COGNITIVE NEUROSCIENCE, TEMPORAL ORDERING, AND THE HUMAN SPIRIT

by John A. Teske

Abstract. Understanding purpose and intent requires attention to our experience of time. Cognitive neuroscientific research into the functional and neural substrates of higher cognitive functions have direct bearing on the experience of temporal ordering. Consciousness, located within the short span of working memory, is made cognitively possible and evolutionarily valuable by biological constraints in time. These constraints, including our longevity, make thought about more extended events both possible and useful. Such cognitive processes, rooted in the neurophysiology of cortical function, are a *sine qua non* for the construction of meaning, relationship, morality, and purposes that may extend beyond our mortality. Research in the cognitive neurosciences is overviewed, and implications are discussed for questions of mortality, design and intention, the reconstruction of meaning, and the experience of eternity.

Keywords: consciousness; design; frontal cortex; meaning; memory; mortality; purpose; somatic marking; spirituality; temporality.

The human experience of time is central to our understanding of purpose and intent, and therefore to understanding design or purpose in the universe more generally, whether or not it is attributed to divinity. The cognitive sciences and neurosciences have developed rapidly over the past generation, especially in understanding the functional and neural substrates of higher cognitive functions such as human memory, planning, and anticipating (Beatty 1995; Gazzaniga, Ivry, and Mangum 1998; Kolb and

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Whishaw 1990). How might these developments bear on our understanding of the temporal ordering of subjective experience, and might they have implications for our understanding of the ideas of purpose and intent so crucial to questions of divine design?

The central argument is this. First, our experience, located within the short span of immediate, conscious, working memory, is made cognitively possible and evolutionarily valuable by the developmental constraints and temporal limits of behavior at the level of biologically relevant, organismically scaled events. Second, the limitations, constraints, and finitude of these temporal boundaries, nested within our limited longevity, are precisely what make it possible for thought about or reconstructed experience of wider and more extended events in our lives. Third, such cognitive processes, rooted in the neurophysiology of remembering and anticipating, are a *sine qua non* for the construction of meaning, personal relationship, moral action, community, and longer-term purposes and intents that may extend beyond our mortality. Given the theological relevance of temporal issues, we will look at research in cognitive neuroscience on the temporal ordering of experience, including its mediation via cortical and subcortical functions and structures, and some of its variations, both within the range of normal functioning and as produced by brain damage and dysfunction. Finally, I will suggest how these findings might bear on religious experience and on beliefs about divine design and intention, about the meaning of human action, including morality, and about theological issues of temporality, eschatology, and eternity.

Time and Consciousness

The Kantian claim that time is an a priori category of experience (Kant 1929) suggests a serious epistemic limit upon our ability to reflect about time, and the backdrop for the present exploration includes Wittgenstein's ([1922] 1961) assertion that our experience of eternity can only be one of a timeless present rather than one of infinite duration. Our understanding of any reality that transcends time can be manifest only within temporally conditioned experience. That we are spatially and temporally discrete organisms may be a requirement for evolution by natural selection, new life being made possible by the death of the old, and our boundaries not so much a constraint but essential to any experience or achievement (Humphrey 1996; Russell 1984). Similarly, human mental processes are time-dependent: planning, hoping, remembering, anticipating. All our goals and desires depend on needs, the satisfaction of which unfolds in time. Moreover, while the scale of our experience is always within the few seconds of the psychic present (Baddeley 1986; 1995), it may refer to that which is not present, the resources of our past thereby helping to shape our anticipations of the future. Indeed, our very sense of continuity and iden-

tity would be meaningless in the absence of memory, tied to the unfolding of our lives in time and their directedness to the future (Davies 1993; Sacks 1985). Planning ahead for regular events is evolutionarily adaptive, although a changeable organism and a changeable environment entail additional advantages for complexity, temporal hierarchy, and flexibility. Because of the temporal boundedness of our experience and our lives, of competing plans and intentions, our timing and our speed of processing do matter (Flanagan 1992). Our very consciousness may be an evolutionary adaptation limiting our processing only to what is worth worrying about, to the options worth considering. This is a system in which judgment and prioritization are necessary for ordering our actions, scheduling our lives, focusing our attention, and organizing our projects. Such a system can only be built upon mechanisms that have already reduced the options to those most significant to our ongoing organismic biases (Damasio 1994). Our consciousness may exist by virtue of such prioritization, necessitated by our very finitude, without which it would serve no function.

