Time and (Un)conscious Processes

Predictive Anticipatory Activity and Potential Applications

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Abstract. Predictive Anticipatory Activity (PAA) is the physiological and behavioral activity in an organism related to gathering accurate information about future events not through the usual senses, inference, or directly causing the events themselves to occur. It has been demonstrated and replicated in multiple independent and controlled laboratory experiments examining human behavior and physiology and in two animal experimental systems. Aside from the versions of PAA explicitly developed through conscious training, spontaneous PAA may represent an unconscious attempt to prepare organisms for future events. The mechanisms underlying PAA are unknown, and it is not clear that physical laws actually forbid it. It is thus possible that information about physical events is time symmetric in nature, and that conscious experience generally only presents us with a unidirectional flow that we call the "arrow of time." Based on these ideas, in this position paper the argument is made that PAA can be thought of as a glimpse into physical reality, not as it is presented to us via the mechanisms that create our conscious experiences, but as it is "beyond the veil" of the conscious mind. Potential research and practical applications for PAA, especially with regard to consciousness in AI systems, are briefly discussed.

Keywords: intuition, PAA, temporal perception, temporal illusions, unconscious processing, temporal experience, Turing test for consciousness

1 PAA arises from unconscious processing

Predictive Anticipatory Activity (PAA) reflects the ability to access information about future events that cannot be gained through the usual means. For instance, if it occurs to you that it might rain right after you subliminally heard distant thunder, then you discover that it is raining, this is not PAA. However, if you are in a laboratory experiment in which future stimuli are determined by a random number generator only after you perform a task, and your performance on that task is consistently correlated at a rate above chance with the future stimuli determined by the random number generator, you are likely to have demonstrated PAA as long as the methods are sound. Evidence for PAA from software-controlled laboratory and online experiments indicate that PAA can be demonstrated in groups of normal humans as well as zebra finches and planarian worms (for recent reviews and commentaries, see [1-4]). This brief paper begins with

the assumption that PAA is a real phenomenon having a small effect size in the general human population. Given this assumption, what can we learn from PAA about consciousness, unconscious processes, and time?

All human behavior and physiology arise from unconscious processing, so it takes no leap of logic to suggest that PAA arises from unconscious processing as well. However, there are three ways in which PAA arising from unconscious processing is particularly and uniquely important to a discussion of time and consciousness. First, perhaps one of the reasons that PAA has been so controversial despite empirical evidence for it is that most people are not consciously aware of their own PAA in action. Second, consciousness seems to present to us a narrative about external events based on a linear temporal track that is coherent and adaptive, but also can be shown to be wildly inaccurate [5-6]. Third, most of the replicable evidence for PAA in the general human population is based on studies examining unconscious PAA–the participants in these studies were not asked to predict a future event, but their behavior and/or physiology could be correlated with future unpredictable events determined by a random number generator [7-8]. These three ideas suggest that information about what we consciously deem "future" events could be available to unconscious processes, but only rarely revealed to conscious ones. If so, the adaptive purpose of unconscious access to information about future events might be to prepare the organism, without concerning conscious awareness, for potential risks and rewards on its temporal "event horizon" for conscious experience. For example, if unconscious processes learned that a tiger attack is likely in the near future on a human's experiential timeline, these processes could increase adrenalin flow without concerning conscious awareness in case the event does not occur. More discussion on the relationship between unconscious and conscious processes can be found in section 3.

2 The physical substrate of time is unclear

When discussing PAA, it is common and reasonable for people to bring up concerns that this counterintuitive phenomenon might violate certain physical laws. For example, the statistical version of the second law of thermodynamics states that in a closed system, entropy is highly unlikely to decrease [9] – this has been interpreted as a statistical "arrow of time" to explain why events seem to flow in a particular direction. Unfortunately, this explanation ends up being circular, given that conscious experience of the order of events in a thermodynamics experiment is what the law was based on in the first place. More importantly perhaps is the fact that no known organism is a closed system, so this particular law is therefore moot when it comes to biological and psychological processes within organisms. Other classical physical explanations fall equally flat [for review, 10]. The fact remains that classical physics equations are time symmetric. Meanwhile, quantum mechanical effects that seem to precede their causes have been shown in convincing reports, although it is not clear whether retrocausality or simply time symmetry is the appropriate explanation for these effects [for two differing reviews, 11-12]. Previously it had been argued that quantum mechanical effects are too unstable to be realized in biological systems, but recent observations of stable

quantum coherent states in molecules within plants and birds indicates that biology has indeed found a way to exploit quantum coherence for its own ends [reviews, 13-14].

Upon reflection it appears likely that, as researchers and humans, our cognitive bias in favor of assuming that our conscious experiences of events reflect physical reality may have contributed to a misunderstanding about the nature of time in the physical world. For whatever reason, many researchers have overlooked the possibility that information about yet-to-be-experienced physical events is possible to obtain in the present. When it comes to the physical world, there are no "yet to be experienced" or "experienced" events – there are just events [15]. Subjective experience is by its very nature a phenomenon created by consciousness – and is a term redundant with subjective consciousness [16]. While undoubtedly the physical world and our conscious, subjective experience of that world are related – there is no clear law that requires their equivalence, and there are good arguments against this equivalence [e.g., 5]. In a conscious state, we can obtain hints about the laws of the physical world, and physical time in particular, through experiments that allow us to look beyond our classical experience at what might be called the "unconscious processes" of physics – quantum mechanics. Results from quantum mechanics are unapologetic – they imply our conscious, everyday experience of events is a narrative that does not reflect physical reality [10].

