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Research Article

Development of the Dual Concept of Perception in the Marine Environment – A Thought Experiment

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Abstract

The long evolution period of life in the sea, long before the successful conquest of land areas by vertebrates about 390 million years ago, laid the foundation for many biological and physiological similarities in land creatures. In mammals, remains of the paired structures of branchial arteries can still be found and prove the common origins. The principles of symmetry and of duality have been observed since the early days of evolution and affect all physical and functional structures. The question arises how in a world of complex processes and chaotic conditions a simple dual system such as dichotomy can prove useful for brain functions. In fact, a lot of detailed information gets lost when things are reduced to two contrasting properties. Obviously, the comparison of only two opposite patterns permits quick discrimination. This is particularly important when rapid recognition of crucial situations and prompt and fitting reaction are vital. Abstraction of sensory impressions accelerates processing by the brain and allows useful information to be prioritized. Externalization of self-awareness facilitates the conscious awareness of a self that is aware of its own existence.

Keywords: Self-consciousness, Dualism, Marine hydrobiology, Memory, Phenomenology, Reality perception

Introduction

This thought experiment is related to the scenario-based approach of traditional hydrology focusing evolution of life in the marine environment [1]. Background is the predator-prey relationship in shallow coastal waters where quickly recognizing danger to life and limb is a survival strategy. The experiment refers to the dual relationship between accuracy and the related time of recognition and its influence on the development of the dual concept of perception.

Frequently, survival in nature is a question of rapid assessment of the prevailing environmental conditions in order to elicit a fitting response. Monitoring the immediate surroundings strongly demands both sensory perception and recall. Early recognition and an adequate reaction matter. In an advanced duality of mental activity Kahneman distinguished two systems that influence the way we think [2]. While the fast system of thinking appears to be intuitive and emotional, the slow system appears more deliberative and logical. Fast thinking permits rapid reaction when needed, but it is also more influenced by cognitive bias and by intuition. In comparison, slow thinking is associated with greater insight and knowledge. According to Kahneman, our thoughts are shaped by these two systems and influence our judgements and decisions [2].

Dichotomous thinking, the divisiveness of two opposing characteristics, appears to be a typical mode of thought processing but does not just depend on brain function. Mental capacity is strongly influenced by somatic functions of heart (e.g.: blood pressure, perfusion), lungs (e.g.: oxygenation), kidneys (e.g.: water and electrolyte balance), liver (e.g.: metabolism), endocrine glands (e.g.: catecholamines and endorphines), to mention some [3]. Furthermore, most brain functions can be assigned to specific areas of the brain or at least to the dominant hemisphere. This applies, for instance, to the somatosensory cortex, which is responsible for body perception. For consciousnes, however, there is no specially assigned brain region. The conscious mind depends on somatic function too. Consciousness is strongly involved in processing everything bound to neuronal impulses from the entire body. Quantitative impairment of consciousness is reflected in the level of vigilance and orientation to oneself, to time and to space. The qualitative impairment of concsciousness is shown in diminished clearness and content of thoughts [3, 4].

Conscious experience can be defined as the primary determinant of the self [3]. In this context, empirical research investigates how the self biases the cognitive processing of stimuli or is altered through a wide range of means but does not explain how conscious experience contributes to building the self. Husserl and Sartre agreed that consciousness acts intentionally [5, 6]. In their models they regarded self-awareness as a separate structure. In that context, it must be noted that being aware of one's existence is not equivalent to being aware of one's self. It remains one's lifelong challenge to discover who one really is.

Discussion

In this thought experiment I applied critical analysis using descriptive, interpretive, and hermeneutic assessment. I refered to three common types of dual relationships, namely between accuracy and the related time of recognition, between excitation and inhibition, as well as between awareness and memory. Duality generally refers to having two different parts while dichotomy specifically refers to having two opposite parts and symmetry often refers to having two similar (mirror-inverted) parts. In this essay the term dual relationship is closely related to dualism, being composed of two interconnected and optionally complementary principles. In philosophy of the mind, the term dualism is defined as two fundamentally different kinds or categories of things or principles for a particular domain that are conceived concurrently [7]. This, for instance, applies to the historic body-mind dualism (attributed to the ancient Greek philosopher Plato approx. 400 BC). In this two-way relationship the mortal body is contrasted with an independent, even immortal mind. Dualism also applies to yin-yang, a dual concept that originally came from ancient Chinese philosophy (related to Yin Yang Jia, approx. 250 BC).

