Causation Bridges the Two Times

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Abstract: The two times problem, where time as experienced seems to have distinctive features different than those found in fundamental physics, appears to be more intractable than necessary, I argue, because the two times are marked out from the positions furthest apart: neuroscience and physics. I offer causation as exactly the kind of bridge between these two times that authors like Buonomano and Rovelli (forthcoming) are seeking. It is a historical contingency from philosophical discussions around phenomenology, and methodological artefact from neuroscience, that most studies of temporal features of experience require subjects to be sufficiently still that their engagement with affordances in the environment can be at best tested in artificial and highly constrained ways. Physics does not offer an account of causation, but accounts of causation are tied to or grounded in physics in ways that can be clearly delineated. Causation then serves as a bridge that coordinates time as experienced, via interaction with affordances in the environment, with time in physics as it constrains causal relationships. I conclude by showing how an information-theoretic account of causation fits neatly into and extends the information gathering and utilizing system (IGUS) of Gruber et al (2022).

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Causation Bridges the Two Times

1.

The physics of time gives us a very different picture than the neuroscience of time; and neither field actually returns a single, determinate, picture of what time is like. Physics provides fundamental equations that are time-invariant, but also time as it is found in thermodynamics. Buonomano and Rovelli (forthcoming) offer a discussion of time as understood from the perspectives of physics and from neuroscience. They note a number of key features of this discussion, such as the contrast between the way(s) in which time is conceptualized in physics, and how temporal features of experience are studied in neuroscience. They offer options for bridging the apparent divide between these two fields investigating time from the neuroscientific or psychological perspective and from the perspective of physical science, noting, quite rightly, that each of the respective fields of neuroscience and physics often place the responsibility for bridging the divide on the other (p. 1; also Callender 2017). They offer a view of time as a layered concept that bridges between their fields, while also highlighting some of the discrepancies between them. This sets up the 'two times' way of framing what, precisely, the issue to be solved is; understanding the problem as one of two conflicting 'times' is also how Gruber et al (2022) frame the issue.

Between these two times is already a major philosophical resource that intersects with both times, is not itself directly time-defined, and which thus constitutes a fruitful point from which to triangulate and coordinate the other two times, serving the purposes of both Buonomano and Rovelli (forthcoming) and Gruber et al (2022), as a mid-point between physics and neuroscience. Causation is well suited to serve as a pivot or crux between experience of time and time in physics. Indeed, at least since Reichenbach (1956), it has been an open question whether the arrows of thermodynamics, information, or causation determine one another in some combination.

I will make the case that causation is the bridge we need between these two times. On one hand, time as studied in neuroscience should be taken to include our interactions with affordances, as we situate ourselves in an ongoingly changing field of opportunities to do things like lift pens, raise a hand to say hello, or catch a ball. Our involvement with affordances can be studied neuroscientifically, and just is how we interact with causal structure in the world. On the other hand, physics does not study causation per se, but accounts of causation involve ways to situate causal relations in the world as studied by physics, especially something like an account of causation based on informational connectivity. Causal structure is part of the physical world as described by physics. Finally, situating causation between affordances and physics provides the bridge required for the two times problem, and it does so in a way that fits into and extends the work on information gathering and utilizing systems offered by Gruber, Block, and Montemayor (2022).

2. Historical and methodological explanations for not drawing on agency and causation

There are both historical and methodological reasons why causation, and anything involving action or agency, have not been drawn on to a greater extent in solving problems about how these 'two times' relate.

Historically, discussions of time consciousness and its distinctive features trace back to work like James (1890), where the idea of the specious present and the temporal extension and continuity of consciousness was emphasized. James and others often invoked examples like watching birds fly, which are passive in the sense that the subject simply watches. Perception, and not motor action, was thus made central to the discussion (see also Grush 2000). This was cemented by the phenomenological approach to time consciousness, such as that of Husserl, where interaction with the world outside of experience was specifically bracketed and set aside (see Andersen and Grush 2009, Andersen 2017).

This led to neuroscientific work on temporal features of experience remaining focused on an understanding of experience that was severed from immersion in action-oriented possibilities. Attempting to identify neural correlates of various features of consciousness, such as Varela (1996), start from phenomenological construals of temporal experience, which means that action, successful and unsuccessful, has already been removed prior to looking for neural correlates. Causation is precisely what phenomenology has already set aside. But neuroscience need not limit itself to phenomenological analyses to study the temporal characteristics of time.

Methodologically, there are reasons why temporal features of human experience as studied by neuroscience fell neatly into this established groove of passivity. Protocols involving scans like fMRI or MRI require substantial periods of physical stillness from subjects. Even when tasks are involved, they are often attention-oriented tasks, a mitigated form of action that does not require bodily movement or coordinated interaction by the subject with any causal structure in the world. Studying something like how children learn how to time their bodily movements in order to catch a bouncing ball cannot be done using such scans. Yet these kinds of physical motions involve temporal features of experience that must be timed to non-subjective timelines such as the trajectory of a bouncing ball.

