Near-Death Experiences

and the Mind-Brain Framework

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The nature of scientific revolutions …

What are the factors *in the past* that enabled the rapid acceptance of a new scientific paradigm?

Two examples: (Butterfield, 1957)

- **In the development of the modern heliocentric theory of planetary motion:**
  - **Copernicus, Galileo, Kepler, and Descartes struggled to fit the observed motion of the planets around the sun**
  - **There was no comprehensive framework—certain planetary motions were *anomalous*—the motions didn't fit their models, which used epicycles, elliptical orbits, or planetary vortices**
  - **Isaac Newton developed a *new intellectual framework* that all bodies of mass attract one another at a distance—the universal law of gravitation, fully explaining the observed planetary motion**
- **In the development of the model of the internal structure of the atom in the early 1900s:**
  - **A number of models were proposed but again, there was no comprehensive framework—the problem was thought to be "too complex" to solve**
  - **Niels Bohr proposed a solar-system-like model based on Max Planck's *new intellectual framework* of *quantized energy* that fit the observed hydrogen spectrum precisely, within experimental error**

Isaac Newton
1643–1727

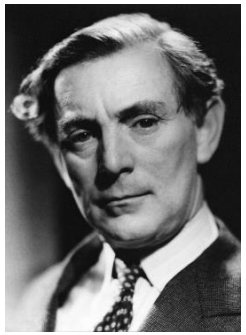
Niels Bohr
1885–1962

- Butterfield, H. (1957). *The origins of modern science 1300–1800*. Simon and Schuster.

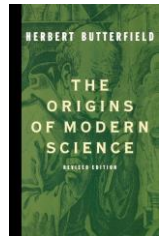
The nature of scientific revolutions

- **Common threads in the process of past scientific revolutions:**
  1. **Recognition of *anomalies*—phenomena *still* needing explanation**
  2. **Proliferation of theories to address some of the anomalies but were *formulated under the existing scientific framework*, resulting in *ad hoc* additions to the framework**
  3. **"[The problem] could not be solved … within the framework of the older system of ideas—it required a transposition in the mind"** (Butterfield, p. 17)
  4. **Leading-edge scientists adopted a radically new way of viewing the problem which led to a *new framework* and model**
     - **Newton proposed that gravitation *applies to all bodies of mass***
     - **Bohr applied Planck's non-continuous "*quantum*" *energy* to the electron in the hydrogen atom and ultimately to *all* atoms**

- **Therefore, the requirements for a successful scientific revolution are:**
  - **To develop an encompassing approach that "grasps the whole in a mighty synthesis"** (Butterfield, p. 57)
  - **To establish an "*adequate intellectual framework*," one that addresses the anomalies** (Butterfield, p. 203)
  - **To describe a theory and a model that *explains the anomalies*, providing a "demonstration that [fits] the facts (on the whole) when applied to the phenomena in detail"** (Butterfield, p. 39)
  - **The new theory needs to encompass *already understood* phenomena**



Herbert Butterfield
1900-1979

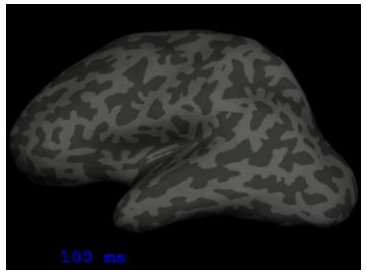


Origins of Modern Science

- Butterfield, H. (1957). *The origins of modern science 1300–1800*. Simon and Schuster.

A new intellectual framework for consciousness …

- What is consciousness?
  - How does it manifest in the world?
  - Does human consciousness survive the death of the physical body?
- There is a proliferation of theories about consciousness: physicalism, idealism, panpsychism, neutral monism, dualism
  - The "hard problem of consciousness" remains—
  - — Brain electrical activity *closely correlates* with conscious awareness ("neural correlates of consciousness")
  - — But the correlation does not address the fundamental question *how* brain activity produces *subjective experiences*
- We propose that consciousness is the experience of *subjective awareness* and manifests in the world *in living beings*, especially in individual human beings
  - Furthermore, consciousness needs to be described through *empirical evidence*, through our own subjective experiences and through the *reported* experiences of others.
  - The common experiences shared by numerous people can be taken as *objectively real*
- Subjectively, one's awareness has a *particular locus*, that is, it is *located* in a particular position in space and has a particular *perspective* or point of view
  - This is understandable because one is generally embodied in a particular physical body
  - One can "project" their locus of awareness, for example through an image-guided surgical instrument to perform microsurgery or through a flight simulator to practice flight maneuvers
  - Also, one experiences different *faculties* in addition to perception—thought, feelings, volition, memory, self-awareness, agency
- We call the ***center of subjective awareness*** the ***mind***, which has its particular locus and point of view



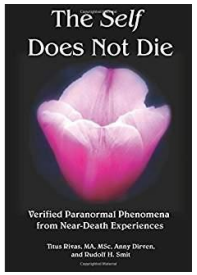
MEG sequence – reading a word, 385 msec

Marinkovic, K., Dhond, R. P., Dale, A. M., Glessner, M., Carr, V., & Halgren, E. (2003). Spatiotemporal dynamics of modality-specific and supramodal word processing. *Neuron*, *38*(3), 487-497.

