**Serotonin 5-HT2A Receptor Activation in Near Death Experiences**

**Abstract (Obviously needs to be shortened)**

Death and near-death experiences represent a unique set of phenomena that include distinct physical (cellular, molecular) and meta-physical (quantum and psychospiritual) processes that seem to be both required and uniquely intertwined.1-24 Investigative inquiry into these processes can yield a greater understanding of life, consciousness/qualia, death, and the possible multi-layered processes that occur in between these two phenomenon (e.g., life and death), as well as the way the two may be related.17-21\_12-15,17-19,22-30 A variety of qualitative, quantitative, and mixed-methods studies find that “near death” experiences are associated with dissociation from- and/or transcendence of the physical world and its physical properties (including the physical human body)31-43 and a greater sense of association and connection with metaphysical entities, properties, and states (e.g., a sense of metaphysical connection to all things, oceanic boundlessness, spiritual- and “other-worldly” connections).32,44-50 12-14,27,51 It would seem that these experiences are aligned with a process of conscious or energetic exit or transcendence from the physical, material world that the life experience is typically associated with, and a preparation for ascension into a more meta-physical, mystical, transcendent, and distinctly non-physical experience. Whether the sense of *consciousness*, *the metaphysical self,* or *awareness* remain intact during the *after-death* experience is a question that currently remains unanswered, as we thus far only have knowledge from individuals with *near-death (e.g., distinctly not-death)* experiences. Here, we (a) provide a brief overview of some specific material/physical (cellular and molecular) and metaphysical (quantum) processes and phenomenon that are known to be associated with life and near-death experiences and (b) propose a quantum theory of life and death whereby total vesicular extracellular serotonin release (as occurs during neuronal hypoxia and necrotic liquidation during death and near-death processes)(Bray, 2018; Li et al., 2015) results in activation and saturation of serotonin’s 5-HT2A receptors. We provide empirical support for this occurrence and for the hypothesis that **5-HT2A receptor activation serves as a biological mechanism for metaphysical experiences associated with near-death** (as well as psychedelic use, extreme stress, and “schizophrenia”).25,55 We also review quantum principles that have empirical support in quantum and biological research and how they are- or may be applicable to life-or-death processes.56 Specifically, we propose that **5-HT2A receptor activation may activate a process of quantum superdense coding** (a communication method that is empirically supported in quantum communication research, though primarily theoretical in large-scale applications, that is thought to allow for the transmission of more information using quantum entanglement)56-59 **of consciousness and qualia** that enables certain metaphysical energies (e.g., consciousness, qualia, and *life)* to engage in **quantum tunneling** (an empirically supported phenomenon that explains the ability of particles to pass through barriers that would otherwise be considered impassable in classical physics)56,60 and/or **quantum teleportation** (a phenomenon involving the transmission of quantum states between particles through entanglement that is empirically supported by successful demonstrations of quantum state teleportation, though it is primarily limited to small-scale systems)61-64 whereby the energetic essence of life, consciousness, or qualia pass from one living body (e.g., *death)* into another (e.g., *birth*). This hypothesis is supported theoretically by a variety of additional quantum principles.56,65,66 For example, the concept of **quantum wave-particle duality** (an empirically supported principle suggesting that fundamental entities, such as photons and electrons, behave both like discrete particles and continuous waves, depending on how they are observed)56,65,66 can be theoretically applied to the process of physical-metaphysical duality to suggest that fundamental entities, such as *human beings*, can behave both like discrete particles (the physical body) and continuous waves (the conscious experience), depending on how they are observed. Together, these and other findings may identify 5-HT2A activation as a mechanism for quantum transcendence of life into *after life.*

**I. Extracellular Serotonin Release and 5-HT2A Saturation in Near-Death Experiences**

A variety of *in vitro* and preclinical (rodent) *in vivo*studies demonstrate that death and near-death experiences are associated with neuronal hypoxia (oxygen deprivation in brain cells) that can result in cell death processes (necrotic liquidation, necroptosis) whereby neurons release their entire vesicular and neurotransmitter contents into the extracellular space (e.g., Nichols & Nichols 2019; Bray, 2018; Bray 2018 unpublished; Dean et al., 2019; Li et al., 2015). This results in rapid increases of neurotransmitters into the extracellular space at levels sufficient to bind and saturate low-affinity receptors that typically remain inactive (“dormant”) during everyday life.

Serotonin (5-HT) and its low-affinity 5-HT2A receptors are among the neurotransmitters rapidly released into the extracellular space during near-death experiences at levels sufficient to bind low-affinity receptors that are otherwise not activated during “regular daily life.”67-74 Serotonin’s 5-HT2A receptors are highly conserved evolutionarily (suggesting a critical evolutionary function)68,70 and implicated in nearly all psychobiological processes of cells, systems, and organisms [citations].67,68,70

