

## Libet's Timing of Mental Events: Commentary on the Commentaries

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This issue of *Consciousness and Cognition* presents four target articles and eight commentaries on the target articles. The present article presents comments on those commentaries, grouped into backward referral and volition categories. Regarding backward referral: (1) I disagree with my fellow commentators and take the unpopular position of defending Libet's notion of backward referral. (2) I join my fellow commentators in critiquing Libet's notion of a 500-ms delay. (3) I examine several of the hypotheses suggested by other commentators for why cortical and lateral meniscus stimulation give very different timing results. I suggest a simple experiment to help discriminate among the hypotheses. (4) I comment on why temporal reordering is more likely to occur late rather than early in mental processing. Regarding Libet's volition experiments, I ask what is the root of the controversy, given the general agreement on the data. I agree with a commentator that Libet's chronotheology rather than his chronoscience is the cause of much of the controversy. Rather than joining others in criticizing Libet for his chronotheology I point out that he is making a respectable philosophical (or theological) point regarding nondeterministic Free Will, but one that is easily misunderstood. I discuss two ways by which Libet's viewpoint can be brought into mainstream science. © 2002 Elsevier Science (USA)

The controversial aspects of Libet's experiments fall into two categories: his "backward referral" experiments and his volition experiments. My target article (Klein, 2002a) was on the first aspect; my commentary on the other target articles (Klein, 2002b) focused on the second aspect. The present commentary on the submitted commentaries is likewise presented in two sections to keep the two topics clearly separated. I will try to have minimal overlap with my previous articles.

### I. LIBET'S BACKWARD REFERRAL EXPERIMENTS

#### *1.1. Libet's Interpretation of Backward Referral Is Reasonable*

One of the most important things needing clarification about backward referral is that most people misunderstand what Libet means. The following quotation from Libet (2000, p. 7) should clarify that misunderstanding:

But the whole thrust of our experiments and conclusions was that the timing of a sensation is subjectively *referred* to the early signal given by the primary evoked potential, not that the conscious sensation itself jumped backwards in time. In other words, it is the *content* of the subjective experience, of the neuronally delayed awareness, that is modified by the *referral* to the earlier timing signal.

Penrose (1989) presents a stronger version of backward referral whereby the conscious sensation does jump backward in time. That strong version violates causality

and thus violates quantum mechanics. Libet (2000) clearly distances himself from that version of backward referral; he prefers the modest interpretation that memory is altered to make the subjective time of the touch feeling synchronous with the actual time of touch. In my target article (Klein, 2002a) I argued that backward referral would be useful so that sensory feedback was consistent with motor commands. That is, when I tap my foot, the planned motor movements are felt to be synchronous with the felt sensation even though there is a delay in processing the foot sensation. Backward referral of the sensation would be a simple way to implement that synchronous feeling.

### *1.2. The 500-msec Delay*

Libet's first point in his summary (Libet, 2002) is, "Cerebral cortical activities, in response to a somatosensory stimulus, must proceed for about 500 ms in order to elicit the conscious sensation." As has been pointed out by so many commentators, including Pockett (2002), Gomes (2002a, 2002b), and Klein (2002a), the 500-ms number applies only to very weak, near threshold stimuli. In the backward referral experiments, a stronger stimulus was used and much shorter brain stimulus durations of between 200 and 300 ms were able to elicit conscious awareness (Libet et al., 1979). A 500-ms delay for consciousness to kick in is a problem, since it precludes consciousness from being involved with many decisions where we think it is involved. Rosenthal (2002) deals with this problem by talking about unconscious volitions and unconscious perceptions that are much faster than the conscious ones. Rosenthal's analysis does not satisfy me, since I still believe my consciousness is capable of making rapid decisions within the 500-ms window. A simple resolution of this paradox is the strong possibility that Libet was wrong about the 500-ms delay. Pockett (2002) and Gomes (2002a, 2002b) argue that the time for consciousness is much shorter. Libet (2000) provides four arguments supporting the 500-ms delay. Gomes (2002a) raises good questions about each of those arguments.

It is too bad that in his present commentary Libet (2002) persists in using the 500-ms number, without responding to Gomes (2002a). His lack of response deflects attention from what I thought was the main point in his commentary (Libet, 2002), namely that backward referral is needed to account for his experiments with lateral meniscus (LM) stimulation.