3. Agency and affordances

The 'causal handles' we use for our own actions are called affordances for action: the parts of the world that are well suited for our basic bodily actions to be used (Gibson 1977). The shape of a well-designed coffee cup is an affordance: part of the physical world shaped so as to enable bodily movements with respect to it. There are many ways an object could be shaped that would make it hard or impossible to use for this purpose. There is already evidence that perception involves a bias towards or highlighting of affordances for action (see, Siegel 2014 for a summary).

We come to a generalized or abstract understanding of causation by coming to understand how to use these handles on the world to achieve our goals (see also Woodward 2021). We monitor our own effectiveness at using these affordances, in ways that reflect Rovelli and Buonomano's layered view of time. Affordances situate us in the causal nexus at different time scales. At one time scale, we might reach to grab an object falling off a table. On another, we might walk towards something at different paces depending on the surface. On longer timescales, we might set a timer so as to remember the bread in the oven, or a calendar reminder so as to remember a meeting in a month. These actions involve us using basic bodily movements to interact with affordances in the causal nexus of the world so as the accomplish various tasks. There are multiple time scales at which we act, monitor, and flexibly respond to correct course if need be. The world of affordances in which we situate ourselves as agents who can, with the right conditions and the right sequences of action and attention, successfully do things, is just a proper subset of the causal structure of the world.

Using affordances allows for the coordination of internal time as experienced with the external time of physics. We don't float free of the world of physics when we experience the frustration of almost but not quite reaching that falling cup in time. This is closely related to work about situation and coordination by Ismael (see especially 2007, chapter 4) on situating the self by coordinating what she calls two 'media' (see also 2017 for her work on affordances and objective modality). It also connects to the work by Grush (especially 2000) and Grush and Springle (2019) on the self as spatiotemporally located at the intersection of sensory and motor activity. It differs from Montemayor (2017) in the details, though shares some overall features.

4. Affordances are a subset of the causal structure of the physical world

However, affordances alone are not enough to serve as the bridge. Affordances gesture at causation: affordances are the causal handles in which we situated human agents are especially interested because we can coordinate ourselves with them, if we do it aptly (where aptness must include effective timing) (Mitchell 2023). The work of bridging must be done by a robust account of causation. That bridge can then connect the two times with a few steps. There is a step from time as studied by neuroscience, to time as it is or could be studied by neuroscience specifically as it relates to physical actions undertaken in a changing environment, or in other words, as it relates to affordances. On the other hand, physics does not tell us about causation directly. Most importantly, time in physics will not be identical to time in causation, but it will be directly relatable to time in causation, such as the directed asymmetry of thermodynamics versus the time-reversibility of many fundamental dynamical equations.

Some accounts of causation are based more directly on physics, such as the process account of Salmon (1998) involving the propagation and exchange of conserved quantities. Another influential contemporary account is based on manipulability, including but not limited to manipulability by humans (Woodward 2003, 2021). Even when manipulability is used as a conceptual foundation for causation, and including variables of which humans cannot themselves directly manipulate (such as stock market prices, or moving planets around the solar system), it still connects what humans can do, as a subset of manipulations, to clearly human-independent features of the world studied using physics. One example involves the distance of the Moon from Earth and how changing that would influence the gravitational pull of the Moon (Woodward 2003, pp. 129-131). This is clearly closer to the realm of physics, and time as studied by physics, than it is to time in neuroscience.

Furthermore, there is at least one account of causation that provides a metaphysics foundation for manipulability accounts, draws on though modifies Salmon's physics-oriented account, and which explicitly involves the idea of physical informational connections as the basis for causation (Andersen 2017). This account dovetails well with the information gathering and utilizing systems IGUS) of Gruber, Block, and Montemayor (2022). In particular, by treating informational connections as a basis for causation, and causation as an especially important part of the world for organisms to be capable of responding to and manipulating, this account extends the points made by Gruber et al regarding the evolution of IGUS. We should expect any organism that has evolved long enough to have temporally structured experiences of time to be very capable of situating itself successfully in the causal nexus of the world, or in other words, in the web of informational connections that it can use for both perception and as affordances.

5. Conclusion

While it may look like time as studied by neuroscience and as studied by physics span a vast chasm, there are actually existing philosophical resources ready to bridge this gap. Neuroscience need not only take a phenomenological approach to temporal features of experience, leaving out anything active or causally connected to the world outside the brain. Instead, time as studied by neuroscience should be expanded to include time as involved in, for example, skilled physical movement that is coordinated with external objectively measureable events. Bringing affordances into the neuroscientific study of time connects our temporal experience to causal structure in the world. In turn, that causal structure derives from and can be also studied using tools from physics. Thus, causation serves as an ideal bridge to coordinate the apparently distinct times studied by neuroscience and physics.

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