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INTRODUCTION

The enactive theories of perception compose a group that textually appeared as such during the course of the last 35 years or so and are conceptually interrelated mainly by their common presupposition that perception is intrinsically bound to agency. The term ‘enaction’ was coined, as relative to this context, by Varela et al. in their 1991 book ‘The Embodied Mind’. Accordingly perceptual content is always enacted by an embodied agent. This enaction gives rise to the ‘world’ of the perceiver the constitution of which is conceived in a radical constructivist manner. That is, as the agent’s specific environmental whereabouts produced by that very agent’s perceptual structure and function which itself (the perceptual apparatus) is bound to executive output. According to the earlier work (1980) of Maturana and Varela, this structure is self-referential in nature. It is an expression of the organism’s biological autonomy or its autopoietic character: its basic function is to produce the components of this very function. The functional circularity of the embodied agent has one and only fundamental role: its perpetual self-production. And the historical constitution of this self-referential function predetermines what this agent can perceive. Autopoietic theory is a direct descendant of cybernetic theory and it can also be viewed as building on

1 For details on radical constructivism epistemology see Reigler (2005).
2 This concept of ‘world’ has its historical precedent in biology in the concept of ‘umwelt’ in the work of theoretical biologist J. von Uexküll: “all that a subject perceives becomes his perceptual world and all that he does, his effector world. Perceptual and effector worlds together form a closed unit, the Umwelt” (Uexküll 1957: 6 quoted in McGee 2005: 27). In philosophy this concept relates with Heidegger’s notion ‘in-der-Weltsein’ (being-in-the-world). On Heidegger’s reading of Uexküll and the difference between their respective accounts see Malpas (2012), also Chien (2006). See also Elden (2006) for a relevant discussion of Heidegger’s views on ‘animality’ and ‘worldliness’.
3 The longer definition is: ‘An autopoietic machine is a machine organized (defined as a unity) as a network of processes of production (transformation and destruction) of components that produces the components which: (i) through their interactions and transformations continuously regenerate and realize the network of processes (relations) that produced them; and (ii) constitute it (the machine) as a concrete unity in the space in which they (the components) exist by specifying the topological domain of its realization as such a network. It follows that an autopoietic machine continuously generates and specifies its own organization through its operation as a system of production of its own components, and does this in an endless turnover of components under conditions of continuous perturbations and compensation of perturbations.’ Maturana &Varela (1980: 78-79)
4 Meaning here the organism’s empirical composure as it was built phylogenetically by evolution and ontogenetically by its personal life history.
Piaget’s developmental psychological constructivism. As Piaget maintained: ‘intelligence organizes the world by organizing itself’.\(^5\)

Another precedent of enactive approaches is the ecological theory of perception of James Gibson (1979). He upheld that perception is the process of extraction of observable invariants via the variance of the optic array as it is accomplished (the variance) by movement. The animal recognizes environmental invariant characters that are of practical use to it, that afford a use to the animal. In this reciprocal way the environment is for the animal and animal is for the environment.\(^6\)

Overall the enactive approaches share a commitment to the following presuppositions:

1. That perception and action are constitutively interdependent.
2. That ‘vehicles of perception are distributed across brain, body and world’.\(^7\)
3. That perceptual content is radically externalist in nature.
4. That this perceptual content has a reciprocal constitutive relation with the embodied subject that is intentionally directed to it.

I will not engage into a direct discussion of either Gibson’s account or the autopoietic strain of enactivism. This is not because of their being of lesser importance for my argument. On the contrary, enactivism can be regarded as a continuation of Gibson’s efforts or as a series of commentaries and developments on ecological theory. And the tradition in cognitive science and philosophy of mind that was born out of Maturana and Varela’s ‘autopoiesis’ offers a decisive ingredient in the core of the sensorimotor problematic, that of the intrinsic self-production of the cognitive agent. But space limitations are constraining me to leave this exciting issues largely unexamined.

Instead I chose to present and offer constructive criticism on two other of the main protagonists of this literature. I will enter the tangle of problems that this study wants

\(^5\) (Piaget 1955: 311 quoted in McGee 2005: 21) For a discussion on the historical theoretical dependence of enactive cognitive theory on Kant’s theory of schematism see also the same article.

\(^6\) Concerning the term affordance Gibson writes: ‘[t]he affordances of the environment are what it offers the animal, what it provides or furnishes, for good or ill. The verb to afford is found in the dictionary, but the noun affordance is not. I have made it up. I mean by it something that refers to both the environment and the animal in a way that no existing term does. It implies the complementarity of the animal and the environment.’ (Gibson 1979: 127)

\(^7\) (Gangopadhyay & Kiverstein 2009: 64)
to raise and to some extent try to solve with Susan Hurley and more specifically with her notion of *non-instrumental interdependence of perception and action*. Her grounding of this interdependence on the subpersonal level constitutional input-output interdependence will be viewed as necessary but not sufficient for the first-personal level perception-action interdependence. That sufficiency can only be provided, as I argue, through an exposition of their constitutive interdependence at the first-personal level itself by a phenomenological analysis of perceptual and intentional acts.

In the second part I examine Alva Noë’s notion of the *virtuality* of perceptual content. By interpreting his relevant concept of *free access* according to the proposed motif of *expectation fulfillment* I suggest that the problem of the virtuality of content should be interpreted as the problem of the constitution of the *temporally enduring perceptual object*. An efficient way to work out this issue is by appealing to the Husserlian account of perception. By a constructive reading of Husserl’s notions of *motivation* and *kinesthesia* we can arrive at the *subjective temporal self-relating core* of perceptual and motor acts. It is this functional temporal self-relatedness, described exclusively on the first-personal descriptive level, that finally offers us the sought after first-personal non-instrumental interdependence of perception and action. Augmented by this notion the sensorimotor approaches, as I also suggest, can have a better understanding of the neuroscientific explanandum and thus be better informed in their potential epistemological role. Some empirical literature is reviewed at the closure of the study in support of my case.

**A. SUSAN HURLEY’S NOTION OF NON-INSTRUMENTAL INTERDEPENDENCE**

**A1. THE TRADITIONAL VIEW REGARDS PERCEPTION AND ACTION AS SEPARATE AND PERIPHERAL**

Susan Hurley (1998; 2001) introduces the notion of non-instrumental interdependence of perception and action in defense of her criticism of what she calls the classical or traditional view of the mind. The classicality of this view consists in conceiving the mind
as hierarchically structured and tripartite: perception is dominant over action and both are viewed as peripheral to a kind of centrally situated cognitive faculty. The causal flow of signals in the case of such a model is strictly linear, beginning with the environment through perception to central cognition for computation, the results of which pass to motor output and finally back to the environment. Hurley calls this the Input-Output Picture.

The classicality of this approach refers also to the kind of treatment information assumes in the cognitive faculty, that is representational syntactic symbol manipulation: internal representations with symbolic properties are syntactically manipulated and the outcome of this manipulation is fed to motor commands. So Hurley names this traditional model the ‘classical sandwich’ view as well. Through these features of centrality of cognition, linearity of information flow and representationalism of cognition the mind is viewed as a tripartite structure with peripherally situated slices of perception and action squeezing centrally a symbol processing cognitive faculty (see 2001: 3-4).

So according to this traditional view ‘perception’ and ‘action’ are separate and delimited unities mediatelly affecting each other through cognition and environment. Their relationship is instrumental: ‘perception is a means to action and action is a means to perception’ (Ibid.: 12). The contents of the unitary perceptual module are varied by the means of motor activity and the contents of the unitary intentional module are varied by the means of perceptual receptivity. We notice here a functional interdependence of perception and action but this interdependence is merely an instrumental interrelation of two separately interacting modules.

Hurley believes that this view is theoretically assailable. It is also empirically unsustainable as she painstakingly goes on to show.

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8 ‘Intentional’ in the practical sense not in the Brentanian or Husserlian sense of ‘aboutness’ of mental acts in general. Because I want this study to deliberately have an interdisciplinary character and textually move between phenomenological, analytical and neuroscientific literature, ambiguities in terms will be noted as we go. Sometimes I will let the context to specify the sense of the term.
From a theoretical point of view this traditional view begs the question because if horizontal sensorimotor processes can offer an account of emergent cognitive abilities (Ibid.: 10) why the added explanatory complexity of an allegedly separate internal symbol-manipulating vertically-modular cognitive subsystem? The projected isomorphism from our personal level qualitative differences between our perceptions, intentions, thoughts and reasoning to the sub-personal vehicular processes that condition this compartmentalization of subjective experience, is illegitimate as Hurley does take pains to illustrate (Ibid.:3).10

For example, in a connectionist framework one could find the theoretical background and empirical evidence for emergent conceptualizing abilities of pattern recognition and quasi-symbol manipulation (linguistic abilities), that spring forth out of non-linear distributed neural network processes. Why should we not develop this bottom-up account in the hope of explaining the apparent vertical modularity of the personal level instead of arbitrarily imposing this verticality to sub-personal processes, especially when experimental evidence speaks otherwise? A horizontal modularity, as Hurley suggests, of parallel closed-loop dynamic sensorimotor layers that are content or task specific could give rise to emergent rationality via their intermodulation.11 In fact recent neurophysiological research on vision seems to support such a view: talk of at least two functional systems for vision, one dedicated to recognition of task-specific objects (a ‘what’ subsystem) and one dedicated to their location in the egocentric space and the computation of motor commands for these objects’ real-time practical manipulation (a ‘where’ or ‘how’ system).12 Hurley elaborates on additional evidence for the role of

9 ‘If the classical structure of an internal ‘language of thought’ could explain the properties of cognition, why in principle couldn’t the classical structure of natural language do so without the extra inward step?’ (Ibid.: 6)
10 Also: ‘At the personal level, we distinguish between a person’s perceptions, her reasoning, her intentions. Vertical modularity finds similar distinctions at the level of subpersonal functions and causal processes. It may be natural to assume such an isomorphism between one level of description and another.’ (Ibid.: 8)
11 ‘…rationality might emerge from a complex system of decentralized, higher-order relations of inhibition, facilitation, and coordination among different horizontal layers, each of which is dynamic and environmentally situated’. (Ibid.: 10)
12 ‘Each layer or horizontal module is dynamic, extending from input through output and back to input in various feedback loops. Layers are dedicated to particular kinds of task. One network, for example, may govern spatial perception and the orientation of action (the so-called ‘where’ system). Another may govern food recognition and acquisition-type behavior (part of the so-called ‘what’ system). Another may govern predator recognition and fleeing-type behavior (another part of the ‘what’ system). Another may govern some of the variety of imitative responses to the observed behavior of others, and so on. Evolution and/or development can be seen as selecting for each layer.’ (Ibid.: 8)
action in perception and of sensorimotor processing in higher cognitive capacities relevant to neuropsychology cases, some of which will be discussed in the next sections.

Hurley’s positive contribution is the elaboration of the theoretical framework for perception-action constitutional interdependence. Accordingly, the examination of this constitutional interdependence will help topple the traditional view by negating all three of its basic presuppositions: centrality of cognition, representationalism and linearity of informational flow. The royal route for such a toppling will be the disproof of the last presupposition. Informational flow is non-linear and the perception-action interdependence is not instrumental.

In what follows I will examine Hurley’s non-instrumental interdependence for the purpose of highlighting it as a fundamental notion of the sensorimotor or enactive approaches to mind. This notion, as the one of ‘virtuality’ in the work of Alva Noë which will be scrutinized in the second part of this study, delimit the hard-core issue of the constitutional interrelation of perceptual and intentional aspects of the mental act in general, as I will try to show. Hurley’s account focuses on the sub-personal aspect of this constitutional interrelation whereas Noë’s account, as I interpret it, focuses on the personal level. Hurley’s non-instrumental interdependence of afferent and efferent components constitutive of the cognitive act as such (whether perceptual or intentional), ignores the possibility that there could be a first personal or phenomenological non-instrumental interdependence. Hurley passes over a phenomenological analysis of perception and action, an analysis which, as I intend to show, reveals their direct and exclusive constitutional interrelation. The theoretical elaboration of this interrelation can be gained by a Husserlian reading of Noë. This reading will hopefully show that the content of perceptions is as much the product of the temporal self-relating activity of the subject as is the content of intentions. This

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13 ‘The third line of resistance to the classical sandwich disputes the separateness of perception and action rather than focusing on cognition and its purported classical or central character. Instead, the third line of resistance works from the outside in. It focuses on the supposed periphery, and criticizes the traditional conception of perception and action. It is this third line of resistance that I want to pursue here.’ (Hurley 2001: 4)
temporal self-relatedness explains by laying out their common ground the personal level non-instrumental interdependence of perception and action, as much as the Hurleyan dynamic sensorimotor singularity explains in an analogue way the sub-personal non-instrumental interdependence.

**A2. PERCEPTION-ACTION NON-INSTRUMENTAL INTERDEPENDENCE.**

As noted above an instrumental interdependence of perception and action is compatible with the traditional view or the Input-Output picture. This traditional view maps the personal level perception-action dichotomy onto a subpersonal input-output dichotomy. This personal-subpersonal level *isomorphism* turns into the view that the only functional\(^{14}\) relationship that can take place subpersonally is that variation in output causes variation in input and vice versa. Thus this reciprocal and instrumental cross-variation is compatible to the traditional view of externally interacting perceptual and action modules that Hurley intents to overcome.

Her basic stratagem is to show that perception as well as action are causally dependent on subpersonal processes that are characterized by a constitutional and not merely instrumental relation between input and output. It is this constitutional interdependence of the subpersonal inputs and outputs that she has in mind when she speaks of non-instrumental interdependence even on the personal level. That is, personal level perception-action interdependence is based on both perception and action *having causal dependence* on that vehicular input-output constitutional interdependence.\(^{15}\) For Hurley perception-action constitutional interdependence in actuality would mean that they both spring from the same subpersonal constitutional

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\(^{14}\) The use of the term ‘functional’ throughout the study should not be regarded as referring to the philosophical current of ‘functionalism’. My use of the term refers only to mere dynamic relations between different parts which by this dynamic relation form a kind of unity that might be named loosely as a function. I will use the term for the subpersonal but also later on sometimes for the personal level of description for the purpose of indicating a kind of structural analogy between the two levels in the specific context of my problematic of act self-referentiality. Whether or not my account might be viewed as a variety of ‘functionalism’ is an irrelevant matter for my thesis and will not concern me here. I should only mention that my account could envelop a notion of *multiple realization* of act self-referentiality by different physical systems but it does not conceive this act quality in internalistic token-identity terms. I believe that the term ‘function’ is also used by Hurley in the sense that I specify.

\(^{15}\) ‘Suppose that that the personal-level contents of both perceptual experience and intentions can in general be functions of the subpersonal *relation between* input and output, such as the relation that holds within a complex dynamic feedback system. Then the contents of perceptual experience and of intention will be essentially interdependent’ (Hurley 1998: 339)
sensory input-motor output interdependence. A personal level examination of any alleged constitutional interdependence is not carried out by Hurley and this point and its consequences is going to be stressed out later in this study. For the present lets follow Hurley’s stratagem in more detail.

A2.1 NON-INSTRUMENTAL INTERDEPENDENCE OF PERCEPTION ON OUTPUT
There is strong empirical evidence against the Input-Output Picture that comes from neurological and neuropsychological cases. These are discussed in essay 9 of the 1998 book and involve commisurotomy, deafferentation and unilateral neglect neurological cases and neuropsychological cases such as the ‘Paralyzed Eye’, the Tactile Visual Substitution System and Spectrum Reversing Goggles. We proceed by examining some of the these cases.

a. The Paralyzed Eye case
In the case of oculomotor paralysis when the subject tries to move her gaze to the side, the visual field seems to move to that same side (1998: 344). The observed world moves to the side regardless of the fact that the eye remains stationary and the retinal pattern of stimulation unaltered. That is, the perceptual content varies not with variation of input but with variation of output, if by output we understand not the overt movement which is here absent, but the internal motor command that is (neuronally) issued. Relevantly, it has been argued that the presence of an internal motor command has a direct (that is, not merely instrumental) influence in the vehicular processes responsible for the phenomenology of this case. Perceptual content depends non-instrumentally on output or on some as yet unidentified subpersonal process that constitutively binds input and output.

b. T.V.S.S.
Bach-Y-Rita (1983) described and produced a device that substituted visual for tactile input (Tactile Visual Substitution System) in patients with congenital and early acquired blindness. It was implemented by mounting a camera on the subject’s body, which
camera was controlled voluntarily by him, and the visual information received by it was fed to a ‘matrix of mechanical or electronic fingers that stimulate the skin in accordance with patterns of light stimulation received by [the] moving camera’. After a training period of some hours the subject begins to have a spatial experience instead of the mere two dimensional tactile sensation on the skin region underneath the matrix. And very importantly, ‘as long as the subject can control movement of the camera, he can perceive in terms of the three dimensional world of which he is a part’ (Bach-Y-Rita 1984, quoted in Hurley 1998: 345). With passive camera movement no spatial perception came about. The active self-handling of the camera (movement, focus, zoom) was the necessary condition for the emergence of spatial perception. In the occurrence of passive movement of the camera the subject experiences mere tactile sensations; it is only by actively engaging in camera handling that two dimensional tactile sensations transform into three dimensional quasi-visual percepts.

So this is another occasion of the dependence of perceptual contents on output since the pattern of skin stimulation is the same both in the case of passive and of active camera movement. But it is only with active movement that a spatial perception is constituted.16 The dependence of this spatial content on output is not merely instrumental, it is constitutive.


Wearing specifically constructed goggles that reverse the observed visual field at first causes a discrepancy between visual and proprioceptive content. The visually appearing objects to the right cannot be reached by grasping movements to the right. When the subject tries to grasp a right side appearing object it seems to recede further to the right while her body seems to be moving to the left because in reality the object is on the

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16 ‘For example, after one experience, a looming object was perceived to be falling towards the subject’s face and prompt defensive movement, even though the tactile array was worn on the back. Subjects learn to recognize lines, shapes and objects, and begin to have visual illusions. As they become more familiar with the system, subjects discover optical effects and develop visual concepts, such as shape distortion as function of viewpoint and apparent change in size as a function of distance. They can describe a layout of overlapping, partly hidden objects on table, and learn to deal with parallax effects, shadows, looming, and depth cues. Subjects who were totally blind at a very early age even show some ability to perceive rotation and to recover a 3-D object structure from 2-D projections of rotating objects.’ (Hurley 1998: 345)
left. But what is remarkable here is that with practice, regardless of the reverse pattern of retinal stimulation, the visual content appears to be reversing back to normal: an object located to the left appears to be on the left even though the subject still has the reversing goggles on.