At the cellular level, this includes cell birth;75 neuronal development and migration;76,77 excitability and excitation52,70,78-84 as well as inhibition and disinhibition79,80,82-84 (inherent in cellular/neuronal communication and internal regulation, respectively, as well as nearly all central neuronal processes); cellular interaction, connection, and systemic integration;52,75,80,85-89 stress responses;75,76,83,90-92 cell survival;77-79,81,83,93-96 persistence and resilience;76,78,91,97-101 **near-death processes** (including asphyxiation/hypoxia);81,102,103 and cell death processes,25,52,77,78,93-95,102-110 including programmed cell death processes like apoptosis (AKA “programmed cellular suicide”),77,93-95,104 ~~suicide,~~~~105-107~~) and unprogrammed cellular death processes, including cellular toxicity,25,52,78,95,108-110 and necrosis,102,103in which the cell membrane and synaptic vesicular membranes that contain neurotransmitter contents rupture, resulting in extrusion of intracellular contents into the extracellular space (including synaptic vesicular neurotransmitter contents like serotonin)(e.g., necrotic liquidation)).111-114

In the same way that cells often represent smaller, cellular representations of larger cellular systems, organs, organisms, and even communities at large, the life and death processes that are underpinned by serotonin’s 5-HT2A receptor activation at the cellular level are similarly underpinned by 5-HT2A activation at alarger psychobiological systems/organism level. For example, serotonin’s 5-HT2A receptor activation is implicated in processes and experiences of birth, development; sleep, wakefulness, and alertness;70,78,81 sensation and perception;115 cognition (learning)115,116 and conditioning (reinforcement of learning);75,85,86,115-118 sex/gender differences;101 emotion;115,116 stress responses;75,76,83,90-92 persistence and resilience;76,78,91,97-101 language and movement;115 mood fluctuations, including depression91,97-100 (which can be viewed from neurobiological perspective a response to changes in stress, stimulation, or regulatory capacity) and aggression;101 depression that can approach suicidality;91,97-100 eating disorders that can approach death biologically (and can involve a drive to live/thrive);99,107,108,119-121 **near-death processes** (including mild traumatic brain injury,25 asphyxiation/hypoxia81,102,103 **and cardiac arrest102,103**); aging and memory;116 and altered states of consciousness (including schizophrenia,70,116,122,123 psychedelic use,54,85,124-130 hallucinations,116,127 transcendental meditation,131 spirituality,89 and – again – **near death experiences102,103**)(e.g., [Moutkine et al., 2018](https://pdf.sciencedirectassets.com/272488/1-s2.0-S1043661818X00139/1-s2.0-S1043661818313252/am.pdf?X-Amz-Security-Token=IQoJb3JpZ2luX2VjEHAaCXVzLWVhc3QtMSJGMEQCIFeRtwORJq1GBQ19lv%2FhwApcDvqgXjW0%2Bp%2FW8Cm6Lv2eAiBxhRsI2dLOlPS9WU21A5ELI0875YJ5955YvyPl41Mz0CqzBQgYEAUaDDA1OTAwMzU0Njg2NSIMpqwa9I6kpxVIbxReKpAFI0y%2BJ6GCZ1fs8UE8BcBoTirbV2Dreyyt7X9VzNUf6FcQDw%2FNl1uh9X%2FO%2FEDDSz3YfH1q%2FK93VJfixzKM%2FnsQqAYwgKfFSk1Hbsha1eS1rwZ%2F8PWcxInqOGntYK1Zv7dwHh0Ee0aUL%2F2DzMs19CxALReqrtscgbyZgLiNoHAXwIe6X25%2BMdPEdv7ZqRe3xhdJKI82J9O1g75buFbIuDSRs%2FwD2dw2yzVpDjPnjCT5ohKm6wDXQyOE4Q6%2BYYuca8sAb93rxbFwvL1ez6tL%2FvuuGPac7%2BOywu7d%2FX07%2BxM36%2FtZC44uFKFNn7DHmjueB3UzGJpM1n4slOm5EC4vJ6tS4COe%2FEz3cXfBY9ZCtWqdhvP9QZRoQTlpC5rxlwrfmpm7M2pBtbd0gUTdsvG%2F57XmFvqTrtL8l5DS0pipMOLiXILCJSe09vVqA4FLkUo2g0WBbGQFxn2u2Q%2BzCXj9TDLNxdaU7OVNnyWys5OnEGFcSvu%2F3s1BNFD3FZmvRnoHuGlhNKF6liJBWYWSupm79OCo6JILI%2FvtJMuxERitNmadLOQIShHBwmUZ70CQp8cLtBqDmyOsurtWVnlIV5K%2B3f0rtd%2Fj4CoXTMXfPDSS8wXWHWgJUv76vhFZvZ0lMmCS63ECi7oudhdXoHWKykmyiajiyhekymijZBDEZa3%2FmYM2weBb723BOMAQm6zJQvAOGwVqmVkeTuOyrHGCX4H%2Ba3k2UF4%2FfCGSOapv4%2FbDjCF0TmfF76dM1pHoCrA6lrdxY9xDR8CIRcjMdk%2FvQK3Tz0hgw2e0LInOBegHqne0EbVX0kVLnQuw3bMNIm7XImoItlshcY0kyDIX8SMo4s52Rwd84juh3oPoLu69eT1JYa%2BmpuIw3quSugY6sgF8vTw65%2BrfD1JXUC2EdqhMSJ09gdx8WkzyjD6rAu%2Bs8H%2B5GaTiI7UhUnfqtvBOFHqRhuNk38bbPXXXgD8TjQPL3O%2Fuynzb3Z%2BYG6dLHN%2FMAwAAPlCCEGdQ3lI25uvjEcMi3kU7EqXsElFhO5AE7lfA86sNQpT0F5nCrPVA5lS9r8wXeOKBzoKFEMZ%2FTjycu9VRk23CRqujd9gokk8MTOeDFCpg82dvB03EJvAeFiKRMmAr&X-Amz-Algorithm=AWS4-HMAC-SHA256&X-Amz-Date=20241125T161359Z&X-Amz-SignedHeaders=host&X-Amz-Expires=300&X-Amz-Credential=ASIAQ3PHCVTY4XGXGQIX%2F20241125%2Fus-east-1%2Fs3%2Faws4_request&X-Amz-Signature=ce7adb6afa56e7806ca9f118c81566b9fe4ab64829a53e5a29f572abb924be13&hash=486a92783c4b22d3a4b023ee6f14cd75bd45e78033c285646d060f8e3c8bee1a&host=68042c943591013ac2b2430a89b270f6af2c76d8dfd086a07176afe7c76c2c61&pii=S1043661818313252&tid=pdf-7cf4e307-75e6-4d31-a178-d0fa3d59a3ca&sid=87e9cfa4869ee841973b83025dadc0e828c7gxrqa&type=client); [Roth et al., 1998](https://pubmed.ncbi.nlm.nih.gov/10348614/); [Bray et al., 2004](https://pubmed.ncbi.nlm.nih.gov/14699448/); [Bray 2018](https://search-proquest-com.ezproxy.usd.edu/docview/2157998281?accountid=14750); [Nichols & Nichols 2019](https://orbi.uliege.be/bitstream/2268/291053/1/alius_bulletin_n°4.pdf#page=24)).25,55

