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# On the immediate mental antecedent of action

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**ABSTRACT**

What representational state mediates between perception and action? Bence Nanay says pragmatic representations, which are outputs of perceptual systems. This commits him to the view that optic ataxics face difficulty in performing visually guided arm movements because the relevant perceptual systems output their pragmatic representations incorrectly. Here, I argue that it is not enough to say that pragmatic representations are output incorrectly; we also need to know why they are output that way. Given recent evidence that optic ataxia impairs peripersonal space representation, I argue that pragmatic representations are output incorrectly because the organizing principle of the vision-for-action system is blocked by optic ataxia. I then show how this means that this principle, not pragmatic representations, is the representational state that mediates between perception and action, i.e. the principle, not pragmatic representations, is the immediate mental antecedent of action.

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## 1. Introduction

How we act in the world depends, in large part, on how we see the world. Putting some spoons of instant coffee in your mug and adding boiling water to it, for example, is visually guided. Close your eyes and you'd most likely break the mug at best or pour boiling water on yourself at worst. This action-guiding role is so integral to how vision works that it has motivated replacing the idea of a monolithic visual system with the idea that the visual control of actions depends on mechanisms that are functionally and neurally separate from those subtending our perception of the world (e.g. Goodale and Milner 2005; Jacob and Jeannerod 2003; Jeannerod 1997; Milner and Goodale 1995; Ungerleider and Mishkin 1982). Vision-for-action and vision-for-perception, it is now agreed, are two separate visual subsystems. My focus in this paper is the vision-for-action system. Specifically, on the role it plays in bringing actions about. What representational states does it output that mediate between perception and action? What is the immediate mental antecedent of action?

Traditionally, the representational states that mediate between perception and action are said to be the propositional attitudes of believing, desiring, and intending (e.g. Davidson 1982). To drink from your coffee mug, you must believe that it is in front of you, desire

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to drink coffee from it, and intend to pick it up. Nanay (2013a, 2013b, 2013c), however, argues that this belief-desire model is not the full story. Even if you have the relevant propositional attitudes, you won't know how far to reach out your hands and what grip size is appropriate to pick up the mug, not unless you represent the locational, size, and shape properties of the mug in action-relevant ways. Calling these action-relevant representational states, 'pragmatic representations,' Nanay says pragmatic representations are necessary for action performance, such that they, not propositional attitudes, are the immediate mental antecedent of action.

We can explain Nanay as saying that the mental antecedents of action constitute a hierarchy, and pragmatic representations come before belief, desire, and intention in the pecking order. We can have only pragmatic representations as the mental antecedent of action, but we can't have only belief, desire, and intention. Thus, his view is that in this hierarchical structure, pragmatic representations occupy the lowest level, and, so, they are the immediate mental antecedent of action. I have some misgivings about this view, at least given recent evidence from optic ataxia.

Optic ataxia is a condition characterized by an inability to perform visually guided arm movements, and it is caused by damage to the dorsal neural stream/pathway, which projects from the primary visual cortex to the posterior parietal areas. Though Nanay doesn't say so explicitly, his diagnosis of optic ataxia must be that pragmatic representations are output by the relevant perceptual system (i.e. the vision-for-action system) incorrectly. While I agree with him on this point, his failure to say why pragmatic representations are output that way leaves much to be desired. It is indeed the job of the neuroscientist to tell us how exactly the dorsal stream is damaged in optic ataxia, but it is an appropriate job for a philosopher, who, talking in functional terms and mapping the vision-for-action system onto the dorsal stream, to tell us why pragmatic representations are output incorrectly. And this can be done without taking a stand on the nature/extent of the damage to the dorsal stream.

Using recent neuropsychological evidence that optic ataxia impairs peripersonal space representation (Bartolo et al. 2018), I will show in this paper, why pragmatic representations are output incorrectly by the vision-for-action system. My submission will be that the relevant organizing principle of the vision-for-action system, which is integral to the computations of the system, and which is coded in terms of peripersonal space, is blocked in optic ataxia. Being so blocked, the computations the vision-for-action system runs are wrong, and its output pragmatic representations are consequently incorrectly generated. But if so, then pragmatic representations are mental antecedents of actions at all because this organizing principle is doing its job as a computational premise for the vision-for-action system. This, I will conclude, suggests that the organizing principle is not just any mental antecedent of action, but the immediate one, i.e. in the hierarchy of mental antecedents of action, the principle occupies the lowest level, coming before pragmatic representations in the pecking order.

This paper will proceed as follows. In Section 2, I go over Nanay's account, according to which pragmatic representations are the immediate mental antecedent of action, showing how optic ataxia presents a challenge to it. In Section 3, I characterize the organizing principle of the vision-for-action system which optic ataxia blocks. In Section 4, I discuss the evidence which shows that optic ataxia impairs peripersonal space representation, explaining how the impairment connects to the current debate. In Section 5, I infer from this evidence the conclusion that the organizing principle of the vision-for-action system, not pragmatic representations, is the immediate mental antecedent of action. I give some concluding remarks in Section 6.

