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SPECIAL SECTION

The Skillful Body as a Concernful System of Possible Actions

Phenomena and Neurodynamics

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ABSTRACT. For Merleau-Ponty, consciousness in skillful coping is a matter of prereflective 'I can' and not explicit 'I think that.' The body unifies many domain-specific capacities. There exists a direct link between the perceived possibilities for action in the situation ('affordances') and the organism's capacities. From Merleau-Ponty's descriptions it is clear that in a flow of skillful actions, the leading 'I can' may change from moment to moment without explicit deliberation. How these transitions occur, however, is less clear. Given that Merleau-Ponty suggested that a better understanding of the self-organization of brain and behavior is important, I will re-read his descriptions of skillful coping in the light of recent ideas on neurodynamics. Affective processes play a crucial role in evaluating the motivational significance of objects and contribute to the individual's prereflective responsiveness to *relevant* affordances.

KEY WORDS: affordances, cognitive neuroscience, emotions, expertise, Merleau-Ponty, nonlinear dynamic systems theory, performance monitoring, phenomenology, relevance, self-organization, significance

The starting point for this paper is the observation that in many situations in our daily lives we act adequately, yet without deliberation. With certainty and fluency we take a chair, we immediately understand a traffic sign, and without deliberation we stop the pedestrian next to us, who, while about to cross the street, does not notice an oncoming car. Often we just act, and normally this immediate action is adequate. The aim of this paper is to contribute to a better understanding of this omnipresent type of everyday expertise, which I will call skillful coping here. Of course not all of our lives is spent in this state of skillful coping; sometimes things go very wrong, situations are new or complex and we are forced to deliberate in a detached way. But I restrict

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myself as much as possible to investigating the episodes that are spent in it and that unfold without explicit deliberation.

For the French philosopher Maurice Merleau-Ponty, consciousness in skillful coping is a matter of prereflective 'I can' and not explicit 'I think that' (Merleau-Ponty, 1945/1962). At each moment there exists an internal relation between the perceived situation and the capacities of the organism. The body as a task-directed system of possible actions unifies many domain-specific capacities. Examples of these capacities are taking chairs, understanding traffic signs, and crossing streets. This task-directedness of the body should be understood as fundamental, prereflective, and dynamic. It is *fundamental* in that 'task' refers to that about which the organism cares: the needs, projects, or interests that move it. The task can be conceptualized as an activity that is related to a state of the individual: to that about which he or she cares, his or her concerns. The organism's task is *dynamic* in the sense that it is 'redefined' constantly, because the organism's situation (in the broadest sense: involving its history, capacities, concerns, expectations, perceived environment, and relation to others) changes continuously. It is *prereflective* because in skillful coping the task and what counts as task fulfillment are not explicitly formulated or (re)defined.

To clarify the roles of consciousness and awareness in this dynamic interaction between coping and world from the phenomenological point of view, Merleau-Ponty (1942/1983) gives the example of a football player in action, who has a prereflective orientation towards the goal and perceives the situation immediately (without explicit thought or deliberation) in terms of possibilities for action:

> For the player in action the football field is … pervaded with lines of force … and articulated in sectors (for example, the 'openings' between the adversaries) …; the player becomes one with it and feels the direction of the 'goal', for example, just as immediately as the vertical and the horizontal planes of his own body. It would not be sufficient to say that consciousness inhabits this milieu. At this moment consciousness is nothing other than the dialectic of milieu and action. Each maneuver undertaken by the player modifies the character of the field and establishes in it new lines of force in which the action in turn unfolds and is accomplished, again altering the phenomenal field. (pp. 168–169)

Here consciousness is a dynamic 'I can' in action. Explicit *self*-awareness and explicit object-awareness, such as noticing that the opponent has a mustache, do not play a role here; the player is absorbed in his activity. Awareness, however, does play an important role, since the player perceives, for example, the openings between the players of the other team. Note that this type of awareness is directly related to seeing the relevant possibilities for action in the situation. Moreover, the presence of motivationally significant aspects in the situation is reflected in the sensed lines of force.

From Merleau-Ponty's descriptions it is clear *that* in a flow of actions without explicit deliberation, the leading 'I can' may change from moment to moment.

How in skillful coping these transitions between domain-specific capacities occur, however, is less clear and is the central question of this paper.

I want to show that phenomenology, psychology, and neurodynamics suggest that affect and self-organization play important roles in this process. According to Bennett and Hacker (2003), 'the manifestation of an emotion exhibits an appraisal of people, things or events relative to one's concerns (and one's concerns may stretch far beyond one's personal welfare and illfare)' (p. 217). This is in line with what we know from emotion psychology: affective perturbations are related to what is significant for the organism. For example, according to Frijda (1986), emotions are changes in action readiness that are generated as a reaction to objects or events that are relevant to the individual's concerns. Emotions regulate 'control precedence,' that is, the priority of an activity over other tasks (Frijda, 2004, p. 159).

This paper is organized in four parts, focusing respectively on phenomenology, self-organization (and affective perturbations), performance monitoring, and the dynamics of evaluations of significance. By analyzing Merleau-Ponty's descriptions of skillful coping, it will become clear that any familiar situation contains many perturbing affective influences as a result of the fact that aspects of our environment attract or repel us before we even think about them. Since Merleau-Ponty (1942/1983) suggested that a better understanding of self-organization is important for understanding behavior, I will pay special attention to the fact that the transitions in the flow of coping are self-organized: they do not require central conscious control, or some unconscious controlling supervisor. In the second part of this paper I will therefore present some current ideas on the self-organization of brain and behavior (Thompson, 2007; Varela, 1999). Varela, partly basing himself on Merleau-Ponty (1945/1962), stresses the role of affect in this self-organizing process. In the third part I will focus on a specific type of affective perturbations that is particularly important in a flow of skillful coping, namely perturbations related to performance errors and task obstructions. For this we turn to the cognitive neuroscience of performance monitoring. Finally I will present an ambitious theory on the neurodynamics of appraisal by Lewis and Todd (2005) that aims to integrate insights from phenomenology, performance monitoring, and dynamic systems theory.

We will now reflect on Merleau-Ponty's example of the football player in action and other descriptions of skillful coping, in order to get a better understanding of the role of affective perturbations.

Merleau-Ponty's Phenomenology of Skillful Coping

In this part of the paper we will see that Merleau-Ponty recognizes the importance of self-organization for understanding the generation of behavior of living organisms. Other important concepts for him are affect and what today we would call 'know-how.'

Merleau-Ponty on Self-Organization and Transparent Coping

In his first book, *The Structure of Behavior* (1942/1983), Merleau-Ponty stresses the embeddedness of living organisms in their familiar environments. Moreover, he recognizes the relevance for the generation of behavior of the way the embodied nervous system organizes itself (p. 207).[1] Probably partly thanks to the dynamic approach to brain and behavior advocated by Wolfgang Koehler (1928), Merleau-Ponty was an early adopter of the idea of *self-organization*. For example, he stresses that the field of action and perception, the brain and the functioning of the organism are 'nothing outside the process which … organizes itself' (Merleau-Ponty, 1942/1983, p. 207).

