Hoffman's Interface Theory from a Bio-Psychological Perspective

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ABSTRACT

Hoffman's interface theory of perception proposes that natural selection is based on icons, which are assessed on the basis of their value for species fitness and have no resemblance to real objects. According to this perspective, perception of truth concerning objects has no value for ensuring the species' survival. The whole truth can only be grasped if all underlying physical factors creating icons of conscious perception are known. However, knowledge of whole truth as well as partial truth is rejected by the theory. Yet, from a bio-psychological perspective, the theory has some important limitations. Perception limited to partial truth would also be adapted for fitness-based evolutionary selection, as it would result in the enhancement of the existing or the creation of new functions of sense organs. Although Hoffman's interface theory does not treat sense organs as physical objects, their functions in consciousness are recognized. Symbolic icons on the computer screen lack any veridical representation of the manner in which the data is stored in the computer memory, but are valuable tools in accessing the relevant content. In contrast icons representing images maintain a direct relation to their stored image. Evolutionary selection over many generations is thought to create icons for increasing fitness. However, icons created in the distant past become fixed and cannot be adapted to the rapid changes during an individual learning process necessary for adaption to unexpected new situations. Human inventions of new objects would also be rendered impossible if icons were solely dependent on evolutionary selection in the distant past. The interface theory is based on quantum mechanical concepts, which are extrapolated from the atomocosm to the macrocosm, but do not consider the Heisenberg cut. The interface approach may be adequate for lower-level organisms, but results in oversimplification when applied to the highly complex human perception.

Key Words: Interface Theory, Truth, Fitness, Evolution, Reality

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Introduction

Hoffman developed the interface theory of perception, in which the perception of real objects is replaced by the concept of icons on a screen without any resemblance to real objects (Hoffman, 2008, 2009, 2011; Hoffman & Prakash, 2014; Hoffman *et al*., 2015). The basic idea that perception is different from truth also underpins the view that evolutionary selection is not based on truth, but rather aims to promote fitness and ensure ability to reproduce. This concept is tested in evolutionary games and genetic algorithms, and has resulted in the emergence of mathematical formalism for describing the interaction among conscious agents. Hoffman's interface theory is based on consciousness, and is grounded on the premise that all individuals have consciousness and free will, which guide their behavior (Hoffman & Prakash, 2014). According to this perspective, perception does not have to be veridical if it results in natural selection that favors greater species fitness and ability to procreate.

The theory, however, exhibits some weaknesses. Specifically, it not only rejects the need for whole objective truth, but also undermines the need for partial truth when

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forming icons. In addition, by considering only evolution-selected icons, it renders it impossible for these icons to be adapted to the present or be used to predict the future. Their postulates also negate the potential for individual learning and new inventions. Quantum mechanical concepts are simply extrapolated from the atomocosm to the macrocosm without considering the Heisenberg cut.

Interface Theory

Hoffman's theory of perception draws on the analogy with computers, in which icons displayed on a desktop have no resemblance to the manner in which the corresponding files are stored in the computer memory. An icon can be blue and rectangular, but its file in the computer is a sequence of bits. In the same vein, the perception of icons selected by evolution could be modeled using mathematical formalism based on evolutionary games and genetic algorithms. This does not mean that mathematics can replace perception, even though this view is supported by physicists like Tegmark (2014), who posit that the universe comprises solely of mathematics. Although physicists have a tendency to attribute primacy to physical formalism, Hoffman's theory is based on the primacy of consciousness, which receives all information through perception and could be modeled with mathematics. An important claim by Hoffman and Prakash (2014) concerns the nature of perception:

Natural selection favors perceptions that are useful though not true. (p. 6)

. . . the idea is that natural selection has not shaped our perceptions to be insights into the true structure and causal nature of objective reality, but has instead shaped our perceptions to be a species-specific user interface, fashioned to guide the behaviors that we need to survive and reproduce. (p. 7).

