The Nature Of Qualia: A Neurophilosophical Analysis

Universität Konstanz
Department of Philosophy

A thesis submitted in partial fulfillment of the requirements for the degree of

Doctor in Philosophy
by

Carlos E. B. de Sousa
BA, MA

Supervisor:
Prof. Dr. Wolfgang Spohn

Konstanz, Germany
May 2009

Tag der mündlichen Prüfung: 29.07.2009
Referent: Herr Prof. Dr. Wolfgang Spohn
Referent: Herr Prof. Dr. Marcel Weber

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Zusammenfassung

Das Problem des Bewusstseins ist traditionell eine philosophische Fragestellung, die sich darauf bezieht, wie das Gehirn qualitative Zustände hervorbringen kann, die singulär, privat und subjektiv sind. Solche qualitativen Zust¨ande werden als ”Qualia“ bezeichnet. Sie werden gemeinhin als ein Problem für neurowissenschaftliche Theorien des Bewusstseins angesehen. Dualistische Philosophen behaupten, Qualia seien nicht auf Gehirnzustände reduzierbar, weil Qualia nichtphysikalische Eigenschaften seien, die im Rahmen bewusster Erfahrungen zustande kämen. Funktionalistische und physikalistische Theorien hingegen halten Bewusstsein für eine Leistung des Gehirns. Dualisten kritisieren Funktionalismus und Physikalismus, indem sie darauf hinweisen, dass in deren Erklärungen die Qualia nicht vorkommen. Egal wie vollständig eine physikalistische und funktionalistische Erklärung ist – da sie in der Dritte-Person-Perspektive verfasst ist, werde sie niemals qualitative Zustände erfassen können. Bis vor Kurzem wurde die Bewusstseinsdebatte durch diesen Kritikpunkt blockiert. Neue Erkenntnisse aus den kognitiven Neurowissenschaften deuten jedoch darauf hin, dass Bewusstsein ein Resultat mehrerer miteinander verschränkter Gehirnmechanismen ist. Genauer gesagt werden bewusste Ereignisse von Verbänden neuronaler Netzwerke hervorgebracht, die sich hauptsächlich in der Gehirnrinde befinden. Entgegen dualistischen wie physikalistischen/funktionalistischen Theorien argumentiert dieser Text für die neurophilosophische Hypothese, dass Qualia auf der Neurobiologie sensorischer Systeme basieren. Bewusstsein ist vor allem ein neurobiologisches Phänomen, ein Produkt evolutionärer Prozesse. Daher muss die Erforschung von Bewusstsein und Qualia diesen biologischen Status berücksichtigen. Die zentrale Hypothese dieser Dissertation fußt auf mechanistischen neurobiologischen Erklärungen. Weder der Dualismus noch das physikalistische/funktionalistische Programm nehmen den neurobiologischen Bedingtheit des Bewusstseins zur Kenntnis. Die (hier vertretene) Diagnose ist, dass die traditionellen philosophischen Werkzeuge sich mit dem Lösen erkenntnistheoretischer Probleme erschöpfen. Deswegen nehme ich eine neue Perspektive ein, nämlich die der Neurophilosophie, d.h. der Verschmelzung von Neurowissenschaften und Philosophie. Die sich aus dieser neuen Perspektive ergebende Schlussfolgerung ist, dass Qualia sensorische Qualitäten sind, die jedes bewusste Ereignis begleiten. Qualia sind neurobiologische Phänomene, die phänomenologisch auf der Ebene des Bewusstseins erfahren werden. Drei zentrale Makromechanismen sind verantwortlich und notwendig für die Entstehung von Qualia: (1) sensorische Modalitäten, die zwischen Organismen und ihrer Umwelt vermitteln; (2) der ”globale neuronale Arbeitsbereich“ (Global Neuronal Workspace) zusammen mit Aufmerksamkeitsprozessen (ein Bewusstseinsraum im Gehirn, der von mehreren miteinander verschränkten neuronalen Netzwerken erzeugt wird); und (3) Erinnerungen auswertende Prozesse (Gedächtnis- und Wertungsprozesse), die den Sinnesinformationen spezifische und singuläre Qualitäten aufprägen. Die Emergenz von Qualia auf der Basis dieser drei Makromechanismen nenne ich ”dreifache Modulation“. Die Instanziierung von Qualia verdankt sich der Verbindung und Integration dieser neurobiologischen Mechanismen. Ohne sie wäre es unmöglich, Qualia zu erleben. Die Hypothese der Dreifacher Modulation wird von verschiedenen neurowissenschaftlichen Befunden gestützt und kann empirisch überprüft werden. Eine Schlussbemerkung besagt, dass die Mechanismen, die an der Erzeugung von Qualia beteiligt sind, das Produkt evolutionärer Prozesse sind und Organismen dazu befähigen, relevante Informationen aus ihrer unmittelbaren Umgebung aufzunehmen. Bewusstsein ist mit Qualia verbunden, weil bei jeder bewussten Erfahrung spezifische Qualitäten präsent sind. Qualia sind keine besonderen Eigenschaften oder nichtphysikalischen Aspekte des Gehirns, sondern eine evolutionäre Reaktion auf Umweltzwänge, d.h. neurobiologische Mechanismen zum Erkennen von Veränderungen in der inneren und der äußeren Umwelt.

Abstract

The problem of consciousness is a traditional philosophical issue and refers to how the brain can generate qualitative states that are singular, private and subjective. These qualitative states are called 'qualia'. They are supposed to be a problem for a neuroscientific theory of consciousness. Dualist philosophers say that qualia are irreducible to brain states, since qualia are non-physical properties coming about during conscious experiences. On the other hand, functionalist and physicalist theories consider consciousness as a function of the brain. Dualists criticize functionalism and physicalism by pointing out the absence of qualia in their explanations. No matter how complete the physicalist and functionalist explanation is, it will never capture the qualitative states in the third-person perspective. Until recently the debate was blocked by this criticism. However, new findings from cognitive neuroscience suggest that consciousness results from the work of several interconnected mechanisms in the brain. In particular, conscious events are generated by assemblies of neuronal networks localized mainly in the cerebral cortex. Against dualism and physicalist/functionalist theories, this text argues for a neurophilosophical hypothesis of qualia based on the neurobiology of sensory systems. First of all, consciousness is a neurobiological phenomenon, that is a product of evolutionary processes. Therefore, a study about consciousness and qualia must presuppose such a biological status. The main hypothesis of the dissertation is based on neurobiological mechanistic explanations. Dualism and the physicalist/functionalist program do not take into account the neurobiological status of consciousness. To some extent traditional philosophical tools seem to be exhausted in solving epistemological problems, e.g., the problem of consciousness. Therefore, I adopt a new perspective, viz., neurophilosophy, i.e., the unification of neuroscience with philosophy. The conclusion from this new perspective is that qualia are sensory qualities present in every conscious experience. Qualia are neurobiological phenomena experienced phenomenally at the level of consciousness. Three central macro-mechanisms are responsible and necessary for qualia instantiation: (1) sensory modalities, the interface between organisms and the environment, (2) the Global Neuronal Workspace (a conscious space generated in the brain by several interconnected neuronal networks) plus attentional processes, and (3) memory-evaluative systems that imprint into the sensory information specific and singular qualities. I call the emergence of qualia due to these three macro-mechanisms "Triangular Modulation". The instantiation of qualia is possible in virtue of the interconnection and the integration of such neurobiological mechanisms. Without them it would be impossible to experience qualia. The hypothesis of Triangular Modulation is supported by various neuroscientific findings and it can be tested empirically. A final remark is that the mechanisms involved in qualia generation are a product of evolutionary processes which enable organisms to detect relevant information in the immediate environment. Qualia are associated with consciousness since in every conscious experience there are present specific qualities. Qualia are not special properties or non-physical features of the brain, but an evolutionary response to environmental constraints, that is, neurobiological mechanisms for detecting changes in the internal and external environment.

Acknowledgements

My thanks and appreciation to my supervisor Wolfgang Spohn and the members of his Colloquium, which in different ways, helped me to keep my objective in mind.

I also want to thank to several people I have met during conferences I attended. Through valuable discussions they have helped me in the development of the main idea presented in this dissertation.

My thanks also go to Gerard Montague, who kindly read the whole text and checked the English. If there are errors still, I apologize to the readers for my fault.

Special thanks go to CAPES-Brazil (Coordenação de Aperfeiçoamento de Pessoal de Nível Superior) which funded me during the whole period of my PhD study.

Finally I would like to thank numerous friends in Konstanz. This is a beautiful city, where my daughter Larissa was born and where I was really happy.

Last but not least, I want to thank my wife Fernanda who has always supported me during the last 15 years. Without her support, I would never have been able to finish this dissertation.

I dedicate this dissertation to my mother and to the memory of my grandparents Ruth and Baptista.

CEBS
Konstanz, May 2009

Part 1

A Philosophical Analysis of Qualia

La Haye, 16 Mai 1643

How can the soul of man determine the spirits of the body, so as to produce voluntary actions (given that the soul is only a thinking substance). For it seems that all determination of movement is made by the pulsion of a moving thing, so that it is pushed by that which moves it, or, by the qualification (quality) and figure (shape) of the surface of that thing. For the first two conditions, touching is necessary, for the third extension. For the one, you exclude entirely the notion that you have of the soul; the other seems to me incompatible with an immaterial thing. This is why I ask you to give a definition of the soul more specific than that in your Metaphysics, that is to say of its substance, as separated from its thinking action. For even if we suppose the two to be inseparable (which anyway is difficult to prove in the womb of the mother and in fainting spells), like the attributes of God, we can, in considering them separately, acquire a more perfect idea of them.

La Haye, 20 June 1643

...and I admit it would be easier for me to concede matter and extension to the soul, than the capacity of moving a body and of being moved, to an immaterial being. For, if the first occurred through information; the spirits that perform the movement would have to be intelligent, which you accord to nothing corporeal. And although in your metaphysical meditations you show the possibility of the second, it is, however, very difficult to comprehend that a soul, as you have described it, after having had the faculty and habit of reasoning well, can lose all of it on account of some vapors, and that, although it can subsist without the body and has nothing in common with it, is yet so ruled by it.

Princess Elizabeth of Bohemia (1618-1680) from Letters to Descartes

... metaphysics is a branch of fantastic literature.

Jorge Luís Borges Ficciones, 1962:25

CHAPTER 1

What Are Qualia Supposed to Be?

1.1. Qualia and Consciousness

The problem of consciousness is a traditional philosophical "hot topic". In the past ten years it has become a scientific issue. Different authors talk about "the problem of consciousness" and "the problem of qualia". However, sometimes it is not clear what the differences are between 'consciousness' and 'qualia'. While the literature on the topic increases exponentially, the agreements among philosophers and scientists conversely decrease. In philosophy, some problems typically arise from personal attitudes towards the supposed problem and methodological issues. Sometimes the better strategy consists in analyzing the problem from other perspective or using other tools.

In philosophy of mind there is a long *index* of known problems. The most famous is how brain generates[1] consciousness, or precisely, *how conscious mind can fit into the physical world*. Over the centuries several solutions were proposed to such an ancient philosophical question. We can sort the main suggestions into two groups: (1) metaphysical or dualistic conceptions of brain and mind, and (2) monistic or naturalistic ones. The former considers the "conscious mind" as an entity separate from the brain. In this case, the conscious mind seems to be a non-physical thing. Obviously a new problem emerges from that claim, namely, *how such a non-physical thing relates with the physical world (the brain)?*

So far no plausible answer has been proposed by partisans of dualism. So that dualism remains a "bizarre" philosophical notion. On the other hand, naturalistic accounts of consciousness start from the assumption that consciousness is what the brain *does* in some unknown and unexplainable way (yet!). Naturalistic conceptions basically adopt the scientific standpoint, and in general are more successful than the dualist conceptions.

I see that part of the problem concerns the method: dualists used to employ the *first-person* perspective (introspection) to analyze consciousness. On the other hand naturalists adopt the *third-person* perspective. However, a quick look at both reveals they are wrong. The dualist faces several obstacles as how a non-physical

[1]Here we can use different synonyms such as "produces"," gives rise", "causes", "creates", etc. I will not deal with conceptual issues. The problem is complex enough to carry out linguistic analysis. The point at stake is the *phenomenon* of consciousness, not the different verbs one can use to explain it.

thing can relate with a physical. Moreover there is the problem of the reliability in introspective methodology. What count as a criterium for introspection?

On the other hand, the naturalist must deal with the methodological issues, for instance, how to investigate something that it is by its own nature *subjective*, *private* and *personal*, from the third-person objective perspective? Thus there is an impasse here. While the dualist uses the introspective method and excludes the third objective one; the naturalist by its turn rejects the subjective introspective method. As result we have always an incomplete report of conscious mental life.

It is a platitude to say that consciousness is subjective, private and personal. Virtually no one will deny that (although there are some authors who do this, as I will show in chapter 3). It is then reasonable to accept the fact subjectivity must be taken into account, regardless of the method. The strategy proposed here is to integrate the first-person perspective with the third in order to gain a more plausible explanation. In other words, in order to attain a closest description of qualia and their underlying mechanisms.

As one could expect, the problem is really complicated, and can be stated in a sentence: *How could we explain the mechanisms underlying consciousness and qualia without dualism?* Nowadays most authors agree that dualism is not a plausible candidate for the solution.[2] Thus naturalistic accounts prevail in the debate. Notwithstanding, few authors present a clear definition of consciousness. Furthermore, a new concept was introduced in the discussion, *viz*, qualia.

Some authors distinguish between qualia and consciousness; others do not accept such a distinction. The problem is complex enough, and a new concept has just appeared. Then, in order to shed some light in the discussion, we must carry out conceptual work, i.e., explain what we understand by 'consciousness', and why it is associated with qualia. What are the main prerequisites to say that one is conscious or not? What are the main features of consciousness? When do we say that someone is conscious? Is *consciousness* a feature shared with other entities in nature?

Before saying that "X is conscious of Y" we must understand on what we are talking about. The task seems to be hard[3] but fortunately some aspects associated with consciousness are taken for granted. For example, consciousness has the followings properties:

(1) **Sentience** or **awareness**: what philosophers like to call *phenomenality*, subjectivity or something expressible in clauses as "what it is like for an organism to experience something" (Nagel, Searle, Jackson, etc.). Examples are: the taste of coffee, the redness of a ripe tomato, the different modal

[2]Although the Australian philosopher David Chalmers still insists on dualistic accounts of consciousness, as I show in the next chapter.

[3]Peter Carruthers points out that the words 'conscious' and 'consciousness' frequently are used in different ways, what makes the task of defining them really hard. (Cf. Carruthers, P. 2000:9).

sensations like cold, hot, wet, pains, orgasms, etc., all can be expressed in a word; *qualia*.

(2) **Intentionality**: the capability of conscious states being always about something, i.e., they have a direction, a content, (Franz Brentano, Edmund Husserl, John Searle, Daniel Dennett). For instance, the thought I have now that "there is a glass of water in front of me" is *about* the fact that in front of me there exists an object that we normally refer to as "glass of water".

(3) **Privacy** and **transparency**: the content of my actual thought is accessible only to me. The content is transparent to me and opaque to a third-person observer (George Moore, Michael Tye, Thomas Metzinger, Gilbert Harman). From those assumptions, some philosophers conclude that there exists a gap between first-person perspective (subjective) and third-person perspective (objective). No matter what I say, you can never realize what the contents of my thought are.

(4) **Unity**: There seems to exist a "self" habiting inside of me, which remains over the time, although each new experience is completely new and diverse. The self seems to be the subject of the conscious experience. Furthermore, the conscious experience is a unified single phenomenon. No one experiences the 'roundness' and 'redness' of a ripe tomato separately. On the contrary, the experience of a ripe tomato is quite cohesive and distinct.

(5) **Immediate awareness of conscious events** (self-recognition): one is able to recognize changing events, e.g., when the body functions get badly or when the weather is too hot. But direct access to the neuronal events is impossible.

(6) **Wakefulness**: consciousness is associated with the state of being alert, or as opposed to asleep or comatose.

(7) **Appearance of a stream**: conscious events flow endlessly. They come and go. As William James once put it, thoughts seem to flow in consciousness like a river. But the *access* to the content of thought seems to be *serial*, i.e., you are able to become or be conscious of only one piece of information at time. Multiple conscious accesses are impossible.[4]

Those are the aspects associated with consciousness. A customary example might be useful here: try to think in the current process of reading these sentences. I have written down on the paper some symbols, and at this moment you become conscious of them. But you are not conscious of the underlying cognitive unconscious

[4]Further features are presented in chapters 7 and 8.

processes taking place at different levels in your body and also the background stimuli. Additionally, maybe now you are not conscious of your feet touching the floor, of your back leaning in the chair, of the actual smells and tastes, the flow of conversation in the background, etc.

Specifically, from the very moment I have pointed them to you, each one, in turn becames conscious and afterwards unconscious again. This is the seriality of consciousness.[5] You can have access to only a single information available at the conscious level. The matter is associated with our evolutionary history (as I will present in chapter 6). With a serial flow of information and parallel unconscious processing, the brain does not become overloaded with a huge amount of insignificant information, and you can attend better to decisive situations (which present important contents with survival values) that can be decisive for your future action.

Turning to the qualia, the article about consciousness in the *Stanford Encyclopedia of Philosophy* divides the problem of consciousness in three parts: the descriptive question (what is consciousness and its main features?) the explanatory question (how should we explain it? Which method?) and the functional question (does consciousness have a function? What are the functions?). The three questions are well stated, and I have just discussed them. However, a central aspect of consciousness was ignored by various authors, namely, the *neurobiological aspect*. Above all consciousness is a neurobiological phenomenon, and as such should be treated within the framework of biological sciences; in particular evolutionary neurobiology.

Essentially, organisms are *biological dynamic living-systems*. They are the owners of consciousness (or the subject of experience). Consciousness is something experienced *biologically*. It is taken for granted that there are various levels of consciousness in different biological entities in nature, but I will not deal with this issue here. My point is concerned with human conscious experience which exhibits certain qualitative features.

After all, human beings are biological living-systems that evolved under fundamentally the same environmental conditions as other organisms. Such a restriction must be considered. However, as a response to a several factors, Natural Selection endowed human beings with such kind of consciousness as we have. Anticipating the discussion of chapter 6, human consciousness is an evolutionary adaptation. With this assumption in mind, the problem of consciousness and qualia should be investigated under the framework of biological sciences. In this context, evolutionary biology works as a common platform where philosophy, psychology, sociology, anthropology, etc. meet each other.

In other words, evolutionary biology is the intersection of several fields, since it deals with living systems, and humans are part of this context, namely, biological

[5]This issue is developed in details in chapters 7 and 8.

living systems as a product of natural selection. In order to deal with such interdisciplinary issues, a new approach is presented, namely, *neurophilosophy*. This is a new interdisciplinary approach that integrates knowledge from several fields, mostly from cognitive neuroscience.

