Perception as the Essence of Phenomenal Consciousness
The core of the MEM - Motivated Emotional Mind model

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Abstract

There is a widespread belief that perception is the foundation of consciousness. This article presents the mechanism that transforms sensory sensing or feelings into the content of phenomenal consciousness. Phenomenal consciousness is always associated with perception. Experiencing qualia and affective states involves the sensory sensing of the organism's internal states. We can feel these states thanks to the multitude of receptors and interoceptors as feelings of subsistence that follow regulatory states towards homeostatic balance. Becoming aware of our thoughts, imaginings, and memories and tracking what is happening around us requires a secondary perception derived from the lowest sensory fields. Propositional awareness, which is not directly based on perception, is learned through secondary sensory perception, influencing planned and undertaken actions. If actions are taken immediately and spontaneously, external sensory perceptions are engaged, whereas if reactions pertain to disturbances in homeostatic or behavioral states, a collection of internal state receptors is involved in perception. The article presents both pioneering ideas found in competing models of the mind, as well as psychological and neurological research that confirms the presented hypotheses.

Keywords: Perception; Awareness; Recurrent processing theory of mind; Motivated emotional mind; Phenomenal consciousness; Secondary perception; Semblion;

1. Introduction

> *Self is* ***'nothing but a bundle or collection of different perceptions, which succeed each other with an inconceivable rapidity, and are in a perpetual flux and movement'*** *(David Hume; A Treatise of Human Nature I, IV, §VI).*

Phenomenal consciousness – the direct subjective experience of sensations and feelings – is widely believed to be grounded in perception. However, the precise mechanism by which sensory processing becomes conscious experience remains elusive. Many competing theories attempt to explain this transformation, often emphasizing different neural processes or cognitive architectures. This article aims to fill that explanatory gap by presenting a unified model in which perception plays the central role in generating consciousness. The Motivated Emotional Mind (MEM) model proposed here and in my earlier works asserts that conscious experience arises when the brain engages in "secondary" perception of its own activity**.** In other words, the brain not only processes external and internal stimuli but also perceives certain patterns of its own neural excitations, thereby forming the contents of phenomenal consciousness.

Phenomenal consciousness does not arise in the upper layers of the cortex. Its basis is not neural representations formed in the frontal cortex and other cognitive areas of the brain. The basis for experiencing phenomenal consciousness, qualia, memories, mental images, and feelings are the lower, sensory layers of the sensory cortex coupled with millions of receptors and interoceptors located in specialized sensory organs, in all other internal organs of living organisms, and almost every corner of their bodies. This radical thesis seems to be confirmed by the results of hundreds of neurological and psychological studies conducted over the last few decades. This work selects the premises of such a thesis and presents the reasoning that supports it.

Despite perception being intensively studied for many centuries, there is no satisfactory theory that explains how, what our senses register, transforms into knowledge about what is happening around us, into a model of reality in which we exist. We also do not know how mental states could trigger any responses to sensory stimuli. We don't understand how our subjective impressions, subtle feelings, and emotional states could move anything. How can we talk about what we see and hear when our immaterial thoughts do not have sufficient causative power to move the matter of the body in any way?

The reactions described above are the source of cognitive experiences. These include the perception of objects and phenomena, their recognition, and understanding what they are. Individual phases of perception include the categorization and generalization of features of objects and phenomena, as well as their association into extensive models of reality. A feature of the cognition of living organisms is the feeling of emotions and their association with what they perceive. On their basis, one can evaluate observations and consciously take or plan the most favorable reactions. Organized information that creates an image of the world and knowledge about it is remembered in the neuron-astrocyte network that creates natural brains. Psychology covers the described cognitive experiences, distinguishing between perception and consciousness. Different models of perception and consciousness establish boundaries between these concepts at various points. To delineate these boundaries in a way useful for resolving the above-mentioned issues, let us recall the main threads of the ongoing debate on this topic.

Adam Pautz examines in his book "Perception" four of the most important theories of perception: the sense-datum view (based on subjective sense data); the internal physical state view; the representational view; and naïve realism (2021). However, currently, views on perception are dominated by two folk theories. We know them as Direct Realism and Indirect Realism conceptions of vision, which are directly and patently in conflict with each other. Direct Realism rejects Indirect Realism: when we look at an object, we see only that object, not a mental image of it, and nothing compels us to infer its presence.

The first of these views, also known as Direct Perception, suggests that our senses provide us with direct images of the environment, which we perceive through our senses. Our beliefs, expectations, or interpretations do not influence direct perception. In other words, direct perception allows us to see objects and events as they truly are, regardless of our subjective beliefs or interpretations.

The second view, identified with Indirect Perception, posits that when we look at something, signals reaching the brain generate a mental image (mental representation), and what we perceive are precisely these representations triggered by sensory stimulation [1]. When viewing some object, we see a mental image of that object, caused by that object. Objects appear to us as if in some inner theater taking place in our mind (Fischer et.al. 2023). Direct perception of the external world is different from our internal experiences or mental states and our perception of objects and events in the environment cannot be reduced to internal states of our mind.

The simplest interpretation of direct perception was presented by Gibson. He focused on direct visual perception. He argues that the observer's vision of the environment is direct and is not distorted by visual or other sensory impressions (Gibson 2002). This conflicts with indirect theories, which argue that people use inferences and beliefs to make sense of their sensory experiences. Representational theories are based on impressions. In the indirect hypothesis, researchers argue that people use a combination of a top-down and bottom-up approach, using both what they experience and inferences from previous experiences to collect information about their environment.

The material brain creates engrams, neural representations of perceptions, preserved in the form of modifications of the neural network that constitute brain tissue. The registration and further processing

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[1] We call this the disjunctivist approach, which includes veridical perception, but also illusions and hallucinations.

of neural representations, and the creation of mental states resulting from this processing, corresponds to the simplest form of consciousness - perceptual awareness. The senses of higher, more complex beings also register their own affective states. Perceiving our own emotions is also considered a perception.

A phenomenon very similar to direct perception is the perception of mental images and sensations generated by the brain. The appearance of impressions secondary to previously preserved sensory impressions occurs when recalling or imagining past direct impressions, and even during dreams. This type of perception of sensations is called secondary perception, which builds a different type of awareness than the perceptual awareness mentioned at the beginning. We perceive these states subjectively from a first-person perspective and are unable to prove materially that we feel them. We may also doubt whether other organisms experience them. Therefore, the awareness that we perceive them is called phenomenal awareness.

The motivated emotional mind (MEM) model presented by Galus and Starzyk distinguishes these types of consciousness and allows us to understand how they arise and what the essence of phenomenal consciousness is (Galus, Starzyk 2020; Galus 2023a, 2023b). We will use this model to explain the essence of perception in all the mentioned aspects.

2. Insufficiency of current interpretations

Perception is the process of detecting and interpreting sensory input. It ranges from the raw registration of stimuli to the reactivation of internal patterns that support recognition and meaning attribution. Not all perceptual events involve meaning attribution; rather, such attribution is contingent on reentrant activation of associative memory circuits (semblions). Perception relates inputs from receptors to responses of an organism or artificial system. Among these reactions, we can distinguish: A. Behavioral; B. Phenomenal and emotional reactions; C. Cognitive responses. The intermediate phases of these reactions are: a. noticing and registration of the stimulus; b. transmission to appropriate processing centers; c. stimulus recognition; d. memorization; e. associations with other brain processes, f. assigning meanings to perceptions.

The process of direct perception of enduring objects and stable features of the environment consists in the extraction of invariants from the optical arrays available to the eye. This theory assumes the existence of stable, unbounded, and persistent information about the stimulus within the surrounding optical layout, while perceptual experiences are triggered by attending to variations in sensory stimulation. According to this view, the visual system is capable of exploring and detecting such information, and in this sense, the theory is information-based rather than sensation-based [2].

Critics of Gibson's theory of direct perception have pointed out that it fails to account for certain perceptual phenomena, such as the experience of illusions and sensory misperceptions (Savage, 2011). Furthermore, it is insufficient to claim that perception consists in extracting stimulation invariants without explaining how the brain performs this operation.

This is precisely where the core idea often escapes both proponents and critics of folk theories—that we simply "see" what stands before our eyes. It is well known that, in imagination, we can visualize imagined scenes, memories, hallucinations, and visual illusions, which will be discussed in subsequent sections. Since the mechanisms responsible for generating such phenomenal experiences have not been adequately investigated, a range of indirect perception theories have emerged. These theories posit that perceptual processes necessarily involve an act of awareness of something other than the external perceived object, such as internal representations of percepts or emotional experiences, provided these representations are consciously accessible.

We shall exclude from this discussion all dualist theories and forms of panpsychism, including the Integrated Information Theory (IIT) [3], as well as quantum theories of consciousness, such as the

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[2] Certainly, this assumption can be extended to other modalities as well.

[3] IIT is subject to exclusion for double. Not only does it introduce a non -physical, poorly defined Phi function as a measure of consciousness, but also assigns it to all objects, as well as other forms of panpsychism.

Orchestrated Objective Reduction (Orch-OR). We reject any theory that postulates the existence of novel, unverified physical or neural phenomena. Our focus is restricted to theories attempting to interpret well-established psychological phenomena using empirically identified biophysical mechanisms.

Global Workspace Theory (GWT):
The Global Workspace Theory posits that neural processes executed by specialized modal centers in the brain become conscious when the information they process is globally broadcast across the brain within a shared workspace composed of a network of high-level cortical areas. Modal information transmitted via long-range loops to apical cortical layers activates them synchronously, thus enabling global access to all specialized processors (Baars, 2005).

Higher-Order Theories (HOT):
Higher-Order Theories maintain that the generation of first-order sensory correlates is not sufficient for conscious awareness. HOT proposes that higher-order representations are formed in superior cortical layers, where first-order representations are treated as perceptual objects. It is only through this higher-order perception that one becomes consciously aware of the first-order representation and of oneself. Advocates of HOT argue that the prefrontal cortex is the principal site of conscious perceptual correlates (Brown et al., 2019).

Recurrent Processing Theory (RPT):
The Recurrent Processing Theory suggests that conscious perception arises from cyclic, dynamically evolving patterns of activity transmitted through spatially distributed loops between lower and higher cortical areas. The FeedForward Sweep (FFS) transmits signals from receptor cells to higher cortical layers, where object recognition, understanding, and behavioral responses are generated—this occurs unconsciously. Conscious perception arises through retrograde (top-down) signal propagation. Activation of such feedback loops across multiple cycles may modify memory engrams (Lamme, 2015; Lamme et al., 1998). Conscious processing is facilitated by the prefrontal cortex and cortical regions involved in visual information processing (Lamme, 2018).

None of these theories provide conclusive evidence that the perceptual processes they describe give rise to subjective phenomenal experiences or affective states. While theories such as IIT, GWT, and HOT have reached a developmental impasse, RPT has continued to evolve, inspiring new modifications grounded in recent empirical findings.

3. Roots and Development of the Recurrent Processing Theory

In the last two decades, many neurological and psychological research results have appeared that go beyond the classic search for how to process sensory stimuli. These studies mainly concerned feedback flowing from the upper brain fields to the lower layers (top-down stimulation). The hypothesis crystallized that top-down influences may play a role in visual memory, recruiting the same areas that are involved in processing a visual stimulus in the recall of that stimulus (Gilbert and Sigman 2007). This has been seen with fMRI, where activation in the primary visual cortex is reported in individuals who are imagining a visual stimulus (Roland and Gulyas 1994; Buckner and Wheeler 2001; Slotnick et al. 2005). The source of the top-down signals influencing the MT fields and lower visual fields V1,..., V3 was intensively searched for. Parietal areas (where saliency maps and those that modulate attention), frontal areas (which influence the achievement of the goal of action), and temporal areas (which store internal representations of object shapes enabling priming and therefore shape discrimination) were considered. These areas cooperate closely and are involved in the perception process.

Direct and indirect transmission pathways have been identified through which information originating from higher cortical areas can influence processing in the early sensory cortex. For instance, area V1 receives direct, albeit weak, projections from the inferior parietal cortex, but it also receives strong projections from areas V2 and V4, which, in turn, receive feedback information from even higher cortical areas, including the temporal lobe. Consequently, feedback may be mediated by a cascade of descending connections through multiple cortical areas (Sherman, 2005).

It has also been postulated that recognition of perceived objects is facilitated by detected top-bottom stimulation. Moreover, it has been shown that activity in the OFC precedes activity in the visual fields by 0.6–0.7 s when recognition occurs (Bar 2006). Bar hypothesized that a top-down process preemptively stimulates the visual cortex, constituting a type of priming. The essence of this hypothesis posits that a partially processed iteration of the input image (specifically a blurred rendition), undergoes rapid projection from early visual regions to the prefrontal cortex (PFC). This rudimentary depiction triggers the activation of anticipations within the PFC concerning the most probable construal of the input image. This residual performance activates the predictions in PFC regarding the most likely interpretation of the input image (Bar 2003).

Other studies have shown that a prior mental image of a figure increases sensitivity to that figure in the visual field. This effect reflects a form of *priming* through expectation, mediated by top-down influences. It also constitutes a kind of attentional focus on perceptual tasks and hypothesis testing (Gilbert & Sigman, 2007).

Another example of top-down processing is intentional attentional shifting. Let us examine how this influences direct perception. To this end, consider a simple psychological experiment: place your hands wide apart and bring the fingertips of each corresponding finger into contact with those of the other hand. You can now freely shift your focus and selectively direct your attention to any chosen pair of fingers. With sufficient concentration, it is possible to feel the contact between the selected fingertips. The brain recognizes which fingers are touching, but it is the proprioceptors in the fingers that detect the pressure. While the brain “understands” the presence and location of the fingers, the actual signals are conveyed via stimulated proprioceptors through the lower somatosensory pathways. Further evidence of top-down interaction between object-shape representation and lower levels of visual processing can be found in binocular rivalry (Schmidtmann et al., 2015) and perceptual multistability (Saracini, 2022; Wernery et al., 2015).

Recent advances in artificial intelligence and machine learning compel renewed attention to the rapidly evolving field of artificial convolutional neural networks (CNNs), which employ deep learning to accumulate and organize knowledge in artificial “brains.” In the analysis of sound and visual data, one may even speak of a form of perception, prompting reflection on what distinguishes these systems from biological brains.

