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# A methodological dilemma for investigating consciousness empirically

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ABSTRACT

This paper exposes a methodological dilemma arising for the research program of finding the neural correlate of consciousness (NCC), the minimal set of brain processes sufficient for a particular percept. The main claim is that it is doubtful that the right kind of correlations will ever be obtained because the foregoing conceptual decisions regarding the relations between consciousness, attention, cognitive access, report, and other cognitive functions determine the interpretation of the correlation data that can be obtained. Relying on subjective reports likely leads to confounding the NCC with neural mechanisms for cognitive functions because reports presuppose cognitive access. No-report paradigms are in danger of confounding the NCC with neural mechanisms underlying unconscious processes. So there does not seem to be a way of making sure to have isolated the neural correlate of conscious experience.

## 1. Introduction[1]

Jerry Fodor once wrote that some philosophers hold that philosophy is what you do to a problem until it is clear enough to solve it by doing science while others hold that if it succumbs to empirical methods then it wasn't a philosophical problem in the first place (Fodor, 1978, p. 501). Many philosophers and scientists now think that this is happening to the problem of consciousness, which was formerly thought of as a philosophical problem. In his 'No progress report', Snowdon (2015) argues that philosophers have not provided any good arguments either for the claim that materialism about mental phenomena is true or for the counterclaim that materialism is false. Philosophers cannot solve the mind-body problem, he claims, since it is about finding out the true nature of the relation between physical processes and mental phenomena: "The problem, when correctly conceived, is a scientific one, an empirical one, rather than a philosophical one. Philosophers do not have the right tools to settle that sort of question" (2015, p. 21). His attitude that this is solely an *empirical* problem that the empirical sciences alone must solve, presumably first and foremost neuroscience (by providing a reductive explanation of it in terms of brain processes), is indeed shared by many neuroscientists and even many philosophers and psychologists. This is explicit in Crick's (1994) early proclamation that philosophers have dealt unsuccessfully with consciousness for too long, not having provided a satisfying theory of consciousness, and that the topic is now ripe for a thorough scientific investigation. Ever since, neuroscientists have devoted lots of energy to the central research program in cognitive neuroscience, namely, the quest for the neural correlate(s) of consciousness (Crick and Koch, 1990), defined as the minimally sufficient neural activation responsible for a given conscious percept (Tononi & Koch, 2008). Philosophers favoring materialism put their money on this project hoping that discovering the empirical evidence will allow them to conceive of consciousness as a physical

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phenomenon.

In contrast to this optimistic attitude to the problem, Nagel (1974) has expressed his doubts about the possibility of a reductive explanation of consciousness vividly a long time ago, even before many of the tools with which neuroscientists investigate consciousness today had been invented. According to Nagel, the contrast between the objectivity of science and the subjectivity of conscious experience is responsible for the impossibility of a scientific explanation. He takes the most characteristic feature of consciousness to be its subjective character. That is, while there may be different forms of consciousness, *all* conscious experiences are intimately connected to a subjective point of view. By contrast, when it comes to scientific discoveries, Nagel argues, "the process of reduction is a move in the direction of greater objectivity, toward a more accurate view of the real nature of things. This is accomplished by reducing our dependence on individual or species-specific points of view toward the object of investigation" (Nagel, 1974, p. 444). According to Nagel, we cannot apply this method to the problem of consciousness, because "if the subjective character of experience is fully comprehensible only from one point of view, then any shift to a greater objectivity—that is, less attachment to a specific viewpoint—does not take us nearer to the real nature of the phenomenon: it takes us farther away" (Nagel, 1974, p. 445). We will return to this point towards the end of the paper.

In a similar vein, Tim Crane has recently argued that "you don't solve the problem of consciousness by looking into the brain" (Edmonds & Warburton, 2010, p. 140). He thinks that the problem of consciousness is first and foremost a *conceptual* problem. The present paper illustrates, contrary to Snowdon's claim, that and how philosophers can and should continue to contribute to the investigation of consciousness, simply because it poses formidable *conceptual* problems which have ramifications for an experimental approach to consciousness. This is not to say that scientists are unfamiliar with or that they never face conceptual problems in their disciplines; on the contrary. But exposing the conceptual problems that impede the empirical research on consciousness yields a dilemma for empirical researchers that strikes at the heart of their methodological possibilities.

The core of the paper is the exposition of this methodological dilemma which arises from conceptual problems surrounding the notion of phenomenal consciousness. According to David Chalmers, the prime task of a science of consciousness "is to systematically integrate two key classes of data into a scientific framework: *third-person data*, or data about behavior and brain processes, and *first-person data*, or data about subjective experience" (Chalmers, 2004, p. 1111). Among the first class are phenomena like voluntary actions and verbal reports about internal states; among the second class are phenomena like visual, emotional or bodily experiences, mental imagery and occurrent thought. The specific challenge is to "admit both sorts of data" and "build an explanatory connection between them" (Chalmers, 2004, p. 1112). The problem with which this paper is concerned pertains to the methodologies available to researchers in gathering the first-person data in order to establish correlations with neural mechanisms: Either the researchers rely on participant's reports of some kind or they bypass reports and use other behavioral measures. I will argue that this dilemma is problematic for the scientific approach to consciousness in general.

