Neuroscience and Conscious Causation:

Has Neuroscience Shown that We Cannot Control Our Own Actions?

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Abstract

Neuroscience has begun to elucidate the mechanisms of volition, decision-making, and action. Some have taken the progress neuroscience has made in these areas to indicate that we are not free to choose our actions (e.g., Harris, 2012). The notion that we can consciously initiate our behavior is a crucial tenet in the concept of free will, and closely linked to how most individuals view themselves as persons. There is thus reason to inquire if the aforementioned inference drawn by some might be too hasty. While there is much evidence appearing to indicate that consciousness does not influence behavior—including evidence indicating that neural activity precedes a decision by several seconds, neural activity predicts what action an individual will perform, and that individuals infer when they decided to act after an action was performed—this evidence seems to suffer methodological issues. Additionally, there are empirically supported interpretations of the aforementioned data consistent with the idea that individuals can consciously control their actions. This paper therefore concludes that neuroscience does not currently substantiate the idea that we cannot consciously initiate or control our actions.

Keywords: Consciousness; Control; Causation; Freedom; Volition; Libet

1. Introduction

1.1 Theoretical Importance

Perhaps nothing is more foundational to our sense of agency than the notion that we are persons in control of our actions. Moreover, the notion that individuals can initiate and control their own behavior is a central tenet of all conceptions of free will (Watson, 1987). In addition to the philosophical importance of this topic, this issue also has great practical relevance; belief in free will seems to confer various societal benefits, including lowering aggression and cheating, increasing helpfulness, and increasing vocational achievement (Baumeister et al., 2009; Stillman et al., 2010; Vohs and Schooler, 2008). Belief in free will also seems to be a cultural universal (Sarkissian et al., 2010), and it even appears to affect neural activity preceding action (Rigoni, et al., 2011). Given all of this, the question of whether or not we can voluntarily control our actions has both apparent and profound implications.

1.2 Background and Definitions

The question of whether an individual is truly free to act as he or she pleases dates back at least two thousand years (Roskies, 2006). As has been the case with many philosophical debates, this single question has since been divided into many smaller questions that are answerable by science. Contemporary neuroscience has begun to make its contribution to one of the relevant questions—the question of whether or not we can consciously initiate and control our actions. Some contemporary neuroscientists and popular-science writers believe that neuroscience has already adjudicated this debate: conscious action initiation is nothing more than an illusion (Harris, 2012; Koch, 2012; Nørretranders, 1999; cf. Spence, 2009). However, given the ubiquity of the belief that we can consciously control our behavior—as well as the importance of this concept in the legal system (e.g., Morrisette v. U.S., 1952; U.S. v. Currens, 3d

Cir. 1961)—one has reasonable justification for investigating whether claims that we cannot consciously initiate our actions are well-grounded. The purpose of this selective review and position piece, therefore, is to critically examine neuroscientific data commonly taken to indicate that we cannot consciously initiate or control our own behavior and ultimately argue for an alternative interpretation of those data. This paper will thus attempt to ascertain if the evidence from neuroscience necessitates the abandonment of our intuitions regarding conscious willpower.

Before exploring the evidence from neuroscience, though, a discussion of the concept of free will is in order. This paper prefers to use the terms "causal efficacy" and "conscious causation" instead of "free will" due to the philosophical issues commonly associated with free will. While these issues are extremely important, and neuroscience can contribute to the overall evidence in favor of or against a synoptic concept of free will, neuroscience cannot completely adjudicate philosophical issues beyond its scope (Roskies, 2006). Moreover, delineating a complete picture of free will is beyond the scope of this paper. Because of these things, this paper will not attempt to address philosophical concepts commonly associated with metaphysical conceptions of free will—that is, this paper will not discuss whether dualism, physicalism, compatibilism, libertarianism, determinism, or indeterminism is true. This paper will therefore proceed on the momentary suspension of the traditional philosophical foundations of volitional freedom in an attempt to understand the findings of neuroscience.

Defined here, the causal efficacy of consciousness—used interchangeably with the term "conscious causation" to reduce repetition—is the ability to initiate and control one's own thoughts and actions consciously and voluntarily. Put differently, conscious causation is the capability of self-controlled conscious thought to produce behavior. This definition does not assume that an individual is always able to act differently than he or she did; this definition supports the notion that there are various degrees of volitional freedom due to internal and external constraints (O'Connor, 2009). Additionally, this definition does not assert that the ability to consciously create thought or behavior is independent from the rest of the body, and it welcomes the idea that one's ability to choose may be dependent upon a variety of physiological factors (e.g., Drubach et al., 2011; Pfurtscheller et al., 2012; Pfurtscheller, et al., 2010). The essential concern of this definition is that an individual's self-controlled conscious choice significantly contributes to his or her actions. Surprisingly, this definition is close to the layperson's conception of free will—which is very different from the presumed Cartesian conception of an "uncaused will" stemming from a dualistic soul controlling a puppet-like body (Monroe and Malle, 2010). Nonetheless, due to the typical philosophical understandings of the term free will, this paper will avoid its use, instead preferring the terms of causal efficacy and conscious causation defined herein.