Neurophilosophy investigates old philosophical problems in the light of new empirical data and tools from cognitive neuroscience. With an integrated approach that comprises biology, psychology, neuroscience etc. we can have a better view of the problem of consciousness. By adopting such a framework, we can understand consciousness and qualia in a plausible way: by integrating the associated disciplines. To do this, one needs to consider the difference between qualia and consciousness.[6]

Strictly speaking there is no great difference, since qualia are based on modal experiences. Qualia are the conscious qualitative features (the content as is said) present in every conscious experience. Most of our conscious experiences exhibit singular qualitative contents. They are based on the sensory modalities which imprint the first qualities into the sensory information.

But the best way to understand qualia consists in giving examples of conscious experiences that present qualia. Thus, let us suppose that you are now on the *Copacabana* beach, Rio de Janeiro, seated comfortably in a hammock, relishing the sweet taste of coconut water, feeling the fresh sea breeze. At the same time you are listening to the waves breaking on the shore, sensing the sun tanning your skin, seeing the blue-green shades of the sea and the blueness of the sky, feeling the sand texture under your feet, listening to people chatting around about, etc.

It is natural to ask the question: What is happening here? Some philosophers might say you are having a conscious experience, with various qualia. Each quale has its own characteristics that everyone knows. However the qualitative conscious content, as you experience it, cannot be accessed by a third person. No matter what you say about your qualitative conscious experience, only you yourself know "what it is like to be you"!

On the other hand the different sensations and perceptions you are experiencing could be explained in pure neurobiological terms: the environment presents several patterns and forms. The sensory systems detect and select what matters from what does not. Environmental stimuli are converted into sensory information according to the sensory modality. Afterwards, sensory information is sent to the brain, where is processed by several neuronal networks. Everything that is happening consists in a sequence of neurobiological events initiated by external stimuli incoming from the environment.[7]

The sensory mechanisms convert the information[8] according to the sensory

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[6]Further details about neurophilosphy in chapter 5.

[7]I develop this idea in chapter 6.

[8]Technically speaking, energy is detected in the environment by the specific sensitive receptors, e.g., cones and rods, taste bulbs, cochlea, etc. The sensory receptors transduce detected energy

modality (visual, auditory, olfactory systems, etc.). After that the sensory information is sent to the specialized neural processors in the brain (a system with a huge number of interconnected neuronal networks). The specialized neuronal networks convert in some way the objective information, captured in the environment, into subjective information by adding specific qualities. As result, qualia emerge for you. Of course this is one side of the story. The other is how we experience such neurobiological events subjectively.[9]

This simple example raises some pertinent questions: could you explain what kind of sensations are you experiencing? How do such qualities emerge for you? In other words, how could low-level neurobiological events generate high-level qualitative feelings? Extra questions could be posed: Are you conscious of all events around you? And are you conscious of events happing in the brain? After those experiences, can you remember them? *What it is like to be experiencing them?* Could you deny the existence of such qualities? Could it be the case that all are only an illusion? Thus stated we can begin the journey into the understating of qualia from a neurophilosophical perspective.

1.2. Philosophical Origins of Qualia

The word 'qualia' (*quale* in singular) means qualities in Latin. The concept entered into the philosophical debate through the philosopher Charles Sanders Peirce, in a short paper called *The Principles of Phenomenology*. Although Peirce does not allude to qualia, he clearly speaks about the qualities of conscious phenomena (experiences); e.g., the qualities of feelings such as colors, odors, sounds, tastes, emotion, etc. All those qualitative phenomena are considered as "the vividness of a consciousness of the feeling."

Peirce considers "the collective total" content of the immediate moment of consciousness as presenting different qualities – depending on current experience. Tim Crane says that Peirce was the first to conceptualize the phenomenon of qualia when Peirce proposed that: "there is a distinctive quale to every combination of sensation (...) a peculiar quale to every day and every week – a peculiar quale to my whole personal consciousness."[10]

After Peirce, Clarence Irving Lewis advanced the analysis of qualia. In fact, Lewis was the first to introduce the term 'quale' into the philosophical discussion. In his book written in 1929, Lewis proposes that conscious experiences present something specific, namely the *given*. According to the author, knowledge is based on experiences that present us empirical content that is "difficult to put in words".

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into neural information (the language of neurons) in order to be processed by several neural networks in the brain. I present a brief introduction to neurobiology in chapter 6.

[9]This issue is the theme of chapters 7 and 8.

[10]For more details about historical issues see Tim Crane (2000 chapter 7).

The *given* in experiences are familiar and qualitatively specific to us. Before Thomas Nagel has used the phrase "what it is like to" to refer to qualia, Lewis already applied the locution "looks like" to characterize what is present in every conscious experience. The given can also be referred to by using expressions such as 'tastes like', 'sounds like', 'feels like', etc.[11] Moreover, the given is a presentation of some experienced object. In Lewis' words:

> In any presentation, this content is either a specific quale (such as the immediacy of redness or loudness) or something analyzable into a complex of such. The presentation as an event is, of course, unique, but the qualia which make it up are not. They are recognizable from one to another experience.[12]

In Brief, Lewis assumes wisely that qualia are "recognizable qualitative characters of given", and they appear in successive conscious experiences, but should not be identified with the properties of objects.[13] In addition Lewis asserts that "The quale is directly intuited, given, and is not the subject of any possible error because it is purely subjective. The property of an object is objective."

Lewis put forward the main features of qualia and anticipated several current arguments as the knowledge argument and inverted qualia. However, he cleverly described the central mistakes about qualia; e.g., the identification of qualia with the properties of the objects. Contrary to the tradition, he recognizes that qualia are properties instantiated by organisms during conscious experiences – as I hold in chapter 6. In conclusion, qualia have the following essential features according to Lewis:

> Qualia are subjective; they have no names in ordinary discourse but are indicated by some circumlocution such as "looks like"; they are ineffable, since they might be different in two minds with no possibility of discovering that fact and no necessary inconvenience to our knowledge of objects or their properties. *All that can be done to designate a quale is, so to speak, to locate it in experience, that is, to designate the conditions of its recurrence or other relations of it.* Such location does not touch the quale itself; if one such could be lifted out of the network of its relations, in the total experience of the individual, and replaced by another, no social interest or interest of action would be affected by such substitution.[14] [Emphasis added]

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[11]C. I. Lewis (1946:173).
[12]C. I. Lewis (1929:60).
[13]Ibid. at page 121.
[14]Ibid. at page 124.

1.3. The Standard Conception of Qualia

The problem of qualia, or as some philosophers like to call it, the *hard problem* of consciousness is supposed to be how neurobiological events, initiated in the sensory systems and further processed in the brain, can give rise to qualitative features, as for example, the unmistakable taste of the Starbucks coffee. Dualists consider such special content arising from conscious experience as non-physical or immaterial. Based on such claim they try to impugn every new naturalistic approach to consciousness and qualia.

Typically such philosophers use a suspect tool, namely, thought experiments.[15] Partisans of those conceptions like to divide reality into two parts: the physical and the non-physical realm. They then conclude that there is a "gap" between physical and non-physical things. Consequently paradoxes and problems multiply, and they acquire an aura of the unsolvable and the mysterious.

Philosophers' thought experiments are based on "home intuitions" – as Dennett likes to say. With this tool, they try to refute naturalistic descriptions of consciousness. That is, frequently they try to refute empirical findings or real experiments by making use of metaphysical imagined scenarios. As result we have some bizarre thought experiments that will be introduced in the next chapter. For a while let us come back to the philosophical definitions of qualia.

The Standard Conception of qualia is mainly described by dualists or anti-naturalist authors. Many other philosophers follow this standard conception. I do not think they are wrong from the outset. I agree in some points, but others are really misleading. In particular, the main disagreements are about the mysteriousness or metaphysical status conferred on qualia. *The Blackwell Companion to Philosophy of Mind* says that:

> Qualia include the ways things look, sound, and smell, the way it feels to have a pain, and more generally, what it is like to have experiential mental states (...) qualia are experiential properties of sensations, feelings, perceptions, and, more controversially, thoughts and desires as well.[16]

On its part, The *Stanford Encyclopedia of Philosophy* asserts that:

[15]In short, thought experiments are hypothetical scenarios that in principle are used to help in some problem, by revealing several features that empirically cannot be deduced or discovered. They are imaginary situations to help us understand about something that could happen in the future. Scientists use thought experiments in order to confirm or disconfirm some hypothesis or theory. With a reasonable use, they can be a very useful tool, but the indiscriminate use sometimes produces perplexities and ludicrous conclusions, such as philosophers' thought experiments presented here. For an interesting discussion about thought experiments see R. Sorensen (1992), and T.S. Glendler (2000).

[16]N. Block (1994:514). In S. D. Guttenplan (ed.).

> Feelings and experiences vary widely. For example, I run my fingers over sandpaper, smell a skunk, feel a sharp pain in my finger, seem to see bright purple, become extremely angry. In each of these cases, I am the subject of a mental state with a very distinctive subjective character. There is something it is like for me to undergo each state, some phenomenology that it has. (...) These qualities — ones that are accessible to you introspectively and that together make up the phenomenal character of the experience are standardly called 'qualia'.[17]

The *Routledge Encyclopedia of Philosophy* explains that:

> The terms 'quale' and 'qualia' (plural) are most commonly understood to mean the qualitative, phenomenological or 'felt' properties of our mental states, such as the throbbing pain of my current headache, or the peculiar blue of the afterimage I am experiencing now.(...) It seems undeniable that our sensations and perceptions have qualitative properties.[18]

Thomas Nagel holds:

> The subjective character of experience (...) is not captured by any of the familiar, recently devised reductive analyses of the mental (...) it is not analyzable in terms of any explanatory system of functional states, or intentional states (...) it is not analyzable in terms of the causal role of experiences.[19]

John Searle[20] says that:

> Conscious states are those states of awareness, sentience, or feeling that begin in the morning when you wake from a dreamless sleep and continue throughout the day until you fall asleep or otherwise become 'unconscious. (...) Conscious states, so defined, are qualitative, in the sense that there is a qualitative feel to being in any particular conscious state. This is the "what- it- feels- like" feature of consciousness. For example, tasting beer is qualitatively different from listening to Beethoven's Third Symphony. (...) All qualia are conscious states,

[17] M. Tye (2007) "Qualia". In *Stanford Encyclopedia of Philosophy.*
[18] J. Levin (1998:863). In E. Craig (ed.).
[19] T. Nagel (1974:436).
[20] Searle and Block are the only non-dualists here.

> all conscious states are qualia. (...) All conscious states are qualitative. (...) Such states are also ontologically subjective in the sense that they only exist as experienced by a human or animal subject.[21]

And David Chalmers states that:

> We can say that a being is conscious if there is something it is like to be that being, to use a phrase made famous by Thomas Nagel. Similarly, a mental state is conscious if there is something it is like to be in that mental state. Equivalently, we can say that a mental state is conscious if it has a qualitative feels — an associated quality of experience. These qualitative feels are also known as phenomenal qualities, or qualia for short. The problem of explaining these phenomenal qualities is just the problem of explaining consciousness.[22]

Finally the *Wikipedia* defines qualia as:

> [Q]ualities or sensations, like redness or pain, as considered independently of their effects on behavior and from whatever physical circumstances give rise to them. In more philosophical terms, qualia are properties of sensory experiences.

According to the definitions, the main features associated with qualia can be grouped as follows:

(1) Qualia are *the way things look like*;
(2) Qualia refer to properties such as "roundness" and "redness" of the objects;
(3) Qualia seem to be non-physical properties of conscious experience (special entities or entities separated from physical reality);
(4) Qualia are subjective, qualitative or phenomenological properties associated with mental states;
(5) Qualia are private, intrinsic, directly acknowledgeable, something fundamental like an atom (unanalysable);
(6) Qualia seems to be something residual and mysterious that remains after the conscious experience;
(7) Being conscious = *what it is like to be* (or undergo) some mental state;
(8) Qualia = consciousness

[21] J. Searle (2007:326). In M. Velmans & S. Schneider (eds.).
[22] D. Chalmers (1996:4).

The grouped characteristics constitute the core of the Standard Conception of Qualia. The basic idea seems to be clear enough: qualia are supposed to be a special and irreducible non-physical property coming about in conscious experience. But qualia are as well subjective and private. For that reason some philosophers consider qualia as a headache for physicalism and functionalism.

The so-called physicalist and functionalist theory of mind try to explain consciousness and qualia only based on some simplistic set of principles. Some authors do not accept that physicalism and functionalism can be identified as a common theory. Let us analyze this. The *Stanford Encyclopedia of Philosophy* defines functionalism as:

> (...) the doctrine that what makes something a thought, desire, pain (or any other type of mental state) depends not on its internal constitution, but solely on its function, or the role it plays, in the cognitive system of which it is a part. More precisely, functionalist theories take the identity of a mental state to be determined by its causal relations to sensory stimulations, other mental states, and behavior.[23]

According to Ned Block, "Functionalism says that mental states are constituted by their causal relations to one another and to sensory inputs and behavioral outputs." The central idea of functionalism is: *whatever state that occupies the role in the causal-functional structure is such state in virtue of its relation with the other states*. In other words functionalism is the assumption that mental states (or events) cause other mental states and are internal causes of behavior. This is also knows as *Multiple Realizability Thesis*.[24]

Physicalism or materialism says that everything that exists in the world is physical or material.[25] The obvious problem concerns the mind: is the mind physical? And are subjectivity and intentionality physical things? Some proposed solutions try either to reduce them to brain states or simply to eliminate them. Others try to maintain the non-physical status of mind by supposing that mind supervenes on the physical. This is called supervenience thesis[26] or non-reductive physicalism.

But functionalism and physicalism sometimes are identified as being two words for the same thing. Both assume the thesis that mind is a *function* that can be

[23]There exist many versions of functionalism. I will not deal with these issues here. For more details see N. Block (1980) and D. Braddon-Mitchell & F. Jackson (1996).

[24]The *Stanford Encyclopedia of Philosophy* says that "In the philosophy of mind, the multiple Realizability thesis contends that a single mental kind (property, state, event) can be realized by many distinct physical kinds. A common example is pain. Many philosophers have asserted that a wide variety of physical properties, states, or events, sharing no features in common at that level of description, can all realize the same pain. This thesis served as a premise in the most influential argument against early theories that identified mental states with brain states (psychoneural identity theories). It also served in early arguments for functionalism".

[25]For more details see *The Blackwell Guide to Philosophy of Mind*. S. P. Stich & T. A. Warfield (eds.).

[26]See chapter 2 section 2.5.

realized in any physical systems; brain, silicon, etc. The core of the functionalism and physicalism runs as follows: If the system behaves as human, then we could say the system is conscious. What matters are the inputs, the internal composition of the systems, the causal relationships, and the outputs. This is the central thesis of what I call the *Physicalist Functionalistic Program* (hereafter *PFP*).

1.4. Problems with the Standard Conception

The Standard Conception of qualia says that they never be explained in neurobiological terms. Qualia just come about as spin-offs or something alike. Consequently if one is following the physicalist thesis that everything is physical and the functionalist idea that what makes something a mental state is the role it plays in the system of which it is part, then qualia would be *de facto* a big difficulty to a naturalistic approach.

Let us consider an example. You see a ripe tomato. Such an experience presents some properties, for instance the round form and the red color associated with ripeness. If we follow the standard conception, the "roundness" and the "redness" associated with the tomato seem to be special properties that exist separated from the object (existent in other reality).

Some philosophers might consider them "universal properties", others might ask for why they are that way. I will neither deal with such "metaphysical" problems, nor argue in favor or against realism, nominalism or conceptualism. A sharp passage in Peirce's *Principles of Phenomenology* summarizes the question: "(...) to ask why a quality is as it is, why red is red and not green, would be lunacy. If red were green it would not be red; that is all."[27] In other words, the things are the way they are and full stop.

But one might say that is question-begging. I reply as follow: first, *being red* is not a universal or special property. In fact, "red" or the "redness" does not exist anywhere, but only *in the brain*. Objects do not have any color.[28] Colors are constructed by the brain according to the inputs incoming from the eyes. On the other hand, the "roundness" results from the molecular arrangements of the object's parts and from its associated function.

Frequently in biology is said that *form follows function*. In this context, the "roundness" of the tomato results from its evolutionary story; e.g., trichromatic organisms prefer round and red objects (like tomato, apple, etc.), for their ripeness can be better detected. Thus the best strategy for tomatos to have more chance of being distributed over the forest was being round and red, since many primates have color vision. Therefore, there was selection for such fruit being the way it is.

[27]C. S. Peirce (1940:78).

[28]Although some organisms have color pigments called chromatophoros that are light-reflecting cells. These cells generate the many color patterns in virtue of the light. Without light color would not exist. Therefore is said that color does not exist except in the brain.

Every organism on Earth follows this basic principle of reproductive success. The more adapted more reproductive success an organism can attain. This is one of the basic principles of Natural Selection.[29]

As I will argue, the PFP is very naive, since it does not take into account a basic thing: organisms are biological entities, although they are composed of physical parts. But they are not physical in the way that stones or mountains are. They are constituted by physical parts, which are not static. On the contrary, parts interact dynamically with others giving rise to biological mechanisms, and mechanisms are responsible for a given function in a biological system.

Organisms are dynamic open-systems that maintain thermodynamic interactions with the environment, and the way they behave can be explained in mechanistic terms. I think the same principle works for qualia. Qualia are generated by three basic mechanisms: sensory systems, global neuronal networks and memory-evaluative systems – as I introduce in the second part.[30]

The Standard Conception and the PFP have nothing to do in the current context of consciousness studies. Put in other words, the hypothesis that consciousness and qualia are physical in the same sense as rocks, and could be reproduced in any physical system does not make any sense. Consciousness cannot be explained only in functional terms or by trying to find it in the brain as a physical thing. Recent data concerning consciousness suggest that it is not a thing, but it is the result of many interconnected neurobiological processes ocorring in the brain at several levels.[31]

Furthermore, it is broadly accepted that consciousness is a biological phenomenon which is highly complex. Simplistic functionalistic and physicalist explanations will never be able to apprehend that. Thus, I consider qualia from the point of view of neurobiology and cognitive neuroscience. The PFP will always fail in trying to explain consciousness, since it excludes its biological condition. Either the supporters of PFP revise its assumptions or the PFP will become history.

1.5. Formulation of the Hypothesis

The proposed hypothesis is based on recent experimental findings. But first of all, I am not a scientist. I am philosopher. I am working on the frontier between philosophy and science. With regards to this claim, one might say that what I do is philosophy of science. But I am not discussing the assumptions, foundations or implications of science, although I do discuss methodological issues. What I do is considering current experimental findings concerning consciousness in order to support the hypothesis that qualia are neurobiological mechanisms.

[29]Further details in chapter 6.
[30]More about this theme see chapter 5 and 6.
[31]See chapters 7 and 8.

