Mechanism for Mind-Brain Interaction

based on NDE and neurological evidence

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Substance dualism …

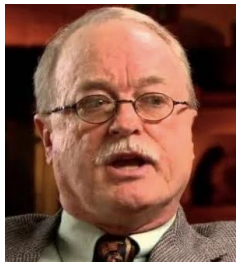
Substance dualism **is a branch of philosophy that holds that two fundamentally, or "ontologically," distinct kinds of things exist—mind and matter**

- **Even though they are different kinds of things, the mind and matter (i.e., the brain) can *causally affect* each other**

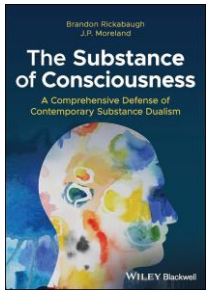
- **In their recent book, philosophers Brandon Rickabaugh and J. P. Moreland describe the mind or soul as a fundamental, immaterial/spiritual substance:**
  - **The human person, in their view,**
    - **(i) is comprised of a soul and a physical body,**
    - **(ii) is capable of existing without a body, but not without his/her soul, and**
    - **(iii) the mental life of which is possessed and unified by his/her soul**

      (Rickabaugh & Moreland, 2024, p. 14)

Brandon Rickabaugh



J. P. Moreland



- Rickabaugh, B., & Moreland, J. P. (2024), *The substance of consciousness: A comprehensive defense of contemporary substance dualism*. Wiley Blackwell.

Substance dualism

- **Rickabaugh & Moreland define how a substance dualist would describe a *thing that has mental states***
- **It would be an entity that—**
  - **Exemplifies mental properties**
  - **Holistically unifies mental properties**
  - **Has continuing mental states**
  - **Refers to itself as "I"**
  - **Has an irreducible "First-Person Point of View"**
  - **When disembodied is a unified center of consciousness**
  - **Displays the power to be necessarily a "Thinker of Thoughts"**
  - **Exercises active power and purposefully guides deliberative processes toward an end** (Rickabaugh & Moreland, 2024, p. 303)
- **Philosophy is limited to defining what makes a thing that *has mental states* but philosophy does not provide a *causal explanation* for conscious states** (p. 303)
- **However, a research project based on the empirical evidence from NDE reports *can be the basis* for a substance dualist ontological framework** (p. 333)
  - **Note: NDE research based on a substance dualist framework has been underway for more than 30 years**

Substance dualist NDE research

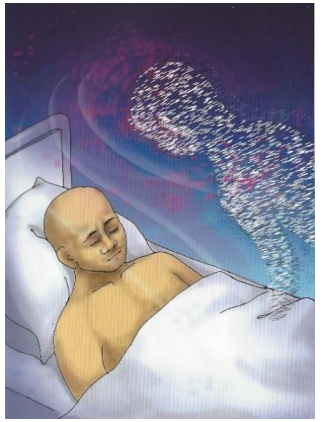
- **Kenneth Arnette's theory of essence (Arnette, 1992, 1995, 1999) and our mind entity framework (Mays & Mays, 2008) were initially developed independently**
  - **We have collaborated with Kenny since 2010, and we acknowledge the scientific priority of his work**
  - **None of us is aware of any other published interactionist dualist models extensively using NDE evidence**
- **Both of our theories are based primarily on *NDE evidence***
  - **Both propose an autonomous, nonmaterial mind or essence that interacts with the physical body and brain and continues to exist independently of the body during NDEs and after physical death**
  - **Both propose a mechanism for mind-brain interaction based on electrical brain interactions which give rise to consciousness, perceptions, thoughts, memory, motor actions, and unconscious mental effects**
  - **Both propose a mechanism for the mind-essence to causally trigger neural activity and causally interact with neural electrical fields to become aware of sensory percepts**
- **The primary differences are in the details of the causal connections between the mind and the brain**
- **In this presentation we will focus on the results of our research (Mays & Mays, 2008 to the present)**

- Arnette, J. K. (1992). On the mind/body problem: The theory of essence. *Journal of Near-Death Studies, 11*(1), 5–18.
- Arnette, J. K. (1995). The theory of essence. II. An electromagnetic-quantum mechanical model of interactionism. *Journal of Near-Death Studies, 14*(2), 77–99.
- Arnette, J. K. (1999). The theory of essence. III: Neuroanatomical and neurophysiological aspects of interactionism. *Journal of Near-Death Studies, 18*(2), 73–101.
- Mays, R. G., & Mays, S. B. (2008). The phenomenology of the self-conscious mind. *Journal of Near-Death Studies, 27*(1), 5–45.

Substance dualist NDE research: Our line of reasoning

Our scientific research is based on the phenomenology of NDErs' subjective experiences

- **In an NDE, the locus of the NDEr's awareness shifts from being within the body to outside the body with veridical perceptions of the surroundings**
- **When out of body, the mind appears to be a nonmaterial "field of consciousness," a region of space where the person's consciousness exists**
- **When out of body, the mind operates with its full mental faculties, although the body and brain have ceased to function**
- **The NDE appears to be a continuous, seamless experience of the *same self* who retains a continuity of memory from before the start of the NDE to after the return to the body**



Tibor Putnoki during his NDE

We propose that the NDEr's autonomous mind is the person's consciousness itself—it *is* the person himself/herself—the person's *mind entity*

- **When embodied, the nonmaterial mind entity is a three-dimensional field that is coextensive with the brain and body, merging with the brain and nervous system and operating through neural activity**
- **When embodied, the mind is intimately integrated with the physical body and, therefore, must interact in some way with the brain and body. At some level, this interaction has a physical effect within the neurons, resulting in conscious awareness**

. Putnoki, T. (2014). *9 minutes: My path to the Light* (Hungarian-English bilingual publication). Szeretet Fénye Közhaszú Alapítvány

Substance dualist NDE research: the cause of all NDEs

- **A 2014 study by Vanessa Charland-Verville et al. showed no significant difference in intensity or content between NDEs associated with:**
  - **Life-threatening events like cardiac arrest resulting in coma and**
  - **"NDE-like" experiences occurring, for instance during sleep, fainting, meditation, or alcohol use**
- **This result suggests that there is a *common proximate cause* of all NDEs, a common mechanism resulting in the NDE**

We argue that the separation of the mind entity from the physical body is the proximate cause of all NDEs (Mays & Mays, 2015)

- **This position was confirmed by an analysis of NDE Scale data from 565 NDEs** (Mays & Mays, 2024)
  - **We selected the nine "separation-related features" of the Scale that directly or indirectly imply the separation of consciousness from the physical body**
  - **When listed in order of prevalence, "separated from the body" accounted for more than 80% of cases; the top two features accounted for nearly 95% of cases; and all nine features accounted for 99.3% of cases**
- **The nine separation features describe a *coherent course of events* beginning with a separation of the NDEr's consciousness from the physical body, suggesting that *NDEs are universal***

Scale Item	Scale question	Individual prevalence	Cumulative prevalence
N12	Separated from your body?	81.4%	81.4%
N14	Encountered a mystical being or presence?	74.3%	94.9%
N13	Entered some other, unearthly world?	74.0%	97.2%
N8	Surrounded by a brilliant light?	68.5%	98.4%
N16	Reached a border or point of no return?	59.1%	98.8%
N15	Encountered deceased or religious spirits?	50.3%	98.8%
N10	Aware of things going on elsewhere (ESP)?	34.7%	98.8%
N3	See scenes from your past?	26.9%	99.1%
N11	See scenes from the future?	25.8%	99.3%

- Charland-Verville, V., Jourdan, J.-P., Thonnard, M., Ledoux, D., Donneau, A.-F., Quertemont, E., & Laureys, S. (2014). Near-death experiences in non-life-threatening events and coma of different etiologies. *Frontiers in human neuroscience, 8*, 203. doi:10.3389/fnhum.2014.00203
- Mays, R. G., & Mays, S. B. (2015). Explaining near-death experiences: Physical or non-physical causation?. *Journal of Near-Death Studies, 33*(3), 125–149.
- Mays, R. G., & Mays, S. B. (2024). Near-death experiences are caused by the separation of consciousness from the body: An NDE Scale analysis. *Journal of Scientific Exploration, 38*(2), 190–211.