Although Merleau-Ponty's view on the organization of the nervous system can be characterized as dynamic in a traditional sense because of Koehler's influence (1928; Merleau-Ponty 1942/1983, pp. 37–39, 46–47), it was of course limited by the knowledge of his age (the early 1940s). Koehler's views on brain dynamics were derived from physics and stressed the tendency towards a stable equilibrium, rather than the brain's inherent instability emphasized by current theories of nonlinear dynamic systems theory which focus on 'metastability,' a notion to be discussed in the second part of this paper. Although Merleau-Ponty (1942/1983) extensively discusses Koehler's views on the role of brain dynamics in the generation of behavior, he always keeps some distance from the latter (and other Gestalt-psychologists) by emphasizing the *fragility* of equilibria in human functioning (e.g., pp. 168–169, 245) and the ambiguous nature of perception and action (e.g., pp. 175–176). It is interesting to see that this inherent fragility of equilibria is reflected in the current theories on the self-organization of brain and behavior (see the second part of this paper).

As we observed above, for Merleau-Ponty (1945/1962, p. 137), consciousness in skillful coping is a matter of prereflective 'I can,' and not explicit 'I think that.' Besides being at every moment the active, leading 'I can,' the body also unifies many other domain-specific capacities, or potential 'I can's. It is an anticipating system, oriented immediately in its familiar world. There exists a direct link between the perceived situation (presenting possibilities for action) and the individual organism. The possibilities for action perceived by the organism depend not only on the external environment, but also on the capacities possessed by the organism and on its concerns. This implies that two persons with the same concerns, but different in terms of capacities, are likely to perceive, and be attracted by, different possibilities for action in the same external environment. The same goes for a person who develops from a novice to an expert in a certain skill-domain, although in this case not only her skills will have developed, but most likely also what she cares about. Having acquired the new skill (and related concerns), she will be able to make more subtle discriminations and more appropriate actions in the situation (Dreyfus, 2002).[2]

Both the state of the organism and its environment change continuously. The adequacy and flexibility of behavior characteristic of living organisms in their familiar environments require the continuous regulation of behavior. At every moment the task-centered generation of behavior needs to take account of the specific situational context. This is of course a very dynamic process: the vital situation changes continuously with the changing circumstances (Merleau-Ponty, 1942/1983).

Merleau-Ponty's (1942/1983) example of the football player presented in the introduction also shows that a flow of actions in familiar domains can be characterized as transparent coping (Dreyfus, 1991, pp. 64–68). The domain-specific capacities take control, and equipment (such as the shoes of the football player or the racket of the tennis player), the actor's own bodyparts, and even 'the self' become transparent. In transparent coping there is awareness (not of the shoes, because these are likely to be transparent, but of the openings between the players of the other team, as we saw in the introduction), but no explicit self-awareness (Dreyfus, 1991, p. 67; Merleau-Ponty, 1945/1962, p. 106). The body just acts; there is a continuous interaction of body and environment. Transparency leaves space for openness to continuously changing circumstances and for taking account of all sorts of feedback.[3] In case of a disturbance of this flow of actions, transparency will diminish or disappear, and the first-person experience of how things are going in the situation will become more or less aware, depending on the strength of the perturbation.

The Roles of Know-How and Affect in Skillful Coping

It is important to realize that for Merleau-Ponty (1945/1962) it is characteristic for the skillful body as a concernful 'system of possible actions' (p. 250) that it inhabits familiar environments, where it has learned and knows how to act, and, moreover, where it cares about what happens. My body did not end up in this room behind my PC by coincidence on this warm day in June; it has got work to do here. Normally we move from one familiar practice to another, implying that we can cope in habitual ways (unless a marked breakdown occurs and we must switch to deliberate problem solving and/or action; Dreyfus, 1991). The body that is attuned to its familiar environment does not deliberate, but allows itself to be invited by opportunities for action; one moves towards objects that look already 'attractive or repulsive' before one perceives their objective qualities (Merleau-Ponty, 1945/1962, p. 24).[4] Here it is important to note how action and perception are meshed for Merleau-Ponty.[5] The craftsman in his familiar environment, for example, perceives the world around him in terms of his possibilities for action.

> … the subject, when put in front of his scissors, needle and familiar tasks, does not need to look for his hands or his fingers, because they are … potentialities already mobilized by the perception of scissors or needle, the

> central end of those 'intentional threads' which link him to the objects given. …[It] is the piece of leather 'to be cut up'; it is the lining 'to be sewn'. (Merleau-Ponty, 1945/1962, p. 106)

Here, in the living present, the direct relation between the perceived situation and the capacities, the prereflective intentionality, of the body becomes concrete: the body's 'I can's' are immediately directed at some of the objects around it, perceiving the piece of leather as that which is to be cut up; a possibility for action. Merleau-Ponty's phenomenological description above is a good example of what Gibson would later call 'affordances' (Gibson, 1979, p. 127; Michaels, 2003).

This process of being responsive to affordances is inseparable from affectedness, because 'we consider everything that bears a significant relationship to our concerns as part of our present' (Merleau-Ponty, 1945/1962, p. 426). With respect to the role of affect in Merleau-Ponty's descriptions of skillful coping, we should note that the craftsman mentioned above never perceives his situation in a neutral way. He is affected by it because the situation relates to his concerns (for which Merleau-Ponty often uses the somewhat confusing word 'task') and 'calls' him for some sort of work: 'The body is no more than an element in the system of the subject and his world, and the task to be performed elicits the necessary movements from him by a sort of remote attraction' (Merleau-Ponty, 1945/1962, p. 106). The body is task-directed; directed at satisfying concerns. But how do we know what the body's concerns are when it seems to have so many? The answer is that it shows itself in the living present where we 'make visible' that which is significant in the world for us, because we, as concernful potentialities for action, relate to certain selected things that we care about and are affected by when we perceive these objects or note their absence. We are solicited by the possibilities for action that we find significant at this moment, and in responding to them our situational concerns are expressed.

Because concerns and domain-specific capacities are components contributing to (and coordinated by) the self-structuring of the field of perception and action, the skillfully coping expert can immediately react to the preferred possibility for action perceived. The craftsman in his habitual world is surrounded by many objects that touch him and invite him to act.

The same goes for us in our familiar everyday world. The neurological disorder 'utilization behavior' sheds some light on our normal relationship with the world and use-objects in particular. It confirms Merleau-Ponty's observation that the objects in our environment do not leave us cold, but affect us in striking ways. In 'utilization behavior' (Lhermitte, 1983) such immediate responding to affordances no longer takes the individual's concerns into account.

The French neurologist Francois Lhermitte coined the term 'utilization behavior' in the early 1980s. It describes the fact that these patients with a lesion of the frontal lobe demonstrate an exaggerated dependency on the environment in guiding their behavior. There exists 'a tendency for the patient to be *attracted* by any stimuli from the outside world that would drive him to act

without being asked' (Lhermitte, Pillon, & Serdaru, 1986, p. 332). Patients with utilization behavior (UB) grasp and use familiar objects when they see them, disregarding a significant part of their situational context (Archibald, Mateer, & Kerns, 2001; Boccardi, Della Sala, Motto, & Spinnler, 2002; Eslinger, 2002). They respond to irrelevant affordances. Such a UB patient may, for example, put on a pair of glasses even though nothing is wrong with his eyes. Or upon seeing a bed he may start to undress, although this bed is in someone else's house. A light switch in his visual field may make him turn the light on and off continuously.