## 2. Pragmatic representations as the immediate mental antecedent of action

Philosophers of action and cognitive scientists have suggested different terminologies for the immediate mental antecedent of action. From Myles Brand and Kent Bach, through John Searle and Ruth Millikan, to Pierre Jacob and Marc Jeannerod, 'immediate intentions', 'executive representations', 'intentions-in-action', 'goal state representations', and 'visuomotor representations' have been suggested. Nanay (2013a, 2013c) calls all these different mental states 'pragmatic representations', explaining his choice of terminology by saying that not all his predecessors are clear about whether their proffered terminology captures representational states, and talking about the immediate mental antecedent of action seems to presuppose computationalism/representationalism about the mind.[1] Building some novel features into 'pragmatic representations' that his predecessors' terminologies lack, he submits that pragmatic representations are the first representational states to mediate between sensory inputs and motor outputs: they are the immediate mental antecedent of action.

Pragmatic representations perform this mediating role by attributing 'action-properties', where action-properties are the properties objects have that can't be fully characterized without reference to agents' actions and bodily capabilities (Nanay 2011, 2012a, 2013a). The featural (i.e. locational, size, shape, and weight) properties of your coffee mug that you represent in action-relevant ways in order to pick the mug up are action-properties. Examples of action-properties, therefore, include being pick-up-able, reachable, graspable, and so on. In this way, even though action-properties are characterized as 'featural properties that are represented in action-relevant ways', they differ from featural properties in that they are objective properties in their own rights. Think of this objectivity in terms of being represented in perceptual content. As Nanay (2011) argues, the fact that unilateral neglect patients can describe an object by its action-properties but not its featural properties is evidence that action-properties are represented in perceptual content, where unilateral neglect is caused by brain lesions, primarily in the right parietal areas, making patients become unaware of the contralateral side of their body and environment.

Nanay distinguishes between 'action-properties' and 'thick action-properties', saying that the latter is (i) the experiential component of the former in that while we don't typically experience action-properties, we experience thick action-properties, and (ii) not necessary for the performance of actions, whereas the former is. Your coffee mug has the experiential thick action-property of being something you can drink from, which is not necessary for picking it up. He is unsure whether thick action-properties are attributed by pragmatic representations as well, for that would mean thick action-properties are part of our perceptual phenomenology, a claim he doesn't want to make. Not that thick action-properties can't be part of our perceptual phenomenology but that being attributed by pragmatic representations may not be how they come to be part of it – they may be attributed by another perceptual state. I will respect his intentions and stick to talking in terms of action-properties throughout.

Since action-properties can be represented without hyper-intellectualizing perception, Nanay says pragmatic representations are a good starting place to explain the minds of small children and nonhuman animals, such that pragmatic representations are the first representational states to both phylogenetically and ontogenetically develop. Even before children can perceptually recognize the colors, shapes, sizes, and spatial locations of objects, they can reach and grasp them, and pragmatic representations subtend the success of reaching and grasping. This cross-species characterization of pragmatic representations then gives much plausibility to the view that pragmatic representations are not only prior to belief, desire, and intention in hierarchizing the mental antecedents of action, but also that they occupy the lowest level in the hierarchy, i.e. that they are the immediate mental antecedent of action.

Using some experiments that modify the visual scene, e.g. the prism goggle experiment (Held 1965),[2] Nanay makes some claims about pragmatic representations. In the prism goggle experiment, participants put on a pair of distorting goggles that shifts everything they see to the left and were then asked to throw a basketball into a basket. Though failing miserably the first time, they succeeded after several trials. After taking off the goggles, they had to unlearn throwing the ball towards the left, failing miserably at first but getting it right after several trials. This, Nanay says, suggests that the locational property participants consciously attribute to the basket is different from the one their pragmatic representations attribute to it: after taking off the goggles, they see the basket centrally, but their pragmatic representations continue to represent it towards the left. Thus, pragmatic representations are typically unconscious states.

In addition to being typically unconscious states, Nanay says pragmatic representations are not labile, and their non-lability underwrites how they guide action in a good or bad way. Before and after taking off the goggles, participants were able to successfully throw the ball into the basket after several trials because their pragmatic representations changed during the learning process: 'The mental state that guides their action at the end of the process does so much more efficiently than the one that guides their action at the beginning […] At the beginning of this process, they represent these properties incorrectly; at the end, they do so more or less correctly' (Nanay 2013a, 24). Thus, he submits that pragmatic representations are the full story about the mental states that mediate between perception and action.