By definition, thought experiments allow complex processes in imagined scenarios to be investigated merely by thinking. According to the Stanford Encyclopedia of Philosophy (1996), a thought experiment typically presents an imagined scenario with the intention of eliciting an intuitive or reasoned response about the way things are in the thought experiment [8].

The accuracy-recognition relationship

The relationship between accuracy of assessment related to time of recognition and the depending outcome has the experimental background of a water/air boundary line. When swimming on the seaside, a dorsal fin suddenly slices through the water's surface. On the one hand, systematically distinguishing and categorizing dorsal fins would be too time-consuming to permit urgent identification of a predatory fish. On the other hand, marked inaccuracy associated with a short time of assessment may increase the probability of mistaking the dorsal fin of a dolphin for that of a predatory fish. In this thought experiment even distribution of frequencies and similar intervals between fin observation of a predatory fish and 100% letal contact is assumed. The potential influences from chance or arbitrariness are ignored.

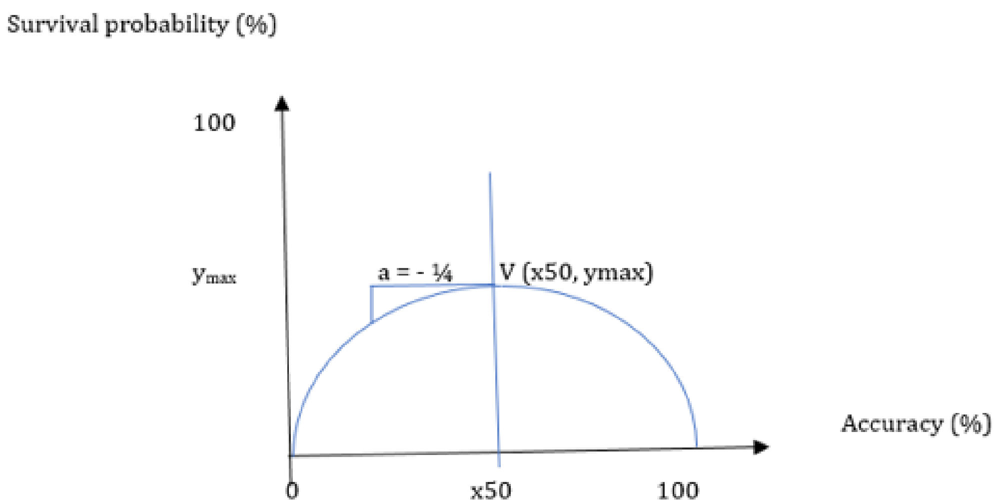

Figure 1: Diagram indicating the proposed interaction between accuracy and the related time of recognition and its potential impact on the probability of survival between vertex (V) and baseline. In case of a predatory fish contact similar intervals between fin observation and 100% letal contact are assumed.

The course corresponds to a parabola [9]. The parabola follows the equation $f(x) = -a(x - x50)^2 + y_{\max}$ with the vertex (V) as the maximum point in height at 50% accuracy. The slope a is - ¼. The value is negative because the parabola is open downwards. Accordingly, the probability of survival increases in the left half of the graph up to V with increasing time of recognition that is associated with increasing accuracy. In the right half from V downwards the probability of survival declines with increasing accuracy that is associated with further increase of time of recognition.