Another important preliminary point necessary to address is the relationship of neuroscience to physics. Many authors have stated that an embrace of physicalism implies a rejection of the causal efficacy of consciousness (Churchland, 1981; Harris, 2012; Schall, 2001). These authors argue that, given the causal closure of physics, our physical experiences and actions have necessary causal precursors and consequences—thus leaving no room for free will (Churchland, 1981; Harris, 2012). Given these assumptions, in order to make plausible the notion that an individual can consciously initiate his or her own behavior, one must at least put forward a plausible mechanism by which this can happen without a violation of physics. Brembs (2011) has delineated one such mechanism: there seem to be nonlinear neural mechanisms preserved in escalating degrees by evolution that allow for variable decision-making and action, and are thus suitable for enabling conscious causation as defined herein. Nonlinear systems are present in both small-scale (Legenstein and Maass, 2011) and large-scale (London et al., 2010; Viinikainen et al., 2010) aspects of neural processing. Nonlinear systems have the ability to amplify or dampen an initial signal, which allows for a variable output from an initial input—suitable for enabling conscious causation given that consciousness is physical. In other words, events that culminate in conscious experience, while perhaps entirely determined, do not have necessary consequences—the inputs may be combined or weighted in novel ways, providing for variable output. While Brembs himself is ambivalent about whether the conscious will can initiate behavior, as long as one assumes that consciousness is identical to neural processes, then conscious processes are assumed to be able to recruit the same nonlinear neural mechanisms that nonconscious processes can.

As an additional plausible mechanism for the causal efficacy of consciousness, if consciousness is an emergent property of the brain, then consciousness may have unique properties of constraint on lower-level properties of the brain—also sufficient for conscious initiation of action (Deacon, 2012). Deacon (2012) illustrates that many emergent entities have unique, supervenient causal properties that are able to modify the events leading to the emergence of that entity, and demonstrates that the brain and consciousness are capable of this same type of emergent causation.

Alternatively, a philosophical analysis of the nature of causation may circumvent these issues entirely. Theories of causation such as interventionism that are wholly compatible with both physicalism and conscious causation (Campbell, 2007; Woodward, 2013). It is thus possible that one can accept both the notion that we can consciously initiate our behavior and the notion of physical determinism.

1.3 Paper Structure

In section **2.1**, this paper conducts a selective review that explores the evidence purported to indicate that individuals should abandon the belief that we can consciously initiate and control our actions. Following this, section **2.2** examines methodological limitations/weaknesses in the aforementioned research and provides room for a cautionary skepticism about the idea that neuroscience has shown conscious action initiation to be an illusion. Then, in section **2.3**, this paper elucidates alternative perspectives that, like the notion that conscious causation is an illusion, allow for a coherent interpretation of the aforementioned data. These data are discussed within a broader perspective in section **3**. This position piece finally concludes in section **4** that, at this point, neuroscientific research does not support the conclusion that the causal efficacy of consciousness is an illusion.

2. Selective Review

2.1 Evidence Against Conscious Control

2.1.1 Readiness potential research. There is a host of neuroscientific data commonly taken to indicate that consciousness cannot cause behavior. As the paradigmatic example of this research, Libet et al. (1983) conducted a seminal neurobehavioral study on volition. In this famous study, the researchers used electroencephalography (EEG) to record neural activity near the scalp while instructing the participants to move whenever they felt the urge to do so. The researchers also instructed the participants to watch a clock and recall the location of the moving spot when they chose to move. This experimental paradigm has become a classic paradigm, and this paper will refer to it as the Libet-paradigm. Libet et al. found that individuals have a buildup of cerebral activity, dubbed the readiness-potential (RP), beginning about 350 milliseconds before they have the ability to report having the urge and decision to move. The conclusion Libet et al. drew from this experiment is that what most believe to be a freely willed act is often initiated unconsciously. The basic findings of Libet et al. have been replicated in numerous other studies (e.g., Haggard and Eimer, 1999; Keller and Heckhausen, 1990; Banks and Isham, 2009; Trevena and Miller, 2002, 2010; for review, see Banks and Pocket, 2007). Recently, Fried et al. (2011) extended the findings of Libet et al. by showing through single-neuron recordings that progressive recruitment of neurons in the supplementary motor area (SMA) starts 1,500 milliseconds before an individual has the ability to report that he or she has voluntarily decided to move. Moreover, Fried et al. found that the activity of an artificial pool of neurons in the SMA drawn over multiple experimental sessions could predict an action with greater than 80% accuracy up to 700 milliseconds before a subject consciously made a decision to act. Fried and colleagues concluded that the experience of volitional choice emerges from an amalgamation of premotor activity. While Libet (1985) noted that individuals could consciously abort, or veto, the RP preceding an action, the findings of Libet et al.—as well as follow-up research such as Fried et al.'s—seem to indicate that the apparent ability to consciously self-generate actions is actually an illusion.