The problem of consciousness (and its related problems) is an old and persistent philosophical problem. The History of Philosophy reveals the different approaches and arguments presented as solution for it. From the ancient Greeks up until our own time, philosophers have been trying to answer the question of what it is that makes us conscious creatures, what is the nature of thought, what is perception, sensation, free will, etc.

Many philosophies and philosophers have their own particular merit; from Platonism to Kantism, all have tried to give an answer to such perennial questions. Some points remain, others have been abandoned. This is the dynamic of knowledge. But the fact is that some questions were not rightly answered. They remain open. I am not saying that past philosophers are fully wrong. Each praiseworthy attempt is a son of the spirit of the age and its society. Putting in another way, every philosopher is a product of the *Zeitgeist*. In this sense, it is not different for me. I am a philosopher of the twenty first century.

I work with current scientific knowledge. Presently, consciousness is a neuroscientific object. For a long time the problem of consciousness was investigated only in philosophical terms. Now it is time to advance in a neuroscientific way. A new scientific revolution is emerging from the sciences of brain. Some authors begin to recognize that the discovery of mechanisms in the brain responsible for consciousness will change our *Weltanschauung* about ourselves. The central question after this achievement concerns with our own nature, about how rational and emotional we are, or how unconscious our commonly decisions are made.

Several empirical findings converge to the conclusion that consciousness is a neurobiological adaptation, a product of natural selection. From this new perspective, a distinct question emerges, namely, *what will we do with such new revolutionary knowledge?* A new agenda is now emerging and the philosophically skilled are welcome in this issue.

Today no one working with human behavior seriously would deny the fact that we are a product of natural selection, that we are animals, that consciousness is a biological condition, etc. Therefore, an investigation concerning consciousness and qualia should take into account current neuroscientific data. As a consequence from this new perspective, the traditional philosophical tools seem to be exhausted and fruitless. This diagnosis is presented by Patricia Churchland.[32]

Thus she proposes a new approach to investigate an old philosophical problem based on current neuroscientific knowledge. The new paradigm is called *neurophilosophy*. In accordance with this new way to philosophy, I consider the problem of qualia in the context of cognitive neuroscience. The proposed hypothesis is fully based on this perspective, and can be stated as follows:

[32]See chapters 4 and 5.

(1) Qualia or the sensory qualities arising from conscious experience are generated by the sensory modalities that imprint the first raw qualities into the sensory information according to the modality specificity. Further qualities emerge from the several neuronal networks and by relationship of sensory information with the memory-evaluative systems.

(2) Sensory qualities are neurobiological phenomena experienced phenomenologically. The explanation requires multilevel analyses since several levels are involved in the generation of qualia.

(3) Highly specialized sensory modalities are neurobiological mechanisms of detecting changes in the environment. They played a central role in the evolutionary history of organisms. They are advantageous adaptations selected for the survival of organisms in an unstable and changing world.

(4) Sensory modalities are the interface between organism and environment. Sensory modalities are responsible for *detection*, *selection* and *conversion* of the environmental stimuli into sensory information. Through such processes they imprint specific qualities into the detected information.

(5) Afterwards, several specialized neuronal networks in the brain attach further qualities by means of the influence of their interconnectivity.

(6) The sensory information receives further qualities after it becomes conscious or present at the *Global Neurononal Workspace* (GNW).

(7) Consciousness is associated with availability of sensory information at the GNW that consist in a set of hierarchical neuronal networks widely distributed over the cerebral cortex. At the GNW level the pre-conscious information becomes available for the whole system (several neuronal networks) and it is modulated by the process of relationship with the memory-evaluative systems. Furthermore to become conscious of something requires attention that can modulate the content of conscious experience.

(8) This is what I call *triangular modulation*; (1) sensory systems modulate the sensory information according to the modality; (2) sensory information receives additional qualities in the GNW due to top-down attentional processes and; (3) afterwards is related to memory-evaluative systems that apply further qualities in virtue of the singularity and organization of organism's memory.

(9) Therefore, qualia are in fact private, personal and subjective in virtue of

the preceding claims. They emerge from the so-called triangular modulation. Thus, some points of the Standard Conception of qualia are kept and explained in neurobiological terms. Contrary what is said, qualia are not special features or non-physical properties. Instead, they are neurobiological phenomena experienced subjectively at the level of GNW.

(10) Since qualia are based on neurobiological mechanisms of detecting differences, then we need a mechanistic explanation of qualia generation. Mechanistic explanations consider a given system as composed of several parts and levels. Parts interact with others forming wholes. The behavior of a system is analyzed at several levels. As result we have a multilevel explanation. Qualia are analyzed at the neurobiological level, at the neuronal level and at the phenomenological level. The final story is a global view of qualia generation.

Those are the main theses defended in the course of the text. Obviously there are some problems that every hypothesis faces. In the course of the text I try to deal with them.

CHAPTER 2

Philosophical Objections to Physicalism and Functionalism

2.1. Dualistic Temptations

This chapter presents the main objections raised against the Physicalist and Functionalist Program (PFP). Descartes' spectre is present in several ways. Numerous criticisms of the PFP suppose that qualia are non-physical special entities. They come into existence through conscious experience. Taken for granted is the claim that brains are necessary to instantiate consciousness and qualia, but they are insufficient. Something extra is required.

The PFP thesis states that consciousness can be reproduced in artificial systems like computers, or in any physical system that is able to carry out the following basic functions: receive inputs, generate causal relationships among the internal states, and produce an output. Then a system that behaviors like a human is supposed to be experiencing the same content as we. Subjectivity emerges in-between. This runs the story.

The thought experiments presented in this chapter have a common conclusion: *all physical facts about the world are not sufficient to explain* "what it is like to be an organism, or what it is like to experience the vision of a ripe tomato."At any rate, the criticism has its merit, in spite of the tool used, *viz*, thought experiments.

While the criticism makes some sense against the PFP, it is not a sound objection to neurophilosophy or *de facto* naturalistic accounts of consciousness, since this new approach is based on neurobiology and cognitive neuroscience, not in imaginary thought experiments. On other words, the arguments here (and in the second part) are based on current experimental findings, not in mere "philosophical intuitions".

The main authors that support a dualistic account of qualia are Nagel, Jackson, Chalmers, and maybe Block (who in the past seemed to be favorable towards dualism, but now takes a contra position). They suggest that qualia are special properties of mental states (something non-physical or residual-like). They do not deny the existence of qualia. They only see qualia either as epiphenomena or as non-physical entities. Qualia do exist, as they recognize, but they are not causally efficacious in the physical world, for they are non-physical features of conscious experience. But at the bottom, epiphenomenalism is merely a variation of dualism.

Since mental properties are unlike physical properties, then what we have here is one kind of dualism, namely, property dualism. This kind of dualism alleges that there exist only physical things in the world. These physical things instantiate two kinds of properties in the world: physical properties and mental properties. The latter are non-physical properties generated by brains. This position is advocated by David Chalmers. Followers of property dualism begin the argument by splitting reality into two entities: physical entities like the brain and non-physical entities like qualia and consciousness.

The objections against the PFP are based on dualistic arguments by using thought experiments. In some points the criticisms make some sense, since the PFP is a weak and incomplete theory of mind. It is obvious that computers are not conscious as we are, or have qualia. The very problem is to consider qualia and consciousness as a non-biological phenomenon, but this is a theme for the next chapters.

The classical thought experiments of Absent Qualia, Chinese Brain, Zombies, Mary, Swampman, etc. do not pose a real threat to the neurophilosophy of consciousness. They are designed to refute physicalism and functionalism. Nowadays they are considered as history, i.e., steps toward a science of consciousness. Currently, it is taken for granted that consciousness studies are a multidisciplinary program.

In a nutshell, many authors accept the idea that consciousness consists of a set of unconscious events in the brain; that it is not a localized event or a special stuff separated of the body, but a result of a set of interconnected cognitive unconscious processes. In other words, consciousness is based on nervous systems. This is what the neuroscientist Gerald Edelman calls the *complete naturalization of consciousness*. He says correctly that "any account of consciousness must reject extraphysical tenets such as dualism, and thus be physically based as well evolutionarily sound."[1]

Physicalism and functionalism are frequently identified with naturalism.[2] There is a great confusion about this topic. Some authors say that "being physical is being natural." This is not wrong, since the world is physical and organisms are composed of physical parts. However, although physicalism might be identified with naturalism, the opposite is impossible.

The naturalistic project does not suppose that physics can explain everything since everything in the word is physical. On the contrary, naturalism states that natural phenomena in the natural world can be explained by the natural sciences. The category of natural phenomena includes not only elementary particles, atoms, electrons, etc., but also the environment, organisms, societies, etc.

Organisms are biological living systems, although composed of physical parts. But the explanation does not consist only in identifying the physical parts, or saying that this thing is responsible for some biological function. As I will consider in chapter 6, organisms are dynamic living systems, which interact dynamically with the environment. There are several biological mechanisms underlying the behavior

[1] G. Edelman (2003:5520).
[2] Cf. *Blackwell Companion to the Philosophy of Mind* p.449.

of organisms, that pure physics or chemistry cannot take into account, since they address different levels. For that reason we have biology.

I assume that qualia are natural phenomena, products of natural selection. Therefore they can be explained according to the naturalistic framework, in particular by neurophilosophy. There is no separation between natural physical phenomena and metaphysical phenomena. There is exists only the actual world, and every event in this world is a natural event which admits of a naturalist explanation based on actual scientific knowledge.[3]

This standpoint denies that non-physical or special entities exist and claims instead that only physical things exist, as they can be measured and detected by scientific devices. One such things would be qualia that can be deteted by using specific tools.[4] I call this *evolutionary naturalism.*[5]

2.2. What is it like to be a Bat? Nagel's Point of View

Thomas Nagel's classical paper "What is it like to be a bat" is the first objection to PFP. Nagel settled the main points about qualia. *Inter alia*, the author asserts that "consciousness is what makes the mind-body problem really intractable."[6] By 'consciousness' Nagel means *subjectivity*, and that refers to "the personal point of view" of some organism. According to the author:

> [C]onscious experience is a widespread phenomenon. It occurs at many levels of animal life (...) the fact that an organism has conscious experience at all means, basically, that there is something it is like to be that organism (...) [and] fundamentally an organism has conscious mental states if and only if there is something that it is like to be that organism – something it is like for the organism.[7]

Since the "subjective character of experience" is irreducible to any functionalist explanation, then the PFP thesis is false. As Nagel puts, "if physicalism is to be defended, the phenomenological features must themselves be given a physical

[3] See footnote 5.
[4] See the second part.
[5] Particularly I am following Quine's naturalism. But I will not discuss Quine's naturalism here. See chapter 5. For more details about naturalism visit: http://www.centerfornaturalism.org. Naturalism is defined as "the understanding that there is a single, natural world as shown by science, and that we are completely included in it. Naturalism holds that everything we are and do is connected to the rest of the world and derived from conditions that precede us and surround us. Each of us is an unfolding natural process, and every aspect of that process is caused, and is a cause itself. So we are fully caused creatures, and seeing just how we are caused gives us power and control, while encouraging compassion and humility. By understanding consciousness, choice, and even our highest capacities as materially based, naturalism re-enchants the physical world, allowing us to be at home in the universe. Naturalism shows our full connection to the world and others, it leads to an ethics of compassion, and it gives us far greater control over our circumstances."
[6] T. Nagel (1974:453).
[7] Ibid. at page 392.

account. However when we examine their subjective character it seems that such result is impossible."[8] In other words, Nagel is saying that just being a physical system does not imply that it has or will generate subjectivity. The subjective character is essentially connected with a single point of view. For that reason no scientific objective explanation is able to describe such subjective character. That is because the third-person perspective of scientific explanation leaves something out, *viz*, the subjectivity.

Subjectivity or *Phenomenality* seems to be a special stuff, something mysterious, or at least a non-physical property. In other words, Nagel dichotomizes two realities: the *subjective* world and the *objective* world. That is the gap between the third-person objective perspective and first-person subjective perspective introduced later by Joseph Levin.

As a matter of fact, what underlies Nagel's argument is the dualistic idea that the first-person subjective perspective is something non-physical, and consequently cannot be explained in terms of third-person objective perspective (the physicalist perspective). The latter leaves something out of the explanation, namely, the subjective character. Between objective and subjective point of view there is an unbridgeable gap.[9]

The bat in Nagel's argument now enters: we have the belief that bats have experiences, *there exists something that it is like to be* an organism. Nagel invites us to imagine what it is like to be a bat. Bats should have very different experiences from humans. Bats have sensory systems completely different from ours. In particular, bats detect information in the environment through a specific sensory receptor called *echolocation*. That is, they detect objects by emitting rapid high-pitched clicks that bounce off any objects in the vicinity and then measuring the time taken for the echo to return.

Hence a bat has experiences that only bats can undergo, i.e., only bats have "a batness point of view", and no physicalist explanation can express *what it is to be* a bat. Thus the experience has a subjective-private character, and no third-person objective explanation can reveal the phenomenality of "batness". *Therefore* we are blocked from seeing a bat's point of view. Likewise Nagel demands an answer to the question, "what it is like for a bat to be a bat. Yet if I try to imagine this, I am restricted to the resources of my own mind, and those resources are inadequate to the task."[10]

In conclusion Nagel says we are *limited* creatures, and the understanding of subjectivity of mental states is beyond the human knowledge.[11] Our conceptual

[8] Ibid. at page 393.
[9] See J. Levin (1983).
[10] T. Nagel (1974:394).
[11] This is a similar conclusion Colin McGinn came. McGinn states that human mind is very limited to understand a high complex phenomenon such as consciousness. The human mind, by its own characteristics, is closed to some facts. McGinn calls this limitation "Cognitive Closure". See chapter 3.

framework does not permit us to understand such a phenomenon. Finally, "what it is like to be a bat seems to lead us, therefore, to the conclusion that there are facts that do not consist in the truth of propositions expressible in a human language. We can be compelled to recognize the existence of such facts without being able to state or comprehend them."[12]

In spite of Nagel's pessimistic conclusion, he very admits that "it would be a mistake to conclude that physicalism must be false (...) It would be truer to say that physicalism is a position we cannot understand because we do not at present [1974] have any conception of how it might be true."[13]

It seems that Nagel would like to save physicalism, because he believes that "mental states" are physical states of the body, i.e., "mental events are physical events". Notwithstanding, he does not have a proper theory and good tools to defend physicalism. His final proposal is an attempt to develop "an objective phenomenology not dependent on empathy or the imagination."[14]

In order to understand the gap between first-person perspective and third-person perspective, one needs a middle term, an "objective phenomenology", which could take both into account, subjectivity and objectivity – which is an admireable goal but so far nothing has been presented in response. We are still waiting.

2.3. Epiphenomenal Qualia: What does Mary know?

The so-called *knowledge argument* or the *argument of Mary*, the super neuroscientist who knows everything about neuroscience but fails to know what it like to experiencing colors, is regarded the strongest objection to PFP. In this argument, Frank Jackson aims to show that qualia are epiphenomena and have no causal power in the physical world. The structure of the argument is very simple:

> Mary is a brilliant scientist who is, for whatever reason, forced to investigate the world from a black and white room via a black and white television monitor. She specializes in the neurophysiology of vision and acquires, let us suppose, all the physical information there is to obtain about what goes on when we see ripe tomatoes, or the sky, and use terms like 'red', 'blue', and so on. She discovers, for example, just which wavelength combinations from the sky stimulate the retina, and exactly how this produces via the central nervous system the contraction of the vocal chords and expulsion of air from the lungs that results in the uttering of the sentence 'The sky is blue'. (...) What will happen when Mary is released from her black and white room or is given a color television monitor? Will she learn anything

[12] Cf. T. Nagel (1974:396).
[13] Ibid. at page 400.
[14] Ibid. at page 402.

> or not? It seems just obvious that she will learn something about the world and our visual experience of it. But then is it inescapable that her previous knowledge was incomplete. But she had all the physical information. Ergo there is more to have than that, and Physicalism is false.[15]

Jackson's argument is direct and bewitching. From simple premises a strong conclusion seems to follow. Let us therefore restate them:

(P1): Before her release, Mary knew everything about neuroscience;
(P2): After her release, she learned something new about color vision (some non-physical information);

Therefore,

(C1): There is some physical information that Mary did not know, and;
(C2): The information Mary did not know is non-physical.

Therefore,

(C3): The supposed complete knowledge about neuroscience is in fact incomplete.

Therefore,

(C4): Physicalism is false.

Additional points could follow from Jackson's premises, but my point here is just qualia. Jackson argues that when Mary comes out from the black and white room, she learns something *fundamentally* new – *what red is like*. In particular, after her release, she had learned a new fact about color, and so her knowledge about all physical facts was clearly false or incomplete, for there is some information that is not physical and that Mary did not know.

At first sight, it seems a strong challenge to PFP. If Jackson is right, then all attempts to defend PFP will be useless, since some physical information is nonphysical. Consequently, "to know" seems to be an arcane ability. According to author, Mary lacks the special qualia, which are properties of certain mental states, for example, properties like hurtfulness of pain, the itchiness of itches, and the qualitative character of one's experience when one smells a rose.

[15] F. Jackson (1982:4).

In Jackson's thought experiment, qualia are non-physical properties arising from conscious experience. No physical explanation is able to account for what qualia are. As Terence Horgan acknowledges, the question is whether physicalism can accommodate these qualitative or phenomenal properties.[16] If qualia are non-physical, then they could not be accommodated in the PFP. Therefore PFP is false.

Jackson is defending a strange epistemology here, for "to know" is not a physical activity: Instead "to know" is something special. Let us consider his premises again:

(P1): 'Physical information' means something propositional (like Frege's concept of proposition);[17]

(P2): Physicalism consists in learning a set of sentences that are about physical facts (they refer to facts in the world);

Therefore,

(C): Knowledge-acquiring is based only on mastering scientific sentences which are about physical facts.

That is the conclusion from the argument. Knowledge-acquiring requires only mastering scientific sentences about physical facts. It is not necessary to experience directly the physical facts. Jackson's epistemology says that knowledge is based only on sentences mastering. Consequently physicalism leaves qualia out of the physical explanation, because the whole physical account is not able to capture the non-physical quale coming about in the conscious experience. Gotcha! Physicalism is false!

Jackson's objective is to show that qualia do not have any causal power in the physical world. Qualia are just product of brain activities and are "causally inefficacious", i.e., they cause nothing, for "their possessions or absence makes no difference to the physical world."[18] Brain activities previously cause the actions and are enough. Nonetheless the functionalist might say that qualia "make a difference to other mental states" because mental events cause other mental events.[19]

[16]T. Horgan (1984:148).

[17]Briefly, 'propositions' or 'thoughts' exists in some special sense as reality. Thoughts or propositions can be expressed in different sentences, for instance, "It is raining", "Il pleut", "Es regent" or "Está chovendo" are sentences that refer to the same proposition; the fact that is raining. They talk about the same thing. What establishes the meaning of a sentence is its *reference*. But in Frege's theory of reference, each sentence has a different sense. The sense is the *mode of presentation* or the cognitive content associated with the sentence. In Jackson's sense, 'physical information' seems something like Frege's concept of proposition. Jackson's physicalism consists in the simple idea that scientific sentences are about physical facts.

