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Neurophenomenology

Integrating Subjective Experience and Brain Dynamics in the Neuroscience of Consciousness

Abstract: *The paper presents a research programme for the neuroscience of consciousness called 'neurophenomenology' (Varela 1996) and illustrates it with a recent pilot study (Lutz et al., 2002). At a theoretical level, neurophenomenology pursues an embodied and large-scale dynamical approach to the neurophysiology of consciousness (Varela 1995; Thompson and Varela 2001; Varela and Thompson 2003). At a methodological level, the neurophenomenological strategy is to make rigorous and extensive use of first-person data about subjective experience as a heuristic to describe and quantify the large-scale neurodynamics of consciousness (Lutz 2002). The paper foocuses on neurophenomenology in relation to three challenging methodological issues about incorporating first-person data into cognitive neuroscience: (i) first-person reports can be biased or inaccurate; (ii) the process of generating first-person reports about an experience can modify that experience; and (iii) there is an 'explanatory gap' in our understanding of how to relate first-person, phenomenological data to third-person, biobehavioural data.*

I: Introduction

As this volume attests, a growing number of cognitive scientists now recognize the need to make systematic use of introspective phenomenological reports in studying the brain basis of consciousness (Jack and Shallice, 2001; Jack and Roepstorff, 2002; Dehaene and Naccache, 2001; Lutz *et al*., 2002). Nevertheless, the integration of such first-person data into the experimental protocols of cognitive neuroscience still faces a number of epistemological and methodological challenges. The first challenge is that first-person reports can be biased or

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inaccurate (Nisbett and Wilson, 1977; Hurlbert and Heavey, 2001). The second challenge is that it seems reasonable to think that the very act or process of generating an introspective or phenomenological report about an experience can modify that experience. This challenge is closely related to broad conceptual and epistemological issues about the relationship of 'meta-awareness' to first-order experience (Schooler, 2002). Finally, there is the challenge of the so-called 'explanatory gap' in our understanding of how to relate (conceptually, methodologically and epistemologically) the first-person domain of subjective experience to the third-person domain of brain, body and behaviour (see Roy *et al*., 1999). This gap still has to be adequately bridged, despite the presence of valuable neural models of consciousness and experimental evidence about the neural correlates of consciousness (or NCCs). As a result of these challenges, the status of first-person reports about experience remains a broad and problematic issue for cognitive science.

In this paper, we explore a research programme called 'neurophenomenology' that aims to make progress on these issues (Varela, 1996; 1997; 1999; Bitbol, 2002; Lutz, 2002; Rudrauf *et al*., 2003). Neurophenomenology stresses the importance of gathering first-person data from phenomenologically trained subjects as a heuristic strategy for describing and quantifying the physiological processes relevant to consciousness. 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 of experience into the experimental protocols of cognitive neuroscientific research on consciousness.

The term 'neurophenomenology' pays homage to phenomenological traditions in both Western philosophy (Spiegelberg, 1994; Petitot *et al*., 1999) and Asian philosophy (Gupta, 1998; Wallace, 1998; Williams, 1998). ('Phenomenology' is capitalized in this paper when referring to the Western tradition derived from Edmund Husserl.) Phenomenology in this broad sense can be understood as the project of providing a disciplined characterization of the phenomenal invariants of lived experience in all of its multifarious forms. By 'lived experience' we mean experiences as they are lived and verbally articulated in the first-person, whether it be lived experiences of perception, action, memory, mental imagery, emotion, attention, empathy, self-consciousness, contemplative states, dreaming, and so forth. By 'phenomenal invariants' we mean categorical features of experience that are phenomenologically describable both across and within the various forms of lived experience. By 'disciplined characterization' we mean a phenomenological mapping of experience grounded on the use of 'first-person methods' for increasing one's sensitivity to one's own lived experience (Varela and Shear, 1999; Depraz *et al*., 2003). The importance of disciplined, phenomenological examinations of experience for cognitive science was proposed and extensively discussed by Varela *et al*. (1991) as part of their 'enactive' approach to cognition. It was then subsequently elaborated by Varela (1996; 1997; 1999) into the specific research programme of neurophenomenology.

Of central importance to neurophenomenology is the employment of first-person phenomenological methods in order to obtain original and refined first-person data. It seems true both that people vary in their abilities as observers and reporters of their own experiences, and that these abilities can be enhanced through various phenomenological methods. 'First-person methods' are disciplined practices subjects can use to increase their sensitivity to their own experiences at various time-scales (Varela and Shear, 1999; Depraz *et al*., 2003). These practices involve the systematic training of attention and self-regulation of emotion (see Section III). Such practices exist in phenomenology, psychotherapy and contemplative meditative traditions. Using these methods, subjects may be able to gain access to aspects of their experience (such as transient affective state or quality of attention) that otherwise would remain unnoticed and unavailable for verbal report. The experimentalist, on the other hand, using phenomenological reports produced by employing first-person methods, may be able to gain access to physiological processes that otherwise would remain opaque, such as the variability in brain response as recorded in EEG/MEG (see Lutz *et al*., 2002 and Section V). Thus, at a methodological level, the neurophenomenological rationale for using first-person methods is to generate new data — both first-person and third-person — for the science of consciousness.

At an experimental level, the 'working hypothesis' of neurophenomenology (Varela, 1996) is that phenomenologically precise first-person data produced by employing first-person methods provide strong constraints on the analysis and interpretation of the physiological processes relevant to consciousness. Moreover, as Varela (1996; 1997; 1999) originally proposed, third-person data produced in this manner might eventually constrain first-person data, so that the relationship between the two would become one of dynamic 'mutual' or 'reciprocal constraints'. This means not only (i) that the subject is actively involved in generating and describing specific phenomenal invariants of experience, and (ii) that the neuroscientist is guided by these first-person data in the analysis and interpretation of physiological data, but also (iii) that the (phenomenologically enriched) neuroscientific analyses provoke revisions and refinements of the phenomenological accounts, as well as facilitate the subject's becoming aware of previously inaccessible or phenomenally unavailable aspects of his or her mental life (for a preliminary example, see Le Van Quyen and Petitmengin, 2002, on neurophenomenology as applied to the lived experience and neurodynamics of epileptic seizures).