With active trial and error efforts the visual content variation conforms to the proprioceptive content variation. Without this active involvement of bodily movement this adaptation of vision to proprioception is very weak at best or wholly absent. Passive movement does not seem to succeed in producing any adaptation.

So this is another example of perceptual content (here visual content) depending non-instrumentally on output. It is active output that conditions adaptation, not mere instrumental variation of retinal input by passive movement.

d. Trevarthen’s Commissurotomy case

Normal neurophysiology dictates that visual information from the right visual field is processed in the left cerebral hemisphere and vice versa. Also the right hand is controlled and proprioceptively sensed by the left hemisphere function and vice versa. The left hemisphere is most of the times the seat of language (Frost et al. 1998). The two hemispheres have a thick band of white matter, a commissure, that connects them called the corpus callosum. In cases where this commissure is disrupted either from disease or surgically (corpus callosotomy or commissurotomy) the two cerebral hemispheres lose their main route of intercommunication and a very peculiar and interesting neurological symptomatology is developed, the so called ‘split brain syndrome’: the two hemispheres seem to operate unbeknownst to each other as if they were two different independently functioning brains each controlling the contralateral side of the body.

A particular case of a commissurotomy patient that is of interest to us has been described by Trevarthen (1984, discussed in Hurley 1998: 170-171 and 354-355). The subject was told to fixate on a central spot while observing with peripheral vision an object on the right visual field. When told to grasp that object with his left hand while
still fixating he reported that the object disappeared. The perceived right sided object disappeared even when the subject were merely contemplating in grasping it with the left hand. That is, when the right hemisphere was operative in preparation or actualization of a left hand movement the content of the right field controlled by the left hemisphere vanished. Or in positive terms: when the right hemisphere is involved in motor output only the content of its visual hemifield (left) comes into appearance.

So in this case as well, an implicit but very much present influence of motor output on perceptual content is revealed: it is the content involved with voluntary movement that is selected for appearance.

Now, Hurley’s purpose in presenting these and other empirical cases is mainly to destabilize the belief in the Input-Output picture (see for example Ibid.: 340). These are cases where a model of linear flow of information through separate modules of perception and action seems insufficient to explain. In all of these cases there are differences in perceptual contents regardless of the sameness of input. It is obvious that here, output is not merely responsible for varying instrumentally patterns of input which latter are themselves responsible for variation of perceptual content. Our conceptual paradigm needs to be substituted: content is not mapped on input which input is instrumentally varied with movement but instead content is conditioned by a constitutional relation between input and output. But of what kind is this constitutional relation? How exactly are input and output interrelated? What kind of functional unity do they constitute? These are questions that Hurley tries to handle by introducing the notion of ‘dynamic sensorimotor singularity’.

A2.2 DYNAMIC SENSORIMOTOR SINGULARITY

According to Hurley, Perception-Action interdependence relates directly to the issue of self-consciousness. The new sensorimotor paradigm about the mind conceives self-consciousness in terms of this interdependence. But of what type is this interdependence?
Self-consciousness for Hurley is mainly perspectival: ‘[a]t the personal level, having a perspective means that what you experience and perceive depends systematically on what you do, as well as vice versa. Moreover, it involves in your keeping track, even if not in conceptual terms, of the interdependence between what is perceived and what is done, and hence awareness of your own agency.’ (Hurley 1998: 86)

In these two sentences there is condensed the basic insight that drives the enactive approaches as whole. Having a perspective means that I keep track of how my voluntary movement modifies my perceptual contents and at the same time that I keep track that what I perceive modifies what I do. In this first personal self-referential dynamic cycle agency, perception and self-consciousness are intricately intermingled with agency: keeping track of perceptual variation by what I do and keeping track that what I do is conditioned by what I perceive.

But we could take some interpretative steps at this point and take notice that self-consciousness is here involved because of another kind of ‘keeping-track-that’: keeping track of content variation by action but also keeping track that content is varied by this very action. What is cognized is not only that the content is varied with the simultaneous occurrence of movement, but also that this content variation is effected not-incidentally by bodily action. ‘Keeping-track-of’ and ‘keeping track—that’ are not two sequential moments of perspectival cognition but the peculiarity of this cognition is that the knowing of content variation is also knowing that this variation is effected by action inherent to that same act. So, our argument goes here, the self-conscious part of the act, is identified with this inherent-in-act knowledge that content variation is enacted by this very act: in this sense the act is self-conscious or something like self-consciousness is prototypically here coming forth not because we pre-suppose a self-consciousness which miraculously appears on top of the ‘keeping-track-that’ but

17 Cf. also the radical constructivist approach of Varela et al. (1991) e.g. ‘the point of departure for the enactive approach is the study of how the perceiver can guide his actions in his local situation. Since these local situations constantly change as a result of the perceiver’s activity, the reference point for understanding perception is no longer a pregiven, perceiver independent world but rather the sensorimotor structure of the perceiver (the way in which the nervous system links sensory and motor surfaces). This structure-the manner in which the perceiver is embodied-rather than some pregiven world determines how the perceiver can act and be modulated by environmental events. Thus the overall concern of the enactive approach to perception is not to determine how some perceiver-independent world is to be recovered; it is, rather, to determine the common principles or lawful linkages between sensory and motor systems that explain how action can be perceptually guided in a perceiver-dependent world’ (p.173) The reminiscences with Noë’s approach are also more than evident as we shall come about them in the second part of this study.
because this latter character describes what it is to be self-conscious. There is no *petitio principii* here. The ‘keeping-track-that’ the content variation is not-incidentally effected *describes* what it is for the perspectively variated perceptual act to be self-conscious.

Hurley does not proceed into any kind of analysis of perspectival self-consciousness of the kind we elementarily undertook above. Instead she goes on to argue that the explanation of the unity of this perspectival self-consciousness is insufficient if it is carried out only in first personal terms. As she characteristically writes: ‘it will turn out that an adequate characterization of perspectival interdependence requires a two-level approach... What subpersonal picture might complement the personal-level aspects of having a perspective? The essays that follow...develop the ideas of complex dynamic feedback system and of dynamic singularity, in the course of considering how both perceptions and intentions may depend on both causal input and causal output’. (Ibid.: 87)

If we follow Hurley, it would seem that there is no more someone could say about perspectival Perception-Action interdependence as such, that is from the first-personal point of view. A subpersonal, objective or physicalistic account needs to be added if this interdependence is to be explained. It is this denial by Hurley’s part to carry out a relevant phenomenological analysis that presents to me the theoretical leverage to build my case in what follows. Because if one were actually to carry this analysis out it would gradually be noticed that this tracking of content variation effected by active movement thrusts us upon the temporality of the cognitive act: it is because the projected anticipations of variation become fulfilled that a knowledge of action effected variation is possible at all, as we shall elaborate in what follows.

For the time being lets limit ourselves to the question of what exactly is this *subpersonal dynamic singularity*, this functional unity which makes possible the personal-level perception-action interdependence. I quote quite extensively: *This type of complex structure of causal relationships is characteristic of what we can call complex dynamic feedback systems: systems in which causal feedback plays multiple roles and is both external and internal. If we track the causal arrow through time, such a complex dynamic feedback system looks like a tangle or knot, centered on the organism and*
moving with it: a singularity in the field of causal flows...the contents of both perceptions and intentions may in general be carried by the complex dynamic relations between inputs and outputs...’ (Ibid.: 308) The system is dynamic because it is based on feedback, both sensory (reafference from movement, visual or proprioceptive) and motor (internal copy of the motor commands), and it is complex because it involves feedback from multiple modalities both external and internal. But this complex system constitutes a singularity, a self-organizing entity that has its center in the body and more specifically in the central nervous system.

For our part, trying to make sense of this dynamic singularity we should differentiate between two general features of this structure: its general function and its location. Its general function is non-linear dynamicity. As we saw above this comes in a direct confrontation with the Input-Output Picture. There does not take place a linear flow of signals that begins causally with the environment, which is then passed to sensory input then to central cognition and then back to the environment via motor output. Instead output, by causing disturbances either directly in the inner networking of the CNS or mediately via proprioceptive and external stimulation is constantly fed back as input. There is operative here a closed loop where output flows into input and where the disturbance of the functional architecture of input is output, and all this without quantum leaps but continuous. A notion of central processing is here none other than this continuous dynamic loop of output fed to itself or input fed to itself.

The location of this general function is distributed. In the CNS itself by reentry of output (copies of motor commands) or externally by reafference.18 So the ‘dynamic singularity’ while centered on the system’s body, is not situated exclusively in that body. Always viewed in a strict subpersonal manner its locus is internal as well external because

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18 As for the clarification of these terms consider the following: ‘...exafference is not feedback, but is input whose source is the external environment, such as the movement of external objects. Both reafference and efference copy are feedback. Reafference is input, or afference, that reflects an organism’s own movement or other changes. It includes visual and proprioceptive inputs caused by limb movement. It also includes visual and other inputs from the environment in so far as they are affected by the organism’s movements...efference copy (or ‘corollary discharge’) is feedback of output or efference internal to the central nervous system. Central efferent or motor output signals are projected back to other processing areas of the brain, including to perceptual processing areas. Such processing areas may then receive both efference copy and reafference from the same movements. Efference copy has a smaller orbit or loop than does reafference. Together, efference copy and reafference make a record of movement available to the nervous system.’(Hurley 2001: 23)
feedback loops pass by reaference through the environment. That is, dynamic sensorimotor processes are operationally mainly externalist as their location is concerned. They are environmentally embedded through this radical embodiment of the sensorimotor loop.

This point is extremely crucial if we are to understand the peculiarity of the enactive approaches in general: while the *general functioning* of dynamic feedback processes existentially *is* the functioning central nervous system which is anatomically situated in the cranium, these processes are *operationally located* mainly in the environment. We can dissolve the contradiction of viewing the singularity as both internal and external by partitioning its concept in *general function* and *location*. In other words the subpersonal singularity is internal as its general function is concerned (because brain processes that causally enable this general function are de facto anatomically internal) and it is external as its operational locality is concerned (as it involves environmental components that participate in external vehicular loops).

In this sense these approaches (the enactive or sensorimotor) are strongly externalist in character. This issue is delicate but decisive. It amounts to a kind of vehicle externalism that Hurley is supporting, which expands content supporting vehicular processes to external physical states as well: in our terms here the *locality* of the feedback loop involves, as is typical with perception, not only central neural processes and bodily sensory surfaces but external objects as well. Commenting on Varela, Hurley states: ‘As Varela puts it, if you talk about a machine with a feedback loop through the environment, so that the effects of the machine’s output affect its input, you’re actually talking about a larger machine that includes the environment and the feedback loop in its defining organization’ (Hurley 2001: 6).

To get a better grip of this dynamicity consider the Control Theory of Action that together with Motor Theory of Perception is for Hurley a basic theoretical alternative model to the Input-Output Picture (see 1998: 435-445 and 2001:22-30). Accordingly, action is the control of input: the output signal is produced by calibration of reafferent input with the desired signal. A comparator juxtaposes the flow of reentrant input with the reference signal (referring to the desired reaference) and their discrepancy
produces an error signal which recalibrates output. The novel motor output produces new reafference which is again compared with reference and so on in infinitum\(^{19}\) (Figure 1).

As Marken writes (quoted by Hurley 1998: 439-440): ‘...the behavior of a control system is organized around the control of input; output is just an arbitrarily identified component in a causal loop, not the last step in a causal chain. The system does not really control the variables typically identified as outputs... Reference signals originating outside the system specify a particular value of input, not output’. Or as Maturana and Varela would have said, the nervous system is characterized by operational closure\(^{20}\).

There is here an entity being temporally perpetuated and this entity is characterized by a general function in a way that it is also constituted itself by that function: disturbances of input are continuously compared with reference and this comparison continuously reproduces an output relative to this process. The dynamic singularity is non-other but this very process.

\(^{19}\) In infinitum does not mean that this process goes on in infinity but that its general functional loopiness is characterized by this continuous cyclic flow.

\(^{20}\) (Maturana and Varela 1980: 127) cf. also Varela (1992: 8): ‘I speak of closure to highlight the self-referential quality of the interneuron network and of the perceptuo-motor surfaces whose correlations it subserves. The qualification ‘operational’ emphasizes that closure is used in its mathematical sense of recursivity, and not in the sense of closedness or isolation from interaction, which would be, of course, nonsense. More specifically, the nervous system is organized by the operational closure of a network of reciprocally related modular sub-networks giving rise to ensembles of coherent activity such that: (i) they continuously mediate invariant patterns of sensory-motor correlation of the sensory and effector surfaces; (ii) give rise to a behavior for the total organism as a mobile unit in space.’ On the other hand a system that is guided by an external reference value, even in dynamic terms, is not strictly speaking self-referential or autopoietic but allopoietic.
We will further discuss Control System Theory in the next section where we shall be examining intentions. But for the purpose of following Hurley in the description of the subpersonal process constituting the dynamic sensorimotor singularity which causally founds and enables the personal level perspectival Perception-Action interdependence the above account should suffice.

Motor Theory of Perception is another theoretical candidate for input-output non-instrumental interdependence. This theory is usually referred to, to explain the personal level differentiation between egocentric and allocentric (environmental) movement or between active and passive egocentric movement where the retinal input pattern is the same in the two cases. These differentiations take place by force of an internal comparison of a copy of the relevant motor command (efference copy) with reentrant\(^{21}\) input. In the case of the presence of an efference copy the perception of movement is subjectively interpreted as active self-movement, that is the perceptual content qualifies as varied by voluntary movement.

This mechanism can offer an explanation for the case of the Paralyzed Eye discussed above. In normal circumstances with a head and/or eye movement to the one side there is a specific pattern of temporal stimulation of the retina. But the same pattern of stimulation might occur if the subject was to be placed in a room and the walls of that room would passively glide to the opposite direction. If abstraction is made from vestibular and other proprioceptive information, how could the subject differentiate between self and environmental movement so that the observed environment does not seem to move passively sideways but instead to remain steady and relative to a bodily movement? It is only with the internal presence of an efference copy, the theory goes, that this differentiation emerges. In the case of the Paralyzed Eye the presence of an efference copy with the absence of retinal input variation causes the emergence of the perceived environmental movement: the pattern is expected to change with the change of the foveation point, and since this change of pattern does not actually occur the environment must have moved to that side to compensate with the lack of pattern

\(^{21}\) ‘Reentry’ is used interchangeably with ‘feedback’. The term is from Edelman (1990).
change, hence the apparent movement. Somehow these inferences must be sensorimotorly effected in the brain with the help of efference copy.\textsuperscript{22}

As we shall see later, research on the so called Forward Models combines features of both the above theories adding to their context the character of \textit{prediction} or \textit{anticipation of imminent reaference}. The ‘dynamic sensorimotor singularity’ might involve not only input regulation by reference value comparison but also by comparison of current input with the \textit{intended input} as it was anticipated at the previous state of the system. This would strongly suggest that what guides the cognitive act is not always some arbitrary external reference but what it itself (the act) intends anticipatorily. To clarify this issue we should now move on to the difficult problem of non-instrumental dependence of intentions on input.

**A2.3 NON-INSTRUMENTAL INTERDEPENDENCE OF INTENTION ON INPUT**

Hurley postulates that Perception-Action interdependence is non-instrumental not because their phenomenological analysis reveals so but because both are causally supported by a subpersonal input-output constitutional interdependence (Figure 2). This subpersonal interdependence constitutes a functional unity of input and output, the so called ‘dynamic sensorimotor singularity’. It is the functional organization of this latter that causally supports the contents of both perceptions and intentions\textsuperscript{23}. Based textually on Hurley we examined empirical cases in support of non-instrumental dependence of perception on output. Now we shall do the same for action.

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\textsuperscript{22} See also section C1

\textsuperscript{23} Not in the technical sense of aboutness of mental acts in general. See footnote 1.
a. The deafferentation case.

Patients with peripheral purely sensory neuropathy occasionally develop a permanent type of tactile and proprioceptive anesthesia (Cole, 1995). These patients are incapable of moving when they shut their eyes. They are unable to walk, or remain upright, they are unable to perform even the simplest of tasks. When shut of their visual surroundings, their limbs begin to wander in space as the patients cannot (proprioceptively) feel where their limbs are. Quotes Hurley (1998: 361) from Cole (1991: 16): ‘[a] common problem in patients without feedback is that when they are not looking at their limbs the arms and legs start to move ‘on their own’. The fingers don’t remain still, but writhe in small movements, and the arm may start moving uncontrollably. If he turned his gaze away for a few seconds, his arm would often come up and hit him, or someone close by.’

Without sensory feedback, there is simply no coherent intentional movement. It is only with visual feedback, strenuous efforts and long term training that the deafferented patient can again produce a coherent sequence of intentional movements. He needs to be mentally concentrated to the act while that takes place and in cases he loses his concentration the movement collapses: ‘When I. W. first sat up in bed, he was so overwhelmed by this achievement that he stopped thinking about sitting and immediately collapsed. Once he had learned to walk, if he sneezed, and thus disrupted his mental concentration, he would fall over. The limits to how much he can do in a day he describes as having to do with his own mental concentration, rather than the amount of physical effort required.’(Cole and Paillard 1995: 250)

It seems that loss of afferent signals destroys motor action. That signifies that real-time action requires a non-instrumental contribution by reafferent input. This is demonstrated most dramatically in deafferentation. But how is this control of action by the inflow of input achieved? And what is this concentrated thinking during action in the case of deafferented subjects amount to?
One way to respond to the above goes like this: by training, the patient reconstructs the ‘kinesthetic engrams’ of intended movements and anticipates the expected reafference of the specific movements. That is, prior learning involving experienced motor movements is being dynamically memorized and this associatively acquired implicit motor knowledge is also projected as an anticipation of reafference to come. This anticipation acts as a rule for motor program selection: ‘...memory-driven activities concern goal-directed movements structured on the basis of a representation of the expected sensory consequences of the planned action once performed. It presupposes the existence of a repertoire of kinesthetic engrams characteristic of the goal to be achieved.’ (Cole and Paillard 1995: 251-252) This associatively acquired anticipatory projection supplements actual reafference as a required component of normal motor action. Its significance will come forth as our thesis will unfold gradually in this study.

b. Basic Neurobiofeedback.