[18]F. Jackson (1982:133).

[19]See the next footnotes.

Jackson retorts by saying that the evidences of instantiation of qualia are dubious. For example, the hurtfulness of pain should be causally efficacious in the physical world. Some might say that the instantiation of pain sometimes causes some typical behavior, such as to avoid the pain with medicines or by going to the hospital. Jackson replies by saying that "it is simply a consequence of the fact that certain happenings in the brain cause both."[20]

Additional evidences for the inefficacy of qualia would be Darwin's theory of evolution. Evolutionary theory supposes that qualia evolved over time because of their advantages; for they help us to survive in the physical world. Jackson says that it is hardly seeing the effect of qualia in the physical world. He makes use of an example: "Polar bears have particularly thick, warm coats. The Theory of Evolution explains this (we suppose) by pointing out that having a thick warm coat is conducive to survival in the arctic. But "having a thick coat goes along with having a heavy coat is not conducive to survival. It slows the animal down."

Jackson concludes his second challenge as follows:

> (...) all we can extract from Darwin's theory is that we should expect any evolved characteristic to be either conducive to survival or a by-product of one that is so conducive. The epiphenomenalist holds that Qualia fall into the latter category. They are a by-product of certain brain processes that are highly conducive to survival (. . .) Epiphenomenal Qualia are totally irrelevant to survival.[21]

Finally, qualia are inefficacious because they are epiphenomena. In order to show qualia cause anything he introduces an example: to know about other minds consists of *knowing by analogy*: I know you have toothache *by analogy* because in the past I had toothache as well and I know *by analogy* what it is being in toothache.

The person's behavior provides evidences for believing he has qualia like mine. His behavior is caused by the qualia (the hurtfulness of pain). We tend to think that a specific quale causes the behavior. Jackson replies by saying that the "epiphenomenalist cannot regard behavior, or indeed anything physical as an outcome of qualia."[22] Then he uses another curious example:

> Consider my reading in The Times that Spurs won. This provides excellent evidence that the Telegraph has also reported that Spurs won, despite the fact (I trust) [that] the Telegraph does not get the results from The Times. They each send their own reporters to the game.

[20]F. Jackson (1982:133).
[21]Ibid. at page 134.
[22]Ibid.

> The Telegraph's report is in no sense an outcome of the The Times', but the latter provides good evidence for the former nevertheless.[23]

Jackson's conclusion is that an effect cannot be a cause of the first cause. Qualia are only epiphenomenon as the report in *The Times* and *The Telegraph*. Both are outcome of the Spurs' winning and not conversely. To conclude, Jackson says that:

> [Q]ualia cause nothing physical but are caused by something physical", (...) they are excrescence. They do nothing, they explain nothing, they serve merely to soothe the intuitions of dualists, and it is left a total mystery how they fit into the world view of science. In short we do not and cannot understand the how and why of them.[24]

2.4. The Chinese Brain

Ned Block puts forward the thought experiment against the possibility of a huge functional system being conscious and having qualia. In order to make the thought experiment more real, he imagines that People' Republic of China could be instantiating qualia. According to the author, the following scenario is "nomologically possible":

> Suppose we convert the government of China to functionalism, and we convince its officials to realize a human mind for an hour. We provide each of the billion people in China (I chose China because it has a billion inhabitants) with a specially designed two-way radio that connects them in the appropriate way to other persons and to the artificial body mentioned in the previous example. We replace each of the little men with a citizen of China plus his radio. Instead of a bulletin board we arrange to have letters displayed on a series of satellites placed so that they can be seen from anywhere in China. The system of a billion people communicating with one another plus satellites plays the role of an external "brain" connected to the artificial body by radio. There is nothing absurd about a person being connected to his brain by radio. Perhaps the day will come when our brains will be periodically removed for cleaning and repairs. Imagine that this is done initially by treating neurons attaching the brain to the body with a chemical that allows them to stretch like rubber bands, thereby assuring that no brain-body connections are disrupted. Soon

[23] Ibid.

[24] Ibid. at pages 134-135.

> clever businessmen discover that they can attract more customers by replacing the stretched neurons with radio links so that brains can be cleaned without inconveniencing the customer by immobilizing his body.[25]

Block's wants to prove the obvious, namely that such a system has no "qualitative states, raw feels or immediate phenomenological qualities". Therefore functionalism is false since it is not able to explain the qualia in functional terms. The classical functionalism says that mental states are identical to functional states, i.e., machine states (in terms of Turing Machine) and can be realized in any physical system, brain, silicon, swamp, etc. What matters is the same functional organization. If this system is theoretically identical to the functional system, but lacks something extra, then, there is a missing special thing, namely the *mysterious* qualia. *Ergo*, PFP is false.

2.5. Philosophical Zombies

The idea of Zombies goes back to Descartes who thought that animals were mere automata. Their behavior is explicable in terms of physical mechanisms, because they do not have an immaterial mind *(res cogitans)*. Only humans have an immaterial mind that interacts causally with the physical body (*res extensa*). Without the immaterial mind we were just automata.[26] However, Descartes did not mention the word 'zombie'. 'Zombie' is a contemporary word.[27] The actual philosophical zombies were formulated by David Chalmers[28] in order to refute the functionalist thesis of supervenience. According to Chalmers:

> (...) consciousness escapes the net of reductive explanation, because "no explanation given wholly in physical terms can ever account for the emergence of conscious experience (...) consciousness is not logically supervenient on the physical (...) [therefore] all the microphysical facts in the world do not entail the facts about consciousness.[29]

[25]N. Block (1993:139).
[26]Cf. F. Ablondi (1998).
[27]There is another variant of zombie, the *Swampman*, a thought experiment conceived by D. Davidson. The argument aims to show the holistic and externalist character of knowledge. Davidson imagines the following situation: someday a lighting strike in the swamp brings about a creature externally and behaviorally identical to us, the Swampman. But the Swampman has no thoughts, beliefs or desires. He lacks too any evolutionary history. The moral is that knowledge about us arises only in relation with other human beings. See D. Davidson (2001) "Knowing One's own Mind".
[28]Chalmers relates in his webpage that 'zombies' appeared in the philosophical literature by the hands of Robert Kirk. Kirk wrote a paper in the review Mind in 1974 called "Zombies vs. Materialists". For more information see http://consc.net/zombies.html.
[29]D. Chalmers (1996:83).

In order to prove that supervenience is false he imagines a creature physically identical to him (the *Zombie* Chalmers):

> This creature is molecule-for-molecule identical to me, and indeed identical in all the low-level properties postulated by a completed physics, but he lacks conscious experience entirely (...) what is going on in my zombie twin? He is physically identical to me, and we may as well suppose that he is embedded in an identical environment. He will certainly be identical to me functionally: he will be processing the same sort of information, reacting in a similar way to inputs, with his internal configurations being modified appropriately and with indistinguishable behavior resulting.[30]

Based on these claims Chalmers introduces two types of problems: the "hard problem" and the "easy problem". The former is just how conscious mind can exist in a physical world, and the latter refers to the mere problem of perception, vision, memory etc. He creates the thought experiment by appealing to intuition and modal logic (like others thought experiments).

For him the possibility of zombies is totally obvious. No empirical data are necessary. What we need is just to imagine some metaphysical scenario, where a possible creature does exist. The argument is grounded in terms of *conceivability*, which can be stated as follows:

(P1): Zombies are conceivable.
(P2): Whatever is conceivable is possible.

Therefore,

(C): Zombies are possible.

Therefore,

(P1): If zombies are possibly conceivable;
(P2): And if possible zombies have no qualia;

Then,

(C2): Physicalism is false.

[30]Ibid.

Thereby stated (as a kind of sleight-of-hand trick), Chalmers thought he had refuted a variant thesis of PFP, *viz*, the supervenience thesis. From mere physical arrangements, supervenience of consciousness does not necessarily occur. Then the gap is established; between physical properties and mental properties. Between them there is an unbridgeable gap. Joseph Levine associates the conceivability argument with the explanatory gap. For Levine the conceivability of zombies is "the principal manifestation of the explanatory gap."[31]

The problem arises because of the epistemological gap between the phenomenal world (non-physical) and the physical world. No matter how complete our physical explanation of conscious experience might be, the neuronal structures and biochemicals transactions cannot explain the *why* and *how* such physical events generate the subjective non-physical feature of consciousness.

Since zombies are possible creatures identical to human beings, but lack qualia, it follows that physicalism is false, because qualia are left out of the scientific explanation. The functional or biochemical structures are not enough to instantiate qualia. Thus consciousness and qualia are beyond science.

With this in mind, Chalmers proposes a new conception, described as naturalistic dualism:

> The dualism implied here is instead a kind of property dualism: conscious experience involves properties of an individual that are not entailed by the physical properties of that individual. Consciousness is a feature of the world over and above the physical features of the world. This is not to say that it is a separate "substance"; the issue of what it would take to constitute a dualism of substances seems quite unclear to me. All we know is that there are properties of individuals in this world - the phenomenal properties – that are ontologically independent of physical properties.[32]

The main point expressed in Chalmers' argument is that zombies have no phenomenal quality and, by definition, *there is nothing it is like to be a zombie*. Although zombies can behave as normal humans, they lack qualia. Chalmers concludes that a mere zombie-replica in all physical, organizational and functional characteristics, and in all possible worlds, does not imply that your zombie is conscious or has qualia. In Chalmers terms, PFP and the supervenience thesis is false, since qualia do not supervene on the functional and organizational structure. Therefore, qualia remain as a special stuff coming about in the conscious experience.

The supervenient thesis is a non-reductionist position. Supervenience is commonly defined as higher-level dependency relation. Some set of high-level properties

[31] J. Levine (2001:79).
[32] D. Chalmers (1996:125).

supervenes on a set of low-level properties. For instance, a set of X-properties supervenes on a set of more basic Y-properties *if and only if* there is no difference in Y-level. The common slogan is "there cannot be an X-difference without a Y-difference".

Three basic elements compound the thesis: (1) *irreducibility*, supervenient mental phenomena are not reducible to subvenient base; (2) *co-variation*, supervenient mental phenomena are determined by, and co-vary with changes in the subvenient base; (3) *dependence*, supervenient mental phenomena emerge from, and are dependent on the subvenient base.

Some non-reductionist theories of supervenience consider that supervenient properties have their own ontological status and have as well causal efficacy.[33] But Chalmers says that the supervenience thesis is false, because nothing in the zombie story points out that conscious states are *necessarily* supervenient in relation to physical states and even though to functional organizations, for instance, if its composed of silicon or alien material. Chalmers' conclusion is that the mere reproduction of the functional-physical structures is not necessary for the supervenience of mental states on the physical basis. It needs something more.

Chalmers goes on to assert that consciousness is a special thing, i.e., a fundamental entity,[34] something like the space and time; he points out that conscious experience *may* emerge from physical organizations, but it is not outcome from it. This is a position akin to Descartes' automata. As stated by Descartes, the duplication of the principal characteristics (functional and physical) of a human being is only a necessary condition, not a sufficient condition. What is needed is the immaterial mind (*res cogitans*).[35] In Chalmers case, what is needed is *consciousness*, a non-physical thing, a special stuff, mysterious. Consciousness is supposed to be a fundamental property existing in the universe.

Behind Chalmers' claims hide a strong distinction: there are two different properties in the world: physical properties and mental properties (something non-physical). Physical properties instantiate non-physical properties, for example, brain instantiates consciousness, a non-physical feature. That is what Chalmers calls property dualism.

Chalmers' conclusion is that "Consciousness is simply not to be characterized as a functional property in the first place. The same goes for analysis of consciousness as a structural property, or in other reductive terms. There is therefore no way

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[33]See J. Kim (1993) or the article from *Stanford Encyclopedia of Philosophy* at http://plato.stanford.edu/entries/supervenience/.

[34]Here are Chalmers' words: "So what we have to do when it comes to consciousness is admit it as a fundamental feature of the world —as irreducible as space and time (...) *All I am saying here is that it is a fundamental feature of the world.*" In S. Blackmore(2006:42-43). Emphasis added.

[35]However Descartes cannot solve the problem pointed out by Elisabeth of Bohemia, as I have cited in the overture; namely, *how physical bodies can interact causally with non-physical souls.* As is broadly known, Descartes solved by claiming that the interaction occurs in the pineal glandule, a very implausible solution. See Stanford Encyclopedia of Philosophy, "Descartes and the Pineal Gland" at http://plato.stanford.edu/entries/pineal-gland/.

for an entailment from physical facts to consciousness to get off the ground".[36] In such terms qualia or consciousness is really a mysterious thing, an immaterial entity separated from the brain, something spook-like. No scientific explanation is able to reveal how physical events give rise to phenomenal consciousness. After all, the issue will remain unsolved forever.

2.6. Inverted Qualia

This kind of argument was first mentioned by John Locke in his *Essay Concerning Human Understanding* book II, chap. 32. There Locke calls this phenomenon "spectrum inversion". He says in that work that "(...) the same Object should produce in several Men's Minds different Ideas at the same time." In this context the spectrum inversion means sense-datum inversion, for instance, color experiences with a ripe tomato looks red to me and green for you. We both call this object 'tomato', but the color we experience is different: I *mean* red when I see a ripe tomato, and you *mean* green. We are having inverted qualia about the same ripe tomato. The question is: How do I know that my color experiences are the same as yours?

That question refers to the classical epistemological problem of other minds. No one is able to look inside the other person's mind when she is experiencing the inverted color. Although we both are functionally identical and we have the same inputs and outputs, the content of your experience is green, not red.

The fact is I am closed to your qualia and *vice-versa*, and after all who is right about the qualia? From the outside the difference in the experience is undetectable. The moral is clear: physical facts are not enough to determine the nature of color experiences, since the phenomenal character of the conscious experience is something non-physical or an extra element, irreducible to functional organization.

The inverted qualia in philosophy of mind are a variant of Locke's example. The thought experiment is introduced by Ned Block in the *Inverted Earth* argument.[37] Block says that, "I will describe a case of two persons whose experiences are qualitatively the same but intentionally and functionally inverted." Block wants to prove that qualia-realism is incompatible with PFP. In Block's own words:

> Imagine genetically identical twins one of whom has had color inverting lenses placed in its eyes at birth. Both twins are raised normally, and as adults, they both apply 'red' to red things in the normal way. But though the twins are functionally identical in the relevant respects, we may suppose that the internal physiological state that mediates between red things and 'red' utterances in one is the same as the internal physiological state that mediates between green things

[36] D. Chalmers (1996:93).
[37] N. Block (1990).

> and 'green' utterances in the other. (...)This appeal to what happens when we ourselves put on the inverting lenses suggests a version of the inverted spectrum example that involves just such a case-the intrapersonal inverted spectrum. I think it is best to treat the intrapersonal inverted spectrum as having four stages. First, we have a functionally normal person. Second inverting lenses are placed in his eyes and he says grass looks red and blood looks green. Third, after a period of confused use of color terms, he finally adapts to the point where he uses color language normally. That is, he naturally and immediately describes blood a 'red' and grass as 'green'. At the third stage, he is functionally normal except in one important respect: he recalls the period before the insertion of the lenses as a period in which "grass looked to me the way blood now looks". Fourth, he has amnesia about the period before the lenses were inserted and is functionally totally normal just as in the first period.[38]

Inverted Earth is just a planet like Earth, but differs from Earth in two relevant ways. First, the sky is yellow, the grass is red and so on. Second, the inhabitants of twin-earth speak an inverted language. When a twin Earthling sees a 'red' grass, normally he uses 'green' for 'green' and 'red' to mean what we mean by 'green', 'blue' to mean what we mean by 'yellow', etc.

His vocabulary is entirely inverted. Now the exciting part; a team of mad scientists come in the middle of night and drug you, immediately after they transport you to Inverted Earth. While you were unconscious "they insert color inverting lenses in your eyes, and change your body pigments." You are totally unaware of any difference. They put you in a similar environment that you lived at home. And so you notice no difference at all; the "What it is likeness" does not change.

According to Block, after enough time living in inverted Earth all your new linguistic skills and environment will unavoidably produce changes in the intentional content of your mental states. Following this reasoning, Block concludes that that qualia are intrinsic features of conscious experience.

As one expects, this thought experiment states the same points as others: the PFP leaves consciousness and qualia out of the explanation. What they explain is not consciousness nor qualia, but only the computational aspect. Block's wants to show that two systems with the same functional and physical organization, that receives the same input, yet differ in the content of mental states. The conclusion is that the content of your visual experience is fully different from mine. The qualia you experience are different from mine. Therefore, the PFP is false for it cannot explain qualia in functional terms.

[38]Ibid. at page 60.

In sum, what determines qualia is neither the functional organization nor the physical constituents, but the special stuff that appears only in conscious experiences. The parts of the functional structure and the structure itself do not have qualia. Qualia are special features of conscious experience. The underlying thesis in Block's argument is the same as in the others thought experiments, *viz*, qualia are non-physical mental properties, distinct from the physical properties.

The thought experiments presented here aim to refute the classical physicalist and functionalist program that consider mind as a function, and for this reason mind could be realized in any physical system. But the PFP is in fact very poor and naïve. If people involved in the discussion had paid attention to a basic fact, we would not have today such an index of bizarre and ridiculous thought experiments.

The PFP did not take into account the fact we are *biological living systems*. We are not thermostats or Coke machines; nor rocks or mountains. It is obviously is not sufficient to have a mere replica of a biological system. Biological systems are thermodynamical systems with an evolutionary history. In the next chapter I present the main replies to the thought experiments. My replies come up in chapter 4.

CHAPTER 3

Philosophical Replies: Trying to Save Appearances

3.1. Mysterious Qualia

The previous chapter presented the main objections against the PFP. As described they seem to pose an unbridgeable gap between the non-physical subjective conscious mind and objective science. Under these circumstances, if the philosophical objections were sound, then no fact about the brain and its functional and organizational architecture would be able to describe the special phenomenal/subjective character of consciousness or the qualia.

Partisans of PFP tried to respond to the thought experiments, but they were not successful in the task. Even philosophers like Daniel Dennett were unable to save PFP. In other words, functionalists and physicalists tried to save appearances, i.e., tried to rescue the moribund PFP, but they were unable to complete that task.

The outcome of the thought experiments is that qualia do not fit into the physical world, and therefore they will never be explained in naturalistic terms. What should we do? One way would be by adopting the skeptical position expressed by Colin McGinn. McGinn is convinced that we are cognitively limited creatures and some problems go beyond our cognitive systems; "Human cognitive systems are just not set up for dealing with problems of this general type [consciousness]".[1]

According to McGinn "Consciousness occurs in objective reality in a perfectly naturalistic way; we just have no access to its real inner constitution. Perhaps surprisingly, consciousness is one of the more knowledge-transcendent constituents of reality."[2] After this skeptical diagnosis he introduces the idea of cognitive closure as follows:

> A type of mind is cognitively closed with respect to property P (or theory T) if and only if the concept-forming procedures at M's disposal cannot extend to a grasp of P (or an understanding of T) (...) What is closed to the mind of a rat may be open to the mind of a monkey, and what is open to us may be closed to the monkey (...) Thus cognitive closure with respect to P does not imply irrealism about P. That P is (as we might say) noumenal for M does not show that P

[1] C. McGinn (2004:182, 173; 1991:15).
[2] C. McGinn (2004:113).