To establish such reciprocal constraints, both an appropriate candidate for the physiological basis of consciousness and an adequate theoretical framework to characterize it are needed. Neurophenomenology is guided by the theoretical proposal (discussed in Section IV) that the best current candidate for the neurophysiological basis of consciousness is a flexible repertoire of dynamic large-scale neural assemblies that transiently link multiple brain regions and areas. This theoretical proposal is shared by a number of researchers, though specific models vary in their details (see Varela, 1995; Tononi and Edelman, 1998; Engel and Singer, 2001; Thompson and Varela, 2001). In this approach, the framework of dynamical systems theory is essential for characterizing the neural processes relevant to consciousness (see Le Van Quyen, 2003). In addition, neurophenomenology is guided by the 'embodied' approach to cognition (Varela *et al*., 1991; Clark, 1997), which in its 'enactive' or 'radical embodiment' version holds that mental processes, including consciousness, are distributed phenomena of the whole active organism (not just the brain) embedded in its environment (Thompson and Varela, 2001, forthcoming; Varela and Thompson, 2003). These theoretical aspects of neurophenomenology have been presented extensively elsewhere (Varela, 1995; Thompson and Varela, 2001; Varela and Thompson, 2003; Rudrauf *et al*., 2003), and are not the main focus of the present paper.

In summary, neurophenomenology is based on the synergistic use of three fields of knowledge:

1. (NPh1) First-person data from the careful examination of experience with specific first-person methods.
2. (NPh2) Formal models and analytical tools from dynamical systems theory, grounded on an embodied-enactive approach to cognition.
3. (NPh3) Neurophysiological data from measurements of large-scale, integrative processes in the brain.

In the following sections of this paper, we follow the steps of this threefold framework. In Section II we discuss some current concepts of consciousness as seen from a phenomenological perspective. In Section III we explain the basic features of first-person methods (NPh1). In Section IV we present the neurodynamical framework of neurophenomenology (NPh2 and NPh3). In Section V we review a pilot experimental study that illustrates the neurophenomenological approach. In Section VI we conclude by summarizing and discussing some of the implications of the neurophenomenological strategy for dealing with the challenge of integrating first-person data into cognitive neuroscience.

II: Concepts of Consciousness

A number of different concepts of consciousness can be distinguished in current research:

1. *Creature consciousness*: Consciousness of an organism as a whole insofar as it is awake and sentient (Rosenthal, 1997).
2. *Background consciousness* versus *state consciousness*: Overall states of consciousness, such as being awake, being asleep, dreaming, being under hypnosis, and so on (Hobson, 1999), versus specific conscious mental states individuated by their contents (Rosenthal, 1997; Chalmers, 2000). (The coarsest-grained state of background consciousness is sometimes taken to be creature consciousness (Chalmers, 2000).)

3. *Transitive consciousness* versus *intransitive consciousness*: Object-directed consciousness (consciousness-of), versus non-object-directed consciousness (Rosenthal, 1997).
4. *Access consciousness*: Mental states whose contents are accessible to thought and verbal report (Block, 2001). According to one important theory, mental contents are access-conscious when they are 'globally available' in the brain as contents of a 'global neuronal workspace' (Dehaene and Naccache, 2001; Baars, 2002).
5. *Phenomenal consciousness*: Mental states that have a subjective-experiential character (there is something 'it is like' for the subject to be in such a state) (Nagel, 1979; Block 2001).
6. *Introspective consciousness*: Meta-awareness of a conscious state (usually understood as a particular form of access consciousness) (Jack and Shallice, 2001; Hurlbert and Heavey, 2001; Jack and Roepstorff, 2002; Schooler, 2002).
7. *Pre-reflective self-consciousness*: Primitive self-consciousness; self-referential awareness of subjective experience that does not require active reflection or introspection (Wider, 1997; Williams, 1998; Gupta, 1998; Zahavi, 1999).

The relationships of these concepts to one another are unclear and currently the subject of much debate. A great deal of debate has centred on (4) and (5): Some theorists argue that it is possible for there to be phenomenally conscious contents that are inaccessible to thought, the rational control of action and verbal report (Block, 2001); others argue this notion of consciousness is incoherent, and hence deny the validity of the access/phenomenal distinction (Dennett, 2001).

This debate looks somewhat different when seen from a Phenomenological perspective. Central to this tradition, and to certain Asian phenomenologies (Gupta, 1998; Williams, 1998), are the notions of intentionality (which is related to (3) above) and pre-reflective self-consciousness (7). Pre-reflective self-consciousness is a primitive form of self-awareness believed to belong inherently to any conscious experience: Any experience, in addition to intending (referring to) its intentional object (transitive consciousness), is reflexively manifest to itself (intransitive consciousness).[1] Such self-manifesting awareness is a primitive form of self-consciousness in the sense that (i) it does not require any subsequent act of reflection or introspection but occurs simultaneously with awareness of the object; (ii) does not consist in forming a belief or making a judgment; and (iii) is 'passive' in the sense of being spontaneous and involuntary (see Zahavi and Parnas, 1998). A distinction is thus drawn between the 'noetic' process of experiencing, and the 'noematic' object or content of experience. Experience involves not simply awareness of its object (noema), but tacit awareness of

[1] It is important not to confuse this sense of 'reflexivity' (as intransitive and non-reflective self-awareness) with other usages that equate reflexivity and reflective consciousness (e.g. Block, 2001, who regards 'reflexivity' as 'phenomenality' plus 'reflection' or 'introspective access'). As Wider (1997) discusses in her clear and succinct historical account, the concept of reflexivity as pre-reflective self-awareness goes back to Descartes, and is a central thread running from his thought through Kant, Husserl, Sartre and Merleau-Ponty.

itself as process (noesis). For instance, when one consciously sees an object, one is also at the same time aware — intransitively, pre-reflectively and passively — of one's seeing; when one visualizes a mental image, one is thus aware also of one's visualizing. This tacit self-awareness has often been explicated as involving a form of non-objective bodily self-awareness — a reflexive awareness of one's 'lived body' (*Leib*) or embodied subjectivity correlative to experience of the object (Merleau-Ponty, 1962; Wider, 1997; Zahavi, 2002). Hence from a neurophenomenological perspective, any convincing theory of consciousness must account for this pre-reflective experience of embodied subjectivity, in addition to the object-related contents of consciousness (Varela *et al*., 1991; Thompson and Varela, 2001; Zahavi, 2002).