The interaction between accurate assessment and the dependent survival probability in this thought experiment shows that survival is most likely when the ratio between level of accuracy and the time of recognition is balanced (Fig.1). Low accuracy that goes along with short time of recognition is associated with a low probability of survival. Correspondingly, marked accuracy that goes along with long time of recognition is also associated with low probability of survival. The interaction between accurate assessment (x axis) and survival probability (y axis) occurs in bivariate form and follows a parabolic equation $[y = -ax^2 + bx]$. The value "a" is negative because the graph of the parabola opens downwards. In the left half of the graph up to the vertex (the highest maximum point of the parabola) the probability of survival increases with increasing time of recognition that is associated with increasing accuracy. In the right half from the vertex downwards the probability of survival declines with increasing accuracy that is associated with further increase of time of recognition. From a retrospective assessment of survivors the graph shows how univariate interpretation of survival depends on the univariate interpretation of the level of accuracy, without taking into account possible influences from chance or arbitrariness. At any rate, when in doubt it would always be better to choose the poorer option. However, leaving the water immediately whenever a fin appears on the surface is only considered a viable solution in waters with a high density of predatory fish.

In fast thinking the rapid comparison of two patterns allows fast discrimination but it is difficult to know when to trust our intuition and when not [2]. Limited accuracy appears to be an accepted principle of conscious experience, especially when time of recognition matters. Rather than offering a complete representation of the surrounding world, the simplest method to achieve maximum utility is prioritized. This may be an efficient approach for limited capacity of awareness and restricted cognitive resources. When reducing our senses to survival tools, quick decisions are more important than well thought-out decisions.

The excitation-inhibition relationship

The relationship between excitation and inhibition deals with chemically and electrically mediated interneuronal transmission. Dichotomous processes prevail throughout the nervous system. Action potentials result from charged ions being moved across the cellular membrane by sodium ion influx via specific sodium channels (depolarisation) followed by the efflux of potassium ions via specific potassium channels (repolarisation). Synaptic transmission can be excitatory or inhibitory depending on the neurotransmitter and on the direction and magnitude of current flow at the postsynaptic membrane [10]. Polarity gains special importance when considering the generation and conduction of electric signals in the neural system. Polarity depends on intensity and whether or not the cell responds in an on-off mode.

Stimulation (technique to activate specific sensory receptors) from environmental stimuli causes the triggering of peripheral nerve impulses that finally reach the brain. In the above thought experiment recognition depends on visual performance (Fig.1). After visual stimulation excitatory inputs switch their polarity independently of cell activity [11]. Screening for dualism in cognitive functions reveals dichotomous discrimination already on the level of stimulation, e.g. light-dark vision via the rod-shaped light sensory cells in the retina using the visual pigment rhodopsin. The resulting image on the retina is converted to electric signals generated by neurons and transmitted to adjacent nerve cells via synapses. Conversion and transmission of complex neuronal patterns also follow a dichotomous mechanism. During transmission the intensification and contrasting of the encoded information is achieved by modulating signals.

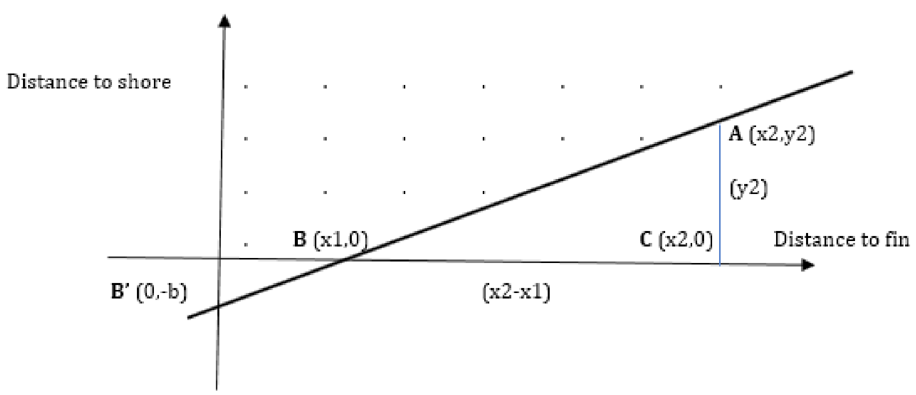

Figure 2: Diagram indicating the adequate prediction of shore arrival from relativation of visually detected motion at a constant ratio between distance to fin and distance to shore. If the swimmer is in the punctured area, survival is less likely.