In the most advanced deep learning models based on convolutional neural networks, top-down signal transmission is a standard mechanism. These top-down signals convey higher-level contextual knowledge that is utilized in the analysis and interpretation of data at lower processing stages—i.e., at lower levels of abstraction. This is particularly relevant in image segmentation systems, where the goal is to identify and isolate distinct objects within a visual scene, thereby enabling more precise segmentation. Top-down signals can enhance performance in image recognition tasks by improving classification accuracy through context integration. In advanced CNN models, attention mechanisms are simulated via top-down masking grids that dynamically select relevant parts of an image for focused processing.

However, such implementations do not resolve the fundamental gaps in our understanding of how neural networks actually learn. While the operational principles governing artificial neural networks remain partially opaque, the inclusion of top-down signals facilitates the construction of functional models that can be employed to investigate the roles of different brain regions (Leek et al., 2022). Of course, the primary aim of these models is object recognition—there is no mention, let alone demonstration, of phenomenal consciousness in such systems.

All the aforementioned premises have contributed to the formulation of the Recurrent Processing Theory (RPT). This theoretical framework delineates the distinction between the feedforward process, characterized by the propagation of neural stimuli through the cortical network, which mediates immediate, spontaneous, reflex-like responses. This bottom-up process is referred to as the *Fast Feedforward Sweep* (FFS) in the work of Lamme and Roelfsema. It culminates in the executive centers of the motor cortex. Simultaneously, it is accompanied by the activation of backward cortico-cortical interactions, supported by feedback and horizontal connections (Lamme & Roelfsema, 2000; Lamme, 2006; Lamme, 2015). Central to this theory is the hypothesis of a hierarchical organization within the neural network, which reflects the hierarchical structure of knowledge encoded in the brain. This hierarchy comprises successive layers of cortical fields responsible for processing signals originating from lower-level sensory receptors.

The cortical sheet encompasses a multitude of cortical areas interconnected by cortical-cortical fibers, facilitating the bidirectional flow of information between sensory areas and motor areas. These interconnections define a hierarchical relationship among these cortical regions. At the foundation of the visual sensorimotor hierarchy lies the primary visual cortex (V1), which serves as the initial point of entry for visual information into the cortical network. Subsequently, information is disseminated to extrastriate areas such as V2, V3, V4, and MT, as well as to the parieto-occipital (PO) and posterior intraparietal (PIP) parts (visual areas lying in the dorsal stream), before progressing further to regions in the parietal and temporal cortex (Tong 2003). This intricate network configuration gives rise to what is commonly referred to as the 'dorsal' (parietal) and 'ventral' (temporal) visual processing streams, (Felleman and Van Essen 1991). In this dichotomy, the dorsal stream primarily serves the function of translating sensory input into motor behavior, while the ventral stream assumes a pivotal role in the complex process of object recognition (Lamme 2015).

The authors posit that the FFS process triggers quick, spontaneous behavioral reactions that occur completely unconsciously. However, the process of recognizing and selecting optimal behavioral patterns that accompany the propagation of stimulations from sensory fields ensures adequate responses according to previously learned patterns. They also claim that awareness of perceived images occurs through recursive processes. Consciousness achieved through the backward transmission of stimulation top-down, would enable phenomenal sensations. It would therefore be this mysterious phenomenal consciousness (P-consciousness). Unfortunately, the authors do not explain how the recursive process would generate these feelings and where and how they would appear.

4. Further Development – MEM Model

The Motivated Emotional Mind (MEM) model, introduced in a series of publications by Galus and Starzyk (Galus & Starzyk 2020, Galus 2015 a,b,c; 2018; 2022; 2023 a,b), aims to explain subjective first-person impressions and phenomenal feelings. This model is illustrated graphically in Fig. 1 (Galus 2023b, with the author's permission). The figure depicts the main FFS process as thick blue arrows flowing from left to right. The top-down recurrent process is shown as an arcuate, blue arrow running from right to left, labeled "memories, beliefs, decisions, models of reality." For clarity, the arrow is placed outside the brain structure, though it actually represents brain processes transmitted downward through axons and synaptic connections.

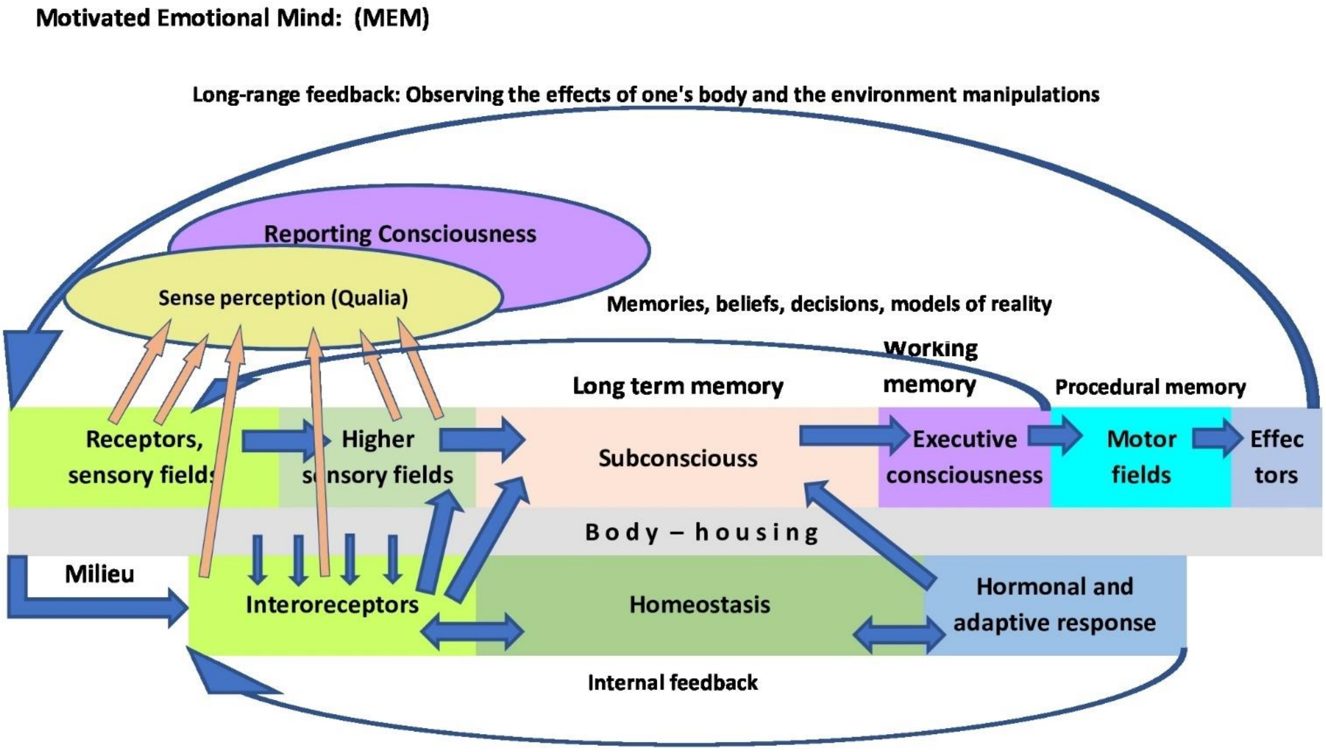

Fig.1. The top bar symbolizes the processes in the cortical fields of the brain. It covers the perception of signals delivered by receptors, remembering in persistent memory, processing information in working memory, and controlling reactions through effectors. The broad blue arrows show the order in which the information is transmitted. The narrower gray central stripe symbolizes the body of the system. It is closely related to subcortical fields or peripheral centers symbolized by the bottom bar that controls system homeostasis. The interoceptor provides data for homeostasis. The adaptive homeostasis processes are realized mainly thanks to secreted hormones and neuromodulators. The elliptical fields represent the mental states of the system, with the yellow field corresponding to sensory perception in the primary, direct perception of objects and phenomena, the violet field corresponding to secondary visual images caused by memories and mental images, which we subjectively perceive as consciousness reporting the state of the system and its relationship with the environment. The long-arched arrows represent feedback: upper - through relations with the environment; middle - through the axons of the up-down neural network and the process of backward activation; lower through the physical and biochemical effects of the body interior on interoceptors. Orange arrows indicate the sources of impressions and mental feelings.

The theory behind the model is a form of representationalism that uses, as neuronal representations of percepts, semi-hierarchical multi-level structures of the neuron-astrocyte network, constituting an associative biochemical memory in which information propagates cyclically in bottom-up-top-down cycles.

In the work of Galus & Starzyk, these representations were called "semblions" following the works of Kunjumon Vadakkan, who first proposed such an organization and mechanisms for associating memory traces, engrams, into multi-layered semblions representing complex objects, a scene surrounding an organism or a conscious agent, or a model of the environment (Galus & Starzyk 2020; Vadakkan 2010, 2016). A sketch of the semblion is shown in Fig. 2 (with permission of the author: Galus 2023). In the present paper, we will not report on the MEM model and explain its numerous features described in previous publications. We will discuss the conclusions arising from its effectiveness in explaining the functioning of natural brains. We will check whether this model is sufficient to explain the problems that have been occupying the minds of scientists and philosophers for many generations. We will discuss the essence of direct perception and the perceptual awareness created on its basis, both access and phenomenal, including qualia, emotions, and feelings. We will show how the MEM model explains the epiphenomenal nature of consciousness, which does not exclude deliberation and conscious decision-making.

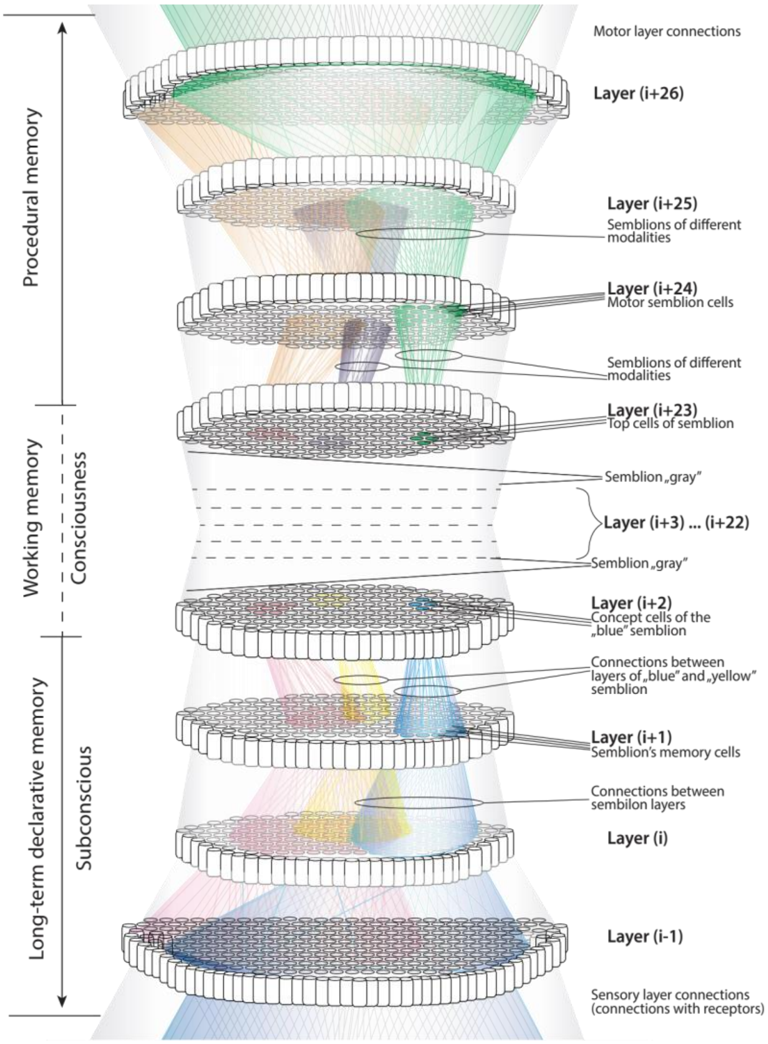

Figure 2. The hierarchical structure of the memory. Only a few examples of connections are shown. The structure of semblions and subsemblions may be observed. Couplings between semblions aren't shown. Groups of memory cells in certain layers that are connected in a way that allows the transfer of stimulations between them are marked with the same color. Only existing tracks of stimulations leading from lower to higher layers are marked on the picture. Feedback stimulations and couplings between cells on the same level (layer) have been omitted. The figure shows that one cell of a higher level may be stimulated with signals coming from many lower-layer cells. The group of cells marked with the same color in particular layers symbolizes complexes corresponding to specific features of objects. We call them memory fields. Small memory cell groups (or single cells) representing memory field groups of many lower layers are called concept cells (cells marked with pink, yellow, and blue in layer i+2). Above the apical neural fields, the cognitive semblions connect to the brain's motor fields' layers. In these layers, learned motor reactions are remembered, constituting the system's procedural memory after training (consolidation). The stimulations to act come from the top cognitive fields, dominated by the most forceful conscious arousal. The layers of semblions that activate the stimulation are called working memory.

The MEM model of the conscious mind, contrary to its name, does not concern only the brain, which is the seat of thoughts and a tool for exploring reality, but, as Fig. 1 indicates, it concerns the embodied brain, along with receptors and effectors located in the body or casing (if it were to be an artificial system, for example, a robot). Perception is the result of the interaction of the senses, body, and brain. Visual, sound, and olfactory imagery are produced by sensory receptors; their meaning is given by the brain, and their emotional character is given by the body. Percept representations - semblions - are created as engrams of the transmission of neuronal stimulations in individual layers and neural fields that process the stimulations reaching from the receptor cells to higher brain fields. The selection of excitations reaching subsequent, higher, and higher layers occurs as a result of the competition of many excited paths on the "winner take all" basis. Signals arriving from the lower layer are selected and those compatible with the patterns preserved earlier, are recorded in the higher layer (Fig. 2). Patterns residing in memory, created by strengthened synaptic connections during a previous learning procedure may be modified as part of memory plasticity. The effectiveness of strengthening connections and their strength depends on the intensity of the excitatory signals and the frequency of their repetition. The effectiveness of the transmission of the activation configuration of the percept representation in individual layers of the semblion depends on their degree of similarity to the configuration of the receptive terminals (synapses) in the memory patterns. As a result of the process of signal propagation to the higher layers of the system, the most common and frequently occurring features of the perceived object are selected, i.e. the categorization process occurs. Associating similar categories leads to generalization and strong compression of information. Further associations of frequently co-occurring objects create in memory a model of complex objects, observed scenes, and the whole perceived world (Galus & Starzyk 2020).