Neurophenomenology thus corroborates the view, articulated by Panksepp (1998a,b) and Damasio (1999; Parvizi and Damasio, 2001), that neuroscience needs to explain both 'how the brain engenders the mental patterns we experience as the images of an object' (the noema in Phenomenological terms), and 'how, in parallel . . . the brain also creates a sense of self in the act of knowing . . . how each of us has a sense of "me" . . . how we sense that the images in our minds are shaped in our particular perspective and belong to our individual organism' (Parvizi & Damasio, 2001, pp. 136–7). In Phenomenological terms, this second issue concerns the noetic side of consciousness, in particular the noetic aspect of 'ipseity' or the minimal subjective sense of 'I-ness' in experience, which is constitutive of a 'minimal' or 'core self', as contrasted with a 'narrative' or 'autobiographical self' (Gallagher, 2000). As a number of cognitive scientists have emphasized, this primitive self-consciousness is fundamentally linked to bodily processes of life regulation, emotion and affect, such that all cognition and intentional action are emotive (Panksepp, 1998a, 1998b; Damasio, 1999; Watt, 1999; Freeman, 2000; Parvizi and Damasio, 2001), a theme central to Phenomenology (Merleau-Ponty, 1962; Jonas, 1966; Husserl, 2001).

This viewpoint bears on the access/phenomenal-consciousness debate as follows. According to Phenomenology, 'lived experience' comprises pre-verbal, pre-reflective and affectively valenced mental states (events, processes), which, while not immediately available or accessible to thought, introspection and verbal report, are intransitively 'lived through' subjectively, and thus have an experiential or phenomenal character. Such states, however, are (i) necessarily primitively self-aware, otherwise they do not qualify as conscious (in any sense); and (ii) because of their being thus self-aware, are access conscious in principle, in that they are the kind of states that can become available to thought, reflective awareness, introspection and verbal report, especially through first-person methods (see Section III).

In summary, whereas many theorists currently debate the access/phenomenal-consciousness distinction in largely static terms, neurophenomenology proposes to reorient the theoretical framework by emphasizing the dynamics of the whole noetic-noematic structure of consciousness, including the structural and temporal dynamics of the process of becoming reflectively or introspectively aware of experience, such that implicit and intransitively 'lived through' aspects of pre-reflective experience can become thematized and verbally described.

III: First-Person Methods

First-person methods are disciplined practices subjects can use to increase their sensitivity to their own experience from moment to moment (Varela and Shear, 1999). They involve systematic training of attention and emotional self-regulation. Such methods exist in Phenomenology (Depraz, 1999), psychotherapy (Gendlin, 1981; Epstein, 1996), and contemplative meditative traditions (Wallace, 1999). Some are routinely used in clinical and health programmmes (Kabat-Zinn *et al.*, 1985), and physiological correlates and effects of these practices have been investigated (Austin, 1998; Davidson *et al.*, 2003). The relevance of these practices to neurophenomenology derives from the capacity for attentive self-awareness they systematically cultivate. This capacity enables tacit, preverbal and pre-reflective aspects of subjective experience — which otherwise would remain simply 'lived through' — to become subjectively accessible and describable, and thus available for intersubjective and objective (biobehavioural) characterization.

First-person methods vary depending on the phenomenological, psychological or contemplative framework (Varela and Shear, 1999). We wish to underline certain common, generic operations of first-person methods. Of particular importance is the structural description of the disciplined process of becoming reflectively attentive to experience (Depraz *et al.*, 2000, 2003). In Phenomenology, this disciplined process is known as the 'epoché' (Depraz, 1999). The epoché mobilizes and intensifies the tacit self-awareness of experience by inducing an explicit attitude of attentive self-awareness. The epoché has three intertwining phases that form a dynamic cycle (Depraz *et al.*, 2000):

1. Suspension
2. Redirection
3. Receptivity

The first phase induces a transient suspension of beliefs or habitual thoughts about what is experienced. The aim is to 'bracket' explanatory belief-constructs in order to adopt an open and unprejudiced descriptive attitude. This attitude is an important prerequisite for gaining access to experience as it is lived pre-reflectively. The second phase of redirection proceeds on this basis: Given an attitude of suspension, the subject's attention can be redirected from its habitual immersion in the experienced object (the noema) towards the lived qualities of the experiencing process (the noetic act and its 'pre-personal' or 'pre-noetic' sources in the lived body).

During the epoché, an attitude of receptivity or 'letting go' is also encouraged, in order to broaden the field of experience to new horizons, towards which attention can be turned. Distinctions usually do not arise immediately, but require multiple variations. The repetition of the same task, for instance, enables new contrasts to arise, and validates emerging categories or invariants. Training is therefore a necessary component to cultivate all three phases, and to enable the emergence and stabilization of phenomenal invariants.

Downstream from this threefold cycle is the phase of verbalization or expression. The communication of phenomenal invariants provides the crucial step whereby this sort of first-person knowledge can be intersubjectively shared and calibrated, and related to objective data.