The pervasiveness of 5-HT2A receptor activation in so many life experiences suggests, paired with its evolutionarily conserved \*\*\*, suggest a critical function of this receptor to life itself. And yet, the 5-HT-2A receptor also had a very **low binding affinity for serotonin (~1.3 nM Ki/KD)**52-54 that requires very high concentrations of extracellular serotonin to be present for receptor activation.52,67,78,115,132,133 In fact, this feature renders 5-HT2A receptors inactive for the majority of the life experience (when extracellular serotonin concentrations rarely exceed 1 nM). This implicates 5-HT2A receptor activation in conditions of extremely high stress (with sufficient cortisol presence to stimulate extracellular serotonergic release centrally29,134-136\_92,134-142), intense emotional or psychological states (that are associated with high stress), serotonergic pharmacotherapy use (e.g., SSRIs, SNRIs, and serotonergic psychedelics54,85,124-130), **and near-death experiences** that increase extracellular serotonin levels sufficient for 5-HT2A receptor activation ([Li et al., 2015](https://pmc.ncbi.nlm.nih.gov/articles/PMC4413312/pdf/pnas.201423936.pdf); [Nichols & Nichols 2019](https://orbi.uliege.be/bitstream/2268/291053/1/alius_bulletin_n°4.pdf#page=24); Bray et al., unpublished).102,103,116

For example, a variety of in vitro and in vivo studies demonstrate that cardiac arrest, hypoxia, and asphyxiation are associated with robust increases in extracellular neurotransmitter concentrations (including serotonin) in the cortex, limbic brain regions, and other areas of the brain (e.g., [Li et al., 2015](https://pmc.ncbi.nlm.nih.gov/articles/PMC4413312/pdf/pnas.201423936.pdf); [Nichols & Nichols 2019](https://orbi.uliege.be/bitstream/2268/291053/1/alius_bulletin_n°4.pdf#page=24); [Bray, 2018](https://search-proquest-com.ezproxy.usd.edu/docview/2157998281?accountid=14750)).29,102,103,142

Notably, [Li et al., 2015](https://pmc.ncbi.nlm.nih.gov/articles/PMC4413312/pdf/pnas.201423936.pdf) found that in adult rats undergoing experimental asphyxiation, serotonin levels increased in the frontal and occipital lobes from ~0 nM at baseline (in both regions) to ~13 nM and ~18 nM at 1- and 2 min post asphyxia respectively (~ 13x and 22x above baseline levels)(**Figure 1**). These increases peaked at ~63 nM and ~42 nM at 4 —  8 min in the frontal and occipital lobes (~70x and 245x above baseline levels in the frontal and occipital lobes respectively) and remained significantly elevated (>~13 – 18 nM, >~13 – 22x above baseline levels) for >20 min (when recordings were ended).29 Importantly, these rapid increases in extracellular serotonin levels are associated with  >80 — 97% binding/occupancy of the 5-HT2A receptor in the rat cortex53,54,67 that onset 1 - 2 minutes after asphyxiation and persist for >20 min (when recordings were ended; see green line superimposed over **Figure 1a** and **1b**).29