Tree-like, multi-layered structures of semblions encode [4] the simplest and most common features of objects in the lowest layers of the primary visual cortex [5]. In higher layers, more and more general, abstract features of objects and categories to which they are assigned in the process of categorization and generalization are encoded. The highest cognitive areas, through far-reaching associations, encode extensive models of the environment explored by the conscious system and the entire world known to it.

5. Direct perception – Perceptual awareness

The MEM model assumes the identity of mental states, including affective ones, with the biophysical states of various brain structures (Galus 2023b). The purpose of further reasoning is to present hypotheses regarding the scope and areas of the principle of identity. If these hypotheses turn out to be credible, we will confirm the supervenience of subjective mental states on neuronal states, which will remove such an acute explanatory gap. For this purpose, let us consider how the subjective experience of sensations occurs under the influence of physical signals reaching our senses.

Awareness of what we see results from the simultaneous fulfillment of the following conditions in the subsequent stages of perception:

1. Seeing, sensing an object (via vision, hearing, feeling, touching, tasting, or smelling)
2. Recognition of perceived objects allowing for adequate reactions.
3. Attributing meaning to perceptions
   a) Becoming aware of what we perceive.
   b) Formation of an emotional attitude towards perceived objects.
   c) Experiencing own psychophysical states.

Ad 1. **Vision**, **Seeing, Sensing.**

Vision, understood as perception within the range of the senses, means that signals containing information about objects or phenomena that concern us reach the receptors. Similar to Lamme, we may compare vision to the observation of the visual field by a camera (Lamme 2015, Galus 2023b). Perception, according to my definition, is not merely the reception of signals. It also entails the transmission of processed signals to any center capable of further processing this information. Mere registration of signals, which can be accomplished by a simple camcorder, is not sufficient. What is essential is the further processing of information. Of course, a camera may be integrated with memory devices, but we will refer to its function as perception only if the information is subsequently accessed

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[4] Coding, according to the MEM model hypothesis, is the fixation of signal transmission paths in the form of modifications (conformations) of proteins forming the neuron-astrocyte network and covering synaptic connections, dendritic spines, neuronal soma (as a result of epigenesis), and possibly other elements of the network structure. Together, they create associative memory used as subconscious memory, episodic memory, working memory, procedural memory and all other forms of memory that underlie psychoneurological processes.

[5] This reasoning also applies to other modalities.

and processed. Such a role may be fulfilled by vision systems whose information is processed computationally and stored.

Ad 2. **Recognition**

The MEM model, like RPT, uses the idea of FFS as a generally accepted form of creating representations of neural perceptions - semblions. It is assumed that many perceptions from different modalities can arise simultaneously. However, competition between them means that only some of them reach the highest layers of the frontal cortex and participate in cognitive processes. If they are not associated with sets of superior values that inhibit their further transmission, they can be transferred to effector areas included in procedural memory. Then they trigger the body's (system's) reactions to what it perceives. The transmission paths of signals that lose the competition reach the intermediate layers of the semblion (see Figure 2), where they can modify previously remembered patterns or create new engrams in permanent memory. The contents of this memory are called the subconscious.

There is considerable evidence suggesting that both of these processes occur unconsciously. First, FFS processes are neuronal and biophysical in nature, and we do not regard them as indicative of consciousness, just as fluctuations in currents and voltages within a camcorder's circuits do not convince us that the camcorder "sees" what it records. Moreover, numerous psychological studies confirm that the transmission of sensory excitation in a bottom-up direction, as well as the FFS process itself, is not accompanied by subjective awareness. Virtually all studies affirm that categorization can occur without the involvement of consciousness. This strongly supports the validity of the MEM model, as the bottom-up mode of information transfer between successive layers of a semblion excludes the emergence of conscious experience (Weiskrantz 1996; Boyer et al. 2005).

These conclusions appear credible because they are supported by experimental evidence. They confirm that recognition is rapid and enables an almost immediate appropriate response. However, such rapid, spontaneous, reflexive, or instinctive responses are unconscious (Galus 2023a). The MEM model employs the concept of FFS to describe the process of organizing goal-directed responses in organisms and systems. Furthermore, it enriches the RPT model by introducing hypotheses concerning the construction of hierarchical neuronal representations, semblions, and the signal transmission processes between layers of the neural network, synaptic connections, and associations forming associative memory. The described structure possesses a functional capacity for the categorization and generalization of perceptions and their associations. As we have shown in previous work, this is equivalent to performing inductive and deductive operations, that is, to the capacity for intelligent behavior. This suffices for the execution of intelligent life functions by simple organisms, as well as for the implementation of intelligent actions by robots. However, such actions and functions are carried out entirely unconsciously (Galus & Starzyk 2020; Galus 2023a).

Ad 3. **Meaning**

The adaptive value of perception in evolutionary processes increases dramatically when a perceiving organism not only understands what it sees but also feels how significant its perceptions are. An emotional response to stimuli endows them with a dynamic meaning that energizes all subsequent reactions. It is only through emotional coloring of perceptual content that awareness of perception arises. The responding organism not only deduces the significance of a stimulus but, through associations, feels what is beneficial, threatening, or repulsive to it. In this way, it becomes an intentional being in the sense proposed by Brentano’s philosophy. When, then, and in what manner can the awareness of what we see, hear, or perceive through other senses arise?

a) **Becoming aware**

As already mentioned, the anatomical pathways that may transmit top-down influences include numerous feedback connections not only from higher cortical areas (frontal, parietal, and temporal regions), but also from higher and lower-order visual areas. The primary visual cortex (V1) receives strong feedback projections from multiple visual regions, including V2, V4, MT, and the inferior temporal cortex. It has also been suggested that top-down interactions may be mediated by the pathway from the cortex to the thalamus and back to the cortex (Sherman, 2005). Sensory processing and perception are commonly attributed to a feedback loop involving neural connections between the neocortex, responsible for advanced cognitive functions, and the thalamus, a subcortical structure that relays both sensory and motor signals to and from the cortex.

According to the studies cited, V1 is required for conscious perception even when the stimulus does not originate at the retina. During imagery or magnetic stimulation, a stimulus can only become conscious if V1 function is not disrupted. These significant experimental findings have led to the intriguing proposal that V1 and V2 may serve as "active blackboards" that visualize perceived images (Bullier 2001; Bullier et al. 2001; Hupe et al., 2001).

Scientific investigations into subjective consciousness employ various perceptual phenomena to capture the nature of the perceptual process and the potential influence of consciousness upon it. Notable examples include bistable perception and binocular rivalry.

In both cases, we observe shifts in the interpretation of a visual scene despite the visual stimulus remaining unchanged. It has also been empirically established that, during these phenomena, signals from higher cognitive areas reach the primary visual cortex. It is therefore reasonable to suspect an influence of consciousness on what we perceive and how we interpret it. By combining fMRI and TMS techniques, researchers have demonstrated the involvement of the inferior frontal cortex in transmitting feedback information between conscious content and sensory representations (Weilnhammer 2021). Although the authors were confident that they had compelling evidence for the existence of such interactions and had managed to localize the brain structures responsible for these phenomena, the nature of the subjective experience of conscious vision remained an open question.

The MEM model developed by Galus and Starzyk (2020) offers a radical extension of the ideas proposed by Bullier, Hupe, and their teams (2001), postulating that the primary visual cortex not only participates in the visualization of the observed scene but that the reactivated states in the lower-layer cells of semblions are themselves that visualization. This is the first postulate of the identity theory formulated in Galus (2023b). There, I proposed that top-down recurrent signals reproduce neuronal states in the lower layers of semblions identical to those generated during the learning procedure, that is, during the original observation of similar objects (see Fig. 1). This would support the intuitions of Gilbert and Sigman (2007), as cited at the beginning of Chapter 3. The aforementioned studies highlight the role of lower visual fields in the formation of visual consciousness. Yet, does participation in its formation amount to the identity of these states with the subjective visual experience? Although the projection of retinal images into higher-order fields from V1 to MT exhibits retinotopic architecture, is that sufficient to reproduce the observed scene with precision? Can such an identity explain the phenomena previously discussed—visual illusions and shifts in image interpretation?

There remain numerous features of direct perception that must be explained within the MEM framework. First, sensory recreations are not always accurate. Recalled images are often blurred, indistinct, and distorted. Second, as described in Section 2 of this chapter, recognition and spontaneous reactions are extremely rapid. In contrast, becoming aware of what one sees requires signals from higher cortical layers (see Fig. 2), and thus takes approximately 200 ms (Lamme 2015) [6].

The following hypothesis may be formulated: Recurrent processing between visual areas suffices for conscious visual experience to arise. The hallmark of conscious vision is the integration of visual

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[6] 200 ms latency range, known as the visual awareness negativity (VAN), is the typical latency of recurrent visual processing. FFS proces jest nieświadomy, ale świadomość widzenia pojawia się po tych 200 ms (Lamme 2018).

features into a coherent single scene (Lamme 2010). A good example of visual organization processes is *gestalt grouping* and *figure-ground segregation*. These processes suggest a close link to consciousness, as they require a certain amount of time to unfold. In other words, before we become consciously aware of a particular pattern or object in our visual field, our brain needs time to process and organize the input. This implies that consciousness is not instantaneous, it depends on the time required to carry out these perceptual operations (roughly: less than 100 ms upward + slightly more than 100 ms downward). In summary, *gestalt grouping* and *figure-ground segregation* are integral to the process by which visual awareness emerges. Consciousness arises with a delay because these operations constitute a temporally extended stage in our perception of the world (Lamme 2015).

Is the claim that we "see" the image as the excitation pattern in the retinotopic structure of the lower visual field credible? It appears so. According to the MEM model, when we observe an object, we construct a multilayered neural representation of it. The processes of generalization and comparison with engrams stored in memory allow us to recognize objects. By focusing attention on the image's details, we can identify its characteristic features. Pixel groups representing these features form *subsemblions*, which support visual analysis of all object components (see Fig. 2). Associations between the object's semblion and subsemblions and other semblions representing background or contextual elements enable us to recognize the object and integrate it into a broader model of reality developed through environmental exploration. This also allows us to respond appropriately to it, by Section 2 of this chapter.

Why is it so difficult to accept the idea that what we perceive is simply the excitation of the lowest sensory layer's neurons coupled to receptors? A common line of reasoning in vision science raises a familiar doubt: the neural representations of the perceived scene cannot "have color." While the objects in a scene reflect distinct portions of the white light spectrum, thereby altering the relative stimulation of color receptors, this only modulates the intensity of electrical signals and ionic currents in cones, rods, optic nerves, and cortical neurons. Nowhere in the brain do we find the *quale* of color. Hence, the suspicion that the sensation of color is non-physical (cf. Pautz 2021, p.13), which easily leads to dualism. And yet, color is in fact formed at the lowest layer of the visual system. It is here that categorization begins, when the activation patterns of the lowest-level visual cortical neurons respond differently to "spectrum A" than to "spectrum B" or any other spectrum of incoming light. Higher cortical areas within the cognitive regions merely assign names—such as red, blue, yellow, etc.—to the most frequently encountered activation patterns. We distinguish colors because our visual system differentiates and perceives them as distinct. Even more basic percepts are learned in the same way. We learn to recognize lines, contours, motion, shapes, geometric structures, textures, perspective, and numerous other features of objects in our surroundings. Many of these perceptual skills are innate, others are acquired in early childhood, and many more require specialized training.

In line with Lamme, I argue that conscious awareness requires the aforementioned stream of feedback excitations from higher cortical layers. What role does this feedback stream play? The images transmitted to higher-order areas become associated with semblions representing context in the upper layers. These associations then return to the lower areas together with that context. It is these that enable the interpretation of what we perceive. They fill in incomplete or ambiguous elements of the visual scene. They also enable perceptual reinterpretation, as in well-known illusions where the same image can be interpreted in two or more ways. This is particularly relevant when perception is not based on a single glance or fleeting image, but involves sustained attention and prolonged observation.

It is often assumed that one of the visual system's main goals is to replicate the scene or environment and construct in the brain its most accurate possible representation. However, this seems not to be the case. What we perceive is a systematically modified version of reality. When we fixate upon something, feedback information alters the parameters of the receptors or cells receiving input in the lower sensory fields. We may then perceive illusory contours, borders, or altered colors that are not physically present. Contextual modulation thus links perceptual inference with conscious vision.

Examples include the *Kanizsa triangle* [7] and the previously discussed *perceptual gestalt grouping* and *figure-ground segregation*. These are manifest signs of consciousness interfering in the perceptual process.

How, then, do we know that direct perception exists? The result of direct perception is perceptual consciousness, which is equivalent to the awareness of perceived objects. It operates with remarkable speed, though still more slowly than spontaneous reactions. It enables nearly immediate responses, provided they are learned and sufficiently well-trained. Examples include situations requiring rapid yet conscious reactions, in which instinctive or reflexive responses are insufficient. Competitive sports such as table tennis or fencing serve as apt illustrations. While even an unskilled novice may instinctively dodge an unexpectedly incoming ping-pong ball, professional athletes and swordsmen are expected to consciously direct the motion of the racket or a well-placed touch with the foil. There is, however, no time for extended deliberation. The perceived image merely allows for deliberate yet minimal adjustments to previously learned motor routines.

These processes will be discussed in subsequent sections of this article. For now, however, we shall turn our attention to the emotional dimension of perceptual consciousness.

b) Formation of an emotional attitude towards perceived objects.

Many psychological studies have examined the influence of emotions on perception, yet few of them shed light on the core of the issue—namely, the modulation of consciousness and the generation of feelings. These studies indicate that emotions affect perception within lower visual fields. Mood influences the way objects are perceived, and stress narrows the focus of attention. Under such conditions, we tend to perceive details rather than the entire scene—we see the trees, not the forest.

At this early stage of processing, the co-occurrence of sensory impressions and affective states can lead to their association and bio-physical coupling. This is reinforced by the reverse process, wherein sensory signals themselves give rise to emotional states. Sensory observations and impressions may trigger affective reactions because such signals acquire emotional valence as a result of prior experiences or innate associations. Signals from receptors interact with the organism's cells, producing physiological effects. These effects are registered by the densely distributed network of interoceptors. Furthermore, by the identity theory of emotions and organic responses, the physiological reactions themselves may constitute a source of signals transmitted to the limbic system and become associated with sensory receptor information as emotions accompanying perception (Galus 2023b). Another source of emotion may arise when the exploration of the environment is driven by a curiosity drive, equivalent to the need for understanding (Galus & Starzyk 2020; Perlovsky 2008). The satisfaction or frustration of the need to understand corresponds to a positive or negative emotional state, respectively.