The paper proceeds as follows: Section 1 introduces some basic assumptions of the central research program in cognitive neuroscience, namely, the quest for the neural correlate(s) of consciousness (Crick & Koch, 1990), which are the minimally sufficient neural activations responsible for a particular conscious phenomenon. I illustrate this research program using the familiar phenomenon of binocular rivalry. Section 2 then develops the first horn of the dilemma by pointing out the prior assumptions and conceptual decisions *preceding* the establishment of correlations. I will expose this by focusing on the neuronal global workspace theory (Dehaene, 2014). The first problem of relying on reports is that it is contentious whether verbal reports, for example, exhaustively capture the subjects' conscious experience. Reporting presupposes cognitive access to what one is phenomenally experiencing. Since there may be a divergence between conscious experience and cognitive access, e.g. if conscious experience exceeds what can be accessed by a subject, reports may leave out a relevant portion of the participant's experience (Block, 2007). The second problem of relying on reports, independent from the first, is that such measures are in danger of confounding the NCC with neural mechanisms underlying *cognitive* phenomena like accessing and reporting. Both problems give rise to the need for a way to determine the neural correlate(s) of consciousness in the absence of cognitive phenomena. One strategy of bypassing reports is to use behavioral measures, discussed in Section 3 (Tsuchiya, Wilke, Frässle, & Lamme, 2015). I will show that this methodology is in danger of confounding the NCC with neural mechanisms underlying *unconscious* phenomena. A second strategy is to give up the traditional notion of consciousness as a subjective phenomenon in favor of a redefinition of consciousness in terms of some neural process that is robustly correlated with it (Lamme 2006). I discuss this proposal in Section 4 and show that this move is premature and so far unjustified.

## 2. The NCC research program

The "core project of current scientific research on consciousness" is the "search for the neural correlates of consciousness" (Chalmers, 2004, p. 1115). The aim is to find correlates for each aspect or dimension of consciousness, since the term 'consciousness' is an umbrella term covering a diverse range of phenomena. It's common to distinguish between consciousness as a *state of vigilance* on the one hand and *specific conscious experiences* in various sense modalities on the other. The former allows an organism to receive sensory stimulation and process information at all and is the aspect of consciousness associated with statements like 'This patient is conscious!' Consciousness in this global sense comes in degrees, ranging from full wakefulness via various levels of sleep, anesthesia, vegetative state and others down to deep coma (Tononi & Koch, 2008) and is sometimes called 'creature consciousness' (Bayne, 2007; Hohwy, 2009). Addressing this aspect of consciousness is only challenging to some extent. We know, for example, that vigilance fades away once the brainstem is severely damaged (Damasio, 2011). It is a background or enabling condition for being able to have particular conscious experiences of pain, color, and so on at all. The latter are distinguished by their contents and must be considered as modifications of our overall unified conscious state at a time (Bayne & Chalmers, 2003; Searle, 1992). For example, looking outside

my open window, simultaneously I may *see* trees in the garden, *hear* birds singing, and *smell* the fresh air, accompanied by mixed *feelings* and *thoughts*. In line with a suggestion by Crick and Koch (1990) researchers assume "that all the different aspects of consciousness, for example pain and visual awareness, employ a basic common mechanism or perhaps a few such mechanisms. If we understand the mechanisms for one aspect, we will have gone most of the way to understanding them all" (Crick & Koch, 1990, p. 264). Neuroscientists attempt to identify the neural correlates of consciousness (NCC), "defined as the *minimal neuronal mechanisms jointly sufficient for any specific conscious percept*" (Tononi & Koch, 2008, p. 239; see also Fazekas & Overgaard, 2018). The assumption is that for every conscious percept there will be a NCC where inducing the NCC will induce the percept and inactivating the NCC will eliminate the percept. The emphasis here is on identifying the *minimal* neuronal mechanisms since presumably not all brain areas or neural processes will play a role in generating conscious experience, and the ones which *do* contribute don't have to do so in the same way. One goal of this research is to determine the neuronal mechanism sufficient for producing one particular percept instead of another one. This minimal mechanism is sometimes called the "core" NCC. This will always be embedded within a "total" NCC, i.e. a much more encompassing neural activation pattern that also comprises various other mechanisms, e.g. the mechanisms in the brainstem necessary for sustaining global consciousness (or vigilance).

Various methodologies used to discover such correlations differ with respect to the fineness of grain with which they can target the mechanisms, activation patterns or regions that can be associated with a given conscious experience.[2] Among the many techniques used to manipulate *visual* experience, say, are masking, binocular rivalry, motion-induced blindness, change and inattentional blindness. All such methods allow researchers to interfere in the relation between a worldly stimulus, the ensuing neuronal activity when this stimulus is registered, and the effected conscious percept. Their goal is to identify the neuronal mechanisms associated with conscious perception of the stimulus and distinguish them from activity during unconscious processing of the stimulus. The rationale of such methodologies shall be illustrated by way of one example, binocular rivalry.