While our experience normally occurs within the objective one- to five-second time span of the psychic present, experience is of or about (has as its content) meaningful psychological events that may span lengthier time periods (Dennett 1978; Edelman 1992; Flanagan 1984), from the hours of ongoing events to the longer projects and purposes of human lives, personal relationships, communities, and even civilization. Here we use temporal ordering to organize and construct our very consciousness, and this ordering may well be influenced or even generated by the cultural and linguistic constructs by which we coordinate activity socially, down to the timing of conversational and momentary interactions. Our very comprehension of events, both simultaneous to their occurrence and in memory or anticipation, involves placing them within a temporally ordered scheme, particular forms of which include ritual, drama, and narrative.

Phenomenologically, we may experience consciousness as a stream, in which the past is carried seamlessly into the present (James [1892] 1961). Nevertheless, attention to the material substrates of memory suggests that the seriality of the stream may be a kind of "virtual reality" produced by a number of interactive neural processes, which need not themselves have this same serial temporal ordering (Dennett 1991).

As adaptive functions, how are our capacities to order events, to prioritize our memories, and to hierarchically organize our actions materially accomplished? It appears that there are brain structures, largely distinctive of human beings, specifically in the prefrontal cortex but including connections to other cortical and subcortical structures, without which such capacities are disordered or nonexistent (Damasio 1989; 1994; Gazzaniga, Ivry, and Mangum 1998).

Varieties of Memory

Our memory systems are likely to operate at a number of different levels and include interactions between different modules in the brain. Some memories may have no direct impact on subjective experience. Nondeclarative memories, like sensitization, habituation, perceptual learning, and classical conditioning, can be studied in lower animals. Sensitization and habituation, found even in sea slugs, involve variations in presynaptic facilitation. Cerebellar mediation of classical conditioning has been found in rabbits. Visual memory has been mapped in monkeys, involving pathways from the occipital cortex, along the inferior surface of the temporal lobe, with projections to the hippocampus and amygdala, and thence to thalamic nuclei (Beatty 1995; Gazzaniga, Ivry, and Mangum 1998).

Human beings also have declarative memories, which can be brought to mind and articulated. These are the things we know and know that we know, the semantic memory for facts and knowledge or the episodic memory of personally experienced events (Tulving 1995). Such memories are made possible by a temporal lobe memory system, rooted in the hippocampus, damage to which produces a severe anterograde amnesia, an inability to store new long-term memories elsewhere in the brain, despite leaving intelligence, working memory, already-established long-term memory, and nondeclarative skill learning intact (Cohen and Eichenbaum 1993; Squire 1987; 1992). Patients suffering from such damage, such as Milner's H.M. or Sacks' Jimmie G, live in a ceaseless present, unable to accumulate new memories through time (cf. Sacks 1985). Infantile amnesia may be produced, in part, by the slow maturation of the hippocampus. The mechanism appears to be a long-term potentiation in the hippocampus, an excitatory synaptic response that may last for weeks (Kandel 1991). Damage to the amygdala and hippocampus prevents learning a delayed nonmatching to sample task (where an animal must displace the novel, unfamiliar object to get a reward) but not a simple discrimination task (simply picking the member of a familiar pair that has consistently been paired with reward) (Mishkin 1978; Mishkin and Appenzeller 1987; Zola-Morgan et al. 1993).

Episodic memory, the declarative memory for personally experienced events, includes "source memory," which is the memory for where and when we learned something. This involves fitting the knowledge of temporal ties to specific contexts, including details of the episode itself, such as its place and time. This memory appears to depend on the integrity of the frontal cortex such that even normal variations in frontal lobe function can produce variations in performance on a source memory task without influencing item recall (Janowsky, Shimamura, and Squire 1989; Glisky, Polster, and Routhuieaux 1995). An entertaining example is of a student who volunteered a research report that he'd "heard of somewhere," as the

rest of the class tittered in recognition that the study had been presented in the previous class.