Hurley’s efforts to demonstrate the constitutive interdependence of action and sensory input, culminate with the discussion of basic intentions and the empirical case of basic neurobiofeedback. It is in basic intentions that the sensorimotor approach finds its personal level explanandum par excellence.

A basic intention involves the minimum of content that an intention can have. The actualization of a basic intention is always the means to an end while it itself cannot have something more basic which can act as a means towards the basic intention. ‘For example, you may intentionally (frighten the burglar by turning the light on). And you may intentionally (turn the light on by flipping the switch). And you may intentionally (flip the switch by moving your finger). But at some point your intentions run out: you do not intentionally (move your finger by firing a neuron), under normal conditions. [y]our basic intentions are where your intentions begin.’ (Hurley 1998: 357)

24 Cf. with the thematic of kinesthesis in Husserl in section B2.2.
On the other hand a non-basic intention is the more distal goal of action, which is always done by doing something else. The non-basic intention to switch on the light is actualized by the more proximal non-basic intention to flip the switch which is actualized by the basic intention to move my hand and finger accordingly.\(^{25}\)

A basic intention is usually\(^{26}\) a motor intention as its content is concerned. It is usually an intention to move my body plain and simple and not an intention to do something by moving. Of course this body movement is usually coupled to the object to be interacted with, be that a tool or even the floor the subject walks on. While as intention it relates to something that is yet to come to presence, as a motor intention it acts causally in the implementation of the motor action it is the intention of. A personal level analysis here can reveal the peculiar self-referentiality of basic intention: what is intended, the movement, is also intended as being caused by this very intention. A basic intentional act produces its content; it is in this way that it is differentiated by a perceptual act which as perceptual does not produce its content.

Hurley comments on this causal self-referentiality only cursorily: ‘If your intention to move a limb in a certain way is basic, then you do not act on it by intentionally doing anything else, such as producing a motor signal in the brain, even if your action depends causally on such signals. You just do it.’ (2001: 28) We might comment here that you just do it but you also know that you do it. But once again she will not carry out a personal level analysis of basic intention. Instead as is typical she states: ‘The content of basic intentions can depend non-instrumentally on sensory feedback, by depending non-instrumentally on a dynamic system of [subpersonal] relations between input and output.’ (Ibid.: 29)

\(^{25}\) cf. Pacherie (2000: 403): ‘In Searle’s terminology, a prior intention corresponds to the initial representation of the goal of the action prior to the initiation of the action. However...it is not enough that a bodily motion be caused by prior intention in order for it to qualify as an action. It is moreover that the bodily motion be caused by an intention in action, that proximately causes the physiological chain leading to overt behavior. The label ‘intention in action’ is indeed quite appropriate in that it highlights an important aspect of this conception of the causation of an action, namely that the intention does not terminate with the onset of action but continues until the action is completed. On this view, the intention des not simply trigger the action, it plays a continuous causal role in shaping the action, guiding and monitoring until its completion’. (My underlining. An intention-in-action causes the action it is the intention of).

\(^{26}\) I say ‘usually’ because in cases of BCI (Brain Computer Interface) settings as is the neurobiofeedback case discussed, there is a basic intention being actualized bypassing body movement. See the basic neurobiofeedback case bellow.
Hurley utilizes the case of neurobiofeedback in a thought experiment so that the distinction between non-basic and basic intention will come into relief. Suppose that your alpha wave brain activity was fed through an electroencephalograph (E.E.G.) to a monitor where a line would ascend when your alpha increased and descend when they decreased. Suppose also that a certain way of moving your eyes, physiologically raises your alpha. At first you look at the monitor and try to raise your alpha by raising the observed line but nothing happens. Then you notice that with a certain kind of eye movement the line ascends (maybe this is accompanied with a different quality of a accompanying general feeling relative to alpha increment or maybe not). By training, you acquire the ability to calibrate (or coordinate) the relative eye movement with the ascending of the line. What has now occurred is that you raise your alpha by leveling up the line by moving your eyes in a specific way. ‘Eventually you realize that when you move your eyes in a certain way, the line on the monitor tends to ascend. The basic intention to move your eyes in that way was already available to you, but you can now act on your nonbasic intention to raise your alpha by moving your eyes in this way. By providing sensory feedback from intentional eye movement, the monitor gives you a new if nonbasic description under which you can act intentionally.’ (Ibid.: 27) The sensory input from the monitor is a means for selecting an already constituted basic intention (eye movement) so that the non-basic intention to make the line ascend becomes actualized. (cf. Figure 1.) Evidently what we have here is an instrumental dependence of intention on input because input motivates the selection of an already available basic intention.

Now consider the basic case. Suppose you are connected to the monitor in the same way as previously but now there is no physiological relevance of eye movement and alpha increment. This means that there is not an already available basic intention to select from, when observing the monitor line. Suppose also that after training somehow in due time you do make the line go up. If you can intend the ascending of the line and this intention is also the cause of the observed ascension then a novel basic intention has been constituted. The received input from the monitor dynamically calibrates with output (via alpha wave then via the E.E.G. to the observed line that ascends) so that a smoothly regulated ascending movement of the line becomes a reality. (Figure 3.) This
regulation occurs directly and not via an already constituted basic intention. In this case the actualized basic intention or basic action is this active line ascension which is effected directly.

I believe that with this thought experiment Hurley has offered the enactive theorists one of their most powerful theoretical tool for conviction. This exciting insight is one of the most clear examples of the power of this approach if it is understood and utilized efficiently. Because what takes place here in clear intuition is the constitution of a novel basic intentional act which we can theoretically anatomize at our leisure for descriptive purposes.

This prototypical emergence of a basic intention is a common event from a psychological developmental point of view: this is how infants acquire new basic skills. In that case also there is not an already available basic skill to choose from. On the contrary, by a novel dynamic coupling of motor output with incoming reafference an infant learns gradually to walk for example. Once noticed as such, we can recognize this procedure in the acquisition of other basic skills in later life as well. Take learning to swim. Or in pathological cases: consider the deafferented patient in the previous section. Having lost proprioceptive reafference he rebuilds a novel visual feedback-motor output (visuomotor) dynamic coupling.

The fact of the unembodied character of this neurobiofeedback case need not alienate us, the fact that no overt bodily movement is involved in effecting a real change in the subjects environmental surroundings. The same ingredients with a corporeal intentional
movement are present here: reafferent input which in this case is strictly visual and a
dynamic coupling with relevant output. In moving my arm the situation is of course
more complex as it involves multimodal reafference but the general dynamic
background is exactly the same. Indeed from the constitution of a subpersonal input-
output dynamic coupling, from the genesis of a constitutive interrelation between input
and output the content of a new basic intention comes to the fore: now I know how it is
to raise the line in a neurobiofeedback setting, now I know how it is to walk.

But this basic intention as so many others in everyday life has also a phenomenological
content, a descriptive content from the first-personal point of view. Hurley cannot deny
this having based her analysis of the basicness of intention on the observation that
‘[y]our basic intentions are where your intentions begin’. A basic intention is the
minimal threshold of intentionality in the domain of action. Below that lurks the abyss of
the subpersonal. Nevertheless, consistent with her stratagem Hurley will not proceed in
any kind of phenomenological analysis of basic intentions. Instead using the conceptual
framework of Control Theory of Action she will once more present an example of the
possible functional properties of the dynamic sensorimotor singularity that carries the
basic intentional content. We will follow her in this with the purpose of showing the
necessity of a first personal analysis not only of the basic intentional but of the cognitive
act in general.

A3 PERSONAL LEVEL PERCEPTION-ACTION NON-INSTRUMENTAL
INTERDEPENDENCE

Regard at first Figure 1. The most important component is the comparator. At that stage
the reentrant feedback is compared with the reference value and the error signal
produced recalibrates the output signal. This causes a motor response which depending
on the embodied features of the system and the environment where it is embedded
results in a token reafference which is then again compared with the reference and so
on. This is a flowing process without temporal discontinuities of functional significance
except those enforced by the physical features of the components. A nervous system
has, say, an approximate 100 to 200msec delay for peripheral sensory signal to reach
centrally\textsuperscript{27} and a thermostat may be adjusted to take input say every 5 minutes. Applied to the neurobiofeedback paradigm this model has its first-person counterpart: the reference value can be seen as the intended ascension of the monitor line, the sensory input as the observed current state of the monitor line. The motor output corresponds to the basic action of eye movement that physiologically raises the line (by raising alpha). This is reminiscent of the kind of local mapping of personal level discriminations on subpersonal processes that Hurley warns us against (Ibid.: 27). Even so we need not conceive this mapping as imposing a verticality to subpersonal processes. Maybe the intention for line ascension belongs along with sensory input from the monitor to a horizontal feedback loop that is specific to this task (of raising the line) which is intermodulated with a different parallel horizontal loop that supports the basic intention for eye movement (cf. Ibid.: 10).

But what is of interest to me here is that the clear and present phenomenological character of the \textit{anticipation of line ascension} is absolutely absent if we remain at the subpersonal level of analysis. Physical states are usually conceived as temporally present states that interact or not with each other. As a physical state a present reference signal interacts with a present input signal. So I would like to suggest that the intention for a future event as such is completely outside this mechanistic conceptual framework. \textit{Subpersonal processes are conceived as relationally fixated to the present}. I believe that this claim is enforced on us by our epistemological presuppositions concerning the subpersonal mechanistic descriptive level. Interactions on that level are conceived traditionally as strictly causal with this causality having an Aristotelian efficient cause sense. This is a billiard ball universe of interactions where one state interacts with the next and that with the next one while all these interactions are merely happening in the ‘now’. In section B2.1 this character of always presently occurring causal relations will be interpreted in contradistinction of a kind of teleological (again in an Aristotelian not Darwinian sense) causality or ‘motivation’ that is inherent to the subjective realm.

\textsuperscript{27} ‘These delays combine to give an unavoidable feedback delay within the negative feedback control loop, and can lie between about 30 ms for a spinal reflex up to 200-300 ms for a visually guided response. (The actual loop delay is difficult to measure exactly, as it depends on factors such as the type of perturbation and the task demands)’ (Wolpert & Miall 1996: 1269)
The dynamic feedback loop with its non-instrumental input-output structure seems to refer to a physical structure of presently interacting physical components either electrical, electromagnetic or electrochemical in nature. There seems to be nothing here of an inherent to the system relation with what is coming and what has passed from the account that Hurley has given us. And because it is exactly the phenomenal contents as perceptual or intentional that are in need of explanation by the enactive theory as their interdependence is concerned, an analysis of these contents at the descriptive level that is proper to them is irreplaceable. In our case of non-basic neurobiofeedback the anticipation of ascension is a descriptive component of first-personal analysis that is explanatorily non-reducible to something else more basic. There is nothing in the description of dynamic singularity that resembles an anticipation as such. I am not upholding any kind of naive idealism here. Anticipation is not reducible to anything in the subpersonal descriptive level but on the other hand that subpersonal level is somehow thought of causally enabling subjecting characters such as anticipation. So a clarificatory description of these subjective characters would be useful if those causal subpersonal processes are to be understood as to their specific type of scientific explanatory role. These remarks have the purpose of pointing to the epistemological use of a phenomenology of intention and perception can and ought to have.

But lets move on to the basic case. Consider Figure 3. There is no external reference now. What do we have in its place? I must quote extensively here: ‘A new basic intention emerges through a kind of bootstrapping process. In place of a predetermined reference signal is internal feedback of motor output. Motor output is subpersonally calibrated against input from sensory feedback on the reafferent loop. The relationship between reafferent sensory feedback and efference copy does not fit the instrumental, local mapping model. Sensory feedback does not merely guide output signals to produce an independent target value, as we could assume in the nonbasic case. Rather, the contribution of output signals to the content of basic intentions depends on their context within the complex subpersonal system of dynamic feedback that calibrates them against sensory input. So the content of basic intentions depends noninstrumentally on these relationships between input and output.’ (Ibid.: 30) What Hurley suggests here is that at the subpersonal level the basic intention of raising the monitor line is composed
of the interrelation of two functional parts: motor output and sensory input. So basic action cannot here be mapped directly and squarely on motor output because the latter is a component part of a functional conglomerate with input. It is this functional conglomerate that corresponds to the basic action. But why, we may ask here, should motor output or an efferent copy of it in its interaction with input be the subpersonal correlate of a basic action? Why should the dynamic interplay of output with input give rise to the behavioral and subjective character of a basic intentional action? Can this question be answered if we remain strictly to the subpersonal descriptive level? I believe that this is not so.

If the content of the specific basic intention is not taken into account then a mere bootstrapping of output with input is blind and devoid of reference to any personal level experience that it is supposed to be enabling. What I mean by this is that the system in Figure 3 is supposed to have a function if it is to be a process that causally enables a basic intention. And the type of its function can only be understood if we look into the experience that this function enables. So keeping the above point in mind we may ask: with what exactly should the comparator compare the flowing reaference which (reafference) is caused by the previous motor output if it is to constitute a function that causally enables a basic intentional action? There must be something of the same ontological kind with input here to be compared with, of the same type. The copy of the motor command (efference copy) from the previous temporal stage of the process is not something that can be compared with input because it is qualitatively something else. Indeed as Hurley insists Control Theory of Action speaks of comparison of sensory signals. And on the other hand the presence of efference copy in Motor Theory of Perception results in self-other movement differentiation in perception and is not directly involved in the control of movement. There should be something else that must be compared with input then for this subpersonal description of basic intention to refer to a function that self-organizes in a way that can causally support the basic intentional content as such. Where should we find this missing component?28

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28 See Footnote 75 for the inadequacy of efference copy for comparison in this context.
I painstakingly insist on this train of thought to force into relief the fact that without appealing to the phenomenological content to be explained (even in this loose sense of defining the causal conditions that enable it) we are driven into a dead-end. This is exactly the point where we must depart from Hurley’s approach. What is imposed on us by our analyses is that the subpersonal account of dynamic singularity is very important in the sense that it is causally necessary for the emergence and perpetuation of basic intentions. It can also be argued that it is necessary for the emergence of perceptual content in the sense that the latter is necessarily causally dependent on it. By appeal to this mutual causal dependence of perception and action on dynamic singularity someone might uphold with Hurley, that perception and action themselves are interdependent. But mutual causal dependence though necessary is not sufficient to explain their constitutive interdependence in the sense of their exclusive interrelationship under the heading of a mental act in general. If two things are built using the same stuff that does not necessarily mean that they are functionally interrelated, that is, interrelated as bound under a common function. A thought and an epileptic seizure might spring from similar subpersonal processes but that does not mean that they are non-instrumentally interdepended. Meaning that they are not exclusively interrelated as belonging to the wider framework of cognition that sensorimotor theories are concerned with. To state it otherwise, the first-personal analysis offers a true constitutive explanation of their interrelation whereas their subpersonal common causal grounding offers an explanation of the enabling physical conditions of this personal level interrelation (cf. McDowell 1994). It is the phenomenological descriptive analysis as such of perception and action that can offer this sufficient constitutive explanation as I am about to show in the rest of this study.

I would like to present here some preliminary remarks here relative to basic neurobiofeedback, remarks about issues that will be better clarified in later sections. By turning my reflective regard on the content of my basic intention to raise the line I observe just that: that I intent the raising of the line. But of what type is this ‘intention’? I intent something that is not now present in the mode of anticipating it. This is revealed to me in plain first personal reflective fixation on what I directly experience. So I perceive the current height of the line and I anticipate its ascension. When I become
competent with this basic intention I also observe something else: my anticipation somehow causes the perceived ascension of the line. And also by constantly retaining mnemonically the past state of the perceived line I am aware whether what I previously anticipated has come to presence by somehow comparing the retained anticipation for the present (where the line was expected to be) with the actually present stage of the line. If my anticipation is being fulfilled at the time that I anticipate it to be fulfilled and this happens in a systematic way with the variation of my anticipations then I am aware that I am the agent for the change. If my anticipation is frustrated then this knowledge ‘recalibrates’ my next anticipation.

I believe that this kind of phenomenological analysis would be helpful in a two level manner.

1. It actually elaborates on the issue of perspectival self-consciousness that we left unconsummated above (pp.15-18). With the suggestion of the motif of anticipation fulfillment and the retaining of past phases we actually have a coherent descriptive analysis of what it is to ‘keep track of the systematic dependence of what I perceive on what I do’. The change in the aspects of perceived things is either caused by my anticipations: in this case my anticipations are causal or active if they predict not only the content of the coming aspect but also the timing of its actual appearance, while they are being fulfilled as these predicted characters are concerned and do so in a systematic fashion. Or this change is not caused by my anticipations, a fact that I am once more aware of by retaining the flow of past phases while either the content or timing of their appearance or both are not fulfilled. We can entertain here the thought that in the first case what we have is an intentional act and in the

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29 (Hurley 1998: 89, also see p. 12 above). Remember that the content of intentions here involves ‘keeping-track-of’ as well as ‘keeping-track- that-’. The second is an account of agency which is not independent from its keeping track that it causes the variation of perspectival content. A basic intention is built when agency is introduced as a controller of variation in this sense, and the same basic intention is destroyed or degenerated into mere happening with departure of agency. Cf. Hurley : ‘In the neurobiofeedback case, sensory feedback enabled the emergence of agency out of happenings, the creation of new basic intentions. In Waterman’s case, lack of proprioceptive feedback destroyed old basic intentions and in this sense permitted agency to subside into happenings’ (1998: 391). The way I see it, agency can be descriptively reduced into something more basic: active-anticipation-fulfillment. This account will become more clear as we move on to later sections.

30 See also pp. 58-60
second a perceptual act, but what is also decisive here is that their interdependence is revealed in the first personal level and their transition into one another is also evident without recourse to a different descriptive level. But we shall elaborate more on this issue on the second part of the study.