This explication of the procedural steps of the epoché represents an attempt to fill a lacuna of Phenomenology, which has often emphasized theoretical analysis and description, to the neglect of the pragmatics of the epoché as an embodied and situated act (Depraz, 1999). By contrast, the pragmatics of mindfulness-awareness (*shamatha-vipashyana*) in the Buddhist tradition are far more developed. This is one reason that the above description of the structural dynamics of becoming aware, as well as attempts to develop a more embodied and pragmatic phenomenology, have drawn from Buddhist traditions of mental cultivation (Varela *et al*., 1991; Depraz *et al*., 2000, 2003). One can also point to a recent convergence of theories and research involving introspection (Vermersch, 1999), the study of expertise and intuitive experience (Petitmengin-Peugeot, 1999), Phenomenology (Depraz, 1999) and meditative mental cultivation (Wallace, 1999). This convergence has also motivated and shaped the above description of the generic features of first-person methods (see Depraz *et al*., 2000, 2003).

This stress on pragmatics represents an attempt to do justice to the difficulty of describing or reporting experiences as they are directly lived, rather than as they are assumed to be, either on the basis of a priori assumptions or extraneous theorizing. According to the Phenomenological way of thinking, in ordinary life we are caught up in the world and our various belief-constructs and theories about it. Phenomenologists call this unreflective stance the 'natural attitude'. The epoché aims to 'bracket' these assumptions and belief-constructs and thereby induce an open phenomenological attitude towards direct experience ('the things themselves'). The adoption of a properly phenomenological attitude is an important methodological prerequisite for exploring original constitutive structures and categories of experience, such as egocentric space, temporality and the subject-object duality, or spontaneous affective and associative features of the temporal flow of experience rooted in the lived body (for an overview of these topics, see Bernet *et al*., 1993).[2]

The use of first-person methods in cognitive neuroscience clearly raises important methodological issues. One needs to guard against the risk of the experimentalist either biasing the phenomenological categorization or uncritically accepting it. Dennett (1991) introduced his method of

[2] Space prevents us from discussing the differences between Phenomenology and classical Introspectionism, particularly when the epoché is meant to initiate and sustain a form of transcendental philosophical reflection, by contrast with naturalistic investigation. Although we believe it is important to be clear about the differences between Phenomenology and Introspectionism (particularly because they are often lumped together by analytic authors), we also think that the historical debate between them is probably not directly relevant to the current renewal of interest in phenomenological and/or introspective evidence in cognitive science, as expressed in the contributions to this volume.

'heterophenomenology' (phenomenology from a neutral third-person perspective) in part as a way of guarding against these risks. His warnings are well taken. Neurophenomenology asserts that first-person methods are necessary to gather refined first-person data, but not that subjects are infallible about their own mental lives, nor that the experimentalist cannot maintain an attitude of critical neutrality. First-person methods do not confer infallibility upon subjects who use them, but they do enable subjects to thematize important but otherwise tacit aspects of their experience. Dennett to-date has not addressed the issue of the scope and limits of first-person methods in relation to heterophenomenology, so we are unsure where he stands on this issue. A full exchange on this issue would require discussion of the different background epistemological and metaphysical differences between Phenomenology and heterophenomenology concerning intentionality and consciousness. There is not space for such a discussion here.[3] We will therefore restrict ourselves to a comment about heterophenomenology as a method for obtaining first-person reports. Our view is that to the extent that heterophenomenology rejects first-person methods, it is too limited a method for the cognitive science of consciousness, because it is unable to generate refined first-person data. On the other hand, to the extent that heterophenomenology acknowledges the usefulness of first-person methods, then it is hard to see how it could avoid becoming in its practice a form of phenomenology, such that the prefix 'hetero' would become unnecessary.

Another methodological issue concerns the modification of experience by phenomenological training. It is to be expected that the stabilization of phenomenal categories through first-person methods will be associated with specific short-term or long-term changes in brain activity. It has been shown, for instance, that category formation during learning is accompanied by changes in the ongoing dynamics of the cortical stimulus representation (Ohl *et al*., 2001). Yet the fact that phenomenological training can modify experience and brain dynamics is not a limitation, but an advantage. Anyone who has acquired a new cognitive skill (such as stereoscopic fusion, wine-tasting, or a second language) can attest that experience is not fixed, but dynamic and plastic. First-person methods help to stabilize phenomenal aspects of this plasticity so that they can be translated into descriptive first-person reports. As Frith writes in a recent comment on introspection and brain imaging: 'A major programme for 21st century science will be to discover how an experience can be translated into a report, thus enabling our experiences to be shared' (Frith, 2002). First-person methods help 'tune' experience, so that such translation and intersubjective corroboration can be made more precise and rigorous. The issue of the generality of data from trained subjects remains open, but seems less critical at this stage of our knowledge than the need to obtain new data about the phenomenological and physiological processes constitutive of the first-person perspective.

Frith, following Jack and Roepstorff (2002), also comments that 'sharing experiences requires the adoption of a second-person perspective in which a

[3] For discussion of this issue, see Thompson *et al*. (1999).

common frame of reference can be negotiated' (Frith, 2002). First-person methods help to establish such a reference frame by incorporating the mediating '-second-person' position of a trainer or coach. Neurophenomenology thus acknowledges the intersubjective perspective involved in the science of consciousness (Thompson, 2001). The subject needs to be motivated to cooperate with the experimentalist and empathetically to understand her motivations; and reciprocally the experimentalist needs to facilitate the subject's finding his own phenomenal invariants. Without this reciprocal, empathetically grounded exchange, there is no refined first-person data to be had.