Specific semantic memory deficits (deficits in knowledge, or *agnosias)* can be produced by damage to a number of particular areas of the posterior cortex, resulting in amnesias for color, faces, object names, or object locations. Specific damage can also produce a wide range of inabilities to recognize perceived objects, including agnosias for sounds, limb placement, or objects at various scales (Kolb and Whishaw 1990).

Working memory, our ability to access and activate the stored memories relevant to an ongoing task, depends on the dorsolateral prefrontal cortex. This is dissociable from the hippocampally mediated long-term memory, which one can develop without working memory (Gazzaniga, Ivry, and Mangum 1998). Working memory is what makes delayed responses possible, where one needs to keep track of recent responses or events, and there are cells in the lateral prefrontal area that respond only during the cue-response delay interval (Goldman-Rakic 1992). Working memory, harmed by damage to the lateral prefrontal areas, makes possible performance on Piagetian object-permanence tasks, delayed alteration tasks, dimension shifting in a sorting task, discriminating which of two objects was presented more recently, and picking a familiar but unselected object out of a pair (one needs to keep track of the previous selection) (Diamond 1991; Milner 1995; Shimamura 1995; Knight and Grabowecky 1995). The mechanism seems to involve a kind of inhibition of connections to task-irrelevant information, producing an ability to ignore distractions. Such capacities are likely to be important to particularly human abilities, like selecting the smaller of two piles of candy, when the selected pile is given to someone else, and it is the unselected, larger pile that is retained. This is a strategy that any child over two years learns quickly but is extremely difficult to learn for chimpanzees, who cannot inhibit the powerful salience of the stronger reward, unless it is mediated via external tokens (Boysen and Berntson 1995; Boysen et al. 1996).

There also is evidence for a role of prefrontal cortex structures (particularly in ventromedial areas) in the broader ordering of events in our lives as a whole, which appear to involve ties to subcortical areas mediating emotion and may underlay important interdependencies between reason and emotion (Damasio 1994; Gazzaniga, Ivry, and Mangum 1998). Human-level emotional response involves a wide range of neocortical response as well, for example, the matching of emotional tone to language that is mediated by a portion of the posterior right hemisphere. Given the evolutionary value of memory for emotionally compelling events, it should come as no surprise that the hippocampus, a limbic structure nestled bilaterally beneath the temporal cortex, should play an essential role in declarative memory.

It is the link between the ventromedial prefrontal cortex and the limbic system (especially the amygdala) that suggests an important tie between emotion and reason. It is largely the evolutionary hypertrophy of the prefrontal cortex that provides the characteristic flexibility of human thought, especially in planning and coordinating complex behavior (Deacon 1997; Teske 1997). Patients with damage here tend to be dominated by perceptual information, lacking the inhibitions necessary to accomplish their own plans or to respond to social constraints (Lhermitte 1983; Lhermitte, Pillon, and Serdaru 1986). With lateral prefrontal cortex intact, patients (like Phineas Gage or Damasio's Elliot) with ventromedial damage can still exhibit high intelligence and normal working memory. But in the real world of complex behavior, such patients lack the link between the prefrontal cortex and the limbic system, which can narrow options automatically via the "somatic marking" of their potential affective consequences (Damasio 1989; 1994). These capacities are likely to constitute "attention" as a critical level of activation of perceptuomotor interactions, the attempted reconstruction of which thinking and memory may be predicated upon. Patients with ventromedial prefrontal damage lose the ability to keep to a schedule, organize higher-order hierarchies of action, or even feel a sense of personal involvement. Such patients do not exhibit a normal GSR (galvanic skin response) to emotional stimuli, nor is their risk-taking tempered by emotional response to the possibility of severe penalties. Lacking the affective ties for evaluating consequences, they have lost the ability to prioritize so necessary for complex reasoning, especially important for tasks with temporal constraints. Such deficits may constitute radical alterations of personality and character, producing, for example, the remark of Phineas Gage's peer: "Gage is not Gage."