2. The indication of anticipatory content points to what it is to be causally explained (as enabled) by the subpersonal processes. And in a reverse manner it gives us a hint about what must be that is compared to reafference in Figure 3 if this constituted singularity is to act as causally enabling anticipatory fulfillment. By projecting the results of our phenomenological analysis, we can assume that that must be the predicted reafference from the previous stage of system function. The system recalibrates its motor output by comparing its previous prediction of current reafference with actual current reafference. In this way the system is in effect (functionally) self-referential: its motor output is always related to an expected reafference, a prediction inherent to the system itself which relates constitutively to its own homoeostasis (Figure 4). By retaining this prediction in the next stage of its function ‘it keeps track’ of itself: it has a ‘cognitive’ relationship with its own past or more strictly it can be described to give rise to a functional entity that can be characterized as having a cognitive relationship with its own past. It compares current reafference with its own past prediction of current reafference and recalibrates itself accordingly by projecting a novel prediction with the relevant motor output and so on. (Cf. Figure 5.)

![Figure 4. The phenomenological analysis of the basic case of neurobiofeedback reveals that for the subpersonal feedback loop to have coherence as a specific function that causally supports the basic intentional content, it is the prediction of the input that must be compared with actual input. In this case first-personal analysis guides empirical presuppositions.](image-url)
Talk of prediction, retaining of past phases and temporal self-relation about subpersonal processes seems to come to contradiction with what was previously suggested about the alleged strict fixation of these processes to the present. But the use of this terminology of referring to past and future is imposed on the subpersonal level for explanatory purposes. For a subpersonal process to be explanatory even in the weaker sense of causally enabling its correlative subjective act it must be viewed as constituting a function that is analogous to that act. That should not be taken to mean that the subjective act is type identified to the subpersonal process. It only means that it is an epistemological necessity to project this analogy if we, as scientists, should take upon us the endeavor of scrutinizing the ‘how’ of this enabling.

To elaborate a little more here, take ‘prediction’ for example. It is implemented as a present physical state (a computation of system state at t+1 maybe but still a present physical state itself) relating with other present physical states. The characterization that it is a prediction is imposed on it from us as subjects observing it precisely by the tracking of its behavior: that it systematically relates to a future physical state. Again the first-personal level analysis is necessary for epistemological purposes here. By projecting the subject’s temporal horizon, its relation with past and future, we make sense of physical events that are supposed to causally enable this temporal horizon or alternatively of events that are supposed to be the ‘vehicles’ of this very subjective domain. In that domain what is behaviorally present is also first-personally present. My moving arm is viewed third personally by me as well (I can visually observe it) but also I have first-personal access to the active-anticipation-fulfillment framework that controls that movement. If we endeavor in an examination of the subpersonal processes that enable the behavioral aspects of this movement shouldn’t we also focus ever more so on the first personal content that seems to control that behavior? And if these subpersonal processes are said to confer to the explanation of this behavior shouldn’t they somehow be said to confer to the explanation of its content? Isn’t this content the more proper explanandum here?

This issue is extremely difficult but I think we should keep it in view. In spite of Hurley’s warnings against personal-subpersonal isomorphism, at least this kind of projected
isomorphism cannot be avoided. Especially if our inquiries involved neurophysiology as well and its alleged explanatory value relevant to the correlative behavior and mental experiences that subpersonal processes scrutinized by neurophysiological research are supposedly explaining. The present-time-fixation of physical states supporting mental states has to be somehow accommodated with the fact of the temporal horizon of that mental states. This is the enigma. But it is an enigma that needs to be worked out by maintaining respect of the qualitative differences of the two ontological domains implicated.

So to recapitulate for emphasis sake, the present time relational fixation of subpersonal processes leads to observable normativities or regularities, say arm grasp movements. These movements are not only observable movements of foreign arms, but also are the subject’s own movements and as such have a specifically describable phenomenological content. Even more than observable behavior these contents need to be scientifically explained as to their causal background. This is a plain and simple epistemic imperative. To be explained first of all they have to be described by an analysis that saves them as phenomena. If thereafter is found that a basic characteristic of these contents is their temporal horizon (the constitutive interrelation of their past and future) then while respecting the present-time-fixation of vehicles we need to come with a satisfying explanation of what kind of causal interrelation these levels maintain. Or, how should the subpersonal processes be self-organized, to be in a position to enable this constitutive temporality of their respective mental acts? This study struggles to shed some light into these colossal issues without of course having illusions of completeness.

In the next part we shall proceed with an interpretation of the notion of ‘virtuality’ in the work of Alva Noë, another main representative of the enactive approach. By utilizing a Husserlian reading of Noë I mean to show that the first-personal perception–action interdependence is possible because of perception and action share a common phenomenological core: that of the subjective temporal self-relatedness.
B. VIRTUAL CONTENT AND THE PERSONAL LEVEL INTERDEPENDENCE

B1. ALVA NOÈ’S NOTION OF VIRTUAL PERCEPTUAL CONTENT

According to Noë’s version of enactivism (Noë 2004) the content of perceptual experience is virtual in the sense that not only the currently visible objective aspect but also its hidden aspects are perceptually present. The hidden aspects are present in their absence because the perceiver has implicit expectations about the way they would look in case she would actually face them. So in the same perceptual act there are functionally31 interrelated current aspect and expectations of the looks of hidden aspects. This interrelation constitutes the unity of the perceptual object which is thus (aspectually) construed not as actually but as virtually present. Taking a hint from Laasik (2011) I intend to show in the sections that follow that the Husserlian notion of fulfillment needs to be brought up to add coherency to Noë’s account.

B1.1 PRESENCE VS ILLUSION PROBLEM

Laasik (2011) argues that there are two issues that need to be differentiated in the context of Noë’s view about perceptual content. On the one hand there is the case of the expected but not actually visible objective aspects. Take for example the case of a perceived tomato: ‘[o]ur perceptual sense of the tomato’s wholeness -of its volume and backside, and so forth- consists in our implicit understanding (our expectation) that movements of our body to the left or right, say, will bring further bits of the tomato into view. Our relation to the unseen bits of the tomato is mediated by patterns of sensorimotor contingency’ (Noë, 2004: 63). The aspectual variation of the perceived object with movement (this might be movement of the embodied perceiver or of the perceived object, Noë does not differentiate between the two) is anticipated in the very same act that intents the current aspect, prior to (and during) any actual movement. The ‘patterns of sensorimotor contingency’ acquired via prior experience are virtually projected along (together with) the actually perceived current aspect and this concomitant projection helps constitute the unity of the perceived object. The object is not, strictly speaking, actually present because as we saw only the current aspect is

31 In the sense of a dynamic constitutional interrelation. See footnote 14.
actually or temporally-now present, so in this sense it is virtually present. Aspect expectations are future projections which the perceiver has open access to: ‘...our sense of the perceptual presence of the detailed world does not consist in our representation of all the detail in consciousness now. Rather, it consists in our access now to all of the detail, and to our knowledge that we have this access’ (Ibid: 63).

Noë conceives in this particular way not only object constancy but also quality constancy, say color and shape constancy: ‘We experience color as that which is, in a wide range of cases, invariant amid that apparent variation. In this way, then, color perception and shape perception are on a par. You experience the roundness of the plate in the fact that it looks elliptical from here and that its elliptical appearance changes (or would change) in precise ways as your relation to the plate, or the plate’s relation to the environment, changes. In exactly this way, we experience the color of the wall in the fact that the apparent color of the wall varies as lighting changes. We are able to experience the actual color of the object as, so to speak, that condition which governs or regulates the way these changes unfold. We see the color of the wall in the way its appearance changes (in the way it interacts with the surrounding environment)’ (Ibid.: 127-128) The same conceptual schema of projected sensorimotor contingencies related functionally with the actually perceived aspect (current hue or current perspectival shape) is found here. A constant color or shape is constituted as a function of the above schema as is the case of the unified visible object.

Laasik delimits two conceptually different problems covert in the Noë’s account, an ‘Illusion Problem’ and the above ‘Presence Problem’: ‘On the one hand, there is the Illusion Problem, viz., we might be subject to illusion about our experience of the unattended detail of the perceptual scene. Noë addresses this problem by arguing that the unattended detail is present to us, or experienced by us, in the sense that it is possible for us to access it. On the other hand, there is the Presence Problem, i.e., the problem of how to account for the presence of the object’s back side, the occluded parts, and the constant properties. It can be solved by arguing that the back side is present to us, or experienced by us, in the sense that we have certain perceptual expectations in regard to it.’(2011: 444)
What the psychological phenomenon of change blindness indicates is that unattended details of an actually perceived scene very often go unnoticed and that there is a great degree of confabulation concerning their content. Content of the visual periphery especially distal from foveation area is perceived as somehow explicit regardless of the fact that upon rigorous questioning the perceiver reports that there is only a very gross givenness of content. This confabulation about peripherally perceived content is explained by Noë in a way analogical to the object/quality constancy case: we perceive the unattended details at the same time as the attended center of perceptual regard because we have open access to them. Or my awareness of the sensorimotor contingencies, my implicit knowledge of them, and their functional relevance to the possible variation of my center of perceptual regard (whether I look left or right on the observed scene) constitutes the scene for me as a perceptual unity regardless of the fact that at any given moment I only attend to a limited part of it.

Laasik argues that the Illusion case is a completely different type of experience than the Presence case in that in the first we have a perceptually now-present peripheral content whereas in the second we have a now-absent content. And he upholds that the problems about their respective perceptual contents cannot be solved in the same way. That is, Noë’s appeal to open accessibility to hidden as well as peripherally present content conflates two very different problems here (Ibid.: 444-446). Accessibility may be invoked only in the Illusion case: ‘[Noë] argues that even though our perceiver has no detailed experience of the Marilyn on the left, she is not massively wrong about the nature and scope of her experience, since it is possible for her to access the Marilyn on the left. Indeed, she can readily access it as well as other details and parts of the scene by shifting her attention from one part of the scene to another and by making eye movements and other movements to explore the scene. We can say that she experiences them in the sense that they are accessible.’ (Ibid.: 444) But in the case of the Presence problem it is the notion of sensorimotor expectations that needs to be invoked: ‘...the back sides are present to us in the sense that we have sensorimotor expectations about them’ (Ibid.: 445)

32 As for example in the case of the Marilyn Illusion discussed below. The illusion refers to Andy Warhol’s ‘Marilyn Diptych’.
So according to Laasik currently present peripheral content is present as a part of the perceived scene because the perceiver has free access to it and this open possibility of access dynamically structures the unity of content. I believe this notion of open access to content as constitutive of content is highly problematic. And that is because the mere possibility of access is not sufficient to bind current area of regard with the possible next area of regard. This is because prior to accessing it the content is absent and the notion of access does not refer to any kind of intentional relationship of the subject to any specific content. That is, the currently perceived area cannot be synthesized into a unified whole with an absent area because nothing mediates their relation, the way the notion of expectation does. Bare ‘access’ is not enough, notions like expectation or anticipation on the other hand refer to an intrinsic intentional relationship with some kind of specific content that is expected and in this way bind that content into a unity with the current area of perceptual regard.

B1.2 FREE ACCESS AS THE OPEN HORIZON OF SENSORIMOTOR EXPECTATIONS

The above remarks are meant as a warning to Noë’s identification of ‘free access to content’ with ‘sensorimotor expectations’. My sensorimotor expectations concerning kinesthetically available content also dictate the possibility that I have access to that content. But the reverse does not necessarily hold: the fact that I have free access to a hidden (or not currently perceived) objective aspect does not dictate that I necessarily have sensorimotor expectations about it.

I believe that it would be helpful here to regard ‘open access’ in the sense of the open horizon of expectation that could be fulfilled. This notion of fulfillment of expectations is also proposed by Laasik (2011: 448) as an addition to Noë’s account to help solve the ‘Presence Problem’. It is this open possibility of fulfillment of the expected aspects of content that should be meant with the notion of free access in Noë. And if we

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33 Here in the technical Brentanian sense of ‘intentional’.
34 Of course its specificity does not mean here detailed presentation but a specific indeterminacy to be determined. cf. Noë (2004: 193): ‘...all detail is presented in experience not as represented, but rather as accessible.’ Should one interpret ‘accessibility’ as ‘determinable indeterminacy’ here?
synthesize access and expectation the way I propose, then we notice something in Noë’s
text that I think Laasik misses: because expectation always refers to some kind of
kinesthetically available content, the free access (the open horizon of expectation
fulfillment) to that content can in principle constitute both the unnoticed peripheral
content of a visual scene as well as the hidden aspects of the visible object. That is, the
intended content of expectation becomes the stuff of the peripheral content
confabulation and on the other hand becomes the intended content of the hidden
aspect. So in this sense the ‘Presence Problem’ needn’t be solved in a way different than
the ‘Illusion Problem’ as Laasik wants to have it but by elaborating on Noë’s notion of
free access and construing it as the open horizon of sensorimotor expectation.

B1.3 THE HORIZON OF EXPECTATION FULFILLMENT

Up to this point we’ve seen that:

1. The notion of ‘virtuality’ in Noë’s work is based on the intrinsic interplay
   between actually perceived aspect and hidden but nevertheless intended
   aspects, whose functional interplay\(^{35}\) constitutes the perceived object constancy.
   This foundational explanatory schema is used by Noë not only for object and
   sense quality constancy but also for the case of peripheral visual scene content
   confabulation.

2. Laasik correctly notices that the hidden aspect is not an unattended peripheral
   visual area. The former’s content is perceptually absent whereas the latter’s is
   temporally present though not directly regarded and therefor vague. Laasik goes
   on to argue that while the former case (Presence Problem) can be addressed via
   Noë’s notion of ‘sensorimotor expectations’ the latter (Illusion Problem) can be
   addressed via Noë’s notion of ‘free access’.

\(^{35}\) Remember the functional interplay of input-output in Hurley’s account of the subpersonal dynamic
singularity. Remember also that in the analysis of basic intentions the output component was construed, after
the phenomenological analysis of the content of biofeedback basic intention, as prediction. In that case the
interplay of reafference and prediction enabled the basic intentional content. Mutatis mutandis, shouldn’t we
project a similar dynamic interplay for the vehicle of perception proper? More of this later.
3. While I believe that Laasik’s differentiation between a ‘Presence’ and an ‘Illusion’ case is correct, I maintain that ‘free access’ is not sufficient a notion to solve the Illusion Problem. Some kind of mediation between contents is needed if foveation content and peripheral content are to be bound together in a perceptual unity. This mediation cannot be given by mere ‘access’. It can be given though by the notion of expectation, being as it is, always an ‘expectation-of’. Later on I will be arguing that ‘expectation-of’ is always and at the same time a ‘retention-of’: I have some kind of givenness of peripheral content because I also retain it or it is because a content is retained that it can be projected or anticipated.

4. So ‘sensorimotor expectations’ can be invoked as explanatory to both the ‘Presence’ and the ‘Illusion’ Problem while at the same time these problems are kept phenomenologically distinct. And Noë’s ‘free access’ should not be understood as severed from the sensorimotor expectations motif but instead should be regarded as connoting the open horizon of sensorimotor expectations. In other words, perceptual expectations of hidden or unattended aspects are coupled functionally with the current objective givenness via the always open potentiality of them being fulfilled. The object itself is not here already presupposed. It is presented as an intentional object in a holistic way by this functional coupling of the current and expected.

This dimension of fulfillment that Laasik propels into Noë’s intuitions reestablishing his phenomenological analyses into their Husserlian background that Noë is not very keen to recognize, is indeed offering coherence to the notion of ‘virtuality’. Knowledge of sensorimotor contingencies allows for the perceptual act to be simultaneously receiving the current aspect and anticipating the fulfillment of concomitant expectations of hidden aspects. This simultaneity of current aspect reception and hidden-aspect expected-fulfilling dynamically constitutes the object.

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36 Cf. Madary’s account in (2013) perceptual anticipation’s content’s dependence on the empirical constitution of the perceiver.

37 ‘Retending’ that is, mnemonically retaining or keeping in working memory. A Husserlian term. See section: B2.4

38 The notion of ‘constitution’ is used throughout the text in the general sense of the production of a novel entity by a synthetic process that involves more basic, to that entity, parts that are nevertheless not
as a perceived unity. The expected or anticipated character of its hidden but
evertheless intended aspects confer to the ‘vituality’ of its appearing: the object is
present but virtual, being actually anchored to the present moment only through the
actually or authentically received (current) aspect.

The character of open horizon of sensorimotor expectation marks a kind of
tendency-towards-fulfillment that points to a certain dynamic strife inherent in the
perceptual act. What is presented in the act, the perceptual object, is always
inadequately presented and this inadequacy can be construed in two ways:

1. Either it refers to the epistemic need of better knowing the perceptual object
   which can be presented more holistically and determinately in subsequent
   perception
2. Or it refers to the structural limitation of the perceptual act per se, to actually
   presenting only the current aspect of its object. This latter is thus foundational
   for the first kind of inadequacy.

It is the second construal that is of interest here. The tendency towards expectation
fulfillment is an inherent moment of the perceptual act as such. It is functionally
interdependent to actual aspect appearance and this is imposed on us by the
realization that the perceptual object is a temporally enduring object and it is given
in perception as such an enduring object. If perception, in essence, is first of all real
time perception, then the perceived object appears during that real time perception
as an identity in time. But if only the current aspect of the object is temporally-now
appearing in the course of this real-time perceptual act then its hidden aspects must
be somehow co-intended if it [the object] is to be perceived as an identity-in-time.
The current and hidden aspectual content is never constant but is in a state of
continuous variation. For this variation of aspects to be cognized as such the falling
of the aspects into hiddenness must be somehow be intentionally retained and
projected as expectations. In this variation a constancy is constituted: the appearing

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independent from that synthetic activity. It is deliberately used in both the subpersonal and personal levels.
Sensorimotor singularity and phenomenal content either perceptual or intentional are both constituted in this
general sense though their constitution takes place in different levels of description each with its own
ontological peculiarities. For the more technical Husserlian notion of constitution see footnote 44.
object. The details of this temporal constitution must be elaborated but for now a general account should suffice.

This is the problem that Noë is primarily facing concerning perceptual experience and his notion of ‘virtuality’ is mobilized as a solution to that: perceptual content appears as virtual in the sense that the hidden aspects of the identically one perceived object can be accessed or in the sense that the perceptual subject has sensorimotor expectations of these hidden aspects. But mere access cannot be a functional moment of the perceptual act because mere access is not as such directed to any specific hidden aspect to be synthesized with the current aspect constituting thus the unitary perceptual object.

