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The Time of Consciousness and Vice Versa

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The temporal granularity of consciousness may be far less fine than the real-time information processing mechanisms that underlie our sensitivity to small temporal differences. It is suggested that conscious time perception, like space perception, is subject to errors that belie a unitary underlying representation. E. R. Clay's (*The Alternative: A Study in Psychology,* 1882) concept of the ''specious present,'' an extended moment represented in consciousness, is suggested as an alternative to the more common notion of instantaneous experience that underlies much reasoning based on the ''time of arrival'' in consciousness.

The articles of Pockett (2002) and Trevena and Miller (2002) complement each other by discussing the timing of perceptual consciousness and of consciousness of intention and action, two issues that appear linked in Libet's (1985) worldview: If we can respond quickly to events, and yet consciousness has a 500-ms delay, then we must be able to decide to respond without waiting around for consciousness. Each article provides new analyses or data that begin to dismantle Libet's views. Pockett's review is particularly damaging because of its very sensible reinterpretation and careful scholarship which suggest that a claim of an 80-ms delay is equally well supported by Libet's data. Trevena and Miller's article suggests that earlier evidence about the timing of initiation of action must be treated with caution since the later lateralized readiness potential (LRP), rather than the readiness potential (RP), seems to correspond to the moment of decision to act. Our commentary is meant to supplement these articles by drawing attention to a few empirical and theoretical issues involved in the timing of consciousness. Although consciousness must lag behind reality (due at least to neural transmission times) and certain actions (perhaps all) may indeed involve unconscious preparation, theories of the timing of mental events need to consider a more complex set of questions than simply ''when did X enter consciousness?''

The first issue we must raise is whether consciousness of time is of real time (moment-by-moment time of arrival in the sensorium) or of represented time. The

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subjective relative timing of events may have much more to do with how they are represented than with when they came to be representable. To elucidate this point, we find inspiration in William James's discussion of time perception. The temporal content of consciousness has been described as the ''specious present'' (Clay, 1882, cited in James, 1890). Specious not merely because it lags behind the present, but because it depicts an extended moment. In Clay's words, ''all the notes of a bar of a song . . . all the changes of place of a meteor seem to the beholder to be contained in the present'' (Clay, 1882, p. 167). James agrees that ''the practically cognized present is no knife-edge'' and suggests that ''experience is . . . a synthetic datum, not a simple one; and to sensible perception its elements are inseparable, although attention, looking back may easily decompose the experience, and distinguish its beginning and end'' (1890, p. 609). What is crucial to recognize is that events contained in the ''specious present'' have temporal extent and that perceived time is part of the representation of those events.

What we propose for consideration is that in the very short term, our awareness of an event is specifically an awareness of the event, over time, and not of the separate individual moments that an event might be cut into (e.g., by the frames of a video representation). Although we do not intend to prove this view, we think it is helpful in considering the psychological literature concerning the subjective timing of events. Our argument will be that although consciousness seems to depict a unitary and continuous flow of sensory information (properties perhaps better ascribed to the physical world), it is quite possible that the representations underlying our conscious experience are neither continuous nor unitary. Our immediate awareness of the world is, in this sense, an illusion.

How Short Is a Moment?

All this talk of the specious present is not meant to deny that fine temporal perceptual discriminations can be made (they can), but to suggest that the fineness of those discriminations may depend on information made available to consciousness by unconscious (subjectively impenetrable) real-time information processing mechanisms. Moreover, the precision of that temporal information may depend on how much of it we try to take in ''at once.''

Consider, by analogy, the conscious registration of visual detail. If one examines the ''snow'' on a detuned television set, one has the impression that one perceives the true snow itself—pixel by pixel, change by change. In fact, motion perception of random signals is particularly susceptible to capture by global interpretive patterns (cf. Durgin, 2002), suggesting that the information actually available to cognition is much less than what consciousness seems (pretends?) to have available. In the aftereffect of texture density (Durgin, 1995), the apparent number of dots in a textured field can be visually diminished by a factor of 2, despite the fact that no particular dot can be assumed to be ''missing.'' Texture perception is probably coded in terms of abstract dimensions that are subject to adaptation; yet we normally assume our visual experience is direct and accurate, despite its dependence on unconscious visual summarizing processes that render us unable to know the difference.

Based on classic difficulties of peripheral perception known as ''crowding'' (cf. Lettvin, 1976), it has been suggested that the resolution of the visual field should be

thought of in terms of units of attention (He, Cavanagh, and Intriligator, 1996). Although I can resolve the orientation of a small grating when it is presented alone slightly out of the fovea, my ability to perceive it in the same location may be entirely disrupted by the presence of other stimuli presented around it. (It will nonetheless produce orientational tilt aftereffects, so it is clearly still available to early visual analyzers.) Although in isolation we can make spatial discriminations finer than the mosaic of the retina (e.g., Klein & Levi, 1985), in context our spatial limitations grow dramatically. The range of temporal errors in the literature suggests that a similar principle may apply to subjective time perception. For example, there is some evidence that time judgments on two different time scales cannot be made concurrently without a great loss of precision (cf. Section VI.D of Sternberg, Knoll, & Zukofsky, 1982). Moreover, when a pair of simple stimuli is embedded in a sequence, what little is known indicates that the resolution of temporal order becomes substantially worse than when the pair is presented in isolation (cf. Sternberg & Knoll, 1973).