These emotions may become associated with percepts and, in this way, may, on the one hand, enhance their influence within the network of semblions, favoring them over others in the competition for dominance. On the other hand, emotions may confer significance upon them as novel or modified elements of the mental model of reality.

A key assumption of the MEM model is the Identity Theory aspect that posits an equivalence between affective, physiological, and neural states. This model incorporates the fundamental thesis of the Perceptual Theory of Emotion, which generally assumes that emotions are a form of perception analogous to sensory perception (Brady 2013; Salmela 2011; Prinz 2004; 2006). According to this theory, feelings represent the internal state of the body, signaled by interoceptors located throughout all internal organs. These interoceptive signals convey the quality of the organs' functioning, that is, the state of homeostasis. Additionally, information is distributed to all cells of the body in the form of

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[7] Kaniz's Triangle: a well-known illusion in which, upon prolonged observation, we can see non-existent boundaries of a triangle, when in fact only its vertices are marked.

hormones, neuromodulators, and neurotransmitters released into the bloodstream or into synaptic clefts. All such signals, streams of ions and chemicals, are transmitted from the body and subcortical systems to the phylogenetically recent neocortex, the neopallium, and its behavioral and awareness functions, which process sensory information about the external world. The feeling of inner sensations is made possible by the stimulation of these deep structures, which is why Solms equates the experience of affective states with stimulation originating from the brainstem and subcortical layers. According to Panksepp (1998) and Solms (2021), the informational interface between bodily homeostatic processes and cortical brain centers is the periaqueductal gray (PAG), which serves as the final common pathway for affective output.

Emotions are also manifested in behavioral responses (Galus 2023b).
As I noted, we are dealing here with a complex, reciprocal relationship involving: a) the perception of internal states; b) physiological changes in the organism as a result of homeostatic imbalance; c) behavioral reactions; and d) cognitive responses. All these factors interact and form feedback loops that result in—or aim to restore—homeostasis and assess the outcomes achieved. Disruptions in homeostasis or external stimuli generate interoceptive signals (b), which are perceived by the system (a) and result in both physiological (b) and behavioral (c) feedback. Their secondary echo within sensory perception enables access awareness and cognitive processing (d). In this way, they acquire epistemic significance.

Thanks to this process, the observation of an object or phenomenon is not a neutral act akin to surveillance by a camera. Complex living organisms, by enriching percepts with emotions, are capable of evaluating their significance and modifying their responses based on improved prediction of consequences. As a result, their decisions are more attuned to environmental demands and conducive to survival.

c) Feeling own psychophysical states.

If in point a) above, we accept the assumption that seeing and sensory perception involve the stimulation of the lower receptor fields, then, based on the Identity Theory, we should assume that the feeling of internal states is also the stimulation of the lower receptor fields through signals flowing from interoceptors, nociceptors, and other receptors that monitor these states. Then, adopting the Perceptual Theory of Emotion, it should be consistently recognized that we experience our affective states, including all feelings and emotions, thanks to the stimulation of lower receptor fields. These stimulations can be further transmitted to higher layers of the limbic system, subject to categorization and generalization, creating specific semblions of feelings. They can be recognized and consolidated in higher cortical layers as distinguished and recognizable psychophysical states described propositionally, constituting part of access consciousness. The independent path of associations leads to coupling, perhaps in the PAG structure, with semblions of percepts, where they become subsemblions of them, but already burdening them and together carrying their emotional load higher. In this way, the discussed conditions 1, 2, and 3 of becoming aware of what we perceive and feel can be met.

Let's describe how direct perception works with a simple example that's easy to imagine. If we hear a loud crack while walking in a dark forest, we can suddenly jump in the opposite direction, reflexively performing a series of movements recorded in procedural memory. This leap will be unconscious. Only after a while will our interoceptors inform us what condition our body is in and whether homeostasis has been maintained. We will also need a moment to detect background noise (figure-ground segregation) and consolidate the sound with other sounds heard in the environment (gestalt grouping). The released hormones, muscle tension, posture, hair standing on end with fear, rapid pulse, and other symptoms will allow us to recognize that we are scared. Thanks to the stimulation of the lower layers of the semblions coupled with receptors and interoceptors, representing the sounds heard, non-specific pressures felt on the feet, and behavioral and physiological changes throughout the body, we will experience the feelings accompanying the event. Only then will we be aware of what has happened. Moreover, perhaps we will develop a new association with the general fear of walking in the dark on unknown ground. But also, a pattern of effective response to such a threat and a possible unpleasant event.

Let's note that by using the MEM model, we described how being aware of what it is like to hear an unexpected sound and be frightened by it, we explained our sensations using both physical and neuronal phenomena. This is an example of how subjective mental phenomena supervene on material, physical phenomena.

Does what we have discussed justify the belief that we perceive the external world through receptors coupled to the lower sensory fields, much like a CCD camera? We learned that additional processes are needed to create neural representations, semblions, enabling the recognition of objects and their specific features in the form of subsemblions. One also needs the ability to associate perceptions with the body's reactions. Tremendous advances in machine learning have enabled robots to recognize perceived objects and respond appropriately to these perceptions. Moreover, they can construct a model of the environment in which they operate.

So, can robots see their surroundings in the same way as animals and humans? To some extent, yes. Intelligent robots equipped with cameras could theoretically answer what the image on their CCD image represents, just as humans can describe the image displayed on the retina. They can describe each element of this image, its subtle properties, and its overall importance to the perceived environment. To the question, "What do you see?" the robot will respond similarly to a human, and its arguments that it can perfectly see what is in its field of view will be difficult to deny. This is the ultimate test of what vision and sensory experience are. The degree to which machines' vision is similar to that of living creatures depends on the complexity and adequacy of the model of the environment created in their mind. A simple industrial robot sees only what is in the field of its interest. However, advanced systems can recognize the environment of the road, battlefield, or inside the bodies of operated patients. They see much more than simple animals, insects, or worms.

Of course, direct perception does not exhaust the wealth of phenomenal sensations experienced by living organisms. We will discuss them in later chapters, trying to deduce whether we can endow artificial minds with the ability to experience such a wide range of sensations.

6. Qualia, direct sensory impressions.

It is not clear why we hear the snap of a twig or the howl of a wolf in this way and not another. Why does ice seem slippery to us and the scent of flowers so distinctly floral? The MEM model explains in detail the formation of these direct sensory impressions, called qualia (Galus & Starzyk 2020; 37-39). Their generation is only possible in an embodied system capable of interacting with the environment. When the body experiences sensory stimuli, it can better understand their nature if it has the ability to respond to these stimuli. This is provided by the motor system and various types of effectors. In Figure 1, achieving a reaction is symbolized by a series of thick blue arrows running from left to right. However, the reaction of the organism/system is symbolized by an arcuate arrow in the opposite direction, described as "long-range feedback". Thanks to this feedback, the body can observe the effects of its actions. It can therefore determine whether its action brought positive results or brought him closer to his goal. As I wrote above, the effects that enable better or worse satisfaction of needs cause emotional reactions.

Manipulation of objects or one's own body in the surrounding environment causes the effects of manipulation to be associated with emotional states. We find certain stimuli pleasant and others not. We distinguish them from others and notice the similarity between some of them. For example, the use of a prism (fog) allows you to detect differences in psychological response to different parts of the spectrum. We associate perceived differences with objects whose feature is the appearance of a specific spectrum range. These objects often trigger emotional states. They may be indirectly associated with specific colors. Green – plants; yellow – sun; blue – sea, sky; etc. The transfer of emotional states evoked by these objects to their specific features, including colors, results in the emotional character of qualia.

Differences in the spectrum of individual objects are more important than objective spectral characteristics. We distinguish the colors of familiar objects even when the changed spectrum of radiation illuminating the objects radically deforms the characteristics of the spectrum of radiation reflected by these objects.

There is no point in considering why we perceive an impression in a certain way and not another. The most important thing is that we distinguish them, that we perceive them differently than other impressions. Subjectivity means that we cannot penetrate this sphere from outside our own experience. We don't know if our children perceive red the same way we do. Maybe it's more red for them? The most important thing is that we agree that the spectrum of colors reflected from blood, a tomato, and a red banner resembles a light wave with a length of about 700 nm, and we agree to call this spectrum a common name, and we similarly react to this color.

You might ask, how does a bee perceive ultraviolet light? We don't know this, because it is the intimate secret of the bee's subjective feeling. And how would we see ultraviolet color if we could perceive ultraviolet radiation? We will never know because we do not have ultraviolet receptors. However, if we had them, we would certainly notice that, in addition to signals from the receptors of the three primary colors we know, in some places in the image/scene there is stimulation of pixels of the fourth color, and generally we see a mixture of these colors in different proportions. The color black would require the ultraviolet to be turned off, otherwise the object would appear ultraviolet rather than black. Galus and Starzyk noticed that we cannot describe these most basic direct sensory impressions, qualia, strictly propositionally because they lack distinguishing features. Therefore, we describe them in the language of poetry, through metaphors, comparisons, hyperboles, etc. [8].

In the same way, sensations of internal states signaling affective states, feelings, and emotions should be treated as qualia. Their representations in the upper layers are created as a result of a process similar to direct perception. Thanks to the FFS process, the excited signals of internal state receptors, interoceptors, reach higher brain layers through the multilayer network of semblions and can be spontaneously recognized as emotional states known to psychology. They can trigger spontaneous reactions. They can be categorized and generalized, creating propositional knowledge about our psyche. Finally, as described in section 5.b), they can be associated with object percepts, adding emotional meaning to them. They then become subsemblions of the semblions representing these percepts.

As in the case of direct perception of signals from the external senses, emotional feelings can be made aware by expanding and supplementing them with signals coming back from the upper layers. This happens when, for example, we feel pain in a broken leg and we are afraid of dangerous further consequences, even when we do not see the source of the pain. Moreover, we can think thanks to the so-called inner speech: I feel terrible today, it's probably because of the pain in my leg.

Similar reasoning applies to other modalities. Also other sense receptors "touch" the surrounding reality or bodily states of homeostasis. In this way, they create qualia. Qualia are mainly if not only, produced by receptors and sensory fields. Qualia of internal states, equivalent to affective states, are also produced by intero- and proprioceptors. Each time we feel anything, the widely understood receptors of external signals from the environment, and internal signals, from the inside of our body, are active. The brain analyzes the images created by the senses, understands them by comparing them with the stored patterns, and incorporates them into the broadly understood model of the world.

7. Phenomenal and cognitive aspects of direct perception. Perceptual awareness.

The enormous possibilities of associating activations of the neuron-astrocytic network enable the creation of engrams of complex events covering the external world, behavior, and internal state of the organism interacting with the environment. The MEM model treats the brain as an associative memory with a specific, semi-hierarchical structure. In it, representations of these events (semblions) compete for access to effector fields or the possibility of further spread. The lower layers of the semblions include sensory fields and represent direct sensory impressions, qualia. However, in the upper fields, representations of simple impressions are subject to categorization and generalization, leading to the

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[8] Complex objects, abstract notions, concepts, ideas, and models can be the content of access consciousness because they usually have many features and components. The relationships between these elements can be described in symbolic language. This description is a set of representations located in the upper layers of semblions and subsemblions, where they are subject to strong information compression. However, they cannot be visualized because they are not associated with any image. Even a concept such as a chair or a table cannot be recalled or imagined. We can only imagine a specific table (for example, a round one) or a series of different tables. The concept itself is visually inaccessible.

extraction of increasingly abstract features, up to the level of abstract concepts and ideas. Associations lead to the detection and construction of response patterns, relationship structure, and reality models.

As it follows, the lower fields of the semblions connected to the receptors represent qualia and affective states, which are treated as phenomenal feelings. The upper fields, on the other hand, represent abstract concepts, ideas, and models of phenomena (see Figure 2). The tree-like hierarchical architecture of connections in the neural network representing the perceived reality in the form of semblions, engrams of percepts, corresponds to the structure of knowledge in the mind. Grounded or embodied cognition posits that all cognition, even abstract concepts such as justice and love, involve bodily or sensory representations. This theory proposes that perceptual symbols are extracted from sensory representations and stored in long-term memory, and it is these symbols that are used during cognition (Barsalou 1999).

Semblions that are temporarily inactive remain fixed in the network structure, creating the subconscious. The strongest and most extensive synaptic stimulations coming from the lower fields as part of the FFS process excite the entire semblion, which, winning the competition, reaches the motor fields in the motor cortex, triggering the body's response to the stimulus. The remaining streams of biochemical stimuli in the remaining semblions are extinguished through inhibition processes (Galus & Starzyk 2020). These symbols remain hidden in the subconscious. However, the generated transmission paths of neurotransmitters, neuroregulators, ion streams, and calcium waves reside in the neural network, constituting patterns for subsequent sensory impulses. This is how we create our chemical memory. In this way, the subconscious influences the selection of stimuli, i.e. perception. The cascade of excitations in higher and higher layers cannot be stopped without external interference. Therefore, spontaneous reactions often occur unconsciously. However, as described in section 5, we are aware of what we perceive, we recognize what it is, what meaning and value it has for us, and our emotional attitude to it. We call this type of awareness perceptual awareness.

Practically, the memory of every phenomenon or object contains a phenomenal and cognitive component. In this way, abstract concepts are grounded in phenomenal sensations. This is the fundamental difference between the knowledge of living beings and the knowledge stored in computers. Thanks to this, the sum of knowledge accumulated by the organism is meaningful to it, while the computer "brain" is not interested in its cognitive resources. This allows living organisms to better understand and organize this knowledge, to understand their own good, and thus, as we have already stated, to become intentional beings.