A new intellectual framework for consciousness …

- **A new perspective is possible if we expand the existing framework for consciousness to include *anomalous experiences* of consciousness**
  - **"Anomalous" phenomena are phenomena that can't be readily explained in normal scientific terms**
  - **Anomalous experiences are reported in near-death experiences (NDEs), shared-death experiences, after-death communications, etc.**

- **Our research focuses on NDEs because NDErs experience an apparent *separation* from the physical body during which the *locus of awareness* is outside the physical body**
  - **There are numerous reported cases during NDEs of *verified, accurate* (*veridical) perceptions* of the physical realm while out of body, especially while the brain is nonfunctional**
  - **In these cases, the NDEr reports particular perceptions in the physical realm from a *perspective outside their physical body*, which should not have been possible either because their brain was not functional, or the object was out of their physical line of sight, or both.**
  - **More than five dozen of these verified cases are documents in *The Self Does Not Die***
    (Rivas, et al., 2016, pp. 1–126)



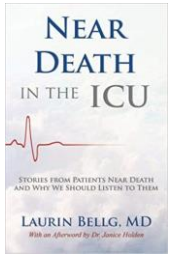
The Self Does Not Die

Rivas, T., Dirven, A., and Smit, R. (2016). *The self does not die: Verified paranormal phenomena from near-death experiences*. International Association for Near-Death Studies.

A new intellectual framework for consciousness

- **Here is Case 3.33 of veridical out-of-body perceptions from *The Self Does Not Die*:**
  - **Dr. Laurin Bellg's patient Howard** (see also Bellg, 2015, 33–43)

Laurin Bellg



Near Death in the ICU

- **The *number* of these cases and the *weight of evidence* in them is strong enough to assert that the locus of awareness has *in fact* separated from the physical body**
- **Veridical perceptions from a vantage point separate from the body, particularly while the brain is nonfunctional, imply that one's subjective awareness can function *independent of the physical brain***
  - **They imply that one's awareness (the mind) *in general* can separate from the physical body and operate independently of it**
  - **In this view, the mind conceptually ceases to be a *by-product of brain neural activity* and can now be viewed as an *autonomous conscious entity***
- **The concept of a *mind entity* separate from the physical body can serve as a *new intellectual framework* for explaining consciousness**

Bellg, L. (2015). *Near death in the ICU: Stories from patients near death and why we should listen to them*. Sloan Press.

The nature of the out-of-body mind …

- **During an NDE, the mind functions as a *cohesive unit***
  - **The NDEr experiences that their entire being has separated from the body**
  - **There is *continuity of* subjective awar*eness* throughout the separation and return**
- ***All aspects* of the NDEr's mind are still consciously present *throughout* their NDE**
  - **Subjectively, the NDEr experiences all cognitive faculties: perception, thought, feelings, volition, memory, self-awareness, and agency**
- **The out-of-body NDEr does not identify with the physical body:**
  - **Some NDErs exclaim, "That physical body wasn't me!"**
- **The out-of-body mind is *objectively real***
  - **The NDEr can be seen by animals – Jerry Casebolt and the German Shepherd**
  - **The NDEr can be seen by other people ("apparitional" NDEs)**
- **Thus, NDE evidence strongly suggests that:**
  - **A person's mind is a *separate entity* that is independent of the body**
  - **The mind is *objectively* real, a *real thing*, a *real being***
  - **All faculties of cognition occur in the mind, not in the brain**
  - **In effect, the separate mind is the *essence* of the person**

Corcoran, D. (1996). *When ego dies: A compilation of near-death & mystical conversion experiences*. Emerald Ink Pub.

The nature of the out-of-body mind

The separation of the mind from the body is a *general* phenomenon

- **The mind can separate from the body under many different circumstances, *not* just "near death"**
  - **There are *also* NDE-like cases that are *not* close to death, as in fainting, sleep, meditation, alcohol, or drugs**
  - **The person's awareness separates *even though* the brain is *still functional***
  - **Such cases are called near-death-like experiences (NDLEs)**
- **The subjective experiences of NDEs and NDLEs are *indistinguishable*—the *same number* and *intensity* of NDE elements** (Charland-Verville et al., 2014)
  - **Therefore, NDEs are a *general phenomenon* regardless of the antecedent causes**
  - **This fact implies there is a *common proximate cause* for all NDEs and NDLEs, regardless of antecedent causes**
- **The main common *feature* of all NDEs and NDLEs is the *separation* of subjective awareness from the body**
- **Therefore, we propose that the *common proximate cause* of all NDE and NDE-like experiences is the *actual separation of the mind* from the physical body, rather than any other antecedent cause**

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)..

The mind-entity framework


In-body state Out-of-body state

- The NDE evidence so far indicates:
  - The mind is a *separate entity* that can *separate from* and operate independently of the physical body
  - The mind entity is an objectively *real thing*, a *real being*
  - All faculties of cognition occur in the mind, *not* in the brain
- Out-of-body NDErs experience easily passing through solid objects like walls
  - Therefore, the mind appears to be *"nonmaterial"*—not made up of material particles (atoms and molecules)
  - The mind can *merge* and be *coextensive* with physical objects like the body and brain

- The mind-entity framework states
  - The human being consists of a nonmaterial "mind" (or center of subjective awareness) that is *united*, *coextensive*, and *integrated* with the physical body
  - The mind entity is the *seat of consciousness* of the person; all cognitive faculties reside in the mind, *not* in the brain
  - There are two possible states of awareness, the "in-body" state and the "out-of-body" state
  - For the "in-body" state, there is a close correlation between brain neural activity and subjective awareness; therefore—
    - The mind entity is *completely dependent* on the brain's electrical activity for subjective awareness
    - The mind entity must *interact with the brain* to achieve subjective awareness even of its own mental content and to effect willed movement
  - For the "out-of-body" state in an NDE, the mind entity *separates* from the body and operates independent of the brain

- For this framework to be consonant with existing scientific knowledge, there must be:
  - Some form of *causal, energetic interaction* between the mind and the brain
  - Some plausible *mechanism* of interaction

NDE evidence of mind-brain interaction

How could a nonmaterial mind interact with the material brain to achieve consciousness?