> does not occur in some naturalistic scientific theory T – it shows only that T is not cognitively accessible to M.[3]

Therefore we are cognitively closed to our own consciousness and *ex hypothesi* to other minds such, as the bat's mind (if it has one). McGinn's idea suggest that consciousness is a transcendent entity, something *à la* Kantian *noumena*, or spooky-like. For this reason, we would face a dilemma: either we are in fact closed with respect to our own consciousness, and then we can never explain it, or we accept the dualist position, since the gap between physical and non-physical reality is unbridgeable. In these terms qualia seem to be really mysterious things, entirely distinct from the physical events in the brain.

3.2. The Ability Hypothesis

Jackson alleges that his argument differs from Nagel's argument,[4] but as is usually done, both can be unified in a single argument: The Knowledge Argument. All objections consider them as variations on the same theme, since they are directed against PFP. Let us restate it: *all scientific sentences about physical facts cannot tell us what is to experience qualia. At the bottom, both are concerned with knowledge-acquisition.* Thus the unified knowledge argument run as follows: Mary does not know what it is like to see colors and she learns what it is like to see colors only after her release.

Since the publication of Jackson's and Nagel's papers, a plethora of replies have been produced and are still coming in nowadays. I will not consider all objections. There is not space or time to present them all. Hence I just stick to the main one. The majority of replies try to save the PFP, while others concern the very plausibility of the thought experiments.

The first group relates to the so-called Ability Hypothesis. As we have seen, "the knowledge argument seeks to show that the material or physical story about us is not the complete story about us, because it leaves out the sensory part, 'the redness of reds' part."[5] According to the ability hypothesis, what Mary learns after her release is not propositional knowledge or factual knowledge, but a *new ability*. David Lewis was the first to reply to Jackson in such terms. Lewis makes a distinction between "knowing that" and "knowing how."[6]

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[3]C. McGinn (1991:3-4).

[4]According to Jackson, Nagel's point is different, *viz*, that no physical information can reveal "what it is like to be a bat." The "what it is likeness" clause concerns the bat's point of view. In other words, Nagel's point is: no objective explanation can tell us what the subjective point of view is. Between first-person and third-person perspectives there is an unbridgeable gap. But at bottom, both authors speak of the same problem, namely, *no physical information can describe the qualia present in conscious experiences.* Jackson did not understand that Nagel's bat is only an example. It could be a cow, an ant, a whale, cockroach or whatever. Both arguments state that physicalism is false and that consciousness is a special entity.

[5]D. Braddon-Mitchel & F. Jackson (1996:127).

[6]D. Lewis (1983, 1990, 1995).

According to Lewis, what Mary learns is a new ability, namely "to know what it is like." "Knowing that" means propositional knowledge and refers how the things are. "Knowing how" is ability, like knowing how to ride a bicycle, knowing how to fight karate, knowing how to swim, and so on. As Lewis says: "...knowing what it is like [is] the possession of abilities: abilities to recognize, abilities to imagine, abilities to predict one's behavior by imaginative experiments."[7]

Following Lewis' idea, Laurence Nemirow holds that "to know what an experience of seeing red" is like is *to have* abilities, for instance, to remember or imagine the experience. Nemirow's "knowing what it's like" may be identified with "knowing how to imagine."[8] In Jackson's argument, "to know" involves propositional knowledge, for example, "x knows that p", where "x" is the knower and "p" is a sentence. Mary has propositional knowledge like "Mary knows that p", where "p" could be "wavelength of 450nm".

According to the ability hypothesis Jackson's argument is invalid since the author equivocates the senses of "to know". The first premise refers to "know-how", the second to "know-that". But "to know", does not consist only in mastering propositional knowledge, but as well abilities to learn. "Know-how" is irreducible to "know-that". Therefore, Mary does not learn any new proposition, since she masters all propositional knowledge. What she learns are only new abilities.

3.3. Modes of Knowledge

The second type of objection appeals to Russell and Frege's philosophy.[9] What Mary learns after her release is a *new mode of knowledge* by means of *acquaintance*. Before her release she knew an old fact about the world by means of description, that is, she knew facts about colors from textbooks.[10] After her release she learns a new fact through acquaintance. Knowledge by acquaintance is a Russellian term which requires experience.

But according to Jackson, our knowledge is learned *through* sentences, and one shows that one knows something by using sentences, describing what one knows. For instance, you can know one way to express your knowledge, but there are various modes of learning and expressing that knowledge.

Moreover, you can say what you know without knowing another specific way of saying it. For example, you can know that "Snow is white", but you do not know necessarily that "Der Schnee ist weiß" or "La neige est blanc or even "A neve é branca". That is, you can express your knowledge that "snow is white" only in English, but cannot express it in German, French or Portuguese. Those are different

[7] D. Lewis (1983:131).
[8] L. Nemirow (1980).
[9] See Paul Churchland's criticisms forward.
[10] T. Horgan (1984a).

modes of description, or in Fregean terms, they are modes of presentation of the same fact, namely, the proposition "the snow is white."

Therefore, when Mary leaves out the room, she learns *by acquaintance* a new mode to express her knowledge in terms of color vocabulary. Now she does not learn anything new about the world, but learns something *about* the words that can be used to express (or refers) what she already knew. Her vocabulary is expanded, not the learning of a new fact. She masters a new sentence.

As Terence Horgan states, what Mary acquires, from her new phenomenal experience, is an indexical "[the] first person ostensive perspective (...) her new information is about the phenomenal color-property as experienced".[11] In this context, the phenomenal redness is some physical information and it is the referent of "this F property"; "The information is new not because the quale she experiences is a non-physical property, but because she is now acquainted with this property from the experiential perspective."[12]

According to Horgan, Jackson's argument is not a challenge to physicalism, because the knowledge argument is fallacious; "it rests upon a subtle equivocation between two senses of 'physical information'". Michael Tye's objections go in the same direction. He examines a fine concept of 'physical information' based on phenomenal experience. According to Tye's PANIC theory (*Poisoned Abstract Nonconceptual Intentional Content*):

> (...) to undergo a state with a certain felt or phenomenal quality is to be the subject of a state that represents a certain external quality (by being appropriately causally connected with it in optimal conditions) and that is poised for use in the formation of beliefs and /or desires (...) Phenomenal character is not in the head (...) There is no extra, special, magical ingredient within phenomenal consciousness. The same physical stuff that makes everything else makes experiences and feelings (...) So what it is like to undergo a given state is broadly physical, second-order property of that state (...) the "what it is like" aspects of phenomenal states are second-order, broadly physical properties that are realized by objective, first-order, physical properties."[13]

> (...) Mary, while she is confined, lacks the phenomenal concept red. This is not to say that she attaches no meaning to the term 'red'. On the contrary, given the information at her disposal, she can use the term correctly in a wide range of cases. Still, the concept Mary exercises here is nonphenomenal. She does not know what it is like to experience red; and intuitively knowing what it is like to have

[11] Ibid. at page 151.
[12] Ibid.
[13] M. Tye (1995:162-163).

> that experience is necessary for possession of the phenomenal concept *red*.[14]

According to Tye, after her release, Mary will know an old fact about human color experience in a *new way*, namely, *by introspection*. By means of introspection Mary is able to represent the phenomenal content acquired in the experience. Before her release Mary cannot fully understand the nature of phenomenal redness, because she had never represented red correctly, with phenomenal content. She was not able to imagine by introspection "what it is like to experience red" before she has experienced red. She has not the phenomenal content which is acquired after the experience, by introspection.

Tye regards phenomenal states as being physical in so far as they can be known in physical terms. However "the phenomenal character is not neurophysiological or biochemical".[15] The plus clause in Tye's argument is the introspection after the experience with phenomenal redness. After this phenomenal experience, Mary can think in phenomenal ways with phenomenal concepts. The "new way to know" presupposes the use of phenomenal concepts from a first-person or subjective perspective. According to Tye:

> (...) phenomenal concepts are the concepts that are utilized when a person introspects his phenomenal state and forms a conception of what it is like for him at that time. (...) Intuitively, possessing the phenomenal concept red requires that one have experienced red and that one have acquired the ability to tell in the appropriate circumstances, which things are red directly on the basis of one's experiences.[16]

Hence for Tye the phenomenal character ("abstract and nonconceptual");[17] or *what it is like to undergo it*, consists in having an objective physical property known only by introspection, from a subjective point of view, but that is acquired through experience.

In Tye's PANIC theory, there are three necessary conditions: (i) having the phenomenal experience and afterwards; (ii) introspecting it by using phenomenal concepts and (iii) representing it by using phenomenal concepts. Thus the objective phenomenal property is converted into subjective property only when the subject considers it introspectively.

[14] M. Tye (2000:17).
[15] M. Tye (1991:162).
[16] Ibid. at page 167.
[17] Cf. Ibid. at page 137.

Gilbert Harman's reply runs in the same vein: "to know what it is like to see something red is to be capable of representing to yourself something's being red."[18] In other words, Mary could not have had a proper concept of redness (or any other color) since in order to have the correct concepts, one needs first to undergo the experience and then form the appropriate and full concept of red. For example, Mary could only know all the facts about color after having those color experiences; "because in order to know it [the fact] the person needs to be able to represent that fact to him or herself, which requires having the relevant concepts."[19]

Paul Churchland follows the Fregean idea of *modes of reference* and the Russellian *knowledge by acquaintance*. He responds to Nagel and Jackson in the same paper. According to him the phenomenal features are in reality objective features. All features that Nagel refers as subjective are for Churchland objective. For example, the 'redness' of an apple is an objective feature that is not excluded from a physical reduction.[20]

The redness of the apple is identical with certain wavelength of electromagnetic reflectance and can be explained in these terms. The "redness" or the "warmth" are genuine objective phenomena and it is a mistake try to "kick the phenomenal properties inwards."[21]

Furthermore, in Nagel's argument, subjectivity is identified with first-person perspective or point of view. The third-person perspective cannot account for the subjective character. Based on Nagel's assumption, Churchland adopts the Fregean mode of presentation to refute it:

(P1): Qualia are knowable only by first-person subjective perspective (introspection).

(P2): Brain States are knowable only by third-person objective perspective.

Hence,

(C): Qualia are different from brain states.

Or in Churchland terms:

(P1): The qualia of my sensations are directly known by me, by introspection, as elements of my conscious self.

(P2): The properties of my brain states are not directly known by me, by introspection, as elements of my conscious self.

[18] G. Harman (1999:44).
[19] Ibid. at page 45.
[20] P. Churchland (1985:18).
[21] Ibid. at page 19.

Therefore,

> **(C):** The qualia of my sensations are different from the properties of my brain states.

Or:

> **(P1):** Hitler is widely recognized as mass murderer.
> **(P2):** Adolf Schicklgruber is not widely recognized as mass murderer.

Therefore,

> **(C):** Hitler is different from Adolf Schicklgruber.[22]

Churchland points out that the problem with Nagel's argument rests on the property ascribed in the first premise and withheld in the second. Again, the same subject can be recognized under different descriptions. Nagel holds that mental states are different from brain states, and the second premise is also false and, according to Churchland, Nagel has profited from the ambiguity of it:[23]

> If mental states are indeed identical with brain states, then it is really brain states that we have been introspecting (...) and if we can learn to think of and recognize those states under their familiar mentalistic descriptions (...) then we can certainly learn to think of and recognize them under their more penetrating neurophysiological description.[24]

Against Jackson, Churchland adopts the Russellian distinction between knowledge by acquaintance and by description. Churchland argues that Jackson commits the intensional fallacy on his use of "knowing about"; "The difference is in the manner of the knowing, not in the nature of the things [for] there are pretty clearly more ways of "having knowledge" than having mastered a set of sentences. And nothing in materialism precludes this."[25]

Mary learned everything about neuroscience in her black and white room *by description*, not *by acquaintance*. Mary does not learn anything new, but only a *new mode* and *media of representation*. In other words, Mary has just actualized her previous knowledge, and physicalism remains unrefuted.

[22]Cf. Ibid. at pages 19-20.
[23]Ibid. at page 22.
[24]Ibid. at page 21.
[25]Ibid at page 24.

Lastly Churchland argues that Mary could very well be able to imagine what it would like to have color experiences. It is possible that Mary learns to conceptualize her inner life (for she masters the language of neuroscience). Although she has never yet been in such states as "a sensations-of-red", she could be able to imagine with relative success what it is like to see red.[26]

3.4. Disqualifying Qualia: Dennett's Criticisms

In the paper *Quining Qualia* Dennett doubts if authors who talk about qualia, know in fact what they mean by 'qualia'. Typically *Folk Psychology*[27] says qualia are properties of conscious experience. Nothing is as familiar, direct, private and so close as qualia are. Dennett wants to undermine such a conception. He calls it the *Classical Cartesian conception of qualia*.[28] Although he recognizes that "I grant that conscious experience has properties. I grant moreover that each person's states of consciousness have properties in virtue of which those states have the experiential content that they do."[29]

But according to Dennett, qualia are not what the philosophers used to refer to. This is a fundamental point, because the so-called "problem of consciousness" will never be solved if we adopt the standard conception, states Dennett. Unfortunately some nonprofessional philosophers and scientists embrace this misleading conception introduced by philosophers.

Thus Dennett's objective is "destroy our faith in the pretheoretical or "intuitive" concept [of qualia]".[30] The author appeals to what he calls "intuition pumps", which are thought experiments devised to question other thought experiments. Here I present the main *intuition pumps* put forward by Dennett.

Intuition pump n° 1, the eater of cauliflower: For you, cauliflower tastes delicious, for me it is nauseating.

Dennett's Explanation: Foods used to tastes very different in different times. Therefore, it is possible to distinguish among different qualia and also isolate some

[26]Ibid. at page 26.

[27]Or *Common-sense Psychology*; which "denotes the prescientific, common-sense conceptual framework that all normally socialized humans deploy in order to comprehend, predict, explain, and manipulate the behaviour of humans and the higher animals. This framework includes concepts such as belief, desire, pain, pleasure, love, hate, joy, fear, suspicion, memory, recognition, anger, sympathy, intention, and do so forth (. . .) considered as a whole, it constitutes our conception of what a person is." *Blackwell Companion to the Philosophy of Mind* p.308.

[28]Or *Cartesian Materialism*, the simple idea that there is a central place in the brain, where consciousness occurs. In this theater there is an observer who sees the conscious events. Dennett had coined this expression saying that "Let's call the idea of such a centered locus in the brain Cartesian materialism, since it's the view you arrive at when you discard Descartes' dualism but fail to discard the imagery of a central (but material) Theater where it "all comes together" (. . .) the Cartesian Theater is a metaphorical picture of how conscious experience must sit in the brain." D. Dennett (1991:107).

[29]D. Dennett (1993:382). In A. Goldman (ed.).

[30]Ibid.

specific quale, for instance, the way juice tastes to me at T_1 and at T_2. At T_1 (06:45) juice is so bitter and at T_2 (08:30) tastes so sweet.

Intuition pump n° 2, the wine-tasting machine: There is a machine which can perform tasting better than humans. It can relate with accuracy which kind of wine it is, giving it a classification and relating which ingredient it lacks, for example, "a flamboyant and velvet Pinot, though lacking in stamina."

Dennett's Explanation: the machine has transducers which replace tastes buds and olfactory organs. Wine is simply a mixture of chemical substances and a machine can identify all these substances, since it is programmed to distinguish different substances. But, it is common-sense that the wine-tasting machine has no qualia or conscious experience. Whatever the wine-tasting machine could do, nobody would say that it is conscious or has qualia, because qualia are some special thing, "the way as the things seems" or the "what it is likeness". What follows from this? Dennett summarizes the central points concerning qualia as follows:

- **(1): Ineffable** – no verbal account can reveal what it is to me to be tasting juice.
- **(2): Intrinsic** – qualia are properties of conscious experience and can be identified by pointing to a specific quale.
- **(3): Private** – only a subject can know his own qualia.
- **(4): Directly** or immediately **apprehensible** in consciousness – there is direct and unrestricted access to qualia.

Now I introduce Dennett's intuition pump number 7:

Intuition Pump N° 7, Chase and Sanborn, the coffee tasters: Their main work is to ensure that the taste of Maxwell House stays constant during the years. In 5 years of works they do not detect any change in the taste of the coffee. But in the sixth year Chase confesses to Sanborn that he does not like anymore the taste of Maxwell House's coffee. He says that his taste has changed. He does not like the taste of Maxwell House any more. It is not astonishing that Sanborn also confesses that something similar has happened to him. Both of them detect no more change in the coffee, and in principle they should no longer work for Maxwell House. They are used to tasting the same coffee for six years and now they do not like the taste of Maxwell House coffee.

Dennett's Explanation: The author wonders how they can know the change in the taste: "Did they check their memory and did they compare the tastes? Did their perceptual machinery derange? Or, did their qualia simply change? Since when do the qualia change? Did they compare with the old quale of coffee and infer that that the old quale tastes this way and the actual quale tastes so different?" Dennett states that this is pure confusion, because people suppose that (1) one can perceive changing in the qualia over the time, (2) isolate the changed quale, and

(3) compare the new quale with the old one.

In this argument, Dennett makes uses of Wittgenstein's discussion about infallibility of memory; There are no criteria of correctness and no infallible knowledge about your own mind. In particular, the infallibilist holds that he can never be wrong about his own qualia and that nobody can know his qualia. Only he can introspect and see them, because qualia are private and subjective and no third perspective can reveal them. But some might still defend the standard conception of qualia. And so Dennett continues with the intuition pump n°9.

Intuition pump N° 9: the experienced beer drinker: Drinking beer is not so palatable for those who have never drunk beer. The taste is gradually acquired until you begin enjoy that specific flavor. One who never drinks beer and is not familiar with the flavor of beer, when they do drink beer for the first time, find the taste unpalatable. If such an individual drinks two kinds of beer they will (probably) not detect any difference, for instance, between *Franziskaner Weißbier* and *Pilsner Urquell*.

On the other hand, for an experienced beer drinker, beer generally tastes pleasant. He can detect the difference tastes in different kinds of beer. But enjoying drinking beer is a practice acquired over time. The first sip is one thing, the second a bit different, the third is very different, until you become habituated and come to enjoy tasting beer. You do not acquire the taste after the first sip, but in the course of various occasions on which you drink beer.

Dennett's Explanation: The supposed intrinsic, private, and phenomenal characters are *de facto* relational. The taste and enjoyment comes about as a consequence of the diverse times when you drink beer, through various experiences. Therefore qualia are relational. The taste is acquired, your taste is educated, and you learn to appreciate the flavor of beer. Therefore, the alleged intrinsic property is in reality extrinsic.