### *1.3. The Lateral Meniscus Results*

The LM and cortical stimulation experiments are simple enough that it is worth repeating the essential points: (1) It takes about 250 ms for medium strength LM and cortical stimulation to become conscious, whereas it takes less than 30 ms for skin stimulation. (2) A 250-ms LM stimulus and 30-ms skin stimulation are judged to be synchronous when they begin at about the same time. (3) A 250-ms cortical stimulus and 30-ms skin stimulus are judged to be synchronous if they end (rather than begin) at the same time. There are two categories of explanations for the 220-ms (250 - 30) discrepancy between points 1 and 2. First, there are exotic explanations that require a modified physics with fundamental changes in our notions of causality such as suggested by Penrose. Alternatively, there could be somewhat bor-

ing, mainstream explanations such as suggested in the target articles by Pockett (2002), Gomes (2000a), and Klein (2002a). Pockett suggests that because of facilitation, LM latency was actually shorter than 250 ms; however, the control experiments Libet mentions in his commentary (Libet, 2002) make Pockett's suggestion less likely. Gomes (and others) suggested that even though the skin duration is brief there might still be a 250-ms delay before the skin stimulus reaches consciousness. Libet in his response calls this an ad hoc explanation. This explanation is not that crazy, however, as Gomes (1998, 2002a) has tried to point out and as I will discuss next.

A critical question is why does the awareness of LM stimulation seem to come earlier than that of cortical stimulation (points 2 and 3 of preceding paragraph). Libet suggests that the answer has to do with his finding that LM stimulation produces an early evoked potential that acts as the time marker. There is no evoked potential with cortical stimulation so the time marker would be the moment of conscious awareness that comes later. As mentioned above, Pockett (2002) suggested the earlier LM latency is due to a facilitation mechanism. Gomes (1998, 2002a, 2002b), on the other hand, has read Libet's methodology (Libet, Wright, & Gleason, 1982; Libet, Gleason, Wright, & Pearl, 1983) carefully and raises the interesting alternative explanation that rather than being related to differences in the LM vs cortical response it is related to the differences in the response to the skin stimulation that was used as the reference in these experiments. Arguments over the variability in skin latency has had several iterations of miscommunication between Gomes (1998, 2002a) and Libet (1999, 2002). It may be the critical weak link in Libet's argument so I would like to clarify the issue. In the cortical experiments, the skin stimulation was a strong suprathreshold single pulse of current. In the LM experiments an attempt was made to match the skin stimulation strength to that of LM stimulation by weakening the skin stimulus. In fact the stimulus was so weak that a single pulse was below threshold. Several pulses were needed to get to threshold. Libet (1999) tries to defend himself by pointing out that after 30 ms the stimulus was above threshold, and 30 ms is very small compared to the more than 200 ms of asynchrony between LM and cortex. However, Gomes still has an excellent point, in that the skin stimulus in the LM experiment is just slightly above threshold so it is expected that the judged time of stimulation would be delayed substantially beyond the 30 ms of stimulation. It seems the cortical stimulus was substantially above threshold so that standard psychophysics would predict a shorter time to awareness for cortical stimulation. Now comes my new suggestion. It would be quite easy to do a psychophysical experiment on the judged time of subjective equality of two nearly simultaneous skin stimuli, one strong and one weak. I hope that some reader of this article will run out and do that experiment, so that by next year we will know whether the shift in time due to the weak stimulation is sufficient to account for Libet's LM vs cortex data. I am hoping that the asynchrony will be too small, removing support for Gomes' conjecture and providing support for Libet's notion about the importance of the evoked potential as a time marker.

#### *1.4. Early vs Late and Fine vs Coarse Mechanisms for Temporal Reordering*

Van de Grind (2002) examines neurophysiological mechanisms for Libet's brain stimulation experiments. He has an interesting way of framing the argument in terms

of whether the neural correlates of consciousness (NCC) are responsible for reordering Libet's time of event data (Libet's viewpoint), or whether neural circuitry before the NCC already have done the reordering. Van de Grind prefers the peripheral reordering. I will take the opposite side and argue for the NCC doing the reordering (note that "reordering" is simply another name for what Libet calls backward referral of temporal information).

I think the NCC do the reordering because only the NCC have enough information from many sources to know how best to do the reordering. There are occasions where a forward referral is needed to make sense of events (Nijhawan, 1994; but note that Baldo and Klein, 1995, have an alternative explanation). There are also occasions where backward referral is needed to produce a sensible ordering of events as Klein (2002a) has argued. The global workspace of the circuitry of consciousness (NCC) has access to diverse information (Baars, 1997) so it seems plausible that it plays an important role in generating a plausible story for the ordering of events.

