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Libet's Research on the Timing of Conscious Intention to Act: A Commentary

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S. Pockett (*Consciousness and Cognition,* this issue) and G. Gomes (*Consciousness and Cognition,* this issue) discuss a possible bias in the method by which Libet's subjects estimated the time at which they became aware of their intent to move their hands. The bias, caused by sensory delay processing the clock information, would be sufficient to alter Trevena and Miller's (*Consciousness and Cognition,* this issue) conclusions regarding the timing of the lateralized readiness potential. I show that the flash-lag effect would compensate for that bias. In the last part of my commentary I note that the other target articles do not examine the most interesting aspect of Libet's unfashionable views on free will. I point out that Libet's views are less strange than they at first appear to be.

The articles in this issue by Pockett, Gomes, and Trevena and Miller raise a number of important methodological issues concerning Libet's experiments on whether there are neural precursors to conscious intents to act (Libet *et al.,* 1982, 1983; Libet, 1985). I'll first comment on a point brought up by both Pockett (2002) and Gomes (2002) concerning the timing method used by Libet *et al.* (1982). The methodological point they bring up could reverse the main conclusions of Trevena and Miller (2002). Then, in the last section, I comment on Libet's controversial position on free will (Libet, 1985, 1999). I point out that Libet's views are not as unscientific as they at first appear to be.

PART 1. BIAS IN LIBET'S ESTIMATE OF THE TIME OF AWARENESS

Libet's subjects estimated the time of conscious awareness (TCA) of their decision to flick their wrist by reporting the location of a spot moving in a circle (the ''clock''). Libet found that the awareness of the decision came about 200 ms before the motor action (TCA ≈ -200 ms). He also found the time of the readiness potential was about 550 ms before the motor action. Both Pockett (2002) and Gomes (2002) suggest that Libet's use of this revolving spot timing device gave a biased estimate of the TCA because of the processing delay (the latency) in the moving spot becoming conscious. Because of this latency the reported TCA (-200 ms) would be earlier than the true TCA. If we assume there is a 100-ms processing latency for peripheral inputs (seeing the moving dot) and a zero processing delay for central inputs (awareness of the decision) then the true TCA will be -100 msec. This shift in TCA from -200 to -100 ms does not affect Libet's original conclusions about the lack of free will in volition since the shift is in the direction of increasing the time between the readiness potential and the conscious decision.

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Trevena and Miller's (2002) data change the timing implications by focusing on the *lateralized* readiness potential (LRP), which follows the readiness potential (RP). The shift in TCA due to the latency bias could have an important effect on the question of whether the time of the LRP precedes the time of the TCA. Trevena and Miller (2002) and Haggard and Eimer (1999) argue that the LRP has greater relevance to the conscious decision than does the readiness potential. A dialog between Libet and Haggard regarding the relevance of the LRP to Libet's task can be found in Haggard and Libet (2001). After reading these arguments I am persuaded that it is the LRP rather than the RP that should be compared to the TCA. The new data of Trevena and Miller (2002) indicate that the average time of the LRP still precedes the TCA, but by much less than does the RP. However, Trevena and Miller argue that the averaging process can distort the story and that one needs to look at the percentage of times that the timing is reversed (TCA coming before the LRP). They find that 20% of the time the TCA occurs before the LRP. Based on that finding it is likely (they say) that the conscious decision to act comes before the LRP. A bias of 100 msec in the TCA could upset Trevena and Miller's argument since the 20% with TCA before LRP would decrease substantially. When the average TCA is shifted from −200 ms to −100 ms it is unlikely that there will be many occasions in which the LRP comes after the conscious decision to move. I will go through the topic of bias carefully with special attention to the flash-lag effect (Nijhawan, 1994). I argue that the forward referral of the flash-lag effect, not a backward referral that had been suggested for this purpose, can compensate for the perceptual delay latency.