IV: Neurodynamics (NPh2 and NPh3)

It is now widely accepted that the neural processes crucial for consciousness rely on the transient and ongoing orchestration of scattered mosaics of functionally specialized brains regions, rather than any single neural process or structure (Tononi and Edelman, 1998; Freeman, 1999; Dehaene and Naccache, 2001; Engel and Singer, 2001; Thompson and Varela, 2001). Hence a common theoretical proposal is that each cognitive or conscious moment involves the transient selection of a distributed neural population that is both highly integrated and differentiated, and connected by reciprocal, transient, dynamical links. A prelude to understanding the neural processes crucial for consciousness is thus to identify the mechanisms for large-scale brain processes, and to understand the causal laws and intrinsic properties that govern their global dynamical behaviours. This problem is known as the 'large-scale integration problem' (Varela *et al.*, 2001). Large-scale brain processes typically display endogenous, self-organizing behaviours (Engel *et al.*, 2001; Varela *et al.*, 2001), which are highly variable from trial to trial, and cannot be fully controlled by the experimentalist. Hence cognitive neuroscience faces at least a twofold challenge: (i) to find an adequate conceptual framework to understand brain complexity, and (ii) to relate brain complexity to conscious experience in an epistemologically and methodologically rigorous manner.

Brain complexity

For the first challenge, neurophenomenology endorses the strategy, now shared by many researchers, to use the framework of complex dynamical systems theory (Kelso, 1995; Freeman, 2001; Thompson and Varela, 2001; Varela *et al.*, 2001; Le Van Quyen, 2003). (This strategy corresponds to NPh2 above.) According to the dynamical framework, the key variable for understanding large-scale integration is not so much the individual activity of the nervous system's components, but rather the dynamic nature of the links among them. The neural counterpart of subjective experience is thus best studied not at the level of specialized circuits or classes of neurons (Crick and Koch, 1998), but through a collective neural variable that describes the emergence and change of patterns of large-scale integration (Varela *et al.*, 2001). Among the various ways to define this state variable, one recent approach is to use as a 'dynamical neural signature' the description and quantification of transient patterns of local and long-distance phase-synchronies occurring between oscillating neural populations at multiple frequency bands (Rodriguez *et al*., 1999; Lutz *et al*., 2002). (This proposal corresponds to a specific hypothesis that falls under the heading of NPh3 above.) The reasons for focusing on neural phase-synchrony are the evidence for its role as a mechanism of brain integration (Varela *et al*., 2001), and its predictive power with respect to subsequent neural, perceptual and behavioural events (Engel *et al*., 2001). Both animal and human studies demonstrate that specific changes in neural synchrony occur during arousal, sensorimotor integration, attentional selection, perception and working memory, which are all crucial for consciousness (for reviews and discussion, see Varela, 1995; Tononi and Edelman, 1998; Dehaene and Naccache, 2001; Engel and Singer, 2001; Engel *et al*., 2001; Varela *et al*., 2001). The irregularity and broad frequency band of these synchronies (2–80 Hz) suggest the presence of more complex forms of neural phase-synchronies than those investigated so far (Tass *et al*., 1998; Rudrauf *et al*., in press). Despite the need for theoretical development in these directions, the cornerstone assumption remains that large-scale, coherent neural activities constitute a fundamental self-organizing pole of integration in the brain, and that this pole provides a valuable physiological candidate for the emergence and the flow of cognitive-phenomenal states (Varela, 1995; Tononi and Edelman, 1998). To reveal the properties of this complex dynamic pole and the laws that govern it, several complementary temporal scales (10–100 milliseconds, 100–300 milliseconds, seconds, hours, days) and levels of description (neuronal, cell assembly, the whole brain) are probably needed. A cartography of conceptual and mathematical frameworks to analyse these spatio-temporal large-scale brain phenomena has been recently proposed (Le Van Quyen, 2003).

In addition, neurophenomenology favours an embodied approach to neural dynamics: The neurodynamic pole underlying the emergence and flow of cognitive-phenomenal states needs to be understood as necessarily embedded in the somatic contexts of the organism as a whole (the lived body in Phenomenological terms), as well as the environment (Thompson and Varela, 2001). In the case of human consciousness, the neurodynamic pole needs to be understood as necessarily embedded in at least three ‘cycles of operation’ constitutive of human life: (i) cycles of organismic regulation of the entire body; (ii) cycles of sensorimotor coupling between organism and environment; (iii) cycles of intersubjective interaction (for further discussion, see Thompson and Varela, 2001; Varela and Thompson, 2003).

In summary, neurophenomenology assumes that local and long-distance phase-synchrony patterns provide a plausible neural signature of subjective experience, and that the embodied-dynamical approach provides a theoretical language to specify cognitive acts in real time as cooperative phenomena at neural and organismic levels within and between brain, body and environment.

Relating brain complexity to conscious experience

Neurophenomenology's new and original methodological proposal, however, is to incorporate the experiential level into these neurodynamical levels in an explicit and rigorous way. The aim is to integrate the phenomenal structure of subjective experience into the real-time characterization of large-scale neural operations. The response to the second challenge is accordingly to create experimental situations in which the subject is actively involved in identifying and describing experiential categories that can be used to identify and describe dynamical neural signatures of experience. As will be seen when we discuss the pilot study, a rigorous relationship between brain complexity and subjective experience is thereby established, because original phenomenal categories are explicitly used to detect original neurodynamical patterns. Such joint collection and analysis of first-person and third-person data instantiates methodologically the neurophenomenological hypothesis that cognitive neuroscience and phenomenology can be related to each other through reciprocal constraints (Varela, 1996). The long-term aim is to produce phenomenological accounts of real-time subjective experience that are sufficiently precise and complete to be expressed in formal and predictive dynamical terms, which in turn could be expressed as specific neurodynamical properties of brain activity. Such twofold dynamical descriptions of consciousness could provide a robust and predictive way to link reciprocally the experiential and neuronal realms. We turn now to describe a pilot experimental study that illustrates the validity and fruitfulness of this research programme.

V: A Neurophenomenological Pilot Study

Background to the study

When an awake and alert subject is stimulated during an experiment, his brain is not idle or in a state of suspension, but is engaged in cognitive activity. The brain response derives from the interaction between this ongoing activity and the afferent stimulation that affects it (Engel *et al*., 2001). Yet because this ongoing activity has not been carefully studied, most of the brain response is not understood. Successive exposure to the same stimulus elicits highly variable responses, and this variability is treated as unintelligible noise (and may be discarded by techniques that average across trials and/or subjects). The source of this variability is thought to reside mainly in fluctuations of the subjective cognitive context, as defined by the subject's attentional state, spontaneous thought processes, strategy to carry out the task, and so on. Although it is common to control, at least indirectly, for some of these subjective factors (such as attention, vigilance or motivation), the ongoing subjective mental activity has not yet been analysed systematically.