Similar increases in extracellular monamine and specifically serotonin levels have been observed by others in other cortical and limbic brain regions. 29,102,103,142142,145 and are braodly considered adequately sufficient to activate and saturate 5-HT2A receptors29,53,102,103,142 *and* induce the “visual hallucinations and mystical feelings” associated with near death experiences in humans.29,87,89,116,127,153 For example, Dean et al (2018) reported rapid influxes in extracellular serotonin levels in visual cortex dialysates (as assessed via microdialysis) that increase from baseline (0 mVolts) to 110% increase (~108 mVolts) at 3.9 min post cardiac arrest and returning to baseline levels at ~5.5 min post cardiac arrest (**Figure 3**).103 Bray et al (2020) and others in Forster-Watt Laboratory have reported rapid influxes in extracellular monoamine oxidation (indicative of rapid influxes in extracellular monoamine release) that precede organismal death, as assessed via chronoamperometry (Figure 2).143-152 These include increases in dopamine, norepinephrine, and ascorbic acid in the nucleus accumbens (core and shell).142,145

A close-up of a paper

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Figure 1: Cortical serotonin secretion shows immediate and marked surge in response to asphyxia, as observed by Li et al., 2015. Graph a (on the left) shows the concentration graph in nM for the entire sampling period (25 min). Graph b (on the right) shows the concentration graph normalized to the baseline graph in fold changes for a total of 10 min. “Extracellular concentrations of measured neurotransmitters, including serotonin (shown here) as well as adenosine, dopamine, norepinephrine (NE), GABA, glutamate, and aspartate (shown in Fig 4 of Li et al., 2015 though not reproduced here), all showed marked elevation in response to asphyxia (n = 7).” In comparison with the baseline serotonin values, significant surges of extracellular serotonin were detected at 1 min of asphyxia in the frontal lobe (P < 0.05) and at 2 min of asphyxia in the occipital lobe (P<0.05, n = 7). In other neurotransmitters measured, these surges were observed immediately, “as early as time 0” for dopamine, norepinephrine, and GABA and at 1 min of asphyxia for adenosine, glutamate, and aspartate in both the frontal and occipital lobes (P < 0.05, n = 7). Additionally, a significant regional difference in the degree of serotonin elevation from baseline was observed in the frontal vs. occipital lobes at 4 – 7 min of asphyxia (P < 0.05, n = 7), with significantly greater elevations observed in the frontal vs occipital lobes. A similar regional difference was observed for NE at 1 min (P < 0.05), with similar non-significant trends observed in adenosine and dopamine (n = 7/group). Error bars denote SEM. \*Asterisks are used to indicate the first time point that shows significant elevation over baseline, with red indicating frontal cortex release and blue denoting occipital cortex secretion. #The black pound signs in figure b indicate significant differences in serotonin release between the frontal and occipital cortices. The green line superimposed over both graphs (a and b) roughly delineates the level of extracellular serotonin required to bind serotonin’s 5-HT-2A receptor (~1.3 nM Ki/KD).52-54 This figure and its findings are reproduced with permission from the authors.

A diagram of a brain

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Figure 2: Placeholder Figure. Rapid influx in extracellular monoamine oxidation (presence) observed via chronoamperometry in the nucleus accumbens shell by Bray et al., 2018-2020. This is Fig 4 of Bray et al., 2020. Will be replaced with a clean sweep fig from Bray 2018 dissertation and a tracing of death in stereotax.

A close-up of a graph

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Figure 3: Additional evidence of extracellular serotonergic increases in the brain after cardiac arrest, as reported and published by Dean et al., 2018. My text here.

**SUBHEAD: 5-HT2A ACTIVATION AS EXPLANATION FOR METAPHYSICAL COMPONENT OF NEAR-DEATHN EXPERIENCES**

Note on above and note SIMILARITIES BETWEEN NEAR-DEATH, PSYCHEDELIC, SCHIZOPHRENIC, AND TRANSCENDENTAL MEDITATION EXPRIERENECS.

Known 5-HT2A involvement in Psychological States: Intense emotional or psychological states can also elevate serotonin levels.{Zhang, 2015 #10270}

5-HT2A receptor is associated perceptions of connectivity, activity, desensitization, and suicide reversal at the level of the cell, system, and organism biologically and psychologically,71,73,115,154 as well as psychological states of non-ordinary consciousness that can include feelings of connectedness, peacefulness, spirituality, euphoria, 'hallucinations,' and disassociation from life in this realm. 54,70,78,87,89,115,117,128,131,154-156

Additionally, Li et al (2015)29 noted “serotonin, whose release in the occipital cortex surged more than 20-fold within the first 2 min of asphyxia, plays diverse central functions via serotonin receptors. Activation of a subset of serotonin receptors, for instance, induces visual hallucinations with mystical feelings in humans (36). Internally generated visions and perceptions apparently occur during cardiac arrest in 10–20% of survivors (22, 24, 37). Although detailed neuronal mechanisms of these realer-than-real (38) near-death experiences remain elusive, our study suggests that the mammalian brain possesses a high capacity for producing well-organized neurophysiological and neurochemical activities and for generation of internal states of consciousness at near-death.” 29…

**SUBHEAD: COMMENTARY ON POSSIBILITY OF EXTRACELLUALR EFLUXES IN OTHER NEUROTRANSMITTERS CONTRIBUTING TO NEAR DEAT EXPERIENCES AND STATES**