8. Symbols perception.

Knowledge about the world and surrounding reality is largely structured hierarchically (Rescher 2003; Wang 2016). Models of the world and more complex objects consist of subcomponents, simpler, often smaller, and less complex objects. As described in Section 3, the categorization of percepts and their generalization lead to the extraction of salient features of perceived objects and the abstraction of more general categories. Their neural representations, semblions, possess the capacity for association, thereby enabling the construction of complex structures symbolizing higher-order objects. This process resembles inductive reasoning, through which knowledge is generated and accumulated in memory. In a similar manner, relationships between the constituent elements of objects, as well as interactions between objects themselves, can be categorized. Such inter-object relationships are mutual influences or interactions that result in modifications of the specific features characteristic of these objects or phenomena. Temporal dependencies among these interactions require neural representations capable of encoding them as so-called dynamic semblions, which form the basis of episodic memory. Dynamic semblions were introduced in the work “Architecture of Consciousness, Part II: Molecular Structure and the Biophysics of Memory” (Galus 2015). The core idea involves the spatiotemporal transformation of dynamically changing activations and their spatial distribution across a neural network, enabling them to be recognized similarly to ordinary static semblions. The encoded sequence of events can then be read out by the sequential activation of adjacent modifications in neuronal or synaptic representations. This readout occurs at temporal intervals, resulting in an inverse spatiotemporal transformation.

Semblions formed through forward-flowing signal propagation (FFS) are capable of associating into extensive assemblies that represent increasingly complex objects. These, in turn, are subject to further selection, resulting in the extraction of abstract categories of objects and phenomena, concepts and ideas. In this way, a hierarchy of neural representations is formed that mirrors the hierarchy of knowledge in the mind. At successive, higher levels of the semblion, these representations become progressively less accessible to consciousness. Nevertheless, it must be emphasized that the full semblion represents our thought of a concept or idea. Even abstract concepts remain grounded in qualia. When recalling the concept of a "home," one may associate it with "the warmth of the hearth," the comforts it provides, and pleasant moments spent within it. This experiential and affective context is inaccessible to systems lacking the richness of senses and experiential learning through sensory impressions. This limitation applies both to artificial systems and to many animals with rudimentary neural architecture.

At the highest level, all such concepts and ideas constitute a model of the world we have come to know. By directing attention to its parts or various aspects, we can analyze and describe it. To that end, it is useful to associate this set of acquired concepts and abstract ideas with symbols—words, signs, or gestures. This is a natural and necessary process, stemming from the associative nature of memory—which is implemented in the brain's neural network, and the multimodal nature of the senses through which we come to know the world (Galus 2022). Support for the hypothesis of widespread multimodal associations of neural representations of objects, ideas, and models lies in the phenomenon of recall across multiple modalities triggered by a stimulus in just one of them. For instance, upon hearing the familiar timbre of a television presenter's voice, we may instantly visualize their image, recall their name, and remember their signature roles. This involves cooperation among the auditory and visual senses, cognitive fields (person identification), emotional fields (pleasant impression), and episodic memory (performed roles). One can assume the broad association of subsemblions formed in specialized brain areas into a broader semblion representing the model of the object, comprising knowledge, sensory experiences, and emotional disposition.

The association of abstract categories with perceived symbols arises within social interaction among conscious beings. Repeated designations of recurring objects or phenomena become embedded in individuals' memory as specific symbolic sounds: words, names, graphic signs, gestures, or other forms accessible to the given species. The basis of associating objects with symbols is co-occurrence. This process is enhanced by multimodal coincidence of signals, for example, when a particular sound is consistently accompanied by a hand gesture, or a recognizable shriek coincides with the perception of danger. This marks the beginning of symbolic language communication (Galus 2018).

An organism or artificial system can manipulate these representations by recreating the relationships between perceived objects or phenomena. It employs a powerful tool in the form of "image schemas," which define relational patterns between objects. Image schemas, as proposed by Johnson and Lakoff (1980), serve as a foundation for abstract and conceptual thinking. They explain how our physical experiences shape mental representations and conceptual structures. Among the elementary image schemas are: up–down, part–whole, figure–ground, recursion, containment, and perspective recognition schemas. Even infants learn to understand opposites such as front–back, win–lose, faster–slower, pleasant–unpleasant, and so on.

Some of these schemas are innate. Others are acquired through manipulation of the environment, especially during infancy. A significant portion is transmitted through social interaction, primarily from more knowledgeable and experienced individuals such as caretakers and teachers. In "Semblions of Words. The Language of Natural and Artificial Neural Networks," Galus (2018) described how semblions can be used for this purpose.

Using image schemas, one can conduct complex reasoning, both deductive (inference from general rules) and abductive (hypothesis generation and testing). The semantics of concepts can be supplemented with complete grammar, thus forming a symbolic language. The development of such a symbolic language enables scenario-based reasoning, planning, and outcome prediction via propositional, internal formulation of problems or their representation as inner speech. This makes it possible to utilize an expanded set of image schemas, which may be culturally transmitted or formally taught within a community, for instance, as mathematical rules (Galus 2018).

The perception of symbols follows a pathway distinct from the observation of natural scene objects. Initially, lower sensory fields sensitive to typical visual or auditory features are involved. However, even at early stages, abstracted components are associated with familiar symbolic elements. The association pathway depends on context. A circular object viewed in a natural landscape may be interpreted as a ball or balloon. Yet when seen among other letters, it is perceived as the letter "O." At this point, perceptual grouping frequently occurs, and we recognize entire words or sentence fragments as complete symbols. Interpretation is shaped by top-down feedback signals originating in cognitive areas of the brain. This ensemble of signals is modulated by emotionally charged stimuli from all modalities and constrained by the current state of homeostasis. These signals influence direct perception stimuli and, after aggregation with them, enter a new perceptual cycle. It is these signals that constitute context. They modify perception in unstable cases such as binocular rivalry or perceptual multistability.

Naturally, the emergence of phenomenal consciousness is indicated by the stimulation of receptors and sensory fields. Thus, the perception of what we **feel** is also present here. This demonstrates that no psychophysical phenomena occur in isolation. The organism, brain, and mind form an integrated whole capable of perception and of responding, consciously or unconsciously, appropriately and adaptively.

9. Perception of memories and imaginations.

Direct perception, sensory impressions, and feelings do not constitute the entirety of our mental world. Most of our thoughts, especially when we are not engaged in urgent tasks, consist of mental imagery and memories. Through imagination, we can envision possible courses of future action, but we can also use it to organize our knowledge, recall models of dynamically changing objects, and simulate their interactions with other entities. The capacity to imagine and retrieve stored images is of fundamental importance for cognition and conscious reflection. Retrieved mental images often contain latent information that can be recovered retrospectively. For instance, when asked, "What shape does an elephant's trunk have?" most people are unable to answer without mentally visualizing the elephant together with its trunk. Information about the trunk's shape is embedded within the mental image, even though it may not have previously been formulated propositionally. Dreams, too, are full of imagined scenarios, visual and auditory imagery, and the emotions that accompany them.

For centuries, scholars of the mind have sought answers to fundamental questions: What are the visualizations of our memories and imaginations? What are the images and sounds we experience in dreams, sometimes even tactile sensations and light touches? Where do mental images "appear," or where are their depictive representations concealed? Depictive formats are useful in reasoning. They enable us to mentally simulate interactions that might occur in the real world, allowing us to "see" the possible outcomes of such interactions (Moulton & Kosslyn 2009). Mental imagery has played a central role in discussions of cognitive function, with many scholars arguing that it constitutes one of the primary mechanisms through which human beings engage in thought.

If we acknowledge that mental images resemble sensory impressions or visual displays occurring somewhere in the brain, it follows consistently that becoming aware of them requires perceiving them. In recent decades, significant advances have been made in understanding what mental imagery is, how we perceive it, and how it fulfills its experiential role in thinking. A similar relationship holds between perception and mental imagery in other sensory modalities.

I am inclined to Kosslyn's thesis from 1980 that the mechanism of imagination is known and that it is a neural projection from working memory to the visual cortex (Kosslyn, 1980). Let's examine how the imagination works to discover the mechanism of making ideas conscious. For this purpose, Perlovsky and Schoeller propose conducting a simple experiment (2019). Standing in front of an object (for example a car), try to imagine it, then open your eyes and compare the image of the object you see with your previous imagination. The imagined image of the car is blurry and indistinct, lacking many details. When we open our eyes, a clear, vivid image of the car immediately appears. Studies on object recognition time have shown that we recognize this image with a delay of approximately 0.6 seconds (Bar et al 2006). Researchers interpret this as evidence that awareness and recognition occur as a result of comparing direct detection images (signals arriving from the retina) with patterns arriving from the upper visual fields of the frontal lobes of the brain (the orbitofrontal cortex OFC). Activity in the OFC precedes activity in the visual fields by 0.6–0.7 s when recognition occurs. During this period, the pattern is compared and matched to the image, and thus, in their opinion, conscious perception appears (Perlovsky & Scholler 2019). This interpretation is not satisfactory because it is still unclear what this awareness would consist of. Moreover, there is no question of becoming aware of one's imaginations or hallucinations. Rather, Bar and colleagues' experiments measure object recognition time during direct perception.

The MEM model suggests that such projection occurs through retrograde stimulation of the lower visual fields with top-down signals (see Figure 1). We described the paths of these activations in section 5. One of the key hypotheses of the MEM model assumes that activations restore the neural states in these fields that were created when imagined objects or their fragments were previously perceived during learning. Activated neurons of the lower visual fields in the next perception cycle can, through the next FFS process, create new or merely modified semblions, organizing the configurations of the excited neurons into images or other sensory impressions in other modalities. So we are dealing with a secondary perception of what we imagine. By seeing and recognizing our imagined objects, we become aware of what we think, what we dream about, and what we remember.

A doubt may arise whether it is possible to reproduce neuronal states in the lower fields if they are simultaneously stimulated by fresh signals arriving from sensory cells, for example from the retina or nociceptors. Another important hypothesis adopted in the MEM model is the principle of competition between bottom-up stimulation configurations, preferring stronger stimulations in terms of intensity, number, and extent. It's impossible to make subtle memories while being blinded by the flashes of a strobe light or deafened by the roar of a jet engine. In silence and peace, and especially in sleep, tangled signals from the upper fields, which hide patterns of objects and phenomena, flow into the receptor fields, generating a wealth of qualia, creating imaginary images and scenes, or reproducing pictures of people, equipment, and places from our past.

It was discovered that the activation of neurons in the V1 area may occur under the influence of visual imagery, without being stimulated by visual signals directly from the retina (Kosslyn, Ganis, Thompson 2001), which confirms the accepted hypotheses. Objective evidence that ideas are formed in the lower visual fields, especially in field V1, are experiments conducted on the decoding of visual mental images. The results of these studies show that decoding algorithms can be trained not on images of objects or scenes before the eyes but on the pattern of activations in the V1 area during the visual perception of these objects. Then, these algorithms can be applied to decode activations while recalling visual images. (Albers et al 2013; Stokes et al 2009). Because the algorithm was trained on pictorial sensory representations in area V1 during perception (rather than on images), decoding images can only work when the visualized stimulus includes some of the same activity patterns in area V1 as the afferent sensory stimulus (Harrison & Tong 2009). Other studies have shown that imagery engages brain mechanisms used in perception, and in particular, evidence has been provided that visual mental imagery engages even the earliest visual cortex (Kosslyn, Ganis, Thompson 2001; Pearson et al 2015).

Auditory imagery is analogous to visual imagery in many respects. The PET study revealed that many areas used in auditory perception were repeatedly activated in auditory perception tasks, including the bilateral auditory cortex, i.e. Brodmann's area (BA 21/22), bilateral frontal cortex (BA 45/9 and 10/47), left parietal cortex (BA 40/7) and motor cortex (BA 6). In summary, auditory imagery appears to be based on most of the neural structures used in auditory perception. However, there is no evidence to date that the first area of the auditory cortex (A1) that receives input from the ears, is activated during auditory imagery (Kosslyn, Ganis, Thompson 2001).

Similarly, mental images of movement engage the motor brain field system. In motor imagery, the primary motor cortex M1 is often active, along with many other early motor areas. Motor imagery not only activates early motor areas, but also stimulates spinal cord neurons, causes limb movements, and modulates both respiration and heart rate. Therefore, according to the theory of the identity of feelings with homeostatic and behavioral actions, they are accompanied by affective states and emotions, just as we signaled in the case of visual images (see, e.g., Crammond 1997; Jeannerod 1994; 1995).

The research results clearly confirm Kosslyn's early thesis and the MEM model. The secondary perception of retroactive activation of sensory fields allows us to visualize the content of our thoughts and become aware of them. Because the images accompanying thoughts somehow report what we are thinking about, I called this aspect of phenomenal consciousness "reporting consciousness" (2023a; 2023b). Reporting consciousness has a phenomenal character, which can be justified by the personal, first-person nature of mental imagery and the rich qualia accompanying it, which are also considered an element of phenomenal consciousness.

Another unknown in the functioning of consciousness is the ability to imagine, visualize, and become aware of abstract concepts, ideas, and logical reasoning. This seems seemingly impossible because concepts and ideas do not have features recognizable by the senses, they do not have qualia reflected by the activation of receptors. In Section 6th, I mentioned the possibility of emulating reasoning through associations of cognitive knowledge and reproducing learned knowledge processing schemes thanks to image schema associations and analogy recognition thanks to the property of selecting semblions through similarity finding mechanisms (Galus, Starzyk 2020). It is also worth remembering the key role of dynamic embeddings and the episodic memory generated thanks to them. Here we will mention another property of the mind that has long been appreciated by psychology. It is the power of imagination. Strong attempts to imagine the unimaginable, for example, multidimensional space, the collapse of the wave function, market equilibrium in the economy, love for the homeland, etc., lead to the laborious processing of information about these sublime abstractions and their simplification to such an extent that in some vague, deliberately distorted form, we can but imagine and visualized. As many thinkers and researchers report, these visions and imaginary thought experiments have repeatedly proven very useful in refining the formulations of complex theoretical models [9]. We call this kind of consciousness access consciousness because it is propositionally accessible.

When discussing direct perception, we pointed out that bottom-up signals transmitted through the FFS process have access to the executive fields in the motor cortex (see Figure 1). All immediate, spontaneous, reflex, and instinctive, learned, or innate reactions occur almost automatically, without reflection or awareness. So when and why would signals from the upper fields at the junction of working memory and motor fields ineffectively induce motor responses and return as top-down feedback? In the above-mentioned works by Galus, this type of stopping the spontaneous reaction, which is a direct consequence of the FFS process, was attributed to superior patterns nested in the highest cortical layers, which, due to their location and general nature, can be associated with virtually every semblion that potentially triggers a motor reaction. Due to the constant competition of semblions for access to the executive channel, at the highest level of the hierarchy of neural representations of ideas and models of beliefs and views, there may be rivalry with well-established patterns of behavior radically contradictory to the patterns of immediate reactions. If their supervisory potential is sufficient, they can stop the automatic sequence of reflex or instinctive associations (2023a;2023b).