The empirical study of NDEs is valid

- **The best estimate is that about 5% of the world's population, about 400 million people worldwide, have had an NDE** (Mays & Mays, 2021, p. 4)
  - **NDEs have consistent, well-defined characteristic features with remarkable uniformity of the NDE elements for people of all ages and across many cultures**
  - **For example, about 35% report hearing the same idiosyncratic admonition: "You must go back; it's not your time; you have more to do on Earth"**
- **NDE accounts are *empirical* observations**
  - **NDErs are credible eyewitnesses to their experiences**
  - **Independent corroboration from other credible witnesses of the phenomenon provides further objective evidence to the NDEr's testimony** (Rivas et al. 2023)
  - **Memories of the NDE are more real than ordinary memories, do not change over time, and are dependable** (Greyson, 2007, Moore & Greyson, 2017)
- **NDE accounts provide *objective* empirical evidence**
  - **Elements reported by millions of NDErs represent a common, objective reality witnessed and shared by many people, providing strong objective evidence**
  - **Therefore, researchers are justified in accepting NDEs as providing valid data for scientific study, using the same rigorous empirical observations as in any other field of science**

- Greyson, B. (2007). Consistency of near-death experience accounts over two decades: Are reports embellished over time?. *Resuscitation, 73*(3), 407–411.
- Mays, R. G., & Mays, S. B. (2021). There is no death: Near-death experience evidence for survival after permanent bodily death. Bigelow Institute for Consciousness Studies. Also in *Winning essays 2023: Proof of survival of human consciousness beyond permanent bodily death* (Vol. 4, pp. 1–85).
- Moore, L. E., & Greyson, B. (2017). Characteristics of memories for near-death experiences. *Consciousness and Cognition, 51*, 116–124.
- Rivas, T., Dirven, A., & Smit, R. H. (2023). *The self does not die: Verified paranormal phenomena from near-death experiences* (2nd edition). International Association for Near-Death Studies.

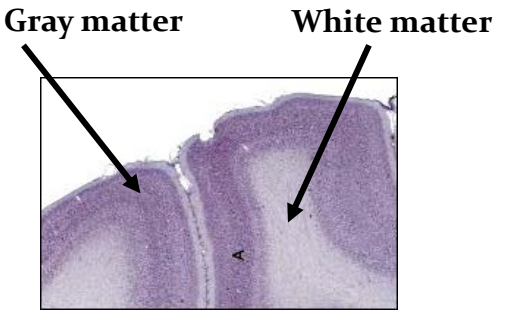
Mind entity is a distinct ontological category

- **The mind entity fulfills the eight substance dualist criteria for a thing that has mental states** (Rickabaugh & Moreland, 2024, p. 303)
  - **In an NDE, the mind entity separates from the physical body, leaving the body effectively dead, and later rejoins and re-enlivens the body**
  - **Hundreds of millions of these cases show that the mind entity is essentially, wholly, and intrinsically distinct from the physical body and is the carrier of the body's forces**

Substance Dualist Criterion	Mind Entity
Exemplifies mental properties	Possesses mental and cognitive faculties of perception, thought, volition, memory, and feelings
Holistically unifies mental properties	Is a thinking, perceiving, feeling, and volitional being with the capacity to form and recall memories
Has continuing mental states	Its mental and cognitive faculties are unified in the mind entity as a center of consciousness in-body and out-of-body
Refers to itself as "I"	As the center of the person's sense of self, the mind entity refers to itself as "I"
Has an irreducible "First-Person Point of View"	Its mental and cognitive faculties are exercised through a first-person perspective
When disembodied is a unified center of consciousness	Endures over time and has a continuous sense of self throughout physical embodiment and during the separation from and return to the physical body
Displays the power to be necessarily a "Thinker of Thoughts"	Is a thinking being with the capacity to intuit, reason, analyze, and plan
Exercises active power and purposefully guides deliberative processes toward an end	Has a sense of agency and can direct and guide its will toward a purposeful outcome

The empirical evidence from NDEs shows that *the mind entity* is not only *metaphysically possible* but is also *metaphysically real* and is a *separate ontological category* distinct from the physical body and other physical objects

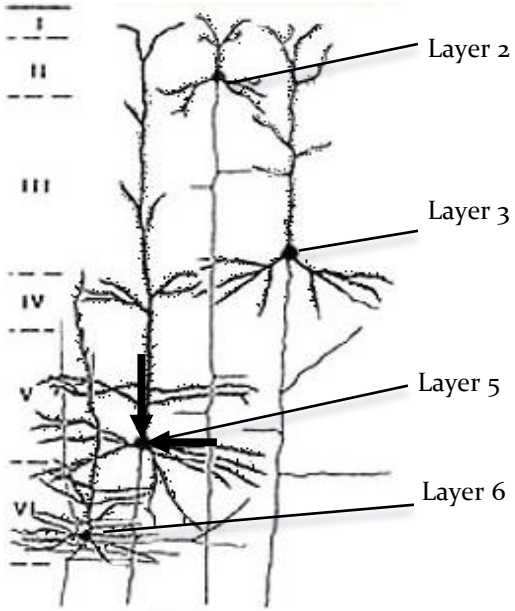
Basic neurological principles …



- Cortical gray matter is the major component in the upper 2–4 mm of the cerebral cortex, consisting of neural cells
- Pyramidal cortical neurons make up most of the neurons in the gray matter of the cortex
  - They have vertical apical dendrites reaching from the soma to the surface and basal dendrites branching out horizontally from the soma
- Dendritic spines are tiny nodules on the surface of the dendrites
  - Neurons connect to other neurons through a *synapse* from the axon of one neuron to the dendritic spine of the other
  - The sending neuron releases a neurotransmitter that activates the receiving neuron's spine and dendrite
  - *Excitatory neurotransmitters* can lead to an accumulation of charge in the soma, causing the neuron to generate an action potential
  - *Inhibitory neurotransmitters* can prevent the neuron from firing

We propose a *second purpose* for dendritic spines, that the *mind entity* can *also* trigger action potentials by interacting with the spines