Most importantly, Nanay argues that pragmatic representations are genuine perceptual states. For if after taking off the goggles, participants continue to throw the ball towards the old adjusted-to-the-left location of the basket despite seeing the basket in a new more-central location, then there are two perceptual states attributing different locational properties to the basket: 'Our pragmatic representation attributes, perceptually, a certain location property to the basket, which enables and guides us to execute the action of throwing the ball into the basket, whereas our conscious perceptual experience attributes another location property to the basket' (Nanay 2013a, 27). This, he says, aligns with the separation of vision-for-action from vision-for-perception, such that pragmatic representations are outputs of the former, and perceptual experiences are outputs of the latter.

Nanay (2013a, 2013b) warns, however, that we shouldn't equate pragmatic representations with vision-for-action, insofar as vision-for-action is taken to be the functional equivalent of the dorsal stream. As he argues, and rightly so, pragmatic representations are multimodal in that they are not necessarily visual – he talks at length about auditory perceptual representations: the buzz of a mosquito can be pragmatically represented to facilitate slapping the mosquito.[3] Whereas the dorsal or vision-for-action system is a visual subsystem. Though the dorsal stream is also multimodal (e.g. Battaglia-Mayer and Caminiti 2002), Nanay says that evidence that there are crossmodal influences in pragmatic representations (e.g. Stein et al. 2004) and a lack thereof in the dorsal stream (e.g. Rozzi et al. 2008), even more shows that pragmatic representations shouldn't be equated with dorsal representations, however much the dorsal stream is multimodal. Pragmatic representations are not just the outputs of the vision-for-action system.

I agree. But even if pragmatic representations are not just vision-for-action representations, we can talk about them in such terms if we qualify them as 'visual'. That is, we can say, without inviting any rollicking from Nanay, that visual pragmatic representations are the outputs of the vision-for-action system. This leaves room for non-visual pragmatic representations to be the outputs of non-visual systems. In what follows, I will talk exclusively in terms of 'visual pragmatic representations.'

Here then is a question for Nanay: what happens to visual pragmatic representations when the vision-for-action system is malfunctioning? When the vision-for-action system malfunctions due to damage to the dorsal stream, visually guided arm movements become impaired. This condition is called optic ataxia, and generally, vision-for-perception remains unaffected because the damage to the dorsal pathway doesn't affect the ventral pathway. As such, optic ataxia is often contrasted with visual agnosia, which is caused by damage to the ventral pathway, and a fortiori, the vision-for-perception system, such that object recognition and identification become impaired but visually guided arm movements remain intact (Milner and Goodale 1995; Goodale and Milner 2005).

Though Nanay doesn't explicitly say what happens in optic ataxia vis-à-vis visual pragmatic representations – perhaps because his position on the topic is clear given what he says about (visual) pragmatic representations – he is committed to the view that visually guided arm movements are impaired in optic ataxia because visual pragmatic representations are output incorrectly by the vision-for-action system. He won't be wrong, but the accuracy of that statement would depend on whether the relevant computations performed by the vision-for-action system, which subtends how it generates visual pragmatic representations, are correct computations. After all, computations specify maps from input to output representational states (Fodor 1975), doing so by way of some determinate matrices.

It seems clear that the vision-for-action system, just like its vision-for-perception cousin, uses some matrices in its computations (Fodor 1983; Pylyshyn 1999). For an example of such matrices, consider amodal completion, where the vision-for-perception system uses some matrices to perceive the partially occluded figures as hidden behind or covered by the occluder, not as fragments of the foregrounded figures (Brogaard and Chomanski 2015). Also, the vision-for-perception system uses some matrices to understand that objects are uniformly shaded and generally lit from above, not below (Lyons 2016). Thus, matrices are called 'organizing principles' (or perceptual principles) since they enable perception to organize itself, and they are stored in the proprietary databases of perceptual systems (Fodor 1983; Pylyshyn 1999).

What then is the organizing principle of the vision-for-action system? More importantly, since the vision-for-action system uses the principle to generate its outputs, is the principle blocked by optic ataxia, such that we have an explanation for why the vision-for-action system outputs visual pragmatic representations incorrectly? I'll argue positively in what follows. But first, let me characterize the relevant organizing principle of the vision-for-action system.

## 3. The organizing principle of the vision-for-action system

As Fodor and Pylyshyn explain it, organizing principles are evolutionarily and developmentally acquired, i.e. they have been purpose-built into the operations of perceptual processing mechanisms over time by evolution, which is why they are clamped in the mechanisms' databases. If so, then to identify the organizing principle of the vision-for-action system, we must consult developmental studies of vision-for-action (e.g. McDonnell 1975; Bower 1976; von Hofsten 1979; Tröster and Brambring 1993; Schneiberg et al. 2002) and see whether there are any such evolutionarily and developmentally acquired principle(s) that aid the vision-for-action system in organizing itself.