- **There is strong evidence that the out-of-body mind *does* interact with physical processes**
  - **Light, sound waves in the air, and solid matter …**
  - **Giving rise to subjective sensations and accurate veridical perceptions in the physical realm**

- **There are also numerous reports that NDErs encounter a subtle *resistance* or *increased density* when passing through solid matter**
  - **This implies a new subtle, *push-pull force* when the out-of-body mind entity passes through solid matter**
  - **According to Newton's third law of motion, for every force of one object on another, there is an equal and opposite opposing force**

- **There is also evidence that NDErs can interact with the *neural processes* of an in-body person**
  - **Example: an NDEr passed her hand through the doctor's arm and felt something that was the consistency of 'very rarified gelatin' that seemed to have an electric current running through it**
  - **Example: an NDEr reported tickling the nose of a patient with dementia causing her to sneeze**

- **Therefore, the evidence indicates the mind can interact with matter and *specifically* with neural electrical processes**
  - **Both to *sense* and to *trigger* neural electrical activity**

The mind-entity framework: Basic principles

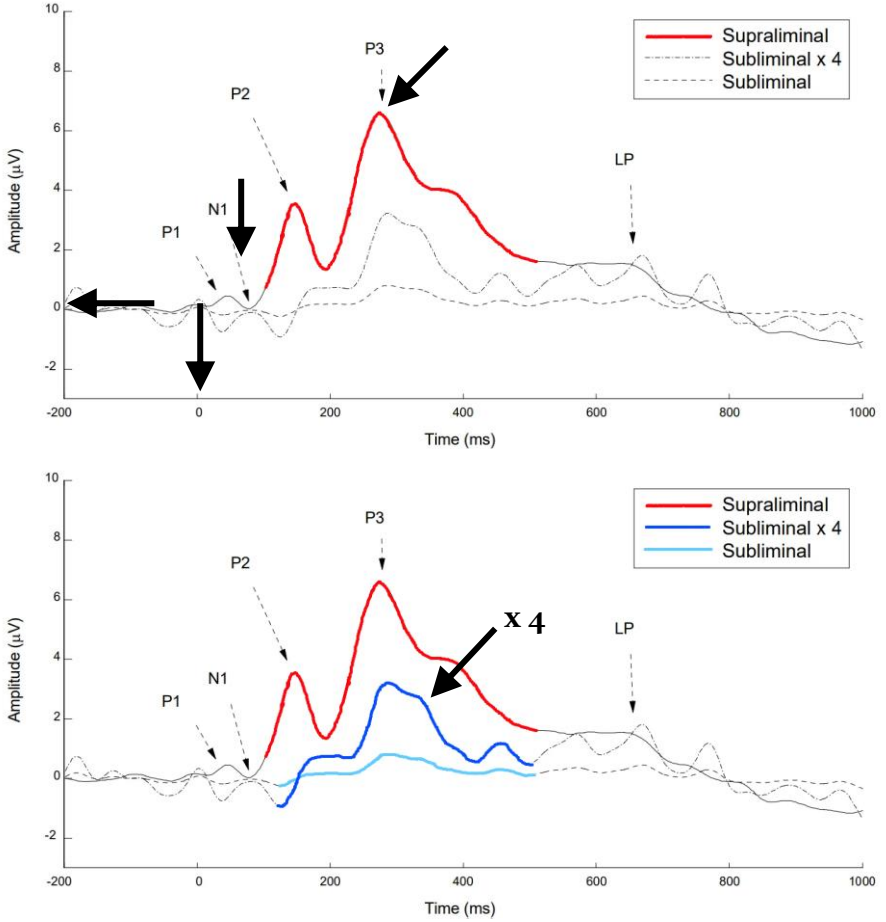
- **Principle**: ***The mind entity is a 3-dimensional nonmaterial energetic "field" that is coextensive with the brain and body***
  - **Because the NDEr retains all cognitive faculties while out-of-body, these faculties reside in the *mind*, not in the *brain***
- **Principle**: ***The mind entity interfaces with the brain and body through neural activity***
  - ***Consciousness* arises in the mind only through neural activity in the *brain's cortex* (the "neural correlates of consciousness")**
  - **All other neural activity in *subcortical* areas and in the body remains *unconscious***
  - **With *in-body* consciousness, the mind must work through the brain's neural activity for subjective awareness …**
    - **even awareness of its *own mental content***
- **Principle**: ***Neural activity begins subliminally followed by "coming to awareness" after at least 300 msec***
  - **Subjective awareness requires a minimum intensity of neuronal firing and a minimum duration of 300–500 msec before the subject can report awareness** (Libet, 2004)
  - **Before awareness occurs, one can still respond within 100 msec (e.g., a baseball batter can adjust his swing before becoming subjectively *aware* of the pitch)**
  - **With neural activity of less than 300 msec, the stimulus *remains subliminal* and does not come to awareness, but it is still *detected* by the mind and there is a *subconscious* influence called "subliminal priming"**
  - **Example: when a word is shown for 100 msec, immediately followed by a *second* word, the subject is unaware of the first "prime" word**
    - **However, the subject's *response time* to the second word is influenced by the prime more than when no prime word is used**
    - **When the prime word is *spider* and the target word is *web*, (i.e., "*spider-web*"), the response time is significantly faster than the case of "*monument–web*"**
    - **The priming effect in the case of *spider–web* shows that the mind has *comprehended* the prime word and established the mental *context* of "spider"**
  - **Libet's findings have now been confirmed in more recent studies of what's called "conscious processing"** (Dehaene & Changeux, 2011)

Benjamin Libet (1916-2007)

- Dehaene, S., & Changeux, J.-P. (2011). Experimental and theoretical approaches to conscious processing. *Neuron, 70*(2), 200-227.
- Libet, B. (2004). *Mind time: The temporal factor in consciousness*. Harvard University Press.