Just in Time, Apparently

Because sound and light travel at different speeds, there has been some interest in our tolerance for arrival time discrepancies. In a large concert hall, for example, the asynchrony between sight and sound might range from 30 to 400 ms. Do perceptual systems need to correct for distance? Instead, it seems, the perceptual systems can get pretty sloppy. Dixon and Spitz (1980) found that artificial delays between video and audio tracks could reach upward of 200 ms for a video of speech and nearly as high for a video of hammering before being noticeable. (Smaller delays were noticeable when audio preceded video.) Consider the advantages of understanding this in terms of the ''specious present'' rather than instantaneous consciousness. Instead of imagining the demons in charge of ''producing'' momentary consciousness busily scurrying about realigning the visual and auditory channels, one can accept that the representation typically available to consciousness of a multimodal event can simply omit information about fairly large temporal discrepancies.

Potential timing errors are everywhere. Simultaneity judgments have shown that sensory systems also fail to ''correct for'' vast differences in neural transmission time for signals from bodily extremities (Halliday & Mingay, 1964). Does that mean we should feel the asynchrony when we touch our toes (between finger and toe signals)? Perhaps not. There is also a literature on the multimodal capture of timing such that, for example, a slightly early click will displace (partly capture) the apparent timing of a flash of light (and vice versa)—as measured by simultaneity judgments relative to a discretely stepping visual clock (Fendrich & Corballis, 2001). Again, the ''specious present'' view seems a better model of event perception than backstage demons editing videotapes and sending them back in time.

In 1796 the Royal Astronomer at the Greenwich observatory famously fired his assistant because of a consistent discrepancy in their observations of stellar transits by 8/10ths of a second (Boring, 1950; Mollon & Perkins, 1996). Such observation required judging the locations of a star moving relative to a vertical wire (before and after it crossed) at the times of two audible ticks separated by a second. Spatial interpolation was then used to estimate the moment of transit in tenths of seconds. Boring (1950) recounts how this amazingly large discrepancy, noted and studied by

Bessel, led to studies of the ''personal equation'' (apparent differences in the perception of simultaneity between trained astronomical observers that sometimes exceeded a second). This led to the complication experiment (involving the comparison of a continuous and a punctate event), which led in turn to studies of ''prior entry''—misalignments between subjective and objective simultaneity due to the biasing of attention toward one of the stimuli (Titchener, 1908).

Prior entry within and between modalities is well known to many psychologists, and the magnitude of these effects with practiced observers can be on the order of 70–200 ms (Frey, 1990; Shore, Spence, & Klein, 2001; Spence, Shore, & Klein, 2001; Stelmach & Herdman, 1991; Sternberg, Knoll, & Gates, 1971). Although large, these values are far too small to explain the personal equation differences. Mollon and Perkins (1996) have suggested that artifacts of subjective spatial interpolation may have contributed to the personal equation. There may be other issues involving the complexity of the event.

It is not obvious that a single underlying representation is responsible for all judgments of time. When their introduction of an attentional bias altered the point of subjective simultaneity based on temporal order judgments (TOJs), Stelmach and Herdman (1991) found that instead of shifting *which* stimuli were judged to be simultaneous, the frequency with which any stimuli were judged to be simultaneous was drastically reduced. They suggested that TOJ and simultaneity may be based on different kinds of information. We mention this to emphasize the plausibility of the notion that multiple (possibly conflicting) sources of information about the relative time of two events might be available to cognition despite the apparent unity of the specious present.

To tolerate the kinds of discrepancies we have discussed here, the temporal extent of the events represented in the ''specious present'' might be quite large. If so, it would be an error to identify the perception of an event's occurrence time with the time that we become conscious of it. Studies that require reporting the second are quite likely to tap the first.

Transitivity Lost

Even if one assumes that one can measure the timing of mental events by either the perceived timing of those events, or by the ability to respond to them, empirical problems arise. Naively, there are at least two methods that seem like reasonable candidates for discovering the relative timing of conscious events. One is TOJs. Discriminations in the timing of stimuli (e.g., between clicks and flashes) can be quite fine, and this might lead one to infer that one had hit upon a method for measuring the precise timing of consciousness of these events. A second method is simple reaction time (RT)—to the flash or the click. Although RT includes other added delays, RT differences might be taken as informative about the relative arrival times in consciousness of a click or a flash.