When Chase thinks of "that taste" he thinks equivocally, for he has no recourse to make a fine-distinction or he has no secure mechanism that can guarantee his conviction. Furthermore he cannot point out what quale, since 'that' is indexical and requires '☞', some referent (would say Frege) or even it depends on the context (would say Wittgenstein). According to Dennett, the assumption that qualia are intrinsic, directly knowable through acquaintance, ineffable and private is a mistake. There is no secure criterion or ground on which to base these assumptions. He concludes that:

> (...) when we look one last time at our original characterization of qualia, as ineffable, intrinsic, private, directly apprehensible properties of experience, we find that there is nothing to fill the bill. In their place are relatively or practically ineffable public properties we can refer to indirectly via reference to our private property-detectors (...)

> And insofar as we wish cling to our subjective authority about the occurrence within us of states of certain types or with certain properties, we can have some authority – not infallibility or incorrigibility, but something better than sheer guessing – but only if we restrict ourselves to relational, extrinsic properties like the power of certain internal states of ours to provoke acts of apparent re-identification. So contrary to what seems at first blush, there are no qualia at all.[31]

Dennett's strategy is to entirely undermine Cartesian materialism. Qualia and the inwardness of consciousness are the last bastion of the philosophers.[32] Some philosophers refuse to accept that science can help solving the problem of consciousness. In *Consciousness Explained* Dennett adds that the thought experiments about qualia are:

> (...) bizarre, sidetrack and time-wasting (...) they are only intuitions about philosopher's own minds (...) those intuitions, alas, form a mutually self-supporting closed circle of doctrines, imprisoning their imaginations in the Cartesian Theater. Even though philosophers have discovered the paradoxes inherent in this closed circle of ideas – that's why the literature on qualia exists.[33]

Now Dennett takes up a stance against the inverted spectrum idea; it is "the most virulent meme" and naturally just another philosophical fantasy.[34] In order to show the idea is absurd Dennett appeals to Wittgenstein's famous example of the beetle-box: "The thing in the black box has no place in the language-game at all; not even as a something; for the box might even be empty. – No, one can "divide through" by the thing in the box; it cancels out, whatever it is."[35]

What is the point? If qualia do exist then they should play some causal role, but as Wittgenstein's suggests, something could not ever be real without being effective. Since qualia are not real, because they have no causal power, then they are just a philosophical illusion. The inversion can never be detected, neither through intersubjective comparison nor through technology. *Ergo*, they are illusions and qualia are too, concludes Dennett.

[31] Ibid. at page 409.
[32] Cf. D. Dennett (1978:149).
[33] D. Dennett (1991:370).
[34] Ibid at page 389.
[35] L. Wittgenstein (1953, §292).

Dennett bases his conclusions on the so-called *Multiple Drafts Model*,[36] which says that the sense-data are incessantly edited by the brain, and consequently the possibility of inversion is excluded because of the uninterrupted editing-process. You cannot be certain about your qualia inversion because they are being edited constantly, says Dennett.

The inversion could make sense in the Cartesian Theater. Given that in Dennett's model there is no central processor or self, inversion does not exist, because there is nobody to detect it. Then the thought experiment does not make sense, because "there is no way to isolate the properties presented in consciousness from the brain's multiple reactions to its discrimination."[37]

Finally Dennett analyses the adaptation hypothesis. Normally people say that after the changing of the lens, the subject will adapt to the new situation. So, the color inversion is adapted or reinverted. Bur how? Could you categorize each quale either in terms of pre-experience or of post-experience, asks Dennett? Supporters of such a hypothesis might hold that there is a compensation or adjustment in the color mechanism and after this, qualia would be normalized. That is quite nonsense, would say Dennett: "many people who like beer will acknowledge that beer is an acquired taste. One gradually trains oneself – or just comes – to enjoy that flavor. What flavor? The flavor of the first sip?"[38]

Dennett puts that there is no way to compare the first sip with the second, the tenth, the fifth, the hundredth, and so on. There is no way to isolate and compare the quale; there is no way to know if your color is inverted now. You are not able to compare an old quale with a new one by means of introspection or self-reference, for example, by pointing to this '☞' quale is new and that one '☞' is old. Nonetheless, the beer drinker might say: "The way the beer tastes to me right now is different". Dennett then replies:

> How could you know that? Would you refer to your internal quale by means of what? By acquaintance or introspection? What do guarantee you this certainty?" The supposed renormalization of the inverted qualia with constant adjusting in dispositions is just "the tenacious myth of the Cartesian Theater (...) if there are no qualia over and

[36] The model of consciousness proposed by Dennett. The *Multiple Draft Model* is an editorial work of incoming information detected in the world. Briefly, coalitions of unconscious, distributed and parallel processors process, edit and interpret many drafts of sensory inputs. The editorial revision is a continuous process occurring "over large fractions of a second, during which time various additions, incorporations, emendations, and overwritings of content can occur, in various orders. (...) At any point in time there are multiple drafts of narrative fragments at various stages of editing in various places in the brain (...) these narratives are under continual revision, there is no single narrative that counts as the canonical version." D. Dennett (1991:112, 135, 136).

[37] Ibid. at page 393.

[38] Ibid. at page 395.

> above the sum total of dispositions to react, the idea of holding the qualia constant while adjusting the dispositions is self-contradictory.[39]

These ideas are not new. Wittgenstein already discussed them and Dennett appeal to him again: "The very fact that we should so much like to say: "'This is the important thing' – while we point privately to the sensation – is enough to show how much we are inclined to say something which gives no information."[40] The conclusion is that these problems arise from the adoption of Cartesian materialism. The *qualophile* has no argument, but just the intuition pump and intuition pumps do not count for, concludes Dennett.

Dennett is indefatigable; now he advances against Jackson by saying that his argument is very bad and "encourages us to misunderstand its premises."[41] In order to show that the argument is non-sequitur Dennett uses a variation; instead of Mary seeing a ripe tomato, she sees a bright blue banana. But, as Mary knows all the physical information about neurophysiology, she detects the trick immediately and retorts, "Hey, you tried to trick me! Bananas are yellow, but this one is blue!" The moral is clear: there is no new fact to know because Mary could detect the trick, even if it was a green banana, blue tomato, etc. Since she knows all about neurophysiology, she could detect the difference. Therefore there are no new things called *qualia*.[42]

According to Dennett, the argument proves nothing (in contrast to Paul Churchland, who says the argument proves a lot). The main premise sounds very attractive (that Mary learns a new fact) and Dennett turns his efforts towards undermining it. Dennett *disqualifies* the underlying intuition in the argument by saying that: "My point is not that my way of telling the rest of the story proves that Mary doesn't learn anything, but that the usual way to imagining the story does not prove that she does. It doesn't prove anything..."[43]

After all, Mary or whoever it it who sees a blue banana, will detect anyway the difference immediately, and this does not pose threaten to physicalism. The point at stake is the main premise: "Mary knows all about neurophysiology of colors." If she knows in fact all about neurophysiology of colors, then she could imagine or figure out in advance what is red and what is not red.[44]

Against the conclusion that qualia are epiphenomenal, Dennett contends that epiphenomenalism "is the last remaining safe haven for Qualia."[45] Epiphenomenalism is pure confusion, because there are two meanings of the term. The word appears firstly in the *Oxford English Dictionary* in 1709. The context of use was

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[39]Ibid. at page 398.
[40]L. Wittgenstein (1953: i298, *apud* D. Dennett 1991:396).
[41]D. Dennett (1991:396).
[42]Cf. Ibid. at pages 399-400.
[43]Ibid. at page 400.
[44]Ibid.
[45]Ibid.

pathology and meant "a secondary appearance or symptom." The evolutionary biologist Thomas Huxley had extended the meaning in order to use it in psychology; "epiphenomenon" is a nonfunctional property or by-product.[46] As Dennett explains, Huxley uses the term in his discussion of evolution of consciousness; epiphenomenal properties could not be explained by natural selection. They are mere by-products with a lot of effects in the world.[47]

Another meaning is the standard philosophical conception. 'Epiphenomenon' means an effect that has no effect in the physical world. In other words, they have no causal power. That is the classical definition proposed by C. D. Broad.[48] According to Dennett the meanings are different. The philosophical meaning is stronger and has no utility, for the epiphenomenon has no effect in the world, and so it is irrelevant. After all is said and done, epiphenomena remain as undetectable appearances, some "phantasmagoric entities", since their occurrence is not noticed. So that how can we detect an epiphenomenon and when it occurs?

In Dennett's words, "If qualia are epiphenomenal in the standard sense, their occurrence can't explain the way things happen (in the materiel world) since, by definition, things would happen exactly the same without them. There could not be an empirical reason, then, for believing in epiphenomena."[49]

According to Dennett, if philosophers who consider qualia as epiphenomena had adopted Huxley's sense, then qualia might have some physical effects. But, they do not. The philosophical term is "ridiculous", and after all, "they just aren't functional", states Dennett. In other words, qualia could be generated by-product of the information-processing, and consequently there would be no challenge to functionalism, because they just cannot be detected by means of any physical mechanism.

Nonetheless most of the philosophers do not consider Huxley's sense of the term. They adopt Broad's conception and this gives rise to the confusion on qualia, which, in turn, gives rise to confusions in the discussion of zombies.

Dennett's diagnostic says that the mistake consists in taking our first-person convictions not as data but as the undeniable truth. We cannot deliberate if they are true or false. In this context Mary will not learn anything new and she will not be surprised, because there are no manifest phenomenological facts.

But one might insist yet Mary has to learn. Then Dennett inverts the situation by asking to the defender to shoulder the burden of proof: if Mary must learn something new, he needs to show how. Only intuitions are not enough. Dennett wonders about such a way of reasoning: "I had no idea philosophers still put much faith in the authority of the homegrown intuitions."[50]

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[46]Cf. T. H. Huxley (1968).
[47]Ibid. at page 402.
[48]C. D. Broad (1925:118), states that: "X is epiphenomenal" means "x is an effect but itself has no effects in the physical world."
[49]D. Dennett (1991:403).
[50]Ibid. at apage 108.

Lastly, Dennett advances against the "zombic hunch": "Must we talk about zombies? Apparently we must", says Dennett:[51]

> Zombie is the "more incoherent" idea created by philosophers (...) an irreparably incoherent idea (...) nobody in philosophy thinks that there are actually any zombies, but many philosophers think it is important to consider the (logical) possibility that there could be zombies, and what the implications of this possibility are (...) When philosophers claim that zombies are conceivable, they invariably underestimate the task of conception (or imagination), and end up imagining something that violates their own definition.[52]

Dennett plays straight: Why should we take into account the problem of zombie? It is just begging the question. When philosophers discuss zombies they legitimate this preposterous idea: "if the philosophical concept of zombies is so important, so useful, some philosopher ought to be able to say why in non question-begging terms. I'll be curious to see if anybody can mount such defense, but I don't be holding my breath."[53] Again Dennett throws the burden of proof to the side of the defender of such an idea:

> One must show that there is a difference between conscious beings and zombies, and one must show that one's demonstration of this difference doesn't depend on underestimating in the well-niche standard way powers of zombies (...) the philosophers' concept of zombie, a strangely attractive notion (...) sums up, in one leaden lump, almost everything that I think is wrong with the current thinking about consciousness.[54]

Those who support the zombic idea must show why we should believe in such a bizarre idea. After all, zombies are "ridiculous."[55] The argument against zombies runs as follows: Imagine a zombie, as Chalmers did, but this zombie is more realistic and complex. He can monitor his own internal activities. This kind of process could be considered as reflection. Let us call such *zombie zimbo*. Zimbo is a zombie that "as result of self-monitoring, has internal (but unconscious) high-order informational states that are about its other, lower-order informational states."[56]

[51]Cf. Ibid. at page 13.
[52]D. Dennett (1995:172; 2006: 92).
[53]D. Dennett (1991:326).
[54]Ibid. at pages 322-325.
[55]D. Dennett (1994:240).
[56]D. Dennett (1991:310).

According to Dennett those who believe in the coherence of the zombic idea must accept the possibility of zimbo. These are the rules of the game in thought experiments. Zimbo's behavior is quite as complex as that of a human being. If we did not know that zimbo is a kind of zombie we would not notice that fact. Dennett holds that *nobody* would say that zimbo has a "I" or some Cartesian Theater in his head.

Indeed zimbo is a zombie. But zimbo behaviors as we do; he makes speech acts as we do, he has higher-order thoughts (and for many philosophers that is enough to be conscious). Furthermore, if one wants to test zimbo's capacity of self-monitoring of his internal activities or behavior, one could use the Turing Test in order to distinguish between zombies and zimboes. Dennett states that not only zimboes could pass the Turing test, but any zombie could pass too.

Now imagine a conversation with a zimbo, for example, you might ask zimbo about its qualia. Since he is able to monitor his internal activities, he could answer the questions as we do. Then it would be natural to suggest that zimbo is conscious, because he could account for his internal states with identical speech acts as those that we use; "Zimbos think that they are conscious, they have qualia, they suffer pains, but they are wrong."[57] In Dennett's thought experiment zimboes have the same cognitive architecture as we. They are not as simple as Chalmers' zombies, and "if you deny that zimboes would wonder such wonders, you contradict the definition of zombie."[58]

So, what is at stake? According to Dennett's Multiple Drafts Model, zimboes are creatures like us. In reality *we are zimboes.* Dennett asks; "Are zombies possible? They're not just possible, they're actual. We are zombies. Nobody is conscious – not in the systematically mysterious way that supports such doctrines as epiphenomenalism." But this claim might be misunderstood or used out of the context. In order to protect himself he states "It would be an act of desperate intellectual dishonesty to quote this assertion out of the context."[59]

In sumary, according to Dennett we are zombies, but not as Chalmers and the standard model of zombies conceive. There is no Cartesian Theater, no "I", no homunculi, no central processor, no higher-order thoughts, but a set of unconscious editorial processes happening in the brain, which gives rise consciousness.

Dennett's criticisms consider no worries with the fact we are just zombies controlled by different unconscious mechanisms in the brain. In fact all these unconscious processes and events are the biological basis of consciousness. Furthermore, Dennett argues that philosophers' qualia do not exist, they are only an illusion. The zimbo idea is only an illustrative example to support Dennet's idea;

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[57] D. Dennett (1998:173).
[58] Ibid. at page 174.
[59] D. Dennett (1991:406).

> (...) this was a strategic move on my past, I hasten to add. Its point was to make a distinction within the imaginary debate of zombies that would have to be granted by believers in zombies, and that could?? all the work they imputed to consciousness, thereby showing either that their concept was subtly self-contradictory, since zombies – zimboes – were conscious after all.[60]

The conclusion from Dennett's critiques is that the idea of zombie is just a preposterous and ignoble relic that will not survive. It will be just a relic of an outworn creed.[61]

3.5. The Hornswoggle Problem: Patricia Churchland's Points

In comparison with several "feeble" attempts to save appearances, Patricia Churchland's criticisms are precise. She draws attention to the very plausibility of the thought experiments. Few people perceived so cleverly the misunderstandings concerning the discussion, and few went directly to the central question as she does: "What is the plausibility of the thought experiments? Are they really well-formed? Are they really compatible with actual cognitive neuroscience? Are the concepts of 'qualia', 'physical information' and 'knowledge' really adequate in those contexts? Is it obvious that physical knowledge could be acquired independently of physical interaction (without direct experience with physical events)?"

Patricia Churchland's inquirings *hit the raw nerves*: What is in fact the positive point from the "Hard Problem"? Followers of Nagel such as F. Jackson, C. McGinn, J. Searle and D. Chalmers, have extended Nagel's basic idea, namely 'Consciousness' is something mysterious, unapproachable by cognitive neuroscience.

In fact, many scientists and some philosophers recognize that the problem of consciousness is not easy. But it not as "hard" as Chalmers puts it. Churchland goes forwards and says that 'Consciousness' is not an extra or metaphysical entity that will not be explained by Science or Philosophy. There are not two problems of consciousness, one easy and other hard.

The so-called 'easy problems' (the problem of short-term and long-term memory, autobiographical memory, the nature of representation, the nature of sensory-motor integration, how information is integrated into neurons, etc.), are not considered as "easy" by neuroscientists. From where did Chalmers take these assumptions?, asks Churchland. Cognitive neuroscientists investigate these processes and they do not have a complete story to tell us.[62] In few years neuroscience has been made exceptional advances – "but what about philosophy?", asks Churchland.

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[60] D. Dennett (1998:172-175).

[61] D. Dennett (1991:314).

[62] Cf. Wolf Singer (2000), "Phenomenal Awareness and Consciousness from a Neurobiological Perspective". In T. Metzinger (ed.).

According to Patricia Churchland the mistake is in thinking that after we have explained the 'easy problems' and understood the neural mechanisms for consciousness, 'Consciousness' should remain as a mysterious thing which remains unintelligible. After all, consciousness is a biological phenomenon based on neural mechanisms in the brain. How could we understand biological phenomena without understanding consciousness? Supposing that the neuroscience had explained all neurocognitive processes, does it make sense to suppose that we still cannot explain consciousness? Why? Asks Churchland.

She calls this type of argument the 'left-out hypothesis',[63] i.e., the statement that consciousness will be mysterious after the full explanation of cognitive processes has been given. This is just question-begging. What guides the left-out hypothesis is the zombie thought experiment; "(...) this argument [is] a demonstration of the feebleness of thought experiments. Saying something is possible does not thereby guarantee it is a possibility, so how do we know the anaqualiac idea is really possible? To insist that it must be is simply to beg the question at issue."[64] The problem is much harder: how real neural networks give rise to consciousness. That is the point. There is no mystery, but only a lack of adequate neuroscientific knowledge, states the author.

Philosophers' objections based on thought experiments aims to prove that any neurobiological theory of consciousness will always leave something out, the "what it is likeness." In such terms, consciousness remains beyond the reach of scientific understanding. She makes use of an analogy to clarify this issue: "if a student really understands the nature of pregnancy by learning all there is to know about the causal nature of pregnancy, no one would expect the student to become pregnant thereby."[65]

The analogy calls into question Jackson's argument, which has various weaknesses, but crucial is the fact that Mary knows everything about the neurophysiology of color vision. For instance, that to experience seeing colors needs certain neural patterns of activity in the brain acquired precisely by experience with colors. Since the argument says that Mary does not have the suitable neural wiring, then Mary will not have relevant neural activity in the visual cortex, because she lacks exactly those neural wirings which are necessary. Mere propositional knowledge is not able to activate the V4 area in the brain and make Mary to see the redness of a tomato.