In binocular rivalry, two different stimuli are presented to each eye, making sure that the left eye can only register one stimulus, while the right eye only registers the other. What happens is that conscious experience alternates between seeing these stimuli separately, rather than a conscious experience of a mixed stimulus. Logothetis (1998) trained monkeys to report when they saw one rather than the other stimulus. In this way, they could compare the neuronal activity in the monkey's brain with conscious and unconscious registrations of the same stimulus. Neuronal activity in the primary visual cortex, for example, did not differ dramatically in these two situations, yielding the hypothesis that this area is not part of the specific NCC. By contrast, neuronal processing in inferior temporal cortex, higher up in the hierarchy of the visual pathway, was correlated with visual experience of the stimulus. Using this methodology, very specific brain areas associated with specific contents have been identified. For example, Kanwisher (2006; also Kanwisher & Yovel, 2006; Kanwisher, McDermott, & Chun, 1997) highlights research on strong correlations between conscious face perception and activations in the (later) so-called 'fusiform face area' (FFA). When a face is presented to one eye, while a house is presented to the other eye, conscious perception of the face alternates with conscious perception of the house, while the former is strongly correlated with activity in FFA. Despite retinal stimulation remaining constant, subjects' experience switches between the two stimuli, accompanied by alternating increase and decrease in the FFA when the face is consciously perceived or not, and increase and decrease in the PPA ('parahippocampal place area') when the house is consciously perceived or not. The FFA has an analogue in the monkey brain's 'middle face patch'. Tsao, Freiwald, Tootell, and Livingstone, (2006), using fMRI to identify three such patches, then recorded from single neurons in that middle patch, 97% of which selectively responded to face-stimuli. This supports the view that the brain may contain multiple such special-purpose modules. The FFA (in the human brain) is located in the ventral processing stream of the temporal lobe on the lateral side of the fusiform gyrus. High correlation of activity in FFA upon registration of face stimuli is supplemented by cases in which patients with a damaged FFA have problems in recognizing faces (Barton, Press, Keenan, & O'Connor, 2002). Taken together, this impressive body of research suggests that activation in FFA is the neural correlate for face perception and recognition. But so far, the evidence can only support the claim that FFA is necessary for the recognition of faces, not that it is sufficient. (Of course, even if it could be demonstrated that such activation was sufficient for distinguishing a conscious experience as of a face from other percepts, the FFA would only constitute the core NCC of face perception, which must be embedded in the total NCC in order to yield conscious face perception.) Similar research using other visual stimuli has led to an impressive body of evidence supporting a modular architecture of sensory mechanisms in the brain. For example, area V4 is taken to play a key role in color perception which is impaired (*achromatopsia*) in case this area is damaged (Heywood, Gadotti, & Cowey, 1992), while area MT/V5 is taken to play a key role in the perception of motion which is impaired (*akinetopsia*) in case this area is damaged (Schenk, 1997; Zeki, 1991). And so on. After having illustrated the main research strategy of finding the NCC for specific stimuli, I will now turn to the exposition of the dilemma.

## 3. The danger of confounds I: Consciousness and cognition

Any empirical investigation of consciousness is preceded by a conceptual clarification of the phenomenon under investigation. Methodological limitations and decisions give rise to various challenges. In order to determine the neural basis of our rich conscious mental life, one needs a notion (or notions) of consciousness, which is both true to the phenomenal facts and can be operationalized in experimental setups. Taking Chalmers' (2004) considerations about first-person data seriously it seems that asking a participant in an experiment for a – verbal or nonverbal – report about her experience is the most straightforward way to gather information about

[2] Rees & Frith (2007) provide an overview of different techniques to investigate the difference between those neuronal processes underlying conscious and those underlying unconscious phenomena.

their conscious experience. But this methodology makes two crucial assumptions that can lead to potential problems: (a) It presupposes that a subject can exhaustively access and report what she phenomenally experiences. Yet, it is an open question whether the capacity of consciousness coincides with or outstrips the capacity of the cognitive system that is involved in providing access to and enabling report of conscious information (Block, 2011). Relying on report seems to prejudge this issue. (b) Since subjective reports do not only involve cognitive access but also other cognitive phenomena like attention and working memory, this approach is in danger of confounding a potential NCC with processes underlying these cognitive phenomena. Both of these problems can be illustrated here by outlining and evaluating the popular neuronal Global Workspace Theory (Dehaene, 2014; Dehaene, Changeux, Naccache, Sackur, & Sergent, 2006).

Dehaene's et al. (2006) approach nicely illustrates the conceptual decisions preceding the empirical research that is ultimately interpreted as motivating the neuronal global workspace theory. According to this theory, consciousness arises when information is made available globally within the cortex, arising from a neuronal network whose function is exactly to share information with higher cognitive functions. Highly specialized, modular, non-conscious mechanisms process information in the brain and compete for access to consciousness. But given the limited capacity for consciousness, only a small fraction of what is computed at any time can be consciously experienced. The so-called global workspace (Baars, 1998) is intended as a *functional* network, not anatomically limited to a certain region. But Dehaene and colleagues have developed this idea further and underpinned it with a theory about its neuronal implementation, comprising many giant pyramidal cells whose long-range axons can crisscross the cortex and interconnect many areas at once into a global complex neuronal ensemble. Once this global network ignites into a burst of high-level activation, the processed information is consciously experienced (Dehaene, 2014). Only a limited number of contents can be part of this global representational state at once. Consciousness arises when the neuronal activation in response to a given stimulus is strong enough and selected by attentional mechanisms in order to be so "broadcast" to various other modules in the brain such that it can be used for action and speech, for planning and long-term memory. Dehaene et al. (2006, p. 205) emphasize that, with respect to vision, early visual activation is not sufficient for conscious report; rather, it "correlates with the activation of higher associative cortices, particularly parietal, prefrontal and anterior cingulate areas". Rather than dwelling on the fascinating neuronal details of this model, we shall focus on the main conceptual, philosophically relevant ideas guiding this approach to consciousness.