In the second part of this paper I will present some of the aspects of nonlinear dynamic systems theory that are relevant for a better understanding of the self-organized nature of skillful coping.

The Self-Organized Nature of Skillful Coping

One of the major problems in neuroscience is how activity patterns of the various areas of the brain become integrated and lead to a unified behavioral output (Edelman & Tononi, 2000). Nonlinear dynamic systems theory is able to clarify how this functional integration is realized. Even though currently the precise link with neuroanatomical and neurophysiological research is still mostly unknown, nonlinear dynamics does shed light on some important topics: on functional brain integration, on how rapid, self-organized switching between skillful acts is possible in coping, and on the fact that affect generated by the perception of a significant object might perturb the system and increase the likelihood of the occurrence of such a switch. Moreover, dynamic systems theory has an important heuristic function because it avoids the pitfall often encountered in cognitive neuroscience of positing some 'idea' or plan entertained by a 'central executive' that would initiate and guide action, but the source of which remains completely unclear (or, even worse, is searched for in vain). A major characteristic of self-organization is that no conscious plan for action or 'idea' is needed to guide action, because unified behavior emerges from the dynamics of the complex system. I will now present aspects of Varela's (1999) analysis of the self-organization of brain dynamics. We will see that his recognition of the importance of 'metastability' and 'phase synchronization'[6] is shared by many other influential researchers in the field of neurodynamics. After that we focus on the important role affect plays in perturbing the metastable complex system.

The Importance of Metastable Dynamics in Complex Biological Systems

Various authors have stressed the importance of nonlinear dynamic systems theory for the understanding of brain functioning (Breakspear & Friston,

2001; Freeman, 2000a, 2000b; Friston, 1997; Kelso, 1995; Korn & Faure, 2003; Le van Quyen, 2003; Stam, Breakspear, Van Cappellen van Walsum, & Van Dijk, 2003; Tsuda, 2001). Especially the importance of the brain's inherent instability[7] or metastability is stressed by many of the relatively small group of people who are experts on both brain dynamics and nonlinear theory (Freeman, 2000a, 2000b; Friston, 2000; Kelso, 1995; Tsuda, 2001; Van Leeuwen, Steyvers, & Nooter, 1997). Metastability concerns the relation between parts and whole: the individual parts of the brain show at the same time tendencies to function autonomously and tendencies for coordinated activity (Kelso, 1995).

Also Varela (1999) points out that normal functioning in complex biological organisms is primarily characterized not by stability, but by metastability. In mathematics and dynamic systems theory the 'phase space' is the space in which all possible states of the system are represented. Each possible state of the system corresponds to a unique point in the phase space. Varela proposes to accept the evidence that for biological organisms, the geometry of the phase space is best characterized by the presence of inherently unstable regions. Owing to these endogenous instabilities, the biological system flows spontaneously between the regions of the phase space without the need for an external perturbation. So Varela proposes to think of phase space not as characterized by an attractor in the traditional sense, but as made up of regions that are visited transiently in an ongoing complex pattern of motion.

Varela (1999) discusses Kelso's (1995) example of looking at ambiguous figures such as the Necker cube or the figure of the rabbit-duck. The spontaneously switching percept of an ambiguous figure reveals the intrinsically metastable dynamics of the perceptual system, which contains many stabilizing and destabilizing forces at the same time. In Kelso's (1995) example there are two different metastable states, each corresponding to a different experience. Importantly, switches between the phenomenal experiences are also *experienced* as occurring spontaneously (Van Leeuwen et al., 1997, p. 320). According to Bressler and Kelso (2001), metastability underlies the capacity for the rapid and fluid change of cognitive processes. This is important because it allows humans and animals to produce on-line a course of action that is adapted to the encountered environment (Bressler & Kelso, 2001, p. 34).[8] Varela (1999) suggests, following and quoting Kelso, that not only the perceptual system but also the (embodied) brain as a whole probably is 'a twinkling metastable system living on the brink of instability' (Kelso, 1995, p. 200).

How can contributions from different brain areas be combined in a consistent manner, given that the brain is a complex network structure made up of areas that are reciprocally connected (Edelman & Tononi, 2000)? Varela and Thompson's (2003) working hypothesis is that a specific transient large-scale emerging cell assembly underlies the emergence and operation of every cognitive act, from sensorimotor behavior to remembering a beautiful experience. To quote Varela (1999):

> The emergence of a cognitive act demands the coordination of many different regions allowing for different capacities: perception, memory, motivation, and so on. They must be bound together in specific groupings appropriate to the specifics of the current situation the animal is engaged in (and are thus necessarily transient), in order to constitute meaningful contents in meaningful contexts for perception and action. (pp. 274–275)

Varela and Thompson (2003) propose that the mechanism that makes numerous widely distributed brain areas function together for a short period of time (a period of a few hundreds of milliseconds) is synchronization of neuronal subpopulations by means of transient phase locking (see also Varela, Lachaux, Rodriguez, & Martinerie, 2001). Metastability guarantees that the brain does not stall in a certain stable state (phase-lock, one synchrony pattern), but generates ongoing sequences of synchronization and desynchronization (Friston, 1997). The nature of the anatomical connectivity between brain areas is crucial for the emergence of metastability and this type of transient phase synchronization (Friston, 1997). Empirical evidence for transient global phase synchronization is discussed in Varela et al. (2001; see also Cosmelli et al., 2004 and Stam et al., 2003).

This discussion on nonlinear dynamics has remained very much at the conceptual level. Unfortunately, as mentioned above, the link to the underlying neural processes is currently mostly unclear. For example, even the nonlinear dynamics of simple motor skills are unknown, although the most important brain areas contributing to the execution of motor skills are known. However, I believe that this is not so much due to an inherent weakness of nonlinear dynamic systems theory, but the result of the fact that both nonlinear dynamics and empirical neuroscience are still in their early stages of development and have developed mostly independent of each other. Most likely our knowledge of the relation between the neural substrate and the nonlinear dynamics will improve when work on the integration of nonlinear dynamics with knowledge about neurophysiology is given a higher priority within cognitive neuroscience. It is, however, important to note that already now nonlinear dynamics generates predictions that can be tested. For example, the prediction by Varela (1999) that alternations of phase synchronization and states of desynchronization will occur in the brain has recently been confirmed in a study on nonlinear synchronization in whole-head MEG recording of healthy subjects (Stam et al., 2003).

To conclude, then, for the purposes of this paper it is crucial that in terms of behavior at the level of the living organism, an autonomous switch may occur rapidly from one transient behavior of the metastable system to the next. This is comparable to the self-organized transitions occurring in the perception of ambiguous figures discussed above. Non-linear dynamic systems theory can model this.

I will now turn to the role of affective perturbations of the self-organizing system in moving from one ‘I can’ to the next. I will try to integrate Merleau-Ponty’s and Varela’s ideas in order to shed some light on this.

