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First-person approaches in neuroscience of consciousness: Brain dynamics correlate with the intention to act

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ABSTRACT

The belief in free will has been frequently challenged since Benjamin Libet published his famous experiment in 1983. Although Libet's experiment is highly dependent upon subjective reports, no study has been conducted that focused on a first-person or introspective perspective of the task. We took a neurophenomenological approach in an $N = 1$ study providing reliable and valid measures of the first-person perspective in conjunction with brain dynamics. We found that a larger readiness potential (RP) is attributable to more frequent occurrences of self-initiated movements during negative deflections of the slow cortical potentials (SCP). These negative deflections occur in parallel with an inner impulse reported by an expert meditator which may in turn lead to a voluntary act. We demonstrate in this proof-of-principle approach that the first-person perspective obtained by an expert meditator in conjunction with neural signal analysis can contribute to our understanding of the neural underpinnings of voluntary acts.

1. Introduction

1.1. Libet experiment

The philosophical debates on the existence of free will made a sharp empirical turn when Benjamin Libet published his now famous study on self-initiated movement (Libet, Gleason, Wright, & Pearl, 1983a). Participants were asked to spontaneously flex their finger in a moment of their own choice. After this movement they were asked to indicate the time of appearance of their 'intention' to act by reporting the position of the clock-hand, which was rotating clock-wise with a period of 2.5 s. At the same time brain activity on the scalp was recorded with EEG. Libet found evidence that the readiness potential (RP), a negative ongoing potential, starts several hundred milliseconds before the awareness of a subjective intention to act. These findings led to the claim that behavior is not under conscious control. This stands in contrast to our subjective experience, which generally provides us with the sense of having free will. This interpretation started a debate on the existence of free will that is still ongoing (Klemm, 2010).

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Libet's experiment has been replicated by many researchers supporting the view that conscious intention follows preconscious brain activity (Haggard & Eimer, 1999; Rigoni, Kühn, Sartori, & Brass, 2011; Sirigu et al., 2004; Trevena & Miller, 2002). In all these studies, the RP started to rise approximately 1.5 s or more before the conscious awareness of the intention to move. Moreover, a recent study by Fried, Mukamel, and Kreiman (2011) recording intracranial single neurons adds to those findings by revealing with more precise methodology and in greater detail the underlying neuronal mechanisms. Additionally, fMRI studies employing two-alternative choice tasks claim to show that predictive information of brain activity is encoded several seconds before the choice enters conscious awareness (Soon, Brass, Heinze, & Haynes, 2008; Soon, He, Bode, & Haynes, 2013). However, it has to be noted that with refined methods and the use of spatio-temporal reconstruction of neural signals it could be shown in magnetoencephalographic recordings that conscious event time coincided with the peak of related neural activation (Guggisberg, Dalal, Schnider, & Nagarajan, 2011).

A recent study has opened the way for a different interpretation, namely that the RP reflects a negative deflection from spontaneous slow fluctuations called slow cortical potentials (SCP) (Schurger, Sitt, & Dehaene, 2012). While the RP is only disclosed by averaging several experimental trials, the specific pattern might be the result of the presence of more negative than positive deflections of spontaneous fluctuations. Moreover, Jo, Hinterberger, Wittmann, Borghardt, and Schmidt (2013) demonstrated that these spontaneous fluctuations of the SCP account for a significant fraction of the RP, that is, the apparent negative RP emerged through an unequal ratio of negative and positive potential shifts preceding self-initiated movement.

Although many empirical studies support Libet's findings, all the results are dependent upon the accuracy of the participant's subjective reports, i.e. introspective capabilities. That is, the Libet experiment relies on the self-reported timing of one's intention to move. The potential inaccuracies in reporting the precise time of an intention may lead to misinterpretations (Danquah, Farrell, & O'Boyle, 2008; Miller, Vieweg, Kruize, & McLea, 2010; Pockett & Miller, 2007). Indeed, participants find it difficult to keep their attention focused when asked to report the precise time of their intention (Lau, Rogers, Haggard, & Passingham, 2004). Thus, many researchers see the subjective reports of mental processes as one of the big problems challenging the reliability of results (Nisbett & Wilson, 1977).

While most researchers try to minimize the impact of potentially flawed subjective reports, we propose an alternative strategy. Since research efforts are all concerned with the subjective experience of free will, we cannot dismiss introspection, but rather have to try to improve its reliability. An avenue to gain more reliable subjective reports regarding the precise moment of a decision is to work with trained experts in meditation with a long history of meditative practice. Meditators have increased attentional control (Chan & Woollacott, 2007; Lutz et al., 2009; MacLean et al., 2010; Sahdra et al., 2011; Valentine & Sweet, 1999), report more accurately their body sensations (Fox et al., 2012; Mirams, Poliakoff, Brown, & Lloyd, 2013, for a contrary result see Khalsa et al., 2008) and mental experiences (Nielsen & Kaszniak, 2006), as well as showing more coherence between physiological signals and emotional content (Sze, Gyurak, Yuan, & Levenson, 2010). Given these results, we assume that an experienced meditator who has trained in contemplative practice for many years can give more reliable first-person perspective accounts, since s/he would have developed enhanced capacities of keeping his or her attention stable on a certain experience; moreover, s/he has a more refined awareness of sensing and differentiating internal processes (Brown & Ryan, 2003; Lutz, Dunne, & Davidson, 2007). Furthermore, these findings also strengthen the view that meditation experience enhances the capability of keeping one's attention consistently focused on a task that requires full attention, as this is the case in the Libet experiment. We hypothesized that these enhanced capabilities of experienced meditators can contribute to our understanding of the neural underpinnings of voluntary acts. We therefore attempted to address the first-person perspective with an expert meditator performing Libet-type tasks.

1.2. Study aims and overview

The basic aim of our study is to get a better understanding of the relationship between accounts of inner experience and the parallel recorded brain dynamics with respect to conscious decision-making. Here the idea is to identify inner experiences or inner strategies which can in some meaningful way relate to the EEG data recorded at the same time. Hence, we attempt to provide reliable and valid measure of the first-person perspective in conjunction with brain dynamics. It is important to note, that we do not attempt to show potential modulating effects of contemplative practice on performance in this task.

Rather than using a third person quantitative approach, we decided to choose an $N = 1$ design with an expert meditator. We developed an iterative neurophenomenological research protocol with the following steps: (i) performance of the Libet task, (ii) interview on the inner experience, (iii) interpretation of the EEG results based on the first-person accounts, and (iv) modification of the Libet task, the analyses strategy and the response strategies. Then we started again with (i) performance of the now modified Libet task.

Here we will report on three sessions. In session one, we replicated the original Libet task in order to explore the reliability of subjective timing and its relation to the neural activity recorded on the scalp with EEG. Furthermore, we compared the performance of the expert meditator with matched controls regarding subjective timing of events and the neural dynamics during the tasks. In session two, to investigate the subjective experience of the intention to act, neural signal analysis was combined with the first-person perspective, which was obtained from a new experimental paradigm. In session three the same Libet task was conducted under different psychological conditions to further validate the correlation of the first-person perspective with neural signals. For all sessions, a single-trial based analysis technique of the Libet paradigm was performed to estimate whether perceiving an intention is correlated with neural dynamics measured on the scalp.