Dendritic spines

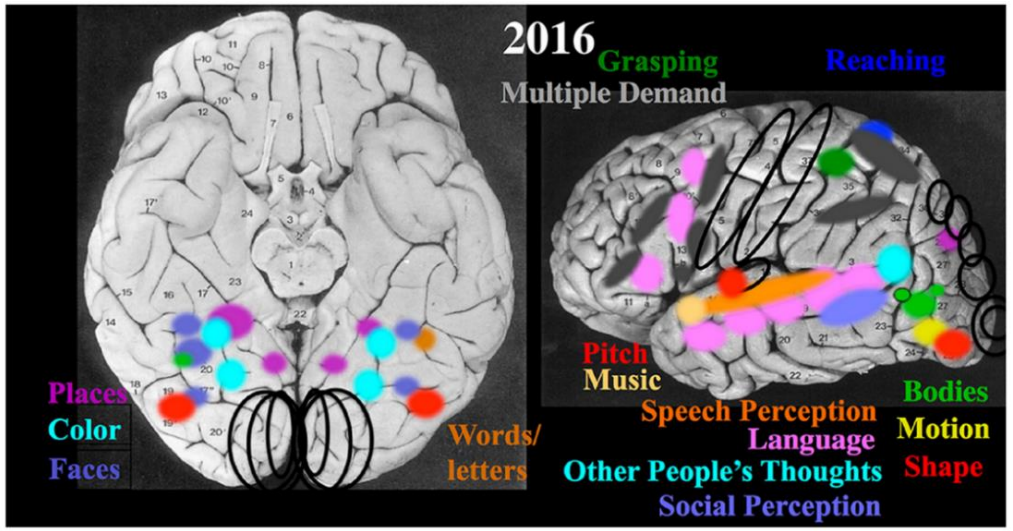


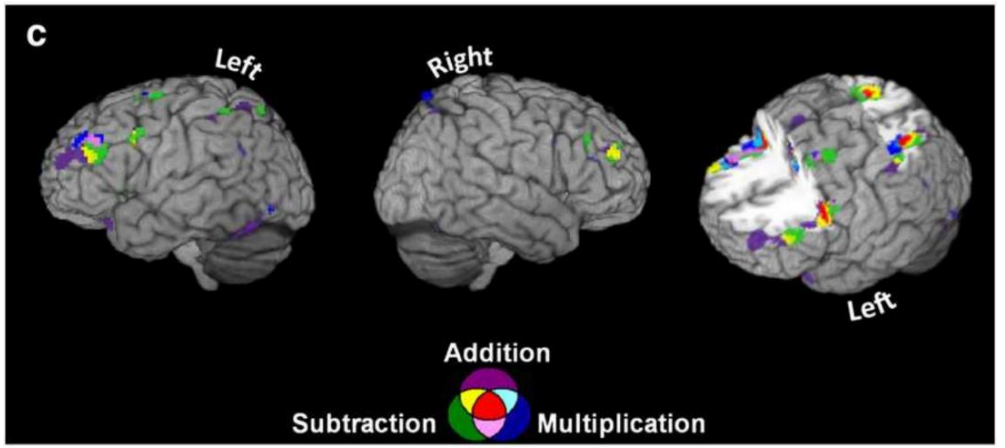
Cortical pyramidal neurons in layers 2, 3, 5, and 6 with apical and basal dendrites

Basic neurological principles

The modular cortical organization of the brain

- The cortex is organized in *specialized domains* or modules responsible for specific mental functions such as recognition of faces, words, shapes, speech, language, pitch, places, and so on
- The evidence for these domains comes from functional magnetic resonance imaging (fMRI) studies which associate activation of a specific module with specific mental activities (Kanwisher, 2010; Kanwisher, 2017)
- The domains can be very specific in function
- Related functions can have overlapping domains, for example separate and overlapping domains for addition, subtraction, and multiplication mental operations (Arsalidou, 2011)
- There are also a number of *generalized domains* in the frontal and parietal regions that support general purpose cognitive and neural mechanisms "from mental arithmetic, to holding information in working memory, to filtering and suppressing task-irrelevant information" (Fedorenko et al., 2013)





- Arsalidou, M., & Taylor, M. J. (2011). Is 2+ 2= 4? Meta-analyses of brain areas needed for numbers and calculations. *Neuroimage, 54*(3), 2382–2393.
- Fedorenko, E., Duncan, J., & Kanwisher, N. (2013). Broad domain generality in focal regions of frontal and parietal cortex. *Proceedings of the national academy of sciences, 110*(41), 16616–16621.
- Kanwisher, N. (2010). Functional specificity in the human brain: a window into the functional architecture of the mind. *Proceedings of the national academy of sciences, 107*(25), 11163–11170.
- Kanwisher, N. (2017). The quest for the FFA and where it led. *Journal of neuroscience, 37*(5), 1056–1061.

Basic mind entity principles for embodied consciousness

The mind entity framework differs radically from the physicalist neuroscientific framework

- **The mind entity is a unitary being, a *separate ontological category***
  - **It is the seat of consciousness, the locus of personal identity, separate from the physical body**
  - **It is the being or soul of the individuated person**
- **Brain processes do not *generate* consciousness**
  - **There are no neural calculations, no neural representations of mental content**
  - **There is no neural storage of short-term or long-term memories or of "working" memory**
- **The mind entity can exist in two different states: embodied within a physical body or separate from it**
  - **During embodiment, neural activity *supports* the mind's cognitive faculties**
  - **Therefore, the mind must be able to work with the brain to *detect* and to *induce* neural activity**
  - **The presence of neural activity (except in sensory areas) *indicates the activity of the mind to bring its mental content to awareness***
- **Embodied awareness requires cortical neural activity**
  - **Neural activity from the primary senses produces *percepts***
  - **Neural activity induced or triggered by the mind brings *conceptual content* to awareness**
- **Memory is "carried" in the mind, rather than stored in the brain; the hippocampi act as an *interface* with the mind**
  - **All declarative and episodic memories are accessible *during the NDE,* and new episodic memories are formed *during the NDE***
  - **So-called "long-term potentiation" occurs with the mind's repeated activity in memory formation and recall, by using common hippocampal neural pathways**

Mind entity interactions with physical processes

- **Evidence of interactions of the out-of-body "body" with physical matter:**
  - **The NDEr felt resistance passing through solid matter (layers of insulation, a door)**
  - **The NDEr sensed penetrating a person's body as "a rarified gelatin with electricity running through it" or "a thick liquid"**
  - **A person's body pushed or "wafted" the NDEr's "body"**
  - **The NDEr's "body" interacted with a person's body, and the person reacted as if tickled**
  - **The NDEr "merged" with a person's body and could see through their eyes and hear their thoughts**
- **Different *forms* of interactions:**
  - **Accurate visual perceptions, depending on ambient light, imply interaction with *electromagnetic radiation* (light waves)**
  - **Accurate auditory perceptions imply interaction with *sound vibrations* (coherent movements of air molecules)**
  - **Accurate olfactory perceptions imply interaction with the *unique molecular structures of odoriferous substances***
  - **Subtle interactions with solid surfaces (touching solid surfaces, bobbing against the ceiling) imply interaction with a *solid surface***
  - **Sudden movement of a person, pushing the NDEr or causing a "wafting" of their form implies a *pressure against the NDEr's "body"***
  - **Interactions with living tissue with a sensation of a viscous or gelatinous substance imply a *weaker interaction within a living body* than passing through solid matter**
  - **Interactions passing through solid objects (a resistance or change in density) imply interaction with the *solid object's rigid matrix of electrons and atomic nuclei***
  - **Feeling electricity when penetrating another person's body and the ability to merge with a person and interface with their neural activity imply an *interaction to <u>sense</u> neural action potentials***
  - **The ability to tickle a person causing the person to react implies *interactions with neurons to <u>induce</u> neural action potentials***

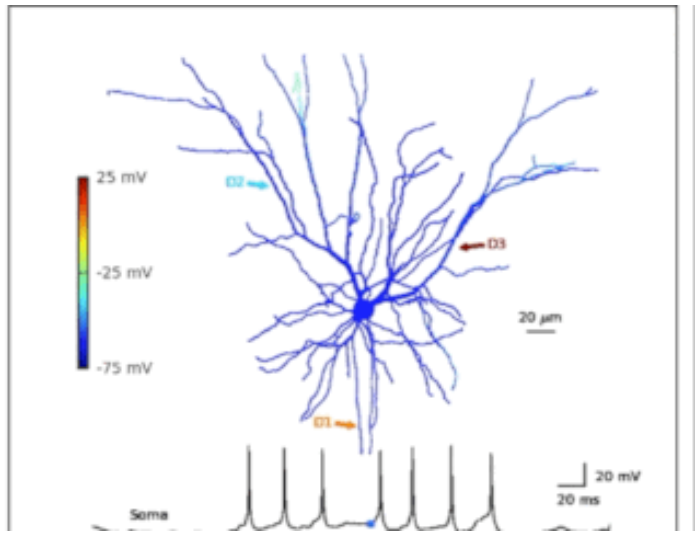
Analysis of forms of physical interactions