Commentary here or in appendix on the fact that Li et al., 2015 did observe increases in other neurotransmitters (as did Bray 2018 and others in the Forster-Watt laboratory), suggesting a possibility that other neurotransmitters (e.g., Dopamine, glutamate) could also contribute to these experiences. For example, N,N-dimethyltryptamine (DMT, a serotonergic psychedelic compound identified endogenously in mammals) is also known to activate and bind the 5-HT2A receptor (kDA here) and relatively rapid increases in extracellular DMT have also been observed in the brains of pineal-intact and pinealectomized rats, as demonstrated by Dean et al, 2018 and others (Figure 3).103 However, Nichols and Nichols (2020) make the strong point that serotonin has “a 10-fold higher affinity for the 5-HT2A receptor than DMT (PDSP Ki Database). Even if we accept that DMT is present at half the levels of 5-HT in cortex under normal physiological conditions, the combination of higher 5-HT levels and higher affinity of 5-HT for the target receptor indicate that DMT will not be engaging the receptor to any appreciable degree at baseline conditions. During asphyxiation, as the authors’ previous work shows, and as they interpret data in Dean et al., 2018,103 levels of serotonin increase over 20-fold compared to only a 6-fold increase for DMT (Dean et al. Fig 4A), further widening this gap.103 At these comparative levels, with the 10-fold higher affinity of serotonin, 5-HT2A receptors would be saturated with serotonin and engagement of receptors by DMT in the presence of that much serotonin (and/or N-methylserotonin) would essentially be zero. That said, it cannot yet be sufficiently ruled out that DMT, even at the relatively low concentrations is occurs in (relative to serotonin) could have a potent, critical, and even substantial role in 5-HT2A activation in near-death experiences.”{Nichols, 2019 #10272}

ADDRESS LI ET ALS NOTATION THAT ALL NTS ARE RELEASED, NOT JUST SEROTONIN. THEY LOOK TO DMT TO UNDERLYING MECHANISM CONTRIBUTING TO NEAR DEATH EXPERIENCES. HERE, I PROPOSE SEROTONIN.

**SUBHEAD: ANY ADDITIONAL COMMENTARY ON DMT, DEAN 2018, NICHOLS & NICHOLS 2020.**

Additionally, note extra//other commentary here in Dean et al., 2018 and Nichols & Nichols’ 2020 response102,103 publications on speculation of DMT as being involved in this role (Dean et al., 2018) and Nichols & Nichols’ rebuttal (2020), and my commentary in response to that (which I can no longer remember off the top of my head).

**SUBHEAD: ANY CLINICAL DATA (PARNIA ET AL)**

Paragraph on near death exerperiences in cardiothoracic surgery

**SUBHEAD: COMMENTARY ON THE MECHANISM OF SEROTONIN RELEASE, E.G., NECROTIC LIQUIDATION, IF NECESSARY (THOUGH PROB IS NOT)**

ALSO, UNDERSCORE THAT LI NOTES “EXTRACELLULAR INCREASES”. THESE ARE SUGGESTED TO RESULT FROM … NECROTIC LIQUIDATION ETC.

A variety of in vitro and pre-clinical (rodent) studies demonstrate that cardiac arrest and the resulting hypoxia can result in cellular death processes (e.g., necrotic liquidation and necroptosis), in which neurons release their entire vesicular and neurotransmitter contents into the extracellular space (including 5-HT) (e.g., [Nichols & Nichols 2019](https://orbi.uliege.be/bitstream/2268/291053/1/alius_bulletin_n°4.pdf#page=24); Bray, 2018; Bray 2018 unpublished).{Dean, 2019 #10273;Nichols, 2019 #10272;Bray, 2018 #2912;Li, 2015 #10291}-{Blaha, 1997 #788;Bray, 2020 #3575}

It may be that these incidences causes release of cellular serotonin in the extracellular space sufficient to activate 5-HT2A receptors, thus producing the euphoric effects reported in near-death experiences and characteristic of 5-HT2A activation.

When cells in brain die, they often “bleb” and release all of their contents - including all neurotransmitters - into their external environment, resulting in massive neurotransmitter dump into the extracellular space in the brain for brain receptor activation).

**NOTE ON CONSERVATION: BEGS THE QUESTION OF WHY THE 5-HT2A EXPERIENCE MIGHT BE IMPROTANT.**

The human brain and body are highly conservative ([Moutkine et al., 2018](https://pubmed.ncbi.nlm.nih.gov/30223085/)).{Moutkine, 2019 #10211} Rarely do we see anatomy or functions that are conserved through time that do not have important functions or contributions to the human life experience ([Moutkine et al., 2018](https://pubmed.ncbi.nlm.nih.gov/30223085/)).{Moutkine, 2019 #10211}

What, then, might be the biological function of 5-HT2A receptors in the brain? How might their use be harnessed in the context of life, death, pain, suffering, and healing/therapy/therapeutic modality?

I think it’s not a coincidence these receptors are so evolutionarily conserved, involved in nearly all aspects of life entrance, exit, and experience, and have such low affinity for serotonin that they are only bound before death, after consuming certain plants that have been used by the ancients to facilitate life exodus/recycling for ages, or through non-ordinary states of consciousness typically associated with transcendence (meditation, spirituality, “schizophrenia”).