Like their neurocognitive counterparts (e.g. Goodale and Milner 2005; Jacob and Jeannerod 2003), developmental studies of vision-for-action also talk exclusively in terms of reaching and grasping, and according to them, the visual guidance of reaching and grasping takes about 21 weeks after birth to develop, from around week 15–36: 'The rather crude and awkward reaching at 15 weeks gives way to smooth and efficient reaching at the end of the period' (von Hofsten 1979, 174). Simply, at week 36, when infants gain motor control, the visual guidance of reaching and grasping is dropped, and the pattern of movement involved therein has become hardwired into the operations of the vision-for-action system. Tröster and Brambring put it best: 'By the end of this learning process, the sequence of movement has become almost automatic so that continuous visual feedback is no longer necessary' (1993, 84).

This sequence of movement is coded in terms of 'peripersonal space', where peripersonal space is 'the space immediately surrounding the body [that consists] neither in the perception of one's own body nor in the perception of far space, but stands in between' (de Vignemont 2021, S4027 & S4028). In this way, the presentation of objects within peripersonal space has a visuomotor format (Bourgeois and Coello 2012), and, so, when vision reaches functional maturation at about 18 months, i.e. when its functional properties become adult-like (Zimmermann et al. 2019) – although anatomical maturity still continues for about 7 years (Kozma, Kovacs, and Benedek 2001) – the information/datum 'objects presented within peripersonal space are reachable and graspable' has become a matrix that the vision-for-action system uses in its computations. Put differently, the information/datum has become a principle used by the system to organize itself, i.e. it has become an organizing principle stored in the vision-for-action system's proprietary database.

This precisification in terms of peripersonal space helps to extend our analysis beyond vision, which is always desirable. The brain area dedicated to peripersonal space representation is the ventral premotor cortex (vPMC) or area F4, which is part of the frontoparietal network (Graziano, Hu, and Gross 1997). Since this network brings together multisensory neurons in that the neurons respond to tactile, visual, and auditory stimuli presented close to the body (e.g. Duhamel et al. 1997; Graziano, Reiss, and Gross 1999; Schlack et al. 2005), tactile and auditory systems [or their subsystems that are dedicated to action-guidance (see, e.g. Hickok and Poeppel [2007] for evidence of dissociation in terms of ventral and dorsal for touch)] also have the same (or similar) organizing principle. To continue to talk in terms of visual pragmatic representation, however, I will limit myself to the vision-for-action system.

I do not mean, however, that this organizing principle 'objects presented within peripersonal space are reachable and graspable' is the only one there could be for the vision-for-action system. Rather, I mean that for our purpose, which is to show what exactly is wrong in optic ataxia vis-à-vis the mental antecedents of action, the principle is important and relevant. How so? Because recent evidence has emerged that optic ataxia impairs peripersonal space representation, and since this organizing principle is encoded in terms of peripersonal space, this evidence from optic ataxia suggests that the principle is blocked from being used as a computational premise by the vision-for-action system. So blocked, it renders the computations of the system incorrect, causing it to incorrectly generate its output visual pragmatic representations. What evidence?

## 4. Optic ataxia and peripersonal space

It has always been suspected that since optic ataxia is an impairment of visually guided reaching and grasping movements, it must have something to do with peripersonal space. However, whether optic ataxia affects peripersonal space representation has been left unexplored until very recently (Bartolo et al. 2018). Bartolo et al.'s study centers around patient IG, a 33-year-old woman, whose posterior cerebral arteries are damaged due to an ischemic stroke. As a result, she has difficulty performing reaching and grasping tasks with her right hand. During these tasks, her hand posture was often inappropriate in terms of aperture and orientation. Simply, she has optic ataxia.

Though IG was tested for both motor and perceptual tasks, I will only discuss the motor task here since our target is peripersonal space and the role it plays in reaching and grasping arm movements. The experiment is set up such that 13 green LEDs, 2.5 cm from each other, are placed along the mid-sagittal body axis, and projected on a screen. IG and the control group (HC) (hereafter, I use 'participants' when I mean both IG and HC) were seated on a chair such that the maximum distance reachable with the arm (i.e. peripersonal space) matched the central stimulus (0 cm). The 13 stimuli were spread out linearly to within 30 cm of the participants, 15 cm on either side of the central stimulus. The motor task IG performed involved a hand-to-target manual reaching task, which was executed while freely gazing at the visual stimulus (Free gaze condition) or fixating on a proximal or distal visual target (Fixed gaze condition). The proximal and the distal visual fixation points (red color LEDs) were located respectively 17.5 cm at both ends of the maximum reachable distance. (Figure 1)