2.1.2 fMRI research. Other studies appear to indicate that conscious causation is an illusion as well. Soon et al. (2008) used fMRI to conduct a more specific neurobehavioral study on volition. In this study, the researchers instructed the participants to freely decide to press a button with their right hand or a different button with their left hand whenever they felt the urge to do so, and to press that button immediately upon deciding. The researchers also instructed the participants to watch a stream of letters presented upon a screen and to remember the letter that was on the screen when they chose to press the button. Soon et al. decoded the predictive information from their fMRI scans with statistical pattern recognition techniques. Like the previously mentioned studies, Soon et al. found that cerebral activity precedes a conscious decision to move, but unlike other studies, Soon et al. found that this activity precedes conscious decisions to move by seven to ten seconds. Moreover, Soon et al. found that the earliest activity does not originate in the SMA, as other studies have found, but instead originates in the frontopolar cortex and the parietal cortex—while later activity predictive of decisions to move originated in the SMA. Additionally, because of the specificity of fMRI in localizing neural activity, Soon et al. were able to determine that the neural activity preceding an action could predict what specific action an individual will take, and this prediction achieved an accuracy of 60%. Recently, the findings of Soon et al. have been replicated using a similar experimental paradigm (Bode et al., 2011) and even extended to the prediction of abstract intentions and actions (Soon et al., 2013). These fMRI studies therefore seem to contribute to the idea that we do not consciously initiate our actions.

2.1.3 The perception of agency. Banks and Isham (2009) recently conducted ingenious experiments that attempted to ascertain whether an individual perceives when she consciously decides to act. In their first experiment, Banks and Isham employed a modified Libet-paradigm: all was nearly the same, except Banks and Isham informed participants that a computerized beep would coincide with their actions upon movement. However, unbeknownst to participants, Banks and Isham actually presented the beep five to sixty milliseconds after the participants had moved. Participants were then asked to report the time they decided to move their fingers. The reported times a decision was made to move were invariably delayed in accordance with the respective delay of the signifying beep. These results therefore appear to indicate that participants were at least in part relying on external cues to form their judgments regarding when they decided to move.

In a second experiment, Banks and Isham (2009) once again used the Libet-paradigm, but also presented each participant with a video of him- or herself pressing the experimental button, as they were told, while they pressed the button. However, in some of these trials, the researchers delayed the presentation of the video recording by 120 milliseconds. In the delayed trials, participants reported deciding to move an average of 44 milliseconds later than the non-delayed trials. Again, this appears to indicate that participants are relying on external cues to determine when they decided to move. From these data, Banks and Isham concluded introspecting a decision to move relies on inference rather than perception, which seems to indicate that people infer, rather than perceive, when they choose to act.

Rigoni and colleagues (2010) extended the findings of Banks and Isham (2009). Rigoni and colleagues presented participants with a beep supposedly signifying movement up to 60 milliseconds after an individual had moved—like Banks and Isham—and looked at the resultant neural activity. Rigoni and colleagues found that presenting these beeps produced an event-related potential in participants' EEGs around 260 to 300 milliseconds after the action, and a regression analysis confirmed that the amplitude of this potential significantly predicted a participant's reported time of action. This study therefore provides neural evidence that participants are, indeed, using external information to determine when they had decided to move.

Related to findings from Banks and Isham (2009) and Rigoni and colleagues (2010), Lau and colleagues (2007), found that perceptions of decisions can be externally modulated. Specifically, Lau and colleagues used transcranial magnetic stimulation—applied up to 200 milliseconds after an individual has moved—and found that this manipulation significantly affected both the participants' reported times of forming an intention to move and the reported time of the movement. The findings of Lau and colleagues thus support the findings of Rigoni and colleagues as well as Banks and Isham: all three studies indicate that reports of decisions to move are *post hoc* constructions. While this finding in itself does not directly contradict the idea of conscious action initiation, the notion that we do not consciously perceive our own actions does distant consciousness from volitional control. Presumably, if consciousness was involved in the initiation of behavior, we should have conscious access to our original intentions and decisions; however, these data appear to indicate that we do not have conscious access to our original intentions or decisions. As such, some have argued that these data suggest consciousness might not play a role in action initiation (Banks and Isham, 2010). On a purely philosophical note, though, it should be noted that awareness of decisions to act may be based upon the combination of perception and inference. Simply demonstrating that we use inference or external cues in determining when we acted does not imply that we also do not possess conscious perception of our decisions; many individuals are aware of potential bias in their perception and often rely on external cues to remediate this potential bias.