Flash-lag experiments use a moving spot as a timer, just as in Libet's (1983) and Trevena and Miller's (2002) experiments. In a flash-lag experiment the subject's task is to indicate the position of a moving spot at the instant when a nearby spot is flashed. The experimental finding is that the judged location of the moving spot is extrapolated into the future (the flash-lag effect). Baldo *et al.* (2002) provides a review of the recent, rich flash-lag literature. Nijhawan (1994) suggests that the extrapolation would be useful for many tasks involving hand–eye coordination (like catching a ball). More recent experiments on the flash-lag effect indicate that one factor in the effective delay of the flash is that it takes some time to shift attention from the flash to the moving timer (Baldo *et al.* 1995, 2002). It seems reasonable to apply this reasoning to Libet's use of the moving spot timer since Libet's observers would have had to shift their attention from their awareness of the wrist flick decision to the moving clock. The flash-lag delay could be up to 100 ms (Baldo *et al.* 2002), which is long enough to affect whether the LRP does or does not precede all conscious decisions to move (Trevena and Miller, 2002). An alternative attention-based explanation similar to the flash-lag delay is that when nonsimilar stimuli are compared (like a mental decision vs a moving spot) there can be a ''prior entry'' delay of more than 100 msec for the less attended item (Spence *et al.* 2001). In this case we make the ad hoc assumption that the person is initially attending to the moving clock (the item constantly present), so the TCA mental decision will be delayed and will have occurred earlier than the clock reading indicates.

All this discussion about ''earlier'' and ''later'' is confusing and error-prone. A diagram is needed to help sort it out. Figure 1 clarifies the flash-lag experiment (top panel) and its application to Libet's conscious volition experiment (bottom panel).

Flash-lag experiment

True rotating clock time (T)	100	200	300	400	500	600
Perceived clock time (T_c)		100	200	300	400	500
Flash			F			
Conscious Awareness of Flash			←---TCA ↗			

Conscious volition experiment

True rotating clock time	-400	-300	-200	-100	0	100
Perceived clock time		-400	-300	-200	-100	0
Unconscious precursors to intention to move wrist		U???				
Conscious Awareness of Intention to move wrist		←--- TCA ↗				

FIGURE 1

The top row of the two panels is the actual time, T, represented by the moving dot, where the numbers represent milliseconds. The second row of each panel is the perceived time, assuming an 100-ms delay in the conscious percept, $T_c = T - 100$. That is, the visual latency is such that at $T = 400$, the observer ‘‘sees’’ the spot at the $T_c = 300$ position. The third row of the top panel indicates that the flash occurs at $T = 300$ ms. The fourth row shows that one becomes consciously aware of the flash (TCA) at $T = 400$ ms ($T_c = 300$ ms), since I assume it takes 100 ms for the percept of both the flash and the moving spot to become conscious. Libet sometimes claims this duration is 500 ms, but Pockett (2002) and Gomes (1999) have critiques of this claim. Finally, the arrow from row 4 to row 2 indicates the time it takes to shift attention from the flash to the moving dot (Baldo and Klein, 1995). In this example I assume the attention shift also takes 100 ms. Because of this delay in shifting attention the observer thinks the moving dot is at position $T_c = 400$ ms. Since the actual flash occurred at $T = 300$ ms the perceived location of the moving spot is ahead of its veridical position. Or one could say that the flash is lagging behind the moving spot. I am using the attention shift interpretation of the flash-lag effect because of its simplicity. For its relevance to Libet's data any interpretation of the flash lag effect is sufficient since all that is needed is knowledge of the data that indicate that the moving spot is seen as being displaced to later positions (forward referral) rather than earlier positions (backward referral).

Gomes (2002) comments that Libet's rationale for not worrying about the latency delay in viewing the clock is that the perceptual delay bias could be cancelled by a backward referral mechanism (Libet, 1985b, p. 559) as indicated by the backward pointing dashed arrow in the figure. That might be true of implausible backward referral mechanisms that violate standard quantum mechanics (see panel B of Fig. 1 of Klein (2002a)) such as proposed by Penrose (1989). With a more reasonable backward referral mechanisms such as Orwellian memory modification, although the subject would think the flash occurred at $T = 300$ ms rather than $T = 400$ ms, the *contents* of the memory would be the information obtained at $T = 400$ ms. Thus the remembered position of the moving dot would still be the $T = 400$ ms position, not the $T = 300$ ms position. For this reason an Orwellian backward referral mechanism would not be able to remove the time delay bias from Libet's volition experiment. For more details on my opinions on Libet's backwards referral hypothesis see Klein (2002a, 2002b).