Patricia Churchland also doubts whether the inverted spectrum argument is sound. She raises two questions: "What are the empirical evidences for? And "is the argument compelling?"[66] Her answers are direct: "there is no evidences", for the thought experiment of inverted qualia is built on philosophizers' intuitions, not

[63]P. S. Churchland (1997:38). In J. Shear (ed.).
[64]Ibid. at page 39.
[65]P. S. Churchland (2005:289).
[66]P. S. Churchland (2002a:180-181).

on established empirical evidences, although the targets are in fact some empirical findings. In order to undermine the intuition, she shows how to collapse the key premise (that our brain is identical, but qualia are inverted). She considers current neuroscientific data that show that differences in conscious experience do in fact involve differences in brain activity:

> For example, we know that if you decrease the activity in the neurons projecting from a decayed tooth to the brainstem, the pain disappears. If nothing is done, the pain persists. Direct stimulation of the hand area of the somatosensory cortex during surgery produces changes in sensations in the hand. We entirely lack any examples where we know the brain remains exactly the same but the conscious experience changes. If there is a causal relationship between neuronal activity and conscious experience, as there certainly seems to be, then the falsity of the key premise is exactly what one would predict.[67]

The thought experiment presents no empirical evidence in its favor, but only philosophers' intuition. It makes sense only if we had adopted Cartesian dualism, by recognizing qualia as non-physical properties. But dualism has nothing in its favour; in fact it is highly improbable. The final diagnostic is that the argument is circular, for "if you defend the key premise by appeal to the very conclusion your argument is supposed to establish, the argument is utterly worthless – it simply runs in a circle."[68] She summarizes her criticisms as follows:

> "It is conceivable." *So what?* "Dualism is true." *Dualism is improbable.* "The conclusion is true, so the premise must be true." *Circular arguments are worthless.* "By definition, qualia are independent of brain states." *Circular arguments are worthless.*[69]
>
> The inverted-spectrum argument gets into trouble not because it envisages perceptual differences between subjects that are difficult to detect. The argument gets into trouble because it wants to crank out a very strong conclusion about the *nature of things* from essentially no facts; i.e., it wants to establish an *a priori* truth. It needs to persuade us that qualitative differences in experience are *undetectable*; not just undetectable given only behavioral data, but undetectable no matter what facts-behavioral, anatomical, physiological-are available.[70]

[67] P. S. Churchland (2006a:181).
[68] P. S. Churchland (2002a:182).
[69] Ibid.
[70] Ibid.

Lastly she procedes against the zombic objection.[71] According to Churchland "many things are logically possible but not empirically possible, such as a 2-ton mouse or a spider that can play the flute."[72] Such conceivability arguments try to convey a sound conclusion about how things really are, based only on conceivability or imagination. I quote Churchland's response in full:

> *Nothing* interesting follows, however, from the fact that some particular human is, or is not, able to imagine something. That something *seems* possible does not thereby guarantee it is a genuine possibility in any interesting sense, so why should we think that the zombie idea is genuinely possible? *To insist on its possibility on grounds that the premises are grammatical is to confuse a real possibility with mere grammaticality.*[73]

In other words, Churchland is saying that the logical possibility of zombies has nothing to do with the actual empirical work being done in neuroscience, because actually *no one believes* that consciousness and qualia are nonphysical things, separated from brain activities. No one that really investigates consciousness as a biological natural phenomenon believes that zombies are possible, or that it is a sound objection to neuroscience. Furthermore:

> What neurophilosophy is really interested in is the actual empirical world and how it works. The reply depends on the pivotal claim about the standards for an explanation, namely, that *a proper explanation must foreclose logical possibilities*. Assuming that this is the pivotal claim here, we need to recognize how absurdly strong a claim it is. Not only does it rule out explaining consciousness in terms of brain function, but it also rules out explaining consciousness in terms of *soul function* or *spooky-stuff function* or *quantum gravity* or *anything else* you might think of.[74]

In other words, philosophers try to refute empirical facts with mere metaphysical logical possibilities. Philosophers want to transform metaphysical possibilities into reality; "one does find something unconvincing in the idea that the conveniently

[71]That runs as follows: "Everything that is conceivable is logically possible. Zombies are conceivable, therefore they are logically possible, and lack qualia. Therefore neuroscience is unable to explain qualia, since they are nonphysical properties. Therefore, consciousness is separated from brain activity."
[72]P. S. Churchland (2002a:177).
[73]Ibid.
[74]Ibid.

elastic and philosophically concocted notion of logical possibility should dictate to neurobiology what it can and cannot discover – ever."[75]

But logical possibilities are, as the same name reveals, just mere possibilities. *Politely speaking*, it is just begging the question. In order to show that the idea is absurd she follows the rules of the game; she imagines two thought experiments to show they are feeble. Let us imagine a planet habited by 'deadbies':

> Deadbies are things composed of cells with membranes, nuclei with DNA, the usual organelles, and so forth. Deadbies reproduce, digest, respire, metabolize, manufacture proteins, grow, and so forth, just as organisms on Earth do. Unlike us, however, deadbies are not really alive. This is a logical possibility. So life is explanatorily independent of biology; (2) imagine a planet where the velocity of molecules in a gas increases, but lo and behold, its temperature does not. Does this tell us that temperature is explanatorily independent of mean molecular kinetic energy? Certainly not. What does this tell us about the actual relation between mean molecule kinetic energy and temperature in a gas? Not a single thing.[76]

The point at stake is: why should we suppose that after science has explained a phenomenon, there still exists something mysterious left out of the explanation? What is the positive point in saying that Science is not able to explain some phenomenon? What else would be able to explain? *Philosophy*? What we can pick up from the thought experiments, asks Churchland. At the bottom, such arguments are based on a fallacy, the *argumentum ad ignorantiam*. We really do not understand much about a phenomenon P (science is largely ignorant about the nature of P). Therefore, we do know that:

(1): P can never be explained, or:
(2): Nothing science could ever discover would deepen our understanding of P, or:
(3): P can never be explained in terms of properties of kinds S.[77]

Churchland plays straight: "from the fact that we do not know something, nothing very interesting follows (...) Perhaps we like to put our ignorance in a positive light, supposing that but for the Profundity of the phenomenon, we would have knowledge."[78] In sum, we cannot conclude from our ignorance about phenomenon P that it is something special, extra, metaphysical, unimaginable, and alien. Perhaps

[75] Ibid. at page 178.
[76] Ibid.
[77] Cf. P. S. Churchland (1997:41).
[78] Ibid.

the problem concerns our conceptual and technological limitations that in the future could be resolved. On this issue, a last remark is useful:

> *The mysteriousness of the problem is not a fact about the problem, it is not a metaphysical feature of the universe – it is an epistemological fact about us. It is about where we are in current science, it is about what we can and cannot understand* (my emphasis) (...) It is not a property of the problem itself.[79]

Finally, Churchland observes that: "we cannot now explain" does not mean "we can never understand". I am fully in agreement with her in those terms. The fact that we cannot still give a naturalistic explanation about qualia and consciousness does not imply we could never explain the phenomena naturalistically. Just by stating that the problem is hard or mysterious does not help:

> The problem does not say: Hey, I am hard" (...) [thought experiments] illustrate the fallacy in arguments from ignorance. From the vantage point of ignorance, it is often very difficult to tell which problem will turn out to be more tractable than some other, and whether we have even conceptualized the problem in the best way.[80]

[79] Ibid. at page 42.
[80] P. S. Churchland (2002:179).

CHAPTER 4

Critical Assessments of the Discussion

The core idea of the Standard Conception is that qualia are the ways things look, special non-physical features coming about in conscious experiences, or something expressible by means of the clause 'what it is like', to experience something from the first-person perspective. So that qualia seem to be mysterious entities. To be conscious means to have qualia in an odd way.

Nagel and Jackson's arguments comprise the core idea. The arguments are 22 and 14 years old respectively, and they continue to impress the professional and the neophyte in philosophy. Both introduced the crucial objections to PFP. The bibliography about the theme is increasing exponentially. Most of the texts try to save the PFP. Nevertheless they are misconceived and misguided. Many authors commit the mistake of accepting the premises of the arguments, and few examine them seriously. It is rare to find a reasonable analysis of the real consequences from the premises.

What does it mean to make use of the phrase "what is it like"? In addition, what is the real consequence behind Jackson's central premise (Mary has complete knowledge about the world)? In this chapter I try to show where they go wrong. I prefer to take the premises seriously, by revealing the real *sequitur* conclusions. But first, let me introduce Jackson's last words about the knowledge argument.

4.1. Jackson's Rebuttals to the Objections

Over the years Jackson has received countless replies. As far as I know, he rebuts only Churchland, Lewis, Nemirow and Horgan, since they posed the strongest critiques. Against Paul Churchland, Jackson says that the way Churchland replaces the argument is not accurate; it is not the knowledge argument, given that he had missed the first premise. What matters is not the kind or the type of knowledge Mary has, but what she really knows; "What she knows beforehand is *ex hypothesi* everything physical there is to know, but is it everything there is to know?"[1]

In regard to Mary's ability to imagine something red before her release, Jackson says that "powers of imagination are not to the point."[2] Although Mary had all

[1] F. Jackson (1986:393).
[2] Ibid. at page 392.

knowledge about neurophysiology, she could never imagine what it is like to sense red, because she would not know. On the other hand, if physicalism were truly a complete theory of the physical world, then Mary should know everything about the world, and "no great power of imagination would be called for."

It is evident that Jackson's epistemology does not allow the imagination argument, for if Mary *really* knows everything about physical facts, then she need not to imagine "what it is like to experience red", because *ex hypothesi*, she knew that *in advance*. What it is at issue is the completeness of physicalism whether it is true or not; if it is true, then Mary must know, regardless of powers of imagination. Imagination, retorts Jackson, "is a faculty that those who lack knowledge need to fall back on."[3]

Apart from that, Jackson replies to the intensional argument, which is not the point at issue; "the argument does not rest on assuming falsely that, if S knows that a is F and if $a = b$, then S knows that b is F. It is concerned with the nature of Mary's total body of knowledge before her release: is it complete, or do some facts escape it?"[4] In Jackson's terms, she certainly lacks some physical information which seems to be non-physical.

According to Jackson, the core of the argument is Mary's lacking of knowledge about the experiences of others, not about her own experiences. Before her release she could never know facts about her experience of red, for there were no such facts to know, concludes the author.

Therefore, the problem for physicalism, says Jackson, is Mary's evidence of her incompleteness of knowledge, after the experience of a red tomato. After this experience she realizes that she never knows anything about the mental life of others, because something was left out, namely, "what it is like to sense red". Nevertheless the argument establishes that Mary knew *de facto* all physical facts about the people's minds; "what she did not know until her release is not a physical fact about their experience. But it is a fact about them. That is the trouble for physicalism."[5]

In spite of Churchland's criticisms, Jackson maintains the distinction between "knowledge by description" and "knowledge by acquaintance". However in Mary's case only the former matters. Churchland argues that Mary lacks "knowledge" by acquaintance", and this is more important than "knowledge by description". By contrast Jackson's physicalism is narrow, and does not allow "knowledge by acquaintance", but only "knowledge by description."[6] Jackson simply states that types of knowledge are not the point at stake. Fundamental is what Mary knows (knowledge by description), not kinds of knowledge.

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[3]Ibid.
[4]Ibid.
[5]Ibid. at page 393.
[6]Owen Flanagan calls Jackson's physicalism *linguistic physicalism*, that is "the thesis that everything physical can be expressed or captured in the languages of the basic sciences: "completed physics, chemistry, and neurophysiology" (Flanagan, 1992:98). In other words, no direct experience with the world is necessary. Sufficient is mastering scientific sentences about the physical world.

Against Lewis and Nemirow, Jackson promptly agrees that after her release, Mary certainly will acquire new abilities of various kinds.[7] But the author asks if that is all she will acquire. For it is hard to believe that that is all she will acquire.[8] Jackson keeps insisting on her learning not only of new abilities as well something extra, what it is like, and that is knowledge that, not knowledge how.

Finally, replying to the "Fregean modes of knowing" Jackson adds that it seems that Mary does learn more than something about language or a new mode to refer to the same fact. Thus Mary would not say, "Oh, now I know a new way of saying this fact". On the contrary, she will learn something much more substantial. Before her release she already knew a great deal about how the different ways to refer to color terms like 'red' are used.[9] Therefore Mary learns *how* to use the special 'what it is likeness' clause.

The point in question is, "Mary already knew all there was to know about the circumstances in which the various color words are used by competent English speakers."[10] To conclude Jackson reaffirms that if Mary's knowledge is defective, then physicalism is false, and if qualia are properties of certain mental states, and these properties are outside of the physicalist picture of the world, then these qualia must be epiphenomenal, or at least mysteriousness.[11]

As time goes by the discussion runs on endlessly. Paul Churchland replies to Jackson's rebuttal[12] by insisting that Jackson equivocates the "knowing about", and this equivocation invalidates the argument. Churchland contends that kinds of knowledge (knowledge by description or knowledge by acquaintance) are independent of each other, and so it is possible to have one without the other. Churchland presents an example of visual experience based on cognitive science. Processing visual information does not presuppose propositional or discursive knowledge. To know consists firstly in having suitable cognitive abilities.

For example, any creature without linguistic capacity is able to represent red, because it discriminates and recognizes many patterns of colors. In Mary's case she lacks this capacity. She has only a space for black and white or shades of gray patterns. Following the ability hypothesis, Churchland holds that what Mary gains is not knowledge of new facts or propositions – assertions that undermine physicalism – but *a new recognitional ability* that involves color sensations.

Churchland's ways of knowing do not consist in discursive or propositional capacities, but in *neurocomputational* ones. His epistemology does not consider only linguistic capacity, but the neurocognitive abilities, which is central to represent color. Moreover he adds that qualia are not metaphysical-subjective properties distinct from the objective physical properties. There is no such division in the

[7] Cf. F. Jackson (1986:394).
[8] D. Braddon-Mitchell & F. Jackson (1996:131).
[9] Ibid. at page 129.
[10] Ibid. at page 130.
[11] Ibid. at page 134.
[12] P. Churchland (1989:68).

world; "What makes an account a "first-person account" is not the content of that account, but the fact that one has learned to use it as the vehicle of spontaneous conceptualization in introspection and self-description."[13]

4.2. Jackson's Turnabout

Recently something unexpected happened; Jackson changed his mind; *physicalism* must be right after all.[14] Nowadays he does not believe that Mary will learn something new, and that qualia are epiphenomenal. What does this radical change mean for the discussion about qualia? I see it as a signal for the implausibility of the argument and therefore an ultimate reason for discarding it. Not even Mary's father endorses his own argument, so why should one concentrate on it still? Must we continue to reply to it? Some think so, and the discussion is still ongoing...

Now Jackson believes that "knowing what it is like is knowing about redness or redness* (phenomenal redness). He adopts Tye's representational theory (phenomenal states are representational states). For Jackson, the knowledge argument is an argument for the conclusion that Mary does not know about *redness* or *redness** – that is, about the property we are, according to the picture, acquainted with when we sense red. Jacksons's last words about the argument are:

> When Mary leaves the room, she acquires knowledge but entirely through knowing about the very same physical things, facts, events and so on under different guises or under different categorizations. She gets new ways of categorizing happenings around her and thereby acquires new knowledge, but it is, all the same, knowledge of the purely physical and so no threat to physicalism.[15]

4.3. What is It Like to be Thomas Nagel?

Nagel starts his argument from the plain allegation that bats have experience, given that bats are mammalian as we are. *Prima facie*, no one will deny it. But the problem begins when Nagel says that "there is something it is like to be a bat." Of course "there is something it is like to be a bat", a *cow*, a *chimp*, a *virus*, a *whale*, a *pregnant*, a *disabled* person, a *German soldier* in the Second World War,

[13]Ibid. at page 75.
[14]See P. Ludlow, Y. Nagasawa, et al. (2004), chapters 18, 19, 20.
[15]F. Jackson (2003:8-9).

a *soldier of the Red Army*, *blind*, *deaf*, *Wolfgang Amadeus Mozart*, *George Walker Bush*, ..., and even *there something it is like to be Thomas Nagel.*[16]

The controversy here is the following: *Are there satisfactory answers to these kinds of questions?* Nagel holds that bats have a point of view, and to have a point of view means *being in some privileged place*, namely the first-person subjective perspective. The conclusion in Nagel's paper is that we cannot know the bat's point of view, because bats are organisms totally distinct from us. Without a doubt! No one would deny it. But by the same token, "we cannot know what it is like to be": a soldier in the Second World War, a chimp, bacteria, George W. Bush, or even *Thomas Nagel*. This is a kind of question of which we know beforehand that there is no answer. In a nutshell, *there is no new information from this sentence*.

If one is able to explain "what it is like to be (___*placeholder*)", then please show the arguments. One might claim that in humans' case would seem easier: they could describe better "what it is like to be *themselves*." For example, to be a soldier could mean wearing a military uniform, having a gun, being in the front, being shot, being captured, etc.

To be George W. Bush could mean living in the White House, being the son of George Bush, Senior, being the forty-third and ex-President of the United States, being the predecessor of Barack Obama, being insulted, being the most unpopular president of USA, the one who declared war to Iraq and Afghanistan, etc. And *being Thomas Nagel*? *Being Nagel* could mean being the philosopher who wrote "What is it like to be a Bat", being Professor of Philosophy at the New York University, being born in Belgrade, Yugoslavia, etc.

The point at stake is: for the placeholder (what it is like to be __) there are countless possibilities that one could insert. My question is simply: Can *in fact* all descriptions by using the clause "what it is like" reveal the subjective perspective of a person or animal? In Nagel's terms we cannot, for every subjective perspective is restricted to the subject. Nagel's argument has the following form "What it is like for Y to be X", where Y is an organism different from X. But could we in practice compare an organism X with an organism Y? Think about being a bat, can you do it? I do not think so. There is no mean to compare different organisms. We cannot even compare X_1 with X_2, because the comparison is always from *inside*.

Just think about the following comparison: Can the experience of *being a fruit-bat* be compared with the experience of *being vampire-bat*? Can the experience of *being Thomas Nagel* be compared with the experience of *being Daniel Dennett*? In particular can Nagel compare his actual experience with his past experiences? *What is it like to be Nagel in 1974* and *in 2009*? Can one do that?

[16] Douglas Hofstader states that "we can't stop our minds from doing it (...) The image conjured up by the phrase "what is it like to be X"? is so seductive and tempting ... Our minds are so flexible, so willing to accept this notion". He imagines different forms of the term "What is it like to be something". I borrowed this idea from Hofstadter. In D. Hofstadter & D. Dennett (1981: 404-406).

Furthermore, there is a mistake in Nagel's premise in supposing that X can be compared with Y. There is indeed a mistake by supposing that X can be compared with X. Does it make sense to ask "what is it like for a human being to be a human being?" And "what is it like for a bat to be a bat?" *De facto* only human beings can be human beings and only bats can be bats! Now, "what is it like for a human being to be a bat?" is a false question. And "what is it like for a bat to be a bat?" is totally nonsense. Following Wittgenstein's philosophy, such questions should not even be raised. They are pseudo-questions, since there are no criteria for comparing different organisms.