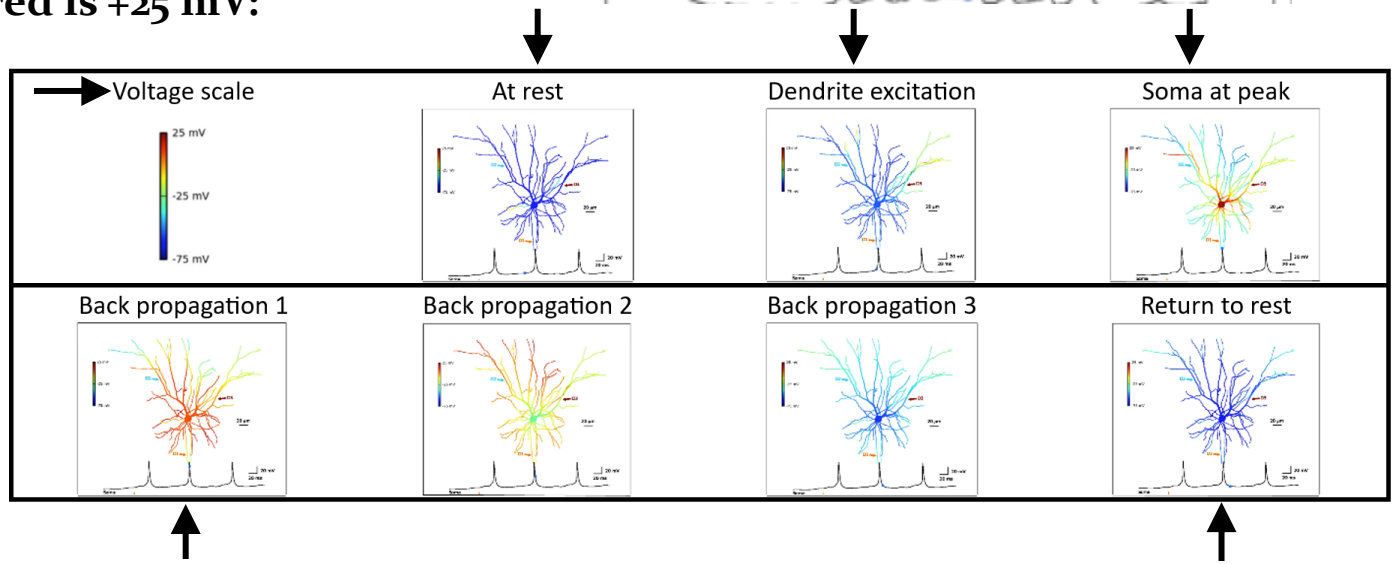
- The out-of-body NDEr perceives directly *without* physical sense organs in these ways:
  - *visually* via direct interaction with the electromagnetic waves of visible light
  - *auditorily* with the sound vibrations of molecules in the air
  - *tactilely* with the molecules at the surface of solid objects
  - *olfactorily* with the molecular structures of specific substances
  - *senses resistance* when penetrating the atoms and molecules in fluids or solid objects
- Therefore, the mechanisms of the mind entity's interactions are, in order of increasing density of matter and force of resistance:
  - Interactions with the weak force of electromagnetic waves (photons) in light
  - Interactions with the weak force of the molecular *shape* of volatile odoriferous substances
  - Interactions with the weak resistance forces of air molecules in sound waves
  - Interactions with the somewhat stronger resistance forces of the molecules within fluids or within a living organism's body
  - Interactions with the strong resistance forces in the densely packed matrix of atomic nuclei and electrons in solid matter

- Resistance experienced in solid matter indicates that the mind entity can *exert a subtle force on physical matter*
- According to Newton's third law of motion, the force of interaction with solid matter is a *two-way push-pull force*

Mechanism to *detect* action potentials

- **We propose that the *spiking of neural action potentials* in the cortex can be detected by the mind**
  - **Neurons at rest have a strongly negative charge**
  - **An action potential is a sudden pulse of positive charge starting in the soma and quickly spreading outward through the dendritic arbor**
- **This video shows an action potential spike in a single L2/L3 mouse neuron in the primary visual cortex *in vivo*** (Smith et al., 2013)
- **The neuron was injected with a *voltage-sensitive dye* to show the change in voltage**
- **Dark blue is –75 mV at rest, yellow is 0 mV and dark red is +25 mV:**
  - **The neuron is at rest (dark blue)**
  - **There is excitation in a dendrite (light blue)**
  - **The soma quickly reaches a peak (dark red)**
  - **The positive charge quickly propagates backwards (red-orange)**
  - **The neuron quickly returns to resting state (light blue to dark blue)**
- **The mind detects simultaneous coherent spiking of numerous neurons in a specific brain region**
  - ***Bringing specific mental content to awareness***

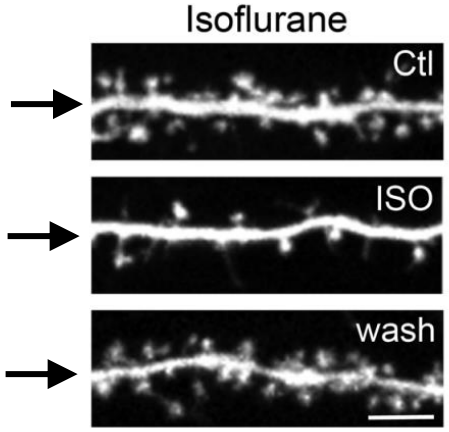




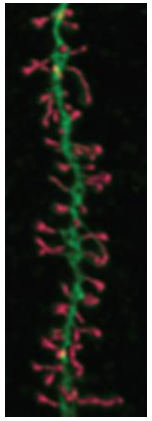
- Smith, S. L., Smith, I. T., Branco, T., & Häusser, M. (2013). Dendritic spikes enhance stimulus selectivity in cortical neurons in vivo. Supplementary information. *Nature, 503*, 115–120.

Mechanism to *induce* action potentials

- We propose that the mind triggers action potentials in specific brain regions to bring its mental content to awareness
  - Otherwise, the mental content remains subliminal
  - How does the mind *trigger* action potentials?
- *Volatile* or *inhalational anesthetics*, like diethyl ether or isoflurane, readily cause the loss of consciousness and, therefore, *inhibit* the action of the mind
- Volatile anesthetics *also* alter the properties of the *dendritic spines* on the pyramidal neurons



- The volatile anesthetics pass through the spine wall and *unravel* the spine's *cytoskeleton* causing the spines temporarily to shrink and collapse (Platholi et al., 2014)
  - This diagram shows the effects of isoflurane anesthetic; the normal spine structure is at the top
  - Then with isoflurane at clinical concentrations, the spines have shrunk and collapsed (middle)
  - These effects are reversed when the anesthetic is washed out and the cytoskeleton has *reassembled* (bottom)