The Role of Affect According to Varela

According to Varela (1999), affect plays an important role in the generation of transitions between cognitive acts. With their emotions intrinsically fluctuating and easily perturbed, living dynamic systems, such as human beings, contain an endogenous ongoing source of self-motion (Rudrauf, Lutz, Cosmelli, Lachaux, & Le van Quyen, 2003, p. 59). It is probably this conviction that motivates Varela (1999) to accept Merleau-Ponty's observation that affect drives the lived flow of experience of this self-perturbing system (Merleau-Ponty, 1945/1962). Moreover, according to Rudrauf et al. (2003, p. 59), Varela also suggests that, from another perspective[9] on the complex biological system, we could regard emotions as the control parameters of this system. Varela speculated that we could see emotions 'as control parameters in the initiation of bifurcations' between two cognitive acts (Rudrauf et al., 2003, p. 59; Thompson, 2007). Now I want to show why this is plausible, and in the final part of this paper I will try to make the idea of a control parameter more specific by linking it to the cognitive neuroscience of adaptive control in brain and behavior, in particular to the dynamics of evaluations of significance.

Varela (1999) primarily discusses the role of affect by describing situations of breakdown in action. One example:

> If, as I write this, I hit a control key, and I am shown a message saying 'Do you really wish to erase this text?' I find myself deliberately avoiding pressing the 'OK' button, in an emotional tone of hope and tension. The awareness of the possibility of making a fatal mistake breaks into the present triggering a (more or less marked) shattering of transparency. In parallel a new stance in ongoing coping emerges: I deliberately click on the 'Cancel' button. (pp. 298–299).

This breakdown ends a sequence of involved skillful coping. The related loss of transparency is accompanied by an emotional tone that induces a bifurcation in the trajectory of the system and can rapidly cause the switch to a behavior that is adequate in the new situation.[10] The typing example helps to understand how an episode of flow can be individuated. One flow of skillful coping, of typing, for example, is an experienced unity of involved activity that can be ended by an interruption.

A limitation of Varela's (1999) focus on marked breakdowns is that these ask for more or less deliberate action owing to the strength of the perturbations involved. However, based on Merleau-Ponty (1945/1962), I would like to suggest that in a flow of involved skillful coping we may switch activities as the result of attraction or repulsion that we experience prereflectively when we perceive objects or, better, possibilities for action. From Merleau-Ponty's descriptions it became clear that every situation contains perturbing influences. So for a switch to another domain-specific capacity to occur, we do not need a complete breakdown.

On Being Affected by Significant Objects and Events

We have seen that the leading 'I can' may change from moment to moment. This leading domain-specific capacity acts on the possibility for action preferred by the organism on the basis of its concerns in the situation. For example, the craftsman can unreflectively switch from cutting, to sewing, to eating an apple, to answering the phone. How these transitions between domain-specific capacities can occur in a context in which preferences and self remain transparent (and so where there is no marked breakdown, but a bifurcation-inducing affective perturbation) can now be articulated further thanks to our better understanding of the importance of self-organizing processes in biological organisms.

We have seen that the body as a concernful system of possible actions is continuously being perturbed by significant objects and events; by possibilities for action that attract or repel it. I would like to suggest that their affective allure often is strong enough to switch from one leading domain-specific capacity to another in the flow of skillful coping. Or in other words, in skillful coping no full breakdown or explicit deliberation is needed to drive the flow of actions, because at every moment the concernful body is affected by some of the familiar and significant objects around it. In this way the body contains an important source of inherent instability that operates at the subpersonal level and does not require the self-awareness and fully fledged (explicit) emotion which appear when a full breakdown occurs. The living organism, however, is far from completely unstable. At every moment, the body also contains two important sources of stability: it is anchored in its familiar world because of the know-how and concerns it embodies.

To conclude, in my opinion Varela's (1999) stress on the contribution of affect to the generation of phase transitions of the self-organizing system is on the right track. Of course the *whole* organism (with its capacities, concerns, etc.) in the situation is needed for the generation of the metastable regime where transient global cell assemblies can emerge that underlie adequate non-deliberative cognitive acts. However, owing to its character as a (not the!) source of endogenous instability, affect does seem to play an important role in moving this system.

In the last two parts of this paper we will focus on a specific type of affective perturbation that is particularly important in a flow of skillful coping. We will first take a look at the cognitive neuroscience of adaptive control in brain and behavior. This should help to understand what happens when a motivationally significant perturbation (small breakdown or error) occurs that is related to one's performance but does not necessarily end one's involvement in a flow of skillful coping. In the final part of this paper we will then try to establish a link between the cognitive neuroscience of performance monitoring and a neurodynamic framework of appraisals.

Performance Monitoring and Error-Related Activity in EEGs

With respect to the neural basis of performance monitoring there is growing consensus that the medial prefrontal cortex, in particular the dorsal anterior cingulate cortex (dACC), contributes to a generic performance monitoring system that operates in relation to the anticipated consequences of actions (Brown & Braver, 2005; Ridderinkhof, Ullsperger, Crone, & Nieuwenhuis, 2004; Rushworth, Kennerley, & Walton, 2005; Rushworth, Walton, Kennerley, & Bannerman, 2004).

When an action's outcome is worse than expected, according to an influential theory by Holroyd and Coles (2002), a negative reinforcement learning signal ('reward prediction error') is conveyed to the dACC via the midbrain dopamine system (ventral tegmental area, VTA). Holroyd and Coles suggest that the impact of this pause in the dopaminergic projection on dorsal ACC activation is expressed in an electro-cortical brain potential known as error-related negativity (ERN/Ne, or informally as the 'Oh shit potential'). Following a wrong response, the ERN is seen as a prominent and negative deflection of the event-related potential (ERP) in scalp EEGs.[11] Given our interest in online action control in a skillful flow of coping, it is important to know that the ERN occurs very rapidly: it peaks between 50 and 120ms (henceforth: 'about 100ms') after the onset of an incorrect response. This is often fast enough to correct behavior on the fly.

Most current articles on performance monitoring tend to be broadly in line with Holroyd and Coles (2002) but also somewhat less specific.[12] Even though there seems to be growing consensus that the ERN reflects the detection of an error in reward prediction, it is not clear what the causal chain of events underlying the ERN is. Rather than having the errors or conflicts at their core, most current articles emphasize that performance monitoring occurs based on expected value, with dACC activation indicating that the current flow of events is unexpectedly disadvantageous (Ridderinkhof et al., 2004). Performance monitoring, moreover, is probably about signalling not only when things go worse than expected, but also when things go better than expected (Rushworth et al., 2004; Walton, Devlin, & Rushworth, 2004).

While the size of the ERN does not correlate with explicit awareness of response errors, a somewhat later positive ERP component, the Pe, has been associated with explicit awareness of the error (Lewis & Todd, 2005; Nieuwenhuis, Ridderinkhof, Blom, Band, & Kok, 2001). The Pe typically reaches maximum amplitude between 300 and 500 ms after an erroneous response and is thought to reflect the motivational significance of the error (Overbeek, Nieuwenhuis, & Ridderinkhof, 2005). Where the ERN probably reflects modulation by dopamine (Holroyd & Coles, 2002), a recent theory on the Pe suggests that the latter reflects modulation by norepinephrine (Nieuwenhuis, Aston-Jones, & Cohen, 2005). The functional significance of the latter modulator is probably that it potentiates information processing

(Nieuwenhuis et al., 2005). Norepinephrine facilitates (by 'mobilization of resources') the response to task-relevant events, including the correction of relevant errors (Nieuwenhuis et al., 2005; Overbeek et al., 2005, p. 326).