2.2 Methodological Issues with Evidence Against Conscious Control

2.2.1 Readiness potential research. While the aforementioned data—suggesting we cannot consciously initiate our own behavior—is empirically persuasive, it also appears to suffer from methodological limitations/weaknesses. Trevena and Miller (2010) attempted to determine if the findings of Libet et al. (1983) are explicable as an artifact of the experimental design. Trevena and Miller employed a modified version of the Libet-paradigm in their study—instructing participants to report both when they decided to move as well as when they decided not to move—and recorded the EEG activity of participants during that decision as well. Trevena and Miller found identical RPs preceding decision times in participants in both the conditions—deciding to move and deciding not to move. Their findings therefore appear to indicate that the neural activity preceding a conscious decision is not due to movement preparation, but instead may be due to engagement in the Libet-paradigm.

Two experiments performed by Miller et al. (2011) further support the notion that the occurrence of the RP is due to the experimental paradigm. Miller et al. attempted to ascertain if attention to the clock in the Libet-paradigm affects the RP preceding a conscious decision. In the first experiment, Miller et al. employed the classic Libet-paradigm; however, they incorporated a control group using the same paradigm, except without a clock present. The researchers found significant differences in EEG activity preceding a decision—notably, with negligible changes in EEG activity in the control group from baseline to preceding a decision to move. That is, Miller et al. found significant differences between the average signals in trials when a clock was not present compared with trials where a clock was present.

In the second experiment, the researchers instructed the participants to wait for a tone and then make a perceptual judgment concerning whether the tone was a high tone or a low tone; one group of participants were instructed to report the position of the clock when the tone played, the other group had no clock. Miller et al. (2011) found a significant difference in the EEG activity between these groups before the tone played. The group instructed to watch the clock before the tone played exhibited a pattern of EEG activity similar to a RP prior to the presence of the tone over a period of two seconds, but the group that did not watch a clock had no RP-like EEG activity preceding the presence of the tone.

Together, these two experiments specifically indicate that the RP preceding a decision to move is not due to movement preparation but seems to be due to attention to the clock, and the RP thus appears to be an artifact of the experimental paradigm. Importantly, the absence of changes in EEG activity preceding a decision to move in the control group of Miller et al.'s

(2011) first experiment indicates that these participants engaged in conscious initiation of movements that preceded the neural activity of motor preparation—indicating that this activity is not caused by unconscious processes. To clarify, while there were changes in EEG activity prior to the action, these changes followed conscious decisions, indicating that this activity was the consequence of a conscious decision, not the determinant of that decision. Due to the potential magnitude of these findings, replicating these findings is appropriate before confidently stating that the RP is dependent on the experimental paradigm.

It should be noted, however, that the original study finding the RP did not employ a clock (Kornhuber and Deecke, 1965). However, this study did employ a similar paradigm: the experimental paradigm required all individuals to fix their attention on a point for the experiment. Although this paradigm differs, there is thus the same mandate for controlled attention in this experiment as in the clock paradigm. While a fixation point obviously differs in some way from fixating on a clock, the results differed as well. Kornhuber and Deecke found that the RP was practically negligible for individuals who were mentally indifferent, tired, or inattentive. Thus, while some might point to the findings of Kornhuber and Deecke as a counterexample to the argument of Miller et al. (2011), the findings of Kornhuber and Deecke may actually be seen to support this argument.

2.2.2 fMRI research. The findings of Soon et al. (2008; 2013) and Bode et al. (2011) may also face methodological issues. Lages and Jaworska (2012) recently published an experiment indicating that the reason some actions were able to be predicted up to seven seconds before their onset may lie in the power of the statistical techniques used to predict those actions. These techniques may be able to detect response biases and tendencies that are otherwise unnoticeable. To demonstrate this, Lages and Jaworska used the paradigm of Soon et al. and

Bode et al.—sans an fMRI scan—and used the same type of statistical pattern recognition technique to predict decisions as in those previous studies. Lages and Jaworska found that the pattern recognition technique was able to predict the responses of participants with 61.6% accuracy and statistical significance based upon behavioral data alone and what appeared to be random responses. In other words, these statistical techniques predicted future behavior from only apparently random past behavior with the same precision as was obtained when predicting future behavior from neural activity. This appears to indicate that the neural activity predictive of an action may not be an unconscious determinant of the action, inasmuch as past behavior is not an unconscious determinant of a future action.

While Lages and Jaworska (2012) explicitly note that behavioral data alone are not strong enough to discredit fMRI data, they explain that naïve participants have extreme difficulty generating truly random sequences, and deciding to press one button or another in succession creates sequence dependencies and response biases. The findings of Lages and Jaworska therefore indicate that the findings of Soon et al. (2008; 2013) and Bode et al. (2011) may be due in part to the power of statistical pattern recognition techniques in noticing individual response bias through the neural correlates of intending to switch responses or keep the current one during a crucial window of time. That is, the statistical pattern recognition techniques may simply be picking up on either a rehearsal of study rules—with the need to determine what action one should perform to keep responses "random"—or other cognitive aspects of "random" decision-making. The preceding activity may thus predict actions for reasons other than that the neural activity is an unconscious determinant of action. Follow-up research is therefore appropriate to either extend the findings of Lages and Jaworska or confirm the findings of Soon et al. and Bode et al.