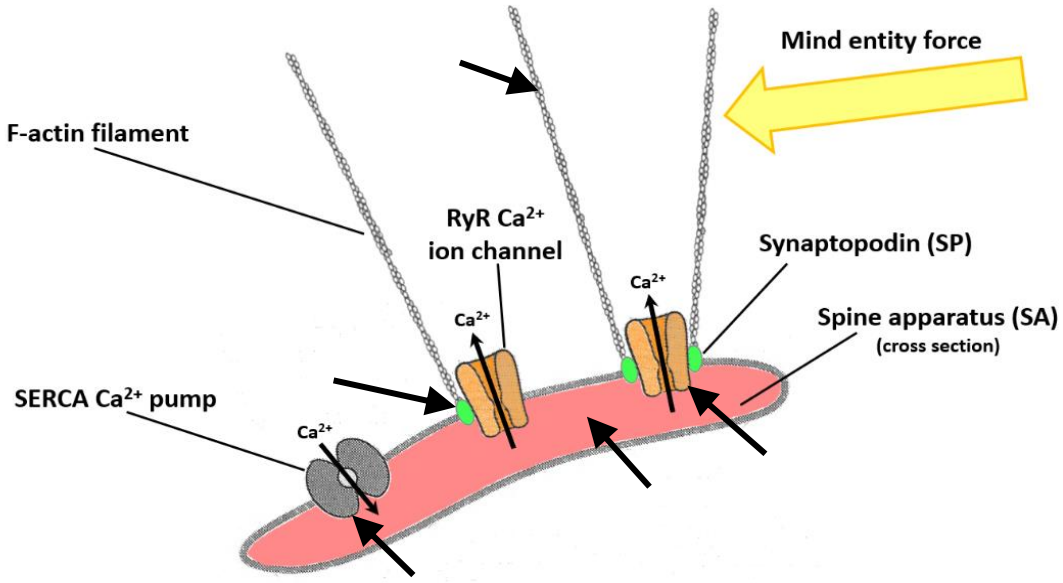
Dendritic spines (red)

- The internal *spine cytoskeleton* consists of numerous microfilaments of a substance called F-actin
  - The F-actin filaments maintain the spine's *shape* and *rigidity*
  - F-actin filaments are polymers of a basic "actin" unit, strung together
  - These structural filaments are *unraveled* by volatile anesthetics and can subsequently be *reassembled*

- Platholi, J., Herold, K. F., Hemmings Jr, H. C., & Halpain, S. (2014). Isoflurane reversibly destabilizes hippocampal dendritic spines by an actin-dependent mechanism. *PLoS One*, *9*(7), e102978.

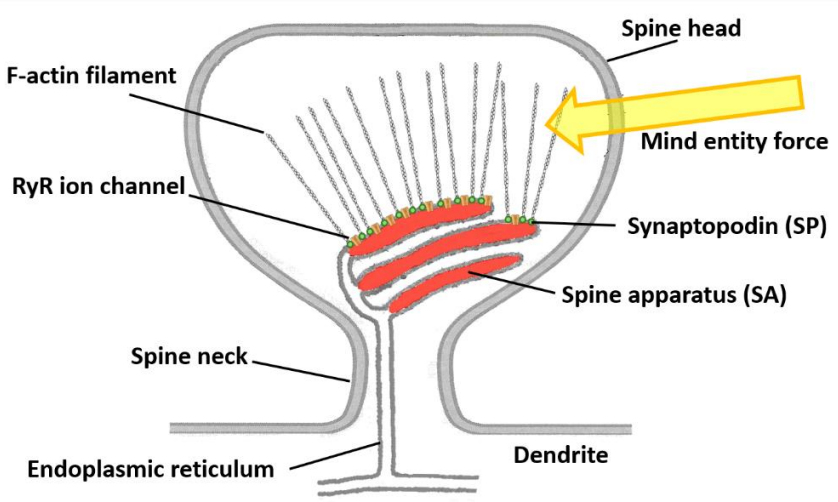
Mechanism to *induce* action potentials …

- Volatile anesthetics cause the loss of consciousness; they *also* unravel the F-actin filaments in dendritic spines
- Because these facts appear to be related, we propose:
  - The *interface* for the mind to *trigger* action potentials is located *in the dendritic spines*
  - The *mechanism* of interaction must rely on interaction of the *mind* with spine F-actin filaments and would be disrupted by anesthetics, preventing mind-induced neural activity and subjective awareness
- We propose such an interface and mechanism exists in the dendritic spines
  - Ordinarily, spines make *neuron-neuron connections* in which an axon impulse triggers neurotransmitter release at the synapse with the spine
  - We propose a *mind-neuron connection* wherein the *mind* triggers cortical action potentials by exerting a slight force against F-actin filaments which mechanically releases positive Ca^{2+} ions to trigger the action potential
- The main functional elements in the spine to do this are:
  - The spine apparatus compartment (SA), an extension of the cell's endoplasmic reticulum, containing a store of Ca^{2+} ions (red)
  - Ryanodine (RyR) ion channels which release Ca^{2+} ions from the SA into the spine when triggered (orange)
  - F-actin filaments anchored on a synaptopodin (SP) protein, next to and touching the RyR channel (green)
  - *Mechanical coupling* between the F-actin-SP assembly and the adjacent RyR channel triggers the channel's opening (green & orange touching)
  - SERCA Ca^{2+} pumps which transfer excess Ca^{2+} ions from the spine back into the SA store (gray)
- The force of the mind entity on the filaments is sufficient to open the RyR channels
  - A sufficient Ca^{2+} ion release triggers an action potential
  - SERCA pumps transfer Ca^{2+} ions from the spine's intracellular fluid back into the SA



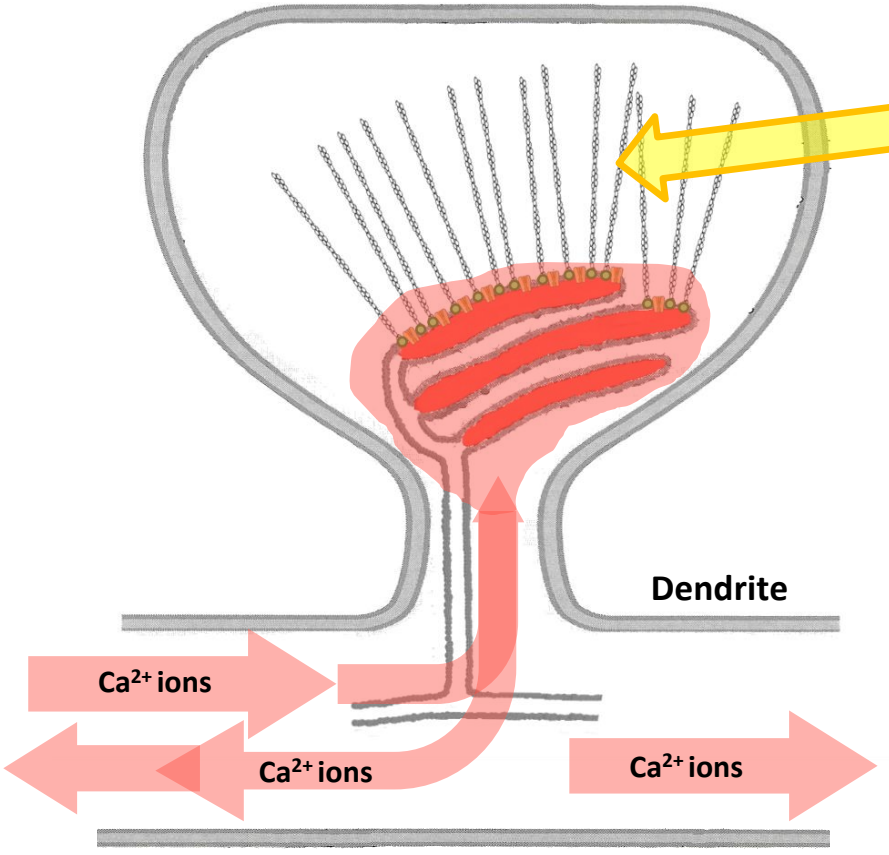
Main functional elements of the mind-spine interface