One strategy would be to describe in more detail this ongoing activity by obtaining verbal reports from human subjects. These reports should reveal subtle changes in the subject's experience, whether from trial to trial or across individuals.

This type of qualitative first-person data is usually omitted from brain-imaging studies, yet if methodological precautions are taken in gathering such data, they can be used to shed light on cognition via a joint analysis with quantitative measures of neural activity. Following this approach, a pilot neurophenomenological study (Lutz *et al*., 2002) investigated variations in subjective experience for one limited aspect of visual perception, namely, the emergence of an illusory 3D figure during the perceptual fusion of 2D random-dot images with binocular disparities.

Experimental task

The task began with subjects fixating for seven seconds a dot pattern containing no depth cues. At the end of this 'preparation period', the pattern was changed to a slightly different one with binocular disparities. Subjects then had to press a button as soon as the 3D shape had completely emerged. Throughout the trial EEG signals were recorded, and immediately after the button-press subjects gave a brief verbal report of their experience. In these reports, they labelled their experience using phenomenal categories or invariants that they themselves had found and stabilized during the prior training session. The recording-session thus involved the simultaneous collection of first-person data (introspective/retrospective verbal reports) and third-person data (electrophysiological recordings and behavioural measures of button-pressing reaction time).

Training session

Subjects were intensively trained to perform the task in order to improve their perceptual discrimination and to enable them to explore carefully variations in their subjective experience during repeated exposure to the task. They were thus instructed to direct their attention to their own immediate mental processes during the task and to the felt-quality of the emergence of the 3D image.

This redirection of attention to the lived quality of experience corresponds to the epoché described in Section III. Its aim is to intensify the tacit self-awareness of experience by inducing a more explicit awareness of the experiencing process correlated to a given experiential content (the noetic-noematic structure of experience). More simply put, the aim is to induce awareness not simply of the 'what' or object-pole of experience (the 3D percept), but also of the necessarily correlated 'how' or act-pole of experience (the performance of perceptual fusion and its lived or subjective character). As described earlier, this method of becoming aware involves the three interlocking phases of suspension, redirection and receptivity.

In this pilot study, these phases were either self-induced by subjects familiar with them, or induced by the experimenter through open questions (Petitmengin-Peugeot, 1999). For example:

> Experimenter — 'What did you feel before and after the image appeared?'

> Subject — 'I had a growing sense of expectation but not for a specific object; however, when the figure appeared, I had a feeling of confirmation, no surprise at all.'
>
> or
>
> 'It was as if the image appeared in the periphery of my attention, but then my attention was suddenly swallowed up by the shape.'

Subjects were repeatedly exposed to the stimuli, and trial by trial they described their experience through verbal accounts, which were recorded on tape. In dialogue with the experimenters, they defined their own stable experiential categories or phenomenal invariants to describe the main elements of the subjective context in which they perceived the 3D shapes. The descriptive verbal reports from a total of four subjects were classified according to the common factor of the degree of preparation felt by the subject and the quality of his/her perception. This factor was used to cluster the trials into three main categories, described below: Steady Readiness, Fragmented Readiness and Unreadiness. Subcategories (describing the unfolding of the visual perception, for instance) were also found in individual subjects. They were not investigated in the pilot study.

1. Steady Readiness

In most trials, subjects reported that they were 'ready', 'present', 'here' or 'well-prepared' when the image appeared on the screen, and that they responded 'immediately' and 'decidedly'. Perception was usually experienced with a feeling of 'continuity', 'confirmation' or 'satisfaction'. These trials were grouped into a cluster SR, characterized by the subjects being in a state of 'Steady Readiness'.

2. Fragmented Readiness

In other trials, subjects reported that they had made a voluntary effort to be ready, but were prepared either less 'sharply' (due to a momentary 'tiredness') or less 'focally' (due to small 'distractions', 'inner speech' or 'discursive thoughts'). The emergence of the 3D image was experienced with a small feeling of surprise or 'discontinuity'. These trials formed a second cluster corresponding to a state of 'Fragmented Readiness'.

An intermediate cluster between these two clusters was defined for subject S3. This was described as a state of open attention without active preparation. It was unique to this subject who found that this state contrasted sharply with that of prepared Steady Readiness.

3. Unreadiness (Spontaneous Unreadiness, Self-Induced Unreadiness)

In the remaining trials, subjects reported that they were unprepared and that they saw the 3D image only because their eyes were correctly positioned. They were surprised by it and reported that they were 'interrupted' by the image in the middle of a thought (memories, projects, fantasies, etc.). This state of distraction occurred spontaneously for subjects S1 and S4, whereas S2 and S3 triggered it either by fantasizing or by thinking about plans (S3), or by visualizing a mental image (S2). To separate passive and active distraction, these trials were divided into two different clusters, Spontaneous Unreadiness for S1 and S4, and Self-Induced Unreadiness for S2 and S3.

Joint analysis of first-person data and third-person data

These phenomenal invariants found in the training session were used to divide the individual trials of the recording session into corresponding phenomenological clusters. The EEG signals were analysed to determine the transient patterns of local and long-distance phase-synchrony between oscillating neural populations, and separate dynamical analyses of the signals were conducted for each cluster. The phenomenological clusters were thus used as a heuristic to detect and interpret neural processes. The hypothesis was that distinct phenomenological clusters would be characterized by distinct dynamical neural signatures before stimulation (reflecting state of preparation), and that these signatures would then differentially condition the neural and behavioural responses to the stimulus. To test this hypothesis, the behavioural data and the EEG data were analysed separately for each cluster.

