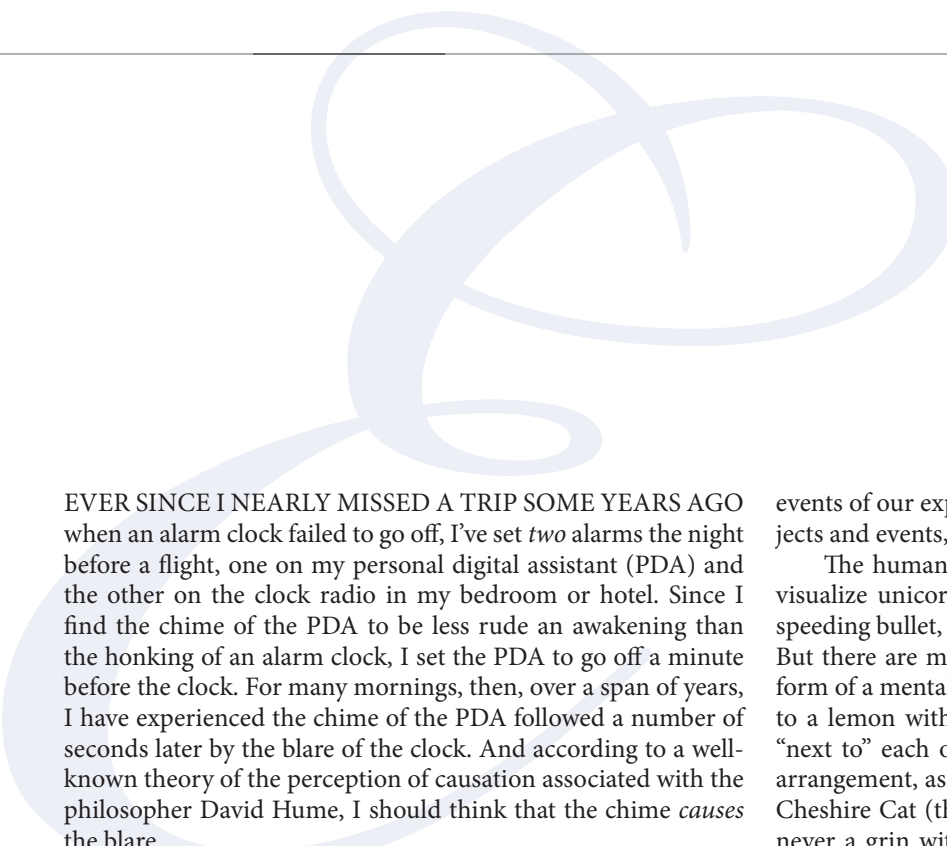


How the Mind Negotiates Reality

Academy member Steven Pinker explores the way our brains grapple with space, time, and causality



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EVER SINCE I NEARLY MISSED A TRIP SOME YEARS AGO when an alarm clock failed to go off, I've set *two* alarms the night before a flight, one on my personal digital assistant (PDA) and the other on the clock radio in my bedroom or hotel. Since I find the chime of the PDA to be less rude an awakening than the honking of an alarm clock, I set the PDA to go off a minute before the clock. For many mornings, then, over a span of years, I have experienced the chime of the PDA followed a number of seconds later by the blare of the clock. And according to a well-known theory of the perception of causation associated with the philosopher David Hume, I should think that the chime *causes* the blare.

Of course I think nothing of the sort. The cause of the clock's noise-making, I firmly believe, was my fiddling with the buttons before I went to sleep. I think this despite the fact that the interval between cause and effect can vary between eight hours and three, despite the fact that the alarm doesn't always go off (since there are so many things that can go wrong in setting a digital alarm clock), and despite the fact that I have only the vaguest idea of how a digital clock works (I think it has something to do with charges in silicon chips).

Yet despite the tenuous connection between twiddled buttons and blaring alarms (and the more immediate connection between the PDA's chime and the clock's alarm), my conviction of the true cause remains unwavering. That's why, when the alarm clock fails to go off, I don't shake my PDA or hold it up to the light but instead think back to my interaction with the clock the night before. Maybe I'm not smart enough to set a digital alarm clock (I failed to notice the p.m. light, or confused the A and B alarms, or set the alarm to music but left the radio dial between stations). Maybe the designers of the clock are not smart enough to make an appliance that a typical person can set. Maybe a part of the clock—a wire or chip inside it—is burned out. Maybe the clock's workings were addled by cosmic rays, or gremlins, or the moon rising in Sagittarius. But somehow, I feel sure, the happenings in the clock have *some* intelligible cause, which is to be found not in whatever happens to precede them but in some force or mechanism with causal powers.

People assume that the world has a causal texture—that its events can be explained by the world's very nature, rather than being just one damn thing after another. They also assume that things are laid out in space and time. "Time is nature's way to keep everything from happening at once," according to a graffito, and "Space is nature's way to keep everything from happening to *me*." But in people's minds, time and space are much more than that. They seem to have an existence even when there are no events to keep apart; they are *media* in which the objects and

events of our experience must be situated—and not just real objects and events, but imagined ones too.

