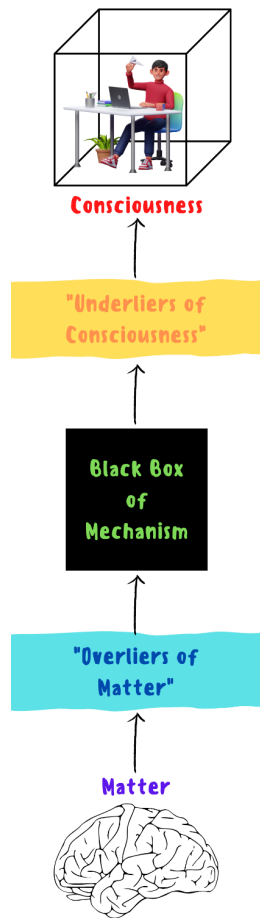


# Perceptual geometry as underlier of consciousness

Brad Caldwell

If we try to understand how the brain makes consciousness, instead of coming from the bottom up, we can actually work from perception downwards.



In other words, describe perception itself and explore what *underlying* things must be done to give rise to perception, before even considering what the neural mechanism might be (see left image, made courtesy of canva.com with stock imagery).

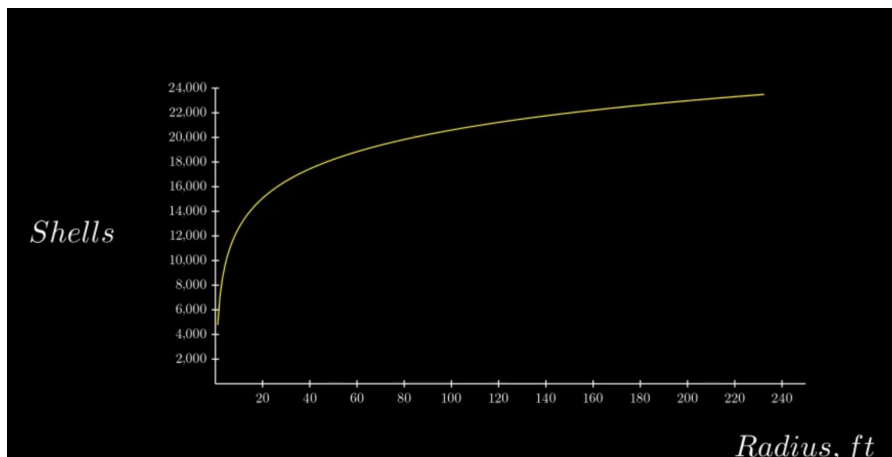
These "underliers" can be uncovered with the tools of both **(1) philosophy** and **(2) artificial neurotransmitters** that slow, distort, or "cyclify" perception, or that help segregate component aspects of perception.

**(1) Philosophically**, we can say that it seems probable that all conscious experience can be boiled down to 3D/2D/1D geometries and their changes over time. If so, the columns/mini-columns of the cortex and the zones/microzones of the cerebellum probably have, as their primary function, the placement of stimuli in, and the extraction of motor commands from, *perceptual space*.

Consciousness then would be a story, or dashboard, that the brain uses for command and control of the body. The viewer and the view, the intake and the output, can all be included and updated in this 3D geometrical story of meaning.

This perceptual space is hypothesized to stay *stationary* your whole life, with the brain showing moving or flowing perception "paint." If you take a hike, it's as if you're walking on a treadmill. This way, you don't need to represent all the infinity of points in the universe, but rather only a single perceptual space, with depth (radius) resolution the same as the x and y

visual field at any given focal depth (technically, resolution the same as the theta and phi visual field at any given focal radius). Thus, the increments of depth (radius) resolution within perceptual space should be given to the left (each step is a single "sphere shell"). Y axis shows the