According to the interface theory, an icon has no relation to the truth. As Hoffman and Prakash (2014) observed, "*to ask if the properties of the icon are true is to make a category error, and to completely misunderstand the purpose of the interface. One can reasonably ask whether the icon is usefully related to the file, but not whether it truly resembles the file*" (p. 7). Dragonflies follow an icon consisting of polarized light reflected from water surfaces in order to find a suitable location to lay eggs in the water. Since oil polarizes reflected light more than water does, it attracts dragonflies. However, as eggs cannot survive in oil, this results in a reduction in dragonfly population that would not occur in their natural habitat. This clearly demonstrates that the icon formed by polarized light does not reflect the whole truth about the medium the dragonfly is observing, as it conveys only one of its properties. This assumption can be easily accepted, since the neural system of a dragonfly is too limited to perceive all properties characterizing water.

However, Hoffman and Prakash (2014) go much further, claiming that "*natural selection does not favor perceptual systems that see the truth in whole or in part*" (p. 6). They further note, "*anything in space and time, including atoms and subatomic particles, are themselves simply icons. . . . it's the atoms, leptons and quarks themselves that aren't there. Object permanence fails for microscopic objects just as it does for macroscopic*" (p. 9). The interface can be any type of icons that favors fitness, although it no longer has any link to physical objects.

A New Worldview

Hoffman's conscious realism theory starts with consciousness as a monism, attempting to explain the evolution of the entire universe since its inception as an interaction among conscious agents. This view is contrasted by physicalism, the aim of which is to conceive how consciousness emerges from a material world and how it can interact with it. Hofmann (2008) observed:

. . . according to conscious realism it simply is not true that consciousness is a latecomer in the history of the universe. Consciousness has always been fundamental, and matter derivative. The picture of an evolving unconscious universe of space-time, matter and fields that, over billions of years, fitfully gives birth first to life, then to consciousness, is false. (p. 111)

If consciousness is the driving force of the entire universe, the mind-body problem would be eliminated, since only consciousness exists and matter is derived from it. This worldview has some similarities with the Hindu philosophy of Vedanta.

Perception Strategies

Hoffman *et al*. (2015) compared the interface theory to other perception strategies. An important aspect of the interface theory is the concept of objective reality, which is a significant departure from the strategies previously

employed for explaining the link between subjective perception and objective reality of the world.

Direct realism, according to Searle (2015), is a veridical perception of all aspects and structures of physical objects representing objective reality (Figure 1). However, this theory is based on the premise that human perception is insufficient to grasp all physical factors, such as the whole spectrum of electromagnetic waves. Perceived physical objects exist independently from human perception and therefore do not need an observer to manifest in reality. In other words, perception is a biological phenomenon unrelated to interactions with physical factors, thereby permitting some philosophers to consider color as a part of objective reality

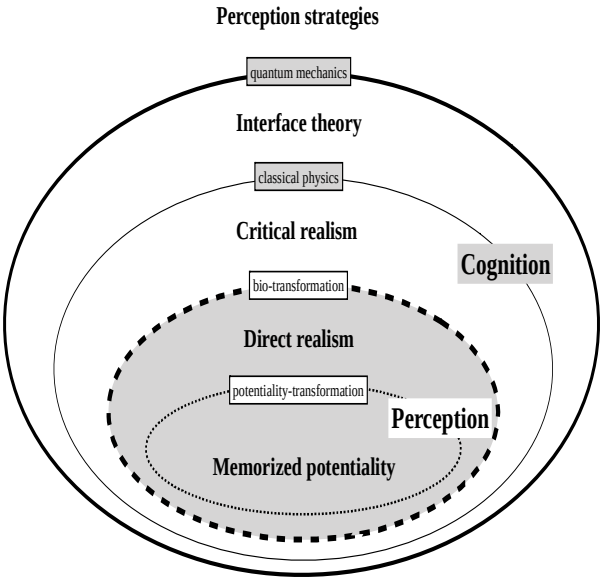

Figure 1. Subjective perception and objective reality

The interface theory does not require any correspondence of subjective perception to objective reality. Perception is only dependent on fitness evaluations acquired by generations of natural selection. Critical realism claims that perception corresponds to objective reality and includes physical factors. Direct realism signifies that objective reality exists even in the absence of causal physical factors. Mental potentiality is a virtual representation of all possible realities, which may or may never become realized. The transformation boundary between direct realism and critical realism signifies a point-to-point transformation of classical physical interactions into biological neuronal activity. The transformation boundary between direct realism and memorized potentiality abandons all exterior physical interactions with the biological realm, but allows past events stored in the memory to be reorganized for predicting a possible future (Jansen 2016). (The Venn diagram is adapted from Hoffman *et al.*, 2015, p. 11).