The final part of this paper presents a recent theory by Lewis (2005; Lewis & Todd, 2005) that integrates a lot of what we have been discussing above. This integration is possible because both Lewis and the people working on performance monitoring such as Overbeek et al. (2005) are interested in how evaluations (or in Lewis's terms, appraisals) of the significance of events can within a split second lead to adaptive actions.

The Dynamics of On-Line Evaluations of Significance

Some authors relate the ERN and the Pe to the motivational *significance* of events. Hajcak, Moser, Yeung, and Simons (2005) suggested that the magnitude of the ERN reflects the significance of errors. Both the ERN and the Pe have recently been related to the motivational significance of errors by Overbeek et al. (2005). They suggested that there might be a case of neural redundancy here: the existence of two parallel systems for evaluating error significance contributing to the generation of adaptive actions. Yet it is clear that the two systems also have different characteristics. A 'rapid preconscious system' centered on the dorsal ACC would be guiding adaptive behavior briefly after the event (Overbeek et al., 2005, p. 325). The related neural activity shows up in imaging studies as the ERN. The Pe is related to a second error-significance evaluation system, which would be slower, consist of more cortical areas, and correlate with more explicit awareness of the error (Nieuwenhuis et al., 2001; Overbeek et al., 2005, p. 325). Although very interesting, these ideas on the functional significance of the Pe are, as noted by Overbeek et al. (2005), in need of direct empirical evidence. But that qualification is true for all theories on the Pe.

Lewis (2005) and Lewis and Todd (2005) have recently incorporated the research on the ERN and Pe within a broader dynamic systems framework for understanding the generation of emotional appraisals. Lewis's dynamic systems model of emotions has the advantage that it brings cognitive neuroscience (the literature on performance monitoring) together with two aspects that we identified as crucial for understanding switches in the flow of skillful coping: self-organization and affect. Although Lewis's (2005) proposal is speculative (and Lewis and Todd's [2005] even more so), I would like to discuss it here because this Behavioral and Brain Sciences article was innovative and well received, and by using a micro-timescale (Klaassen, Rietveld, & Topal, 2006; Varela & Depraz, 2005) it integrates a lot of what we have been discussing: phenomenology, self-organizing neurodynamics, and activity in the medial frontal cortex related to breakdowns (of various sizes) in action. Although Lewis's framework was developed for understanding emotional

appraisals, I hope that by shifting our focus towards the microtemporality of motivationally significant (task-relevant) events, it will help us to integrate knowledge from various disciplines. A second aim of this part of the paper is suggesting how Varela's idea of emotions as control parameters inducing bifurcations in the trajectory of the system could perhaps be linked conceptually to current cognitive neuroscience.

The Microtemporality of Significant Events

Intentions and emotions take some time to develop. Phenomenologically, it is possible to distinguish various phases within an emotional episode on a micro-timescale of about 1.5 seconds (1500 ms; Klaassen et al., 2006; Varela & Depraz, 2005). Often affective fluctuations are small and do not get further than the first non-conscious or prereflective phases (Varela & Depraz, 2005). Valence is sometimes prereflectively experienced as a tension to move (Varela & Depraz, 2005). It is related to the ability of the organism to quickly determine, thanks to an implicit understanding of the broad context, whether it best moves towards or away from something that appears in its environment. Valence is behavioral and affective at the same time; characterized by both the (prereflective) affective experience of attraction/repulsion and the related behavioral tendency to move towards/away from the triggering event. Emerging a few hundred milliseconds after the event, valence is the earliest coordinated evaluation of the new situation by the organism as a whole (Klaassen et al., 2006). A more specific emotional experience takes probably at least a few hundred milliseconds more to develop (Klaassen et al., 2006; Varela & Depraz, 2005).

Lewis and Todd's Hypothesis

Lewis and Todd's (2005) hypothesis is that variations in the extensiveness of the self-organizing neural network (integrating more and more cortical areas with the brain stem, hypothalamus, and limbic system) underlie the various phases of emotional episodes. Moreover, they distinguish between various types of triggering events of emotions. They describe three levels of task or goal1[13] obstruction (breakdown) depending on the intensity or unexpectedness of the event (Lewis & Todd, 2005, p. 229):

- *level 1*: a minor obstruction that can be dealt with more or less automatically (bending down to pick up the key that one had just dropped or speeding up to change lanes);
- *level 2:* a small but significant obstruction that does not break the flow of coping and does not require explicit attention to object, action, goal, or affect (attention is primarily focused on what to do next to overcome the obstruction and the consequences that are likely to result

from it; to stay with the football example, the player might immediately shift attention from a blocked opening to another opening);
- *level 3:* an obstruction (failure) of sufficient intensity to get one out of the flow of skillful coping and into comprehensive and explicit awareness of emotions, objects, and intended actions (like in Varela's typing example presented above; Varela, 1999, pp. 298–299).

In all three cases a triggering event leads to self-organizing dynamics in the brain. However, the size of the neural network involved and the extent to which action is postponed increase with the level of goal obstruction. Tailoring an adequate response generally requires more time when the obstruction encountered is bigger (Lewis & Todd, 2005, p. 226). As far as the first-person experience of emotional awareness is concerned, Lewis and Todd distinguish between background (prereflective) and focal emotional awareness. They suggest that background awareness of emotional feeling (probably partly 'mediated by the insula', Lewis & Todd, 2005, p. 228) is always present (yet constantly changing), but that focal and explicit awareness of intentions and emotions is related to the third level of goal obstruction. The nature of intentionality at the various levels can be summarized as follows: well-learned routines unfold automatically at level 1; level 2 seems to be characterized by prereflective intentionality and affect because here we have purposeful (voluntary) correction of the situation without explicit awareness of intentions or emotions (Lewis & Todd, 2005, p. 229); and at level 3 we encounter explicit intentions and emotions.

Importantly, Lewis and Todd (2005) relate the ERN and the Pe to the self-organization of the global neural dynamics. After a perturbing event, first the parts of the brain involved in affective (or more neutrally: 'evaluative') processes become integrated, to be followed only later by the prefrontal cortical areas (Lewis & Todd, 2005, p. 218; see also Luu, Tucker, Derryberry, Reed, & Poulsen, 2003; and Lewis, 2005, for a review and synthesis):

> There is evidence for spontaneous coupling or synchrony at the theta frequency range across brainstem, hypothalamic, limbic, and paralimbic systems when animals are motivationally aroused [or] exposed to violated expectancies …—in other words, when they are emotional. (p. 218)

A significant goal obstruction triggers the emergence of transient phase-synchronization in the theta band, and the onset of this synchronization is what shows up in the ERPs (both ERN and Pe), according to Lewis and Todd (2005, p. 225; see also Luu et al., 2003; and see Yeung, Bogacz, Holroyd, Nieuwenhuis, & Cohen, 2007, for a critical discussion of the latter's methodology). This large-scale synchronization does not just generate a unitary emotional appraisal (an evaluation of its motivational significance), it is crucial that it also 'embodies the animal's intention to do something about its state in the world' (Freeman, 2000b, as cited in Lewis & Todd, 2005, p. 224). We

encounter here an internal relation between (prereflective) affective experience and (prereflective) intentionality similar to the one seen in the notion of 'valence', discussed above. To use words of Lewis and Todd (2005): 'Emotions and intentions arise together' (p. 210).