The line runs along the hypotenuse of a right-angled triangle with vertices A (x2,y2), B (x1,0) and C (x2,0) and the two legs as horizontal change dx (x2-x1) and as vertical change dy (y2). The point A indicates the position of the swimmer and the point B' (0, -b) indicates the intersection with the y axis. The point B (x1,0) indicates the intersection with the x axis with the vertice C (x2,0) at right angles. Applying the linear equation (y = mx +b) the slope of the point-gradient m can be estimated from the formula

$$m = \frac{dy}{dx} = \frac{y2}{x2 - x1}$$

In this thought experiment it is assumed that a swimmer who recognizes an approaching object as the fin of a predatory fish takes the shortest route to shore. That means, the relationship of motions follows a linear equation [y = mx + b]. The slope "m" depends on the ratio between distance to shore (y axis) and distance to fin (x axis) at a certain point in time $m = \frac{dy}{dx}$. For simplicity, the speed of the swimmer and the speed of the predatory fish are assumed to be constant. Fatigue or abandonment are excluded. Potential influences from chance or arbitrariness are ignored. In this figure "b" corresponds to the y value of the point B' (0,-b) where the line intersects the y axis (Fig.2). The value is negative when the swimmer reaches the shore before the predatory fish. The linear relationship enables the situation being assessed at every point (P) along the line (l) depending on the ratio between distance to fin and distance to shore $[P = (x, y) : 1 = \{(x, y) \mid y = \frac{dy.x}{dx} + (-b)\}]$. Due to the linear relationship, predictions can be made quickly.

The estimated distance to the fin depends on the swimmer's visual angle. This angle is formed between the length of the fin and the distance to the swimmer. The visual angle therefore determines the swimmer's perception of space. Comparing the immediate past situation (memory) with the current situation (observation) allows to predict the immediate future (anticipation). Thus, recall from memory is the basic requirement for a sense of time.

Modulation (technique to convert signals by adjustment and tuning for optimized transmission) of axonal excitability by oligodendrocytes facilitates and suppresses axonal conduction [12]. This allows intensification and contrasting of the encoded information during transmission. Visual perception is processed primarily in the occipital cortex but is connected to other brain areas. Special circuits are used to process color and direction of motion. Incoming signals have lower frequencies for color than for motion. This permits separate processing before assembling the information into a common image. Similarly, object recognition and spatial movement are evaluated separately in temporal and parietal lobes before the two processing streams are complemented in the frontal lobe with simultaneous impressions from other sensory organs [13].

Abstraction (technique to reduce an impression to its essential characteristics) turns out to be a key factor in the processing and recalling of information. If one assumes that the sensory cells function the same way for all living creatures of a species, the impressions still differ due to the individual abstraction. Abstraction can be seen as de-contextualization by removing an object from its original context and its associated interactions [14]. The higher the processing level of the involved neurons, the greater the ability to abstract is. Sensory impressions are systematically classified in abstract categories, verbalized and stored in the hippocampal region of the temporal lobe. Verbalization facilitates retrieval of information.

Abstraction is a process wherein common patterns of perceived specific objects are identified and categorized according to their common properties. Again, selecting only a few aspects that are relevant for discrimination permits rapid recognition at the expense of precision. In addition, abstracted information is easier to recall from previous perceptions. Recalling a pattern includes the abstracted completion of missing information from related patterns. This abstraction may contain known properties or attributed properties. When more detailed information is needed, a two-dimensional image can even be pre-translated into three dimensions [14].

Working from incoming signals perceived as stimuli that are transmitted and modulated, processed and filtered, interpreted and categorized, compared and completed in different cerebral regions, the brain creates an image. Accurate interpretation of visual impressions is crucial. Depending on one's expectations, we can even focus on missing information within an experienced vision that attracts most of our attention. Notion and anticipation alter our observation. Cognitive bias appears to prevail. Optical illusions are more likely when the information available is limited or inconsistent [13, 15]. While small errors may not matter, a major error can be life-threatening. Indeed, our visual awareness goes way beyond pure sensory perception.

Cognitive biases stem from and reinforce paradigms (frames). They are systematic mental errors that lead to inaccurate assessments of situations involving numbers, social encounters, and memories [16]. Biases can lead to choices that are inconsistent or even irrational [2]. Ultimately, we can see more than we can perceive with our eyes [15]. Our brain makes a uniquely composed mental effigy of the surrounding world. Presumably, all that we can comprehend is all that we can imagine. When we speak about the world, we speak about our imagination of the world.