Results

By combining first-person data and the analysis of neural processes, the opacity in the brain responses (due to their intrinsic variability) is reduced and original dynamical categories of neural activity can be detected. For an example, we can consider the contrast between the two clusters of Steady Readiness and Spontaneous Unreadiness for one of the subjects (Figure 1 — see back cover). In the first cluster (A), the subject reported being prepared for the presentation of the stimulus, with a feeling of continuity when the stimulation occurred and an impression of fusion between himself and the percept. In the second cluster (B), the subject reported being unprepared, distracted, and having a strong feeling of discontinuity in the flux of his mental states when the stimulus was presented. He described a clear impression of differentiation between himself and the percept. These distinct features of subjective experience are correlated with distinct dynamical neural signatures (in which phase-synchrony and amplitude are rigorously separated in the dynamical analysis). During steady preparation, a frontal phase-synchronous ensemble emerged early between frontal electrodes and was maintained on average throughout the trial, correlating with the subject's impression of continuity. The average reaction time for this group of trials was short (300 ms on average). The energy in the gamma band (30–70 Hz) increased during the preparation period leading up to the time of stimulus presentation. This energy shift towards the gamma band occurred in all subjects and was specific to the 'prepared' clusters. The energy in the gamma band was always higher in anterior regions during the pre-stimulus period for subjects in the 'prepared' clusters than for subjects in the 'unprepared' clusters, whereas the energy in the slower bands was lower. These results suggest that the deployment of attention during the preparation strategy was characterized by an enhancement of the fast rhythms in combination with an attenuation of the slow rhythms. On the other hand, in the unprepared cluster, no stable phase-synchronous ensemble can be distinguished on average during the pre-stimulus period. When stimulation occurred, a complex pattern of weak synchronization and massive phase-scattering (desynchronization) between frontal and posterior electrodes was revealed. A subsequent frontal synchronous ensemble slowly appeared while the phase-scattering remained present for some time. In this cluster the reaction time was longer (600 ms on average). The complex pattern of synchronization and phase-scattering could correspond to a strong reorganization of the brain dynamics in an unprepared situation, delaying the constitution of a unified cognitive moment and an adapted response. This discontinuity in the brain dynamics was strongly correlated with a subjective impression of discontinuity.

Apart from these patterns common to all subjects, it was also found that the precise topography, frequency and time course of the synchrony patterns during the preparation period varied widely across subjects. These variations should not be treated as 'noise', however, because they reflect distinct dynamical neural signatures that remained stable in individual subjects throughout several recording sessions over a number of days (Figure 2 — see back cover).

Synopsis

This study demonstrated that (i) first-person data about the subjective context of perception can be related to stable phase-synchrony patterns measured in EEG recordings before the stimulus; (ii) the states of preparation and perception, as reported by the subjects, modulated both the behavioural responses and the dynamic neural responses after the stimulation; and (iii) although the precise shape of these synchrony patterns varied among subjects, they were stable in individual subjects throughout several recording sessions, and therefore seem to constitute a consistent signature of a subject's cognitive strategy or aptitude to perform the perceptual task. More generally, by using first-person methods to generate new first-person data about the structure of subjective experience, and using these data to render intelligible some of the opacity of the brain response, this pilot study illustrates the validity and fruitfulness of the neurophenomenological approach.

VI: Conclusion

This paper began by delineating three challenges faced by the attempt to integrate first-person data into the experimental protocols of cognitive neuroscience: (1) first-person reports can be biased or inaccurate; (2) introspective acts can modify their target experiences; and (3) there remains an 'explanatory gap' in our understanding of how to relate subjective experience to physiological and behavioural processes.

Neurophenomenology's strategy for dealing with the first two challenges is to employ first-person methods in order to increase the sensitivity of subjects to their own experience and thereby to generate more refined descriptive reports that can be used to identify and interpret third-person biobehavioural processes relevant to consciousness.[4] First-person methods intensify self-awareness so that it becomes less intrusive and more stable, spontaneous and fluid.

Such development implies that experience is being trained and reshaped. One might therefore object that one form of experience is replacing another, and hence the new experience cannot be used to provide insight into the earlier form of untrained experience. This inference, however, does not follow. There is not necessarily any inconsistency between altering or transforming experience (in the way envisaged) and gaining insight into experience through such transformation. If there were, then one would have to conclude that no process of cognitive or emotional development can provide insight into experience before the period of such development. Such a view is extreme and unreasonable. The problem with the objection is its assumption that experience is a static given, rather than dynamic, plastic and developmental. Indeed, it is hard to see how the objection could even be formulated without presupposing that experience is a fixed, predelineated domain, related only externally to the process of becoming aware, such that this process would have to supervene from outside, instead of being motivated by and called forth from within experience itself. First-person methods are not supposed to be a way of accessing such a (mythical) domain; they are supposed to be a way of enhancing and stabilizing the self-awareness already immanent in experience, thereby 'awakening' experience to itself.[5]

The final challenge comes from the 'explanatory gap'. We wish to draw a distinction between the 'explanatory gap' and the 'hard problem'. The 'explanatory gap' (in our usage) is the epistemological and methodological problem of how to relate first-person phenomenological accounts of experience to third-person cognitive-neuroscientific accounts. The 'hard problem' of consciousness is an abstract metaphysical problem about the place of consciousness in nature (Chalmers, 1996). It is standardly formulated as the issue of whether it is possible to derive subjective experience (or 'phenomenal consciousness') from objective physical nature. If it is possible, then physicalistic monism is supposed to gain support; if it is not possible, then property dualism (or substance dualism or idealism) is supposed to gain support.

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[4] It is important to note that the biases and inaccuracies in first-person reports as documented in the well-known study by Nisbett and Wilson (1977) occurred when subjects made statements about what they took to be the causes of their mental states. Such statements, however, are not properly phenomenological, precisely because they engage in causal-explanatory theorizing beyond what is available to phenomenological description.