How Obstructions in a Flow of Skillful Coping Lead to Intentions and Emotions

Given our central question, I am primarily interested in level 2 obstructions in what follows, but in order to get the bigger picture I will also briefly present what happens, according to Lewis and Todd (2005), in the case of a smaller and a bigger obstruction. What are the characteristics of the various levels of goal obstruction distinguished by Lewis and Todd?

At level 1, the obstruction and delay in goal satisfaction is 'expectable and unremarkable' and the animal's global intention remains unchanged (Lewis & Todd, 2005, pp. 224–228). The required correction occurs automatically by means of small modifications without engagement of the dorsal ACC (and without ERN) or other areas of the prefrontal cortex (PFC). Attention is maintained on the task at hand and activities remain directed towards the anticipated consequences (Lewis & Todd, 2005, p. 228).

On some occasions, when the impact of the obstruction (level 3) is intense (e.g., when a—potential or actual—failure occurs), we become *explicitly* aware of the emotional significance of the obstruction. Extending Merleau-Ponty's example of the football player (Merleau-Ponty, 1942/1983, pp. 168–169), awareness might, for example, shift from the relevant openings (typical for levels 1 and 2) to the characteristics of this adversary who now repeatedly manages to obstruct one's way and one's emotional response to him. Another example of level 3 obstructions was the breakdown while writing a text that was described by Varela (1999) and presented above.

This type of awareness takes some time to occur, and Lewis and Todd (2005, p. 224) suggest that the Pe is an indicator of the (minimal) timeframe within which such awareness can develop, that is, a few hundred milliseconds after the maximal amplitude of the ERN (so typically at least about 300 ms after an erroneous response). In a sense this implies a switch from the primacy of the anticipatory, task-directed awareness characteristic of skillful coping (focused on how one would like things to be), to a more factual awareness of the obstruction itself and of one's emotional response to it (Lewis & Todd, 2005, pp. 230–231). Moreover, the complexity of the experience increases because now 'attention to actions, mediated by the dorsal ACC, becomes integrated … with attention to emotional feelings themselves' (Lewis & Todd, 2005, p. 230). Many areas of the prefrontal cortex are now engaged and functionally integrated by means of phase synchronization (Lewis & Todd, 2005, p. 230).

In between automaticity (level 1) and explicit (reflective) control (level 3), we encounter the level of obstruction that is most relevant for our central question. According to Lewis and Todd (2005), at level 2, dorsal ACC involvement and theta band phase synchrony, about 100 ms after the response onset, show up in scalp EEGs as the ERN. This is the moment that the self-organizing cortical oscillations begin to stabilize (Lewis & Todd, 2005, p. 225).[14] The ERN seems to be an early indicator that the obstruction has some degree of *significance* for the organism (Hajcak et al., 2005; Overbeek et al., 2005, p. 325). This evaluation process is sometimes non-conscious and sometimes prereflective (part of implicit or background emotional awareness but not of explicit or focal emotional awareness). The rapid error evaluation system can probably initiate on-line (re-)appraisal as well as re-tailoring and correction of one's actions.

Attention in the case of level 2 obstructions does not become occupied with the obstruction itself, or with one's emotional response to it, but remains future-oriented, directed at the stream of (possibilities for) action in the world (Lewis & Todd, 2005, p. 229). An example of this could be one's awareness of the openings between the adversaries mentioned by Merleau-Ponty and quoted in the introduction: '… the kind of attention mediated by the ACC is integrative and holistic, … focused on the actions one is about to undertake and on the changes in the world that are likely to result from them' (Lewis & Todd, 2005, p. 229).

To conclude, thanks to Lewis and Todd's use of a micro-timescale, we encounter an important clue for improving our understanding of how switches in a flow of skillful coping can occur without explicit deliberation or awareness of objects and intentions. During this type of activity, what we normally pay attention to are the possibilities for action afforded by the environment (and not the objective qualities of objects). What Lewis and Todd add to this by using a micro-timescale is a specific hypothesis of both of the brain areas involved in the case of a type 2 obstruction (a medial frontal network in which the dorsal ACC and subcortical areas play crucial roles) and of the minimal duration (after the more or less 100 ms that it takes for the phase synchrony to emerge) for the activity of this network to start inducing changes in the person's directedness, prereflective intentionality, and affect.

Concluding Remarks

The aim of this paper was to increase our insight into the way we switch from doing one thing to doing another thing without explicit deliberation. Conceptualizing the skillful body as a concernful system of possible actions, I showed that self-organization and affect play important roles in these transitions. Perceived objects and events that matter to the individual produce intentions and emotions simultaneously. Thanks to the brain's metastable

regime of coordination, the neural system is poised for the detection of (and fast response to) unexpected, potentially significant aspects of the situation. Given our focus on episodes in which one remains engaged in a flow of skillful coping, we primarily have been interested in what Lewis and Todd (2005) call 'level 2 obstructions' and the following emotional perturbations and changes in behavior. This type of affective perturbations can occur when things are going worse than expected. Lewis and Todd's theory suggests that the ERN reflects the first appraisal of a significant event (after about 100 ms). What shows up in this ERP appears to be the result of a self-organizing process: phase synchronization in the theta band. At the same time emerge: (1) an emotional appraisal; (2) an intention to do something to the new situation by being responsive to a new possibility for action; and (3) a shift in focal attention towards this affordance. No explicit awareness of object, emotion, self, or goal is necessary for this.

In relation to our central question we saw that Varela (1999) suggested that we can see emotions as a control parameter inducing bifurcations between cognitive acts. This idea on how we switch from doing one thing to another is interesting but very general. Another limitation of Varela's proposal that we mentioned was that it does not link up to the underlying neural activity of the brain areas as studied by cognitive neuroscience. There is, however, a way to link these, because the central notion of metastability emphasizes not only the partial coordination tendencies of brain areas but also the simultaneous tendencies of specialized brain regions to express their autonomy. One would therefore expect that activity of the relevant regions has been reported by cognitive neuroscientists. By focusing on one type of affective perturbation relevant during a flow of actions, namely goal obstructions, it appears that we are able to make more specific how a switch develops over time and which areas are crucial for this. The neural activity underlying the ERN might perhaps give us an indication of the areas constituting this early control parameter in the specific case of emotions related to violated expectations in action: a medial frontal network including the dorsal ACC and subcortical structures. The minimal duration for the emergence of such a control parameter would be about 100 ms. The Pe may reflect a second, later control parameter inducing another bifurcation between two types of intentional states.

A limitation of Lewis's theory is that it is speculative. Our current knowledge of the functional significance of one of its building blocks, the Pe, is still 'a bit shadowy' (Overbeek et al., 2005, p. 327). Progress in our understanding of the neural generators of the Pe should be used to update Lewis's framework. Moreover, it is evident that the young discipline of neurodynamics is hampered by the fact that it still has to prove convincingly that it can lead to more than plausible models; it is in urgent need of corroborating empirical evidence and making the move from promises and novel predictions to findings (Frijda, 2005).