We can anticipate that being is more than we can identify by senses and imagination. Sensory perceptions and memorized experiences are interlinked. However, different from their definitions facts and even proofs do not need to be true. Considering the distribution of true (t) and false (f) facts and proofs ($n \in N$ and $p \in [t, f]$), there is the theoretical potential of four dependencies between facts and proofs ($t \cap t$; $t \cap f$; $f \cap t$; $f \cap f$). Furthermore, the objective proof in a mathematical problem is not comparable to the provisional proof in a thought experiment.

The awareness-memory relationship

The relationship between awareness and memory is based on the discriminative awareness of one's self and the environment as a characteristic of being-consciousness. In terms of developmental history, the distinction between "me" and "not me" can be made at the single-cell level of an amoeba. Detecting edible objects via pseudopodia can already be considered an early stage of the direct self-awareness of a living creature. In this relationship being corresponds with appearance. This makes it necessary to distinguish between a "physical me" and a "spiritual me". The latter also includes the "emotional me" and the "social me". It also means that perception, seen in the abstract, is not equivalent to the actual experience thereof. Furthermore, conscious experience is beyond the awareness of one's self (Fig.3).

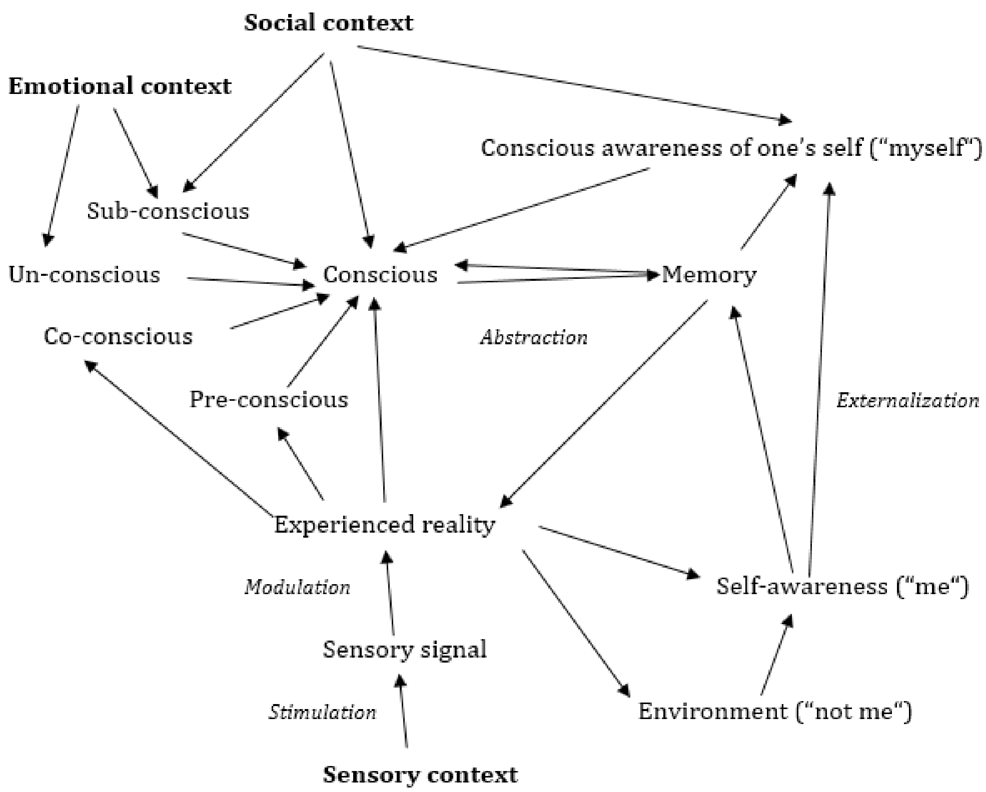

Figure 3: Concept-map displaying the hermeneutic cycle of brain status and mental status between sensory context, the emotional context and the social context. Stimulation, modulation, abstraction and externalization influence the experienced reality, the levels of consciousness and the transitional states of awareness.