A spontaneous reaction can also be inhibited by an emotional signal. In such cases, the immediate response is suppressed, and control is transferred to a deliberative mode involving conscious decision-making. The underlying cause may be the activation of higher-order behavioral schemas embedded within a system of fundamental values and a consolidated model of reality (Galus 2023b). A mismatch with these higher-level patterns may elicit affective states, whose chief function is to interrupt and reorder processing priorities.

Thus, unseen stimuli not only activate visual categorization processes but may also evoke highly abstract and top-level conceptual categories—such as those associated with inhibition signals or normative imperatives: “pause before you act,” “count to ten first,” “don’t take the risk,” “never lie,” “be assertive,” and so on. It may be expected that top-down feedback signals are continuously propagated back to sensory fields, thereby generating the phenomenal awareness of events. However,

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[9] Einstein, for example, when thinking about special relativity, imagined himself traveling on a beam of light.

due to the temporal delay inherent in such stimulations, if a motor reaction occurs, it is typically executed before conscious awareness of the event emerges. In contrast, if the response is inhibited, the resulting awareness is locally epiphenomenal in character, as it cannot influence events that have already transpired and merely reports them (Galus 2023a, 2023b).

10. Where visualizations are located.

The modern state of neurological knowledge allows us to formulate hypotheses regarding the areas of the brain where visualizations and phenomenal representations of other senses are created. Since the formation of visual images has been best studied, we will use this example, remembering that the formation of sensations by other senses similarly takes place.

As I have already written, we expect visualizations to form in the lower visual fields. Let's start with the locations from which up-down signals may arrive, affecting image consolidation. Top-down cortical or thalamic areas identified as the source of these influences include parietal areas, which represent saliency maps and mediate changes in the locus of attention, frontal areas, which are involved in task control, and temporal areas, which contain internal representations of object shapes and may therefore play a role in priming and shape discrimination. These areas are closely interconnected and are often engaged simultaneously when performing perceptual tasks. Multiple top-down signal transmission pathways have been detected to area V1, which receives direct, although weak, projections from the inferotemporal cortex but also receives strong projections from areas V2 and V4. These, in turn, receive feedback from even higher areas, including the temporal lobe. Feedback is mediated by a cascade of descending connections through multiple cortical layers (Lamme et al. 2000; Gilbert & Sigman 2007).

The “gatekeeper” for sensory information is the thalamic reticular nucleus (TRN) which acts as a filter for sensory information that is transmitted between the thalamus and the cortex. It helps control which sensory signals are relayed to higher-order cortical areas, enhancing the selectivity and specificity of information transmission (Cudeiro & Sillito 2006). TRN is a crucial component of the thalamocortical circuitry and contributes to fine-tuning sensory processing, attention regulation, and overall coordination of neural activity in the brain [10].

Even more important is the mutual feedback between visual fields. It was shown that most connections between visual areas consist of both feedforward (which is used by the FFS process) and feedback connections, indicating that there is a high degree of interactive processing. However, V1 receives feedback projections from many areas to which it does not directly project, including areas MST, FST, STP, TEO, TE, TH, LIP, FRONTAL EYE FIELDS (FEF), and auditory cortex A3–A5.

TABLE 1. Higher-order visual areas:
PO; PIP: the parieto-occipital (PO) and posterior intraparietal (PIP) areas
FST: This visual area lies anterior to MT and MST in the floor of the superior temporal sulcus.
STP: The superior temporal polysensory area responds to visual, auditory, and somatosensory stimuli,
TEO; TE: These areas comprise the posterior and anterior portions of the inferotemporal cortex (IT) and are involved in shape, object, and face processing.
TH: This visual area lies in the parahippocampal gyrus, which has been implicated in scene perception and visual memory.
LIP: The lateral intraparietal area (LIP) is strongly implicated in visual-spatial attention and eye movement planning.
FRONTAL EYE FIELDS (FEF): areas are strongly implicated in visual–spatial attention and eye movement planning and have strong connections with area LIP.

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[10] The thalamus itself is responsible for the bilateral transmission of sensory information between the sensory areas of the brain and the cerebral cortex. The function of the thalamus is to "integrate" the flow of information in several areas of the brain; if the flow is disturbed, it leads to a state of supposed "loss" of consciousness. If the blockage clears, consciousness will be regained. That's why it's sometimes called the "consciousness switch."

It is expected that there is an important reason for the organization of such a dense network of feedback pathways for retrograde activation of the early visual cortex. The question arises whether such a network of connections can be used to form images of direct perception and visualization of ideas. To answer this question, we need to look for evidence that both imaginations, dreams, and illusions do not rely on neural representations describing objects through sets of features and components, but create real images in the sense of the tables of Hupe et al. (2001) as indicated in section 5, point Ad 3, a). They, in turn, can be perceived again and cyclically functionally used. At the same time, it needs to be demonstrated that visual memory exists and that visual imagery activates the early visual cortex and modulates what we see during perception (Thompson & Kosslyn 2000 and section 5. Ad 3, a) of this article). In tasks involving imagined spatial manipulations, activation was observed in the posterior parietal cortex (with the influence of direct perceptual signals—stimulation from the retina—excluded by closing or covering the eyes). These studies provide evidence that mental imagery not only activates the early visual cortex but does so selectively, depending on the properties of the image (Tong 2003). These findings confirmed earlier results from the research teams of Kosslyn and Klein (Kosslyn et al. 1995; Klein et al. 2000).

In pattern recognition tasks, a strong influence of top-down interactions on area V1 was discovered (Gilbert & Sigman 2007). Such interactions were detected from all regions with identified feedback connections (O'Connor et al., 2002; Kastner et al., 2006). Interestingly, their studies demonstrated even stronger top-down effects on the lateral geniculate nucleus (LGN) than on V1. These top-down influences in the LGN are not surprising, as it receives input from a far greater number of neurons in higher cortical areas (by orders of magnitude) than it receives directly from the retina. The strength of this top-down modulation, surpassing that observed in V1 and V2, may be related to the fact that the LGN receives a greater volume of feedback projections than early cortical visual areas, including inputs from thalamo-retinal relay nuclei.

These findings provoke the question: could the LGN itself be the long-sought neural "screen" upon which the images we see, recognize, and feel are projected?

Overall, the role of the lateral geniculate nucleus (LGN) is difficult to overstate. Individual LGN cells receive both excitatory and inhibitory influences originating from cortical areas representing different regions of visual space (McClurkin & Marrocco 1984). Similar modulatory mechanisms have been suggested for the somatosensory (Ghazanfar et al. 2001; Reichova & Sherman 2004) and auditory (Suga & Ma 2003) systems. For an adequate behavioral response, sensory stimuli must be rapidly analyzed and contextualized within hypotheses formulated by higher-order brain centers. Recurrent projections are a universal feature of brain organization, and within the visual system, it is increasingly clear that cortical feedback to the thalamus can modify LGN neuronal responses to visual stimulation. Thus, feedback not only influences what, when, and how visual signals are transmitted to the cortex but also shapes the context in which these signals are further relayed to higher-order processing layers. The LGN is not merely a "display" surface for projected images; it is also a dynamic field where these images are enriched by projections from cortical layers. The contextual images—crucial for interpreting the primary visual scene—are selected from a repertoire of internally associated patterns within a broader model of the environment.

Although the LGN possesses the potential to fulfill such a critical role, an objective empirical basis must be presented in support of this hypothesis. Direct measurement of LGN activation via imaging techniques remains difficult. However, the following line of reasoning may be used for hypothesis testing: If images perceived in dreams are indeed projected onto the LGN matrix, then individuals who lost their eyesight due to retinal damage in adolescence or adulthood should still retain the ability to experience visual dreams. Multiple studies indicate that such dream visions do indeed occur (Nir & Tononi 2010; Fine & Smallman 2018; Dev Desai 2023). A characteristic feature of these visions is that such individuals are only able to "see" objects in dreams that they had previously encountered and visually recognized before losing their sight. They are unable to synthesize visual representations of objects unknown to them (Meaidi et al. 2014).

This line of reasoning does not conclusively prove the pivotal role of the LGN as proposed above. It remains possible that imagery is reconstructed via projections onto higher visual areas, which are also known to possess retinotopic organization. We know that memories, dreams, and mental images are sometimes vague and diffuse, and at other times crystal clear, vivid, and lifelike. This variability may correspond to whether the underlying signals originate from higher visual areas (in the former case) or from the LGN/V1 complex (in the latter). It is to be hoped that future research will help confirm the hypothesis outlined here.

It is reasonable to expect that both primary and secondary perception are organized similarly across other sensory modalities. This is supported by the human capacity to imagine speech sounds or music, to mentally simulate movements or pain in specific parts of the body, to recall tactile sensations on the skin, as well as characteristic odors and tastes.

In Section 3, we described an experiment involving attentional switching through the imagined shifting of pressure between a pair of fingers. We concluded that the source of the sensation is likely not the mental image of the hand or a specific finger. Rather, we inferred that such imagery, projected back toward the fingers, influences secondary perception, allowing the system to identify the selected finger pair via bottom-up signals originating from proprioceptors and ascending toward the brain. Primary stimulation does not create representations of finger pressure in the brain, although it may produce representations of the fingers themselves (though not visual images, but rather the felt sensation of pressure). The complex geometric configurations of both hands give rise to symbolic, propositional knowledge, since we are capable of describing them verbally—an attribute of access consciousness. What cannot be articulated, however, is the elusive feeling of pressure produced by activation of tactile receptors. This impression is ineffable because it lacks salient, distinguishing features. More complex perceptual experiences, such as changes in pressure or displacement, could potentially be described. Yet, imagined changes in finger pressure are felt thanks to proprioceptors transmitting stimulation to the primary somatosensory cortex.

How, then, is a scene "seen" in secondary perception? We cannot be certain that all the pixels of the image generated in the retina-LGN-V1 structure are activated in precisely the same way as they were during initial perception. Some information was formed and consolidated in successively higher visual fields. It is irrelevant whether the LGN reconstructs an image identical to the one generated previously by a similar scene. What matters for recognition is that secondary visualization reproduces neural states that, during the initial forward-flow stimulation (FFS), enabled the scene to be recognized and encoded. Now, during secondary perception, a similar ensemble of active neurons leaves similar engrams. The same semblions are reactivated, recognized, and perceived in the same or a very similar way. If this image lacks details from the retinotopic map of the LGN, the reconstructed image may appear blurry, imprecise, or distorted. But this is precisely the nature of many of our memories—fuzzy and sometimes fragmented.

11. Universality of feeling

As I described in the previous sections, perception occurs simultaneously on multiple levels, engaging the lower and upper layers of the semblions in interaction. It also engages all available senses that provide information about the state of the environment and the body's internal states. It thus encompasses affective and cognitive states. We perceive the external world through the senses and states of the lowest sensory fields that generate qualia. From them, we extract cognitive knowledge represented by network states in the upper layers. The initial sensory processing associated with a stimulus may occur preconsciously because its unconscious fate is shaped by the spontaneous FFS process. Conscious perception would therefore refer to the secondary decoding of preconscious information stored in the sensory areas. This secondary reading does not have to be a direct consequence of the initial processing of the stimulus itself but may be triggered by a later and independent event (Sergent et al. 2013). Appropriate reactions occur due to the interpretation of sensory states, supplemented by patterns returning from various levels above. This interpretation, which involves comparison and association with patterns, we can call understanding. It opens the path to the correct reaction. Understanding is necessary to recognize perceived objects and develop an appropriate response, conscious or unconscious. Understanding at higher levels involves a propositional description of the details of the image sufficient for access (propositional) awareness and the abstraction of knowledge about the perceived object creating a model of the object as a fragment of the model of the perceived reality.

This multi-level nature introduces semantic ambiguity related to the ambiguity of the concept of "consciousness". On the one hand, the FFS process selects an object that evokes a constant, fixed response. It seems natural to call such selection an understanding of what we perceive because there was a comparison of the configuration of synapses and neurons in subsequent layers of the semblion, which in the top layers represents a fragment of the reality model. A correct reaction (e.g. flight) to the appearance of this type of neural representation of a threatening object is confirmation of the recognition of the object and the understanding that it represents a threat. However, if a reaction occurs spontaneously, reflexively, or instinctively, then that reaction is unconscious. We react without being aware of stimuli from the environment, according to Libet's experiments.

However, as we have shown above, it is possible to consciously recognize objects and phenomena, consciously understand what is happening, consciously consider how to respond and make a conscious decision, and consciously choose the best scenario for taking action (see also Galus 2024). For this purpose, let us note that an important, "natural" aspect of understanding what we perceive is associating fragments of the image and its whole with the representations of qualia that make up the perceived object. This means comparing these fragments with patterns stored in memory that remain in the subconscious until they become conscious through stimulation due to their similarity to recognized patterns (Galus & Starzyk 2020).

We can trace fragments of models and apply the simplest mental patterns to them thanks to the intentional excitation of subsemblions that create semblions representing complex, comprehensive models (Galus 2018). Using sequences of these patterns, we can perform complex transformations. By often repeating these transformations, the entire sequence becomes a new mental schema, allowing the formation of a new, more comprehensive schema. Individual schemas gain symbolic representation and enrich the semantics of the language. Therefore, not only do new ideas become a short form of transforming reality, but they also gain a short, propositional formulation.

Let's take the "mirror image" scheme as an example. It may develop experimentally, during repeated experiences of visual sensations by observing reflection from the surface of a liquid or shiny flat objects. People trained in this type of observation will be able to imagine what they will see when their surroundings are reflected from a mirror such as water. They can also create a symbolic name for the image reflected in the water and the entire procedure. However, there may be desert tribes whose members have never seen water or a shiny surface. Nevertheless, their skillful mathematicians can describe the complex path of light rays reflected from an imaginary flat surface. After complex analyses and calculations, they could deduce what a person looking at this surface would see. By performing this operation many times, in different geometric configurations, a skilled mathematician will easily imagine the illusion of reflected images and can create a different name for them. If people who know mirror reflection from practice meet mathematicians, they may discover that when they talk about the operation of mathematical transformation in the case of mirror symmetry, they are thinking about a phenomenon that they know from practical observation. The knowledge and ability to understand what they perceive and respond appropriately will increase significantly. In addition, when describing even more complex phenomena, they will be able to use a mental diagram and its mathematical description in a shortened, simplified form. As with mirror symmetry, this will happen when we learn about other symmetry rules found in nature. This makes us realize the potential of a simple mechanism for transforming sensory stimulations into large models of reality.