In order to "turn subjectivity into a science", Dehaene proposes a number of initial steps which 'prepare' consciousness for scientific investigation, allegedly turning a "philosophical mystery into a laboratory phenomenon" (Dehaene, 2014, p. 8). The first decision is conceptual in nature and concerns the working definition of consciousness: Since the term 'consciousness' denotes too many phenomena, Dehaene argues, "we will have to narrow our subject matter to a definite point that can be subjected to precise experiments […] What counts as consciousness […] is conscious access—the simple fact that, usually, whenever we are awake, whatever we decide to focus on may become conscious" (Dehaene, 2014, p. 9). The second ingredient is the discovery that consciousness can be experimentally manipulated (for example, by using binocular rivalry or masking); the third is "a new respect for subjective phenomena" (Dehaene, 2014, p. 9). In this paper, we will be mostly concerned with the first of these three ingredients.

In defending the workspace model for consciousness, Dehaene et al. (2006, p. 205) hold the quite strong claim that "without attention, conscious experience cannot occur". They support this restriction with empirical research on phenomena like "inattentional blindness" and "change blindness" (Chabris & Simons, 2010; Rensink, O'Regan, & Clark, 1997). Accordingly, attention plays a central role in their model since the scope of consciousness is now restricted to the scope of attention, which provides the amplification needed for a given neuronal activation to reach the required threshold. They write: "Both bottom-up stimulus strength and top-down amplification […] are jointly needed for conscious perception, but they might not always be sufficient to cross the threshold for conscious perception" (2006, p. 206). A further constraint of the experimental investigation of consciousness is due to the demand for subjective reports provided by the participants. Dehaene et al. (2006, p. 206) explicitly claim that "conscious perception must […] be evaluated by subjective report, preferably on a trial-by-trial basis". Attention and cognitive access thus constrain consciousness such that the capacity of consciousness coincides with the range of attention and the range of cognitive access that is ultimately feeding the subjective report. All neuronal representations outside the focus of attention count as unconscious or "preconscious", i.e. as representations carrying enough information to *become* conscious, remaining "temporarily buffered in a non-conscious store because of a lack of top-down attentional amplification" (2006, p. 207). That is, in the absence of attention, the conscious subject remains unaware of them.

### 3.1. The overflow argument

Block (2007, 2011) criticizes Dehaene's Global Workspace Theory because of its conceptual reduction of phenomenal consciousness to a cognitive notion of consciousness. He argues that the phenomenal content of consciousness is much richer than suggested by the Workspace Theory, since the capacity of consciousness allegedly "overflows" the capacity of cognitive access. In contrast to Dehaene, Block defends a sharp distinction between consciousness and cognitive access, accepting the Global Workspace Theory only as a model for the latter, but not for the former. He holds that neither attention nor cognitive access and report are necessary conditions for conscious experience. Block relies on various change detection experiments in support of his position (Landman, Spekreijse, & Lamme, 2003; Sligte, Scholte, & Lamme, 2008; Sperling, 1960). These equally familiar experimental data suggest that after a brief presentation of a stimulus, e.g. a pattern of twelve letters arranged in three rows, an imagistic neuronal representation can be maintained for up to several seconds such that a subject can still subsequently attend to a subset of the stimulus array, guided by a cue, and report this subset. Block takes this as evidence for the notion that the stimulus must have been consciously experienced from the start, *before* focal attention highlighted the subset and allowed for cognitive access and report. This interpretation is controversial (see Block, 2014; Cohen & Dennett, 2011; Cohen, Dennett & Kanwisher, 2016; Schlicht, 2012; Stazicker

2011; and the commentaries on Block, 2007 for discussion). In this paper, I will not attempt to settle this debate once and for all. Rather, what's important here regarding the overflow debate, is that the controversy exists because it demonstrates the problematic conceptual decisions preceding Dehaene's empirical research program and its controversial status in the debate.

The methodological impact with respect to gathering the relevant first-person data is that the two accounts differ regarding the alleged range of conscious experience. Consequently, the NCC will differ accordingly. A restriction of the range of consciousness to the range of attention seems unreasonably strong (Koch & Tsuchiya, 2007; Lamme, 2003). But neither is it clear whether Block's conceptual distinction is without problems. In the remainder of this section I will focus on one of them. Although the research cited by Block indicates that a visual representation with high capacity (exceeding the capacity of access and report) is formed, one consequence of Block's position is that a subject can have conscious experiences she does not and *cannot* know about (Block, 2007, p. 498). We can illustrate this with a patient suffering from visuo-spatial extinction (Aimola Davies, 2004; Rees et al., 2000). When such a patient is presented with only one object either in her left or in her right visual field, she can see and identify this object. But if a second object is introduced in the remaining visual field, then suddenly the patient can identify only the object on the right, while claiming that she does not see the object on the left. Now, consider the phenomenon of binocular rivalry explained earlier. Rees et al. (2000) presented such a patient with a face stimulus on the left and a competing stimulus on the right such that the patient reported not seeing the face (because of the competing stimulus). But two fMRI-studies demonstrated that the fusiform face area (recall: the alleged core neuronal correlate of face perception) in the patient's right hemisphere was activated almost as strongly as when he reported actually seeing the face (Driver & Vuilleumier, 2001; Rees et al., 2002). Block considers various possibilities how to interpret this finding: One could take it as a counterexample to the hypothesis that activation in the fusiform face area is the neuronal correlate for face perception. Alternatively, one could argue that possibly the 'extinction' may have been caused by a failure in the rest of the patient's total neuronal correlate of face perception, while the fusiform face area remains its core neural correlate. Or, and this is Block's favorite possibility, "should we conclude that (the patient) has face experience that—because of lack of attention—he does not know about?" (2007, p. 482-3)