Noë insists on this notion because he inquires into the role of action, understood rather limitedly as locomotion, in perceptual experience. This is how he organizes his enactive approach to cognition: bodily motion alters the aspectual appearance of the perceptual object but this object is constituted as a unity transcending its currently appearing aspect because the subject implicitly knows that he can always access by moving, the hidden aspects. For the subject to know he has access he must have prior knowledge of this, sensorimotorly contingent, aspect variation and this prior knowledge is projected as an implicit expectation that if moved thus the object will look thus. So in perception the notion of expectation is presupposed if that of access should have any relevance at all because access is relevant here only on the precondition of already known and thus expectantly projected sensorimotor contingencies.

But why should all this be of any importance? Because Noë’s wavering between access and expectation indicates that for his enactive approach the guiding thought of the interrelation of action with perception could be better worked out as a problem of the constitution of the temporally enduring perceptual object. We are captured here by the insight that what appears in perception is never a passively received sensory percept that could be instrumentally varied by movement, but an object that is constituted through and through from scratch by the functionally coupled interplay of current aspect receptivity and tendency-towards-fulfillment of hidden aspects expectation. Shouldn’t we speak here of a first-personal non-
instrumental interdependence of receptivity and tendency-toward-fulfillment? This interplay of receptivity with expectation on this most primordial of levels should also be interrogated for its subpersonal level equivalent of an allegedly functional interplay of a sensory component with a motor component in the case of perception, reminiscent to Hurley’s input-output non-instrumental interdependence, a notion so important for the enactive research program. This is a task for the next sections. But to fathom the phenomenological intricacies of such interdependencies one should turn to Husserl.

B2. THE HUSSERLIAN ACCOUNT

The Husserlian phenomenology of perception is unambiguous concerning the issue that is of outmost importance for our study, namely the intrinsic interrelationship of perception and action. I will focus on two notions that in my opinion play a central role in Husserl’s account on the matter: motivation and kinesthesis. My textual basis will mainly be ‘Thing and Space’, ‘Ideas II’ and ‘On the Phenomenology of the Consciousness of Internal Time’ as well as relevant to the issue secondary literature.

B2.1 MOTIVATION

According to Husserl the perceptual Ego has a reciprocal relationship with its perceptual objects which is reminiscent of the causal relation that holds sway between physical objects but also sharply differentiated. The appearing objectivities affect the Ego in a way that their presence in its perceptual regard motivates a cognitive response: ‘I hear that a lion has broken loose, and I know a lion is a bloodthirsty animal, and therefore I am afraid to go out in the street. The servant meets his master, and because he acknowledges him as master, he greets him with deference. We make a note for ourselves on a memo pad about tomorrow’s schedule; the consciousness of the schedule in connection with the knowledge of our forgetfulness motivates the making of the note. In all these examples, the “motivational because” appears. There is no question here of a judgmental
orientation to something real as such. The "because" expresses here anything but a causality of nature (a real causality)’ (Husserl 1989: 241-242).

My prior knowledge of my skillful practical relation with the appearing objects ‘causes’ or more correctly motivates a response on my part, but this response is not effected by rigid natural causal laws the way environmental circumstances cause a variation in the expression of objective qualities. The material thing varies passively with the variation of its external circumstances and the normativity of this alteration is a necessary one, dictated as it is by the thing’s physical qualities. The variation of the material thing is passive in the sense that it is caused in an absolute manner by the outside but also lawful. This lawfulness confers to the apprehension of his variation caused by varying circumstances as expression of its physical qualities.

And most importantly, ‘material things are conditioned exclusively from the outside and are not conditioned by their own past; they are history-less realities’ (Ibid.: 144, my emphasis). The thing of nature is apprehended as passively conditioned to ontological variation on external circumstances. Even the physical qualities of its compositional matter, of its molecules and atoms and subatomic particles, are external to it. These physical qualities form a causal nexus with external circumstances (themselves conditioned by the passive interplay of physical qualities in general) and even though they genetically condition the formation and conservation of the material unity they are qualities of, they are external to it, in the sense that its formation by them is completely circumstantial. The transforming material thing in its compositional and decompositional variation has no inherent relation to its past phases but only helplessly falls perpetually into the always novel stream of variations. Circumstances permit, it might compose itself in exactly the same state as a previous phase only to be thrown again into the spiral of passive variation. But, writes Husserl, ‘[o]n the other hand, it pertains to the essence of psychic reality that as a matter of principle it cannot return to the same total state: psychic realities have precisely a history. Two temporally contiguous cycles of external circumstances would affect the same soul in similar fashions, but within the soul itself the psychic unfolding of states could not be the same. For the earlier state functionally determines the following one’ (Ibid.: 145). The psychic being is sharply
differentiated to mere materiality through this functional dependency of its present on its past.

It is imperative here to note that the psychic being, the being through which perceptual objectivities are intentionally present, is ontologically characterized by the fact that its previous states relate functionally to its future states. In other words it is associatively predisposed to predict a possible outcome of its present state based on sedimented or internalized prior experience. This can mean that in perceiving it projects a possible variation of the content of the perceptual experience via its associative learning of previous encounters with the same kind of content. In this sense perceptual objects motivate subjective responses: because it always has a functional relationship with its past the perceptual subject projects possible variations of perceived perceptual objectivities, it anticipates them. And the content of these anticipations is always open to fulfillment.

It would be wise to recapitulate at this stage:

1. The psychic thing, the perceptual subject, differentiates itself from the material thing because it is internally conditioned. It is self-related.

2. This self-relation is its basic ontological characteristic. It can be further descriptively elaborated as temporally self-related.

3. The formal structure of this temporal self-relatedness is thus: perpetual internalization of its past which is projected as its possible future on the circumstance of its present.

4. Its present is construed here as presence of perceptual objectivities which by force of the above formal structure act (the objectivities) as motives for the production of expectations of their possible variation.

5. These expectations are posited as always possible to come to presence, that is, as open to fulfillment.

But for Husserl perceptual intentionality is always embodied perceptual intentionality and our lived body (Leib) enters the thematic of temporal self-relatedness via the
concept of kinesthesis. Its analysis will offer a leverage for the criticism for Noë’s notion of ‘sensorimotor contingencies’.

B2.2. KINESTHESIS

I noted above that, according to Husserl, the perceptual Ego has a reciprocal relation with its objects. Not only the objects motivate the Ego to project expectations regarding possible perceptual content variation but conversely the Ego itself motivates via its bodily movement the aspectual variation of appearing objectivities. ‘Those sensations which undergo extensional apprehension... are motivated as regards the courses they take either actually or possibly and are apperceptively related to motivating series, to systems, of kinesthetic sensations, which freely unfold in the nexus of their familiar order in such a way that if a free unfolding of one series of this system occurs (e.g., any movement of the eyes or fingers), then from the interwoven manifold as motive, the corresponding series must unfold as motivated. In this way, from the ordered system of sensations in eye movement, in head movement freely moved, etc., there unfold such and such series in vision’ (Ibid.: 62-63). Kinestheses are bodily movement sensations, kinetic sensations. These kinetic sensations are temporally coupled with related sensory modalities and the perceptual contents that appear via those modalities. Turning of the gaze motivates variation of the visual field as does turning of head or walking. Moving the arm motivates tactile content variation.

Kinesthesia is not mere sensation of bodily movement. It is sensation of active movement, self-movement. The co-appearing of relevant bodily self-movement in parallel with the series of appearing objective aspects. But kinesthetic sensations do not only involve movement or possible movement but also proprioceptive stasis: ‘in the case of "eye-movements, head-movements, hand-movements," etc., we have to do with continuous sequences of sensations which terminate at will and every phase of which can extend, with unchanged content, into a duration. These unchanged sensations thus provide us with pure and simple kinaesthetic sensations versus kinaesthetic changes or sequences.’ (Husserl 1997: 136) In other words they involve the whole spectrum of

39 ‘What matters above all, then, is "self-movement," and that manifests itself in kinaesthetic sensations’ (Husserl, 1997, 134)
kinetic sensations, from movement to stasis where they seem indistinguishable from static proprioception.

Husserl does not elaborate much on the phenomenal character of this sensations\textsuperscript{40}, but these along with tactile sensations and pain and pleasure sensations which are localized on (or in) the body (Ibid. 138) and the phenomenological character of the absolute center of orientation of the visual and auditory domains, constitute the first personal corporeality, my phenomenological Body (Leib)\textsuperscript{41}. More importantly for Husserl, kinestheses are the bodily expressions of the Ego’s spontaneity, its ‘I-Can’ (see Husserl 1989: 270-271). They are the ‘I-Move’ of the Ego’s ‘I-Can’: ‘Concerning the constitution of the personal Ego, it must be considered as having the Body as field of its free will, and especially in this respect, that the kinesthetic processes, which already provide essential contributions toward the constitution of the thing of the lowest level are characterized as free processes... If perception is to be constitutive of a thing, then there must also pertain to it the possibility of Bodily movements as “free” movements’ (Husserl 1989: 323)\textsuperscript{42}.

How then are we to construe this ‘motivational pendulum’ so to speak, between Ego’s motivation by perceptual content and content’s variation motivated by kinestheses? Some interpretative steps need to be attempted here if the connecting thread with Noë’s account is to be lured out in relief.

**B2.3 TEMPORAL SELF-RELATEDNESS**

On the one hand the aspectual presence of the object, conditions the projection of expectations that intend its variation and this projection is based on the prior associative learning (relevant to the specific kind of objects and states of affairs). This

\textsuperscript{40} As he characteristically writes: ‘Whether they make up a fundamentally and essentially new basic category of sensations, or whether they do not rather belong together with the tactile sensations in a higher genus, is a question the doctors can dispute.’ (Ibid. 136)

\textsuperscript{41} Lived corporeality is of course constituted as well by the empathetic recognition of the Body of the other as a perceived body with introjected the above characters and the reciprocal realization that I myself am recognized by her as such a Body (Husserl 1989: 254). I also consider that the reader is familiar with the difference of the Husserlian terms Leib (lived body- translated usually in English as Body) and Korper (material body, translated as body).

\textsuperscript{42} See also Zahavi (1994: 70)
prior learning is not associative because it was produced by behavioral associative
techniques but the term ‘associative’ refers to the inherent tendency of mnemonically
(implicitly) retained encounters with objects to reignite in the occurrence of
reencountering those objects. On the other hand actual (or possible) kinesthesia,
conditions the variation of content (or the expectation of variation). What the analysis
of kinesthesia points to is that actual or possible variation of content is always
embodied, the perceptual subject who experiences content variation or projects
expectations of that variation is always an embodied subject. That is an indisputable
conclusion of Husserl’s analyses of kinesthesia: no perceptual object variation without
kinetic sensations with the latter being the concomitant appearance of the lived body’s
active self-movement. So objective motivation of the Ego (its motivation by the presence
of objects) is always kinesthetic motivation of the Ego or motivation of the embodied
Ego. The double sense of motivation indicates that present content motivates
expectations of variation which variation is possible only through embodied movement.
And also this embodied variation of content sediments associative learning which in its
turn is responsible for the projection of expectations. So lets formalize anew this
perceptual subject’s temporal self-relatedness:

- The perpetual internalization of the subject’s past (in terms of embodied
  associative learning) is projected as its possible future on the circumstance of its
  present. And because the subject as perceptual is always intentional43:

- The internalized associative learning of previous embodied encounters with the
  object on occasion of a present encounter with the same object motivates
  expectations of this object’s variation.

This conclusion indicates the dynamic temporal horizon into which the perceptual
subject is ontologically situated. Perception is always and foremost an ongoing process
and the transcendent object that appears (as appearing) is a constitutive product of that
process44. This process involves a closed loop of future with past that is mediated via the

42 In the Husserlian, not the practical sense here.
43 It is beyond the scope of this study to delve into extensive clarifications concerning the notion of
‘constitution’ in Husserl’s work. The issue is vast. I refer to the classic study of Robert Sokolowski,
‘The Formation Husserl’s Concept of Constitution’ for details. In general terms, Husserl uses the term
constitution to name the way in which subjectivity carries out its function of giving sense’ (1970: 196). So in his first static
present aspect of the perceptual object. The present aspect motivates the perceptual act to express itself, to express its temporal self-relatedness: to project expectations of the aspect’s variation based on the act’s internalized associative learning, or in other terms based on its sensorimotor knowhow.

What we should realize here and keep as a kind of axiom is that the ontological character of the historicity of the subject has a specifically describable structure. We mentioned it previously:

- perpetual internalization of its past which is projected as its possible future on the circumstance of its present.

This is the formal description of the type of self-relatedness that is proper to the subject. It finds its token implementation in specific cognitive acts. For example in real time perceptual acts. The past of such an act is the flow of passing objective aspects or adumbrations which is internalized by the mode of primary memory or retention. This is a first level of past internalization. But the empirical subject has an already internalized ‘stockpile’ of associative learning acquired in its past life which can be view as a deeper second level of internalization. Now, this internalized past (first & second level) is motivationally projected on the circumstance of the current aspects in the mode of anticipations. This anticipatory projection of internalized past (retentive and associative) is a self-sustained coherent structure, a kind of metaphorical temporal elastic spring, that involves the moments of internalized past, anticipations and current analysis period in the case of perception, immanent contents which really present in consciousness are animated by apprehension (auffassung) and the intentional perceptual object is constituted as a transcendent worldly thing. In his later genetic analyses period he allegedly abandons this apprehension contents-apprehension constitutiving schema for temporal constitution where no immanent contents can be identified: ‘There is only the flow of inner time building immanent objects, which from this point of view cannot be distinguished into the two groups of sensations and intentions.’ (Ibid.: 179) There are alternative views about whether Husserl abandoned the schema. (e.g. cf. Mensch 2010)

45 See next section for a more detailed analysis.

46 Relevant to temporal and genetic synthesis respectively in Husserlian phenomenology. Again, while I am aware of the issue of different levels of constitution and the need for their proper descriptive analyses, it is not my purpose to delve into it. In fact I quite deliberately try to avoid these issues while simultaneously attempting to extract what is decisive for my thesis. But my analysis of anticipations being motivated by retentions as well as by associative habitual learning is not in contradiction with the relevant secondary literature. Cf. Rodemeyer (2006: 94): ‘Differences between specific experiences disappear in far retention as similar experiences become grouped together into general “memories.” Nevertheless, these “memories” remain in touch with the living present; we could say they remain passively present. And when these “memories” arise through association with our current experiences, they are what we can call “motivated” associations. They give us general expectations about the experiences we face now, because of their similarities with the current situation’ (see next section for the notion of retention).
impression which as moments are non-independent either from each other or from the whole *temporalizing process*. This typical subjective structure is *expressed*, as I write above, in synthesizing perceptual contents. It expresses itself by temporally relating, according to the formal structure just described, the flow of objective adumbrations. It is by this *function*, this synthesis, that the co-intention of current and hidden aspects is possible. This function is the necessary condition for the ‘projection of sensorimotor expectations’ constitutive of the ‘virtual’ content of perception. It is not in itself a sufficient condition because various empirical subjects are differentially already [genetically] constituted and thus project different anticipatory contents" but without the ‘spring’ of dynamic temporal self-relation as such no projection would be possible at all. The analysis of fulfillment will help solidify this view.

**B2.4 FULFILLMENT**

Having gained the formal structure of the perceptual act’s temporal self-relatedness lets now move on to the Husserlian constitutive analysis of perceptual fulfillment. Concerning the act of perceiving a cube by moving around it Husserl writes: *The continuity of the apprehension includes the perpetual play of intention and fulfillment. We understand this in such a way that in the transition, as soon as the direction is indicated by the differential of movement, there continuously take place anticipations [vordeutungen] and fulfillments of the anticipations... The square comes to givenness in ever new ways with ever new adumbrations, and each new adumbration “belongs” to this course of direction and integrates itself in it as “intentionally” belonging therein’* (Husserl 1997: 89). What synthesizes the unity of the perceptual object from the *hyle* of its flowing aspects is this schema of fulfillment of anticipated aspects. This schema is the expression of the temporal self-relating core structure of the perceptual act itself. The object is intended as a concrete unity transcending the presentation of its current aspect because its hidden aspects are co-intended, that is: anticipated. This temporal

47 Cf. Sokolowski (1970: 201): ‘...temporal constitution does not explain the quality of acts, the material aspect of sensations, or the content of meaning and objects which we constitute.’
self-relating apprehensional schema binds together in one stroke perceptual object
givenness and lived body givenness.48 In one stroke perceptual object and perceiving
body (my first-personal perceiving body) are co-appearing.