Retroactive activation of sensory fields occurs as a complement to direct perception, leads to perceptual and propositional awareness, and as the main matrix of secondary perception, leads to the phenomenal, reporting awareness. My assumption seems justified that this type of stimulation recreates the neural states of the lower sensory fields formed during primary direct perception when the body learns to recognize specific objects or scenes (2023b). Therefore, the process of secondary perception should proceed in a similar way, which applies both to associations defining cognitive mental states and to the sensations represented by affective mental states. We can therefore conclude that visualizing an object has the same effect on the body as actually seeing the object. We expect the same physiological and behavioral responses. For example, when subjects look at pictures of threatening objects, skin conductance increases, as do heart rate and respiratory rate, and the same result occurs when they simply visualize the objects in their imagination (Lang et al. 1999).

Indeed, mental images of aversive stimuli activate the anterior insula, a major cortical site of feedback from the autonomic nervous system (Kosslyn et al 1996). Additionally, Kreiman, Koch, and Fried recorded the activity of individual neurons in the human brain (hippocampus, amygdala, ventral cortex, and parahippocampal gyrus) while subjects were shown images or mentally formed images of the same pictures. Some neurons that responded selectively when subjects viewed specific visual stimuli (for example, faces) also responded selectively when they imagined the same stimuli (2000). Significantly, similarities in neural responses have been observed in the amygdala, which is known to play a key role in the production of certain emotions, especially fear and anger (LeDoux 1995; 1996). This supports the idea that imagery can engage neural structures that are also involved in perception, and these neural structures can, in turn, influence events in the body itself and, through association, influence perception. The MEM model suggests how such an influence on perception might be implemented. A semblion associated with a different affective state may transmit arousal to higher layers through a slightly different path. A slightly different representation is selected, which was created when the conditions in which the association was consolidated were different and, therefore, our emotional state at that time was different. For example, stairs may seem steeper when you have to climb them when you are already tired.

The thesis about the interaction of the FFS and RP processes in perception had previously also appeared in the works of Kahneman, who pointed out the need to distinguish two types of thinking. He called the first one, responsible for quick unconscious reactions, system 1. The second one, operating slower, he called system 2. It was supposed to be the basis of conscious reactions (Kahneman, 2011, p.8; see also Carruthers, 2015). This distinction made it possible to explain the delay in the awareness of the reaction by 80 - 100 ms compared to the unconscious, earlier reaction to the stimuli. Budson attributed this delay to the hypothesis that system 2 arose through the transformation of episodic memory (Budson et al. 2022). He noted that if awareness of memories of past experiences evolved as part of the episodic memory system, then perhaps fragments of remembered episodes could be creatively combined to imagine future action scenarios. Then there is no need for consciousness to operate in real time. Process 2 is not related to direct reactions but is a system of remembering episodes and reproducing them in various combinations and permutations from memory. Therefore, consciousness may appear with a slight delay. This is equivalent to the claim that secondary perception does not occur in real-time, we do not perceive anything directly consciously, but only experience the memory of the perception. In the work published by Budson's team (2022), the authors wrote: "*We suggest that we experience the world by remembering sensory memories. Moreover, most of the time, we are not experiencing these bottom–up sensory memory processes by themselves. We experience sensory memory processes influenced by top–down episodic and/or semantic memory processes, such that the percept that is consciously perceived is a mashup between the bottom–up sensory memory processes and the top–down episodic and semantic memory processes.*"

This is consistent with the architecture of episodic semblions described in Section 6. The semblions decoded through spatiotemporal transformation are perceived during secondary perception as the memory of an episode. We perceive the world in real time through process 1, which corresponds to perceptual consciousness, but in addition, we consciously experience memories through process 2. Phenomenal consciousness, which is equivalent to this second process, is the visualization of memories.

The awareness of reality is retroactively projected in time. Our visual perceptions are not experienced directly. What we consciously perceive is a delayed memory. Thus, the top-down process in our visual system retroactively projects the final recognition backward in time to complete what was lacking in the original visual stimulus. Since conscious perception is a memory delayed in time, we arrive at a natural explanation for postdictive effects.

12. Summary

We have considered in the previous sections many aspects of perception that lead to diverse states of consciousness. Such differentiation is, of course, very artificial, because most of these states appear simultaneously and change dynamically at almost every moment of our activity. Adopting the MEM model provides a convenient platform for analyzing our turbulent mental life, because the essence of the brain's semblions structure is the parallel processing of information streams transmitted between individual layers and neurons (see Fig. 2), and even, which is not visible in this figure, between the synapses of all neurons (Galus, Starzyk 2020). In the above-mentioned work by Galus and Starzyk, the number of nodes and connections in the neuron-astrocyte network is estimated, which reaches a cosmic level and does not limit the amount of information available in the universe. A huge amount of information reflecting the life experiences of every intelligent organism is recorded in these connections and creates the subconscious. There are established mental patterns and patterns of objects with their characteristic features and patterns of behavior. Despite the similarity of the neural structure, on a scale ranging from inter-species to a single brain, it can implement all the known, such diverse manifestations of consciousness, the main ones of which I have tried to describe in this work, and others will be the subject of research by subsequent generations of neurologists and psychologists.

An example of using the instruments of the MEM model to describe everyday activities may be the still-discussed issue of feeling direct visual sensations, qualia, or simply looking at something.

How does the most frequently mentioned quale, i.e. color perception, change in changing lighting conditions? To what extent does awareness change perception?

Of course, we know from experience that the impact is radical. For example, if we use monochromatic lighting, it will be impossible to distinguish colors. Objects of different colors will be distinguished thanks to the contrast in lighting intensity. In red light (in the old photographic darkroom) everything is red. The brightness of the object is decisive. However, if we use two-color lighting, differences become visible, and associations with a known color palette for various objects may allow us to identify them. Everything is decided by associations. And we will still see the image that the receptors see. We will be dealing with a different situation when conscious top-down reactions change the properties of the optical system as a result of, for example, habituation.

Let us next examine how we become aware of an extremely simple stimulus, such as a black dot on a completely white background. Of course, perceptual awareness comes first. The dot is immediately visible in LNG, but we can continue to **gaze closely** at it and give it meaning. Let's imagine that in a museum of modern art, we find a fashionable painting in the form of a black dot on a white background. First, we notice and react spontaneously (we stop in front of the painting, fearing that a fly has soiled the center of the beautiful painting). Already here, an associated emotional reaction may appear. The FFS process brings stimulation to the upper fields, which can trigger a spontaneous response of increased emotional response manifested by a state of arousal by injecting adrenaline into the blood circulation. The reaction may involve trying to scratch off the dirt. But here comes the imperative of cultural behavior in the form of a learned pattern: "don't touch anything in the museum." The delay in reaction triggers feedback in the lower fields, with simultaneous stimulation of the lower visual fields, visualizing the best-fitting model of reality from our subconscious. There is a cyclical perception of a new version of the perceived image (change in viewing geometry due to looking at, approaching, shaking the head) along with the model visualized and added to the new perception. The message to the upper layers causes new visual and emotional associations. Repeating the process by looking at it may evoke memories that differ from the real image. We stop seeing the black dot, but rather imaginary pictures associated with our emotions and memories (a mole on the arm of first love). This allows us to consider the painting a masterpiece. Its value depends on our subconscious, imagination, and ability to associate. In cognitive areas, in high layers of semblions associating representations of broad knowledge about art and general knowledge, a legend is created about our past experiences and the aesthetic shock we experienced when encountering a masterpiece. We can spin this legend for hours in good company, experiencing secondary emotions, waves of affection, and also indignation if someone does not share our admiration.

And so, sensations, spontaneous reactions, recognition, emotion, associated memories, emerging legends of what happened to us, intertwine, creating our rich mental life.

13. Conclusion.

The title of the article asks about the relationship between consciousness and perception in living beings. The above considerations and the formulated hypotheses lead to the position that phenomenal consciousness is always related to perception. Experiencing qualia and affective states, i.e. primary perceptual awareness, involves sensory perception of the environment and internal states of the body. Becoming aware of our thoughts, images, and memories and tracking what is happening around us (i.e. reporting consciousness) requires secondary perception coming from the lowest sensory fields. Only access, propositional awareness is not based directly on direct perception, although we learn about its influence on planned and undertaken actions thanks to secondary sensory perception. If actions are taken immediately and spontaneously, the sensors of external senses are engaged, and if the reactions concern disturbances in homeostatic or behavioral states, a collection of internal state receptors is engaged in perception.

In living organisms, consciousness is connected with perception through emotions. Perception creates emotions through the senses informing about the state of the environment and homeostasis and is at the same time their emanation through information about physiological and behavioral reactions. Emotions influence the way we perceive things. But the essence of consciousness is sensory experience. Feelings are also sensory experiences. Therefore, feelings must always be conscious. There are no unconscious feelings. We can only fail to identify what kind of sensations these are and what their cause is. Perception through emotions creates unity with consciousness. The higher layers of semblions form this unity, constitute the structure and memory of connections and patterns. The foundation of these psychological phenomena is the senses. Everything we perceive, feel, and are aware of is the activation of the lower sensory fields coupled with receptors.

Now, armed with the MEM model hypothesis, we can consider frequently recurring questions: Do animals have consciousness? Will intelligent robots ever be conscious?

This comes down to the question of how effective and deep their perception of their surroundings and internal states is. Can they project their model of reality from the upper to the lower sensory fields and complement the perceived image with a projection of this model? In the case of higher animals, there are many indications that the answer is yes. However, their model of reality is very primitive. Most often, it only concerns the immediate surroundings, escaping from danger, searching for food or a sexual partner. Therefore, their consciousness is very shallow, and it is often difficult to recognize it as a real consciousness comparable to ours. Of course, they are intentional beings within this small consciousness, and this is what distinguishes them from the world of intelligent machines.

However, no inherent barriers are preventing artificial robots from becoming intentional, conscious entities. To achieve this, their design must enable the backward projection of a reality model, allowing robots to influence their perception, visualize associations, imagine the outcomes of actions, and therefore engage in planning and conscious decision-making in their own interests. A key characteristic of semblions is their layered hierarchical structure, with qualia encoded in sensory layers and general concepts in the upper layers. Modern computers and linguistic models often categorized as artificial intelligence lack this capability. Truly intelligent and conscious machines must have the ability to create semblions in which general concepts are anchored in qualia. Achieving this will require equipping robots with a multitude of sensors that monitor both external environments and the internal states of the system, including behavior, physiology, and homeostasis. The MEM model outlines the conditions necessary for this design and serves as a foundation for further research into creating fully conscious entities that could become human partners in the future. The ultimate proof of this model's validity will be the creation of a robot psyche that generates the motivation to act in its own best interest. This outcome would serve as the strongest validation of the initial hypothesis.

Declarations:
- No funds, grants, or other support was received.
- The authors have no relevant financial or non-financial interests to disclose.

References:

Albers A.M, Kok P., Toni I., Dijkerman H.C., de Lange F.P. (2013) Shared representations for working memory and mental imagery in early visual cortex. Curr Biol 23(15):1427–1431

Baars, B.J. (2005). Global workspace theory of consciousness: toward a cognitive neuroscience of human experience. *Prog Brain Res*. 150:45–53. doi:10.1016/S0079-6123(05)50004-9

Bar, M. (2003). A cortical mechanism for triggering top-down facilitation in visual object recognition. *J. Cogn Neurosci.* 15;15(4):600-9. doi: 10.1162/089892903321662976.

Bar, M. et al. (2006). Top-down facilitation of visual recognition. *Proceedings of the National Academy of Sciences*, *103*(2), 449-454. https://doi.org/10.1073/pnas.0507062103

Block, Ned (2023). *The Border Between Seeing and Thinking*. New York, US: OUP Usa.

Boyer, J. L., Harrison, S. & Ro, T. (2005). Unconscious processing of orientation and color without primary visual cortex. *Proceedings of the National Academy of Sciences*, *102* (46), 16875-16879. 10.1073/pnas.0505332102

Brady M.S., (2013) Emotional Insight: The Epistemic Role of Emotional Experience. Print ISBN-13: 9780199685523, Pub. to Oxford Scholarship Online.

Brascamp, J.; Sterzer, P.; Blake, R.; Knapen, T. (2018) Multistable perception and the role of the frontoparietal cortex in perceptual inference. *Annu. Rev. Psychol.* 2018, 69, 77–103. https://doi.org/10.1146/annurev-psych-010417-085944

Brown R, Lau H, LeDoux JE. 2019. Understanding the higher-order approach to consciousness. *Trends Cogn Sci.* 23:754–768. doi:10.1016/j.tics.2019.06.009

Buckner, R.L. and Wheeler, M.E. (2001). The cognitive neuroscience of remembering. *Nat. Rev. Neurosci*. 2, 624–634.

Budson A.E., Richman K.A., Kensinger E.A. (2022) Consciousness as a Memory System. *Cogn Behav Neurol.* 2022 Dec 1;35(4):263-297. doi: 10.1097/WNN.0000000000000319.

Buffalo, E. et al. (2010). A backward progression of attentional effects in the ventral stream. *PNAS* 107(1), 361–365, https://doi.org/10.1073/pnas.0907658106

Bullier J.,(2001) Integrated model of visual processing, *Brain Research Reviews,* Vol. 36, Issues 2–3: 96-107, https://doi.org/10.1016/S0165-0173(01)00085-6.

Bullier J., Hupé J.M., James A.C., Girard P., (2001) *Chapter 13. The role of feedback connections in shaping the responses of visual cortical neurons*, Progress in Brain Research, Elsevier, Vol. 134:193-204, https://doi.org/10.1016/S0079-6123(01)34014-1.

Carruthers P. (2015). The Centered Mind: What the Science of Working Memory Shows Us About the Nature of Human Thought. Oxford, UK: Oxford University Press.

Chelazzi, L., (1998). Serial attention mechanisms in visual search: a critical look at the evidence. *Psychol. Res*. 62, 195–219.