The crucial question highlighted by this example is that, quite generally, when someone *denies* consciously seeing object X, can we be sure that she does not experience it? Cognitive access and report cannot help us decide whether the subject's alleged representation of X is *unconscious* in principle or simply phenomenally conscious (in Block's sense) but *cognitively inaccessible*. In both cases, the answer to the question whether she is consciously seeing X will be negative. The first lesson to draw from this controversy is that the empirical evidence regarding the conceptual relation between attention, cognitive access, and consciousness is contradictory or at least pointing in two different directions. The second lesson is that in order to decide this issue empirically, the subject's report must somehow be bypassed. We need research methodologies independent of subjective reports.

### 3.2. Consciousness and cognition

Even if we reject Block's distinction between the capacity of consciousness and the capacity of attention and cognitive access, Dehaene's proposed methodology to determine the NCC is still problematic. As outlined above, the first-person data that are correlated with neuronal activation are determined via subjective reports which presuppose and therefore involve various cognitive phenomena: attention, cognitive access, and working memory. As Fazekas and Overgaard (2018) put it:

> "From a methodological perspective, the cognitive access mechanisms in question are all candidates of possible postconscious activities that might not be constitutive parts of the neural basis of consciousness but are only downstream processes acting on the information content of independently conscious states. From this perspective, relying on subjective reports possibly confounds the findings, resulting in an overestimation of the neural basis of consciousness and rendering delineating the neural basis of phenomenal consciousness itself likely out of reach."
>
> Fazekas & Overgaard, 2018, p. 2

As long as the conceptual relation among these phenomena (consciousness, cognitive access, attention, working memory) is unclear, we cannot rule out that the empirical investigations of putative NCCs are confounds. Any neural activation correlated with a subjective report will involve brain mechanisms underlying cognitive phenomena in addition to (or rather than) neural activations underlying consciousness. That is, methodologies relying on reports will be unsuccessful as long as these conceptual problems are still unresolved.

As a solution to this predicament, there seem to be two avenues that researchers pursue in order to determine the NCC of phenomenal experience: (a) Reliance on other behavioral (and automatic) measures in the absence of reports. (b) Rejecting the traditional characterization of consciousness in favor of a neural criterion via a *neural redefinition* of consciousness. We shall evaluate these avenues in turn.

## 4. No-report paradigms

The first possibility is to rely on so-called no-report paradigms as elaborated by Tsuchiya et al. (2015). They argue that

> "there are potentially many ways that can bypass the need of overt reports to investigate whether the decoded contents are conscious or not. For example, subjects' perceptual contents can be reliably inferred from physiological measures, such as eye movements or pupil size (Frässle, Sommer, Jansen, Naber, & Einhäuser, 2014), and they can be reliably manipulated by subtle stimulus changes (Wilke, Mueller, & Leopold, 2009) or by instructions (Pitts, Martínez, & Hillyard, 2012, 2014). Refining these

> psychophysical techniques, and applying them to a variety of experimental situations of ambiguous conscious/non-conscious perception, will be an important and fruitful research endeavor for the future […] Once no-report paradigms are established, they will provide extremely powerful tools for studying the neural correlates of conscious perception, compensating for some of the disadvantages of report-based paradigms."
>
> Tsuchiya et al., 2015, p. 758

One such strategy exploits the finding that certain automatic eye movements show a high correlation with conscious reports of perceptual dominance during binocular rivalry studies. With the help of such correlations, scientists aim to measure alternations in conscious percepts, being able to ignore explicit reports of any kind. In their ingenious study, Frässle et al. (2014) made use of two automatic reflexes, namely the *optokinetic nystagmus* (OKN) and the pupil reflex, as objective measures of the percept that is dominant in perceived rivalry (either a green grating moving to the left or a red grating moving to the right). The nystagmus consists of a slow phase in which the eye follows the stimulus, and a fast phase in which the eye quickly reorients in the opposite direction. We are unaware of these movements but they seem to be highly correlated with the percept rather than the stimulus. Thus, the researchers are confident that the nystagmus and pupil size are reliable measures of the subjective percept rather than the stimulus material. Since "OKN and pupil make a prediction of the observer's current perceptual state at any point in time" (Frässle et al., 2014, p. 1742), this methodology allowed them to skip the report in the second set of trials to go only with these reflexes in order to infer the perceptual content. Then they matched active trials involving reports with passive trials where rivalry was perceived without issuing a report in order to "dissociate the effects of rivalry switching per se from the effects of active report" (Frässle et al., 2014, p. 1744). Although the activation pattern was superficially similar to the report condition, the intensity was somewhat reduced and the predominantly frontal activation was largely missing. The researchers concluded that this frontal activation typical for report studies (used by Dehaene et al., 2006 and others) was due to the active report condition and plausibly associated with the participants' introspecting, or accessing, their own perceptual experiences. Using this methodology, proponents of no-report paradigms suggest that this provides a better way of determining the neural correlates of conscious experience without confounding it with the neural mechanisms correlated with cognitive functions such as introspection, cognitive access, attention and report.