Critical realism advocates similarly purport that perception does not capture all of the objective reality (for instance, when considering metamerism). The physical light spectrum can only be perceived with three types of cone cells in the retina, each of which is a specialized receptor for one primary color. However, metamerism allows different combinations of wavelengths to produce an equivalent receptor response or color sensation. Thus, critical realism departs from direct realism, as it integrates cognition of classical physical factors with biological factors in the conception of objective reality, whereby physical factors are the cause of biological perception. Physical factors, such as wavelengths of the electromagnetic spectrum, have to undergo a transformation by specialized sense organs into the completely different biological activities of neurons, which is called bio-transformation (Figure 1). Consequently cognition and perception are merged by forming an enlarged concept of objective reality at the bio-physical level.

The **interface theory** goes a step further and incorporates knowledge of quantum mechanics into the concept of objective reality, which thereby contains biology, classical physics and quantum physics at the bio-quantum reference level. From the quantum mechanical perspective, all perceptions are merely probabilities that can be modeled with physical formalism. This and other key aspects of quantum mechanical theories are applied to perception (for instance, the concept that physical factors have no causal power).

Consequently, at the bio-quantum level, perception becomes completely independent from causal links. Hoffman and Prakash (2014) wrote, "*Our views on causality are consistent with interpretations of quantum theory that abandon microphysical causality…*" (p. 37). Hoffman and Prakash (2014) summarized the final aim as follows:

We develop the dynamics of interacting conscious agents, and study how the perception of objects and space-time can emerge from such dynamics. (p. 1)

. . . particles are vibrations not of strings but of interacting conscious agents. (p. 2)

Another quantum mechanical concept, the notion that no elementary particle has a precise position in space-time when it is not perceived, was also applied to perception. Consequently, the intuitive consideration that objects have permanent existence was abandoned. However, this quantum mechanical rule can only be

partially true. When seeing the Moon in the sky, one perceives a physical object in its precise location. However, even if the Moon is obscured from our view, we are aware that it still exists although at a different position. An electron, on the other hand, is too small to be visible to humans. Thus, only its location can be measured, which is posited to change when not perceived. The conclusion that the electron, an unobservable object, only exists when perceived is therefore doubtful, as only its measurable location changed between two observations.

The interface theory replaces the perception of real physical objects by icons with no resemblance to real objects, similar to icons on the computer screen. These icons are constructed by interaction with conscious agents, but cannot be voluntarily changed. Hoffman (2008) described this process as follows:

. . . we construct our icons does not entail that they do whatever we wish. We are triggered to construct icons by our interactions with the objective world (whatever its nature might be) and, once so triggered, we construct our icons according to certain probabilistic rules. . . . The objective world and our rules for icon construction make the icons stubborn. Still, these icons exist only in our conscious perceptions. (p. 99)

According to Hoffman stubborn icons triggered by the objective world of conscious agents and further limited to probabilistic rules, become fixed, which results in major problems.

The Truth Concept

According to Hoffman and Prakash (2014), perception is not geared toward finding the truth, as "*natural selection does not favor perceptual systems that see the truth in whole or in part*" (p. 6). The authors further note, "*our perceptions have endogenous limits to the range and complexity of their representations. It was not adaptive to be aware of most of our mental processing, just as it was not adaptive to be aware of how our kidneys filter blood*" (p. 11).

