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The 13-Millisecond Bridge: Reconfiguring External Space within the Brain's Oscillatory Default Mode

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Abstract

We exist in a conscious experience of life that is transitive and moment-by-moment, yet significant enough non-zero-time latencies exist across the visual, auditory, and somatosensory systems that transduction and processing do not take place instantly. This paper attempts to examine these non-zero-time latencies to resolve the conflict, ultimately suggesting that instead of consciousness accessing an external world, it accesses a high-fidelity bioelectric representation of the external world generated during this pre-conscious time interval. This external representation is the byproduct of Default Space Theory (DST), which indicates that oscillatory movements of the brain and body form a continuous three-dimensional "default space" over time. The default space exists as we exist, separately. Our external inputs from the retina, cochlea, and dermis "clothing" the default internal configuration occur via phase-locked neural oscillations over time, which occur at significant non-zero latencies. For example, the earliest cortical stages for auditory and tactile processing occurs at ~10–20 ms, while the olfactory and visual features of stimuli occur at ~50–70 ms. This doesn't mean we're perceiving them in time; it's quite the opposite. We're not perceiving in time because the default space is so well-templated all at once that somehow, the brain must erase this time interval and use the integrated multisensory processing to update continuously. Thus, we need to redefine consciousness as this continuously updated internal projection of externalized realities instead of an experience of what's outside.

Keywords

Default Space Theory; Consciousness; Neural Oscillations; Perceptual Latency; Sensory Processing; Vision; Audition; Somatosensation; Binding Problem.

Introduction

The paradox of seamless perception

We subjectively experience the world in an immediate phenomenological "present." The moving object, the sound, the touch all occur at that moment in time and are thematically blended. But this phenomenological blending conflicts with neurophysiological realities: transmission of any sensory message takes time from the receptor organ at the periphery (retina, cochlea, etc.) to synaptic relaying in the brainstem and thalamus to the primary We subjectively experience the world in an immediate phenomenological "present." The moving object, the sound, the touch all occur at that moment in time and are thematically blended. But this phenomenological blending conflicts with neurophysiological realities: transmission of any sensory message takes time from the receptor organ at the periphery (retina, cochlea, etc.) to synaptic relaying in the brainstem and thalamus to the primary sensory cortex [1].

This suggests a paradox if the brain functions on information that is milliseconds behind real-time, why does perception not fragment a la an antiquated film reel? Why isn't the world always a continuous "present"? Theories of consciousness (Global Workspace Theory (GWT) and Integrated Information Theory) attempt to assess consciousness via correlates of information access but fail to hypothesize any mechanical engagement to accommodate such a temporal binding problem [2,3].

This paper posits that the solution stems from a greater illusion: the brain is not perceiving the world, it is creating the world in any moment via an ongoing bioelectric field [4]. Therefore, we argue that within Default Space Theory (DST), what we consider the "present" is assembled by the mind as a simulation within an expected field of bioelectric energy called "default space," or our conscious awareness as we understand it [4,5]. The perceived milliseconds of delay are merely milliseconds used by the brain to make sense of reality in an active time stream so that multisensory integrations may occur as a singular conscious awareness [5].

The Temporal Discrepancy

From initial input to conscious response

Years of electrophysiological research via event related potentials (ERPs) show that the brain processes information across modalities at different rates, and one could say that this collection of information across time provides a holistic perspective of where elements change from the earliest subcortical relays to later cortical involvement [1]. The following are some cross-modal latency distinctions:

Visual pathway

A visual stimulus starts with phototransduction in the retinal photoreceptive cells. It transmits via the optic nerve to the thalamus' lateral geniculate nucleus (LGN) to the primary visual cortex (V1) of the occipital lobe. The cortical response of V1 as determined by visual evoked potentials (VEPs) occurs approximately 50–70ms after stimulus onset [1]. Yet figure-ground separation and the emergence of a conscious percept that we can report, sometimes associated with a later ERP component N200, occurs on the order of 150–275ms and beyond [2], indicating a vast threshold from stimulus exposure to conscious experience and acknowledgment.

Auditory pathway

The auditory pathway is the fastest. Sound waves are converted into action potentials through cochlear hair cells; this information travels through the brain stem to the auditory cortex. But non-invasively determined ERPs suggest that cortical processing can occur relatively early—around 50ms with the P50 wave associated

with sensory gating, or determining what sounds are unimportant [6]. Intriguingly, some subcortical pathways even connect to cortical areas in under 10ms [1]. Later components like N100 which peaks around 100–200ms relates to higher-order cognition like detection of change and novelty generation [1].

Somatosensory pathway

The latency of the sense of touch activated by mechanoreceptors in the skin is also quite fast. Somatosensory evoked potentials (SSEPs) show that information from peripheral signals can reach the primary somatosensory cortex (S1) in as few as ~20ms (the N20 component of classic median nerve SSEP) [1]. This happens so quickly due to reflexive responses occurring in ~25–50ms with no cortical involvement; however, when it comes to cognitive awareness, what we perceive as painfulness of pain occurs on the order of latencies 250–500ms because this measured latency reflects additional processing necessary to figure out how it feels to be in pain rather than merely acknowledging a stimulus [7]. Ultimately, these kinds of latencies support the necessary problem: how can the brain create a cohesive sense of reality when stimuli arrive across modalities at such differing times when we might see a ball bounce and simultaneously hear it hit the ground? [5].