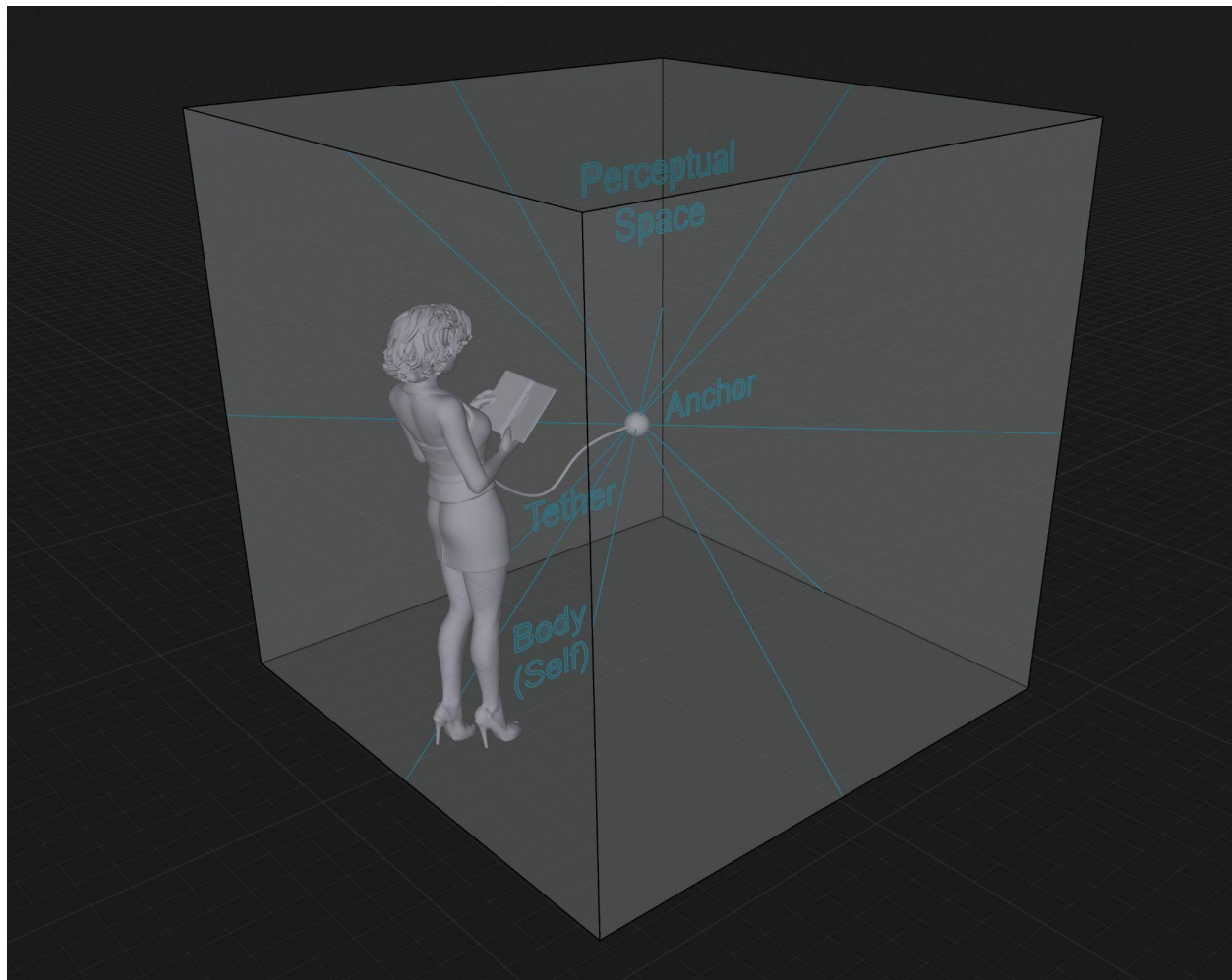


cumulative number of shells at any total radius depth. It takes an increasing step size to add another step of radius resolution at increasing radius values. Image (of accumulation of shells at growing radius) made with Python and Manim code.

With this stationary perceptual space (say, roughly, an 8' cube for the vast majority of your interactions, but with decreasing resolution going off to miles of distance), the vastness of the world can exist within the story, just like it does within the story of a movie on a (fixed-size and fixed-location) television set, except that the "screen" of perception is translucent, and has thousands of copies placed at radially outward growing depths, and they are spherical and cubical, not flat. It makes for the truest 3D movie you could ever have.