Similarly, Hoffman (2011) claimed that "*visual perception is simply a species- specific user interface that has been shaped by natural selection to guide adaptive behavior and to hide the complexities of the truth*" (p. 6). Subsequently, Hoffman (2014) wrote, "*natural selection has not shaped our perceptions to be insights into the true structure and causal nature of objective reality*" (p. 7). The notion of truth implicit in different historical perception strategies is directly dependent on the underlying concept of objective reality, which varies at the biological, bio-physical and bio-quantum reference levels.

At the biological level of **direct realism** without inclusion of cognition, truth is identical to what is directly perceived, i.e., existing physical objects. This assumption does not counter the natural selection for fitness, as claimed by the interface theory. Biological perception, according to the direct realism postulates, is entirely dependent on sense organs transmitting information from extra-mental reality to the brain. However, this information can be more or less precise, thus affecting the accuracy with which physical objects are recognized. An eagle needs visual precision five times higher than that developed in humans to recognize distant prey when flying at high altitude. On the other hand, bats living in darkness are almost blind, and rely instead on the highly developed sense organ of echolocation. The acquisition of stronger vision by eagles and highly effective echolocation by bats clearly increased the truth of the presence of a prey and led to higher fitness through natural selection over many generations. Therefore, at this reference level, the perception of truth is not inconvenient for fitness, since it does not occur randomly, as claimed by Hoffman and Prakash (2014), who argued, "*some aspects of our perceptions might be shaped to accurately report the truth, in the same sense that your lottery ticket might be the winner*" (p. 34).

At the bio-physical level of **critical realism**, perception and cognition of physical factors are merged in the definition of objective reality. Consequently, the whole truth has to include not only perception, but also all knowledge of the implied physical factors. Similar to the transformation of an icon into algorithms, physical factors cause a transition to completely different neural factors (for instance, by transforming electromagnetic waves into color experience). Biology makes a strong distinction between physical factors by sense organs required for their perception, determining which part of physical activity has to be transformed into neural activity. Only three cones in the retina are sufficient for human color vision, distinguishing only a small portion of the wavelengths out of the entire electromagnetic spectrum. In other words, strong biological selection limits the whole truth only to the physical factors causing neural activity in sense organs.

At the bio-quantum level, Hoffman's **conscious realism** considers perception as an interface to an objective world that consists of conscious agents. A person is necessarily a conscious agent, but not all conscious agents are persons, since their existence is premised on mathematical theories. Hoffman and Prakash (2014) described this concept as follows, "*Conscious realism is the hypothesis that the objective world W consists of conscious agents. The theory of conscious agents is a mathematical theory of consciousness that quantifies over qualia that it assumes really exist*" (p. 32).

Hoffman (2008) gave the following interpretation of the objective world, "*To say that a world is objective means that the world's existence does not depend on the agent*" (p. 96). He further noted, "*What exists in the objective world, independent of my perceptions, is a world of conscious agents, . . . when I see a table, I interact with a system, or systems, of conscious agents, and represent that interaction in my conscious experience as a table icon"* (p. 103). Similarly, he stated, "*The brain does not cause conscious experience; instead, certain conscious agents, when so triggered by interactions with certain other systems of conscious agents, construct brains (and the rest of human anatomy) as complex icons*" (p. 108). Therefore, the objective world is the interaction of conscious agents, who are not limited to humans, but they trigger the construction of icons in our perceptual system.

A different perception strategy is grounded in the **reality / potentiality** theory purporting that the perception of reality in the present requires active sense organs (Jansen, 2016). In contrast, reminiscence of perceptions in the past and stored in the memory does not need active sense organs, but allows us to imagine the past or to predict a possible future through reorganization of our recollections of past events. Since the past could be different from the actual present, and the not yet existent future can be different from predictions, they can only be represented as potentiality. Thus, there is a profound gap between imagined past and future without active sense organs as potentiality and the experienced present warranted by active sense organs as reality.

Weakness of the Icon Concept with Lacking Truth

The main claim of Hoffman's interface theory is that, during evolutionary selection, fitness dominates truth, "*We find that veridical perceptions—strategies tuned to the true structure of the world—are routinely dominated by non-veridical strategies tuned to fitness*" (Hoffman *et al*., 2015, p. 1).