**II. TURNING TO QUANTUM**

Death and near-death experiences represent a unique set of phenomena that include distinct physical (cellular, molecular) and meta-physical (quantum and psychospiritual) processes that seem to be both required and uniquely intertwined.1-24 Investigative inquiry into these processes can yield a greater understanding of life, consciousness/qualia, death, and the possible multi-layered processes that occur in between these two phenomenon, as well as the way the two may be related.17-21\_12-15,17-19,22-30 A variety of qualitative, quantitative, and mixed-methods studies find that “near death” experiences are associated with dissociation from- and/or transcendence of the physical world and its physical properties (including the physical human body)31-43and a greater sense of association and connection with metaphysical entities, properties, and states (e.g., a sense of metaphysical connection to all things, oceanic boundlessness, spiritual- and “other-worldly” connections).32,44-50 12-14,27,51 It would seem that these experiences are aligned with a process of conscious or energetic exit or transcendence from the physical, material world that the life experience is typically associated with, and a preparation for ascension into a more meta-physical, mystical, transcendent, and distinctly non-physical experience. Whether the sense of *consciousness*, *the metaphysical self,* or *awareness* remain intact during the *after-death* experience is a question that currently remains unanswered, as we thus far only have knowledge from individuals with *near-death (e.g., distinctly not-death)* experiences. Here, we provide a brief overview of some quantum processes and phenomenon that are known or proposed (by others or by us here) to be associated with life and near-death experiences. Specifically, we review quantum principles that have empirical support in quantum and biological research and how they are or may be applicable to life-or-death processes.56 We also propose a quantum theory of life and death whereby total vesicular extracellular serotonin release (as occurs during neuronal hypoxia and necrotic liquidation during death and near-death processes)(Bray, 2018; Li et al., 2015) results in activation and saturation of serotonin’s 5-HT2A receptors25,55 that activates processes of quantum superdense coding, tunneling, and teleportation that enables life force to travel from the death of one physical body to the birth of another.

Specifically, we propose that **5-HT2A receptor activation may activate a process of quantum superdense coding** (a communication method that is empirically supported in quantum communication research (though primarily theoretical in large-scale applications), that is thought to allow for the transmission of more information using quantum entanglement)56-59 **of consciousness and qualia** that enables certain metaphysical energies (e.g., consciousness, qualia, and *life)* to engage in **quantum tunneling** (an empirically supported phenomenon that explains the ability of particles to pass through barriers that would otherwise be considered impassable in classical physics)56,60 and/or **quantum teleportation** (a phenomenon involving the transmission of quantum states between particles through entanglement that is empirically supported by successful demonstrations of quantum state teleportation, though it is primarily limited to small-scale systems)61-64 whereby the energetic essence of life, consciousness, or qualia pass from one living body (e.g., *death)* into another (e.g., *birth*). This theoretical hypothesis is supported theoretically by a variety of additional quantum principles.56,65,66 For example, the concept of quantum wave-particle duality (an empirically supported principle suggesting that fundamental entities, such as photons and electrons, behave both like discrete particles and continuous waves, depending on how they are observed)56,65,66 can be theoretically applied to the process of physical-metaphysical duality to suggest that fundamental entities, such as *human beings*, can behave both like discrete particles (the physical body) and continuous waves (the conscious experience), depending on how they are observed. Together, these and other findings may identify 5-HT2A activation as a mechanism for quantum transcendence of life into *after life.*

In the past half century, scientific paradigm shifts in psychology and psychoanalysis have emerged that focus on applying contemporary scientific materialist, biomedical, and technological, *physically-oriented* approaches to psychological and neurobiological experiences, concepts, constructs, and practices.1 Among these, there is a new but growing movement that applies quantum mechanics (a branch of physics that studies the behavior of particles on a very small scale, at the level of atoms and subatomic particles) to psychological and neurobiological phenomenon (e.g., quantum biology, neurobiology, psychology, cognition, consciousness, and healing).1,2 These quantum psycho-neuro-biological fields seem to be driven in large part by consumer interest and develop largely outside of conventional research and allopathic medicine systems. This is especially true for quantum healing.

Alongside this highly biomedical, scientific materialist movement exists a post-materialist, metaphysical counter-movement that uses nonmaterial and metaphysical perspectives to explore psychological and psychospiritual experiences, phenomenon, theories, and concepts/constructs (e.g., the essence and nature of reality, existence, qualia/consciousness, time, causality, and the fundamental principles of being).3 Interestingly, these nonmaterial, metaphysical perspectives increasingly include elements of quantum mechanics (e.g., quantum psycho-neuro-biological perspectives and approaches),1,3-9 representing a unique convergence of materialist/biomedical/physical and nonmaterial/psychospiritual/metaphysical orientations.1

BRIEF summary of a few critical texts here: “For example, quantum applications to biology,

Theise & Kafatos (2016) offer fundamental awareness as a framework for integrating science, philosophy, and metaphysics. [brief description here]. They specifically address quantum applications to nondual awareness.3

Beshkar (2020)

Quantum applications to Buddhist perspectives of consciousness.10-16 and qualia.3,17-39

Quantum applications to Buddhist meditation and mindfulness practices.10,40

Quantum applications to nondual awareness.3

Recent interest in quantum neurobiology — exploring the presence of well-established quantum mechanics principles (wave-particle duality, quantum entanglement, quantum superposition, and — most relevant here — quantum teleportation, quantum tunneling, and quantum superdense coding.

Quantum teleportation: Phenomenon involving the transmission of quantum states between particles through entanglement. The phenomenon is empirically supported by successful demonstrations of quantum state teleportation, though it is primarily limited to small-scale systems.