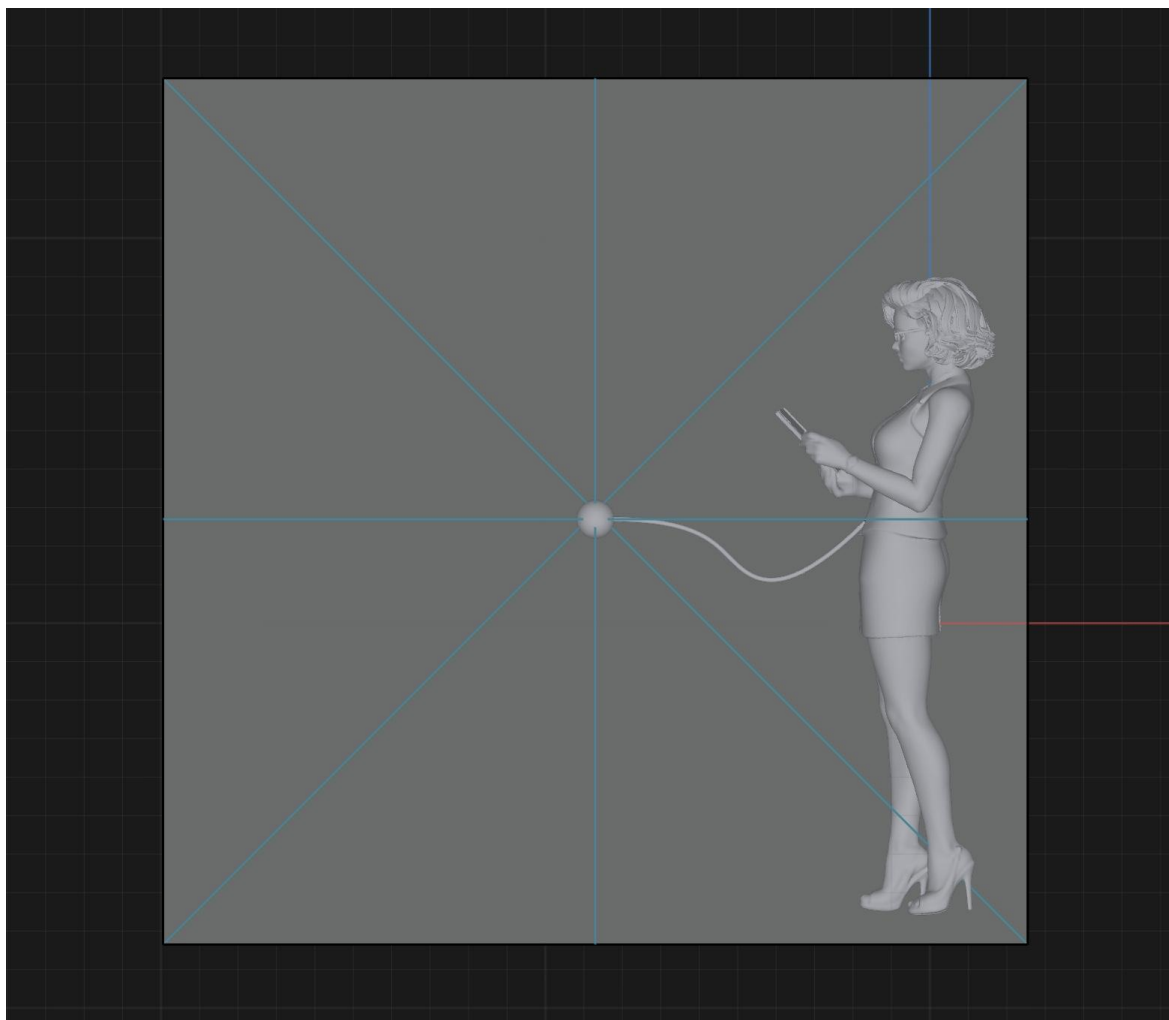
Perception, as a point of fact, has its centroid usually 2' or more in front of your body, but the centroids of depth resolution would be each pupil (the contribution to perception from each eyeball). Therefore, it would make sense for the brain to concern itself not as much with the body, but with the area in front of the body, although it can paint pain that is internal to the body.

It is hypothesized that the environment just in front of the body is the hard fixation point for perceptual space. The body is then loosely tethered to this, with some temporal latency, or