Hoffman *et al*., (2015) conducted an experiment to test the aforementioned hypothesis using evolutionary games and genetic algorithms, which yielded convincing results after about 500 generations. However, species that presently exist on our planet have clearly demonstrated their fitness over extensive number of generations. Homo sapiens seems to be a very good model to verify the hypothesis that natural selection of partial truth favors fitness, since the species sustained more than 100,000 years of natural evolution, providing superior evidence to that produced by the evolutionary games for natural selection of perception for fitness. Hoffman (2015) claimed that "*perception is about having kids, not seeing truth*" (p. 21). Since human population is continually increasing, this is an adequate proof that natural selection of partial truth has led to optimal fitness. Consequently, humans are a good model for verifying whether partial truth can be helpful for acquiring fitness.

The Computer Icon Metaphor

Hoffman illustrated the interface theory using the computer as a metaphor. On the desktop, there are icons linked to folders in the computer. When they are activated, the folder is opened, revealing its contents. Hoffman *et al*. (2015) explained, "*Suppose that there is a blue rectangular icon in the upper right corner of the desktop for a text file that you are editing. Does this mean that the text file itself is blue, rectangular, or in the upper right corner of the laptop? Of course not*" (p. 10). Clearly, the icon presented to the user is only a convenient symbol with no resemblance to the manner in which the information contained in the file folder is stored in the computer memory. Each point of the symbol icon is linked to the algorithm developed for opening the corresponding folder. This metaphor can be helpful in accepting that human perception can be completely different from the objective reality it represents.

However, icons on the desktop can also be reduced images of the original images stored in the computer. Each point of an image icon is linked to a specific algorithm in the computer corresponding to the same point of the stored

image. Yet, it is necessary to activate the icon to open the folder. In this case, the image icons are in direct relation to the stored original image. At the bio-physical reference level, image icons illustrate critical realism, which claims precise relations between perception and truth, here represented by the icon and its algorithm.

The metaphor of icons should illustrate the relation of subjective perception to the objective reality of its algorithms. Both types of icons on the desktop undergo a transformation into algorithms, whereby symbol icons are linked to a common algorithm with no direct correspondence to the content of the folder, while image icons are related to multiple individual algorithms by preserving their relations to the image in the folder. What is the situation in humans?

Whole versus Partial Truth

Hoffman *et al*., (2015) claimed "*An interface serves to guide useful actions, not to resemble truth. Indeed, an interface hides the truth*" (p. 1). Is this requirement fulfilled in humans? From the perspective of bio-physical realism, merging biology and classical physics, biological perception hides much of the truth of physics, because during bio-transformation by sense organs, it selects only a subset of all physical factors. Human vision is restricted to electromagnetic wavelengths between 390 and 700 nm, sound frequencies between 20 Hz and 20,000 Hz are audible, and human olfaction is inferior to that of many animal species. In addition, our knowledge on the causal physical factors is not perception but cognition, which is not represented by sense organs after bio-transformation.

Further selections are effected within the perception process. For instance, all details captured in a photograph are not simultaneously perceived in consciousness. Only a small part of the environment is in focus in our visual field and is seen with high accuracy. In addition, our attention span is limited in order to optimally utilize the available brain processing power. This concept is known as inattentional blindness. Thus, at any given moment, it is impossible to grasp the whole truth, which is in agreement with the interface theory.

Since whole truth is hidden, can partial truth be found in perception? Hoffman and Prakash (2014) wrote, "*In short, natural selection does not favor perceptual systems that see the truth in whole or in part*" (p. 6). The dragonfly needs water for her eggs to develop and hatch, and is guided to find the optimal environment for her eggs only by polarized light reflections. This is not the whole, but rather partial truth of all water properties. Yet, in the dragonfly's natural habitat, it is sufficient for maintaining the species and promoting fitness. Fish have perception organs for electric fields with which they can localize prey, since their vision is hampered in opaque water. Again this is only partial truth, but is sufficient for the fish to ensure the species' survival. Birds have sense organs for magnetic fields they rely on for navigation during migration. Bats are equipped with sense organs for echolocation, since their vision is underdeveloped, which is another kind of partial truth. Human perception lacks sense organs for electric fields, magnetic fields or echolocation; thus, we rely on our limited vision to perceive our surroundings, resulting in only partial truth of the environment (which is, nonetheless, sufficient to assure survival).