Temporal Ordering

The upshot of this research may be, as philosophers of mind like Daniel Dennett (1991) and Owen Flanagan (1992) indicate, that the temporal orderings of events as we experience them are produced by neural interpretation and do not directly reflect the order of those events. A number of phenomena provide evidence for this suggestion, including apparent motion with color changes, the "bunny hop" tactual illusion, "backwards referral" in time, and experiential delays of consciousness of intent (Dennett and Kinsbourne 1992). The apparently serial stream of consciousness may be a kind of virtual temporality installed in our massively parallel neural system by socialization (in part why this temporal ordering may vary cross-culturally). The substrate of our stream of consciousness is likely to be a set of "parallel streams of conflicting and continually revised events," producing what Dennett (1991) calls a "multiple drafts" model of consciousness. The narratives with which we constitute our sense of ourselves through

time are therefore likely to be a constantly revised set of "drafts," which we organize from fragmentary information provided by simpler neural systems. We experience ourselves as only doing one thing at a time, in a serially ordered temporal fashion. However, our capacity to organize memory and anticipation into a hierarchy of actions that extend backward and forward in time at a number of different levels of organization is what is behind our ability to organize fuller, more coherent, and more meaningful lives.

Cognitive psychologists have recognized the reconstructive character of declarative memory for more than a generation, including its omissions, elaborations, and distortions, and its transformation over time via the recall of previous recollections and imaginings and the repetition of events across the cycles of our lives (e.g., Loftus 1979; Neisser 1981). Even our consciousness of ourselves is likely to be a kind of "remembered present" (Edelman 1989) as when, for example, our confusions upon awakening are clarified by reconstructing our memories of ourselves and our circumstances. Reconstructions of intent, important to our grasp of meaning, can certainly be fed back into, and have subsequent effects upon, ongoing actions and future plans. Nevertheless, it is clear that such reconstructions can also be accomplished during or even after a relevant action, as when our intentions become clear only in the process of accomplishing the action itself or, probably more often than we would like to admit, subsequent to it. This is most clearly the case in psychotherapeutic constructions of unconscious intents or the larger accomplishment of constructing an identity by "owning" events in our lives, by accounting for them in terms of directions or purposes, "as if" they were formulated ahead of time, although if pressed we may be capable of recognizing that this may be reconstructive (cf. Teske 2000). We are often unable to distinguish between what we thought (at the time) we were doing and what we think (now) that we must have been up to, though our capacity to revise such accounts at a much later time has been clear since Augustine's *Confessions.*

Meaning, Morality, and Theology

It may be important to recognize, however, that our understanding of larger patterns of meaning in the universe, even if understood to be external to and inclusive of us, are likely to involve the same sort of reconstructive, interpretive processes ("in the image of God"). We understand that concepts like "destiny" or "God's plan" may be ex post facto bits of anthropomorphizing. Recognizing that what one was doing was not one's destiny seems to require some construction that what one is doing now, *is*. Understanding something as God's plan seems to provide an even further preclusion, an inability to do what is *not* part of God's plan. But it may be that we have no choice, that the reconstruction of intent is the means by which

we grasp meaning at all, including those meanings that we experience as not of our own doing, not of our own authorship (whether the sources are our own unconscious cognitive processes or the grace of God—or both). The present claim is merely to assert that it may behoove us to recognize that such meanings may emerge from, or supervene upon (in the sense of Murphy 1998), the causal forces of the material substrates by which they are reconstructed. That is, the neural processes by which we constitute "what I meant" are the same ones behind the constitution of any meaning at all. Consciousness and selfhood may be better understood as emergents rather than determinants of experience (Teske 1996). Nevertheless, the structuring of our lives, its ordering in time, is also learned and internalized from those agents of socialization with whom we have close physical and emotional interdependencies, whose lives are themselves structured and ordered by the higher orders of cultural and institutional life to which we also learn to accommodate ourselves (Teske 2000). Our consciousness may depend on the emotional prioritizing of "somatically marked" memories, which is in turn structured by the culturally and socially available narratives that may themselves have contributed, by virtue of their use by our fellows, to that very marking (by whatever rearing practices, social rituals, or life-changing events produce such marking).

Our very sense of the meaning and, ultimately, the moral significance of events depends on neurally mediated emotional and narrative ordering, as well as upon the temporal constraints and the mortal finitude that make such neurophysiologically emergent cognitive processes adaptive. As Charles Taylor (1989) once indicated, the connections between events, their coherence and continuity, and finally, the integration or disintegration of one's life through time are constituted in narrative. Understanding who we are requires both a reconstruction of how we got here and an anticipation of where we are going. This locates us in a "moral space," but it is one that exists within constraints of time and requires a temporal ordering. Such ordering, as we have seen, is also heavily dependent on the neural structures and functions by which such orderings are constructed.