The mind-entity framework: Subliminality

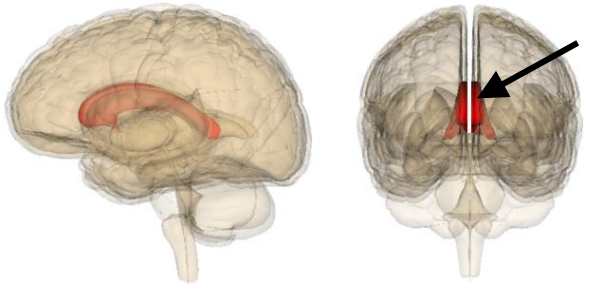
- **Principle**: ***Subliminal** neural activity is essentially identical to **supraliminal** neural activity, only at a **lower voltage or power***
  - **This is shown in this example of neural activity measured with EEG**
  - **Each type of stimulus causes specific regions in the brain to fire, creating a characteristic pattern of "event related potentials" (ERPs) over time**
  - **In this experiment, emotionally evocative words (e.g., *elated, angry*) were presented both subliminally (for 1 msec) and supraliminally (for 40 msec)** (Bernat et al., 2001)
    - **Supraliminally, the words produced a characteristic ERP shape (in red) with a peak at P3**
    - **Subliminally, the ERPs are quite small (light blue), and the shape is ambiguous**
    - **Multiplying the subliminal ERPs by a factor of four reveals a "visually apparent component structure (dark blue) nearly identical" to that of supraliminal ERPs**
  - **Substantial similarities in the subliminal and supraliminal ERP patterns suggest that the *same neural activity in the same brain regions* is involved but at *lower voltage* (i.e., at a reduced power)** (Shevrin, 2001)
- **Principle**: ***The mind entity does the same neural processing with subliminal stimuli as with stimuli that come to awareness***



- Bernat, E., Bunce, S., & Shevrin, H. (2001). Event-related brain potentials differentiate positive and negative mood adjectives during both supraliminal and subliminal visual processing. *International journal of psychophysiology*, *42*(1), 11-34.
- Shevrin, H. (2001). Event-related markers of unconscious processes. *International Journal of Psychophysiology*, *42*(2), 209-218.

The mind-entity framework: Split-brain phenomena

- **Principle**: ***The process of neural activity, starting subliminally and then coming to awareness, applies to all awareness***
  - **Including inward (or endogenous) thoughts, imaginations, planning, daydreaming, etc.**
  - **This principle can help explain *anomalous* neurological phenomena, like split-brain phenomena**
- **In split-brain patients, the bundle of neurons connecting the two brain hemispheres—the *corpus callosum* (shown in red)—is severed to relieve intractable epilepsy** (Gazzaniga, 2000)
  - **The corpus callosum is severed but the *subcortical* structures below this tract are spared**
  - **The patient appears to be completely intact, retaining normal perceptions, language, memory, general knowledge, physical coordination, intentionality, etc.**
  - **However, there are anomalous aspects to perception:**
    - **Stimuli—in the patient's left visual field—go just to the patient's non-dominant *right* hemisphere; the images appear to be *detected* by the mind but remain *unconscious***
    - **The patient is not aware of the stimulus going to the right hemisphere, but the patient can *identify the object* by pointing with the non-dominant left hand and says, "I don't see it. I just point."**
    - **Or the patient will have a strong emotional reaction. For example, when shown a Nazi swastika, the patient said, "What was this that you just showed me!" … "[It was] bad, very bad." He was never able to guess what the image was.** (Zaidel, 1994)

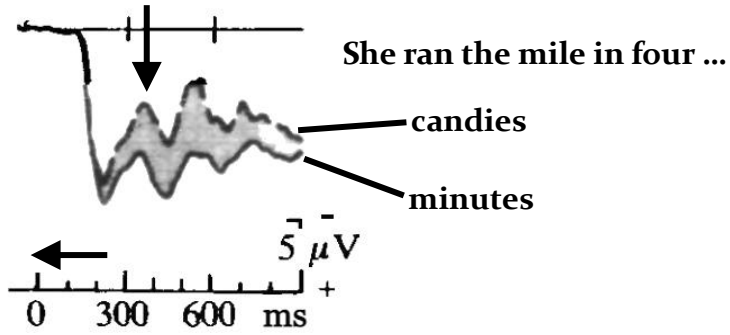


  - **The conventional explanation for split-brain anomalies is that the non-dominant right hemisphere has specialized function but is *deficient* in perceptual and language ability**
- **We propose instead: *all* anomalous split-brain phenomena can be explained with the framework that the mind entity's processing *remains subliminal* in the non-dominant right hemisphere**
  - **The prior examples of accurate perception and emotional reaction to perceptions are classic examples of subliminal perception**