The evolution of a particular sense organ, such as the eye from eyespots in unicellular organisms to pinhole eyes in nautilus and further to camera type eyes in vertebrates, is the adaptation of a sense organ for a much better acquisition of partial truth (for instance, the presence of a prey, which also entails fitness). The eagle developed a 4–5 times higher visual acuity than humans, as this was necessary for the detection of prey from high altitudes. These examples further confirm that a better detection of partial truth increases fitness and thus survival.

Partial truth is in disagreement with the interface theory, since symbol icons have no resemblance with the truth of the structure of their folders. Nevertheless, image icons reflect partial truth by their point-to-point relationship to a stored image. Therefore, in contrast to the interface theory, partial truth was sufficient and necessary for the fitness of species to assure survival in their specific environments.

Non-adapted Evolutionary Fixed Icons

Hoffman and Prakash (2014,) wrote:

evolution has shaped us with a species-specific interface whose icons we must take seriously. (p. 8)

. . . the idea is that natural selection has not shaped our perceptions to be insights into the true structure and causal nature of objective reality, but has instead shaped our perceptions to be a

species-specific user interface, fashioned to guide the behaviors that we need to survive and reproduce. (p. 7)

During many generations of evolution, icons required a selection process in order to indicate the necessary behavior for survival and reproduction. In experimental evolutionary games, a selection typically requires about 500 generations to become conclusive. After such a long period, icons can be considered as fixed, which conflicts with the need for rapid adaptation to changing environments.

Incompatibility with Individual Learning

The interface theory attributes perception and free will to a conscious agent, which requires a mental choice. However, with evolutionary fixed icons, the choice will be highly restricted, since there is no freedom for forming new icons through learning. In all sports and other professional domains, better performance can only be reached through continued practice, as each individual has to undergo a learning process. Learning by trial and error is an immediate adaptive process, which is the opposite of evolutionary selection of fixed icons.

Although icons that have been fixed after generations of evolution may suffice for avoiding harmful snakes, as Hoffman claims, a similar selection of icons for fitness to avoid the dangers of recent human acquisitions, like cars or a trains, cannot wait for generations of selection. A rapid learning process is needed for avoiding the immediate but unexpected danger.

Incompatibility with Human Inventions

Human inventions of new objects seem to be excluded from consideration in the interface theory. Leonardo da Vinci envisaged a helicopter in 1493, as a spontaneous pure mental construction. His icon of a helicopter was not selected by generations of evolution and had no advantage for survival at that time. How can an evolutionary fixed icon be obtained for new objects, like space vessels, which were invented within about one generation?

No Prediction of the Future

The interface theory postulates do not account for the mental process of imagined future, since only evolutionary fixed icons of the past can be seen with open eyes. Hoffman and Prakash (2014) described this situation, "*When I open my eyes and see a red apple, that red apple is indeed an icon of my perceptual interface. When I close my eyes that icon disappears; I see just a mottled gray field*" (p. 36).

The disappearance of the icon once eyes are closed seems to be the key assumption underpinning the interface theory, as it would be inconsistent if the icon did not cease to exist when the transmission of messages from the objective world are disrupted. Hoffman and Prakash (2014) explained, "*each time a conscious agent interacts with the world and, in consequence, has a conscious experience, we can think of this interaction as a message being passed from the world to the conscious agent over a channel*" (p. 13). Therefore, being able to observe through the channel of active sense organ functions is essential for the theory to hold true.

However, the future can never be perceived with the function of active sense organs, which can only represent the present. A memory of stored perceptions of the past is needed, which can then be reorganized by cognition to imagine a potential future, as proposed in the reality-potentiality theory (Jansen, 2016). A potential future based on reorganized past perceptions is not envisaged by the interface theory. It is clearly not identical to truth, since the past is rarely the same as the present or the future. As the future does not yet exist, predictions can only be potentiality consisting of different possibilities in a kind of superposition, which may or may never be realized in the future. Thereby, observable reality is completely different from potentiality based on the memory of past events as the vision of future, which is characterized by a range of possibilities much broader than reality. However, evolution-fixed icons of the past are not adapted to predict the future.