Mechanism to *induce* action potentials …



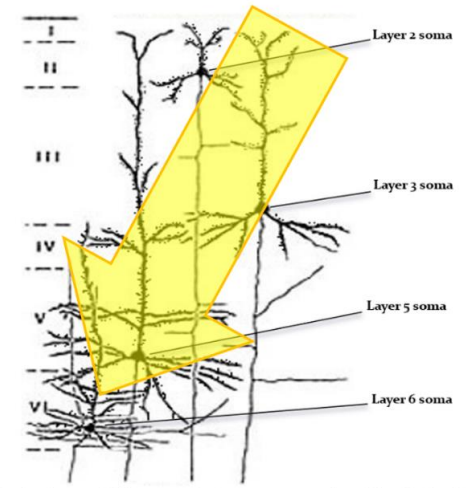
- A conceptual model of the mind-interface spine shows how these elements are arranged
- The mind entity impresses its field into the cortical gray matter and penetrates the spines
- The mind *triggers* the release of Ca^{2+} ions from the spine apparatus by interacting mechanically with the spine apparatus filaments
- The force needed to trigger the F-actin filaments is likely very small, probably comparable to the subtle resistance NDErs report when passing through solid matter

- The mind entity's force against the filaments moves synaptopodin (SP) proteins against their adjacent RyR channels
- Causing a brief "mind-induced calcium release"
- The positive Ca^{2+} ions flow into the dendrite down to the soma; enough dendritic spikes can then trigger an action potential
- The action potential, in turn, causes an influx of Ca^{2+} ions *back* throughout the dendrites and spines
- The Ca^{2+} ions are stored again in the spine apparatus—resetting the neuron for further action potentials
- Similar calcium-driven mechanisms are well-understood and operate throughout the body, for example in regulating the heartbeat and skeletal muscle contractions

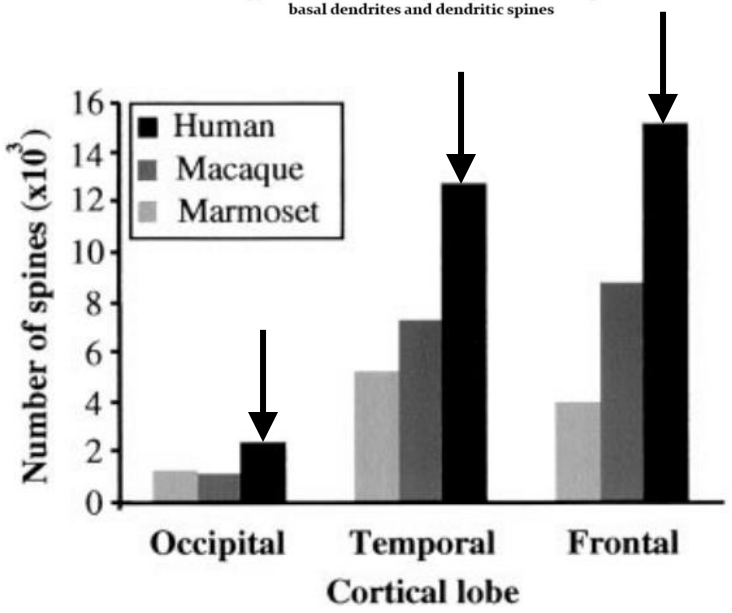


Mechanism to *induce* action potentials

- The mind entity does not act on individual spines, but rather on segments of a brain region, probably on the order of a cortical column, containing 7,000 neurons, about 0.5 mm in diameter
  - In activating a cortical column, the mind entity would activate countless dendritic spines
  - Ca^{2+} ions released from countless spines generate widespread action potentials in the brain region, which the mind detects as a surge of neural activity in the region
- The activation of specific brain regions brings certain mental content into awareness
  - Neural activity "mirrors" this content to the mind, which then becomes conscious of it
- In the mind entity theory, the mind activates cortical regions, depending on the mental content, except in the primary sensory regions for sight, hearing, and touch
  - Since the primary sensory areas are purely input modalities, the mind does not activate these areas
  - These points suggest that there should be *more dendritic spines* in temporal and frontal regions compared to the primary sensory regions
- This prediction is validated by studies done by Guy Elston, for example in estimating the number of spines in different regions of the cortex (Elston et al., 2001)
  - In the human brain, the dendritic spine densities are significantly higher in the temporal and frontal lobes compared with the occipital lobe



Cortical pyramidal neurons in layers 2, 3, 5, and 6 with apical and basal dendrites and dendritic spines



- Elston, G. N., Benavides-Piccione, R., & DeFelipe, J. (2001). The pyramidal cell in cognition: a comparative study in human and monkey. *Journal of neuroscience*, *21*(17), RC163-RC163.

Coming to awareness

Delayed awareness and subliminality

Benjamin Libet
(1916-2007)

- Neuroscientist Benjamin Libet found that it takes time for neural activation to build up to conscious awareness
  - Libet's "time-on" principle (2004): subjective awareness requires a minimum duration of 300–500 msec of neural activity. Otherwise, the stimulus remains unconscious (a "subliminal" stimulation)
- Libet distinguished between *detection* and *subjective awareness*
  - Before awareness occurs, the stimulus is still *detected*
  - Responses can happen within 100 msec, such as braking a car when a child appears suddenly in the street
  - If neural activity duration is under 300 msec, the stimulus stays subliminal and does not reach conscious awareness, but is still detected by the mind such that the driver instinctively avoids hitting the child

Coming to awareness ("Ignition")

Stanislas
Dehaene

- Coming to awareness or ignition was confirmed by the study done by Stanislas Dehaene et al. (2001) and related studies
  - Dehaene found that a visual word that is *flashed* for only 30 msec remains readable
  - However, when the word is presented immediately followed by a "masking" image, the word becomes indistinct or even invisible
  - When words are visible (unmasked), there is propagation of neural activation and "ignition" of large-scale correlated brain regions
  - There is a sudden, coherent activation of specific brain regions that "code" for the specific mental content
- The process of coming to awareness applies to *all* awareness, of sensory perceptions and *also* of thoughts, imaginations, etc.

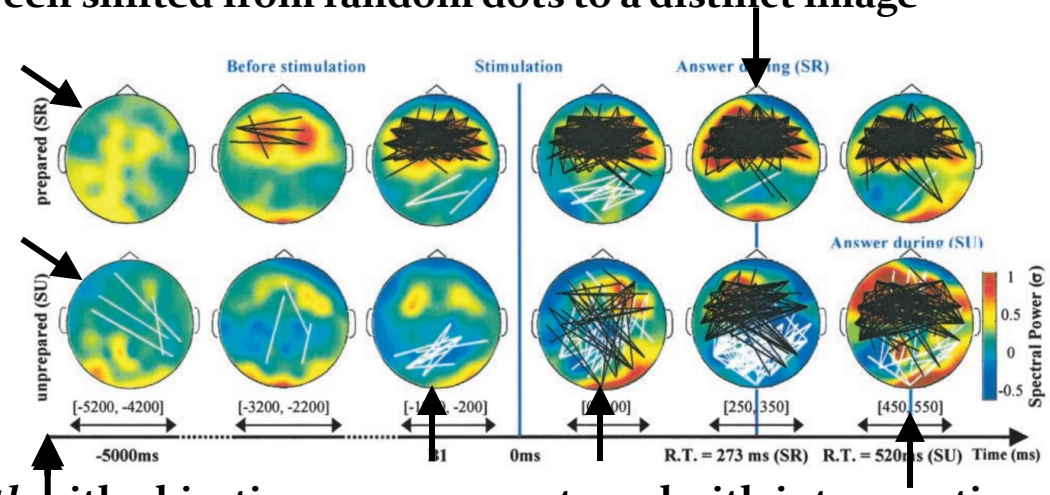
In our view, *the primary function of neural activations is to make mental content conscious*

- Dehaene, S., Naccache, L., Cohen, L., Bihan, D. L., Mangin, J. F., Poline, J. B., & Rivière, D. (2001). Cerebral mechanisms of word masking and unconscious repetition priming. *Nature neuroscience*, *4*(7), 752–758.
- Libet, B. (2004). *Mind time: The temporal factor in consciousness*. Harvard University Press.