Quantum Tunneling: Empirically supported phenomenon that explains the ability of particles to pass through barriers that would otherwise be considered impassable in classical physics. Experimentally supported by- and central to modern technology (e.g., functionality of semiconductor devices like transistors).

Table 1: Quantum Principles and Their Broader Psycho-Neuro-Biological Implications

| **Key Concepts & Constructs in Quantum Mechanics and Quantum PsychoNeuroBiology** | |
| --- | --- |
| **Term, Description, Level of Evidence** | **Neuro-Psycho-Biological Applications and Their Empirical Support** |
| **Principles Central to the Theory Proposed Here** | |
| **Wave-Particle Duality:**  Empirically supported principle suggesting that fundamental entities, such as photons and electrons, behave both like discrete particles and continuous waves, depending on how they are observed.1,41,42 This dual nature challenges traditional notions of fixed categories in science and is one of the cornerstones of quantum mechanics, supported by experiments like the double-split experiment. | * **Life/Death:** * **Neurobiology**: This principle parallels the dual behavior of neurons, which operate through discrete electrical signals yet produce continuous patterns of brain activity. * **Psychology**: It underscores the fluidity of human cognition, where thoughts can seem both distinct and interconnected. * **Contemplative Buddhism**: Resonates with teachings on the interdependent nature of reality and the necessity of embracing paradox. |
| **Quantum Superdense Coding:**  Communication method thought to allow for the transmission of more information using quantum entanglement. While this communication is empirically supported in quantum communication research, it is primarily theoretical in large-scale applications. | * **Neurobiology**: Mirrors the brain’s ability to condense and efficiently transmit complex information. * **Psychology**: Reflects the nuanced ways humans communicate deep meanings through minimal expression. * **Counseling**: Highlights the richness of verbal and nonverbal communication in therapeutic work. * **Healing**: Suggests that brief moments of connection can carry profound meaning and impact. * **CBIP**: Resonates with the depth of wisdom that can be conveyed through mindful, compassionate dialogue. |
| **Quantum Tunneling:**  Empirically supported phenomenon that explains the ability of particles to pass through barriers that would otherwise be considered impassable in classical physics. Experimentally supported by- and central to modern technology (e.g., functionality of semiconductor devices like transistors). | * **Neurobiology**: \*\*\* * **Psychology**: \*\*\*. |
| **Quantum Teleportation:**  Phenomenon involving the transmission of quantum states between particles through entanglement. The phenomenon is empirically supported by successful demonstrations of quantum state teleportation, though it is primarily limited to small-scale systems. | * **Neurobiology**: Can symbolize the brain’s capacity to transfer information across vast networks. * **Psychology**: Suggests the rapid transfer of emotional or mental states through shared understanding and empathy. * **Counseling**: Highlights the deep connection possible in therapeutic relationships, enabling transformative communication. * **Healing**: Serves as a metaphor for the instantaneous shifts that can occur through profound insight or connection. * **CBIP**: Reflects the transmission of wisdom and understanding through shared presence and teaching. |
| **Principles Supporting the Theory Proposed Here** | |
| **Observer Effect:**  Similar and related to quantum superposition, the observer effect describes the idea or phenomenon that observing or measuring a quantum system can disturb it, leading to a change in its state. This occurs because observing the system involves interacting with the system (e.g., using photons to observe electrons), which causes the superposition to “collapse” into one specific state. |  |
| **Quantum Entanglement:**  A non-classical phenomenon with strong empirical support in which particles become interconnected such that the state of one instantaneously affects the state of another, irrespective of the distance separating them.1 Empirical support includes Bell’s Theorem test and real-world demonstrations of entanglement. | * **Life/Death:** Reinforces the idea of collective healing and the interdependence of all beings. * **Neurobiology**: Resonates with the interconnected nature of neural networks, where activity in one region can influence another. * **Psychology**: Highlights the profound impact of relationships and the interconnectedness of individuals’ emotional experiences. * **CBIP**: Closely tied to Buddhist teachings on interdependence and the shared nature of existence.   Objective empirical support exists for quantum entanglement within the field of quantum mechanics and some areas of quantum biology, focused specifically in plants (e.g., photosynthesis). Conceptual/theoretical empirical support for presence in neurobiology (e.g., conceptual models have been developed that propose microtubules and neuronal myelin sheaths as sources for quantum entanglement; however, these models lack empirical validation).1,43 |
| **Heisenberg Uncertainty Principle:**  Empirically supported principle stating that we cannot simultaneously determine both the precise position and momentum of a particle. This principle is fundamental to- and underscores a fundamental limitation in – quantum mechanics (e.g., in quantum predictability) and has been demonstrated in many contexts involving atomic and subatomic particles.1 | * **Neurobiology**: Reflects the probabilistic nature of synaptic processes, where precise outcomes cannot always be determined. * **Psychology**: Illustrates the difficulty in fully understanding or predicting complex human behaviors and mental states. * **Counseling**: Emphasizes the value of working with ambiguity, accepting that not all aspects of a client’s experience can be fully known or controlled. * **Healing**: Encourages a mindset of openness to uncertainty, recognizing that progress does not always follow predictable paths. * **CBIP**: Aligns with Buddhist views on embracing impermanence and relinquishing the desire for absolute certainty. |
| **Schrodinger Equation** (Time-dependent Schrodinger Equation in One Dimension):  “Serving as the bedrock of quantum dynamics, the Schrodinger equation outlines how a quantum system evolves.” |  |
| **Quantum Superposition:**  Empirically-supported principle used to describe the ability of a quantum particle or system to exist in multiple states or configurations simultaneously until observed or measured. For example, an electron can be in multiple energy states or positions at the same time until a measurement is made. Experimental support includes Schrödinger’s cat thought experiment and demonstration in quantum systems like qubits in quantum computing. | * **Neurobiology**: Suggests parallels to the brain’s ability to hold multiple possibilities before making a decision. * **Psychology**: Reflects the coexistence of conflicting emotions, thoughts, or identities within an individual. * **Counseling**: Encourages exploration of alternative perspectives and the acceptance of internal contradictions. * **Healing**: Highlights the transformative potential that exists in embracing complexity and uncertainty. * **CBIP**: Aligns with Buddhist practices of holding paradoxical truths and seeing the multiplicity within reality. |
| **Quantum Decoherence:**  Empirically supported and widely accepted rationale that describes why quantum systems appear classical in large-scale environments (e.g., via loss of coherence due to environmental interactions, resulting in the appearance of classical behavior). | * **Neurobiology**: Highlights how external stimuli influence neural processes, impacting coherence in brain activity. * **Psychology**: Reflects the role of environmental factors in shaping and sometimes destabilizing mental states. * **Counseling**: Underlines the importance of providing a supportive and stable therapeutic environment. * **Healing**: Suggests the need for creating safe spaces where coherence and clarity can be reestablished. * **CBIP**: Aligns with mindfulness practices that stabilize the mind amid external distractions. |
| **Quantum Zeno Effect:**  This principle states that frequent observation can inhibit the evolution of a quantum system. While this principle is experimentally demonstrated, it remains somewhat abstract in its broader implications. | * **Neurobiology**: Suggests that over-monitoring or fixation can stabilize certain neural patterns, hindering change. * **Psychology**: Warns against excessive self-monitoring, which can impede natural psychological progress. * **Counseling**: Encourages stepping back to allow clients the space to grow and evolve organically. * **Healing**: Highlights the importance of patience and not forcing outcomes in the healing process. * **CBIP**: Aligns with the Buddhist practice of non-attachment and trusting the unfolding process. |
| **Table Legend:** [Brief Table Description Here]. **Abbreviations:** [Include any abbreviations you use here or delete this]. **Sources:** 1, Kyriazos & Poga, 2024; 2, Liu et al., 2024; 3, etc.. | |