3 Unconscious processes may be intermediaries

If we assume that physical reality has no temporal flow at all and that temporal flow is constructed and conferred by subjective consciousness, what does this tell us about the role of unconscious processes and how they relate to conscious ones? It seems possible in this context that unconscious processes act as liaisons between physical processes (containing only events but no flow) and conscious experience (containing events and a unidirectional flow). If this were the case, the unconscious mind would have the job of helping piece together a coherent story, which we call conscious experience, to provide some way that the organism can experience a subset of the information available to it. Only a subset is available to consciousness, as it has fewer processing resources; conscious experience is serial and linear, while unconscious processing is parallel and nonlinear [for review, 17-18]. It is possible that providing to a set of parallel processes (e.g., unconscious processes) full access to possibilities in what we consciously deem to be the future may be a better design than providing that information to a set of serial processes (e.g., consciousness) with a relatively limited ability to use that information. Regardless of whether subjective conscious experience is an evolutionary by-product or necessary for adaptations that support survival, it seems evolutionarily advantageous to avoid weighing down a less agile set of processes, at least in a split-process system such as we have in humans.

Along this line of reasoning, PAA could be thought of as a glimpse into physical reality. Unconscious PAA, which is the most frequently demonstrated variety, would be just another tool the unconscious uses to help prepare the organism for what it will experience in its "future." In this way, unconscious PAA would exist in the borderland of time. It could be considered partly non-temporal, as it consists of information from

the physical world without concern for the conscious flow of events. It could also be considered partly temporal, as when PAA is operating, the unconscious passes information in what seems to be a timely and predictive fashion to the body and, at times, consciousness. Meanwhile, conscious PAA-related effects, which have been established using free-response methods [19], could be considered a rare but powerful glimpse into the full access to information that is provided to the unconscious mind.

4 Potential applications of PAA

If PAA is really a window into the relationship between conscious processing, unconscious processing, and physical reality, its potential as a tool for consciousness research and for everyday applications is under-realized. For example, in terms of experimental consciousness research, unconscious PAA could potentially be used to tap into physical events that are probabilistic. If, in a group of people with excellent PAA, their accuracy scores reflect the probability of the upcoming physical events (as controlled by quantum random number generators), this result could help constrain models of physical reality and its relationship to unconscious processing. Another example that could revolutionize consciousness research is to determine whether PAA could work in reverse order – instead of receiving information about "future" events, instead, offering information to the "past" about events in the present and potentially changing the conscious experience of the past event. Both types of experiments would serve to further explicate the relationship between the physical world, unconscious processes, and subjective experience.

In terms of applications, boosting PAA signal strength would be necessary for reliable applications of any type. It is possible that if PAA faculties only access information about future events based on probabilistic information, only high-probability events could be foreseen. Even if this were the case, PAA-based applications, probably crowdsourced from groups of people with excellent PAA abilities, could still be used to prepare for and potentially avoid high-likelihood adverse events and facilitate positive ones. Based on data from skilled participants, it appears that PAA-based applications are already in use in the financial sector [20-21], but it is not clear whether applications are fully developed in the defense and intelligence communities.

For those interested in testing for human-like consciousness in artificially intelligent (AI) systems, testing for PAA in these systems could be an interesting approach. The logic of this admittedly unusual "PAA as a test for human-like consciousness" idea is briefly outlined here, based on three assumptions. The first assumption is that physical processes, including unconscious ones, are bidirectional in time. The second assumption is that consciousness is generally unidirectional in its presentation of experience – by definition, more than one thing would be happening in conscious experience if simultaneous events in both temporal directions occurred in consciousness. The third assumption is that consciousness doesn't exist without unconscious components that set up consciousness in the system.

On the assumption that physical events are bidirectional in time, information about what we call "future" events is necessary for the functioning of unconscious processes,

which must function in both temporal directions so they can somehow work within the constraints of physical systems in order to set up consciousness. Meanwhile, as consciousness seems to require a unidirectional order of events, producing a dominant unidirectional flow of consciousness would be a chief directive of the unconscious. Thus evidence of human-like PAA behavior in an AI system suggests both human-like unconsciousness, in that it has access to future events, and human-like consciousness, in that the system would either not notice the behavior or would spontaneously comment on its inconsistency with the usual linear, forward temporal flow of experience. That is, PAA behavior would only seem remarkable to a conscious mind that has subjective experience. Under the three original assumptions, an AI system not showing PAA behavior, or showing it but not thinking of it as odd or unusual, likely does not have enough unconscious intelligence to produce consciousness.

Regardless of the validity of these speculations, it is worth noting that a public normalization of PAA skills and the eventual creation of a consortium of high-profile individuals with excellent conscious PAA abilities may be important steps toward the mainstream adoption of PAA-based technology and the eventual understanding of time and consciousness in humans and AI systems. It is likely that only with multiple such research and application efforts will the phenomenon of PAA be well understood and its meaning fully explored in all relevant fields.

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