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COMMENTARY

Time to Lay the Libet Experiment to Rest: Commentary on Papanicolaou (2017)

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For more than 30 years, "the Libet experiment" has inspired and dominated philosophical and scientific discussions of free will and determinism. Unfortunately, this famous experiment has been compromised by a serious confounding variable (i.e., there has been no control for watching the clock), and the method of data collection ignored conscious mental activity that occurred prior to the decision to act. Because Libet's results appear to be wholly an artifact of his method, his experiment should be discounted in future discussions of the problem of free will.

Keywords: agency, consciousness, free will, Libet experiment, readiness potential

For more than 30 years, an experiment by Benjamin Libet, a psychophysiologist interested in psychoanalytic theory, has inspired and dominated discussions of free will and conscious agency. Starting with Libet, Wright, and Gleason (1982), Libet capitalized on an electroencephalographic (EEG) signature known as the *readiness potential* (RP, or *Bereitschaftspotential* in the original German; Kornhuber & Deecke, 1965, 1990), a negative shift in voltage which occurs prior to voluntary muscle movements—somewhat in the manner of an event-related potential (though recorded *before*, not *after*, the event in question). There is also a lateralized readiness potential (LRP), discernable in the hemisphere contralateral to the limb which actually makes the movement (Trevena & Miller, 2002). The usual interpretation of both the RP and LRP is that it they are the neural correlates of the "planning, preparation, and initiation of volitional acts" (Kornhuber & Deecke, 1990, p. 14) initially appearing in both hemispheres, and then shifting to the hemisphere contralateral to the limb that will actually execute the movement.

In his experiment, Libet and his colleagues asked subjects to perform a simple spontaneous motor activity, flicking a finger or flexing a wrist, while watching a fast-moving clock, and to note the time at which they decided to make the movement (Libet, 1985; Libet, Gleason, Wright, & Pearl, 1983; Libet et al., 1982). Examining the EEG data, they observed that the RP began approximately 350 ms *before* subjects decided to make the movement—which, in turn, occurred about 200 ms before the movement began. Libet concluded from this *predecisional negative shift* (PNS) that "cerebral initiation of a spontaneous voluntary act begins unconsciously," although he argued that subjects could still exercise conscious control, or "veto," over "the final decision to act" (Libet, 1985, p. 529; see also Libet, 1999).

As Papanicolaou (2017) showed, Libet's essential findings have been independently replicated in a number of different laboratories. The precise onset of the PNS varies considerably from one subject, and one experiment, to another, but the confidence interval around Libet's average does not include zero, and if anything, his estimate of the onset of the PNS may be too short by a factor of 2 (Trevena & Miller, 2002). It is interesting to note, the same EEG signature also occurs before subjects decide *not* to make a movement (Trevena & Miller, 2010), so by Libet's logic, the beginnings of *inaction* are unconscious as well. Presumably, by extension, the origins of the veto,

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which is the only function Libet allowed for consciousness, are also unconscious. To paraphrase William James (James, 1882, p. 82), it's unconscious all the way down.

Libet's experiment has often been taken as a challenge to the folk-psychological concept of free will. Consider just a few salient examples, among dozens, that have invoked the Libet experiment as evidence for the conclusion that the commonsense notion of free will is incompatible with modern science.

1. The late Daniel Wegner, a prominent social psychologist, used the Libet experiment as the springboard to argue that the experience of conscious will was an illusion, that the true causes of action were unconscious, and that the reasons we give for our behavior are little more than after-the-fact rationalizations (Wegner, 2002; for précis and commentary, see Wegner, 2004).
2. Michael Gazzaniga (2011), often called the "founding father" of cognitive neuroscience, and sometime member of the President's Commission on Bioethics, argued that Libet and other neuroscientists had solved the problem of free will for philosophers—by showing that we do not have it.
3. Christof Koch (2012), a prominent neuroscientist and author of the "Consciousness Redux" column in *Scientific American*, concluded that "The brain acts before the mind decides! This is a complete reversal of the deeply held intuition of mental causation—the brain and the body act only after the mind has willed it" (p. 106).
4. Sam Harris (2012), another neuroscientist and leader of the "New Atheist" movement, similarly concluded that our thoughts and actions are determined by causes of which we have no conscious awareness and over which we have no conscious control.
5. In 2012, widespread interest in Libet's experiment and similar challenges prompted the John Templeton Foundation to initiate a grant program on "Finding Free Will," devoting millions of dollars to the study of the philosophical, theological, and scientific aspects of the topic (e.g., Glannon, 2015).
6. Inspired by the Libet experiment, Yuva Harari (2017), author of the acclaimed *Sapiens: A Brief History of Humankind* (Harari, 2015), wrote in his sequel, *Homo Deus: A Brief History of Tomorrow* that "The life sciences undermine liberalism, arguing that the free individual is just a fictional tale concocted by an assembly of biochemical algorithms" (p. 293).