2.2.3 The perception of agency. Similarly, methodological considerations preclude drawing conclusions about perceptions of volitional intentions from experiments similar to the ones conducted by Banks and Isham (2009). As Roskies (2010b) notes, reporting the time one makes a decision is a metacognitive task—not a cognitive one. Metacognition of agency uses neural circuits that appear to be dissociable from those employed during action monitoring (Guggisberg et al., 2011), and while the metacognition of agency relies on inference, action monitoring appears to be more perceptually basic (Miele et al., 2011). To say that the results of Banks and Isham indicate that individuals do not have direct access to their decisions or intentions may be a conflation of two discrete neural systems. Reporting the time of a decision to move therefore might be an inference made not without the perception of agency, as Banks and Isham conclude, but with the perception of agency ("I chose to move") in conjunction with a metacognitive state ("I am the one creating a beep by moving my finger at time *x*") and thus subject to influence by flawed cognitive information. Additionally, should the results of Banks and Isham imply what the researchers state they do, this would preclude studies such as that done by Libet et al. (1983) or Soon et al. (2008) from making bold claims about conscious causation, as this research assumes that individuals can introspect their actual intentions and decisions. There are thus methodological issues in all veins of research appearing to indicate that we cannot consciously initiate our own actions. These methodological issues thereby provide for a healthy skepticism regarding the claim that neuroscience has provided a definitive answer to the question of conscious causation.

2.3 Alternative Interpretations of the Aforementioned Data

2.3.1 Decision-making as a process. Even if the experiments appearing to indicate that consciousness could not control behavior were methodologically sound, it would still not be possible to draw the conclusion that the causal efficacy of consciousness is illusory. There are additional interpretations of that data that are compatible with affirming conscious causation. One necessary consideration is that taking the aforementioned evidence indicates that conscious causation is an illusion relies on a potentially dubious assumption. That is, interpreting the research in this way presumes that making a decision is instantaneous and binary—one has not made a decision, and then one has—but common experience and experimental evidence indicate otherwise (Klemm, 2010). As Mele (2010) notes, it is important to distinguish between making a decision and the processes involved in making that decision. Through common experience, one understands that making a decision involves conscious thought about one's current circumstances, the consequences of actions, how one should act given the circumstances, and alternative possibilities before one makes a decision. Additionally, experiments indicate that making a decision incorporates experience, information-processing speed, and all forms of memory (Henninger and Madden, 2010; Rakow et al., 2010; Worthy et al., 2011). There is thus reason to examine whether interpreting decision-making as a process might lead to alternative interpretations of studies related to the conscious control of action.

In studies exploring neural activity preceding a free decision, making a decision involves a number of activities before the solidification of a decision. These activities include a rehearsal of the study's rules, the consideration of making a decision, the recollection of which finger one was instructed to move or the consideration of which finger to move, and the recruitment of attention and memory to the clock or letter on the screen—all before firmly making a decision. Given that all of these tasks require conscious cognition, it is therefore plausible that the neural activity preceding an individual's reported choice to move is not an unconscious determinant, but instead reflects the complexity of making a decision.

Support for the idea that a continuous—non-binary—decision-making process is responsible for the neural activity preceding free choice comes from three studies. In one of these studies, Baker et al. (2011) showed that pre-movement activity of the RP may depend on cognitive capacity and function. In this experiment, the researchers measured the RPs of participants as they chose to move their fingers whenever they desired, but the researchers also gave participants one of two tasks limiting either attention or cognitive ability while participants moved their fingers. The attention-limiting task was a high-demand perceptual attention task, which thus limited participants' attentional resources; the other task was a demanding working memory task, which thereby limited participants' executive function resources. The researchers found no differences in the RP of participants before action in the perceptual task compared to a control condition, but the early stages of the RP were diminished significantly for participants in the working memory task—as early as 1,000 milliseconds before action. The researchers also varied the load placed on participants' cognitive resources and found that the diminishment in the early stages of the RP corresponded with the degree of diminishment of cognitive capacity—no cognitive diminishment producing a typical RP. Because diminished cognitive capacity corresponded with a diminished RP, this study may be taken to indicate that the early stages of the RP are not an unconscious preparation for action or even a redirection of attentional processes in general; instead, this study presumably suggests that the early parts of the RP reflect cognitive processes in particular. These findings thus lend preliminary support to the idea that the RP may reflect a continuous decision-making process influenced by cognitive factors.