The bottom panel applies the above flash-lag reasoning to Libet's conscious volition experiment. Rows 1 and 2 are the same as in the flash-lag experiment since Libet uses a rotating dot timing device similar to what is used in flash-lag experiments. Row 3 is the time of unconscious precursors to the conscious intention of moving ones wrist (or vetoing that intent). The presence or absence of unconscious precursors for the veto is the controversial item (indicated by question marks) that I'll discuss in the last part of this commentary. Row 4 represents the time of the conscious awareness of the intention to move the wrist (TCA). In this figure I am assuming this true time of awareness to be TCA = −200 ms. Gomes (2002) and Pockett (2002) correctly point out that the subject's estimate of TCA would be biased because of the time delay needed for the clock information to become conscious. If we suppose that delay is 100 ms then the subject will think the clock reads TCA = −300 ms (row 2 rather than row 1). Alternatively, if the subject thought that the clock read −200 ms then the actual time of the awareness would be −100 ms, as was discussed above in connection with the Trevena and Miller (2002) experiment. Let us assume, however, that the flash-lag effect operates in Libet's experiment. This is a reasonable assumption since Sheth *et al.* (1999) showed the flash-lag effect operates even when the ''flashes'' arrive through a wide range of sensory modalities including cognitive ''flashes''. The flash-lag effect produces a forward referral (arrow from fourth line to second line) that could compensate for the time delay brought up by Gomes (2002) and Pockett (2002) (the bias being discussed in this commentary). In the example shown in the lower panel this flash-lag ''forward referral'' compensates for the delay in processing the moving dot so that the observer's estimate of the time of the conscious intention to move the wrist (TCA = −200 ms) is veridical. So after all this complicated discussion we end up back with the Trevena and Miller timing. This is not surprising given that Nijhawan (1994) originally discussed the flash-lag effect as being a predictive mechanism able to compensate for latency delays so that the positions of moving objects are seen as if there were no delay.

PART 2. LIBET'S VIEWS ON FREE WILL

Libet's central concern is whether there are neural precursors to free will. He wants to know whether the conscious decision to move one's hand is determined by prior unconscious neural causes. Libet strongly believes that there is true free will, without unconscious neural causes. He notes that typically, neurally based unconscious urges do precede conscious decisions. The early readiness potential and even the lateralized readiness potential could be neural correlates of these urges. However, in further experiments, Libet et al. (1983) provide evidence that the urge could be vetoed, and the veto is not preceded by a measurable potential. Libet (1985, 1999) makes it very clear that he thinks the veto is not determined by any unconscious neural causal precursors. He believes that there is a break in the deterministic chain of connections. The implications of Libet's veto results are not discussed by Pockett (2002), Gomes (2002), or Trevena and Miller (2002). I feel that any in-depth discussion of Libet's volition experiments should not ignore this point that is so important to Libet's framework. A number of commentators (Wood, 1985, Gomes, 1999, Clark, 1999) have pointed out that Libet (1999) is out of step with mainstream thinking on this topic.

I will now argue that although these commentators raise an excellent point about the mainstream, compatibilist position on free will, they do not address Libet's specific concerns.

Compatibilists say that free will is compatible with determinism. Gilberto Gomes (1999, p. 62) offers a succinct summary of this viewpoint in his discussion of Libet's stand on free will:

> The incompatibility between free will, as seen from the first-person perspective, and natural causation dissolves if we adopt the ''astonishing hypothesis'' (to use Crick's phrase; Crick, 1994) that we ourselves, as free agents, are brain systems capable of choice, decision and action. This is the ''compatibilist'' position concerning free will, that is, one that considers free will as compatible with natural causality.