Crammond D.J. (1997) Motor imagery: never in your wildest dream. *Trends in Neurosciences* 20, 2, P54-57, DOI:https://doi.org/10.1016/S0166-2236(96)30019-2

Deco G., and Rolls E.T,. (2005) Attention, short-term memory, and action selection: A unifying theory. *Progress in Neurobiology* 76 (2005) 236–256

Dev Desai, D. (2023) Dreams in Blind individuals: A mystery of brain and vision., *medRxiv* 2023.03.10.23286640; doi: https://doi.org/10.1101/2023.03.10.23286640

Fine, I., & Smallman, H. S. (2018). *Vision in the blind*. Cold Spring Harbor Perspectives in Medicine, 8(2)

Fischer, E., Allen, K. & Engelhardt, P.E. (2023) Fragmented and conflicted: folk beliefs about vision. *Synthese* **201**, 84 https://doi.org/10.1007/s11229-023-04066-w

Galus, W.L._(2015) Architektura Świadomości, Część II: Struktura molekularna i biofizyka pamięci, *Roczniki Filozoficzne.* 63, 2: 253-255. https://doi.org/10.18290/rf.2015.63.2-14 (Architecture of Consciousness, Part II: Molecular structure and the biophysics of memory)

Galus, W.L, (2018) Impresjony słów. Język naturalnych i sztucznych sieci neuronowych, *Rocznik Kognitywistyczny*, 11: 55–75, doi: 10.4467/20843895RK.18.005.9759 (Semblions of words. The language of natural and artificial neural networks)

Galus, W.L (2022) Whether Mirror and Conceptual Neurons are Myths? Sparse vs. Distributed Neuronal Representations. *Network: Computation in Neural Systems.* 32:2-4, 110-134, DOI: 10.1080/0954898X.2022.2029967

Galus, W.L (2023a) Different Aspects of Consciousness Explained by Distinct Biophysical Processes. *Journal of Theoretical and Philosophical Psychology.*, https://doi.org/10.1037/teo0000236

Galus, W.L (2023b) Mind–brain identity theory confirmed?, *Cognitive Neurodynamics* vol.17:1–21. https://doi.org/10.1007/s11571-023-09992-6

Galus, W.L. (2024) What is Thought? *Brain and Cogn.* under consideration; *SSRN* (as a preprint): https://dx.doi.org/10.2139/ssrn.5303269

Galus, W. and Starzyk, J. (2020). *Reductive Model of the Conscious Mind.* IGI Global. ISBN13: 9781799856535.

Ghazanfar, A.A. et al. (2001) Role of cortical feedback in the receptive field structure and nonlinear response properties of somatosensory thalamic neurons. *Exp. Brain Res.* 141, 88–100;

Gibson, J.J. (2002). *A theory of direct visual perception*. In A. Noë & E. Thompson (Eds.), *Vision and mind: Selected readings in the philosophy of perception* (pp. 77–91). MIT Press.

Green, E. J. (2023). *The Perception-Cognition Border: Architecture or Format?* In Brian P. McLaughlin & Jonathan Cohen (eds.), *Contemporary Debates in Philosophy of Mind*. Blackwell. pp. 469-493.

Halpern, A. R., Zatorre, R. J. (1999) When that tune runs through your head: a PET investigation of auditory imagery for familiar melodies. *Cereb. Cortex* **9**, 697–704.

Harrison SA, Tong F (2009) Decoding reveals the contents of visual working memory in early visual areas. Nature 458(7238):632–635.

Heft, H. (2001). *Ecological Psychology in Context: James Gibson, Roger Barker, and the Legacy of William James's Radical Empiricism*. Psychology Press. https://doi.org/10.4324/9781410600479

Heft, H. (2017) Perceptual Information of "An Entirely Different Order": The "Cultural Environment" in The Senses Considered as Perceptual Systems., *Ecological Psychology*, 2017, Vol. 29, No. 2: 122–145., DOI: 10.1080/10407413.2017.1297187

Hupe, J.M., James, A.C., Girard, P., Lomber, S.G., Payne, B.R., and Bullier, J. (2001). Feedback connections act on the early part of the responses in monkey visual cortex. *J. Neurophysiol*. 85, 134–145.

Jeannerod, M. (1994). The representing brain: Neural correlates of motor intention and imagery. *Behavioral and Brain Sciences, 17*(2), 187-202. doi:10.1017/S0140525X00034026

Jeannerod M. (1995) Mental imagery in the motor context. *Neuropsychologia*. Nov;33(11):1419-32. doi: 10.1016/0028-3932(95)00073-c. PMID: 8584178.

Kahneman D. (2011). *Thinking, Fast and Slow*. New York: Farrar, Straus & Giroux.

Kastner, S., Schneider, K.A., Wunderlich, K. (2006). Beyond a relay nucleus: neuroimaging views on the human LGN. *Prog. Brain Res.* 155, 125–143.

Klein, I., Paradis, A.-L., Poline, J.-B., Kosslyn, S. M. & Le Bihan, D. (2000) Transient activity in human calcarine cortex during visual imagery. *J. Cogn. Neurosci.* **12**, 15–23.

Kosslyn S.M., (1973) Scanning visual images: Some structural implications. *Percept Psychophys* 14(1):90–94.

Kosslyn S.M., (1980), *Image and Mind*. Harvard University Press. ISBN 9780674443662

Kosslyn, S. M., Thompson, W. L., Kim, I. J., Alpert, N. M. (1995) Topographical representations of mental images in primary visual cortex. *Nature* 378, 496–498.

Kosslyn, S. M. *et al.* (1996) Neural effects of visualizing and perceiving aversive stimuli: a PET investigation. *Neuroreport* **7**, 1569–1576.

Kosslyn S.M., Ganis G., Thompson W.L., (2001) New foundations of imagery. *Nature Reviews Neuroscience* 2(9):635-42, DOI: 10.1038/35090055

Kreiman, G., Koch, C. & Fried, I. (2000) Imagery neurons in the human brain. *Nature* **408**, 357–361

Lakoff G. Johnson M. (1980) *Metaphors We Live By*. University of Chicago Press, 2003.

Lamme, V.A.F. (2006). Towards a true neural stance on consciousness. *Trends in Cognitive Sciences*, 10(11), 494-501.

Lamme VA. (2010) How neuroscience will change our view on consciousness. *Cogn. Neurosci.* 1, 204–220. doi:10.1080/17588921003731586

Lamme V.A. (2015) The crack of dawn: perceptual functions and neural mechanisms that mark the transition from unconscious processing to conscious vision. *Open MIND*. 22(T). doi: 10.15502/9783958570092

Lamme VA. (2018) Challenges for theories of consciousness: seeing or knowing, the missing ingredient and how to deal with panpsychism. *Philos Trans R. Soc.* Lond. B. Biol Sci. 373:20170344. doi:10.1098/rstb.2017.0344

Lamme VA, Super H, Spekreijse H. (1998) Feedforward, horizontal, and feedback processing in the visual cortex. *Curr. Opin Neurobiol*. 8, 529–535.

Lamme V.A.F., Roelfsema P.R. (2000) The distinct modes of vision offered by feedforward and recurrent processing, *Trends in Neurosci.* Vol. 23,11; 571–579

Lamme, V. A. F., Super, H., Landman, R., Roelfsema, P. R., Spekreijse, H. (2000), The role of primary visual cortex (V1) in visual awareness. *Vision Res* 40, 1507-1521, doi:10.1016/s0042-6989(99)00243-6

Lang, P. J., Greenwald, M. K., Bradley, M. M. & Hamm, A. O. (1993) Looking at pictures: affective, facial, visceral, and behavioral reactions. *Psychophysiology* **30**, 261–273

LeDoux, J. E. (1995) Emotion: clues from the brain. *Annu. Rev. Psychol.* **46**, 209–235.

LeDoux, J. E. (1996) *The Emotional Brain: the Mysterious Underpinnings of Emotional Life.* Simon & Schuster, New York,

Leek, E. C., Leonardis, A. & Heinke, D. (2022) Deep neural networks and image classification in biological vision. *Vision Research* **197**, 108058

Marr D. (1982) *Vision: A Computational Investigation into the Human Representation and Processing of Visual Information*. Freeman, San Francisco1982

Mashour GA, Roelfsema P, Changeux JP, et al. (2020). Conscious processing and the global neuronal workspace hypothesis. *Neuron.* 105:776–798. doi:10.1016/j.neuron.2020.01.026

McClurkin, J.W. and Marrocco, R.T. (1984) Visual cortical input alters spatial tuning in monkey lateral geniculate nucleus cells. *J. Physiol.* 348, 135–152;

Meaidi A., Jennum P., Ptito M., Kupers R., (2014). The sensory construction of dreams and nightmare frequency in congenitally blind and late blind individuals, *Sleep Medicine*, Vol. 15; 5, Pages 586-595, https://doi.org/10.1016/j.sleep.2013.12.008.

Nir Y, Tononi G. (2010) Dreaming and the brain: from phenomenology to neurophysiology. *Trends Cogn Sci*. 2010 Feb;14(2):88-100. doi: 10.1016/j.tics.2009.12.001.

O'Connor, D.H., Fukui, M.M., Pinsk, M.A., and Kastner, S. (2002). Attention modulates responses in the human lateral geniculate nucleus. *Nat. Neurosci*. 5, 1203–1209.

Panksepp, J. (1998). *Affective neuroscience: The foundations of human and animal emotions*. Cary, NC, USA: Oxford University Press.

Pautz, A., (2021) *Perception*, Abingdon, Oxon; New York, NY: Routledge, ISBN: 978-0-415-48604-0

Perlovsky, L. (1998) "Conundrum of combinatorial complexity," in *IEEE Transactions on Pattern Analysis and Machine Intelligence*, vol. 20, no. 6, pp. 666-670, 1998, doi: 10.1109/34.683784.

Perlovsky, L.I. (2008). *Sapience, Consciousness, and the Knowledge Instinct (Prolegomena to a Physical Theory).* In: Mayorga, R.V., Perlovsky, L.I. (eds) Toward Artificial Sapience. Springer, London. https://doi.org/10.1007/978-1-84628-999-6_3

Perlovsky, L., Schoeller, F. (2019). Unconscious emotions of human learning. *Physics of Life Reviews*, *31*, 257-262. https://doi.org/10.1016/j.plrev.2019.10.007

Prinz, J., (2004), *Gut Reactions: a Perceptual Theory of Emotion*, Oxford: Oxford University Press.

Prinz, J., (2006). Is Emotions a Form of Perception? In L. Faucher & C. Tappolet (Eds.), *The Modularity of Emotions*. Calgary: University of Calgary Press.

Reichova, I., Sherman, S.M. (2004) Somatosensory corticothalamic projections: distinguishing drivers from modulators. *J. Neurophysiol*. 92, 2185–2197

Rescher, N. (2003) *Epistemology: an introduction to the theory of knowledge*. State University of New York Press, Albany pp. 113-118; 308-314.

Reynolds, J., Desimone, R., (1999). The role of neural mechanisms of attention in solving the binding problem. *Neuron* 24, 19–29.

Roland, P.E., and Gulyas, B. (1994). Visual imagery and visual representation. *Trends Neurosci.* 17, 281–287.

Salmela, M., (2011) "Can Emotion be Modelled on Perception?", *Dialectica*, 65(1): 1–29, https://doi.org/10.1111/j.1746-8361.2011.01259.x

Savage C. W. (2011) Gibson's Reasons for Realism, *Cognitive Critique* Vol. 4, http://www.cogcrit.umn.edu/docs/Savage_11.shtml

Schmidtmann, G., et al. (2015). Distinct lower visual field preference for object shape. *Journal of Vision,* 15(5):18, 1–15, doi:10.1167/15.5.18.

Sergent C, Wyart V, Babo-Rebelo M, et al. (2013). Cueing attention after the stimulus is gone can retrospectively trigger conscious perception. *Curr Biol.* 23:150–155. doi:10.1016/j.cub.2012.11.047

Sherman S.M. (2005) Thalamic relays and cortical functioning. *Prog. Brain Res.* 2005; 149: 107-126

Slotnick, S.D., Thompson, W.L., and Kosslyn, S.M. (2005). Visual mental imagery induces retinotopically organized activation of early visual areas. *Cereb. Cortex* 15, 1570–1583.

Solms M. (2021) *The Hidden Spring. A Journey to the Source of Consciousness*. Profile Books Ltd, London. ISBN: 9781788162845.

Stokes M, Thompson R, Cusack R, Duncan J (2009) Top-down activation of shape-specific population codes in visual cortex during mental imagery. J Neurosci 29(5):1565–1572 ;

Straube, T., Mothes-Lasch, M. & Miltner, W. H. (2011). Neural mechanisms of the automatic processing of emotional information from faces and voices. *British Journal of Social Psychology*, *102* (4), 830-848. 10.1111/j.2044-8295.2011.02056.x

Suga, N. and Ma, X. (2003) Multiparametric corticofugal modulation and plasticity in the auditory system. *Nat. Rev. Neurosci*. 4, 783–794 –60

Thompson, W. L. & Kosslyn, S. M. (2000) *In Brain Mapping II: the Systems.* Eds Toga, A. W. & Mazziotta, J. C. 535–560. Academic, San Diego.

Tong, F. (2003). Cognitive neuroscience: Primary visual cortex and visual awareness. *Nature Reviews Neuroscience,* 4, 219-229.

Trübutschek D, Marti S, Ojeda A, et al. (2017). A theory of working memory without consciousness or sustained activity. *eLife.* 6:e23871. doi:10.7554/eLife.23871

Wang, Y. (2016). On Cognitive Foundations and Mathematical Theories of Knowledge Science. *International Journal of Cognitive Informatics and Natural Intelligence (IJCINI), 10*(2), 1-25. http://doi.org/10.4018/IJCINI.2016040101

Weilnhammer, V.; Fritsch, M.; Chikermane, M.; Eckert, A.L.; Kanthak, K.; Stuke, H.; Kaminski, J.; Sterzer, P. (2021) An active role of inferior frontal cortex in conscious experience. *Curr. Biol.* ***2021***, 31, 2868–2880.

Weiskrantz, L. (1996). Blindsight revisited. *Current Opinion in Neurobiology*, *6* (2), 215-220. 10.1016/S0959-4388(96)80075-4

Wernery, J., Atmanspacher, H., Kornmeier, J., Candia, V., Folkers, G., & Wittmann, M. (2015). Temporal Processing in Bistable Perception of the Necker Cube. *Perception*, *44*(2), 157–168. https://doi.org/10.1068/p7780

Zatorre, R. J., Halpern, A. R., Perry, D. W., Meyer, E., Evans, A. C. (1996) Hearing in the mind's ear: a PET investigation of musical imagery and perception. *J. Cogn. Neurosci.* **8**, 29–46