In another study, Baker et al. (2012) recently potential cognitive process reflected in the RP, and this process harmonizes with the results of Miller et al. (2011) discussed earlier. Baker et al. sought to determine if orienting attention in time was a cognitive process partially responsible for the early stages of the RP. The researchers measured the EEG activity of study participants while the participants attempted to replicate the temporal spacing of two auditory tones—either 3.5 or 4.5 seconds—by pressing a button twice after a pause following the original tone presentation. Baker et al. did not inform or hint to participants that they would measure the participants' EEG activity during the first button press—they just instructed participants to wait a little while before pressing the button the first time. The researchers also gave participants feedback on how closely they came to replicating the actual temporal interval, which further contributed to the participants' belief that the goal of this study related to replicating a temporal interval rather than studying movement. This experimental paradigm allowed the participants' first button press to be relatively unattended in time and comparable in all ways except a cognitive state to the second button press, which specifically attended to temporal spacing. Baker et al. were thus able to control for the type of movement but presumably vary cognitive processes preceding movement. They found that the RP preceding the first button press was significantly smaller than the RP preceding the second button press. Moreover, they also found that the RP preceding the first button press was completely lacking the early pre-movement stage typically seen in an RP. Furthermore, they found that the early activity—unique to the second movement—was from right prefrontal regions, indicative of cognitively orienting attention in time. While inconclusive, this pattern of results is consistent with the idea that at least one of the processes responsible for the pre-movement stages of the RP is the cognitive process of orienting attention in time. This interpretation of the results harmonizes with the findings of Miller et al., who showed that the presence of the clock in the Libet-paradigm appears to produce the RP. The findings of Baker et al. therefore contribute to the understanding of decision-making and volitional action as a process rather than something instantaneous. However, Baker et al. (2012)

and Baker et al. (2011) do not directly test the idea that the RP reflects cognitive processes; these data are merely consistent with the idea that the RP reflects cognitive decision-making processes rather than determinative motoric activity—and data supporting a theory's predictions do not necessarily support the theory. More research is necessary in order to determine the extent cognitive factors play a role in the RP.

Some might argue that these cognitive processes are independent of consciousness—determining that the RP reflects cognitive processes does not determine that these processes are conscious. However, it is worth mentioning that the aforementioned cognitive processes need not be conscious processes for the success of this argument. Cognitive processes such as attention and rehearsal of study rules are not unconscious determinants of action; these processes are extensions of decision-making over time—which may or may not eventually become conscious—and they do not initiate actions. Even if these processes were entirely unconscious, there would still be much room for the causal efficacy of consciousness in this research.

Nevertheless, there is at least some evidence that this extended decision-making process may be in part conscious. Fahle et al. (2011) conducted an experiment that supports the idea of an extended conscious decision-making processes, as discussed herein. Fahle et al. investigated visual awareness through an experimental paradigm known as binocular rivalry. This paradigm presents the two eyes of participants with different stimuli, and, with a particular type of stimuli, conscious experience alternates between each of the two stimuli. Which stimuli participants attend to is a reflection of conscious selectivity. Pupil size differs depending upon which stimulus participants observe, and pupil size therefore serves as an objective measure for identifying conscious awareness. Fahle et al. found that when participants push a button indicating which stimuli they perceive, there is a delay of approximately 590 milliseconds in the pushing of the button behind the respective dilation of the pupil. The researchers also found that the delay of pressing a button in comparison to pupil dilation was not due to faster response times of the pupil. These results are thus similar to that of Libet, et al. (1983), in that pupil dilation might appear to unconsciously precede conscious awareness or selection by nearly 600 milliseconds.

However, Fahle et al. (2011) found that when participants moved a joystick to reflect their perceptual awareness as opposed to pressing a button, this lag in reported awareness behind pupil dilation or constriction vanishes. Instead, both pupil size and joystick movement demonstrate a gradual transition between visual awareness—requiring around 1000 milliseconds—synchronously. To explain the discrepancy in awareness between the measures of a joystick and button pressing, Fahle et al. argue that it is explicitly the conscious aspect of decision-making that is extended in time, and an analog measure allows detection of tendencies prior to a firm decision being made.

Fahle et al. (2011) extend their results to the debate about conscious action initiation by arguing that the neural activity preceding a choice in decision-making experiments represents the beginning of a conscious decision-making process, and that participants likely delay pressing a button until they have crossed a threshold of assurance in making a decision. One obvious methodological problem with this extension is that it is analogical in nature. No comparative neuroscientific experiments have been performed on conscious action initiation employing a joystick-type measure rather than a button. However, this analogical argument does provide an avenue for future research, and it offers at least preliminary support for the idea that an extended decision-making process may be responsible for the discrepancy between the reported times of deciding to act and the neural activity related to action.