The human imagination is a wondrous concocter. We can visualize unicorns and centaurs, people who are faster than a speeding bullet, and a brotherhood of man sharing all the world. But there are many things we *can't* imagine, at least not in the form of a mental image. It's impossible to visualize an apple next to a lemon with neither one to the right, just noncommittally "next to" each other (though of course we can *talk about* that arrangement, as I just did). And as with Alice's comment on the Cheshire Cat (that she had often seen a cat without a grin, but never a grin without a cat), we can't imagine an object that is symmetrical or triangular but that does not otherwise have a particular shape (in the case of a triangle, equilateral or isosceles or scalene). We know that elephants are big and gray, take up space, and are at a particular location at any given time. But while I can imagine an elephant that isn't big and isn't gray, I cannot imagine an elephant that doesn't take up space or isn't located somewhere (even if I have it floating around in my mind's eye, it is *somewhere* at every moment). In the old joke, a tourist seeking directions is told by a local, "You can't get there from here." We laugh because we know that it's in the nature of space that all its locations are connected. And as the cognitive psychologist Roger Shepard has noted, people often wish that they had an office with additional space, so they would have more places to put their books. But they never wish they had an office with additional *dimensions*, so they would have more ways to *arrange* their books. Continuous three-dimensional space is an ever-present matrix in which the objects of our imagination must be located.

Our mind's eye is also sentenced to live in a world of time. Just as we can imagine an empty space devoid of objects but cannot imagine a set of objects that aren't located in space, we can imagine a stretch of time in which nothing happens but cannot imagine an event that doesn't unfold in time or take place at a given time. We can imagine time slowing down, speeding up, going backwards, or stopping altogether, but we can't imagine time having two or three dimensions. In fact, it's not even clear that we do imagine time slowing down or stopping so much as we *simulate* those possibilities by imagining things moving at half throttle, or halting in freeze-frame, while time marches on as usual.

You might wonder whether these features of our experience come from the design of the mind or from the nature of the perceptible universe. After all, the world exists in three dimensions, unfolds in time, and obeys causal laws (at least on the scales detectable by our sense organs), and perhaps the mind simply reflects its observable surroundings. But there is a crucial difference between space, time, and causality as they are represented



Space, time, causality.
We can't think without
them, yet we can't make
sense of them.

Though we can never
directly know the world,
it's not as if one could
know the world without
some kind of mind, and
the minds we are stuck
with harmonize with the
world well enough for
science to be possible.



in our minds and as they exist in reality. Our intuitions of these entities are riddled with paradoxes and inconsistencies. But *reality* can't be riddled with paradoxes and inconsistencies; reality just *is*.

Take space. It has to be either finite or infinite, yet neither possibility sits well with our intuitions. When I try to imagine a finite universe, I get Marcel Marceau miming an invisible wall with his hands. Or, after reading about manifolds in books on physics, I see ants creeping over a sphere, or people trapped in a huge inner tube unaware of the expanse around them. But in all these cases the volume is stubbornly suspended in a larger space, which shouldn't be there at all, but which my mind's eye can't help but peek at.

An infinite universe might seem more congenial, since the mind's eye can fly through space indefinitely, with new expanses always materializing in the nick of time. But an infinite space, too, has disturbing implications. Would an infinite amount of space have an infinite amount of matter in it? It's not just possible but likely: physicists have recently discovered that at large scales matter is distributed evenly throughout observable space. That raises the possibility that an infinite space would be studded with an infinite number of universes. Since a given set of elementary particles can be in only a finite number of states and positions, there are only a finite number of possible arrangements of matter in a given volume. Combined with an even distribution of matter through space, this would imply that there are only so many possible universes, which would in turn mean that universes would repeat themselves in an infinite multiverse. If so, then about 10 to the 10^{28} meters away there is an exact replica of you reading an exact replica of this book, and somewhere else a replica of you that decided to put it down, and in still another universe one that is named Murray, and in yet another a replica with a hair sticking out—indeed, an infinite number of doppelgängers in their doppelgänger universes. This seems too much to stomach, yet it is an implication of the apparently innocuous intuition that space and matter go on forever.

Time, too, doesn't want to be either finite or infinite. It's hard to conceive of time coming into existence with the Big Bang, since we are apt to cheat and imagine a primeval empty space in which a

little cosmic time bomb sits waiting to explode. Nor can we fathom an empty time stretching indefinitely in the past before it. At best we can rewind a blank and silent videotape, let the tape play for a moment, then rewind it some more, and so on, never really encompassing an infinity of pastness. Nor can we make sense of what time would mean in the absence of matter and energy. Nothing in that nothingness could distinguish one moment from the next, so we would have no way of understanding why the Big Bang went off at the moment it did go off, as opposed to a few trillion years earlier or later or never. Not to mention the disturbing possibility that if time goes on forever, a rerun of every possible event that has happened will happen again an infinite number of times, a cosmic version of *Groundhog Day*.

As with space and time, the causal grid that we imagine connecting all events cannot stand up to too much scrutiny. I set the alarm, causing it to go off later. But who set *me*, causing me to set the alarm? On the one hand, I can consider myself a heap of clockwork, the neurons in my brain impinging on one another like tiny gears and springs. Yet when I make an uncoerced decision it certainly *feels* like I'm choosing whichever option I want, rather than being the helpless housing of a chain of machinery. Nor can a bystander predict any but the most banal of my choices. On the other hand, I can make no sense of a free will that mysteriously ups and does things without a prior trigger or spark. How does it work? If it's truly random, how can it make choices that are sensible in context? And how can we hold it responsible for its choices if they occurred by chance? But if its choices do respond to the context, including our contingencies of moral credit and blame, in what sense is it truly free?

Space, time, causality. We can't think without them, yet we can't make sense of them. These ruminations on the infrastructure of our experience are not, of course, original; I have taken them (with some twists and embellishments) from the German philosopher Immanuel Kant (1724–1804). Kant said he was awakened from his “dogmatic slumber” by reading Hume, particularly his skeptical probing of causality. Hume wrote that we have no justification for our belief that one event must follow another in the world. All we