Durgin and Sternberg (2002) introduce an alternative to temporal reordering. They say, "the 'specious present' view seems a better model of event perception than backstage demons editing videotapes and sending them back in time." By "specious present" they mean a present that has some thickness (finite duration) so that brief events are represented as wholes rather than as movies. Their suggestion makes sense to me and I suspect that there are occasions for which it is an appropriate way to view temporal processing. However, I do not see it as excluding a temporal reordering mechanism that does such a nice job of explaining my foot tapping experiment and the shifts in Libet's synchrony psychometric functions (Klein, 2002a). Durgin and Sternberg's specious present still needs to produce fine-grained asynchrony shifts. Both mechanisms, specious present and backward referral, can be operating. I think part of my fondness for the notion of a long-duration present is that a similar concept turned out to be the pivotal idea in Pirsig's *Zen and the Art of Motorcycle Maintenance*, one of my favorite novels. Pirsig's hero actually goes crazy when dealing with some of the paradoxes of a specious present, as applied to the connection of objectivity and subjectivity (Pirsig, 1974, see especially Chaps. 19 and 20).

## II. LIBET'S EXPERIMENTS ON VOLUNTARY HAND MOVEMENT AND FREE WILL

Why has there been continuing controversy over the past 20 years regarding Libet's volition experiments (Libet et al., 1983; Libet, 1985; Libet, 2000) when there is so much agreement on the basic facts? In the last section of their article, brilliantly titled "The Future of Chronotheology," Bolbecker et al. (2002) present what I believe is the correct answer. They say:

The question then is why did Libet's ideas evoke such a high degree of interest? As noted above, one view was given by Wasserman (1985): Libet's views support a chronotheology in which activities in the supernatural domain putatively lead to effects in the natural world of matter that can be detected by the methods of natural science. Bluntly put, in Libet's universe, immaterial intentions precede human actions. Another view is sketched by Klein (2002a) as well as by Pockett (2002), who draw attention to the strong support which Libet's views have received from eminent figures whose reputations were largely made in other areas of scholar-

ship. These are not necessarily independent explanations. The dualist views of some of these eminences are well known.

To appreciate what Libet is saying about volition one must separate his science from his theology. On the science side there is actually very little difference among Libet and the many commentators, other than Libet's claim of a 500-ms consciousness lag time, with which hardly anyone agrees. Everyone seems to agree that there are some conscious decisions that are reliably preceded by measurable unconscious neural activity. Libet associates this early unconscious activity with urges. The readiness potential preceding the awareness of the decision to move one's hand is an example of this measurable correlation. Everyone also agrees that there are cases of conscious decisions for which nobody has yet measured a prior neural correlate. For example, Libet did not find a prior correlate for the veto decision.

Nothing in this brief summary has been controversial. So what is being discussed in all the articles and commentaries? There have been some wonderful technical discussions such as those carried out between Haggard and Libet (2001) and Trevena and Miller (2002) regarding the importance of the lateralized readiness potential and the precise causal circuitry involved in the volition decision. In addition, there have been lots of technical hasslings about biases that can shift some of the measured timings (Gomes, 2002a,b; Klein, 2002a,b; Pockett, 2002; Bolbecker et al., 2002; Joordens, Van Duijn, & Spalek, 2002; Breitmeyer, 2002; Durgin & Sternberg, 2002; van de Grind, 2002). As can be seen in my target and commentary articles (Klein, 2002a, 2002b), I love finding flaws in other people's methodologies just as much as the other commentators. All this activity is standard science in action, but it is not what continues to produce so much discussion of Libet's results. It is Libet's veering into chronotheology that provokes discussion. In order to present Libet's views accurately it is best to quote him directly and then I will discuss whether it is science or theology. On the topic of free will, Libet said (1999, p. 55, 56):

What we have achieved experimentally is some knowledge of how free will may operate. But we have not answered the question of whether our consciously willed acts are fully determined by natural laws that govern the activities of nerve cells in the brain, or whether acts and the conscious decisions to perform them can proceed to some degree independently of natural determinism. The first of these options would make free will illusory. The conscious feeling of exerting one's will would then be regarded as an epiphenomenon, simply a by-product of the brain's activities but with no causal powers of its own. Determinism has on the whole, worked well for the physical observable world. That has led many scientists and philosophers to regard any deviation from determinism as absurd and witless, and unworthy of consideration. But there has been no evidence, or even a proposed experimental test design that definitively or convincingly demonstrates the validity of natural law determinism as the mediator or instrument of free will. . . . My conclusion about free will, one genuinely free in the non-determined sense, is then that its existence is at least as good, if not a better, scientific option than is its denial by determinist theory. Given the speculative nature of both determinist and non-determinist theories, why not adopt the view that we do have free will (until some real contradictory evidence may appear, if it ever does). Such a view would at least allow us to proceed in a way that accepts and accommodates our own deep feeling that we do have free will. We would not need to view ourselves as machines that act in a manner completely controlled by the known physical laws. Such a permissive option has also been advocated by the neurobiologist Roger Sperry.