I wrote above (p42) that the perceptual object as perceived is characterized by a kind of
presentational inadequacy. And I differentiated between a so called epistemic
inadequacy and a structural one inherent to the perceptual act itself. The first one refers
to a kind of teleological dynamics in perception. This teleology refers to the appearing
object and the inherent tendency of the act to better perceive it. The second refers to
the inherent structural tendency of the act to anticipate the hidden or not directly
regarded aspects. The Telos of the epistemic tendency is the best, more fully given
aspect of the appearing object.49 The Telos of the structural tendency is the givenness of
the object itself50. The epistemic tendency is founded on the structural tendency the
latter being a more basic constitutive stratum.51

48On the other hand I would hereby prefer to leave open the question whether Leib is already constituted
prior to its involvement in perceptual acts as Husserl seems to imply (e.g. Husserl, 1997, 138) or if one would
follow Merlau-Ponty in that Leib is foremostly a constitutive moment of perceptual acts (see Carman, 1999).
49"The more the rotation proceeds, so much more clear becomes the presentation, so much more complete,
and finally a high point or peak is reached, in which the square "best" presents itself in this direction of
change, such that further changes would again decrease the completeness of the presentation, progressing
on again to slight indication and then complete disappearance.’ (Husserl,1997, 89) There are two
supplementary lines of thought that could be followed here. The one could read the tendency toward the best
appearance in a pragmatic or practical manner, seeing the adequately appearing aspect as objects
affordances, aspects that are conditioned as adequate by the practical needs of the organism. This line of
thought would make a bridge here to Gibsonian perception and thus mediately with the whole of the enactive
program. And I believe that this reading is not a violation of the Husserlian text. The other relevant line of
thought here would set a contradiction with Noë’s insistence that objects and qualities of objects are
constituted as the sum total of projected sensorimotor contingencies and that no specific aspect better
presents the appearing object or quality.
50 ‘In normal perception, these are anticipatory intentions (the series of appearances is dominated by a certain
teleology). Every phase refers to the following one. That, of course, should not be taken to mean that we
focus on the appearances, since we are indeed directed to the object as the perception flows on. But every
adumbration is precisely an adumbration of the square; every one "brings the square to appearance," but
each in a different way. And every one brings to appearance something that previously did not appear, not
precisely that way. In addition, each one points forward: in the stream of appearances, the stream of
objective adumbrations, we feel ourselves drawn on from adumbration to adumbration; each one points
forward objectively in a continuity, and in this forward referral, the adumbration is an intimation of what is
now coming, and the intimation, the allusion, the intention, is fulfilled.’ (Ibid: 86)
51 Theodorou (2006) concludes that the inherent praxiality of perception for Husserl refers to the inherent in
the perceptual act ‘fulfillable telos of evidence itself’ and not to ‘…the possible means that are employed in
arriving at [this] proper telos’ (318). Those means are meant to be the bodily executive movements that fulfill
empty intentions. So the praxial character of perception does not fundamentally refer to accompanying
This more basic stratum of perceptual constitution is discussed in Husserl’s analyses of time consciousness (Husserl 1991). What is added there, as an additional structural moment of the expectation fulfillment schema is the retention of the previous aspects that ‘flow’ into the past. There is not only current and expected aspect co-intention but also the flowing into the past aspects is retained in the act. This ‘retention’ is also projected as expectation in the sense that hidden aspects already experienced which are (even vaguely) retained in this ‘primary memory’ are co-intended as open to re-access.

As Rodemeyer (2006: 96-97) explains: ‘on many occasions... protentions are motivated by retentions, often indicating that the content of a retention as "just-past" can influence my expectation of the “just-coming”’. In this sense these retained hidden aspects (or adumbrations in Husserlian jargon) are projected as expectations open to fulfillment. We see here in this most fundamental level of constitution that the structural temporal self-relatedness of the act is always operative. Analogously to the projection in expectation of the associatively learned aspect variations, here the immediately experienced as aspects that has only recently passed into retention are projected in the mode of expected aspects prone to fulfillment or else to access. Husserl comments: ‘... the style of the past is projected into the future...’ (quoted by Mensch 1999: 57).

Of course the problematic of protentions was examined at a later stage by Husserl himself than the one of retention. My narrative reverses this order because it was forced by my reading of Noë.

Rodemeyer speaks also of ‘far retentions’ as differentiated from ‘near-retentions’. These refer to the flow of retentions of retentions that sink into the past which constitute the sedimented associative memory that motivates anticipations as well. This comes in agreement to what is said in the text about retention and associative learning motivated anticipations. (2006: 94): ‘Differences between specific experiences disappear in far retention as similar experiences become grouped together into general “memories.” Nevertheless, these “memories” remain in touch with the living present; we could say they remain passively present. And when these “memories” arise through association with our current experiences, they are what we can call “motivated” associations. They give us general expectations about the experiences we face now, because of their similarities with the current situation. These “motivated” associations are to be distinguished from specific memories (i.e., the activity of recollection), which, with their clarity of content, are the reliving of certain experiences from the past, regardless of any connection with present circumstances’. See also footnote 46.

This view does not capture the whole breadth of Husserl’s treatment of the matter. The outflow of retentions does not only condition protentions by re-projecting their content as protented content, but as I keep stressing, more generally shapes the character of protention (and the specific outflow that perception tends to follow) based also on already implicit learning. These matters are worked out in a wider array of
Let’s explore a final twist to this story before we return to Noë. Inquiring into the intrinsic interplay between protention\textsuperscript{56} and retention in the Bernau manuscripts Husserl writes: ‘As long as the tone sounds, . . . protention continually directs itself to what comes and receives it in the mode of fulfillment, intentionally shaping it. Every primal presence is, therefore, not just content, but ‘interpreted’ content. Primal presentation is, thus, fulfilled expectation.’ (Ibid: 46). The appearing current aspect (primal presence) contains not only the present content of the current aspect but also the knowledge that this content is the fulfillment of the previous protention (expectation). The fulfillment of the expectation can only be realized in the present if the past phase is retained as protending the present. Only thus can there take hold a comparison between previous expectation and current aspect, a comparison inherent in the act. As Kortooms (2004) explains: ‘An actually present phase of consciousness is conscious of itself as an actually present phase of consciousness, because it is conscious of itself as the actualization of a preceding anticipation of what is to come.’ (163) By this motif of what Husserl calls ‘General Fulfillment’ (Ibid.: 158-164) the act itself is genuinely self-relating by perpetually currently retaining its previous protention of its current phase (Figure 5.). The act itself by temporally self-relating in this way is self-intending or self-constituting. And at the same time in its self-relation it constitutes the perceptual object because in its self-relational process it is the objective aspects that get temporally related. The act itself has no content of its own, what it inter-relates through the implementation of its structural self-relation is nothing else but the objective content itself. There are not two processes here but only one process of primal constitution of the perceptual object: the temporal inter-relation of content is the temporal self-

\textsuperscript{55} Cf. Husserl (2001: 611): ‘The tone resounding and continuing to sound, sounds for consciousness into a future; it reaches out to perception, so to speak, with open arms. No matter how empty and indeterminate this anticipatory continuity may be, it cannot be completely indeterminate; the style, so to speak, of “what is to come” is prefigured through what has just past... Indeed, it is a primordial law that every retentional course in pure passivity, without co-participation by the active ego-immediately and steadily motivates and thus generates intentions of expectancy that are determined in the sense of a similarity of style.’

\textsuperscript{56} The more neutral term Husserl uses for the moment of intending the immediate future.
relation of the act and the temporal self-relation of the act is the temporal inter-relation of content, its synthesis\textsuperscript{57}.

\begin{figure}[h]
\centering
\includegraphics[width=0.8\textwidth]{figure5.png}
\caption{The temporal diagram of basic intention/perception. This same diagram adapted from Husserl (Mensch 1999) can be utilized both for the case of a basic intentional and the case of a perceptual act. $E_1\ldots E_4$ refer to the current aspects presented. Above the horizontal line lie anticipations of hidden aspects or in the case of neurobiofeedback of the anticipated monitor line level. Below the horizontal line lie retentions of previous aspects together with prior anticipations for the current aspects. At $t+1$ the retention of prior anticipation for $E_2$ is compared with the actual $E_2$ aspect or else $E_2$ is fulfilled (or not). The outcome of anticipation fulfilment motivates novel anticipations ($E_3'$) and the same fulfilment process takes place at $t+2$ and so on. Notice that this diagram is neutral as to whether an active (basic intention) or passive (perception) anticipation-fulfilment takes place. But both share the same temporalizing core.}
\end{figure}

\section{B3. INSIDE THE SENSORIMOTOR LOOP}

I believe that the above Husserlian reading offers a clear phenomenological account of the constitutive interdependence of perceptual receptivity and active agency. The formal core of this interdependence is given to phenomenological description as the perceptual act’s temporal self-relatedness. The intentional-anticipatory moment is intrinsically bound to the received moment of actual presence (current aspect) in a fundamental way so that this binding is not reducible to either constituting moment. In one stroke the current aspect is always already perceived together with the anticipation towards hidden aspects and this non-reducible togetherness constitutes the identical object whose aspects are given in this very act. The content of the anticipatory moment

\textsuperscript{57} One should look into the Sokolowski-Brough-Zahavi dispute to adequately elaborate on these issues (see Zahavi 2011). My view here reflects Zahavi in that the absolute flow as pure experiencing (erleben) is not itself presented as object (erlebnis) for that would lead to a vicious cycle. Experience as temporalization itself experiences the object, that is it temporalizes it, that is it constitutes it. It is not itself a constituted objectivity. On the contrary it does not relate to itself vertically (reflexively) but horizontally as temporal self-relating but its content, what are temporally interrelated are objective aspects. Its locality can only be the temporalized objectivity, it has no location of its own and hence its radical externality to which I refer at various points in the main text.
is possible because of the subject’s structural historicity: the anticipated aspects do not appear arbitrarily out of the void but they are projections on the basis of prior learning, short term (projected aspects that have only just been retained) or long term (implicit prior learning). In the course of the real, always real-time perception, anticipations produce retentions and retentions (or implicit memory) produce anticipations. The perceptual object is perceived as an enduring unity in its flowing aspects through this temporally self-relating process: this is the true phenomenological account of the so-called ‘sensorimotor loop’ employed so avidly in enactive approaches. And this is the true phenomenological account of the non-instrumental interdependence of perception and action. I do not mean here that perception is bound to intention in the sense that there is no high level differentiation between a perceptual act and an action, that would be absurd. But perception is interdepended with agency at this basic level in the sense that passive receptivity is intrinsically bound to anticipatory intending that tends to fulfillment. What is this tension and tendency towards anticipation fulfillment if not an elementary activity? The active moment in the perceptual act’s dynamics is this tension for fulfillment as is also the awareness of actual fulfillment itself in retention of prior anticipations.

I think that this account is the phenomenological counterpart of Hurley’s notion of non-instrumental interdependence of sensory input and motor output, understood by her at the sub-personal level. And I believe Noë’s not consummated theoretical struggle is that he tries to fathom this issue of non-instrumental interdependency mainly on the personal level. Consider the following from Noë (2008): ‘Seeing...is an activity of exploring the environment drawing on one’s understanding of the ways in which one’s movements affect one’s sensory states...The back of the tomato is present to me now in so far as I know, now, that by the merest movement I can modulate my relation to

58 To forestall an obvious objection here, passive receptivity is not the constituted act of perception which as such is related to anticipatory intending. The already constituted perceptual act as well as the already constituted intentional-practical act are both products of a lower level constitution involving passive receptivity of current aspect, receptivity as primal impresional givenness of what faces me now, and retention-anticipation of what is hidden. The co-intention of what is currently received and what is retended and anticipated constitutes the content of what is perceived or what is intended and this constitutive co-intention is not possible without the temporalization structure of the act. The way this temporalization takes place is responsible for the constitution not only of the content but also the kind of act that emerges. See pp. 50, 53 and 60 for elaboration on the last point. So the term ‘passive receptivity’ used here is rather abusive but it has the utility of negatively reflecting the quasi-‘active’ character of anticipation.
it….[p]erceiving is an activity of exploring the environment drawing on an understanding of the ways in which one’s movements affect one’s sensory relations to things.’ (p663)

It is crucial here to note that prior understanding of the way possible movement will affect content is presupposed for perception to be enacted. If this prior understanding is not operative no perception would be possible. It is also imperative here to note that Noë is not stating the trivial fact that perception is actively modulated by movement. That would be mere instrumental dependence of perception on movement and he explicitly wants to surmount this. On the contrary, it is the understanding in advance that (specific) patterns of movement will effect (specific) patterns of aspectual variation that open the perceptual content to access. It is this prior projection of possible aspectual variation with movement that makes perception possible.

Experiential blindness patients cannot see because they lack this prior understanding, they lack this structural and structured coupling between sensory variation and active bodily movement, they don’t possess the skill to guide eye movements based on anticipated visual content because of lack of prior coupling between what is currently received and what should follow (see Noë 2004: 4 and for a critical discussion see Gangopadhyay and Kiverstein 2008). Compare this example with the empirical case of deafferentation discussed in section A2.3 where a similar coupling should take effect for a motor action to be possible. This temporal self-relatedness core is apriori operative for a cognitive act to be possible in general either perceptual or motor.

In our case here the experiential object stands there before me, an enduring identity in the temporal course of my perceptual regard because its appearing aspect from my current point of view is coupled with its hidden aspects in the strong sense that those aspects are co-intended by my perceptual regard. And they are co-intended in the sense

59 ‘Nor do I mean that seeing requires action in the sense of movement. Granted, you need to move your eyes in order to see; but there is no deeper sense in which movement is necessary for seeing. It is possible to see something in a unit of time too brief for one to make movement. By sensorimotor skills I have in mind something more basic, namely, an understanding of the way in which sensory stimuli change as a result of movement.’ (Ibid: 663)

60 ‘Experiential blindness is a form of blindness that is not due to damage to a perceiver’s sensory apparatus and a consequent lack of sensation. It is a form of blindness that occurs as a result of an “inability to integrate sensory stimulation with patterns of movement and thought”. Blindness of this kind occurs following the removal of cataracts in congenitally blind patients. Removal of the cataracts in these patients restores visual sensation but it does not fully restore sight. Patients that have undergone this operation report undergoing sensations that lack form. Sack’s patient Virgil reports for instance movement and colour that is “all mixed up”; “meaningless”; and “a blur”. (Gangopadhyay and Kiverstein 2008: 69)
of being open to be fulfilled by becoming actual aspects of a future direct regard. This self-relatedness of objective aspects is essentially given in a temporal format. And this temporal format is effected or enacted by the subjective temporal self-relatedness of the act as described in the last section.

I believe that the founding of objective aspectual co-intention (that constitutes the concrete object of perception) on subjective temporal self-relatedness (and not on mere open access) proffers an elegant solution to the aporia of the alleged conceptuality or conceptual penetration of perceptual experience. Noë insists, building on McDowell’s position (McDowel 1994) that understanding or some kind of conceptual capacity is constitutively operative in perception (Noë 2004 ch.6). He construes this capacity as sensorimotor understanding: ‘...to perceive you must have sensory stimulation that you understand. But unlike Kant and the tradition spawned by him, the form of understanding I have taken as basic is sensorimotor understanding. Mere sensory stimulation becomes experience with world-presenting content thanks to the perceiver’s possession of sensorimotor skills’ (p183). But these sensorimotor skills together with the variation of content they are coupled with, become ‘understanding’ by force of their possible normative effect on (active) perception that is established prior to actual movement. A stream of sensory data becomes an object of perceptual regard (is recognized as such an object) and remains in perceptual regard because this prior (sensorimotor) understanding guides the regard so that it remains ‘anchored’ on the object. The hidden aspects of the object are co-intended by force of this always present prior understanding whether there is movement going on or not. And Noë makes clear on numerous occasions that there is an active anticipating of the sensorimotor actualization of objective hidden aspects. It is this active anticipating that acts ideomotorly on the flow of the perceptual process anchoring it so to speak on its object of regard and thus constituting it. It is important to understand that prior to this ‘anchoring’ no perceptual object is present.

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61 Meaning that anticipations guide the process of the perceptual act the way future directed goals direct causally the present state of the acting agent according to the Ideomotor principle (James,1890). For a review on the implementation of the Ideomotor principle in sensorimotor theory, simulation theory of motor control and current representation theory of mind see Pezzulo (2008).
Interestingly this ideomotor effect of anticipations on perceptual content can be conceived of having gradations. A perceptual object may be kept in view or it may be explored by actively fulfilling its anticipations. In the second case the perceptual act has a basic intentional character (remember the neurobiofeedback cases in section A2.3). Let us reflect: the transition from passive perception to active perception is achieved by the mode alteration of the same anticipatory moment common to the passive and active case. In the second case the act is not merely retending the flow of objective aspects while simultaneously fulfilling (or not) its anticipations. Something new is organically added here: anticipations effect the relevant kinestheses (bodily movement) so that the objective aspects vary fulfilling the content of those anticipations. The awareness of fulfilment is effected by the same structure of retention of past anticipations and comparison (fulfilment). The ‘ingredients’ are exactly the same: retention, anticipation, retention of past anticipation of current aspect and comparison, tendency-toward-fulfilment. The difference is that active perception springs forth by the plain and simple actualization of this tendency-towards-fulfilment. This active character can be further described as anticipatory fulfilment not only of the intended content but also of the indented timing of its appearance. When these two conditions are met, namely aspect and timing of aspect appearance fulfilment, then as I propose the general phenomenological character of the act becomes active. To understand this point go back to the neurobiofeedback case of Hurley. There, the intending of the ascending of the line meant the anticipating of its futural content, namely the ascended line. We should add that the timing of the appearance of this content is also anticipated. When the line ascends in a regulated way by my anticipations, that is as I anticipate it and at the time that I anticipate that its ascension will occur, then the character of the act acquires an ‘activity’ or ‘spontaneity’. One objection to this would be as follows: I might be anticipating the futural content as well as the timing of the appearance of this

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62 See Hoffmann (2003) for the Ideomotor principle in action initiation and control relative to the research program of ‘anticipatory behavioral control’ in neuropsychology.
63 (by retending past anticipations and comparing them with current aspects)
64 I shall not chase in this study the obvious connection of active anticipatory fulfilment and the Husserlian ‘Ich kann’ that opens up before us here. Is the ‘Ich-kann’ presupposed for active anticipating to be possible or is it itself constituted by them? Though I would favor an interpretation that reduces the Ego’s fundamental spontaneity on temporalization and more specifically on the motif of General Fulfillment, these are issues that I must leave unexamined for the time being.
content which are indeed sometimes being fulfilled in the case of passive intentional act also. Take for example the observation of a rotating visual object. I anticipate both its futural appearing aspects and the rate of its rotation which are both being fulfilled. But this is still a passive perceptual act. It seems that adding the anticipation of the rate of changing aspects does not confer to the differentiation between passivity and activity here. But consider the following possible empirical case now: the rotating object is part of a neurobiofeedback setting where my anticipations act ideomotorly on its rotation. In this case I observe the rotating object by retending its flowing aspects and experiencing the fulfilment of my anticipations of its futural aspects as well as their timing. Now imagine that my anticipations change as the rate of rotation is concerned. Suddenly the object obeys this new tendency-towards-fulfilment and rotates at the rate that I anticipate. Then my anticipations change again and the object obeys again. I believe that the phenomenological quality of this act should now be characterized as active. And that is because I experience it as such. What is added in this case is the actual fulfilment of my varying anticipations, my varying anticipations that are being fulfilled systematically. And this systematic fulfilment of my varied anticipations describe the spontaneity of the act.