Long-distance neural synchrony

Francisco Varela
(1946-2001)

- **Neuroscientist Francisco Varela introduced *neurophenomenology*, a method that correlates the subject's first-person accounts with the observed neural activity** (1996)
  - **Applying the method to a specific cognitive task, Varela and colleagues showed a striking correlation between neural activity and the subjects' subjective experiences** (Lutz et al., 2002; Lutz & Thompson, 2003)
- **Subjects viewed a three-dimensional autostereoscopic image as the screen shifted from random dots to a distinct image**
  - **They were trained to identify their subjective experiences as they tried to focus on the screen to be ready for the image to appear**
  - **These scans show one subject's results: <u>On the top row</u>, the subject had focused attention (shown by the synchronous EEG lines in the frontal region), quickly recognized the image, and responded in 273 msec**
  - **<u>On the 2nd row</u>, the subject was distracted (shown by the lack of synchrony beforehand), was surprised when the image began to be visible (shown by the weaker, disorganized synchrony), and responded in 520 msec**
  - **The subject's different subjective experiences matched the EEG patterns**



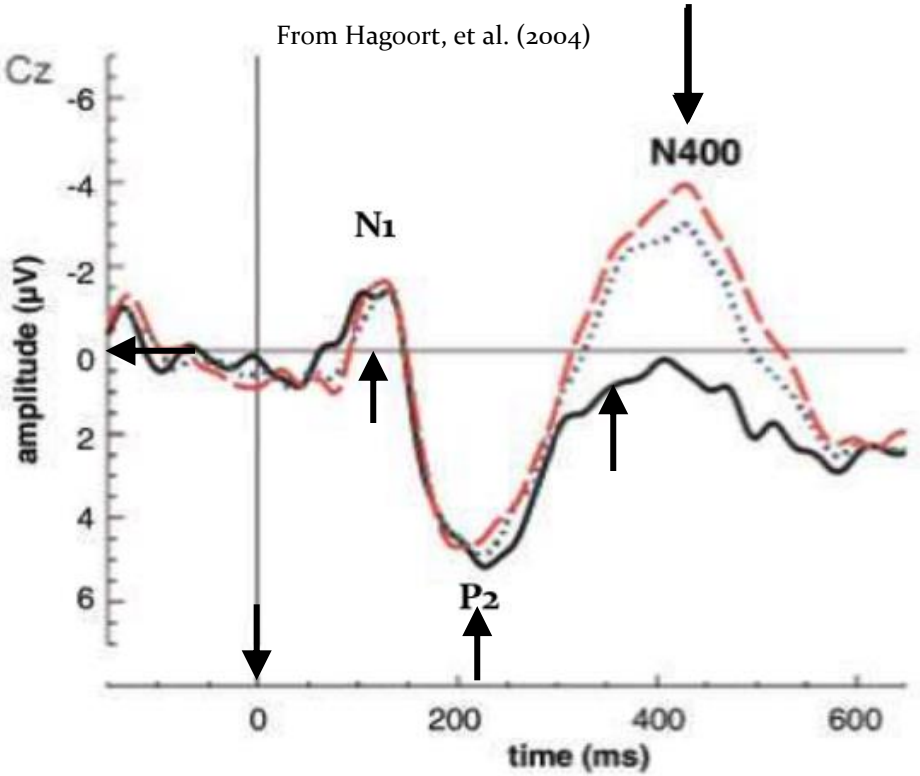
- **These studies demonstrated that the mind's activity can be studied *both* with objective measurements and with introspection of the subject's experiences in an experimental setting**
  - **The uniqueness of the mind's activity in each trial is reflected in the brain's neural signature**
  - **Its unique neural signature mirrors the subject's cognitive strategy or aptitude to perform the perceptual task**
  - **The mind's idiosyncratic activity appears as idiosyncratic *neural activity* which strongly suggests that *the mind drives* the brain's activity**
  - **In our view, the mind's activity is the *crucial determinant* of the experimental result.**

- Varela, F. J. (1996). Neurophenomenology: A methodological remedy for the hard problem. *Journal of Consciousness Studies*, *3*(4), 330-349.
- Lutz, A., Lachaux, J. P., Martinerie, J., & Varela, F. J. (2002). Guiding the study of brain dynamics by using first-person data: Synchrony patterns correlate with ongoing conscious states during a simple visual task. *Proceedings of the National Academy of Sciences*, *99*(3), 1586–1591.
- Lutz, A., & Thompson, E. (2003). Neurophenomenology: Integrating subjective experience and brain dynamics in the neuroscience of consciousness. *Journal of consciousness studies*, *10*(9–10), 31–52.

Steps of cognition in perception …

- **In our view, the mind is engaged throughout the process of "coming to awareness"—from detection to subjective awareness**
  - **The mind induces its mental content by *activating* the specific brain regions for that cognitive content**
  - **The *neural activations* in these regions bring the mental content to subjective awareness**
- **To explore how the mind works with the brain, we'd like to examine what goes on in the brain when we read a word**
- **The distinctive EEG pattern called N400 shows that the mind proceeds in distinct steps over time and in distinct brain regions during perception and comprehension** (Kutas & Federmeier, 2011)
  - **When reading words, an incongruent word in a sentence evokes a strong minus voltage**
- **In our view, the full process for reading a single word happens this way:**
  - **At 115 ms (N1): the minus voltage is associated with detecting the *word percept* (form of the word)**
  - **At 200 ms (P2): the plus voltage is associated with detecting the *meaning* of the word (concept)**
  - **At 400 ms (N400): strong minus voltage is associated with awareness of how congruent or incongruent the word is in *context***
- **Perception and comprehension proceed in three distinct stages:**
  - **Detect the *form* of the word**
  - **Recognize the *meaning* of the word**
  - **Evaluate the word's meaning *in the current context* as the word comes to awareness**
  - **The mind is involved *at each stage***

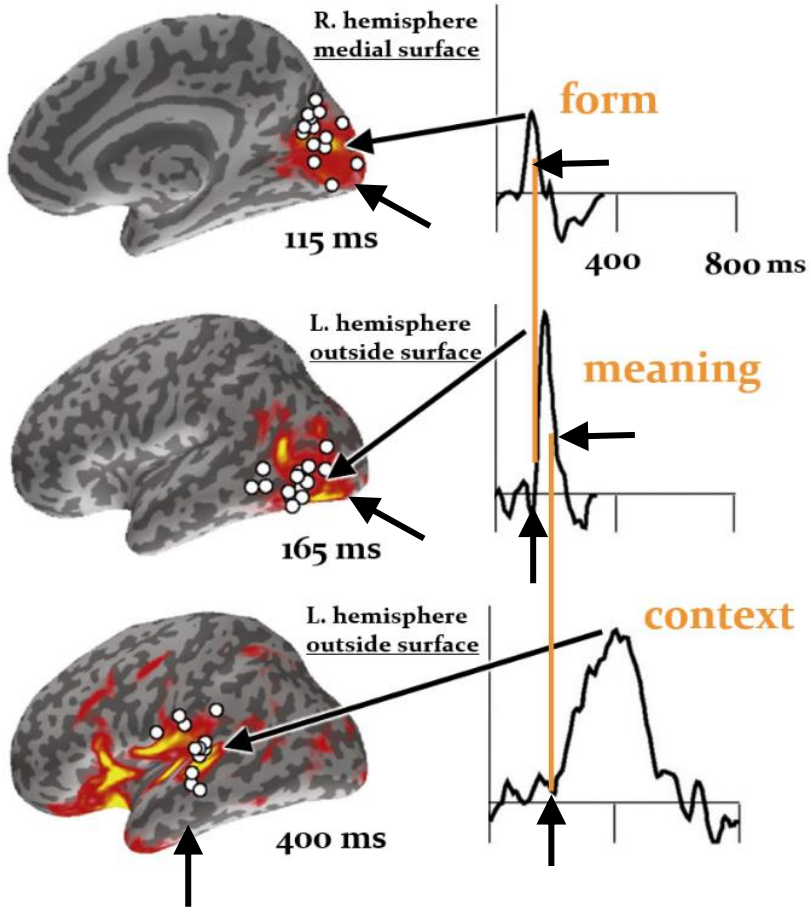
From Hagoort, et al. (2004)



- Hagoort, P., Hald, L., Bastiaansen, M., & Petersson, K. M. (2004). Integration of word meaning and world knowledge in language comprehension. *science*, *304*(5669), 438-441.
- Kutas, M., & Federmeier, K. D. (2011). Thirty years and counting: finding meaning in the N400 component of the event-related brain potential (ERP). *Annual review of psychology*, *62*(1), 621–647.