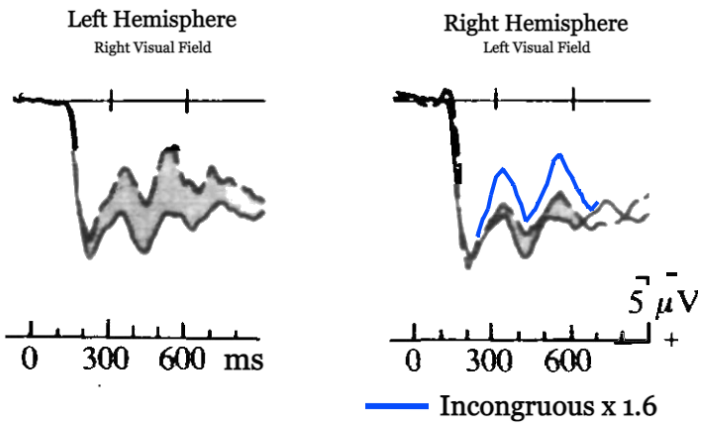
- Gazzaniga, M. S. (2000). Cerebral specialization and interhemispheric communication: does the corpus callosum enable the human condition?. *Brain, 123*(7), 1293-1326.
- Zaidel, D. W. (1994). A view of the world from a split-brain perspective. In *Neurological Boundaries of Reality, edited by EMR Critchley* (pp. 161-174). Farrand Press..

The mind-entity framework: N400 evidence

- When one reads a word, the event related potential (ERP) tracks the process of (1) comprehending the word's meaning and (2) evaluating the word in the preceding context of the sentence
  - This is an EEG trace of brain activity when reading a word at the end of a sentence
  - If the word fits the context (e.g., She ran the mile in four…), there is a normal, low ERP pattern
  - However, if the word is incongruous, there is a larger amplitude ERP peaking initially around 400 msec—the N400; the N400 difference is shown in the shaded area.



- Marta Kutas tested the N400 ERPs in 3 split-brain subjects who showed no ability to read words in the non-dominant right hemisphere (Kutas et al., 1988)
  - These subjects all showed the normal N400 pattern to incongruous words when projected to the dominant *left* hemisphere (shown above)
  - However, they showed a *very reduced* response to incongruous words projected to the non-dominant *right* hemisphere
  - Kutas interpreted this "failure" as a general deficiency of the right hemisphere to hold the sentence context when evaluating the final word (Kutas et al., 1988, p. 569)
  - However, when the incongruous trace is adjusted times 1.6, it shows a proper N400 form
  - Therefore, a better interpretation would be: the N400 is reduced because it is *subliminal,* rather than a *deficiency* of the right hemisphere
  - The split-brain right hemisphere shows *all of the normal language processing* except that the neural activity *remains subliminal*
  - The likely reason right hemisphere processes are subliminal is that they ordinarily need supporting neural activity from left hemisphere modules but their neural pathways through the corpus callosum have been severed



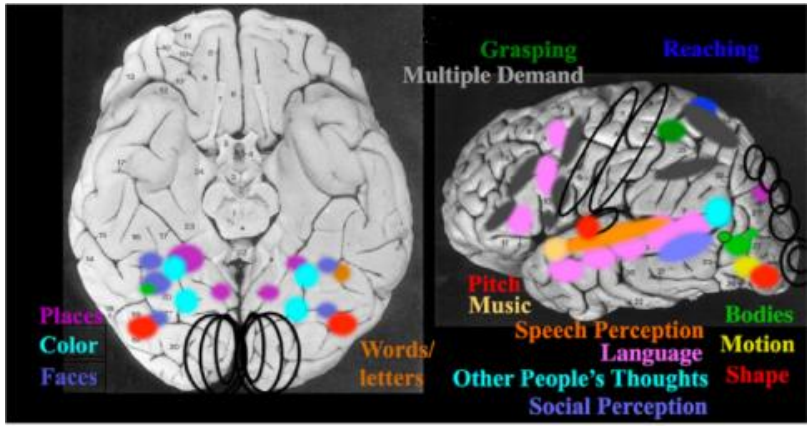
- <u>Principle</u>: ***The mind entity works <u>globally</u> in the brain and is engaged <u>throughout</u> the process from subliminality to awareness***

- Kutas, M., Hillyard, S. A., & Gazzaniga, M. S. (1988). Processing of semantic anomaly by right and left hemispheres of commissurotomy patients: Evidence from event-related brain potentials. *Brain, 111*(3), 553-576.

The mind-entity framework and modular organization

The cortex is organized in specialized areas called "modules"

- **The mind uses such specialized modules to become aware of specific mental content**
  - **There are 16 different specialized modules shown here in different colors**
  - **If the module is damaged or absent, this *mental content* cannot come to awareness**
- **The evidence for specialized modules comes from:**
  - **Brain lesions which associate a damaged module with a specific loss of cognitive function**
  - **fMRI studies which associate activation of a specific module with specific mental activities**