Libet's beliefs on free will have been attacked for being out of step with mainstream neuroscience and for dabbling in dualism (Wood, 1985; Gomes, 1999; Bolbecker et al., 2002). In order to clarify this dualism, in my earlier commentary (Klein, 2002b) I distinguished free will (compatible with determinism) from Free Will (not compatible). The above quotation from Libet (1999) shows that he has a noncompatibilist view, whereas most of the commentators have a compatibilist view (Gomes, 1999; Bolbecker et al., 2002). One's first tendency is to brand Libet as being out of step with modern scientific thought. Most modern scientists, believing in causal chains of events, would say without hesitation that there are causal neural antecedents of any conscious decision. I present two very different arguments that allow Libet's extremist views to be compatible with a scientific, reductionist outlook.

My first argument is that a deep understanding of emergence makes it possible to have nonepiphenomenal conscious decisions in a manner compatible with determinism. It is useful to look at Roger Sperry's view on the topic, since Libet (see his comment above) refers to Sperry's "permissive" option. Sperry (1998, p. 1065), one of the most respected neuroscientists, provides a wonderful summary of the emergentist, compatibilist position within a classical physics framework:

Not only is the whole, as traditionally assumed, constantly controlled from below by its parts, but also, we claim, it works the other way around. The emergent whole, that is, constantly exerts downward control over its parts. The subsequent course and destiny of the parts, once joined together in a larger whole, are determined thereafter by the new higher level, emergent properties of the whole. The recognition of the major causal role thus played by the higher, more evolved, forces of both human and non-human nature, gives science a vastly changed view of the entire natural order. The mental, subjective, vital, and social forces are given their due, as well as physics and chemistry. No longer is science incompatible with the humanities, values, or ethics.

Scientists who writhe at the thought of a brain nerve cell being fired by any kind of nonphysical new mental force, don't have to worry. Nothing of the sort is called for. The downward causal effects are evidenced, not within the conscious brain process, but in the way its lower-level components are ordered relative to things outside the given cerebral process. With respect to a particular given cortical brain cell, for example, whether it fires or not and its overall firing pattern is determined both locally by biophysical mechanisms, and also at higher levels by the types of thoughts, feelings and other higher-level cognitive phenomena that happen to be passing through—not because these directly fire the given cell, but indirectly because they encompass the whole brain process as an emergent property.

In Sperry's framework the top-down causes are not epiphenomenal, and they do not violate a causal interpretation. I suspect that if Libet would read Sperry's various writings on the topic he would discover great compatibility with his point of view. If he would adopt Sperry's language many of his detractors on this topic (Bolbecker et al., 2002; Gomes, 1999) would probably be pacified.

My second argument for bringing Libet's dualistic views within a science framework is for those (like me) who believe that Sperry's emergentist view does not go far enough in producing true Free Will. Searle (2000, 2001) points out that by having the bottom-up causal story available, true Free Will is not possible. For true Free Will a dualistic ontology is needed. Luckily, a dualistic ontology is not only available for this purpose, it is forced upon us because the present best guess at the natural laws that govern the universe is quantum mechanics. Conveniently, *all* interpretations

of quantum mechanics have a subject/object duality (Stapp, 1993, 2001; Klein, 1991) of the sort needed by Libet (1999) and Searle (2000, 2001). I provide more details in my earlier commentary (Klein, 2002b).