Although Lewis has developed his theory using errors or goal obstructions as triggering events, recent work on performance monitoring (Walton et al., 2004) suggests that when things go better than expected, there might be a similar motivation to switch to another possibility for action. It would be interesting to see if phase synchronization in the theta band also emerges when the triggering event is a more or less unexpected *opportunity* (something better than expected) that, because of its motivational significance, changes the direction of flow of skillful coping without breaking it.

Notes

1. Merleau-Ponty writes in the concluding chapter of *The Structure of Behavior* (1942/1983): 'What is profound in the notion of "Gestalt" from which we started is not the idea of signification but that of *structure* ' (p. 206). Immediately following this important conclusion he gives the following example:

   > … the nervous system is the place in which an order without anatomical guarantee is realized by means of a continuing organization. It already permitted us to establish a rigorously reciprocal relation between function and substrate; there was not an area which was not linked in its functioning to the global activity of the nervous system, but also not a function which was not profoundly altered by the subtraction of a single of these areas; and function was nothing outside the process which is delineated at each instant and which, based on the nerve mass, *organizes itself* [italics added]. (p. 207)

   So, aiming at understanding Merleau-Ponty's central notion of 'Gestalt' is one of the reasons why one might be interested in current-day neurodynamics.
2. For a discussion of this phenomenon in the context of Wittgenstein's descriptions of acting craftsmen, see Rietveld (2004).
3. Gruenbaum (2005) argues that there still has to be some sense of agency in cases of transparent coping and that feedback from acting in the world contributes to this.
4. See also: '[Our phenomenal] body, as the potentiality of this or that part of the world, surges towards objects to be grasped and perceives them' (Merleau-Ponty, 1945/1962, p. 106).
5. This may explicate the sense in which previous intentional (task-directed) activity 'chooses' the sensory stimuli that it has:

   > … since all the stimulations which the organism receives have … been possible only by its preceding movements which have culminated in exposing the receptor organ to the external influences, one could … say that the behavior [of the organism] is the first cause of all the stimulations. (Merleau-Ponty, 1942/1983, p. 13)

6. Phase synchrony is the phase-locking of oscillatory discharges. Metastability will be introduced in the main text. Kelso (1995) can be read as an introduction to nonlinear dynamic systems theory. Port and Van Gelder (1995) give an overview of the dynamic approach to cognition. Varela (1999) contains a summary of the most important neurodynamic concepts and Le van Quyen (2003) gives a useful more detailed overview of these.

7. Varela's (1999) use of the term 'inherent instability' is comparable to Friston's (2000) use of the term 'dynamic instability,' which the latter uses as a synonym of metastability.
8. Le van Quyen (2003) writes with respect to the metastable regime of coordination that it allows great flexibility:

> The generation of behavior or of neural patterns of activity is [dynamically] unstable in the sense that a variety of behavioral or neural patterns may be assembled from a multitude of sensory, motor, and neural systems in response to the sensory situation, the inner state of the neural or behavioral system, and its recent history. (pp. 70–71)

9. Friston (2000) supports the possibility of such a change in perspective when he distinguishes type I and type II complexity (dynamic instability).
10. Again, unfortunately, we must note that the link between dynamics and brain activity as identified by cognitive neuroscience is missing. The last (fourth) part of this paper tries to provide such a link.
11. These ERPs are obtained by averaging over a number of trials.
12. It is important to note that I write 'Most' because there is also a different theory on the ERN called the conflict monitoring hypothesis (Carter et al., 1998). I cannot discuss this here, however.
13. Importantly, Lewis and Todd (2005) stress that goals are certainly not to be regarded as stored representations that become activated: ' … goals emerge through a messy juxtaposition of past attainments and present opportunities, elaborated through emotional processes including physical sensations, and they tilt us forward in a continuous preoccupation with the future' (p. 214). Goals understood in this way are similar to my notion of 'task' as presented in the introduction.
14. The beginning of such self-stabilization will occur earlier in level 1 obstruction cases, and later in level 3 cases (Lewis & Todd, 2005, p. 228).

References

Archibald, S., Mateer, C. & Kerns, K. (2001). Utilization behavior: Clinical manifestations and neurological mechanisms. *Neuropsychology Review*, *11*, 117–130.

Bennett, M.R., & Hacker, P.M.S. (2003). *Philosophical foundations of neuroscience.* Oxford: Blackwell.

Boccardi, E., Della Sala, S., Motto, C., & Spinnler, H. (2002). Utilisation behaviour consequent to bilateral SMA softening. *Cortex*, *38*, 289–308.

Breakspear, M., & Friston, K.J. (2001). Symmetries and itinerancy in nonlinear systems with many degrees of freedom. *Behavioral and Brain Sciences*, *24*, 813.

Bressler, S.L., & Kelso, J.A.S. (2001). Cortical coordination dynamics and cognition. *Trends in Cognitive Sciences*, *5*, 26–36.

Brown, J.W., & Braver, T.S. (2005). Learned predictions of error likelihood in the anterior cingulate cortex. *Science*, *307*, 1118–1121.

Carter, C.S., Braver, T.S., Barch, D.M., Botvinick, M.M., Noll, D., & Cohen, J.D. (1998). Anterior cingulate cortex, error detection, and the on-line monitoring of performance. *Science*, *280*, 747–749.

Cosmelli, D., David, O., Lachaux, J.P., Martinerie, J., Garnero, L., Renault, B., et al. (2004). Waves of consciousness: Ongoing cortical patterns during binocular rivalry. *Neuroimage*, *23*, 128–140.

Dreyfus, H.L. (1991). *Being-in-the-world: A commentary on Heidegger's Being and Time, Division I*. London: MIT Press.

Dreyfus, H.L. (2002). Intelligence without representation—Merleau-Ponty's critique of mental representation: The relevance of phenomenology to scientific explanation. *Phenomenology and the Cognitive Sciences*, *1*, 367–383.

Edelman, G.M., & Tononi, G. (2000). *Consciousness: How matter becomes imagination*. London: Penguin.

Eslinger, P. (2002). The anatomic basis of utilisation behaviour: A shift from frontal-parietal to intra-frontal mechanisms. *Cortex*, *38*, 273–276.

Freeman, W.J. (2000a). *Neurodynamics: An exploration in mesoscopic brain dynamics*. New York: Springer Verlag.

Freeman, W.J. (2000b). Emotion is essential to all intentional behaviours. In M.D. Lewis & I. Granic (Eds.), *Emotion, development and self-organization: Dynamic systems approaches to emotional development* (pp. 209–235). New York: Cambridge University Press.

Frijda, N.H. (1986). *The emotions.* Cambridge: Cambridge University Press.

Frijda, N.H. (2004). Emotions and action. In A.S.R. Manstead, N.H. Frijda, & A.H. Fisher (Eds.), *Feelings and emotions: The Amsterdam symposium* (pp. 158–173). Cambridge: Cambridge University Press.

Frijda N.H. (2005). Dynamic appraisals: A paper with promises. *Behavioral and Brain Sciences*, *28*, 205–206.

Friston, K.J. (1997). Transients, metastability, and neuronal dynamics. *Neuroimage*, *5*, 164–171.