2.3.2 Choosing to prior to choosing. The interpretation of data outlined above thus requires more research to establish its certainty. As an alternative, Zhu (2003) has championed another interpretation of the data—first discussed by Libet (1985), who viewed it as *ad hoc*, as it was then empirically unsupported—often taken to indicate that the causal efficacy of consciousness is illusory. Zhu argues that one should not view the neural processes preceding choice during the experiment in isolation: the intentions formed by participants at the beginning of the experiment likely influenced the individual actions performed during the experiment. The actions of the participants during the experiment are not truly free; instead, individuals explicitly perform these specific actions under the constraints of the experimental instructions, and participants would therefore freely choose these actions not during the experiment but before the experiment. The unconscious cerebral processes, then, would reflect the initiation of actions consciously chosen prior to the experiment, and the participants' reported decision time reflects the conscious re-approval of the initiated action. Sheffield et al. (2011) recently showed that neurons can integrate spikes over a period of minutes, and this slow integration later produces an output pattern of persistent firing on the duration of minutes in the absence of any additional input. This is consistent with Zhu's interpretation of volition experiments, as a conscious choice could send a signal from higher-order brain centers to regions such as the SMA wherein activity would arise upon the fulfillment of the conditions of the conscious choice's signal—namely, the beginning of the experiment fulfilling the conditions for initiating the experimentally constrained movement.

One obvious problem in applying this interpretation to all the related data is that this interpretation does not fit well with the experiments performed by Soon et al. (2008) and Bode et al. (2011); it is difficult to imagine that each individual preplanned their entire selection of left-and right-button presses at the beginning of the experiment. Zhu's (2003) interpretation is thus not immediately extendable to all data related to conscious causation. Because of that, Zhu's interpretation is at least somewhat *ad hoc*, and is therefore less parsimonious than the notion that conscious causation is an illusion.

Nonetheless, the interpretation of experiments concerning the causal efficacy of consciousness outlined by Zhu (2003) is not without experimental support. Perhaps the strongest experimental evidence in favor of Zhu's interpretation is a theoretical model and experiment detailed by Schurger et al. (2012). Schurger et al. suggest that the readiness potential may reflect a leaky stochastic accumulation moving towards a decision-making threshold when there is no explicit temporal command to move, but a general imperative—that is, a decision has previously been made to move at some time, but the precise time has not been decided. They tested this model theoretically by employing a leaky stochastic accumulator simulation and testing the fit to an actual RP; their simulation compared with the actual RP yielded an R^2 of .96, $p < .00000001$. Moreover, the model outlined by Schurger et al. predicted that individuals with a greater negative voltage trend interrupted in the Libet-paradigm and told to move at the time of interruption would move faster than when presented with the same interruption with a lesser negative voltage trend, regardless of the time of the interruption in the length of the trial. If the RP reflected a preparation for movement, then small-scale voltage trends would be predicted not to affect the time of movement when interrupted; instead, interruptions in the late stages of the trial should elicit faster responses than interruptions earlier in the trial. The results of the experiment performed by Schurger et al. confirmed the prediction made by their model. Nonetheless, Schurger et al. are careful to note that just because this model is theoretically consistent, that does not mean the RP actually reflects a stochastic accumulation tending towards a threshold. Additionally, the theoretical model of Schurger et al. is inconsistent, *prima facie*, with the findings of Miller et al. (2011)—who found that some voluntary actions appear to entirely lack a preceding RP. More research is therefore necessary to elucidate the empirical status of the perspective of Schurger et al. and Zhu.

3. Discussion

3.1 Summary of Findings and Broader Perspectives

While it is possible for consciousness to be a kind of accidental epiphenomenon of evolution (Carter, 2001), most neuroscientists and psychologists believe that consciousness has a function of some sort (Gray, 2007; Koch, 2004; Morsella, 2005). Evolution has preserved conscious experience too ubiquitously for it to be nonessential (Gray, 2007). Nevertheless, simply because consciousness has a function does not imply that its function is anything like it seems. Indeed, it is possible for consciousness to have a function yet remain unable to produce, alter, or inhibit actions. For example, a sense of control of one's surroundings is adaptive as it promotes health and well-being (Lachman & Weaver, 1998), likely by moderating biological stress responses (Mausbach et al., 2011); an illusory conscious will would function to provide a sense of control (Wegner, 2004), thus potentially providing a function unrelated to the control of actions or thoughts. However, this position piece has attempted to show that neuroscientific data do not currently support philosophical considerations of an illusory conscious will.