I agree with Bolbecker et al. (2002) that once one starts discussing Free Will, rather than free will, one is getting close to theology (or metaphysics, for those who prefer not to discuss theology). One can distinguish theology (or metaphysics) from science in that the latter asks testable questions, where the former does not. I call the various interpretations of quantum mechanics different theologies (or metaphysics), since they all predict identical physical outcomes so there is no experimental way to test the interpretations. That brings up the question of whether such theological discussions belong in scientific journals. I believe that it is okay to discuss them because some clever person may come up with tests that can convert the topic from theology to science. For example, several large-scale double-blind tests of prayer are currently being conducted. One can also continue to look for paranormal human mental feats or decisions. Paranormal phenomena (such as telepathy) are those phenomena that violate the predictions of natural law (quantum mechanics), thus providing evidence for Libet's break in the chain of natural law. So far no paranormal feats have been replicable, but it is scientifically appropriate to keep looking, since any evidence of a break in the causal chain would create an enormous scientific revolution. Libet's narrow case is simpler: if one keeps looking, the neural antecedents of the veto may someday be discovered and Libet would have to question his faith in scientifically based Free Will. He could still believe in a metaphysical, nontestable Free Will supported by the quantum duality.

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### REFERENCES

- Baars, B. J. (1997). *In the theater of consciousness: The workspace of the mind*. Oxford Univ. Press.
- Baldo, M. V. C., & Klein, S. A. (1995). Extrapolation or attention shift? *Nature*, **378**, 565–566.
- Bolbecker, A. R., Cheng, Z., Felsten, G., Kong, K-L., Lim, C. C. M., Nisly-Nagele, S. J., Wang-Bennett, L. T., & Wasserman, G. S. (2002). Two asymmetries governing neural and mental timing. *Consciousness and Cognition*, **11**, 265–272.
- Breitmeyer, B. G. (2002). In support of Pockett's critique of Libet's studies of the time course of consciousness. *Consciousness and Cognition*, **11**, 280–283.
- Clark, T. W. (1999). Fear of mechanism: A compatibilist critique of 'The Volitional Brain'. *Journal of Consciousness Studies*, **6**, 279–293.
- Durgin, F. H., & Sternberg, S. (2002). The time of consciousness and vice versa. *Consciousness and Cognition*, **11**, 284–290.
- 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., & Libet, B. (2001). Conscious intention and brain activity. *Journal of Consciousness Studies*, **8**, 47–63.
- Joordens, S., van Duijn, M., & Spalek, T. M. (2002). When timing the mind one should also mind the timing: Biases in the measurement of voluntary actions. *Consciousness and Cognition*, **11**, 231–240.
- Klein, S. A. (1991). The duality of psycho-physics. In Gorea (Ed.), *Tacit assumptions in vision research*, pp. 231–249. Cambridge Univ. Press.
- Klein, S. A. (2002a). Libet's temporal anomalies: A reassessment of the data. *Consciousness and Cognition*, **11**, 198–214.
- Klein, S. A. (2002b). Libet's research on the timing of conscious intention to act: A commentary. *Consciousness and Cognition*, **11**, 273–279.
- 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. (2000). Time factors in conscious processes: Reply to Gilberto Gomes. *Consciousness and Cognition*, **9**, 1–12.
- Libet, B. (2002). The timing of mental events: Libet's experimental findings and their implications. *Consciousness and Cognition*, **11**, 291–299.
- Libet, B., Gleason, C. A., Wright, E. W., & 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., Jr., Feinstein, B., & Pearl, D. K. (1979). Subjective referral of the timing for a conscious sensor experience: A functional role for the somatosensory specific projection system in man. *Brain*, **194**, 191–222.
- Libet, B., Wright, E. W., & Gleason, C. A. (1982). Readiness potentials preceding unrestricted spontaneous and preplanned voluntary acts. *Electroencephalography and Clinical Neurophysiology*, **54**, 322–325.
- Penrose, R. (1989). *The emperor's new mind: Concerning computers, minds, and the laws of physics*. Oxford Univ. Press.
- Pirsig, R. M. (1974). *Zen and the art of motorcycle maintenance*. William Morrow.
- 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.
- Rosenthal, D. M. (2002). The timing of conscious states. *Consciousness and Cognition*, **11**, 215–220.
- 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.
- Stapp, H. P. (1993). *Mind, matter and quantum mechanics*. Springer Verlag, Berlin.
- Stapp, H. P. (2001). Quantum theory and the role of mind in nature. *Foundations of Physics*, **31**, 1465–1499.
- Sperry, R. W. (1998). A powerful paradigm made stronger. *Neuropsychologia*, **36**, 1063–1068.
- Trevena, J. A., & Miller, J. (2002) Cortical movement preparation before and after a conscious decision to move. *Consciousness and Cognition*, **11**, 162–190.
- van de Grind, W. (2002). Physical, neural and mental timing. *Consciousness and Cognition*, **11**, 241–264.
- Wood, C. C. (1985). Pardon, your dualism is showing. A commentary to Libet (1985). *Behavioral and Brain Sciences*, **8**, 557–558.