In both Free and Fixed gaze conditions, manual reaching movements were triggered by 3 visual targets located along the mid-body sagittal axis within peripersonal space. The visual targets were presented 8 times each in a random order for a total of 24 trials, and participants were requested to reach out and touch the green target with

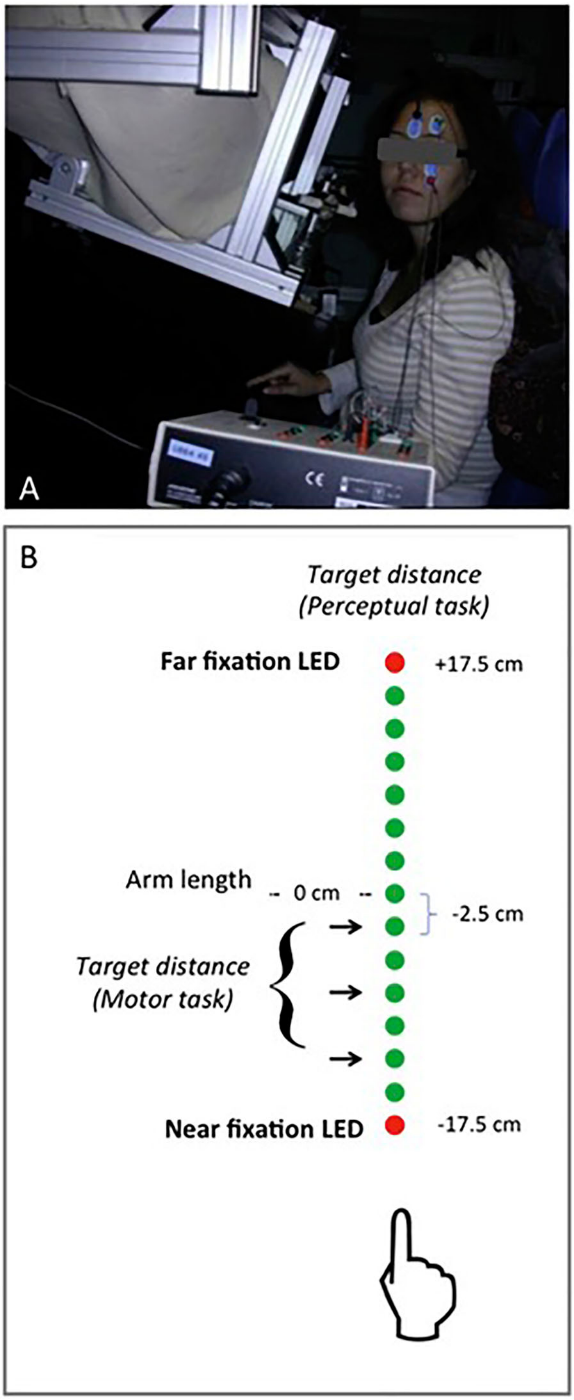


**Figure 1.** IG and the motor task on which she was tested. Reprinted from Bartolo et al. (2018), Copyright (2018), with permission from Elsevier.

their right index finger as quickly as possible, returning to the default position after completing the movement. For the Fixed gaze condition, the red fixation stimulus was turned on briefly for about 2 s before the green visual target appeared on the screen. Thus, they performed manual reaching movements for 3 stimuli locations, for 2 fixation conditions, in 8 iterations, resulting in a total of 48 trials.

What Bartolo and colleagues discovered was that when participants were asked to fixate on the red LED, either in Fixed near or Fixed far conditions, the boundary of peripersonal space increased for IG but not HC: there was 'an overestimation of nearly 10 cm in the Fixed far condition compared to 1.8 cm in the Free gaze condition [and the reaction time] for stimuli at the boundary of reachable space was registered in the Fixed far (3313 m) and Fixed near condition (2875_ms) compared to the Free gaze condition (2756 m)' (Bartolo et al. 2018, 110). This finding that IG presents difficulty with reaching movements only when fixating on a target is not new; it is widely reported that optic ataxics only present difficulty in performing reaching movements in peripheral, not central, vision (Perenin and Vighetto 1988; Rossetti et al. 2010). What is new is the overestimation of the boundary of peripersonal space when IG fixates on a target. Thus, Bartolo et al. conclude:

> This indicates that in optic ataxia patients, the difficulty in estimating reachability does not result from a specific motor deficit, but rather from the difficulty of processing visual information in relation to the motor system, which contributes to the encoding of peripersonal space […] This provides new insight on optic ataxia, by […] revealing a novel impact of optic ataxia on combining information from the upper and the lower visual fields, specifically in altering the representation of peripersonal space. This confirms the determinant role of the visual dorsal stream in the perception for action […] Another original finding is that deficits in processing information in peripheral vision in optic ataxia substantially affect the perception of what is reachable in peripersonal space. (2018, 110)