Conservation of Anti-fitness Icons

Icons were selected by natural evolution for fitness ensuring survival. Nevertheless, there are also anti-fitness icons, which were not eliminated by the evolutionary pruning process. The daily need for food was initially met by agriculture, which is a very tough and painful work and often leads to injuries and illness. The illness icons could be understood as anti-fitness icons, which were, nevertheless, conserved to the present day.

Evolutionary selection for survival also preserves anti-fitness perceptions of pain and birth defects.

Since physical bodies do not exist in the interface theory, elimination of these icons during natural selection would have been another way of increasing fitness.

Icons and Objective World are Incompatible with Monism

Hoffman (2008) claimed, "*Conscious realism is a non-physicalist monism. What exists in the objective world, independent of my perceptions, is a world of conscious agents, not a world of unconscious particles and fields*" (p. 103).

In contrast to the dualism of physicalism distinguishing between mind and matter, in which the latter has primacy over the former, the interface theory is thought to be a monism of consciousness. However, in this monism, a clear distinction is made between perception and an objective world of conscious agents. According to this theory, while objective world is completely independent and without any resemblance to icons, it nonetheless imposes its rules on the construction of icons in a similar sense as matter influences the mind.

The conscious perceptual experiences of an agent are a multimodal user interface between that agent and an objective world. To say that a world is objective means that the world's existence does not depend on the agent. MUI theory claims nothing about the ontology of that objective world. It requires no resemblance between properties of the interface and the world. (Hoffman, 2008, p. 96)

Is the opposition of conscious experiences and an independent objective world, which imposes its rules to experienced icons, not similar to the gap between mind and matter, given that in physicalism the mind is dependent on the existence of a physically healthy and continuously nourished body? Does the separation of the interface icons and the undefined objective world not recreate unsolved dualism akin to that between mind and matter?

In virtual tennis, there are two interacting realities, the virtual reality of the tennis ball and the player reality. The computer software renders the virtual game possible, whereas the player causes the interactions in the actual tennis game. If the player becomes exhausted or hungry, the virtual game is necessarily interrupted. A similar situation seems to exist in the interface theory according to Hoffman (2008):

We are triggered to construct icons by our interactions with the objective world (whatever its nature might be) and, once so triggered, we construct our icons according to certain probabilistic rules. (p. 99). . . . *Conscious realism asserts that the objective world, i.e. the world whose existence does not depend on the perceptions of a particular observer, consists* entirely of conscious agents. (p. 103)

As the player in virtual tennis, Hoffman's objective world seems to have a similar dominating role on the interface. This would also indicate a dualism.

How does Hoffman's objective world support the icons of the interface with sufficient energy for their existence? If however, energy does not exist like physical objects, the first physical law of thermodynamics prohibiting perpetual motions is rejected, whereas the laws of quantum mechanics are considered as valid.

Quantum Mechanical Principles Extrapolated to the Macrocosm

The interface theory is based on mathematical models underpinning evolutionary games and genetic algorithms and respects principles of some quantum mechanical interpretations. Hoffmann and Prakash (2014) wrote, "*conscious agent is a technical term, with a precise mathematical definition*" (p. 12). They further noted, "*However, it does not assume . . . that the mathematics of conscious agents is itself identical to consciousness*" (p. 32). Later on, they observed, "*Our views on causality are consistent with interpretations of quantum theory that abandon microphysical causality, such as the Copenhagen, quantum Bayesian and (arguably) many-worlds interpretations*" (p. 37). They also acknowledged, "*space-time and three-dimensional objects have no causal powers and do not exist unperceived*" (p. 10). Therefore, object icons can only exist if they are consciously perceived, and are lacking causality. These are quantum mechanical conceptions for the atomocosm, which are here extrapolated to the macrocosm.