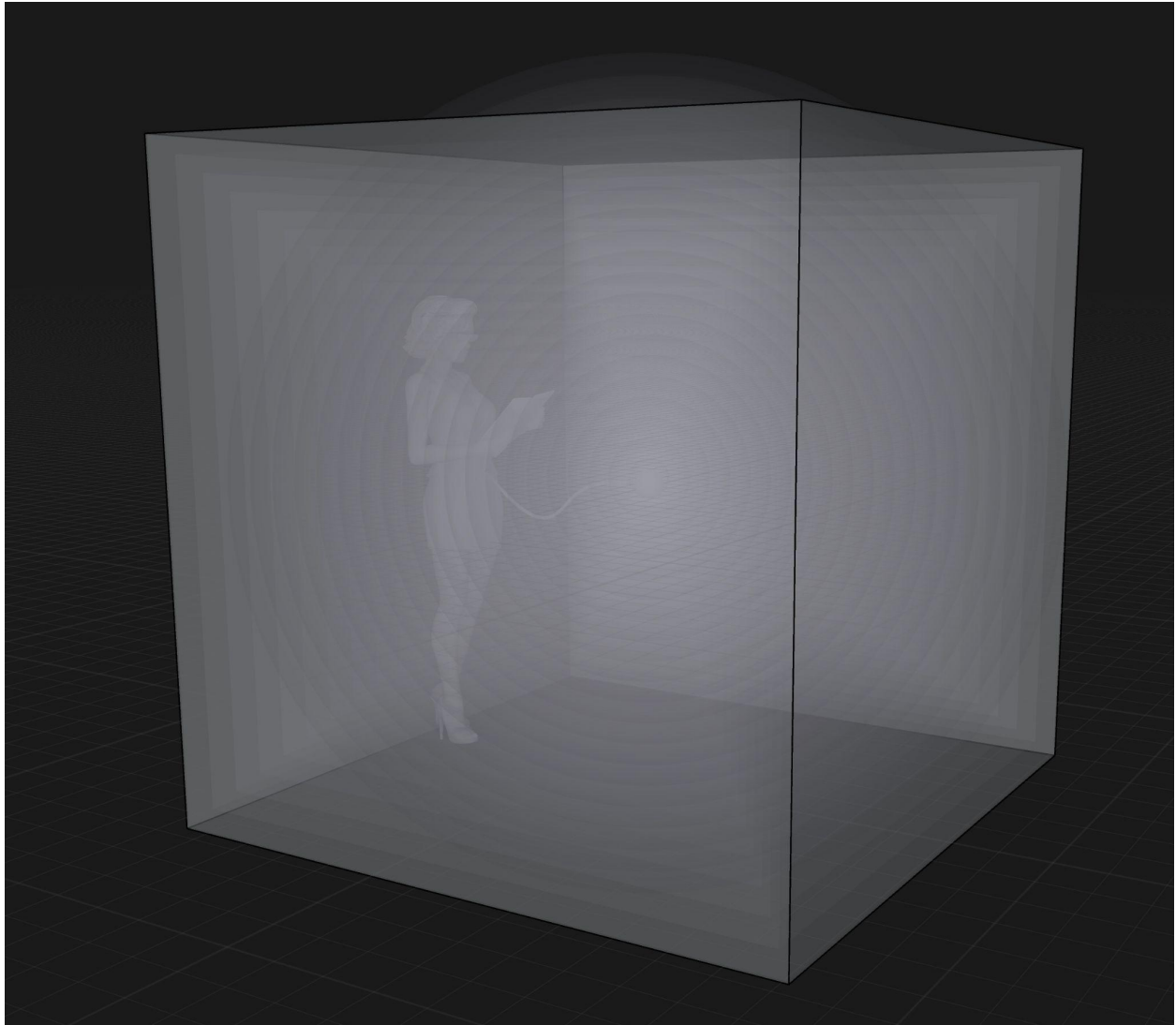
hysteresis, between the two allowed. It takes large (walking) movements of the body (~4') in the physical universe for perceptual space to “pick itself up and move forwards” (but remember, it never actually moves, but rather updates the painting of the physical world to show movement). Hence, perceptual space would act something like an anchor, affixing itself to the local frontwards environs unless reasonable size movements are made (otherwise, it can “paint” the body moving, rather than bother updating the paint of the rest of the perceived world), just like a lightweight anchor stays in place until sufficient force pulls it a little.

It is hypothesized that sound and inertial forces are the only things that “move” the fixed perceptual space — sound as vibrating and inertial forces (like a right turn in a car) throwing the space away from equilibrium. It is as if the brain playfully allows sound and inertial forces to discombobulate its own printhead, even though the brain actually has to use sound and inertia information and actively create the “discombobulation.” If so, there is a yet even more fundamentally fixed anchor — an “equilibrium anchor” — which truly never moves.



These (and all similar) images were created with Shapr3D, using “Woman with Notepad” STL file by WalterMois; licensed under the Creative Commons - Attribution - Non-Commercial license.