At the same time, some philosophers and psychologists have raised conceptual and methodological objections to Libet's conclusions (Libet, 1985, 1999; Libet et al., 1982, 1983). For example, it has been argued that the task set for Libet's subjects was utterly trivial, so his findings should not be generalized to the real world of decision, choice, and action. More substantively, it was argued that, in Libet's experiment, the important decision had already been made before individual trials began—namely, the decision to participate in the experiment to begin with. Here, for example, is the philosopher John Searle, writing about the Libet experiment and others like it (Searle, 2013, p. 55, emphasis original).

> The cases in question are all cases where the subject *has already made up his mind* to eventually perform a course of action, and the brain has an increased activity prior to his awareness of a conscious decision to physically perform it; but the presence of the readiness potential does not constitute a causally sufficient condition for the performance of the action. It could be the case that a person would have been inclined to push a button, that the brain then undertook the activity called readiness potential, and that the person would *not* push the button. Readiness potential in the brain is not a condition that is *sufficient* to cause the act. It is associated with the act but does not determine it.

Papanicolaou (2017) covered most of these objections in his review, and there is no need to go over that territory again here—except to say that Searle's (2013) criticism turns out to have been very close to the mark.

Papanicolaou (2017) also does an excellent job detailing the major methodological objections to the Libet experiment. Libet gave both subjects and experimenters extremely challenging tasks, with a lot of potential for random and systematic error to creep in. Subjects have to pay attention to their own thoughts as well as to a swiftly changing timer—essentially a divided attention task. Experimenters have to determine precisely when the readiness potential begins to

rise—in the early 1980s, with polygraphs generating reams of paper records, a challenge for the eyes. However, the best guess is that these sources of potential errors probably cancel each other out (Banks & Pockett, 2007; Pockett, 2004).

Unfortunately, Papanicolaou (2017) gives short shrift—only a single sentence—to the most important objection of all to Libet's experimental design (Libet, 1985, 1999; Libet et al., 1982, 1983): *It has a fatal methodological flaw*. For all the various arguments over measurement error, Libet's critics missed an important feature of his experiment: Subjects must keep track of a timer while they're deciding to move. Miller and his colleagues (Miller, Shepherdson, & Trevena, 2011) replicated Libet's procedure, and observed a clear PNS. But they also ran a control condition in which subjects made spontaneous movements, but *did not* watch the clock. The logic of Libet's argument is that the PNS should be observed regardless of whether subjects are timing themselves. In either case, the PNS should begin to appear by about 350 ms before the subject moves. But it didn't: Eliminating the clock also eliminated the PNS entirely. Libet's PNS occurred as a consequence of watching the clock.

As if that were not enough, research by Schurger and his colleagues has undercut the traditional interpretation of the RP itself (Schurger, Mylopoulos, & Rosenthal, 2016; Schurger, Sitt, & Dehaene, 2012). Kornhuber and Deecke (1990) assumed that the RP reflected planning and preparation for movement; Libet agreed, but concluded that most of this activity was unconscious. Schurger et al. (2012) followed Libet's basic paradigm, but in addition, subjects were asked to make a movement in response to occasional auditory cues—a procedure they called *Libetus interruptus*. These cued responses were intended to preclude the kind of planning and preparation normally implicated in the RP and PNS. Response latencies were shortest when the cue was presented as the fluctuating EEG signal approached its peak negativity. Based on these findings, as well as the results of a computer simulation, (Schurger et al., 2016) suggested that the "*apparent* premovement buildup of neuronal activity" (emphasis added) reflected "the ebb and flow of background neuronal noise, rather than the outcome of a specific neural event corresponding to a 'decision' to initiate movement" (p. 77). When the activity of this stochastic "neural accumulator" crosses a threshold, the "neural decision to move" is made, and the movement is executed roughly 200 ms later. But what is being accumulated? In the case of externally cued movements, it is "sensory evidence" of the cue to move; in the case of spontaneous movements, as in the RP or the PNS, it is "internal noise".