The biggest problem with this move is the danger of including neural processes within the NCC which are actually underlying *nonconscious* processing instead of conscious processing. After all, the objective measures used—although tested regarding their correlation with the conscious percept rather than the stimulus—are pure reflexes, outside voluntary control and outside conscious experience. Yet, they are presumably supported by neural mechanisms enabling them. Is it clear that they correlate with conscious rather than unconscious processing? Tsuchiya et al. (2015) acknowledge this possibility but do not elaborate on how to overcome this risk. If a subjective report cannot be obtained at all, the *inferred* contents of conscious experience that are correlated with such eye movements, say, need not reflect the *real* contents (or range) of conscious experience as opposed to unconscious information processing. The risk is here to overestimate the NCC by including *unconscious* neural processes, whereas the risk of report-methodologies was to overestimate the NCC by including *cognitive* neural processing. Overgaard and Fazekas (2016, p. 241), in a critical comment on Tsuchiya et al. (2015), point to possible confounds with post-NCC activity, e.g. introspective acts, directing attention and meta-cognitive reflections: "Refraining from issuing a verbal (or other) report obviously does not rule out that participants in experiments are still introspecting, reflecting, associating, and so on." Thus, it is not clear why no-report paradigms should be considered to be introspection-free methods as Tsuchiya et al. (2015) claim. People may simply *always* be self-monitoring to some extent. In such cases, even no-report methods cannot ensure that what is measured on the neural level is *only* correlated with conscious experience. But in defense of their approach, it is worth highlighting that Frässle's neural measurements show a significant absence of frontal activity in the no-report condition. If cognitive activities are associated with activations in these frontal areas, then it is plausible to conclude (at least until disconfirming data appear) that no cognitive acts are executed. But Frässle's data can be taken as problematic for Dehaene's approach whose NCC activations do involve exactly the frontal areas which are not activated in Frässle's paradigm. Phillips (2018) argues that no-report paradigms cannot settle whether frontal activity may after all be a constitutive part of the total NCC (if not the core NCC). The debate about these complex conceptual, theoretical and methodological issues continues (Boly et al., 2017; Koch, Massimini, Boly, & Tononi, 2016; Lamme, 2018; Naccache, 2018).

The more general worry here echoes Aru, Bachmann, Singer, and Melloni, (2012) discussion of three possible NCCs: From the NCC proper (whose determination is the aim of the research program), they distinguish the NCC-pr and the NCC-co. While the NCC-pr refers to neural processes *preceding* the actual NCC (at a time), including various processes that merely support unconscious processing, the NCC-co includes neural processing supporting the *consequences* of the NCC-proper (at a given time), particularly cognitive consequences. It may be a difficult if impossible task to isolate the NCC proper from these two neighboring NCCs due to methodological constraints of different ways of obtaining information about neural activation *at a given time*. Kriegel (forthcoming) discusses further issues regarding the timing of neural processes and events and the problems arising for NCC research. These brief comments on the exploitation of no-report paradigms illustrate that it is far from clear how scientists could ensure that they have isolated an NCC that is free from (a) post-NCC activity on the one hand (including attention and cognitive access), and (b) pre-NCC activity on the other (including unconscious information processing). If these methodological problems cannot be solved, then the NCC-research program will not deliver what's promised, namely the backbone of an empirical approach to consciousness that takes seriously the subjective character of conscious experience.[3]

[3] Metzinger (2018) seems to intend to bypass these problems by targeting the NCC for "pure consciousness" or "minimal phenomenal experience". But his target is rather to be identified with what has been called creature consciousness or global consciousness, the precondition of enjoying specific states of consciousness (of X say) at all.

## 5. A neural definition of consciousness?

As one further way out of this dilemma that arises from the choice between report- and no-report-paradigms, Block (2007) follows Lamme's (2006, p. 499) suggestion to give up on the traditional philosophical characterization of consciousness that we started with. Instead, they propose to rely on a *neural* criterion in order to decide the case. How is this supposed to work? If consciousness was *redefined* in terms of its (putative) neural correlate, recurrent processing say, then it could be determined whether the subject's representation of X is conscious by determining whether this signature of consciousness (recurrent processing) is present or not, *irrespective* of the subject's report. If recurrent processing can be measured, then the subject is (judged to be) phenomenally conscious of X. If recurrent processing is absent, then the subject is (judged to be) not phenomenally conscious of X. In this case, third-person neurophysiological evidence trumps the subject's first-person authority regarding his or her conscious experience. The scientist becomes the authority when it comes to deciding what the subject is conscious of and what not.

Lamme highlights the open question arising from Dehaene's Global Workspace Theory regarding unattended stimuli which Dehaene calls "pre-conscious", forming a third category between (a) (reportable and thus) fully conscious and (b) (unreportable and thus) fully unconscious representations: The question is "whether there is any phenomenally conscious aspect to such a state" although it will not be reported as being consciously experienced (Lamme, 2006, p. 499). While Dehaene and colleagues do not regard this as a question that can be answered empirically, Lamme argues that "when we let neuroscience go beyond 'finding neural correlates of'", we could allow for "neural arguments" showing that it is not the activation of pre-frontal areas per se which leads to conscious experience, but the recurrency of processing even in purely visual areas. According to Lamme,

