problem with postulating mental states if the only way in which we can explain the agent's complex behavior is by postulating these mental states. We have extremely rich and varied evidence that our introspective access to our own mind is limited and often systematically misleading. But then we should not expect that we are aware of all the crucial building blocks of the mind and of all the causal ingredients of action performance.

Finally, the fact that some causally relevant components of action initiation are unconscious is not a bug, but a feature (Nanay 2014). There are many actions where we are not aware of whatever moves us to act. Impulsive actions would constitute one kind of example. We just find ourselves acting – we have a sense of ownership of our action, but we do not have a sense of having initiated it. Akratic actions, as we have seen, would be another.

But there are even more prosaic cases. You're lying in bed in the morning, having hit the snooze button three times already and you know you need to get up, but somehow you just don't. And then all of a sudden, you find yourself getting up. You are not aware of the state that moved you to act. Here is a literary example by Robert Musil:

> I have never caught myself in the act of willing. It was always the case that I saw only the thought – for example when I'm lying on one side in bed: now you ought to turn yourself over. This thought goes marching on in a state of complete equality with a whole set of other ones: for example, your foot is starting to feel stiff, the pillow is getting hot, etc. It is still a proper act of reflection; but it is still far from breaking out into a deed. On the contrary, I confirm with a certain consternation that, despite these thoughts, I still haven't turned over. As I admonish myself that I ought to do so and see that this does not happen, something akin to depression takes possession of me, albeit a depression that is at once scornful and resigned. And then, all of a sudden, and always in an unguarded moment, I turn over. As I do so, the first thing that I am conscious of is the movement as it is actually being performed, and frequently a memory that this started out from some part of the body or other, from the feet, for example, that moved a little, or were

> unconsciously shifted, from where they had been lying, and that they then drew all the rest after them.[9]

Many of our actions are like this. And we should not dismiss these cases as rare instances of unimportant actions. Some of our actions of great importance are also like this: going in for that first kiss (assuming you don't do it by counting to three), for example.

Any philosophical account of action needs to take actions of this kind seriously. But if so, then we need to postulate a mental state that we do not have to be aware of. So we could turn the table and argue that those accounts of action are problematic that do not posit causally efficacious mental states that we are not aware of.

VII. Conclusion

An old and influential (Kantian) idea about mental imagery (or imagination) is that it is "a necessary ingredient of perception itself" (Strawson 1974, p. 54 – the metaphor and the quote are originally from Kant (*Critique of Pure Reason*, A120, fn. a, see also Sellars 1978, Thomas 2009), but it has become a widespread slogan. Eugène Delacroix, for example, wrote: "Even when we look at nature, our imagination constructs the picture".[10] There are many ways of substantiating this claim, some more plausible than others. One relatively strong version is that of this claim is that perception depends constitutively on the exercise of mental imagery. A weaker claim would be that this dependence relation is a merely causal one. What these different accounts of the dependence between mental imagery and

[9] Robert Musil: *Diaries*. New York: Basic Books, 1999, p. 101. See also James 1890, Goldie 2004, pp. 97-98.
[10] Delacroix: *Journal*, 1859, September 1.

perception agree on is that understanding mental imagery is a crucial part of understanding perception per se (Nanay 2010, 2015, 2018).

To pursue the structural analogy between sensory imagery and motor imagery, one way of summarizing the philosophical upshot of the proposal outlined in this paper is that just as understanding sensory imagery is a crucial part of understanding perception per se, understanding motor imagery is an equally crucial part of understanding action per se. Just as perception would be very different if mental imagery played no role in it (in amodal completion as well as multimodal perception), action would also be very different if motor imagery played no role in it. Philosophy of action should take the concept of motor imagery seriously.[11]

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