Nevertheless, Heisenberg (1927) limited quantum mechanics to the atomocosm, whereas von Neumann (1955) extrapolated it to the entire universe. Heisenberg restricted the validity of his uncertainty principle to the area under the so-called "Heisenberg cut." With his microscope thought experiment, he explained that light as a transformative detection system in the atomocosm directly interfered with the position of an elementary particle during measurement. Consequently, the real behavior of elementary

particles before their interaction with the detection system will never be observable (Jansen, 2018). Thus, two opposite interpretations of quantum mechanics can be taken as reference, one extrapolating it to the entire universe, as followed by the interface theory, and the other limiting it only to the atomocosm, which would not allow their extrapolation to perception in the macrocosm.

Conclusions

The authors of Hoffman's conscious reality, the interface theory start with consciousness as the only aspect of our surroundings we can know with certainty. Their aim is to understand perception of conscious agents and to describe it with mathematical models based on Monte Carlo simulations of evolutionary games and genetic algorithms. Their approach is based on quantum mechanical concepts, such as the Copenhagen interpretation, which purports that phenomena exist only if they are observed and consequently have no object permanence. The general concept is a monism claiming that the whole universe is immaterial consciousness (Chopra and Hoffman, 2018), which resembles the Hindu philosophy of Vedanta.

The concept of objective reality is not clearly defined. It is based on the vibration of interacting conscious agents, which include persons but also other factors, since it is essentially a mathematical approach. The underlying premise is that perception is not selected by evolution as the means for acquiring truth, but for survival. Consequently, icons with no resemblance to real objects but indicating the necessary behavior are sufficient for the survival of a species. It can be easily accepted that perception of the whole truth, including all participating physical factors, is inconceivable with the limited mental capacity afforded to humans by brain anatomy and physiology, but even perception of partial truth for increasing fitness is rejected by this worldview.

According to the interface theory, sense organs do not exist, but their functions such as consciously seeing, hearing, or touching are maintained. Nevertheless, these functions would be extremely limited if they could only perceive icons of the past, firmly fixed by multiple generations of selection. Perception functions should necessarily include the adaptation of actions based on free will that is necessary for survival in a changing environment, which is imposed by objective reality.

It is easily conceivable that icons cannot represent the whole truth, which would include all participating physical factors and exceed the neural capacity. Nevertheless, why would the knowledge of partial truth—like seeing, hearing or smelling a prey—not be sufficient to increase fitness for survival? In Homo sapiens, as an example of great fitness, partial truth and fitness evolved in the same sense.

The main weakness of the interface theory is essentially due to the premise that icons are fixed by natural selection across many consecutive generations in the distant past, rendering them non-adaptable to the continuously changing present. Therefore, fixed icons are not adapted for individual learning by trial and error, or for instantaneous invention of new icons, like Da Vinci's helicopter and for any prediction of the future. Although evolutionary selection is thought to favor survival of the fittest, it nevertheless preserves anti-fitness icons, such as illness and birth defects.

The consideration of the interface theory as a monism is highly doubtful, since the opposition of experienced perceptions and an undefined objective world of conscious agents, which have absolutely no resemblance, suggests a similar gap as the one between mind and matter. As a result, the unsolved mind–matter problem would also be transposed to the interface theory.

The interface theory is based on quantum mechanical concepts, which are thereby extrapolated to the macrocosm, although they were initially conceived for the atomocosm. Two opposite conceptions interpret quantum mechanical indeterminism (Jansen, 2018). Heisenberg (1927) limited it to the atomocosm, caused by transformative detection of light in the atomocosm, whereas von Neumann (1955) extrapolated it as inherent properties of elementary particles to the entire universe. Thus, there are two possible interpretations. While von Neumann's interpretation would be in agreement with the interface theory, that offered by Heisenberg would not.

The interface theory is essentially based on mathematical formalism and might correspond well to lower-level animals. However, Homo sapiens as a species has proven its fitness over more than 100,000 years, and this survival has been ensured by the great complexity of perception considering the past, the present and

the future that cannot be modeled with basic evolutionary games or genetic algorithms.

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