The compatibilist definition of free will is that our actions are free as long as they are primarily determined by our conscious, rather than unconscious decisions. A most eloquent statement of the compatibilist position was provided by Sperry (1998), whose top-down emergentist view of the mind is fully compatible with a deterministic neuroscience (see quotation in Klein, 2002b). The compatibilist position on free will provides a sound basis for the use of free will as a foundation of our jurisprudence system. I personally believe that the compatibilist view on free will is relevant to almost all discussions of free will that commonly take place. However, that is not what Libet is talking about.

Libet is talking about a definition of free will that is antithetical to determinism. Libet's definition requires a break in the neural chain of causation. To make it clear that we are dealing with two different notions of free will, I use ''free will'' (lower case) for the compatibilist definition and ''Free Will'' (upper case) for nondeterminist free will. For Libet, the conscious veto of the urge to move a hand does not have an unconscious neural deterministic precursor (Libet, 1999). One might be tempted to dismiss Libet's views as being several centuries out of date. It reminds one of the old dualistic debates that our modern worldview has presumably replaced. Most scientists, including compatibilists who believe in free will, would reject the Cartesian notion that we have Free Will of the sort that requires a break with natural law. However, there are both philosophical and scientific arguments for taking Free Will seriously. On the philosophical side, Searle (2000, 2001) discusses the Free Will–free will distinction (not using those terms) and dismisses the compatibilist definition as being more about moral responsibility than about true Free Will. Searle (2001) provides a clear discussion of the implications of true Free Will. He believes it presents a problem for standard neuroscience.

On the scientific side, there is a flaw in most previous discussions of this topic in that they use a classical mechanics ontology. However, classical mechanics has been replaced by quantum mechanics. Stapp (1993, 1999, 2001) and Klein (1991, 1993, 1995) discuss the importance of the quantum ontology for the topic of fundamental human freedom. The approaches of Stapp and Klein are not simply that quantum mechanics has a fundamental randomness that eliminates determinism. The randomness aspect of quantum mechanics gives random will rather than Free Will. The aspect of quantum mechanics that is critical for Free Will, is that all present interpretations of quantum mechanics are dualistic. The dualism is not the repugnant Cartesian dualism with separate mental and physical realms. It is a sophisticated dualism that so far seems to be an inescapable part of the fundamental laws of physics. One aspect of the quantum dualism is that there is a central role for observers, not present in classical mechanics. I should immediately say, however, that I am fully in the camp of standard neuroscience in believing that the brain is not a ''quantum computer'' with its requirements of phase coherence of quantum states. That is, I believe in the astonishing hypothesis that classical neural networks are able to produce consciousness. The importance of the quantum ontology is restricted to the philosophical topic of Free Will, which by its definition is unable to fit into a classical ontology. The specifics of the role and place of Free Will in the quantum ontology depend on which interpretation of quantum mechanics one uses. Stapp and I differ in that regard so the issue is by no means settled. My view, based on the Copenhagen interpretation, involves a somewhat metaphorical view of the world (''dreams that stuff is made of,'' ''it from bit''), whereas Stapp has a more absolutist view. This is not the occasion to go into the details of this topic. I just wanted to bring attention to a central aspect of Libet's thinking on the topic.

In summary, rather than abandoning natural law to make room for Free Will, we can embrace the most modern understanding of natural law (quantum mechanics) and find thereby a comfortable place for Libet's ideas. Rather than Libet's views on Free Will being several centuries behind the views of his detractors (Wood, 1985, Gomes, 1999, Clark, 1999) he may actually be ahead.

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REFERENCES

Baldo, M. V. C. and Klein, S. A. (1995). Extrapolation or attention shift? *Nature*, **378**, 565–566.

Baldo, M. V. C., Kihara, A. H., Namba, K., and Klein, S. A. (2002). Evidence for an attentional component of the perceptual misalignment between moving and flashing stimuli. *Perception*, **31,** 17–30.

