Seeing in time

Measuring time in a time past—before the Apple

The chronoscope circuit contains besides the reaction key, a sound hammer and control hammer. When the clang reactions are to be taken, the two hammers are closed. For comparison purposes, noise reactions may be taken with the sound hammer: the control hammer is then closed, and the low resistance-circuit (wire-and-pick circuit) left open. Control times for the noise reactions may be taken with the control hammer in its present position: key and sound hammer are closed; the low-resistance circuit is open. The hammer makes the high-resistance circuit as it falls past the upper contact and breaks it again at the lower contact. Control times for the clang reactions are taken by connecting the wires of the low-resistance circuit to an upper break-contact, and the wires of the high-resistance circuit to a lower break-contact on the control hammer: key sound hammer, and wire-and-pick are closed. As the hammer falls, it first breaks the low-resistance circuit (the clock hands move) and then breaks the high-resistance circuit (the clock hands stop).

From: Edward Bradford Titchener Experimental Psychology: a manual of laboratory practice. Vol.II Quantitative experiments. Part I, Students' Manual (New York: The Macmillan Company, 1905) page 155.
The specious present—bytes of the Apple?

Time was a major interest at the start of experimental psychology. Now we are so busy we don't seem to have any. Although it is such a precious commodity. At the present time there is rather little research on time. Half a century ago both the physics and the psychology of time captured the imagination of scientists and the public. No doubt this was triggered by Einstein's theory of relativity published in 1905 where time was seen in a quite new way, slowing with velocity, and with the realisation of the vast distances between galaxies, so space travel became time travel. There was also limited time travel both backwards and forwards in quantum physics though not, it seems, able to change the future. In the nineteen-thirties there was a burst of books on time, following H G Wells's early story The Time Machine (1895), J W Dunne's best-selling Experiment with Time (1927) and The Serial Universe (1934), J B Priestley's Time and the Conways (1937), and Aldous Huxley's Time Must Have a Stop (1944). Stephen Hawking's A Brief History of Time (1988) at the top of the best-seller list for many months is the publishing phenomenon of our time.

William James wrote interestingly on time in The Principles of Psychology (1890), especially on the specious present and the flow of time in consciousness. There were many experiments on the perception of time in the 1930s–1960s, probably the best book being Paul Fraisse's La Psychologie du Temps (1963), published in English as The Psychology of Time (1964). Paul Fraisse was Professor of Psychology at the Sorbonne and Director of the Institute of Psychology at the University of Paris. He carried out and described many experiments on the perception of time, but they are seldom referred to now. Perhaps we should reappraise this forgotten era in this area of psychology.

Time has always interested philosophers. A key question is the relation between motion and time. Zeno tried to show that motion is paradoxical, and so impossible. The argument was that as something moves from A to B it halves, then quarters, and so on the remaining distance; but the series will never get to zero, so the object will never arrive, or move at all. This is a lovely example of the importance of choosing appropriate kinds of descriptions. Perhaps we don't know how to describe time.

For Plato reality was timeless, like mathematics and geometry. This tradition continued into the fundamental laws of physics which are timeless, or reversible in time. It is interesting that the pendulum used in clocks to measure the inexorable one-directional flow of time is itself time-reversible. It is revealing to watch a film played backwards. What looks different, what the same? A pendulum looks exactly the same in reversed time though of course the hands of the clock rotate backwards.

Traditionally, the great mystery has been the one-way arrow of time. And would there be time in a static stationary Universe? Is time like colour—dependent on observers? Do we observe or do we create time? It is now thought that the arrow of time comes from the extreme improbability of reversing steps of events, such as mutations of organic evolution. Thus it is incredibly unlikely, rather than strictly impossible in the sense of violating laws of nature, that we will ever go back to becoming amoebas. And yet the second law of thermodynamics is often held by physicists to be the most fundamental law of all.

