

## Time, flow, and space

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**Abstract:** Does a temporal dual process theory explain the illusive flow of time? I point out one shortcoming of such a theory and propose an alternative that does not require either dual cognitive processes or demand such a stark asymmetry between space and time in the brain.

Time flows, but space does not. Languages the world over attribute to time a dynamic quality not also attributed to space. Relative to a deictic center, we chop up the world temporally into past, present, and future, and we chop up the world spatially into here, there, right, left, up, down, and so on. As we move about, both deictic structures update themselves. What was once there becomes here. What was once future becomes past. Crucially, this updating happens monotonically in one direction in the case of time. That is why time flows, but space does not. Although our construals of temporal flow may vary with language and culture, representing time with flowing temporal deictic structure seems very nearly universal.

What explains this? Some philosophers suspect a kind of contradiction lurks at the heart of time flow. McTaggart (1908) argued that combining temporal deictic structure (past, present, future) with temporal sequential structure (earlier, later) is inherently incoherent. More recently, Price (2011) writes that we want a theory of time that is at once both exclusive – privileges only

present times – and inclusive – acknowledges that all times exist. Because a signature of a dual process theory is supposed to be the occurrence of simultaneously contradictory beliefs (Sloman 1996), Hoerl and McCormack see this as an opportunity to put their dual temporal systems theory to work. The impression that time flows, they say, is due to a clash between our primitive temporal updating system, which represents only the present, and our more sophisticated temporal reasoning system, which represents past, present, and future events.

What I like about this rich and original idea is that, if true, it would explain the near universality of the time flow phenomenon. If mature human beings have these two systems and time flow is a result of their conflict, we should expect claims about time flowing to be widespread. However, I do not think that this can be the full story about flow nor do I think this is necessarily the most parsimonious way to get this result.

What this account misses in our naive account of time flow is the idea that *something* flows. There is more to our talk and thought of flow than a tension between a wide existential quantifier (quantifying over all times) and a narrow one (quantifying only over present events). That conflict will generate tension, but it will not underwrite the beliefs that *future events draw nearer* and *past events recede*. I am closer to my birthday than I used to be. You too. The temporal monotonic updating is updating something. To make sense of the above beliefs, something must endure (or appear to endure) through time (Velleman 2006). The naive theory of time is not fundamentally accurate. Still, to explain flow, even if it is illusory, we must explain this feature of it.

Some have suggested that what flows is the self (Velleman & Callender 2017). The self may itself be illusory in some sense. Based on that theory, the self is constructed along one's

world line, giving the appearance of something enduring when nothing in fact is. Whatever the right answer, the dual systems approach needs supplementation. It gives us friction, not flow.

The paradigmatic type of motivation for dual process theories is the occurrence of simultaneously contradictory beliefs. Evidence that we have such beliefs typically appeals to performance error (e.g., violating the probability calculus) and a residual tendency to still make the error even when we realize we are mistaken. The well-known conjunction fallacy illustrated by the Tversky and Kahneman (1983) case of Linda the bank teller is an example. It is the cognitive counterpart of a perceptual illusion. Learning about the mistake (if it is one) does not eliminate the perception in the illusion case or the thought in the belief case. But where is the performance error? Everything works smoothly. I never confuse tomorrow with today. So I wonder if positing dual systems is really called for on the basis of flow. Perhaps I'm simply thinking one thing and then another.

Here is an alternative suggestion that also explains Price's inclusive versus exclusive tension in terms of a clash: Temporal flow partly stems from a mismatch between perceptual and cognitive systems. The former gives us short temporally extended presents. The latter extends over more time. This perceptual/cognitive tension would make the flow of time more like the illusion it is commonly said to be. We are already committed to both systems. Unless a cognitive/cognitive clash is better for some reason than a perceptual/cognitive clash, then this mismatch may be a better explanation.

Finally, why does space not flow according to the authors? One can easily imagine a similar conflict in the spatial case between our representations of the spatially proximate and the spatially distant. The authors have a fine answer: In the temporal case, we have two systems,

whereas in the spatial case, we have only one. Animals and young children presumably come (or are earlier) equipped with a single sophisticated spatial reasoning system, so there are not two conflicting systems generating flow. Note that the authors' answer must rely on the stark asymmetry that they posit between space and time in the brain.

I do not have space to develop the point, but against this, I want to advocate for conceiving of the brain as employing a generalized system that constructs a *spatiotemporal* representation of the world, not separate spatial and temporal systems like those assumed here (Arnold 2013). Such a system seems a better fit with the data. We live and evolved in a spatiotemporal world. What matters is not just *where* the fruit is located but where it is *when* it is ripe. Perception is filled with multimodal effects involving space and time. Cognition employs very similar measure concepts for both. The hippocampus utilizes place cells and time cells. It would be very surprising if two separate systems, one for time and one for space, evolved and appeared at such different times developmentally, given how tightly linked the two are in physics, biology, and psychology.

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