Crick, F. (1994). *The astonishing hypothesis: The scientific search for the soul.* New York: Simon & Schuster.

Clark, T. W. (1999). Fear of mechanism: A compatibilist critique of ''The Volitional Brain.'' *Journal of Consciousness Studies*, **6,** 279–293.

Gomes, G. (1998). The timing of conscious experience: A critical review and reinterpretation of Libet's research. *Consciousness and Cognition*, **7,** 559–595.

Gomes, G. (1999). Volition and the readiness potential. *Journal of Consciousness Studies,* **6,** 59–76.

Gomes, G. (2002a). Problems in the timing of conscious experience. *Consciousness and Cognition,* **11,** 191–197.

Gomes, G. (2002b). The interpretation of Libet's results on the timing of conscious events: A commentary. *Consciousness and Cognition*, **11,** 221–230.

Haggard, P. and Libet, B. (2001). Conscious intention and brain activity. *Journal of Consciousness Studies*, **8,** 47–63.

Klein, S. A. (1991). The duality of psycho-physics. In A. Gorea (Ed.), *Representations of Vision: Trends and Tacit Assumptions in Vision Research,* pp. 231–249. Cambridge, UK: Cambridge Univ. Press.

Klein, S. A. (1993). Will robots see? In *Spatial Vision in Humans and Robots,* pp. 184–199. Cambridge, UK: Cambridge Univ. Press.

Klein, S. A. (1995). Is quantum mechanics relevant to understanding consciousness? A review of *Shadows of the Mind,* by Roger Penrose. *Psyche,* available at http://psyche.cs.monash.edu.au/v2/.

Libet, B. (1985). Unconscious cerebral initiative and the role of conscious will in voluntary action. *Behavioral and Brain Sciences*, **8,** 529–566.

Libet, B. (1999). Do we have free will? *Journal of Consciousness Studies*, **6**, 47–58.

Libet, B., Gleason, C. A., Wright, E. W. and Pearl, D. K. (1983). Time of conscious intention to act in relation to onset of cerebral activity (readiness potential). The unconscious initiation of a freely voluntary act. *Brain,* **102,** 623–642.

Libet, B., Wright, E. W., and Gleason, C. A. (1982). Readiness potentials preceding unrestricted spontaneous and preplanned voluntary acts. *Electroencephalography and Clinical Neurophysiology,* **54,** 322–325.

Nijhawan, R. (1994). Motion extrapolation in catching. *Nature,* **370,** 256–257.

Pockett, S. (2002). On subjective back-referral and how long it takes to become conscious of a stimulus: A reinterpretation of Libet's data. *Consciousness and Cognition*, **11,** 144–161.

Searle, J. R. (2000). Consciousness, free action and the brain. *Journal of Consciousness Studies,* **7,** 3–22.

Searle, J. R. (2001). Free will as a problem in neurobiology. *Philosophy*, **76**, 491–514.

Sheth, B., Nijhawan, R., and Shimojo, S. (2000). Changing objects lead briefly flashed ones. *Nature Neuroscience,* **3,** 489–495.

Spence, C., Shore, D. I., and Klein R. M. (2001). Multisensory prior entry. *Journal of Experimental Psychology: General,* **130,** 799–832.

Sperry, R. W. (1998). A powerful paradigm made stronger. *Neuropsychologia,* **36,** 1063–1068.

Stapp, H. P. (1993) *Mind, matter and quantum mechanics.* Berlin: Springer-Verlag.

Stapp, H. P. (1999). Attention, intention, and will in quantum physics. *Journal of Consciousness Studies*, **6,** 143–164.

Stapp, H. P. (2001). Quantum theory and the role of mind in nature. *Foundations of Physics,* **31,** 1465–1499.

Trevena, J. A. and Miller, J. (2002). Cortical movement preparation before and after a conscious decision to move. *Consciousness and Cognition*, **11,** 162–190.

Wood, C. C. (1985). Pardon, your dualism is showing. A commentary to Libet (1985). *Behavioral and Brain Sciences*, **8,** 557–558.