But still one might object that it is the capacity for anticipation variation, the capacity of production of a variety of anticipations that is at issue here and not their mere fulfilment. This capacity would point to an agency that is presupposed at this point and which consequently cannot itself be reductively explained by anticipatory fulfilment. In other words the ‘I-Can-Do’ is presupposed for the ‘I-Do’ to be possible. I don’t favour this interpretation but it would take great pains to support my view on this delicate but extremely important matter. We are already in very deep waters here. At least this should stay clear: the regulated fulfilment of the varying anticipatory content and timing of that content characterizes this process as active-anticipation-fulfilment which in turn characterizes the specific act no longer as passive but as active.

If we are attentive enough what we notice here is that this active perception is a kind of actualized intention even if a non-basic one: the intention to better observe is effected
by the means of the basic intention to bodily move (kinaesthetic component). This is
another example of how the temporal self-relating core makes possible the non-
instrumental interdependence of perception and action. This interdependence is not
only purported by the suggestion that both are subpersonally supported by the same
input-output non-instrumental interdependence as Hurley insists, but also by the
suggestion of their directly organically inter-migrating into each other by force of their
common temporal self-relating phenomenological core (Figure 6).66 Or, by descriptively
reducing perception and action on the temporal self-relatedness functional core we
situate them as species under the genus of cognitive or mental act in general, thus
delimiting their special constitutive interrelationship. An epileptic seizure might be
causally based on the vehicle of some dynamic singularity but based on our analysis it
cannot be placed as species under the genus cognitive act. The phenomenological
analysis and only that, can directly explain in this sense Perception-Action non-
instrumental interdependence.

It would be wrong to assume that the above confers to an internalist reading of
sensorimotor theory. This is warranted by the realization that the co-intended aspects in

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66 I am well aware that this phenomenological analysis of the temporality of passive perception, active
perception, basic intention and basic intention is not exhaustive by these analyses. To clarify this issue one
should delve deeper into the phenomenological literature on temporalization and genetic synthesis,
something that I can not undertake in the context of this study. Here it would be enough for me to present
the general framework of first-personal non-instrumental interdependence in way that is accessible to the
general philosophical and scientific reader. So the phenomenological informed reader or phenomenologist
should not be alienated with my deliberate choice not to use a stricter Husserlian language in this study. That
is also why I speak above of plain reflection on the act of perception or intention without raising issues of
phenomenological reduction. I must postpone these more detailed analyses for a future study.
the act are perceived as aspects of ‘that’ object which I perceive as perspectively situated ‘there’ in my egocentric space. The intended perceptual object is directly perceived from my point of view as present there in my spatial surroundings. I can always fulfil my anticipations regarding it by moving closer to it, by picking it up and manipulating it in a useful way etc. And the subjective structure of temporal self-relatedness is only operative at the constituted object, it is situated where its content lies. The content is always transcending the act. The subjective does not have a locus of itself: it is situated where it temporalizes.67

C. FUNCTIONAL AND NEUROPHYSIOLOGICAL CONSIDERATIONS

My primary theoretical motive in this study is scientific or better stated, epistemological neuroscientific. I believe that philosophy of mind should act instrumentally to neuroscience in the sense that its task should be to clarify the conceptual framework into which neuroscience finds its objects. A main portion of the epistemological work to be done is the clarification of the phenomenological entities that neurophysiology is supposed to explain. These entities are to be found in the domain of phenomenological description as well as in the field of psychological and neuropsychological research. And these entities need to be worked out in phenomenological reflection68 so that they acquire a form that can be useful for neuroscience.69

67 Remember the differentiation between general function and location that we made in the case of the dynamic sensorimotor singularity in Hurley (section A2.2) We shouldn’t confuse the locus of vehicular non-linear dynamicty with the locus of the subjective temporal self-relatedness. The first as a physical process involving the brain as well as external feedback loops. The second is always where the constitution takes place, at the appearing objectivities which them only can have an (perspectival-egocentric) spatiality. But on the other hand, if neural processes enable subjectivity then there is a strong internalist aspect to be taken notice here: the locus of the physical neuro-computational processing of dynamic input-output coupling is the Central Nervous System. After all neurological damage destroys any dynamic singularity. But input-output dynamic coupling considered in its strict neuronal physical implementation, does not contradict vehicle externalism nor content externalism.

68 Methodologically I affiliate with the neurophenomenological project here: ‘The general approach, at a methodological level, is (i) to obtain richer first-person data through disciplined phenomenological explorations of experience, and (ii) to use these original first-person data to uncover new third-person data about the physiological processes crucial for consciousness. Thus one central aim of neurophenomenology is to generate new data by incorporating refined and rigorous phenomenological explorations into the experimental protocols of neuroscientific research on consciousness.’ (Thomson et al.,
In my opinion the sensorimotor or enactive approaches move in the right direction as for their neuroscientific epistemological role. My own motive hereby is to try to enforce a subtle but important change in perspective by a more targeted phenomenological clarification of Noë’s notions of ‘virtual content’ and ‘free access’ to content as well by providing a phenomenological counterpart to Hurley’s non-instrumental interdependence. The moral is here the same: the better the phenomenology the clearer the neurophysiological explanandum.

I believe that the ‘open horizon of expectation fulfilment’ as an interpretative synthesis of Noë’s notions of ‘free access’ and ‘sensorimotor expectations’ more resolutely points to the temporal structure of the perceptual act. I think that this structure needs to be stressed out explicitly because it is situated in middle of the enactive thematic. By a reading of Husserl’s concepts of motivation and kinesthesis we ended up discovering that a subjective core of temporal self-relatedness must supplement Noë’s notion of virtuality to make his account more coherent. By appealing to this structural core three main doctrines of the enactive approach become integrated, namely:

1. The personal level non-instrumental interdependence of perception and action
2. The fundamentally embodied character of the perceptual subject
3. The externalist account of content and its non-represantationalism

I will try to guide this study to a closure by examining two objections Jacob (2006) makes to Noë’s enactivism that stem from neurophysiological considerations. These objections are neither the most important nor the best articulated of the objections that have been fired against Noë. But they relate to the neurophysiology that the enactive approach as a philosophy of mind in its epistemological role need take into account.
Our conceptual framework thus far gained:

**A. Personal Level Interdependence**

A1. Subjective Temporal Self-Relatedness. The general function that grounds:

A1.1 Active Perception by force of active-anticipation-fulfilment. An ‘active perceptual act’ is also an intentional act that involves Basic Motor Intentions enforced themselves by the same active-anticipation-fulfilment dynamic structure.

A1.2 Passive Perception by force of the passive-anticipation-fulfilment.

A2. The flow of retentions is always operative and is functional role is to:

A2.1 Synthesize the flow of past aspectual phases with the current phase

A2.2 Retend the past anticipation of current phase for comparison with current phase

**B. Sub-Personal Level Interdependence**

B1. Dynamic Sensorimotor Singularity. The general function of input-output dynamic feedback loop that causally founds both perceptual and basic intentional acts.

B2. Output also produces a reafference prediction which is used for prediction control of movement.

B3. A copy of the output command is used for self-other movement differentiation.

**C1. FORWARD MODELS**

‘Contrary to the enactive view that my sensorimotor knowledge of the sensory consequences of my own bodily movements is the main source of the phenomenal content of my perceptual experiences, the internal models theory of action suggests that because they are predictable, the sensory consequences of my own actions should not give rise to perceptual experiences endowed with much phenomenal content.’ (Jacob 2006: 10)

We should resist a quick response to Jacob’s objection. Instead we should examine in some detail the theory of internal models for motor control with the intention of
examining whether it is compatible with our conceptual framework. Then the answer to Jacob will present itself.

First of all two words about terminology. *Internal models* are models computationally present in the central nervous system that *simulate* the state of the motor system. The purpose for this simulation is for motor planning, control and learning (Miall & Wolpert 1996). Internal models are of two major categories: forward and inverse models. Based on a copy of the motor command and the current state of the system *forward models* estimate the future state of the motor system and the sensory consequences of the relevant motor output.\(^70\) Based on the current state of the system and its desired state *inverse models* produce the relevant motor command that would achieve the desired state.\(^71\) A hybrid model is one that utilizes both these models.

Their purpose is for the computational implementation of prehension tasks in robotics and consequently provide a functional theoretical framework for the relevant neurophysiology of prehension tasks in animals (primates mainly) and humans. Prehension tasks are visuomotor tasks that involve arm and hand grasping movements.

Now more specifically about the potential uses of forward models:

- **Canceling sensory reafference.** The prediction of movement produced sensory feedback (reafference) can be subtracted from the overall afference. This latter usually also involves sensory input which is co-produced by environmental variation (exaference). In this manner there can be a differentiation between self and environmental movement\(^72\). (remember the paralyzed eye case in Hurley, section A2.1)

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\(^70\) ‘In its simplest version, this model receives as input a copy of the motor outflow. Based on this information, the end-point of the movement can be predicted and continuously compared to the target location. Discrepancies cause an error signal to be generated, which triggers a modulation of the motor command.’ (Desmurget & Grafton 2000:426)

\(^71\) ‘An inverse model takes into account the inertial and viscous properties of the arm to estimate the motor command that will produce the desired displacement. Inverse models are therefore critical for feedforward control systems’ (Ibid.: 424)

\(^72\) ‘A forward model is a key ingredient in a system that uses motor outflow to anticipate and cancel the sensory effects of movement. Sensory signals arise in the periphery from two causes: those as a result of environmental influences on the body, and those resulting from self-generated movement. The first are termed afference, while the second type of sensory signals are known as reafference as they are the sensory consequences of movement. Although the afferent and reafferent signals have distinct causes they are carried by the same sensory channels. From a behavioural viewpoint it may be necessary to distinguish between signals from the two causes especially to monitor changes in the external world separate from those resulting from self-movement.’ (Miall & Wolpert 1996: 1266)
• **Overcoming feedback time delays.** Reafference is necessary for the control of movement. But in real circumstances the feedback delay takes too long for the efficient control of the smoothly and accurately executed prehension acts in primates. A prediction of reafference by a forward model can be used to rapidly control the movement by internal comparison with the desired state. This is prediction control. (figure 3, cf. with figures 1. and 2.)

• **Motor learning.** ‘[A] forward model can be used to transform errors between the desired and actual sensory outcome of a movement into the corresponding errors in the motor command, thereby providing appropriate signals for motor learning...Similarly, by predicting the sensory outcome of the action without actually performing it, a forward model can be used in mental practice to learn to select between possible actions’ (Wolpert et al. 1995: 1880)

• **State estimation.** During fast movements the sensory information about the real time limb location cannot be updated fast enough due to the aforementioned time delays. So a prediction of the sensory state can be used for estimation of the current sensory state.

We notice that forward models are used in the control of prehension movements. These movements are actualized basic intentional acts (in Hurley’s terminology) that also involve a non-basic intentional component (to grasp that object). The anticipation of the reafference is used for quick comparison with reference value (remember figure 1) so that the motor output is recalibrated. This is completely compatible with our discussion of Hurley, but of course Jacob’s issue is with Noë not Hurley. What Jacob says is that the ‘canceling of reafference’ in visuomotor tasks means that anticipation of reafference is not perceptually experienced. Indeed, it is widely known that someone cannot experience tickling sensations when tickling himself. An fMRI scan of this occasion demonstrated diminished activation of somatosensory cortex in self-tickling in comparison with tickling by another (Blakemore et al. 1998). This cancelation though,

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73 ‘...about 30 ms for a spinal reflex up to 200-300 ms for a visually guided response.’ (Ibid.: 1269)
74 The article demonstrated also a potential role of the cerebellum in prediction: ‘We used fMRI to examine neural responses when subjects experienced a tactile stimulus that was either self-produced or externally produced. More activity was found in somatosensory cortex when the stimulus was externally produced. In the cerebellum, less activity was associated with a movement that generated a tactile stimulus than with a movement that did not. This difference suggests that the cerebellum is involved in predicting the specific
takes place after the comparison with actual reafference for the purpose of self-other movement or self-other caused experiential content differentiation in general. If I had an experience of self movement in those cases then I wouldn’t be able to have a proper intentional relationship with my surroundings: I would feel that I move when in actuality I am not, I would experience visual field translocation where there would be none and be inflicted with vertigo, I would experience disarrayed tactile movement of touched items etc.75

But on the other hand, anticipation of reafference has a positive effect on contents. By fulfillment of anticipations I experience myself as the agent of movement. That is, the comparison of anticipations with current state does have a positive experiential effect as well: I experience voluntary self-movement and voluntary perceptual content variation. It is these positive effects that Noë implicitly has in mind. In our conceptual framework: if by retending the flow of my previous anticipations that are actively or passively fulfilled (see p.58) then by internalization of this process and expectation projection, I can aspectually intent the appearing object holistically. This more holistic intentionality76 confers to phenomenality. Predicted reafference cancelation is not here a counterargument.

To the objection that could be raised that a prehension movement is not a perceptual act we respond as follows: the phenomenological analysis of perception and action that let to the suggestion of their first-personal non-instrumental interdependence above, demonstrates that there is a gradated transformation from a passive perceptual act to an active perceptual act and then to an active manipulating act (prehension act). It is in my view an historical peculiarity of current philosophical discussions on the matter often sensory consequences of movements, providing the signal that is used to cancel the sensory response to self-generated stimulation’ (from the abstract)

75 ‘As an example consider the problem of moving the hand over an object on a table and estimating without the aid of vision whether the object is itself moving. The slip velocity (the velocity of the object across the palm of the hand) is the sum of the velocity of the hand and the velocity of the object in the outside world. So to decide if the object is moving, the component of its slip due to self-generated arm movement must first be removed. However, an efference copy cannot itself provide this information, as it is a motor signal predictive of muscle activation, rather than of sensory input. By generating an estimate of the sensory consequences of a motor command, an internal forward model can be used to cancel reafferent sensory signals, and thus allow the external environment-related signals to be recovered’ (Miall & Wolpert 1996: 1266-1267)

76 In the technical term of ‘aboutness’. The use of the term can be construed contextually and I think there is no gain in reminding by footnotes the particular meaning it has: practical or Husserlian.
to view an action as not having phenomenal content. Maybe I don’t have an imaginative content of ongoing anticipations involved in fast hand movements but that does not mean that I have no experience of the movement at all or of the goal of the movement. There are three lines of defense here for this thesis which I’ll try to fathom in brief:

1. **Phenomenological.** Turning my reflective regard on my prehension movement I can describe (and after practice with some detail) what I proprioceptively feel, what I visually see, what I intent to grasp and how. If I go deeper in reflective analysis I observe a temporal self-relating structural core common to passive perception, active perception and prehension. With the occurrence of the prehension act from a perceptual act phenomenal content does not suddenly disappear: that is absurd and in violation of the findings of plain phenomenological description which can be validated by other phenomenological subjects (cf. the case of the ‘Anarchic Hand’ below).

2. **Neuropsychological.** The deafferented patient does not only appear behaviorally unable to perform motor acts because of lost sensory innervation. He reports that he cannot feel his body. It is only with strenuous effort of visual observation of the torso and limbs that patient I.W. can again walk. When this observation is disrupted the action dramatically collapses.(Cole & Paillard 1995). That is, only when he begins feeling (seeing) his body he is one’s again able to move. There is also the case of the anarchic hand. Patients with a lesion at the supplementary motor area in the medial frontal lobes (SMA) cannot voluntarily control their actually moving contralateral arm. Their arm performs tasks almost as normal but the subject experiences it as moved by another agent: ‘...the patient is aware that the movements of the hand are discrepant with his goals. He therefore corrects errors due to the action of the hand and tries to prevent the hand from making further unwanted movements’ (Frith et al. 2000). The movement is perceived both visually and proprioceptively. We may ask then, what if sense of agency returned to the experience of the arm: would that mean that its perceptual content would suddenly disappear? That would again be absurd, to say the least.
3. Neurophysiological. Simulation theory of action (for review see Jeannerod 2000) has accumulated a growing mass of neuroscientific evidence pointing to the presence of the same neural networks in performing, observing and imagining an action. Networks of so called ‘mirror neurons’ in premotor and parietal cortices are activated in all three occasions (Rizzolati & Sinigaglia 2010), being even implicated in mere observation of observable objects (Chao & Martin 2000). This is an indirect evidence of a perceptual component in actions: perceived action shares neural computation with performed action.\textsuperscript{77}

Of interest to my case is also the Frith model for schizophrenia symptoms. Accordingly Frith et al. (2000) argue that it is the comparison of prediction of reafference with actual reafference that confers to our sense of agency. In our terms, anticipatory fulfillment constitutes singlehandedly, \textit{sense of agency} and content of the act. It is because I recognize that my anticipations regarding a mental act in general, are being fulfilled\textsuperscript{78} that I have a sense that I am the agent of that act, precisely because I live in that recognition of fulfillment. The computational background of the theory is based on internal models theory (Figure 7). Secondary to a lesion in the production of motor predictions various symptoms appear such as thought insertion or delusions of control. The theory is elegant but I will not elaborate more. The crucial point is that the absence of anticipation of the sensory consequences of the action enables the symptom of agency \textit{agnosia}.\textsuperscript{79}

\textsuperscript{77} In fact mirror neurons in imitation are discussed quite extensively by Hurley as well (2001, 2007)
\textsuperscript{78} In Husserlian terms via retention of prior anticipation of the current phase and comparison.
\textsuperscript{79} ‘In the patient with delusions of control something is wrong with that part of the motor system concerned with the generation of a forward model and the representation of the predicted state of the system. Since the rest of the system remains intact, the patient can represent the desired state, can calculate and carry out the motor commands required to achieve the desired state, and can check that the desired state has been reached. However, in the absence of an awareness of the predicted state his actions seem to move in one step from desire to execution with no intervening sense of volition, i.e. selecting and checking the action. Even though his actions are being correctly carried out the patient does not feel in control’ (Frith et al. 2000: 359-360)
There is another point that I’d like to stress here. My interpretation predicts a working memory component in the functional organization of the cognitive act, a prediction gained through the first-personal account of retention. It is through retention that prior anticipation of the current phase is retained for comparison. The question is, how could this be accommodated with forward models theory?