For TOJ, it would seem self-evident that relative timings ought to be transitive, as are physical timings. Thus, if event A must be 30 ms ahead of event B to seem simultaneous with it and B must be 20 ms ahead of event C to seem simultaneous with it, then one expects that a lag of 50 ms between A and C ought to make A and C appear simultaneous. Although it is difficult to control for possible intrusions of

attentional effects at these time scales, the most persuasive of the few studies that have tested for transitivity of TOJ have found it to fail (Hansteen, 1968, 1971; cf. Sternberg & Knoll, 1973). Even when practiced observers, judge simple punctate simuli, intransitivities have been observed as large as 50 or 60 ms. Thus, while the pairwise time differences among sets of physical events permit defining a unique occurrence time for each event (a point on a time line), mental events appear not to have such unique occurrence times. Assuming transitivity in comparing TOJs for different stimulus pairs is not justified.

Moreover, there are common variables, such as stimulus intensity, which have characteristic effects on both RT and TOJ, but their effects often differ in magnitude. Presumably, if RT and TOJ both reflect the timing of a stimulus entering consciousness, then increasing the intensity of a stimulus ought to have equivalent effects on RT and TOJ. That is, if an increase in intensity reduces mean RT by a given value (ΔRT), then the point of subjective simultaneity (PSS) between stimuli with the same increase in intensity of one stimulus ought to be similarly shifted (ΔPSS). In fact these two values are seldom the same (e.g., Sanford, 1971). If one imagines a punctate stimulus to be neurally smeared over time, this divergence might be understood by supposing that RT reflects a threshold level of stimulation, whereas PSS is computed across peaks of stimulation (cf. Sternberg & Knoll, 1973). Stimulus intensity could affect these differently. Nonetheless, the clearest implication of these divergent measures is that the timing of a cognitive event is problematic at fine temporal scales and that different measures will give divergent results.

Note that these kinds of ''mental measurement'' problems are not restricted to considerations of time. Willen (1994) has shown that judgments of both spatial position and extent in the same spatial configurations vary with task requirements in ways indicating the use of multiple distinct mechanisms with different characteristics in different tasks. Again, the implication is that not only is the apparent spatiotemporal continuity of consciousness illusory, the informational contents that support it need not be consistent with one another.

When Is a Decision?

When we turn back to the consideration of purely internal conscious moments (moments of deciding to move, for example), and we try to bind those moments to other perceptual events, what sort of temporal resolution should we expect? What sort of attentional misalignments might result? How long does a decision take and where, in the specious present, do decisions normally appear? These are difficult questions. Having abandoned the naive view of the Cartesian theatre (Dennett, 1991), it strikes us as patently unclear what sort of neural or cognitive machinery concerning the precise timing of ''decisions'' ought to be available to consciousness. For present purposes we will limit our observations to a few considerations about Libet's task, and Trevena and Miller's (2002) argument.

The task devised by Libet to study the conscious timing of a spontaneous decision relative to brain potentials and actions is a modern version of 19th-century complication experiments involving the intermodal temporal comparison of ongoing and punctate events (cf. Boring, 1950). The subject undertakes to act spontaneously while

also carefully keeping track of the apparent timing of the spontaneous decision by tracking the position of a dot continuously moving along a circular trajectory. We leave aside issues of predictive extrapolation in the perception of continuous movements (Boring, 1950; Nijhawan, 1994).

Trevena and Miller (2002) suggest that the LRP better reflects the timing of the decision to act, though they agree that the RP precedes the decision by a substantial amount. Thus the RP, an apparently unconscious process, precedes the decision to act; it remains open whether it is causally linked to that decision. Trevena and Miller's conclusion deserves some explication. The decision to act (at all), as we understand it, is actually made before the beginning of each trial—the question that remains before the subject is *when* to act—and in Trevena and Miller's paradigm, the subject has 8 s. Thus, although the subject is faced with the somewhat paradoxical instruction to ''act spontaneously'' (can one voluntarily act at random?) the appropriate strategy seems to be to wait to be struck by an urge (RP?) before choosing a moment to act. On this reading, the (eventual) onset of RP may be said to be consciously ''allowed,'' whereas the decision to act *now* may indeed be best indicated by the LRP, as Trevena and Miller propose and their data suggest. Possible biases in the subjective timing of this decision using Libet's clock technique are simply unknown at present.

Conclusions

Our observations have been intended to promote the idea that the temporal characteristics of consciousness are not necessarily those of the physical world. Conscious contents concerning the relative timing of events need not derive from the comparison of independent ''conscious experiences'' but could be born from unconscious real-time cognitive computations that support the illusion of the specious present (experiencing an extended moment). There are plenty of examples of discrepancies between cognitive processes and introspective reports (e.g., Durgin, 1999; Whittlesea, Jacoby, & Girard, 1990). Here we have argued that the perceived time of an event may not directly reflect the time at which the event ''entered consciousness.'' We take it that consciousness is *of* a temporally continuous and unitary world, but that it may be an error to ascribe such characteristics to the temporal information used in the synthesis of the specious present.

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