The cognitive neuroscience of temporal ordering can also be used to understand variations in temporal experience. Such variations include the normal dilation and constriction of subjective time, the reorderings of reconstructive memory, and common experiences of source errors, including backward referencing, and capacities for later memories for unattended experience. Variations can also include less common variations like *déjà vu* (already seen or seen before), *presque vu* (almost seen or as if anticipated) and the experiences of dreams and altered states of consciousness, as well as more common disordered experiences like alcoholic myopia. Finally, by examining the dysfunction and damage of the neural structures involved, we may also be able to understand the "permanent present" of anterograde amnesia and the derailed lives of frontal cortex patients. Such

discussions also may better show how our conscious, ordered experiences may produce a remembered present, a remembering of oneself within temporal orderings at different scales and with different relationships to each other.

What is the relationship of the cognitive neuroscience of temporal ordering to more general theological questions about design and order? Lawrence Fagg once remarked that the goal of religion is "to reconcile the time of living experience with the eternal rhythm of the universe" (1998, 4). While our present goal has been to contribute to this project by helping to better understand the "time of living experience," several implications have clear theological bearing. The first concerns our mortality. We wish not to be forgotten, that our lives will have meant something, yet it may be in remembering ourselves that our finite lives can have their only living meaning (Teske 1999). Despite our wish for some kind of continuity of personality, involving some sort of activity, it may be useful to reflect that "[God] alone has immortality" (1 Timothy 6:16). It may be our very mortality, the finitude of our time, that makes possible the existence of consciousness at all and the requirement for moral prioritizing. What commitments we have may be important precisely because of our temporal limitations, and those commitments may be vouchsafed only by how we order our lives in time and prioritize our activities, including the religious: the reminding and focusing effects of making time for expressing gratitude, of repeated rituals and markers that supervene on the reconstructive ordering of our remembered lives, and of the directive and goal-apprehending foci provided by prayer and meditation.

The second implication concerns the particular means by which religious beliefs and their theological supports may help construct more meaningful lives. Notions of destiny or of God's plan need not involve ontological claims about some preexistent plan of which we were previously unaware, or might have no hope of becoming aware, but an ex post facto way of seeing difficult or surprising events as meaningful, as a way of reconstructing a meaning and playing a role in directing us toward a particular and life-affirming form of reconstruction (Freeman 1993). "Considering God's plan," or asking God for direction, could well be construed as a way to orient ourselves to what is valued, via the accessing and prioritizing made possible by the ventromedial prefrontal ties to the limbic system, the "somatic marking" of physically and emotionally significant events.

Third, while we might be advised to be wary of anthropomorphizing tendencies for particular temporal orderings in attributions of divine design, purpose, or intent (and of anthropic claims about low probabilities that are accumulated over evolution, history, development, and memory), we can recognize that meaning making may well require such reconstructions, without forgetting that they are reconstructions. We may well unpack a deeper understanding of a personal God in seeing how purposes

may be necessarily emergent, reading greater openness and freedom in human consciousness and greater care in continuous creation.

Fourth, in the recognition, with cognitive neuroscience, of an important role for the temporal ordering and emotional marking that constitute drama and narrative, of temporal quality over temporal duration, we have a means for improving our understanding of the synchronies necessary for shared time and shared memory in interaction, long-term relation, fellowship, and community. We also have further reasons for examining the resource provided by religious traditions, of narratives, of dramatizations, of regular rituals, for cementing individual and broader social integrities. In understanding the neural substrates of temporal ordering and emotional marking of events, we may also learn to better understand the relationship between the *chronos* of graspable durations and finite lifetimes and the *kairos* of decisive moments. And finally, a better understanding of the role of human finitude in temporal ordering, in consciousness, and in meaning making alerts us to the possibility of an eternal life (and an eschatology) which is *both* a future, temporally ordered subjective anticipation and (with Bultmann 1958) a present, existential reality.

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