> "recurrent processing is the key neural ingredient of consciousness. We could even *define* consciousness as recurrent processing. This could shed an entirely different light on the matter of whether there is conscious phenomenal experience in states of inattention, split brain or extinction. The matter would now become a *scientific* debate, where evidence from behavioral observations is weighted against the evidence from neural measurements. If recurrent activations of sufficient strength are demonstrated, it can be argued that the 'inattentional', 'preconscious' or 'not reported' still have the key neural signatures of what would otherwise be called conscious processing."
>
> Lamme, 2006, p. 499

Lamme mentions several advantages of his strategy. One of them is an alleged increase in our "fundamental understanding of what consciousness is or does", e.g. facilitation of learning and providing a better chance of solving the 'hard problem' of consciousness (Lamme, 2006, p. 500). A second alleged advantage would be the resolution of confounds by dissociating consciousness from attention and other cognitive functions via dissociating their neural bases. Of course, this will only hold true to the extent that recurrent processing is not involved in enabling any of these cognitive functions. As the simple example of Dehaene's Global Workspace Theory shows, there is lots of room for dissent.

Lamme is of course fully aware that such a 'redefinition' is counterintuitive because "consciousness" is often taken to be "synonymous to private access and personal feeling" (Lamme, 2006, p. 500), whereas on a neural definition, these subjective features of conscious experience would no longer carry the same weight as the presence or absence of the recurrent neural activation. But given that adopting this strategy amounts to deciding what consciousness is independently of and prior to an explanation of subjectivity, Lamme's optimism seems misplaced. It can be seen as a premature move to take the available evidence we now have as indicating that it is recurrent processing rather than some other neural process or mechanism that makes the difference between conscious and unconscious processing. It is important to emphasize the fact that on Lamme's neural definition of consciousness in terms of recurrent processing those stimuli that are unattended yet processed with sufficiently strong activation turn out to be consciously experienced (because of the presence of recurrent processing), whereas on the Global Workspace Theory they count as unconscious (or preconscious). So with regard to such stimuli, scientists like Dehaene and Lamme disagree about whether the subject is conscious of them. Likewise such disagreement will always result in cases where the neural evidence about recurrent processing can be dissociated from the behavioral response (cf. Super, , 2001). Therefore, if we decide to follow Lamme's suggestion then we better be sure about recurrent processing being the best candidate definition of consciousness. How could we be sure? If recurrent processing is only "closely associated with" or "highly relevant for" consciousness but not identical to it, then this strategy does not yield the promised "understanding of what consciousness is" (Lamme, 2006, p. 500). What's worse, deciding this issue now in favor of recurrent processing will preclude further investigations into other possible NCCs.

Over the years, the NCC research program has come up with a number of possible processes and mechanisms that may make the difference between unconscious and conscious information processing. An incomplete list of competitors, compiled by Chalmers (2000, p. 17), includes (a) 40H-hertz-oscillations in the cerebral cortex, (b) intralaminar nuclei in the thalamus, (c) reentrant loops in the thalamocortical systems, (d) 40-hertz rhythmic activity in thalamocortical systems, (e) extended reticular-thalamic activation system, (f) neural assemblies bound by NMDA, (g) certain neurochemical levels of activation, and many more.[4] At the present state of inquiry, it is much too early to decide in favor of any one of them. Lamme would have to pile up decisive evidence that it is recurrent processing and not any of the other processes (or combination of them) that should be identified with consciousness. This is important because a significant number of cases will be judged differently depending on the criterion (or neural definition) that we take as decisive.

Part of the problem is of course that recurrent processing – like any other of the candidates just mentioned – leaves us with an

[4] See Chalmers (2000) for references.

explanatory gap with respect to the most important feature of consciousness, its subjective character (Levine, 1983). It may be argued that as long as a candidate signature of consciousness does not provide us with a clue as to why *this* process should be subjectively experienced, we have no reason to favor it over any of the other candidates. Although the "hard problem" (Chalmers, 1996) was not a topic of this paper, it is relevant at this point when we have to decide whether we should accept Lamme's suggestion. For example, philosophers who are inclined to follow Searle's (2005, p. 98) characterization of conscious experiences as involving a "first-person ontology, in the sense that they exist only insofar they are experienced by some human or animal subject, some 'I' that has the experience" may express their doubts why we should reduce consciousness to recurrent processing or identify them. On Searle's view, this subjectivity makes conscious experiences "irreducible to any third-person ontology, any mode of existence that is independent of any experiencing agent" (2005, p. 98). With this emphasis, Searle does not intend to proclaim some sort of Cartesian dualism. He simply reminds us of the importance of the subject's first-person point of view when it comes to conscious experience. When we trade in his (more traditional) characterization of consciousness which respects subjectivity for some neural definition which may be completely devoid of any sign of subjectivity, then this is problematic because we are in danger of changing the topic. As far as recurrent processing is concerned, many open questions remain. For example, it is unclear why *this* process should be accompanied by something that it is like to experience a given stimulus. It is not even clear *which* aspect of recurrent processing could be responsible for phenomenal character. These open questions remain for every candidate process listed above. So recurrent processing is no worse off than these suggestions. But it is also unclear why we should think it is any better off than those such that we should put all our money on it at this point.[5]