[5] Of course, the generality of results from phenomenologically trained subjects remains open as an empirical matter (as we indicated in Section III). Our point, however, is that this particular conceptual or a priori objection to first-person methods is misguided.

Although Varela (1996) proposed neurophenomenology as a 'methodological remedy for the hard problem', a careful reading of this paper indicates that neurophenomenology does not aim to address the metaphysical hard problem of consciousness on its own terms. The main reason, following analyses and arguments from phenomenological philosophers (Husserl, 1970; Merleau-Ponty, 1962), is that these terms — in particular the dichotomous Cartesian opposition of the 'mental' (subjectivist consciousness) versus the 'physical' (objectivist nature) — are considered to be part of the problem, not part of the solution. Space prevents further discussion of these issues here (see Bitbol, 2002, and Thompson and Varela, forthcoming, for discussion of neurophenomenology in relation to the hard problem).

With respect to the explanatory gap, on the other hand, neurophenomenology does not aim to close the gap in the sense of ontological reduction, but rather to bridge the gap at epistemological and methodological levels by working to establish strong reciprocal constraints between phenomenological accounts of experience and cognitive-scientific accounts of mental processes. At the present time, neurophenomenology does not claim to have constructed such bridges, but only to have proposed a clear scientific research programme for making progress on that task. Whereas neuroscience to-date has focused mainly on the third-person, neurobehavioural side of the explanatory gap, leaving the first-person side to psychology and philosophy, neurophenomenology employs specific first-person methods in order to generate original first-person data, which can then be used to guide the study of physiological processes, as illustrated in a preliminary way by the pilot study.

Our view is that the way experimental data are produced in the neuroscience of consciousness is implicitly shaped by the way the subject is mobilized in the experimental protocol. Experimental investigations of the neural correlates of consciousness usually focus on one or another particular noematic or noetic factor of experience, and accordingly (i) try to control as much as possible any variability in the content of subjective experience, and (ii) aim to minimize reliance on the subject's verbal reports. Yet this approach seems too limited, if the aim is to investigate the integrated, labile, self-referential and spontaneous character of conscious processes (see Varela, 1999; Hanna and Thompson, in press). Neurophenomenology, on the other hand, focuses on the temporal dynamics of the noetic-noematic structure as a whole. Thus, in the pilot study, the focus of investigation was the dynamics of the noetic-noematic interplay between the subjective-experiential context leading up to perception (hence the comparatively distant baseline of 7000 milliseconds: see Figure 1 — back cover), and the perceptual event itself. One aim of this sort of investigation is to understand the circular causality whereby (1) the antecedent and 'rolling' subjective-experiential context (noesis) can modulate the way the perceptual object appears (noema) or is experientially 'lived' during the moment of conscious perception, and (2) the content (noema) of this momentary conscious state can reciprocally affect the flow of experience (as noetic process). This global, noetic-noematic structure and its temporal dynamics are taken to reflect the endogenous, self-organizing activity of the embodied brain (Varela, 1999; Lutz, 2002), which in turn is understood as an autonomous dynamical system (Varela, 1995; Varela *et al*., 2001; Rudrauf *et al*., 2003). We believe that the most fruitful way for the experimentalist to investigate these sorts of processes, and to define and control the variables of interest, is to make rigorous and extensive use of the subject's first-person insight and descriptive verbal reports about her experience. Hence neurophenomenology, without denying the validity of trying to control experimentally the subjective context from the outside, favours a complementary 'endogenous' strategy that explicitly takes advantage of the first-person perspective in action. By thus enriching our understanding of both the first-person and third-person dimensions of consciousness, and creating experimental situations in which they reciprocally constrain each other, neurophenomenology aims to narrow the epistemological and methodological distance in cognitive neuroscience between subjective experience and brain processes.

To conclude this paper, let us point to a few general areas of research in which a neurophenomenological approach seems promising and complementary to more standard forms of biobehavioural and cognitive-scientific research (this list is meant to be illustrative, not exhaustive):

- Plasticity of human experience: To what extent can experience in domains such as attention, emotion, imagination and introspection be trained, and to what extent can such training modify structural and large-scale dynamical features of the human brain? (For a discussion of imagination in this context, see Varela and Depraz, 2003.)
- Time consciousness: Can phenomenological accounts of the different constitutive levels of time consciousness (Husserl, 1991) shed light on neurodynamics (Varela, 1999)? What role does emotion play in the spontaneous generation of the flow of consciousness (Freeman, 2000; Varela and Depraz, 2000)?
- Intersubjectivity: Can phenomenological accounts of intersubjectivity and empathy (Depraz, 1995) help to disentangle different aspects of intersubjective cognitive processes and their physiological basis (Thompson, 2001; Gallagher, 2003)?
- Dreaming: Can phenomenological explorations of dreaming through first-person methods of lucid dreaming (LaBerge, 1985, 1998, 2003) cast light on the neurodynamics of consciousness across sleeping, dreaming and wakefulness?

As we have proposed throughout this paper, the investigation of such empirical issues depends fundamentally on the ability of subjects to mobilize their insight about their experience and provide descriptive reports in a disciplined way compatible with the intersubjective standards of science. For this task, better procedural descriptions and pragmatics of the process of becoming aware of experience need to be developed (Varela and Shear, 1999; Depraz *et al*., 2003). A paradigmatic neurophenomenological collaboration could therefore involve subjects with extensive training in the know-how of rigorous contemplative phenomenologies (such as those cultivated in Buddhist traditions), which seem to comprise stable experiential categories, detailed procedural descriptions and precise pragmatics, and have already begun to be explored in relation to cognitive science (Varela *et al*., 1991; Austin, 1998; Wallace, 1998, 2003; Goleman *et al.*, 2003).

In Memoriam

We dedicate this paper to the memory of Francisco Varela, who first proposed the research programme of neurophenomenology (Varela, 1996), and profoundly shaped the ideas expressed here. For an obituary see: http://psyche.csse.monash.edu.au/v7/psyche-7-12-thompson.html

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