Friston, K.J. (2000). The labile brain: II. Transients, complexity and selection. *Royal Society*, *355*, 237–252.

Gibson, J.J. (1979). *The ecological approach to visual perception*. Boston: Houghton Mifflin.

Gruenbaum, T., (2005, August). *Agency – the feeling of control*. Paper presented at the conference 'Toward a Science of Consciousness 2005', Copenhagen, Denmark.

Hajcak, G., Moser, J.S., Yeung, N., & Simons, R.F. (2005). On the ERN and the significance of errors. *Psychophysiology*, *42*, 151–160.

Holroyd, C., & Coles, M. (2002). The neural basis of human error processing. Reinforcement learning, dopamine, and the error-related negativity. *Psychological Review, 109,* 679–709.

Kelso, J.A.S. (1995). *Dynamic patterns: The self-organization of brain and behavior*. Cambridge, MA: MIT Press.

Klaassen, P., Rietveld, E., & Topal, J. (2006). Gesitueerde normativiteit: Van Wittgenstein naar neurofenomenologie. *ANTW*, *98*, 1–17.

Koehler, W. (1928). An aspect of Gestalt psychology. In C. Murchison (Ed.), *Psychologies of 1925* (pp. 163–195). Worcester, MA: Clark University Press.

Korn, H., & Faure, P. (2003). Is there chaos in the brain? II. Experimental evidence and related models. *Comptes Rendus Biologies*, *326,* 787–840.

Le van Quyen, M. (2003). Disentangling the dynamic core: A research program for a neurodynamics at the large-scale. *Biological Research*, *36*, 67–88.

Lewis, M.D. (2005). Bridging emotion theory and neurobiology through dynamic systems modeling. *Behavioral and Brain Sciences*, *28*, 169–245.

Lewis, M.D., & Todd, R.M. (2005). Getting emotional: A neural perspective on emotion, intention, and consciousness. *Journal of Consciousness Studies*, *12*(8–10), 210–235.

Lhermitte, F. (1983). 'Utilization behaviour' and its relation to lesions of the frontal lobes. *Brain*, *106*, 237–255.

Lhermitte, F., Pillon, B., & Serdaru, M. (1986). Human anatomy and the frontal lobes. Part I: Imitation and utilization behavior. A neuropsychological study of 75 patients. *Annals of Neurology*, *19*, 326–334.

Luu, P., Tucker, D.M., Derryberry, D., Reed, M., & Poulsen, C. (2003). Electrophysiological responses to errors and feedback in the process of action regulation. *Psychological Science*, *14*, 47–53.

Merleau-Ponty, M. (1962) *Phenomenology of perception* (C. Smith, Trans.). London: Routledge. (Original work published 1945)

Merleau-Ponty, M. (1983). *The structure of behavior* (A.L. Fisher, Trans.). Pittsburg, PA: Duquesne University Press. (Original work published 1942)

Michaels, C.F. (2003). Affordances: Four points of debate. *Ecological Psychology*, *15*, 135–148.

Nieuwenhuis, S., Aston-Jones, G., & Cohen, J.D. (2005). Decision making, the P3, and the locus coeruleus-norepinephrine system. *Psychological Bulletin*, *131*, 510–532.

Nieuwenhuis, S., Ridderinkhof, K.R., Blom, J., Band, G.P., & Kok, A. (2001). Error-related brain potentials are differentially related to awareness of response errors: Evidence from an antisaccade task. *Psychophysiology*, *38*, 752–760.

Overbeek, T.J.M., Nieuwenhuis, S., & Ridderinkhof, K.R. (2005). Dissociable components of error processing: On the functional significance of the Pe vis-à-vis the ERN/Ne. *Journal of Psychophysiology*, *19*, 319–329.

Port, R.F., & Van Gelder, T. (Eds.). (1995). *Mind as motion: Explorations in the dynamics of cognition*. Cambridge, MA: MIT Press.

Ridderinkhof, K.R., Ullsperger, M., Crone, E.A., & Nieuwenhuis, S. (2004). The role of the medial frontal cortex in cognitive control. *Science*, *306*, 443–447.

Rietveld, E.D.W. (2004). Wittgenstein's directed discontent: Clarifying the roles of experience and appreciation in skillful coping. In J.C. Marek & M.E. Reicher (Eds.), *Experience and analysis: Papers of the 27th International Wittgenstein Symposium* (pp. 306–308). Kirchberg am Wechsel, Austria: ALWS.

Rudrauf, D., Lutz, A., Cosmelli, D., Lachaux, J.P., & Le van Quyen, M. (2003). From autopoiesis to neurophenomenology: Francisco Varela's exploration of the biophysics of being. *Biological Research*, *36*, 27–65.

Rushworth, M.F., Kennerley S.W., & Walton, M.E. (2005). Cognitive neuroscience: Resolving conflict in and over the medial frontal cortex. *Current Biology*, *15*, R54–56.

Rushworth, M.F., Walton, M.E., Kennerley, S.W., & Bannerman, D.M. (2004). Action sets and decisions in the medial frontal cortex. *Trends in Cognitive Sciences*, *8*, 410–417.

Stam, C.J., Breakspear, M., Van Cappellen van Walsum, A-M., & Van Dijk, B.W. (2003). Nonlinear synchronization in EEG and whole-head MEG recordings of healthy subjects. *Human Brain Mapping*, *19*, 63–78

Thompson, E. (2007). *Mind in life: Biology, phenomenology, and the sciences of mind*. Cambridge, MA: Harvard University Press.

Tsuda, I. (2001). Toward an interpretation of dynamic neural activity in terms of chaotic dynamical systems. *Behavioral and Brain Sciences*, *24*, 793–847.

Van Leeuwen, C., Steyvers, M., & Nooter, M. (1997). Stability and intermittency in large-scale coupled oscillator models for perceptual segmentation. *Journal of Mathematical Psychology*, *41*, 319–344.

Varela, F.J. (1999). The specious present: A neurophenomenology of time consciousness. In J. Petitot, F.J., Varela, B. Pachoud, & J.M. Roy (Eds.), *Naturalizing phenomenology: Issues in contemporary phenomenology and cognitive science* (pp. 266–329). Stanford, CA: Stanford University Press.

Varela, F.J., & Depraz, N. (2005). At the source of time: Valence and the constitutional dynamics of affect. *Journal of Consciousness Studies*, *12*(8–10), 61–81.

Varela, F.J., Lachaux, J.P., Rodriguez, E., & Martinerie, J. (2001). The brain web: Phase-synchronization and large brain integration. *Nature Reviews Neuroscience, 2*, 229–239.

Varela, F.J., & Thompson, E. (2003). Neural synchrony and the unity of mind: A neurophenomenological perspective. In A. Cleeremans, (Ed.), *The unity of consciousness: Binding, integration and dissociation* (pp. 266–287). Oxford: Oxford University Press.

Walton, M.E., Devlin, J.T., & Rushworth, M.F. (2004). Interactions between decision making and performance monitoring within prefrontal cortex. *Nature Neuroscience*, *7*, 1259–1265.

Yeung, N., Bogacz, R., Holroyd, C. B., Nieuwenhuis, S., & Cohen, J.D. (2007). Theta phase-resetting and error-related negativity. *Psychophysiology*, *44*, 39–49.

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