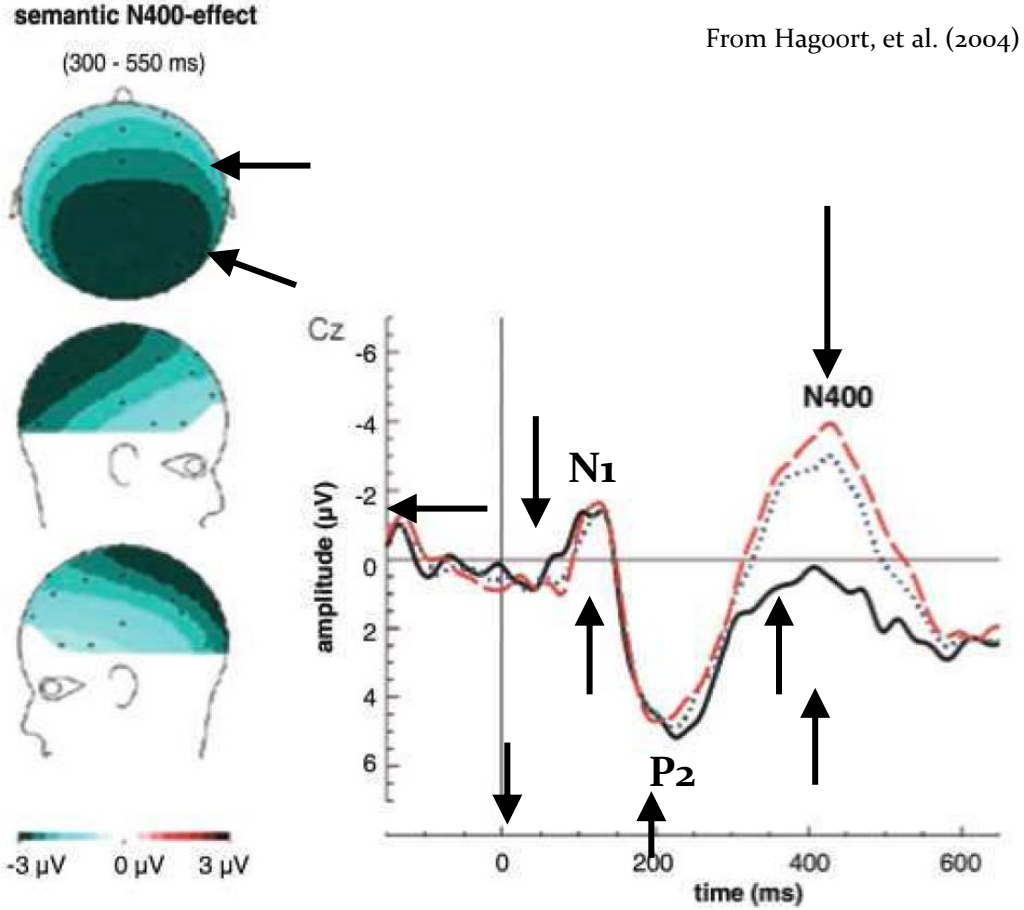
- **With brain damage or lesions (e.g., from injury, tumors, stroke, etc.), the loss of specialized function results in:**
  - **Loss of primary senses (sight, hearing, touch, smell, taste) and the loss of motor ability**
  - **"Sensory agnosias" – the inability to recognize objects, faces, spoken or written words, etc., even though the specific sense is not defective**
  - **"Aphasias" – the inability to *comprehend* language (Wernicke's area) or to *form* language (speech and writing – Broca's area)**
  - **Many other forms of agnosias**
- **<u>Principle</u>: *The mind entity impresses specific mental content on a specialized module to bring that content to awareness <u>except</u> for the primary sensory areas, which are <u>purely input modalities</u>***
  - **The mind entity also *initiates* neural activity:**
    1. **To focus specific attention by *enhancing* neural excitability in certain modules and *inhibiting* neural activity in other modules, and**
    2. **To initiate specific motor movements by activating certain motor modules**
- **<u>Principle</u>: *The mind entity remains whole and complete; memory, cognitive, mental, and motor dysfunction are due to brain or other neural dysfunction***

How does the mind entity interface with the brain? …

When reading words, an <u>incongruent</u> word in a sentence evokes a strong minus voltage at the top of the scalp

- **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 <u>congruent</u> or <u>incongruent</u> the word is in context**
- **Perception and comprehension proceed in three distinct stages in time and also in three different brain modules**
  - **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 entity is involved *at each stage***

From Hagoort, et al. (2004)



The Dutch trains are <u>yellow</u> and very crowded. ←
The Dutch trains are <u>white</u> and very crowded. (elevated N400)
The Dutch trains are <u>sour</u> and very crowded. (elevated N400)

- 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.

The mind entity induces neural activations to come to awareness

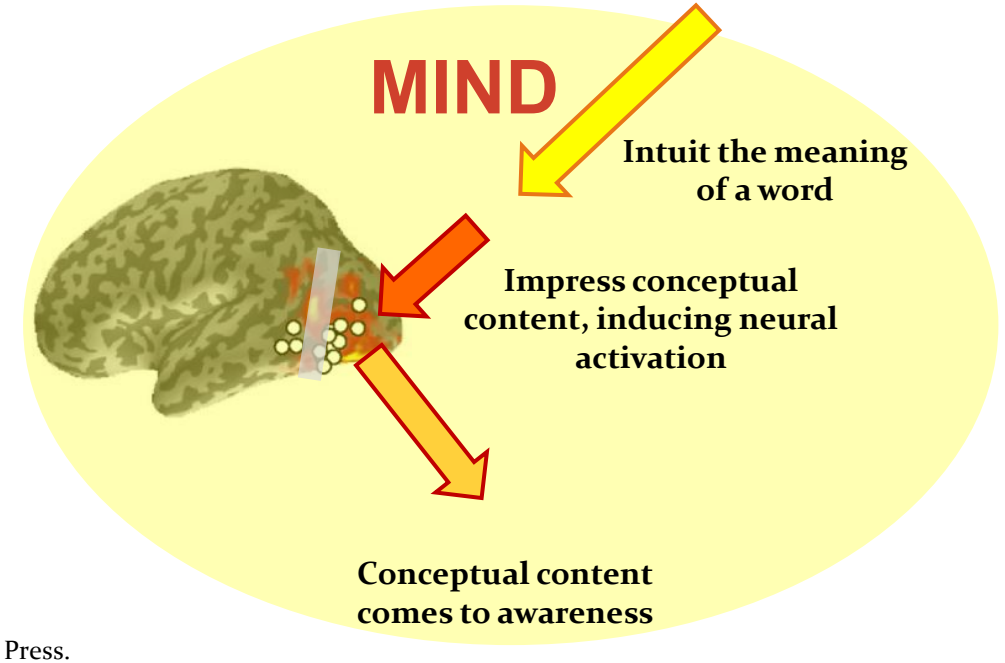
Neural activations **are needed to bring** ***mental content*** **to conscious awareness**