If so, and since the organizing principle of the vision-for-action system – namely, 'objects presented within peripersonal space are reachable and graspable' – is coded in terms of peripersonal space (Section 3), then optic ataxia undoubtedly impairs it. Now, this impairment may be that the principle is blocked from being used as a computational premise by the vision-for-action system, or it may be that is used but erroneously, and there seems to be no principled reason for choosing between these options. Put differently, either works just fine for our purpose. That said, the former but not the latter seems to stop further questions. For instance, saying the principle is erroneously used seems to invite queries like 'what other premise(s) is involved in the computation, and how does the impairment of peripersonal space representation thwart the combination of the premise(s) with our organizing principle?'. To sidestep this sort of query with which we needn't get entangled, I will continue to talk in terms of the principle not being used at all as a computational premise by the vision-for-action system.

Consequently, so blocked (or, so erroneously used, if you prefer), the vision-for-action system computes wrongly and outputs visual pragmatic representations incorrectly. Notice how this corroborates my claim that we can say why the vision-for-action system outputs visual pragmatic representations incorrectly without taking a stand on the nature/extent of the damage to the dorsal stream (Section 1) – the exact extent of the damage to the dorsal stream hasn't been discussed here. Let's return to the immediate mental antecedent of action.

## 5. The immediate mental antecedent of action

Now that we know why the vision-for-action system generates visual pragmatic representations incorrectly, might it be that visual pragmatic representations are not the immediate mental antecedent of action after all? For if the reason they are mental antecedents of action at all is that the organizing principle 'objects presented within peripersonal space are reachable and graspable' is doing its job as a computational premise for the vision-for-action system, then, indeed, it seems visual pragmatic representations are not the immediate mental antecedent of action. It seems this organizing principle is. I argue for this claim in the remainder of this section.

It is clear from Section 3 that the principle plays a computational role in the generation of visual pragmatic representations. Why give it any other role, it might be asked? Why say it is also a mental antecedent of action at all? After all, haven't I conceded that there might be other organizing principles that play the same computational role for the vision-for-action system (Section 3)? What makes the principle 'objects presented within peripersonal space are reachable and graspable' special? It is special because we have evidence that it is necessary for the performance of visually guided arm movements – take it out, as in optic ataxia, and difficulty is faced in performing the movements (Section 4). Whereas we have no evidence that any other organizing principle(s) of the vision-for-action system, if there such be, is necessary for the performance of visually guided arm movements.

But why think the principle's mediating role is more fundamental than visual pragmatic representations'? Because by playing its mediating role, it also plays a causal role in the generation of visual pragmatic representations. The correctness and incorrectness of visual pragmatic representations depend on whether the principle does its job. Even so, why think its fundamental role extends beyond optic ataxia, applying to everyone? Because the methodology of cognitive neuropsychology allows us to infer mental structure from brain-damaged subjects (Glymour 1994; Lyons 2001; Nanay 2012b), such that if it plays such a role for optic ataxics, then it plays the same role for everyone. Lastly, why think its fundamental role extends to nonhuman animals? Because visual pragmatic representations are cross-species mental states (Section 2), and this organizing principle is why there are correct visual pragmatic representations at all. In short, the organizing principle passes as the immediate mental antecedent of action.

But if so, does it meet the necessary and sufficient conditions Nanay gives for being the immediate mental antecedent of action, which were enumerated in Section 2? It does. According to him, these conditions include being non-conceptual, being typically unconscious, being perceptual, being non-labile, being evolutionarily/developmentally prior to other mental antecedents of action, and being necessary for action performance. I will show not only how our organizing principle meets all these conditions, but also how, contrary to Nanay, visual pragmatic representations do not meet all of them. In so doing, I will recharacterize the necessary and sufficient conditions for being the immediate mental antecedent of action.

First, Nanay says the immediate mental antecedent of action need not be propositional attitudes, understood in terms of having conceptual content. His reason is that nonhuman animals and small children also perform actions, and they lack concepts. Clearly, our mental attitude towards the datum 'objects presented within peripersonal space are reachable and graspable' is not conceptual. It is an assumption our vision-for-action system makes about the world that underwrites its non-accidental reliability, which we typically don't make, at least not unless one is trained in perceptual psychology. My infant son's vision-for-action system operates under the same assumption, yet he neither makes any assumption about the world nor has any concepts.

Second, Nanay says the immediate mental antecedent of action is typically an unconscious mental state. This follows from the above for our organizing principle. If it is an assumption the vision-for-action system makes about the world that agents typically don't make, then it is typically unconscious. Like visual pragmatic representations, the principle is to be attributed to the relevant perceptual system, not agents.

Third, Nanay says the immediate mental antecedent of action must be a perceptual state. It goes without saying that the organizing principle of the *vision*-for-action system is a perceptual state.