In this concept conscious experience is also influenced by the cognitive processes of the co-conscious, the un-conscious, the pre-conscious, and the sub-conscious. If one transfers conscious experience to conscious recognition within the field of vision, then the co-conscious would conform to peripheral vision. The un-conscious would correspond to the ignored, the pre-conscious to the anticipated, and the sub-conscious to the supplemented one. Consciousness arises from the processing of sensory perceptions and recalled information that facilitates recognition. Considered as a whole, consciousness is a function of the entire body coordinated by the nervous system. During induction of anesthesia consciousness fades through stages of depersonalisation and disembodied self-awareness. Despite high concentrations of anesthetics the connectivity within the posterior brain regions is maintained potentially representing a core self that is involved in preserving a reduced state of homeostasis [17].

When consciousness is reduced to awareness, it can be seen as the discriminative awareness of one's self ("me") and the environment ("not me"). It provides the fundamental prerequisite for awareness of an existing self based on the recognition of previous discriminative awareness as abstract condensations of items that are categorized in the pattern personal features ("myself"). This applies to the momentary awareness of one's self that corresponds to the recalling of abstract recognition of oneself according to body sensations based on remembered patterns. Accordingly, Wittgenstein distinguished between "me as subject" and "me as object" [18]. Human consciousness is a fundamental concept of philosophy and the derived scientific subjects. Definition and understanding of consciousness are difficult in that the object used to examine and the object being examined are identical. Limitations on the function of consciousness used for examination directly influence the appearance of consciousness being examined, which is consciousness used to examine consciousness. Further inaccuracy arises from the fact that physical surrounding as we experience it corresponds to an indirect and incomplete reflection of a reality created by our brain. According to Wittgenstein, memory is already an aspect of present consciousness [18]. Memory function requires multiple regions of the brain, e.g. visual recognition memory of objects in the perirhinal cortex and recognition of location in the hippocampus.

The resulting hermeneutic cycle of brain status and mental status from this thought experiment refers to the problem that our understanding of the interactions of factors depends on our understanding of the individual factors on which the interaction is based (Fig.3). Occasionally, we may understand the individual factors on which the interaction is based without understanding the interactions between factors. For instance, to be aware of emotional and social context is important as these interrelations can dominate our thoughts. However, the cognition of awareness of an external event does not necessarily mean that the context (emotional and social) is understood. The ability to think of events independently of current observation provides the basis for abstract thinking. This also allows us to experience being "conscious about awareness." Most likely, the inner consciousness that deals with self-awareness is abstracted from consciousness. Hypothetically, the ability to store abstracted information and to recall it in a meaningful context to momentary sensory perception provides the basis for conscious experience (Fig.3). Linking of perceived sensory impressions and associated patterns that are recalled from memory gives us an object-like imagination that appears as an externalized object.

Externalization in this context means to give an abstracted thought its own entity. While conscious experience is momentary, abstracted thoughts and object-like imagination can be reflected independently of time and occasion. Verbalization (coining a specific term) facilitates the recall of this object-like imagination. Abstraction of previous perceptions and the simultaneous externalization of momentary self-awareness facilitate the external view of the "me". From this it follows, that externalization facilitates the conscious awareness of a self that is aware of its own existence.

Conclusion

During the long period of evolution of life in the marine environment, a dual concept of perception has developed. Duality in sensory perception and thought processing influences the proportion of our reality that we can consciously experience. In brain function the interaction of highly complex processing and dichotomous evaluation is essential. On the one hand, a lot of detailed information gets lost when reducing to two contrasting properties. On the other hand, dichotomous evaluation enables fast discrimination. Dichotomous processing of sensory perception also provides the basis for momentary discrimination between one's self ("me") and the environment ("not me"). Hypothetically, the ability to store abstracted information and to recall it in a meaningful context to momentary sensory perception provides the basis for conscious experience. In this concept, externalizing information arising from momentary sensory perception and recalled abstracted information regarding "me" facilitates the conscious awareness of a self that is aware of its own existence ("myself").

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Conflict of interests

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