Current chaos theory says that long-term prediction, for example of the weather, is not possible because we cannot know the starting position with sufficient accuracy: the tiniest error gets magnified in nonlinear systems, so they run away from prediction. What I don't understand (among much else!) is how physicists say this, while also claiming to know, with great precision, the state of the Universe a micro-second after the Big Bang at the beginning of time. Is there an asymmetry for past and future prediction in physics? This seems incredibly unlikely. Stephen Hawking does not discuss chaos in A Brief History of Time. One wonders why not?
Aristotle thought that time does not exist without change (*Physics*, book IV); though he was not clear what changes are time, or indicate time. Descartes held that our notion of time comes from within the mind. This was also Kant's view, though he thought there must be one time, intuited by the senses as a basic mental category. For Kant the experience of time is not a copy of the world of objects, but rather a way of considering the physical world and ourselves. This fits a constructivist theory of perception such as that of Helmholtz. ‘Time’ does not actually appear in the index of the great *Treatise of Physiological Optics*, though Helmholtz was the first to measure the rate of conduction of nerve, and physiological reaction time (1850). This he did in Johannes Müller’s laboratory; though Müller (his professor) thought that the conduction rate would be at least the speed of light, and would be forever unmeasurable. Helmholtz used the rotating smoked drum of the chronograph, invented in 1849, and found neural conduction to be about a tenth the speed of sound. He also estimated cortical synaptic switching time—this becoming the basis of Michael Posner’s *Chronometric Explorations on the Mind* (1978).

Helmholtz measured conduction time of nerve noninvasively in human subjects by stimulating the leg or the arm in two places: as far from the brain as possible and as near as possible. The subject pressed a key. A longer response time for the more distant stimulus indicated the extra time of conduction along the extra length of nerve. An excellent practical class demonstration is to sit the students close together in a line, and get them to touch the shoulder of their neighbour as soon as they experience a touch on their shoulder, then to repeat the performance with a touch to the lower arm or wrist. The time elapsed between the first touch to the final response is measured with a stopwatch. Although the difference is too small to measure so crudely for a single subject, when ten or a hundred are placed in series the time difference is easy to measure, as the total length of nerve is ten or a hundred times greater than for a single arm. The motor delay in moving the finger to touch the neighbour’s arm does not, of course, matter, for this is constant for both positions of the stimulus and so can be ignored. Possibly a ring of subjects might be used—giving a nerve a mile long.

When an action is repeated rhythmically, so that prediction is possible, the reaction-time falls to zero. It is zero although the signal takes time to arrive. So cortical intelligence has overcome the basic physiological limitation of low conduction velocity in nerve. Shouldn’t such experiments be required for all psychology students? They might say and write a lot less nonsense when they become teachers, if they get such basics, presented with clear simple experiments and the implications thought through.

How do we estimate duration? What are the errors, illusions, of time? Following Wundt, several of his pupils measured errors of estimated duration, the consensus being that short intervals are overestimated and long intervals underestimated, the ‘indifference zone’, or ‘indifference interval’, lying between 0.59 and 0.62 seconds (Woodrow 1934). It is often thought (at least by philosophers, who always put thoughts first, as in Descartes’s “I think, therefore I am”) that apparent time depends on the rate of succession of thoughts. So if one sticks to one thought, time comes to a stop. Presumably this is a basis of meditation and immortality. It is also often said that time passes faster and faster through life, challenging nonageing of sages.

When we are busy, time passes fast; but when we look back on a busy period it appears of long duration. How this is related to the rate of processing information seems to be unclear. There is more evidence of effects of metabolic rate, such as with differences of body temperature. With raised temperature time seems to flow faster. This is related to biological clocks—which, of course, are upset by air travel, when we take off and land in different time zones. Presumably debilitating jet lag is due to loss of synchrony of biological clocks.
Experimental psychology, to my mind (Gregory 1981), started off on the wrong foot, by failing to see the significance of the astronomers’ personal equation. This is a fascinating story. Time was read from the stars with a transit telescope, which can only move in one direction. Set to catch a chosen star, the image of the star is carried by Earth’s motion across five hairlines in the eyepiece. At the moment it crosses the central hairline, the observer presses a key, to set clock time from the stars. But it turned out that observers did not agree.

As described by E G Boring (1950, chapter 8), the Astronomer Royal at Greenwich observatory, Maskelyne, sacked his assistant named Kinnebrook, in 1796, for observing transits almost a second later than he did. This was an extremely serious error. Years later the German mathematician Friedrich Wilhelm Bessel (1784–1846) realized that this difference is far too great for neural differences of reaction (or response) time. From observations with an artificial star, it turned out that some observers pressed the key before the star’s image crossed the line. So it was clear—and should have been clear to psychologists!—that observers do not respond to stimuli—they predict when the star will cross the line. If this had been taken on board we could have missed out sterile paradigms of behaviourism and direct accounts of perception. If we were slaves to reflexes, or controlled directly by the external world, we would always be a substantial part of a second behind events. So ping pong would be impossible.

If we had heeded our link to the stars, we could have avoided a couple of centuries of slavish adherence to billiard balls cause and effect accounts, and got on with studying predictive brain models for representing past, present, and future for seeing in time.

But when thinking about time, the temptation is to rewrite history.

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References
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