Data commonly purported to show that the apparent ability of consciousness to cause behavior is nothing more than an illusion, while compelling at first, suffer from methodological limitations/weaknesses that preclude strong conclusions. The notion that conscious causation is an illusion cannot be ruled out; however, it is not a conclusion to which the data command assent. In addition, this paper has illustrated that there are at least two empirically supported alternate interpretations of data related to conscious causation. The two interpretations of experiments concerning the causal efficacy of consciousness discussed in this section do not necessarily oppose one another; rather, they may coalesce into a complex view of decision-making and volitional action. Making a decision might be a continuous, cognitive process influenced by previous decisions and more. Individuals appear to report making a decision only after the consideration to make a decision has crossed a threshold, and reaching that threshold likely involves the consideration of making a decision, current circumstances and constraints, and the consequences of acting. Nonetheless, both of the interpretations sketched in this section also present with discrepancies between other studies they must overcome or a lack of evidence they must rectify to be fully persuasive. While either of these interpretations may not be strong enough to command support, they are at least coherent interpretations of the data regarding conscious causation. Moreover, these interpretations are consistent with the idea that individuals can consciously control their actions—and they appear to be on equal empirical footing with the perspective that conscious causation is an illusion.

It is also worth noting that the previous two alternative interpretations are not the only plausible alternative interpretations—though they are the most empirically supported. For example, Roskies (2010b) and Desmurget (2013) suggest that the RP is not a preparation for movement, but instead represents a buildup of neural activity that leads to a conscious intention to move—which is then the cause, rather than the consequence of a movement. Presumably, there may be other coherent and comprehensive theories of conscious action initiation as well.

3.2 Research Unaddressed

There is no doubt a substantially greater neuroscience literature pertaining to conscious causation than has been discussed here. Some of this literature deserves a brief mention, though this paper will not discuss those parts in detail. For example, some might state that the ability to manipulate a person's sense of agency (e.g., Desmurget et al., 2009; Fried et al., 1991) bears directly upon conscious causation. However, assuming the physical nature of the mind, the ability to manipulate a sense of agency is expectable and still wholly consistent with the idea that individuals can initiate their own actions (Desmurget, 2013). Similarly, this paper has not discussed in detail another classic study performed by Haggard and Eimer (1999), but this is because a recent, larger, and more thorough study (Schlegel et al., 2013) was not able to replicate their important contribution—that the lateralized RP covaries with the awareness of wanting to move—with any of six different analytical methods. A final relevant strand of this literature worth mentioning but that will not be addressed in detail is recent work predicting actions well above chance before their onset using appropriate methodology (Maoz et al., 2012; Schneider et al., 2013). This work was not discussed in detail in this paper, as it does not directly relate to the question of whether or not conscious causation is illusory—predicting action content before action onset says nothing about whether or not consciousness can initiate behavior, even if these actions were initiated unconsciously.

The selective review also did not cover evidence from psychology proper indicating that the apparent ability to consciously generate one's behavior might be an illusion (e.g., Wegner, 2002). However, this is a topic for a separate paper, and it has been discussed elsewhere (Baumeister, 2008; Frith, 2013; McClure, 2012). There have also been important advances in the philosophical literature regarding free will that have not been discussed at great lengths in this paper. This paper refers its readers to these relevant discussions (e.g., Mele, 2009; Tse, 2013). Similarly, while this paper focused on methodological issues regarding these neuroscientific data, meticulous philosophical work has also provided room for conscious causation given the neuroscientific data discussed herein (Bayne, 2011; Mele, 2008), irrespective of the methodological issues with those data highlighted in the selective review. The purpose of this position piece was to critically examine neuroscientific literature regarding conscious causation and offer an alternative interpretation of those data, to which it restricted its coverage.

4. Conclusion

Although some neuroscientists have asserted that neuroscience provides good reason to reject a belief in free will (e.g., Harris, 2012), stating that neuroscience shows that consciousness cannot cause behavior, this paper has attempted to show that evidence from neuroscience does not necessitate this assertion. As for neuroscience providing reason to reject the philosophical conception of free will, neuroscience cannot make claims about metaphysical issues beyond the scope of its evidence, and its scientific findings do not extend to the areas of the philosophical debate concerning free will such as indeterminism or determinism. Because of that, neuroscience does not significantly modify the philosophical concept of free will (Roskies 2006; cf. Roskies, 2010a). However, this paper has shown that evidence does not require the abandonment of the common belief that an individual can consciously initiate and control his or her thoughts and behavior. Given methodological considerations, studies purported to indicate that conscious intentions and decisions come after determinant neural activity seem flawed, but warrant more research. Additionally, there are extant interpretations for the data derived from these experiments that are each consistent with the idea that individuals can consciously initiate and control their behavior. Most notably, volitional action may be seen as the end result of a complex yet rapid decision-making process, incorporating cognitive elements and previous decisions. The data outlined herein, therefore, are wholly consistent with the idea that individuals can consciously control their behavior.

To recapitulate: contrary to the assertions of some, neuroscience does not provide reason to reject a belief in conscious causation. There are methodological issues with the data purported to indicate that the causal efficacy of consciousness is an illusion, and there are extant interpretations of the data that are on equal empirical footing with the idea that individuals cannot consciously control their actions. Put simply, more research is necessary before drawing firm conclusions about the bearing of neuroscience on conscious causation. Put more strongly, neuroscientific data do not support the notion that consciousness cannot initiate or control behavior.

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