One quite general objection to the research program of identifying the NCC comes from the recent wave of embodied and enactive approaches to mental phenomena (Noë & Thompson 2004; Noë, 2009; Varela, Thompson, & Rosch, 1991). The NCC, recall, is defined as the *minimal* neuronal activation *sufficient* for a particular percept. Proponents of enactive views claim that there is no such thing as a *neural* correlate of consciousness. If there is a correlate of consciousness, then it contains much more than just brain processes, or so the reasoning goes. As Noë (2009, p. xii) puts it, the turn to neuroscience in the search for an explanation of consciousness is wrongheaded, since "we have been looking for consciousness where it isn't. […] Consciousness is not something that happens inside us. It is something we do or make. Better: it is something we achieve." Therefore, he claims, "the locus of consciousness is the dynamic life of the whole, environmentally plugged-in person or animal" (Noë, 2009, p. xiii). This objection would preclude us from *defining* consciousness in neural terms. Noë is quite right about the *importance* of an animals' *body* and it's *sensorimotor capacities* as well as the environment surrounding the animal. On this point, neuroscientists may even agree with him. Noë may be right about the importance of features of the body and environment playing *causal* roles for our conscious experience. Of course, what I see *depends* on where I look. But neuroscientists may strongly disagree with Noë when he downplays the role of the brain with respect to consciousness (Clark, 2009). Moreover, understood as a metaphysical claim about the *locus* of consciousness which situates it *within* the interaction dynamics of the animal and its environment, Noë's enactivist approach to consciousness contains an unconvincingly strong thesis; at present, it is hard to understand. What does it mean for consciousness to 'take place' or 'be achieved' in interactions with the world? The theoretical move from treating body and world as *causal* factors contributing to the emergence of consciousness to treating them as *constitutive* elements of consciousness is problematic (Aizawa, 2010). Even if we accept that consciousness results from the whole dynamic relation between brain, body and world, the neuroscientist's task remains the same: to determine the brain's contribution to this dynamics. Since in their experimental setups all bodily and environmental factors are held constant, it is still worthwhile to measure the differences in activation regarding different percepts in contrast to unconscious information processing. The explanatory status of the neural findings will be different, of course. But Vernazzani (2017) argues persuasively that Noë's sensorimotor approach to consciousness can only supplement but not replace the mechanistic neuroscientific approach. Indeed, it seems to be consistent with a mechanistic perspective. Substantiating this bold reply to the enactivist objection to the NCC research program would require a separate paper, but the present paper is only concerned with the prospects of a cognitive neuroscience of consciousness. Thus, we will stay contend with mentioning the enactivist objection to a neuroscientific approach to consciousness at this point. But although I am defending the NCC research program against the enactivist challenge, I still think that following Block's and Lamme's suggestion to redefine consciousness in neural terms is highly problematic. Consciousness may turn out to be recurrent processing, but right now the move of choosing a neural definition of consciousness in order to solve the dilemma seems premature and potentially damaging since it may preclude further investigations of alternative candidates.

## 6. Conclusion

This paper presented a methodological dilemma for a thoroughly scientific approach to consciousness. The dilemma arises partly because of controversial conceptual disagreements among the researchers and philosophers with regard to the relations between consciousness and various cognitive phenomena like attention, cognitive access, and report. Depending on one's stance on these conceptual issues, the empirical evidence about correlations between conscious experience and neural processes that can be obtained will vary to some extent. The first horn of the dilemma is that although relying on subjective reports seems to be the most

[5] In a recent paper, Block (2018) discusses the popular suggestion that the brain is a prediction machine that enables perception by drawing probabilistic inferences from internally generated predictions about sensory signals and ensuing feedback. Block criticizes this as an approach to perception by alluding to the difference between the probabilistic description of the neural processes and the deterministic description of phenomenal experience. The same reasoning can be applied to recurrent processing: Why should we favor the recurrent processing account over the predictive processing account?

straightforward methodology for correlating first-person data with third-person data, it turns out to be problematic because of the danger of confounding the NCCwith neural activations underlying cognitive phenomena. Report paradigms (as used by Dehaene et al., 2006) are in danger of overestimating the NCC with the neural mechanisms of cognitive phenomena such as attention, access and report. The second horn of the dilemma is to bypass reports. If researchers rely on behavioral data such as unconscious eye-movements rather than subjective reports then they are in danger of confounding the NCC with neural processes underlying unconscious processing. And if researchers bypass reports by directly redefining consciousness in terms of some neural process (e.g. recurrent processing), they are in danger of changing the topic because it has not been established that any such candidate neural definition *is* the phenomenon we started out to investigate in the first place. It may only be closely associated with it.

Although this methodological dilemma is serious and difficult to escape, I do not intend this to be a decisive point against the very possibility of investigating consciousness empirically. Establishing correlations between conscious experience and neural processes and mechanisms is important, and I briefly defended this agenda against objections from proponents of enactive accounts. What the present paper emphasizes though is the fact that scientists will always be determining different neural correlates of consciousness *depending* on their preconceptions of the relations between consciousness and cognitive access, attention etc. Consciousness will not be explained empirically as long as such conceptual and theoretical questions are not clarified in a sense that is commonly accepted. Here is a decisive role for philosophical theorizing. Report-paradigms could overestimate the neuronal correlate of consciousness in the direction of cognition, while no-report paradigms seem to be in danger of overestimating the neuronal correlate of consciousness in the opposite direction, by including substrates of non-conscious processing. If that is so, then there is currently no way to secure that neuroscientists are investigating the neuronal correlate of consciousness proper.[6]

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[6] Phillips (2018) makes a similar case for what he calls ‚the methodological puzzle of phenomenal consciousness", arguing that given the conceptual disputes, this puzzle will remain with us.

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