- **The mind entity must first *impress* its conceptual content on the appropriate brain modules, inducing neural activations**
- **The neural activations in those modules act like a *mirror* to raise the mind's conceptual content to awareness**
- **Neural activations indicate that the mind's mental content is in the *process of coming to awareness***
- **In this view, the will impresses the mental content into the neurons; only *then* can the mind detect the effect of this willed action**

- **Analogy: When we walk over soft ground, our feet leave impressions in the soil.**
- **It would be absurd to say that the footprints were formed *from below* by the forces of the soil.**

"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 perception takes place. The preparatory work on the brain remains entirely unconscious." (Steiner, 1914)

Schematic process

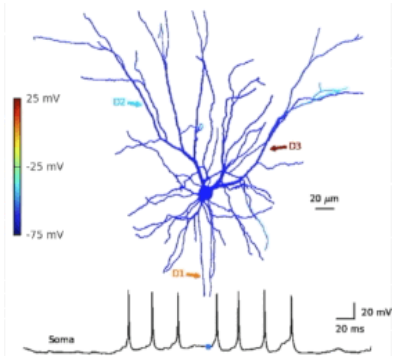


Principle: ***Beyond the primary sensory areas, cortical neural activity is the result of the mind entity's impressions, its "footprints," on brain neurons***

- Steiner, R. (1894/1964). *The Philosophy of Freedom: The basis for a modern world conception.* Rudolf Steiner Press.
- Steiner, R. (1914, Jan. 23). Human and cosmic thought. Lecture 4, GA 151.

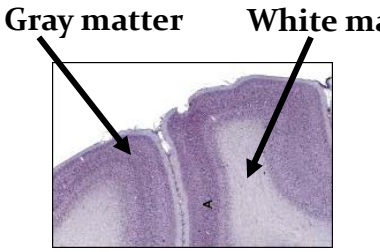
A plausible mechanism for *sensing* neural activity

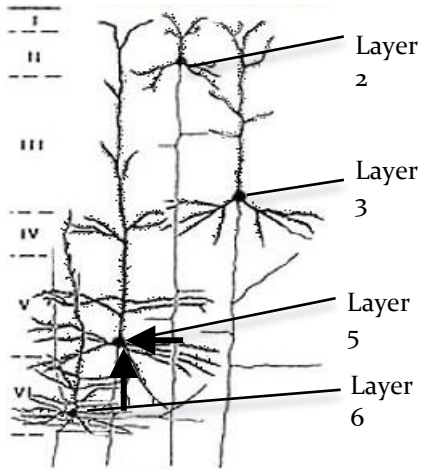
- **In the mind entity framework, the mind *impresses* its mental content on cortical neurons and causes *action potentials* which bring the mental content to awareness**
  - **This implies that the *interface* of the mind with the brain is *at the surface* of the cortex, in the gray matter**
  - **The gray matter contains pyramidal neurons with their apical and basal dendrites**
  - **On the dendrites there are innumerable nodules called *dendritic spines***
- **The mind must be able to *trigger* action potentials in the pyramidal neurons and in some way *sense* the resulting action potentials**



Action potentials propagate back through the dendritic arbor

- **Out-of-body NDErs can directly *sense* neural activity as a kind of electrical current in an *in-body* person**
- **Therefore, the mind most likely *senses* the *back propagation* of action potentials when they spread throughout the dendritic arbor**
- **The question *now* is how does the mind *trigger* action potentials**





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

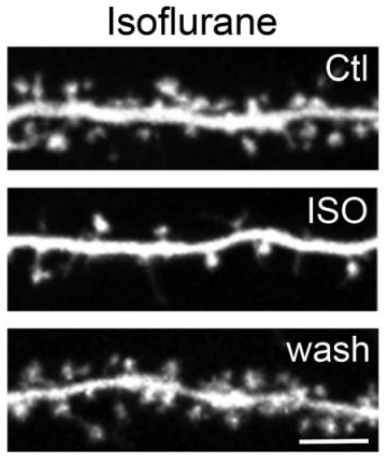
Dendritic spines

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

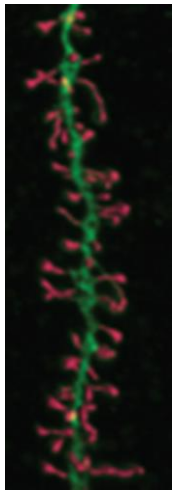
A plausible mechanism for *triggering* action potentials …

***Volatile* or *inhalation anesthetics* provide evidence for how the mind operates with the brain**

- **Volatile 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 where 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)