Since this perceptual space can be thought of as the ultimate movie screen, with thousands of layers of translucent cube-shell and sphere-shell screens upon which to print the voxels, the set of “screens” collectively could be thought of as a “printhead” of consciousness. How the brain might advance a tiny “3D cursor” around in this space, printing consciousness (like how a ray gun shoots electrons painting pixel by pixel of an old TV screen) is explored in the book, “Rings of Fire: How the Brain Makes Consciousness” (Brad Caldwell, 2022).



The “3D movie theater screen” of consciousness, “printing” a scene of a woman reading a book. Again, image made with Shapr3D as before.

At small temporal resolution (0.1 second), the brain doesn’t print every voxel (pixel, but 3D) of the “story” of a woman reading a book; rather, it prints in “frames” plus “paint.” The paint is what your eyes (or occasionally, your mind’s eyes) see, and it “all” gets painted as it comes in through the eyes (probably at 40 Hz resolution or even much higher). The frames happen at 2-14 Hz,

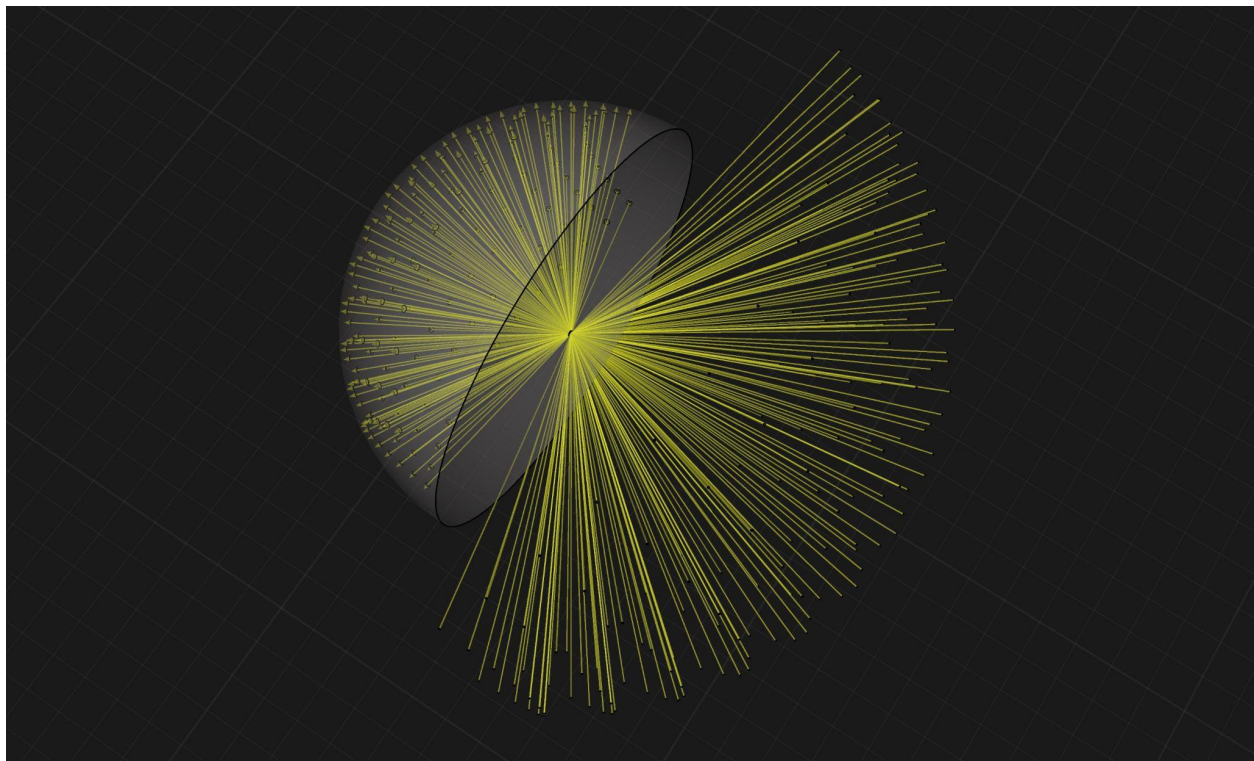
and draw the translucent 3D skins (“point clouds”) of mental imagery, but mental imagery often models the real world, so in this case the skins could be the skin of the woman and her book. If, while she is reading, she needs to conceptualize a word like “soccer,” then the mental imagery may morph very quickly into a kid kicking a soccer ball.