To get some sense of what this "internal noise" is all about, we should examine the Libet experiment—and, for that matter, the other experiments as well—from the subject's point of view (Orne, 1962, 1969, 1973; see also Kihlstrom, 2002). In the classic Libet experiment, a tone signals the beginning of each trial; subjects are instructed to relax for 1–3 s, then fix their gaze on the clock, and then spontaneously flick their fingers or wrist; finally, they are asked to report *when they decided* to make the movement. Now let us imagine what must go on in the mind of a subject in a libet-type experiment, to which *Libetus interruptus* has been added.

> OK, there's the start. . . . Gotta relax, gotta watch the clock, gotta remember not to blink . . . Damn! Just blinked . . . OK, watch the clock . . . Now I've got to flick this finger sometime . . . Maybe now . . . Naah, not yet, maybe later . . . OK, soon . . . Now! Note the time *[Flicks finger]* . . . OK, now wait a while . . . Oh! Here's the click! Gotta move . . . *[Flick]* . . . OK, let's wait a while . . . Not yet . . . Soon . . . There's another click! *[Flick]* . . . That's been a coupla flicks, I think I'll take a break . . . Aaarrrghhh! Another damn click! *[Flick]* . . . Gotta keep my ears open for that click and stay ready . . . No click for a while, maybe it's time for me to do it on my own . . . Maybe. now . . . Naah, not yet, maybe later . . . OK, soon . . . Now! Note the time. *[Flicks finger]* . . . When's this experiment going to be over?

Note that, as instructed, subjects only report the time at which they consciously decide to move (by all accounts, the movement itself occurs about 200 ms later). But there is putatively a great deal of mental activity transpiring besides this activity, and Libet's exclusive focus on his subjects' actual decision *as to whether and when to move* misses the additional activity entirely. True, Libet asked his subjects to avoid "any preplanning or concentration on when to act." But this is clearly impossible—especially given the instruction to note the time when they finally decide to move their fingers. The point here,

to quote William James, is that "*The first fact for us, then, as psychologists, is that thinking of some sort goes on* (James, 1890/1980, p. 224, emphasis original). Whether the thinking is task-dependent or task-unrelated (Raichle, 2010; Singer, 1978; Smallwood & Schooler, 2006; Stawarczyk, Majerus, Maj, Van der Linden, & D'Argembeau, 2011), it is still thinking. Libet's experiment records the subject's conscious decision to act, but misses all the rest of the process of consciously deciding.

Papanicolaou (2017) moves beyond the Libet experiment to cite more recent studies employing neuroimaging techniques rather than psychophysiological measures like EEG. Some of these studies have sought to identify the brain region(s) generating the RP (such as the supplementary motor area), or the neural correlates of the feeling of agency, and are not really germane to the status of PNS. But others simply substitute functional magnetic resonance imaging for EEG in search of the PNS itself, somewhat along the lines of "brain fingerprinting" (Farah, Hutchinson, Phelps, & Wagner, 2014). For example, Soon and colleagues observed a PNS arising in the frontopolar cortex as long as 10 s preceding the subject's reported decision to move (Soon, Brass, Heinze, & Haynes, 2008). They concluded that "when the subject's decision reached awareness it had been influenced by unconscious brain activity for up to 10 s" (p. 545).

Unfortunately, this study shares the two problems noted in the original Libet experiment (Libet et al., 1982, 1983) and its replications and extensions: (a) Subjects had to watch a timer—and in addition, had to decide which of two keys to press, and (b) their thoughts prior to the actual decision went unrecorded—10 s is a long time for subjects to go without thinking whether they are going to respond, which response to make, when to make it, and whether they are going to be interrupted by the auditory cue. There is no reason to think that any of this preparatory mental activity was unconscious.

The "consciousness revolution" in psychology and cognitive science legitimized a number of topics that had previously been considered beyond the pale of scientific discourse. Among these were the nature of unconscious mental life (Kihlstrom, 1987, 2012) and free will and the experience of agency (Baer, Kaufman, & Baumeister, 2008; Haggard & Eitam, 2015; Searle, 2001). The Libet experiment promised to bring these topics together, purportedly showing that the conscious experience of agency is an illusion, and that the true causes of behavior are inaccessible to phenomenal awareness and voluntary control. But it now appears that Libet's experimental results were wholly an artifact of his method. Maybe we do not have free will, and conscious agency is an illusion, but the Libet experiment offers no warrant for thinking so, and it is time to lay it to rest.

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