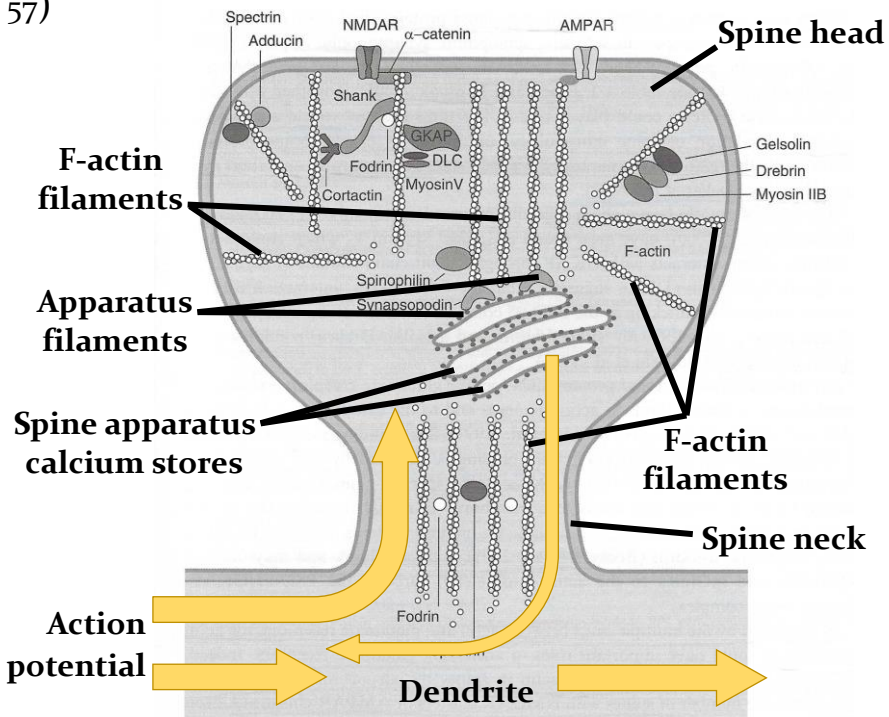
- **The internal *spine cytoskeleton* consists of numerous microfilaments of a substance called F-actin**
  - **The F-actin filaments maintain the spine's *shape* and *rigidity*, and help with vesicle *movement* within the spine**
  - **F-actin filaments are polymers of a basic actin unit, strung together**
  - **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.

A plausible mechanism for triggering 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 believe such an interface and mechanism exists in the dendritic spines
- This is a schematic of a dendritic spine connected to its dendrite (Yuste, 2010, p. 57)
  - Numerous F-actin filaments maintain the structure of the spine neck and the spine head
  - At center are several *stores of positively charged calcium ions* in a collection of vesicles called the "spine apparatus"
  - The spine apparatus also has F-actin filaments associated with it

- In our view, the *mind can trigger* the release of calcium ions from the spine apparatus by interacting with the spine apparatus filaments—
  - Causing a "mind-induced calcium release"
  - The positive calcium ions flow into the dendrite and induce spikes which can then trigger an action potential
  - The action potential, in turn, causes an influx of calcium ions *back* throughout the spines.
  - The calcium ions are stored again in the spine apparatus—resetting the neuron for further action potentials

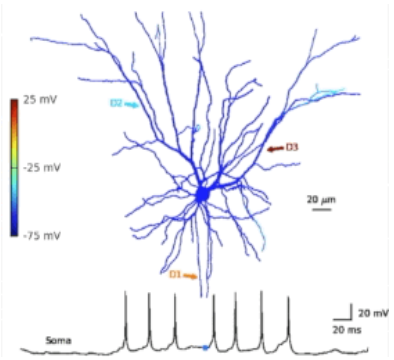


- Yuste, R. (2010). *Dendritic spines*. MIT press.

A plausible mechanism for triggering action potentials

- **Volatile anesthetics unravel the F-actin filaments in the spines such that the mind *can't trigger* the release of calcium ions from the spine apparatus**
  - **This prevents mind-induced action potentials and causes the loss of consciousness because the mental content remains unconscious**
  - **When the anesthetic has washed out, the F-actin *re-forms* enabling consciousness to return**

- **In this view, the mind triggers action potentials *only* by triggering the spine F-actin filaments**
  - **The force needed to trigger the actin filaments is likely very small, probably comparable to the *subtle resistance* NDErs report when passing through solid matter**
  - **In contrast, the *force of the action potential* propagating back through the dendritic arbor can be inferred in this image of a series of action potentials from Smith and colleagues**
  - **The energy of the back propagation *resets* the neuron for further action potentials, allowing it to achieve *high firing rates***



Action potentials propagate back through the dendritic arbor

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

Individuated versus "non-local" consciousness

- **We have presented a plausible framework for the non-material mind entity working within the brain**
- **We also want to point out a *misconception* that consciousness is somehow "non-local"**
  - **The idea of non-locality is that somehow consciousness is either spread out across all space or exists independent of space and time**
    - **With the brain acting merely as a transceiver of consciousness, operating like a television set**
    - **And leading to the notion that ultimately at the end of our evolution, our drop of individual consciousness slips into the ocean of Oneness and dissolves into nothingness**
  - **In our view, there is overwhelming evidence from NDEs and other death-related phenomena that the mind is *individuated* and *localized*, even in the transcendent-spiritual realm**
  - **Yet the human experience of oneness in transpersonal consciousness is very real**
  - **NDEr Christian Sundberg: "From a state of *both simultaneous individuality and blissful Oneness* [in the spiritual realm], you collapse into individuality only [in physical incarnation]."** (Sundberg, 2021, 5, emphasis added)
- **Rudolf Steiner: The ancient cliché that "we must ultimately lose our individual consciousness and merge into a universal consciousness" is *no longer* correct:** (Steiner, 1998, 247–248)
  - **"Universal consciousness *will* be a harmony of *all* forms of consciousness**
  - **"Human beings who have passed through the final stage of human development will form a unity *out of their own free will;* they will *remain individual entities* and will *also* form a unity, because they *choose to do so* rather than because they are forced**
  - **"Each one will contribute the particular *colors* of their consciousness as individuals, which cannot be lost**
  - **"The great variety of colors will shimmer more beautifully than could ever have been before and will become 'the living garment of the divine'"**

- Steiner, R. (1998). *The Christian Mystery*. Anthroposophic Press.
- Sundberg, C. (2021). *A walk in the physical: Understanding the human experience within the larger spiritual context.* Author.