Also at this temporal resolution (0.05-0.1 seconds), the frames may still occur in the form described above, but they also often assume the form of slicing the “theater” at some angle, and merely drawing a squiggly ring on that surface to denote where objects are at the moment. The attitude (angle) of this drawing plane can “3D rotate” smoothly over time.

At the highest observable temporal resolution (<0.025 seconds), it is possible, when the brain is drawing rings, to see them actually getting drawn (phase). A “3D cursor” or “3D paintbrush (without a handle)” paints the ring from beginning to end, and comes back to eat its tail (starting point), with a little axial offset sometimes.

It is possible, but uncertain, that this 3D cursor may actually print all of consciousness (even the part that the eyes see), not by physically moving to every point in the scene, but by extremely high precision temporal encoding, mapping “zigs” and “zags” of the cursor, along its arc path, to the spatial and color components of what is seen.

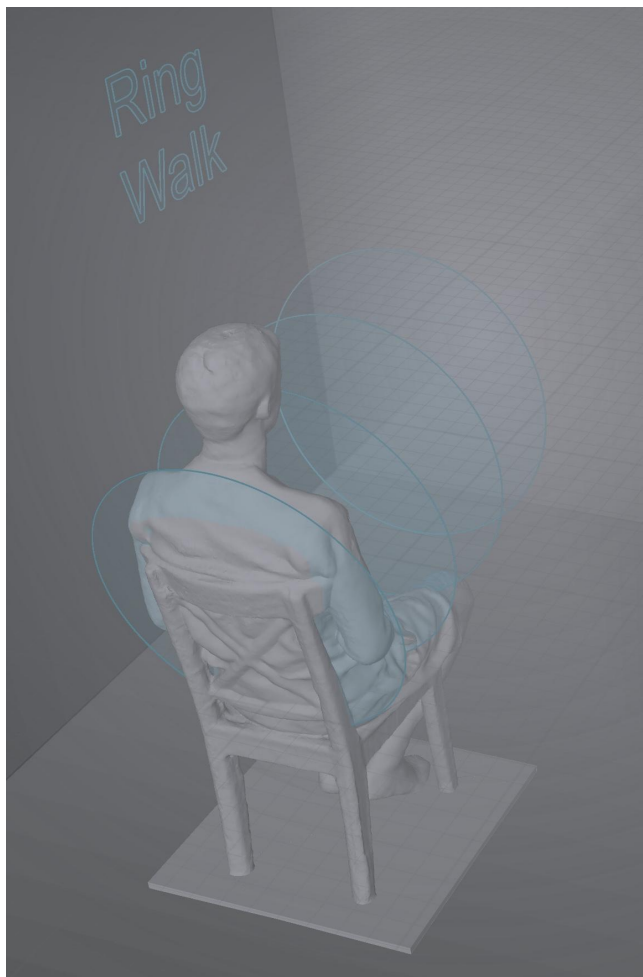
I figure this is possible since it is possible for a 2D sphere shell image (or think of a 2D photo) to be contained in a single point in the universe (at your pupil, a 2D image inverts, but right at the inversion point, all the data of the image is contained in a single point, with vector orientation direction of the light rays holding the info for each pixel).





Consciousness doesn't need to be aware of every seen and unseen voxel every millisecond, but rather *certain ones at certain times*. As you move the point of your attention (usually by moving your fovea) in 3D space, that is generally what you want to include in consciousness, as least as far as the visual component. Other things that need to be included are inertial shifts in your body, sounds you hear, your mood, what you smell, etc. These can all be done by including them in the 3D movie that is getting painted, and drawing the things that are pertinent, moment-by-moment.

So, consciousness doesn't always move attention in rings drawn from start to finish — it may move attention by “printing” a complete ring in a near-instant moment of time, then “walking” to a new position in the theater, printing a ring there, walking to another position, printing a ring there. The movements are always fairly smooth, except if the stimulus is particularly jarring. If you are sitting down, and decide to lean back in your chair, almost certainly the rings will walk themselves back to the back of the chair as you lean into it, then back forwards again to whatever you were attending to in front of you.



The brain just has to print the story, which is evolving over time — if the only meaning in that 0.2 seconds of you leaning back in the chair was your leaning back into the chair and the feeling of softness, then that is all that gets painted in those moments of consciousness as they are getting “laid down.” This is probably all that would get recorded in episodic memory, too. Consciousness in this sense never includes more than your focus (your experience).