In such a model, prediction of reafference from (t+1) is compared with actual reafference from (t) (cf. Figure 5). The previous prediction is retained in the system and interacts, in the present, with the current sensory input. Somehow a more complex retaining of the flow of passing anticipations as well as of past results of state estimations should be accommodated in this view, a kind of functional working memory for the system. This working memory function would also be responsible of producing anticipations of probable future states in an analogical manner as the phenomenological account of act temporality has revealed: that the internalization of its past predisposes the content of its projected anticipations. This issue needs more thorough examination of course, but as a preliminary observation consider the following from Franklin & Wolpert’s 2011 review article on sensorimotor control (p427): ‘The prior reflects that not all states are a priori equally likely. For example, it may be that some configurations of the body are more common than others...the prior can be considered analogous to another sensory modality in that it provides
information that is weighted with sensory inputs depending on how reliable the prior is relative to the sensory evidence. The optimal estimate (or posterior), obtained by the combination of the sensory information and prior belief, always has lower uncertainty than the estimate based on the sensory information alone’. The previous phases of the visuomotor task (and the relative prior associative learning) statistically predispose the system to a limited range of anticipations that themselves have a direct effect to state estimation and prediction control. So at the sub-personal descriptive level as well, a temporal self-organization seems to be taking place where a cognitive act is formed. Even here we can’t help but recognize that ‘the style of the past is projected into the future’, when a self-relating temporal entity comes forth and perpetuates itself.

C2. THE TWO VISUAL SYSTEMS

Building on the work of Ungerleider and Mishkin (Mishkin et al. 1983), Milner and Goodale (review: Milner & Goodale 2007) described a twofold system of visual processing. Both subsystems bifurcate anatomically from the primary visual cortex at the occipital pole region with the one running dorsally into the parietal region and the other ventrally into the temporal region (figure 8). The dorsal system (or dorsal stream), the theory goes, processes visual information for real-time action control and is not conscious and the ventral system (or ventral stream) processes information of object recognition for verbal and conceptual manipulation and thus is conscious.

Figure 8.

The gross neuroanatomical topography of the ventral stream (arrow bellow) and the dorsal stream (arrow above). The first radiates into temporal lobe structures while the second radiates into the parietal lobules.

(http://commons.wikimedia.org/wiki/File:Gray728.svg)
There is here a sharp differentiation between vision for action and vision for perception. Jeannerod similarly differentiates a pragmatic and semantic visual processing (1997). The pragmatic processing occurs mainly in the dorsal system and is involved in planning and effecting a prehension movement rather than recognizing visual objects, a job for the semantic processing of the ventral steam.

Lesion to the ventral stream leads to optic agnosia or blindsight, the inability to recognize objects even though the subject can manipulate those objects almost normally. Lesion to the dorsal stream leads to optic ataxia, the inability to manipulate objects even though recognition ability is normal. Similarly, according to Milner and Goodale (1995) the dorsal stream is responsible for the programming of an imminent motor task and for its subsequent real-time implementation: ‘[t]his then is the specialized meaning we give to “vision for action”: not the use of visual information for abstract planning, but rather its use in the detailed programming and real-time control at the level of elementary movements. To achieve this, the dorsal stream does not use the high-level perceptual representations of the object constructed by the ventral stream, but instead relies on current bottom-up information from the retina to specify the required movement parameters such as the trajectory of the reach and the required grip aperture needed to grasp the target object’ (Milner & Goodale 2007: 775).

Jacob takes issue with Noë on this: ‘...I am not convinced that Noë can reconcile the enactive conception with the evidence for the two-visual systems hypothesis by conferring to his own appeal to one’s sensorimotor knowledge of the sensory consequences of one’s own actions the status of a constitutive claim’ (Jacob 2006: 9). In other words: if the neurophysiology of vision has proven that sensorimotor knowledge is

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80 see also Pacherie (2000: 411)
81 ‘In the anatomical context of a dorsal (occipitoparietal) versus a ventral (occipitotemporal) visual stream, the visuomotor deficit of optic ataxia has been used as the main argument to attribute the How function to the dorsal stream. Indeed, such patients demonstrate an exaggerated and poorly scaled grip aperture compared with healthy subjects, although they are not impaired in object recognition. On the other hand, patients with lesion of the inferotemporal cortex (ventral stream) are impaired in object recognition (visual agnosia) but remain able to reach and grasp these same objects that they cannot describe.’ (Rossetti et al. 2003)
82 Similar objections are raised in (Block 2005).
implicated in the *unconscious* control of action then Noë’s appeals to its status in the constitution of *perceptual content* are unfounded.

Noë comments that his approach is compatible but frames this belief in a way that seems as if he seeks to avoid direct confrontation: *‘The enactive approach is not committed to the idea that vision is for the guidance of action, so neither the fact that some visual processing is for the guidance of action, nor the fact that some visual processing is not, has any direct bearing on the enactive approach. From the standpoint of the enactive approach, all perceptual representation, whether the result of dorsal or ventral stream activity, depends on the perceiver's deployment of sensorimotor skills* (Noë 2004: 19). All perceptual representation whether from dorsal or ventral stream must depend on sensorimotor skill deployment. But how?

Mutatis mutantis what ever conclusion we arrived at in the last section when we examined forward models can be applied in the thematic of the dorsal stream. And that is because internal models are mainly computational functional models of prehension acts which are supposed to be processed in the dorsal stream. So internal models must be present in the anatomical confounds of the dorsal stream. In consequence our objections to the non-phenomenality of prehension acts can be enforced on Millner and Goodale’s insistence that whatever the functional outcome of the dorsal stream, it is unconscious.

So in a similar vein we notice that dorsal stream function acts as the neurophysiological vehicle of the prehension act as such. This act is a cognitive act in that it involves a practical intentional relationship with a visual object, an embodied relation to a perceived thing that the embodied subject manipulates. And it is an embodied relation to a visually given\(^{83}\) thing which as such a relation has an inescapable temporal endurance, during which this relation is constituted as a temporally self-relating act: this concrete reaching and grasping (prehension) act. In Hurley’s terms, the basic intentional act of arm movement unfolds in parallel with the non-basic intentional act of grasping the object, but in-between their interaction mediates the perceptual appearing of the graspable object.

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\(^{83}\) Abstraction here is made from proprioceptive givenness.
The aforementioned constitutive self-relation of the prehension act involves an anticipatory moment: ‘[o]bject grasping and manipulation rely heavily on the ability of the nervous system to anticipate the consequences of ongoing movements so that fine dexterity can be achieved’ (Grafton 2010: 482). Anticipation of reafference functions as prediction control on the temporal constitution of the on-going movement. Without this anticipatory control no smooth grasping movement is possible. In first-personal terms there is a running expectation that tends to be fulfilled and the actual fulfillment or frustration of this ongoing expectation are constitutive to the dynamic self-organization of the act itself. So the formal core counterpart of the ‘open horizon of expectation fulfillment’ of the act’s temporal self-relatedness seems operative in this context of the dorsal stream function. The prehension act is self-organized via the dynamic interplay of goal, predictions and reafference, it is self-organized as a temporally enduring entity and this entity enables the first personal level temporal phenomenology of prehension. After all in Milner and Goodale’s account the act itself is not in principle unconscious, only the visual information specific for motor planning is: ‘The visual information used by the dorsal stream for programming and on-line control, according to the model, is not perceptual in nature. According to our definitions, therefore, it cannot be accessed consciously, even in principle. In other words, although we may be conscious of the actions we perform, the visual information used to program and control those actions can never be experienced...’ (2007: 776, my underlining).

From all the above it seems as though the contradiction of the sensorimotor approach would not so much be with the dorsal stream account but with the account of a separate not sensorimotorly involved ventral stream which is exclusively responsible for perception. If perception per se does not involve sensorimotor mechanisms then Noë’s view would be out rightly mistaken.

Lets stay inside Milner and Goodale’s framework at first before examining some alternative views about the two visual systems. Elaborating on the role of the ventral stream they write: ‘The ventral stream transforms visual inputs into perceptual representations that embody the enduring characteristics of objects and their spatial relations (Ibid.: 774, my emphasis). This constituted objective endurance enables ‘the
identification of a goal object such as a coffee cup, and [enables] other cognitive systems to plan the action of picking up that cup’ (Ibid.: 775). But the role of the ventral stream is not exhausted here. In the cases where an action is not adequately learned, the ventral stream provides real-time supervision of the action: ‘The more unpractised and novel the action, the more likely it is to require a good deal of cognitive supervision and thereby to be influenced by perceptual processing’ (Ibid.: 779).

So there is a functional implication of the ventral stream with prehension acts after all. In cases where there is not an already situated anticipatory control of the movement in the dorsal stream, information of the perceptual type is used so that the temporally enduring objects of perception can be manipulated. This perceptual type of information has a close affinity with working memory: ‘The products of perception also need to be available over an indefinite time scale, to allow us to recognize objects (and their relations) from one occasion to the next, by combining current input with stored information. Such perceptual mechanisms allow us to escape the present and to use visual information from the past to inform our actions’ (Ibid.: 778). This very informative observation is all the more instructive in the case of patients with optic ataxia where when a time delay is imposed between stimulus and patient response the patient performs much better. So, ‘[w]hen there is a delay between stimulus offset and the initiation of the grasping movement, the programming of the grip would be driven by a memory of the target object that was originally derived from a perceptual representation of the scene, created moments earlier by mechanisms in the ventral stream” (Ibid.: 779).

We shouldn’t lose grip of what is going on here: this perceptual type of processing that the ventral stream confers has the functional role of retaining previous input so that it can be associated with current input for the purpose of organizing the prehension movement. One might even say that this retention of previous states is functionally coupled with the flow of current states. And this temporal self-relation of the aspects of the objects (remember that the authors themselves speak of a perceptual process here) that is effected by the workings of the ventral stream in the absence of skilled dorsal stream output is enough to produce prehension movements, in other words the retention of the object visual parameters motivates an anticipation of its grasping. In
this sense both ventral and dorsal streams are ontologically related because of this background mechanism or functional core of temporal self-relatedness. This demonstration of a common ground of ‘perception’ and ‘action’, this dynamic self-relatedness of the temporal flow of the act phases, situates us philosophically in a stage prior to both ‘perception’ and ‘action’, and it is through that common ground that both these notions should acquire their meaning. But, we should add here, even if both visual processing subsystems share a common functional ground, that does not mean that their respective outputs relate to the same cognitive skills. Maybe the dorsal stream supports fast movements of skillful interaction with the environment while ventral stream working memory capacities might offer a wider temporal horizon to be available to the act.

This wider horizon might be conferring to higher grade anticipations relative to the act that somehow act as simulation of the act’s future. These might play the role of non-basic intentions for the basic intentional act that unfolds. Simulation theory of motor control upholds a similar thesis: ‘In the field of human motor cognition, it is only recently that it was realized that actions involve a covert stage. This covert stage is a representation of the future, which includes the goal of the action, the means to reach it, and its consequences on the organism and the external world’ (Jeannerod 2000: S103).

In a similar vein Hesslow (2002) writes: ‘The anticipation mechanism will ensure that most actions are accompanied by probable perceptual consequences, so that during normal behaviour, we will always, ‘in our thoughts’, be a few steps ahead of the actual events. A simulation can thus be triggered by the same stimuli that elicit overt behaviour (p244). Anticipations involved in real-time motor control, apperception of object affordances and motor preparation can in principle (in phylogenetically advanced enough animals) get detached from real-time sensorimotor flow and acquire a protoconceptual character: ‘Evolution thus discovered that a good solution is creating internal, emulative loops. Representations, and in particular anticipatory representations, thus emerged in many organisms for two related reasons: correction (with respect to errors and delays) and selection (filtering only relevant info and parsimony). Both of them were initially related to the here-and-now, to the control of action (Pezzulo & Castlefranchi 2007: 120).
As we can evidently see here there is ample support for the view that maintains that perceptual content constitution as well as empirical categorical content constitution are intimately and intricately related with mechanisms of anticipatory motor control. My analysis also reveals that a working memory component must always be operative in these processes. The phenomenological description of the temporal self-relatedness of the mental act in general, can offer guidance in an epistemological manner so that we make sense of relevant empirical data. An example of this epistemological role is given by the above interpretation of Milner and Goodale’s view: even the ventral stream’s recognitional capacities can be seen as stemming from the same temporalizing core of anticipatory control of embodied movement. The high level perception-action distinction then, might not be isomorphically mapped onto anatomically and physiologically distinct areas of the brain. The phenomenological analysis of their interdependence offers a hint about an interdependence of the two streams as to their role in anticipatory control action and as to the way their difference can be thought in terms of wider and narrower temporal horizons.

Not everyone in the neuroscientific community agrees with Milner and Goodale as to the role of the two streams. For example Rossetti et al. (2003) argue that ‘the crucial role of the dorsal stream [is] in real-time automatic adjustments but not in movement programming, nor in slow intentional motor control’ (p174). Its fast reacting magnocellular innervation and its peripheral retinal field connections make it a system that computationally supports real-time control and corrections of fast movements: ‘Indeed the dorsal system allows quick adjustment of movement trajectory based on the kinetic feedback of the moving arm seen in peripheral vision, which becomes more important during reaching to peripheral targets, since action is directed away from eye fixation.’ (Ibid.: 174) On the other hand the ventral stream is not irrelevant to action control. Optic ataxics with bilateral lesions can perform close to normal in visuomotor

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84 This issue is explored extensively by Pezzulo in (2008). The decoupled anticipatory ‘representations’ retain intentionality because of their sensorimotor background. An intentional relation with what is not actually perceptually present is thus made possible. Similar views are developed by Hesslow (2002) as is noted in the text and also in the later work of Hurley (2008).

85 Posterior Parietal Cortex (PPC) Lesions
tasks involving central vision.\textsuperscript{86} So the operative ventral stream is very much involved in these tasks.

Based on this work Madary (2011) interprets the twin visual system in Husserlian terms. He argues that ‘the crucial difference between the two cortical streams is in their spatiotemporal processing, rather than functional output: the dorsal stream processes peripheral retinal input with a high temporal resolution, and the ventral stream specializes in foveal input with less temporal resolution.’ (p424) This picture directly relates to Husserl’s phenomenology of visual perception the account of which involves an always present horizon, both temporal and spatial, operative in the visual act. The spatial horizon involves the indeterminacy of the peripheral field and the temporal its anticipated determinability\textsuperscript{87} (cf. Noë’s account of the unregarded peripheral visual scene details, sections B1.2 & B1.3). These can be mapped on what we know about the neurophysiology of the dorsal stream: its fast reacting magnocellular innervation and its peripheral retinal field connections. So, ‘dorsal stream processing plays a main role in the spatiotemporal limits of visual perception, in what Husserl identified as the visual horizon.’ (p424)

So here is an interpretation of hard-core empirical data in a way alternative to the one that views perception and action as phenomenologically and subpersonally distinct. This appeal to Husserl’s more intricate descriptive analysis of the phenomenology of vision reveals their interdependence (non-instrumental in our terms)\textsuperscript{88} and act epistemologically in a predictive way as regards the interpretation of empirical data and

\textsuperscript{86} ‘To explain this simple fact, one has to argue that a different system has to be recruited for action in central vision, or at least that actions directed to centrally viewed objects must be processed through visuomotor channel(s) that bypass(es) the dorsal stream. As a consequence, the specific implication of the dorsal stream in action would be restricted to movements guided in peripheral vision’ (Rossetti et al. 2003: 173)

\textsuperscript{87} ‘The visual horizon is spatial because of peripheral indeterminacy, and it is temporal because it involves experiences that are possible in the most immediate future.’ (Madary 2011: 427)

\textsuperscript{88} ‘Husserl’s general structure of perception brings three important points. First, visual perception and action are intimately related. We continuously move our eyes and our bodies in visual perception (Hua XVI; Hurley 1998; Noë 2004; Findlay and Gilchrist 2003). When we are moving, we perceive by anticipating the consequences of those movements. This ongoing cycle of movement, anticipation, and fulfilment reveals the close connection between perception and action. Second, the role of action in visual perception highlights the ever-changing indeterminate spatial fringe of our experience (more on this shortly). Third, the notion of anticipation incorporates a temporal fringe of visual perception: according to Husserl, all perception essentially involves the anticipation of the immediate future. To sum up: action and perception are closely linked through the cycle of anticipation and fulfillment, and this cycle always includes a spatial and temporal fringe. Following Husserl, we can refer to this spatial and temporal fringe as the horizon.’ (Ibid.: 427)
as regards possible ways to construct new neurophysiological and neuropsychological experimental settings.\footnote{It should be noted that both accounts of Rossetti et al. and Madary’s on this issue have their counter-criticism in Milner & Goodale (2007) and Laasik (2014) respectively.}

I believe that we can safely conclude that the two visual streams account is in no strong conception incompatible with the sensorimotor account. On the contrary, after the phenomenological clarification of perception-action non-instrumental interdependence this empirical evidence stands in support of this account.

CONCLUSION

This study had two main theoretical goals. On the one hand the non-instrumental interdependence of perception and action had to be elaborated in strictly first-personal terms. This would supplement Susan Hurley’s account by demonstrating that the common causal dependence of perception and action on a subpersonal input-output non-instrumental interdependence while necessary is not sufficient for the proper demonstration of their constitutive interdependence. The interpretation of Alva Noë’s notion of ‘perceptual content virtuality’ in Husserlian temporalization terms helped accomplish the above.

On the other hand, this study intended to demonstrate the epistemological augmentation of sensorimotor theories could help themselves with, by an actual phenomenological analysis of perception and action. This was accomplished by the presentation of the \textit{subjective temporal self-relating core} operative in both perception and action and mediating their mutual inter-transformation. This account guided our interpretation of empirical data as supporting perception-action interdependence. By making more explicit the relevant neurophysiological explanandum this account also enabled us to attempt some empirical predictions regarding the role of working memory as well as of the particular way it must be interrelated with reafference prediction (in the context of functional models of vehicular processes enabling that explanandum).
The analysis of the ‘internal models theory of motor control’ and of the ‘two visual streams theory’ was an example of how such an interpretation could be carried out.

Further research is needed for a more coherent elaboration of the above two goals of this approach. The neurophenomenological school that sprung from Varela as well the theoretical founding fathers of enactivism such as Gibson and the cyberneticists should be scrutinized, as well as a more detailed reading of the phenomenological literature on the issues of temporal and genetic constitution should be undertaken. Relevant neuroscience and psychology literature should also be reviewed.

But this undertaking would overwhelm the scope of this study which had the moderate purpose to lay out the general conceptual framework for such an endeavour.
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Figures 1,2 and 3 adapted and modified from Hurley (1998).