Steps of cognition in perception

- **In reading a single word, the mind *also* engages three specific *regions* of the brain as can be shown using magnetoencephalography (MEG)**
- **These images are MEG recordings of reading a novel word, producing a large magnetic N400m, similar to the N400 recordings** (Hari et al., 2012, pp. 389–390)
  1. **At 115 ms: activation in the medial occipital area is associated with detecting the word percept (form). Note this is showing the *inside* or medial surface of the *right* hemisphere**
  2. **At 165 ms: activation in the fusiform and occipitotemporal areas is associated with detecting the meaning of the word (concept) in the "visual word form area"**
  3. **At 400 ms: activation in superior temporal and prefrontal areas is associated with awareness of the word in the current context**
  - **Each new word adds to and builds the context of the sentence in the mind**
- **Note the *timing gap* between steps 1 & 2 (Pause A), and steps 2 & 3 (Pause B)**
  - **Pause A: In this gap, we propose the mind recognizes the percept as the form of an English word, intuits its meaning, and activates the next region, the visual word form area**
  - **Pause B: In this gap, we propose the mind recognizes the concept of the word and evaluates the *congruity* or *incongruity* of the word in the *context* of the sentence. The mind activates the next regions to bring the *revised context* of the sentence to awareness**
- **There is no apparent neural activity during the pauses that warrant a *neural basis* for the mind's activity during these pauses**



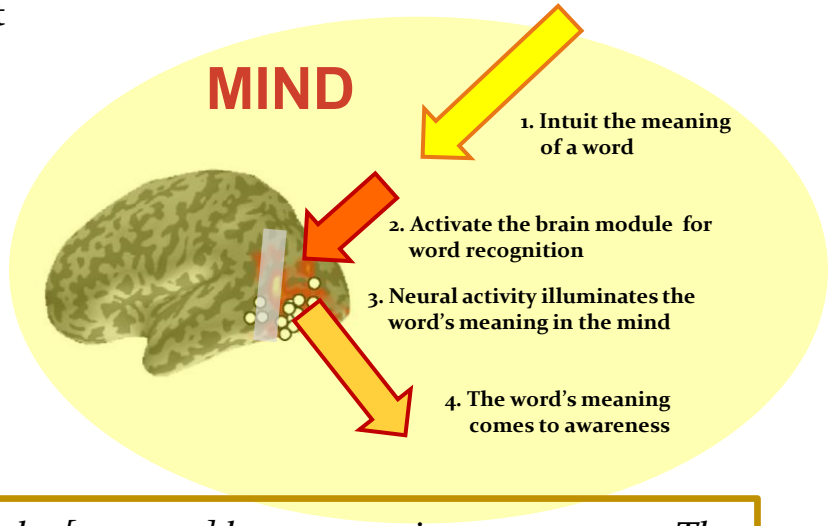
- Hari, R., & Salmelin, R. (2012). Magnetoencephalography: from SQUIDs to neuroscience: Neuroimage 20th anniversary special edition. *Neuroimage, 61*(2), 386-396.

Elaboration of coming to awareness ("mirroring")

- **We envision that the mind entity's three-dimensional field is coextensive with the brain's cortical surface, including sulci. Rather than standing apart from the brain, the mind merges with every part of the cortex, activating specific locations depending on its mental content**
- **We propose the neural activation in the region *mirrors* the mind's mental content *back to itself*. The activation *illuminates* its *mental content* so the mind can become aware of it**
- **As an analogy, physical embodiment is like being imprisoned in darkness. In a completely dark room, a man can stand in front of a mirror but will not see the message written on his forehead. If he shines a flashlight *at the mirror*, the reflected light will *illuminate* his forehead so he can read the message**
  - **When the mind has a thought, it triggers neural activity so the activity can *illuminate* its thought**

To illustrate the process of coming to awareness in more detail:

1. **The mind first receives the intuition of some mental content (for example the meaning of a word – yellow arrow)**
2. **The mind activates the brain module associated with that type of concept (red arrow)**
3. **The neural activation in that module *acts as a mirror* to illuminate that mental content in the mind**
4. **Finally, the conceptual content comes to awareness (orange arrow)**



Rudolf Steiner (1861-1925) similarly described the mind's activity in coming to awareness

"Human thinking-activity first lays hold of the brain and sets in motion [neural activity]; by this means the [neurons] become a mirror-apparatus. The thought is reflected, and the soul becomes conscious of the thought.

"Thus, there are two phases: first the [mind's] work on the brain in preparation of the experience; then after the [mind] has prepared the ground, the [awareness] takes place. The preparatory work on the brain remains entirely unconscious." (Steiner, 1914)

Steiner, R. (1914, January 23 / 2024). *Human and cosmic thought.* Rudolf Steiner Press.

Mind entity neuroscience vs physicalist neuroscience

The weight of empirical evidence from NDEs, in addition to empirical neuroscientific evidence, establishes the validity of:

- **An *additional ontological category*—the mind entity or soul—which has philosophical validity as a form of substance dualism. The mind entity/soul defines the "thinking thing"**
- **A *change of conceptual framework*: The mind entity is the seat of consciousness. Brain processes do not generate consciousness; rather, neural activity *triggered by the mind* enables the mind to come to awareness. There are no neural calculations, no neural representations of mental content, no neural storage of memories**
- **An *additional category of experimental data*, namely, first-person experiential reports used as valid empirical data as in neurophenomenology, rather than the use of computer simulations or mathematical modelling**
- **A *change of terminology*: the mind "triggers" action potentials in specialized regions and "detects" neural activity by back propagation *versus* performing "calculations" through synaptic connections in feedforward and feedback connectivity**
- ***Incommensurability*: A new framework revises the interpretation of neurological processes. It should be evaluated from its own reference point. The framework's entire conceptual web must be "laid down again on nature whole"** (Kuhn, 1970, pp. 149–150)

- Kuhn, T. S. (1970). *The structure of scientific revolutions* (2nd enl. ed.). University of Chicago Press.

Conclusion

Validation of substance dualism

- **Rickabaugh and Moreland suggested that a substance dualist research project could use the *empirical data* on NDEs to provide causal explanations of consciousness**
  - **Empirical evidence from NDEs supports the idea that the mind can separate from the body, implying the existence of a *mind entity,* a nonmaterial, spatially extended "field of consciousness," which is the locus of awareness of a human being**
  - **The features and properties of the mind entity fit the substance dualist list for a "thing that has mental states"**
  - **Thus, the empirical evidence from NDEs shows that *the mind entity* is not only *metaphysically possible,* but can also be considered *metaphysically real* as a *separate ontological category* distinct from the physical body**
  - **In support of these propositions, we have described a framework for embodied consciousness, plausible mechanisms for mind-brain interactions, and for the functional relationships between the mind and brain**

In our view, the evidence from NDE empirical phenomena validates the philosophical stance of substance dualism

- **A draft of the paper that this talk is based on is available on our website *selfconsciousmind.com***