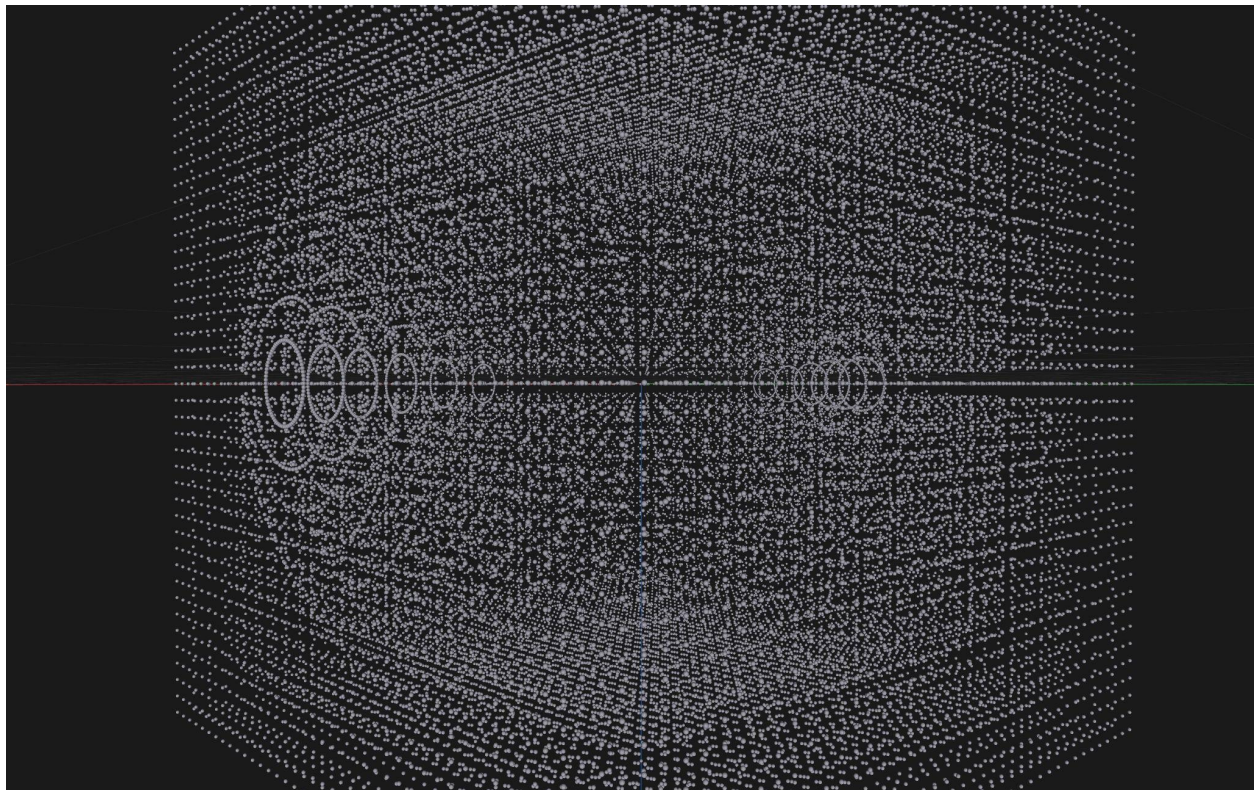
If you could zoom in to the drawing of a single ring, you would find that only about four to six stops are made along the ring (~0.1 second to draw a ring, so only ~0.02 seconds for each “stop”). And, each stop appears to be given to a different modality (stop one, inertia at left elbow; stop two, mood/self, at back of neck; stop three, sound of heater running; stop four, another inertia movement, of stopping of right side of head; stop five, the look of some blue patch of sheet you're looking at).

Image made with Shapr3D. STL of man sitting: A Young man sitting on a chair by thoweis licensed under the Creative Commons - Attribution - Share Alike license.

Anyway, the point has been, all qualia can be depicted by changes in the “paint” (seen voxels), focal frames/skins/rings, and changes in the printhead (inertial bumps, sound vibrations). As long as it is painted in the 3D movie, and the “chair” (printhead) “rocks” according to the sounds and forces, and attention is drawn to the right places and forms, then any modality of qualia can be “printed” and “experienced.”

Any motor command can be extracted and translated from this 3D movie into the specific control needed to be exercised over specific muscles at specific times. This can simply be a learned mapping (by seeing how “avatar” is affected in real time by various muscle commands), and needn’t involve any “calculus” math!