**III. ADENDUM PROBABLY CAN EXCLUDE FROM HERE.**

1. **Death & Migration at the level(s) of the cell & the human**
2. The process(es) by which cells in the body die can be categorized into the one of several categories/processes (e.g., necrosis, autophagy, apoptosis).
   * [Yuan & Ofengeim, 2018. "A guide to cell death pathways."](https://pubmed.ncbi.nlm.nih.gov/38110635/)
   * [Newton, 2024, "Cell death."](https://pubmed.ncbi.nlm.nih.gov/38242081/)
   * [D'Arcy 2019. "Cell death: a review of the major forms of apoptosis, necrosis and autophagy."](https://pubmed.ncbi.nlm.nih.gov/30958602/)
   * [Bertheloot et al., 2021. "Necroptosis, pyroptosis and apoptosis: an intricate game of cell death."](https://pubmed.ncbi.nlm.nih.gov/33785842/)
3. One form of cell death (apoptosis) involves imitation of a "death" program. This is often referred to as "programmed cell death," akin to cellular suicide and it can occur in several different forms (see references above).
4. One form of apoptosis (programmed cell death) is called cellular "blebbing" (scientific term for "blistering") and it has an important role in facilitating the movement of cells from one location in the body to another (called "cellular migration").
   * [Charras 2008. “A short history of blebbing;"](https://pubmed.ncbi.nlm.nih.gov/18755002/)
   * [Fackler & Grosse, 2008. “Cell motility through plasma membrane blebbing;"](https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2426937)
   * [Wickman et al., 2013. “Blebs produced by actin-myosin contraction during apoptosis release damage-associated molecular pattern proteins before secondary necrosis occurs;"](https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3770329)
   * [Charras & Paluch, 2008. "Blebs lead the way: how to migrate without lamellipodia;"](https://pubmed.ncbi.nlm.nih.gov/18628785/)
   * [Paluch & Raz, 2013. “The role and regulation of blebs in cell migration"](https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3989058).
   * [Charras et al., 2005. “Non-equilibration of hydrostatic pressure in blebbing cells"](https://www.ncbi.nlm.nih.gov/pmc/articles/PMC1564437)
5. If certain cell death processes can serve to facilitate cellular migration (migration of cells from one space to another) (Charras 2008, Fackler & Grosse, 2008; Wickman et al., 2013; Charras & Paluch, 2008; Paluch & Raz, 2013; Charras et al., 2005), **how might human death processes do the same thing?**
6. How might this question be explored through a scientific lens?
7. What aspects could be observed, measured, and studied?

ADD IN NADYA’S INFO ON APICAL BASAL SLOUGHING

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