Fourth, Nanay says the immediate mental antecedent of action must not be labile, such that its non-lability underwrites how it can correctly or incorrectly guide the performance of action. Since organizing principles are evolutionarily and developmentally acquired, they can change but the change they undergo is a slow and arduous one that involves a large amount of repetition. This enables them to not be sensitive to new evidence agents may possess. As Lyons puts it: 'even if I learn that things here are lit from below, this won't affect visual processing [which assumes that things are generally lit from above], in part because I can't change the weights in my visual system in response to this new knowledge' (2016, 254). Similarly, the datum 'objects presented within peripersonal space are reachable and graspable' doesn't immediately respond to new evidence. It doesn't matter what you come to believe about objects in your peripersonal space, your vision-for-action system will still use the datum to run computations. In fact, since the datum plays a computational/causal role in the generation of visual pragmatic representations, it follows that the reason visual pragmatic representations don't immediately respond to new evidence is that the datum, ab initio, doesn't so respond.

All this takes us back to the hierarchical structure of mental antecedents of action (Section 1). Nanay says visual pragmatic representations occupy the lowest level in this hierarchy, i.e. no representational state that mediates between perception and action occupies any lower level. But if what I've said so far is correct, then there is one more level below visual pragmatic representations, and its occupant is the vision-for-action system's organizing principle.

It might be said that one reason Nanay says visual pragmatic representations occupy the lowest level in the hierarchical structure is that they are the first representational states to both phylogenetically and ontogenetically evolve. Even this doesn't seem right. Information travels from the retina to the visual cortex through the magnocellular (M) and parvocellular (P) pathways, with the dorsal or vision-for-action system receiving more inputs from the M than the P pathway (Milner and Goodale 1995).[4]

Although the available evidence is from macaque monkeys, not from infant humans, there is a consensus that the M pathway develops faster than the P pathway (e.g. Mates and Lund 1983; Distler et al. 1996). The evidence is that macaque monkeys' M cells are nearly adult-like by week 4, an age that is comparable to a 4-month-old human. This then suggests that the vision-for-action system is up and running at about week 16, coinciding with when human infants start to learn motor control – as I've said

(Section 2), this learning period spans from week 15–36. If so, then the vision-for-action system doesn't start outputting visual pragmatic representations until the end of week 36 even though it is up and running at about week 16. Were that not the case, there wouldn't be any need for the vision-for-action system to learn the pattern of movements involved in reaching and grasping. Human infants would just go from being unable to reach and grasp objects to being experts at reaching and grasping movements at week 15 (or week 36?), skipping the learning process altogether.

This aligns with other psychophysical studies (Dobkins, Anderson, and Lia 1999), according to which there is a significant difference between the M pathway of a 16-week-old human and that of an adult human. That is, even though the vision-for-action system is up and running at about week 16, it doesn't start functioning to its full capacity until much later, sometimes before adulthood. Learning the sequence of movements involved in reaching and grasping enabled the vision-for-action system to develop its organizing principle, and it wasn't until this principle has been clamped in the system's database that the system starts to correctly generate visual pragmatic representations. If so, then to the extent to which this evolutionary/developmental priority thesis is why a given mental state type is postulated as the immediate mental antecedent of action, the organizing principle of the vision-for-action system is that mental state.

Though Nanay doesn't say so explicitly, he also takes this evolutionary/developmental priority thesis to suggest the causal priority of visual pragmatic representations, i.e. in terms of occurrent action performance, visual pragmatic representations are prior to any other mental antecedents of action. He then takes this causal priority thesis to cement the place of visual pragmatic representations as the immediate mental antecedent of action, i.e. they are the first mental state to mediate between perception and action whenever actions are performed. It is clear by now, that this is not so. The first mental state to mediate between perception and action whenever actions are performed is the organizing principle of the vision-for-action system. As I've said, and it bears repeating, the reason there are visual pragmatic representations at all is that the principle is doing its job as a computational premise for the vision-for-action system. If the principle is blocked from doing its job, actions are performed wrongly. Put simply, the principle is causally prior to visual pragmatic representations. If so, then to the extent to which causal priority thesis cements the place of a mental state type as the immediate mental antecedent of action, the organizing principle of the vision-for-action system is that mental state.

Lastly, Nanay says that visual pragmatic representations are the immediate mental antecedent of action because they are necessary for action performance. He is correct on this point: you can't pick up your mug if you don't visually pragmatically represent the mug's action-properties. But a mental antecedent of action can be necessary for action performance without being the first mental state to be triggered in the mental sequence that leads to action. For one, being necessary for action performance, unlike, being the first mental state to be triggered in an action sequence, is not temporal. Were it so, only my organizing principle, which has been shown to be evolutionarily, developmentally, and causally prior to Nanay's visual pragmatic representations would be necessary for action performance.