Then, we may be able to explore the “black box of mechanism” and posit that the mapping of every point in perceptual space (the “3D theater screen”) to a certain subpopulation of neurons within a cortical column is that mechanism. Each column in the cerebral cortex would need to have a mapping to every point in perceptual space, and each column would need to hook up each voxel location within it to each voxel location in every other column. Perhaps thalamus, cerebellum, and prefrontal cortex help with that (there are 10 Hz and 100 Hz traveling brain waves in the cortex which may carry this information telephone style by carrying a single focused voxel across in each wave [of the 100 Hz variety]). Fairly quickly, the brain could learn enough voxels to have a whole “matrix bank.”

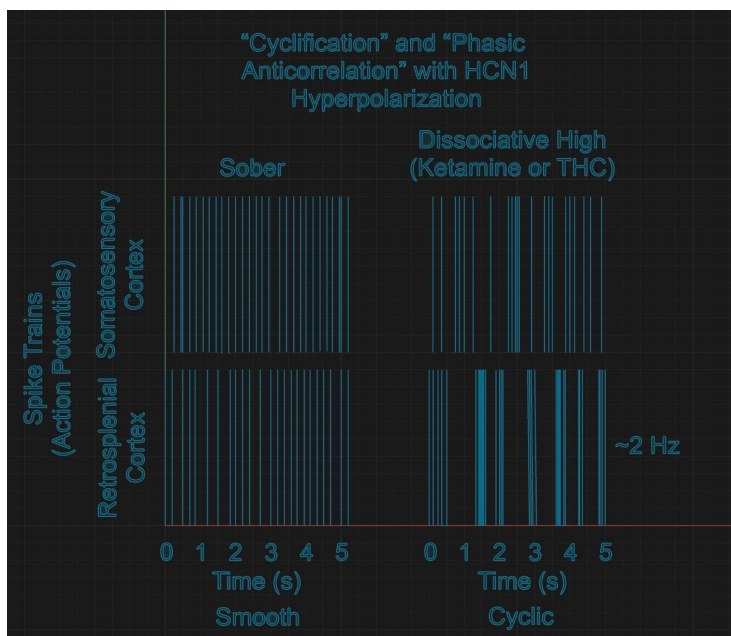


(2) Using artificial neurotransmitters, we can also go from consciousness downwards towards the “black box” and towards matter.

- (a) Anesthesia shuts down consciousness completely.
- (b) Ketamine induces cyclification (jerkiness) of consciousness and dissociation.
- (c) THC (legal hemp variety) is inhibitory and acts similarly to Ketamine.

Cyclification (jerkiness) brings the “frames” or “rings” or “skins” of consciousness into greater relief (2-12 Hz). Dissociation also may occur as the greater relief of “frames/rings/skins” also enables greater relief of the imagination (which is usually only “felt,” not paid attention to), including the “mind’s eye” which swings out wildly from the body and from the physical eye (probably the reason for reports of being “out of body”). It isn’t that the physical eye actually leaves the body and is able to see a hidden paper on top of a shelf, as Neil deGrasse Tyson inquired in an interview with Joe Rogan; rather, it is the ubiquitous activity of the mind’s eye, which is able to draw 3D skins of the environment, and look at them from funny angles. If you don’t know what’s on the sheet of paper up there, it is just going to fill in the unknown details just as you do for an occluded object or for your retina’s blind spot — you won’t magically be able to know the details of what is on the paper! The reason people report their “out of body experiences” is because you usually aren’t aware that your mind’s eye is so active, wild, and precise in the 3D skins it is drawing since it stays mostly subconscious — they’re blown away by the experience, even though it is one that happens (subconsciously) all the time. You can see your mental imagery if you pay better attention. Just someone speaking will launch it into drawing something (a mental video of the person speaking, or of the concept conveyed by the words spoken).

Multiple people (and an experiment\*: <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7553818/>) attest to the fact that consciousness can be cyclified and appear to have a jerky rate (2-12 Hz, varying in real time).



\*Experiment citation: Vesuna S, Kauvar IV, Richman E, Gore F, Oskotsky T, Sava-Segal C, Luo L, Malenka RC, Henderson JM, Nuyujukian P, Parvizi J, Deisseroth K. Deep posteromedial cortical rhythm in dissociation. *Nature*. 2020 Oct;586(7827):87-94. doi: 10.1038/s41586-020-2731-9. Epub 2020 Sep 16. PMID: 32939091; PMCID: PMC7553818.

The compressed bands of action potentials in the image are proposed to be temporally simultaneous with frames of consciousness.