The Default Space

A bioelectric bridge

Default Space Theory (DST) provides a solution to this issue of temporal binding. Information consciously perceiving does not come from an, per se, active engagement with stimulus, but an involvement with an inherent, three-dimensional experience [5]. This "3D dynamic default space" is a literal, bioelectric experience brought about by the whole brain-whole body synergistic process [4,8]. Thus, rather than the brain passively responding to an external world, it actively generates an internalized one, a simulation, and this is what is consciously experienced—not the external world, per se.

This 3D experience operates in a sustained baseline or "dark space" [9], an experience which is maintained by non-conscious brain systems, such as the Default Mode Network (DMN). Ocular, auditory and tactile systems bring in information which serves to "clothe" the "default" experience, rendering its basic substance filled with perceptual qualia. The thalamus serves as the final common pathway through which sensory/interoceptive information is integrated and aligned prior to becoming aligned in conscious awareness [7,10]. Therefore, temporal binding need not occur spontaneously; this is how the process works. The fact that there is a delay from stimulus to experienced cognition allows for wholing from what otherwise would be disparate elements experienced across time. Instead, that delay is advantageous to create the perception of "now." Thus, without the existence of this theory, such delays become problematic. But in the service of this theory, they become meaningful and essential.

The Role of Neural Oscillations

Proposed mechanisms behind the emergence and reinvention of Default Space involve neural oscillations. Osicllations create the relative timing to synchronize disparate brain regions to put previously unconnected information together to form a whole [11]. Each frequency band contributes to the construction of a Default Space in unique ways:

- **Gamma Oscillations (>30 Hz):** According to [12], high-frequency gamma oscillations are necessary for local binding of features within a single sensory domain. For example, retino-geniculo-cortical oscillations between ~60–120 Hz help to synchronize the retina and visual cortex so that visual

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perception constitutes a stable, coherent unit within the brain, retroactively forming what should be processed as the visual version of the Default Space.

- **Beta Oscillations (13–30 Hz):** Beta oscillations are associated with top-down constraints [11], long-range communication across some brain networks, salience tagging [12]. When this process goes array, as in excessive oscillation in psychosis, for example, information is not successfully integrated across distant brain regions or fails to be assigned proper relevance. The Default Space is therefore disrupted due to a failure to correctly augment features.
- **Alpha Oscillations (8–13 Hz):** Alpha rhythms were historically considered markers of resting states for the cortex; however, they are now understood as relative idling mechanisms for attenuating perceptually distracting regions [13]. This suggests that alpha oscillations create a perceptual sampling rate, where within certain frequencies sensory features keep time, meaning that the relative 'rest' is more about making sensory features aware rather than allowing for distraction—not only can the brain's reliance upon alpha oscillations keep certain non-attentional regions silenced but it also sets up an ultimate timing resolution by which information accrues as accessible to consciousness.

Thus, rather than merely being states of rest, alpha oscillations contribute to how long an individual has access to non-sensory distracted dimensions while still being able to process what's actively around them. Thus, disparate oscillatory frequencies work together (particularly within thalamic circuits) to create the very semblance of reality within the Default Space through a degree of temporal illusion [5,14]. Fast features integrate quickly—gamma binds local features on short timescales—while beta and alpha ensure that longer distances can also be integrated over time. Ultimately, the thalamus possesses reciprocal connections with extended cortical areas, granting it access to information integration and timing. Thus, the thalamus offers oscillatory frequency overlap attempts to make sure that incoming information keeps accuracy in time with the constructed internal model.

To illustrate how different modalities are integrated within this oscillatory framework, consider the following summary:

Conclusion

The master illusion

Conscious perception may feel that it is seamless but that is not the case. We are not seeing what's out there but being led to believe we are seeing it. Yet the brain does not see, for the brain is an amazing simulating device that creates a holographically projected and anticipated universe superimposed atop the bio-electric field of Default Space. The solution lies within the lags of perception those momentary delays in comprehension that give rise to the idea of seamless perception. Millisecond lags in perception allow the brain to compile disparate incommensurate streams of information produced by the eyes, ears and skin. In other words, when neural processing does not occur at the speed of light, it would appear there is a problem, but the contrary is true. The brain utilizes the relative timing of these neural oscillations that connect such discrepancies to dissipate these lags, modalities, facets and time. What we call "now" is merely an updated version of our bio-electrical rendering of the outside based on information a few milliseconds ago rendered as so real and in deep enough color to appear completely present. Therefore, when we shift the mindset of consciousness from merely being aware to aware being built we come to understand what the brain is doing

all along, for the brain cannot passively see reality, it must build it. It puts consciousness into perspective, as it makes us realize we are merely 13 milliseconds (and more) away from reality.

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