In sum, being evolutionarily, developmentally, and causally prior to other mental antecedents of action is the only necessary condition for being the immediate mental antecedent of action; being perceptual, being typically unconscious, being non-conceptual, being non-labile, and being necessary for action performance are sufficient but not necessary. As we've seen, Nanay's visual pragmatic representations meet the sufficient but not the necessary condition. Whereas my organizing principle meets both the necessary and sufficient conditions.

## 6. Concluding remarks

I began by saying that if visual pragmatic representations are the immediate mental antecedent of action, then the reason optic ataxics face difficulty in performing reaching and grasping actions must be that their visual pragmatic representations are output incorrectly by their vision-for-action system. Since the vision-for-action system performs some computations to generate its outputs, we are owed what computational fault led to the incorrect generation of visual pragmatic representations. I argued that the faulty computation is down to the organizing principle of the vision-for-action system, which optic ataxia blocks. This blockage ensures that the principle isn't used by the system to generate visual pragmatic representations, and, so, they are incorrectly generated. Following the methodology of cognitive neuropsychology, which allows inferring mental structure from lesion cases, I argued that if this principle plays this role for optic ataxics, then it plays the same role for everyone, and, so, it, not pragmatic representations, is the immediate mental antecedent of action.

Outside its role as the immediate mental antecedent of action, this organizing principle plays other roles. For instance, it helps to give a foundationalist account of modal justification, á la Lyons' (2009, 2016) and Ghijsen's (2021) foundationalist accounts of perceptual justification. According to them, subpersonal assumptions of perceptual systems – i.e. other organizing principles – are used as evidence when the systems generate high-level representational states. For instance, the assumption that 'objects are generally lit from above' is used as evidence by my visual system when it outputs the high-level representational state that 'the light is on in the room'. For Lyons, even though there is a basing relation here – i.e. the high-level representational state is evidentially based on the organizing principle – the high-level representational state is still foundationally justified. His reason is that the organizing principle lacks justificatory status. This, for Lyons, ends any justification regress. Ghijsen argues differently: he says organizing principles have justificatory status, but the foundational justification of high-level representational states is not thereby threatened. His reason is that the justificatory status of organizing principles was reliably – perhaps evolutionarily – acquired in the first place. So, justification isn't also threatened by any regress here. Whoever is right between Lyons and Ghijsen, the important point is that the organizing principle of the vision-for-action-system 'objects presented within peripersonal space are reachable and graspable' is used as evidence in the generation of high-level representational states. This would be a foundationalist account of perceptual modal justification. I'll give a defense of it in future works.

In addition, the principle also explains why intentions aren't needed before agents are affected by the reach- and grasp-fostering features of objects: 'a viewer is being affected by grasp-related properties of an object, which he/she has no intention of grasping' (Ellis and Tucker 2000, 466; fn. 3). We saw earlier that area F4 is the brain area dedicated to peripersonal space representation (Section 3), and it has been reported that once objects are within peripersonal space, even when they are stationary, F4 neurons fire (Graziano, Hu, and Gross 1997). If so, then when you see your coffee mug, such that you represent it as being within peripersonal space, F4 signals are broadcast to your vision-for-action system, activating the organizing principle that 'objects presented within peripersonal space are reachable and graspable'. In this way, at stimulus onset, you see the mug as reachable and graspable immediately – á la its colors, shape, size, and location – even though you have no intentions to reach, grasp, and pick it up. Simply, the mere fact that an object is presented within peripersonal space is sufficient for representing its reachability and graspability properties.

The result is that this organizing principle – objects presented within peripersonal space are reachable and graspable – is central to understanding different aspects of the vision-for-action system specifically, and perceptual systems generally, as well as what roles the systems play in our cognitive framework.

## Notes

1. Of course, one can be an anti-representationalist/enactivist about vision-for-action (e.g., Ballard 1996; Noë 2005), but that would mean cutting out any mediators between perception and action since sensory inputs and motor outputs would now be intertwined in a dynamic process. Talk of the mental antecedent of action is precisely about those mediators, and, so, anti-representationalism can be safely ruled out.
2. He also enlists some optical illusions to this end, especially the 3D version of the Ebbinghaus illusion (Milner and Goodale 1995), whereby a poker-chip surrounded by smaller poker-chips appears to be larger than when it is surrounded by larger ones. The prism goggle experiment suffices for our purposes here, however.
3. Although, as Nanay argues, things are much more complicated. It is also coherent to say that the pragmatic representations attribute the buzz to the spatiotemporal region, guiding where, not what, you slap.
4. The ventral system, however, gets as much inputs from the M as it does from the P pathway (Milner and Goodale 1995).

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No potential conflict of interest was reported by the author(s).

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