Therefore, there is no other creature a bat might be than a *bat*, and there is no other creature a human being might be than a *human being*. One might say the term "what is it like to be" means a 'projection'. One projects himself into the "skin" of another human. But what about projecting yourself into the bat's skin? Can one project oneself into the "skin" of the bat? Not unless one could metamorphose into a bat,[17] but this is nonsense and should not be considered.

So, what is it the additional information from these questions? A bat is a bat and a human being is a human being, full stop. I follow Hofstadter in arguing: "How can something be something that it isn't?" Therefore it makes no sense to ask "what is it like to be Thomas Nagel, George Bush, Napoleon, a blind person, a soldier, etc", because there is nothing to know from this clause.

The term "what is it like" commonly is used to mean "to know". That is a mistake. I do not infer knowledge when I am before the mirror and say "Oh that is me! Now I know that is me!" Similarly, I do not infer every instant that "I am a human being", and I do not infer that the ground is under my feet. I do not infer over there "Oh! That is what it is like to be me!" After all, it does not make sense to make inference "we know what it is like [for us] to be us" as Nagel claims.

What I am trying to say is that Nagel's point of view is *invisible* (or closed). It is *inaccessible* not because it is metaphysical or mysteriousness, but because the subject *is occupaying such a point*. Nagel's terms suggest that this point of view is localized in some place, but where? Could Nagel point where this point of view is? Such a point is in fact *inaccessible*. Let me explain. The point where you are now cannot be accessed, because you *occupy it*. For example, think (again) in Wittgenstein's discussions about the metaphysical subject: "Where in the world is a metaphysical subject to be found? You will say that this is exactly like the case

[17] As in Franz Kafka's surreal novella *The Metamorphosis*; Kafka opens the book by saying. "One morning, as Gregor Samsa was waking up from anxious dreams, he discovered that in bed he had been changed into a monstrous verminous bug. He lay on his armour-hard back and saw, as he lifted his head up a little, his brown, arched abdomen divided up into rigid bow-like sections. From this height the blanket, just about ready to slide off completely, could hardly stay in place. His numerous legs, pitifully thin in comparison to the rest of his circumference, flickered helplessly before his eyes". But Gregor cannot speak in his insect form. So in Nagel's terms I ask "What is it like to be Gregor, the insect?" This little story reminds me Wittgenstein's claim – somewhere in his *Philosophical Investigations*: "If a lion could speak we would not be able to understand it". We cannot put ourselves into the bat's perspective, because we are not bats. Paraphrasing Wittgenstein; if a bat could speak, we would not be able to understand it.

of the eye and the visual field. But really you do not see the eye. And nothing in the visual field allows you to infer that it is seen by an eye."[18]

In other words, you *cannot see your own first-person perspective* because *you occupy it*. Therefore it is *inaccessible* to you. "Point of view" is *Weltanschauung*. It is inaccessible and untransferable. The first-person perspective is inaccessible to you and to everyone, because you occupy it, and you experience the world from this *hidden* perspective where you stand. I would say that *this body* (what I used to refer to as *my body*) experiences something, and it is unique.

Such an experience is personal and private because it is sensed by *this body*, not by *that body*. Try to take yourself as the object of your experience and maybe you understand what I am saying. Every time you try to catch yourself in the experience, what are you catching is *another you*, not the same. This sounds like Heraclitus' river. Keep this metaphor in mind.

Putting in other words, when you try to see *yourself* as the object of your current experience, the "Self" you try to get is dislocated, because another takes the place, or another object enters in the focus of your consciousness. This is what William James referred to as "the flow of consciousness". Now Heraclitus' river makes sense with James' concept of flow of consciousness: *conscious events flow like a river; they come and go, and you are not able to catch your "self" in the experience, because you are experiencing now.*

Putting differently, *you are the experience*. That is, you occupy the role of the experience, and by this reason you cannot access your "self" at the moment you are experiencing consciously. Consequently the so-called "self" is only an illusion. You cannot access your "self" because you are it! You are placed in it.

But one might ask: what then do I experience? I would say that the contents of the experience are directly sensed by *this* body. The contents come from the sensory systems. There are no *self* or an intermediate point between experience and the body. The body *is* the experience. The contents arise from the several sensory receptors (internal and external). In other words, it is a matter of neurobiology, as I try to show in the chapter 6. The body just has the ability to distinguish between *this* body and *that* body.

This has an evolutionary advantage, since organisms must navigate and act in a changing and unstable world. "Bodies" must protect themselves from external damages, and propagate the genes in the world. In this context, the "first-person perspective" or the "self" is only a useful strategy in order to live in this chaotic world. It is advantageous to have the capacity to distinguish "yourself" from "otherselves", i.e., to distinguish *this* body from *those* bodies outside of *this* body, and also to detect differences in the environment in order to give a better response.

In sum, natural selection endowed some organisms such as *Homo sapiens* with such ability. *You* have access to what comes from the sensory systems. The incom-

[18] L. Wittgenstein, *Tractatus Logico-Philosophicus* (1922:5.633).

ing sensory content supports consciousness, and this is enough. You have access to your qualia, not knowledge. That is automatic and immediate.

Finally, the subjective character that Nagel refers to applies neither to bats or to human beings. Physicalism cannot explain the qualitative aspect of conscious experience ever, as long as it is a naïve and simplistic theory of mind. But "subjective character" is not a clear term. *Subjectivity* cannot be matched to the term "what it is like", because the latter is vague. Subjectivity is a phenomenon linked with qualia, because some qualities are experienced by the subject (*this* body).

The term "what it is like" is vague and elastic, and therefore could be used in an infinite number of contexts. At the end it can mean nothing. No additional information comes from the "what it is like". The term leaves the phenomenon of qualia untouched. On the other hand, 'subjectivity' is a central concept, and needs some clarification.

The *Oxford English Dictionary*[19] says that it comes from 'subjective', pertaining or relating to one who is subject; pertaining to the subject as to that in which attributes inhere; relating to the thinking subject, proceeding from or taking place within the subject; having its source in the mind; belonging to the conscious life.

'Subjective' in turn comes from Aristotle's philosophy, in particular from the use of "ύποκείμενον" (*hypokeimenon* or *subiectum* in Latin), and it has three senses: (1) material out of which things are made, (2) subject of attributes, and (3) subject of predicates. Accordingly, 'subjectivity' refers to the subject's conscious experience. In such terms, the qualia are directly associated with subjectivity and consciousness, not with Nagel's term "what it is likeness". Nagel's clause is vague and does not represent the subjective and qualitative aspect of conscious experience.

But one might insist that "you leave something out". Then I ask in a *Dennettian* way: What? One might reply: the "what it is likeness". I retort: what does this expression really mean? What is the additional information? Just show me, and I will concede. I can certainly talk about the different properties assigned to, for instance, George W. Bush. But I cannot talk about George W. Bush's contents of thought at all. This is obvious. Here there is no objection to physicalism – and I am not defending physicalism or functionalism. I am just claiming a basic fact: no organism has access to another organism's conscious states or memory systems, and that Nagel's clause is therefore vague.

At the most, I can make suppositions about what Bush has in his mind.[20] Is this an objection to physicalism or an inevitable biological condition? We did not evolve such ability to scan other people's mind. I cannot have access to your system and that is a biological limitation, not an objection to physicalism. Maybe someday scientists of Artificial Intelligence could create a *Mind Reader* or a *Scanning of*

[19] *Oxford English Dictionary (2002).*

[20] The magazine *Time* presents the closest description of what could be happening inside Bush's mind. See http://www.time.com/time/magazine/article/0,9171,995011,00.html.

Mind.[21] So far we do not have such a device.

4.4. Is There Really Something About Mary?

Jackson's thought experiment suggests that knowledge about all physical facts does not imply all knowledge about the world. Physicalism is in consequence false because it leaves qualia out of the explanation. In particular, physicalism fails since qualia are only epiphenomena without "causal power". Now let us take the premises seriously. So far no one has considered the weight of the premises.

The main quarrel concerns about the *plausibility* of the thought experiment. Then let me ask some questions concerning this issue: *Firstly*, is it possible to someone that lived in a black and white room, and who never saw colors before, when is released can recognizes immediately colors? *Secondly*, does Mary really know everything about neuroscience? *Thirdly*, does "to know" consist only in mastering a set of propositions about the world, i.e., is language-dependent? I take Jackson's premises *literatim*, and I show that the second point undermines Jackson's conclusion.

I suppose that Mary is about 40 years of age. She is a PhD in her specialty: neuroscience. I presume too that Mary is about 40 years old when she is released. As runs the argument, Mary was educated since infancy in a black and white room. She has spent all her life in a black and white room. Regardless of several missing points, let's assume that the premises are true. The main premise says that *Mary knows everything about neuroscience*. Consequently Mary *must know* some basic neuroscientific facts, for example, how colors are constructed by the brain. *Inter alia*, she must know that infants born almost blind and very far-sighted. They can see only contrasts, shapes, and notice movements.[22]

Most of newborns' vision is blurred. They learn to see through the experience, for instance, newborns need stimuli in order to develop the ability to see colors. Although the necessary structures are already present at the birth, they do not develop without correct stimulation. By 4 months of age, babies' visual systems have developed the ability to see full colors.

Most importantly, there is a critical period when babies need to be exposed to colored stimuli in order to form the necessary neural structures to recognize colors. If the infant does not receive the appropriate stimulation during this critical period, it may be very difficult, even impossible, to develop that ability later. The

[21]Indeed there are already some tools that make possible the prediction of the content of one's thought based on fMRI images and EEG activities in the cerebral cortex. The name is the tool is *Mind Reading* and it is proposed by John Dylan-Haynes. For furher details see the papers "Predicting the orientation of invisible stimuli from activity in human primary visual cortex"; "Predicting the Stream of Consciousness from Activity in Human Visual Cortex "; "Reading Hidden Intentions in the Human Brain"; "Predicting Individual Perception from Individual Brain Responses: Tracing the Neural Correlates of Consciousness".

[22]Cf. V. Bruce, P. R. Green, et al. (2003), N. Daw (2006), J. E. Dowling (1987) and D. H. Hubel (1988).

critical period for color vision development is defined as the period during which the appropriate properties of the system can be changed by neuroplasticity.[23] If infants are deprived of correct stimulus, their retina and visual brain do not develop, and the necessary connections are not made.[24] Consequently they cannot see color.

Humans have three different types of color-sensitive cones (the photoreceptors in retina), leading to what is known as *trichromatic vision*. Color vision results from the stimulation of these three kinds of cones.[25] Cones convert photons into electrical signals through chemical transduction.[26] Cones begin to develop from the age of two months, and tt this age infants can distinguish between red and white[27] because the cones have low spectral sensitivity.

As I have stated, newborns need external stimuli in order to detect long wavelengths associated with color. In order to see we need light, which consists of a stream of tiny wave-like particles called *photons* travelling in a straight line at the speed of light. Cones detect such photons, which divide into specific wavelengths. We have one cone for red-green wavelength, another for yellow-blue and one for violet. The three different kinds of cones work better at some wavelengths than at others. This differential sensitivity of cones enables us to distinguish colors.[28]

For example, whether we see an object as white or colored depends primarily on which of the three cones types are activated (see figures 4.1 and 4.2), if the red-green cones are stimulated with no stimulation of the blue cone, what we see is a yellow spectrum (monochromatic light at 580 nm). If none of the three kinds of cones are stimulated and the wavelength is long, then the rods are stimulated and you see white. In short, color is the consequence of non-stimulation or unequal stimulation of the three types of cones.

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[23]N. W. Daw (2006:169).
[24]R. Gregory (1997:138).
[25]Rods are responsible for black and white and vision in dim light (vision at low light levels, for example night vision).
[26]See chapter 6 for a detailed description of the process of transduction.
[27]N. W. Daw (2006:40).
[28]We cannot see ultraviolet light, but many bird species possess a type of cone sensitive to ultraviolet light and can detect ultraviolet light. In addtion bees and other insects have the ability to detect ultraviolet light. See D.Purves et al. (2004:248); G. K. H Zupanc (2004 chapter 6); and J. R Krebs. & N. B. Davies (1997).

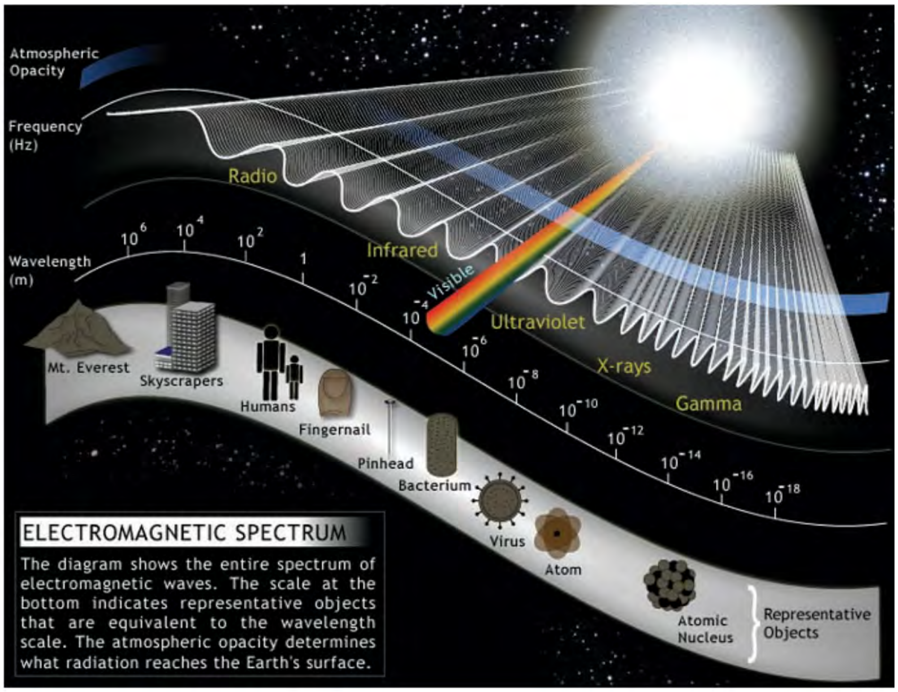

Fig. 4.1 Wavelength is commonly measured in metric units and the wavelength of visible light ranges from approximately 400 nanometers (nm, billionth of a meter) to 700 nm. Human eyes are able to detect only a small part of the spectrum (the visible spectrum). Figure available at http://ds9.ssl.berkeley.edu/LWS_GEMS/2/em.htm.

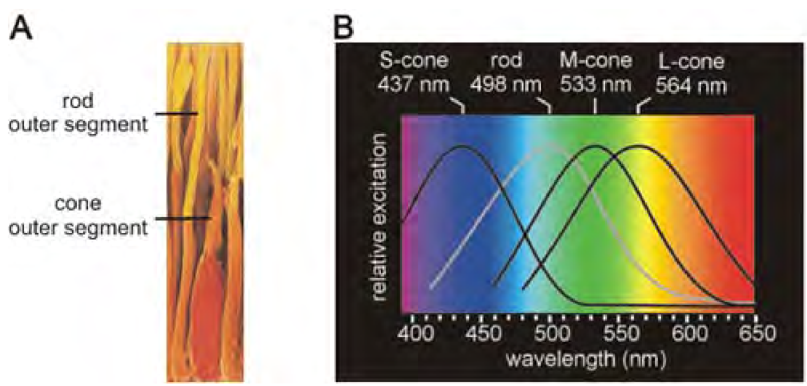

Fig. 4.2 A shows the rods and cones in the primate retina. B represents the peak spectral sensitivities of the three cones types and the rods in the human retina. After J. E. Dowling (1987).

Human eyes can detect only wavelengths between 400 and 700 nanometers (this is known as the *visible spectrum*). Each rod and cone in the retina absorbs some specific wavelength. The so-called primary colors have wavelengths within the visible spectrum: for red it is 645 nm, for green 535 nm, for yellow 590 nm and for blue 452, 7 nm.

Some classical experiments with kittens and chimpanzees[29] show that during the critical period, if the animal is not exposed to the suitable stimuli, they are not able to see colors.[30] For instance, with longs periods of deprivation, animals from birth were left in complete darkness. When the animals were brought out into the light, they turned out to be blind or, at least very defective visually.

The animals deprived of light did not develop the visual cortex correctly. With deprivation of light the neuronal assemblies responsible for processing color information respond to other modalities, for example, to auditory signals.[31] In other words, neurons must learn how to process specific sensory information, and the visual cortex must also develop in order to process visual information.

In the 1960's scientists sewed closed the eyes of both young and of adult chimpanzees. When after weeks or months the eyes were re-opened, the young chimpanzees could not see or they had serious problem in seeing. On the other hand, adults had no problem after the reopening of the eyes.[32] The main point made from that is the degeneration of neural mechanisms responsible for vision; without the correct stimuli the neural pathways from the retina to the visual cortex do not develop. According to specialists:

> Rearing in the dark leads to disruption of the day – night cycle and disturbances in the levels of circulating hormones, particularly melatonin and the adrenal hormones. Morphological effects, such as a reduction in the thickness of the cortex, are found in all parts of the cortex in dark-reared animals.[33]

Therefore, it is not possible to recover after a long period of deprivation of some stimuli. The cerebral cortex is highly complex and interconnected. In particular, the visual cortex is organized in seven layers of processing. If it does not receive

[29]The experiment showed that kittens living in world with only vertical stripes were afterwards blind to horizontal stripes. The explanation was that they lacked horizontal detectors. Since the kittens were reared in a vertical ambient, they did not develop the ability to detect horizontal lines. The appropriate cortical neurons were not developed. As result the neural system was not specialized in the faculty of detecting horizontal lines. See R. Gregory (1997). There are uncountable such experiments with other mammals. But satisfactory answers came from clinical cases. For example, it was reported that children with cataracts since birth cannot recover if an operation is carried out after the critical period. They were blind forever, and children operated before the critical period, had the vision restored (See Gregory and Hubel). The point is, if the child does not have the correct stimulus during the critical period, they can be blind or have profound deficits.

[30]D. H. Hubel (1995:164).

[31]S. Zeki, J. D. Watson, et al. (1991); C. Kayser, C. I. Petkov, et al. (2008); K.-M. Fu, T. A. Johnston, et al.(2003); D., Senkowski, T. R. Schneider, et al. (2008); M. G. Woldorff, C. C. Gallen, et al. (1993); B. G. Shinn-Cunningham (2008).

[32]D. H. Hubel (1995:190-197).

[33]N. W. Daw (2006:104).

the correct input from the retina, it organizes differently, by giving priority to other sensory inputs. As result, the neural pathways from the retina to the visual cortex are not built and sensory information from retina does not reach the visual cortex. The result is a defective vision.

Consequently there is no stimulation and no color experience. The development of color vision involves several developments of specialized neural structures in the brain. The most important structures are the projections from retina to the visual cortex, the optic chiasm, the cortical geniculate nucleus, the retinotopic maps, the several layers of processing in the visual cortex and the reciprocal projections to other brain areas.[34]

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[34] See R. G. Kuehni (2005); R. Gregory (1997), and D. Hubel (1988).

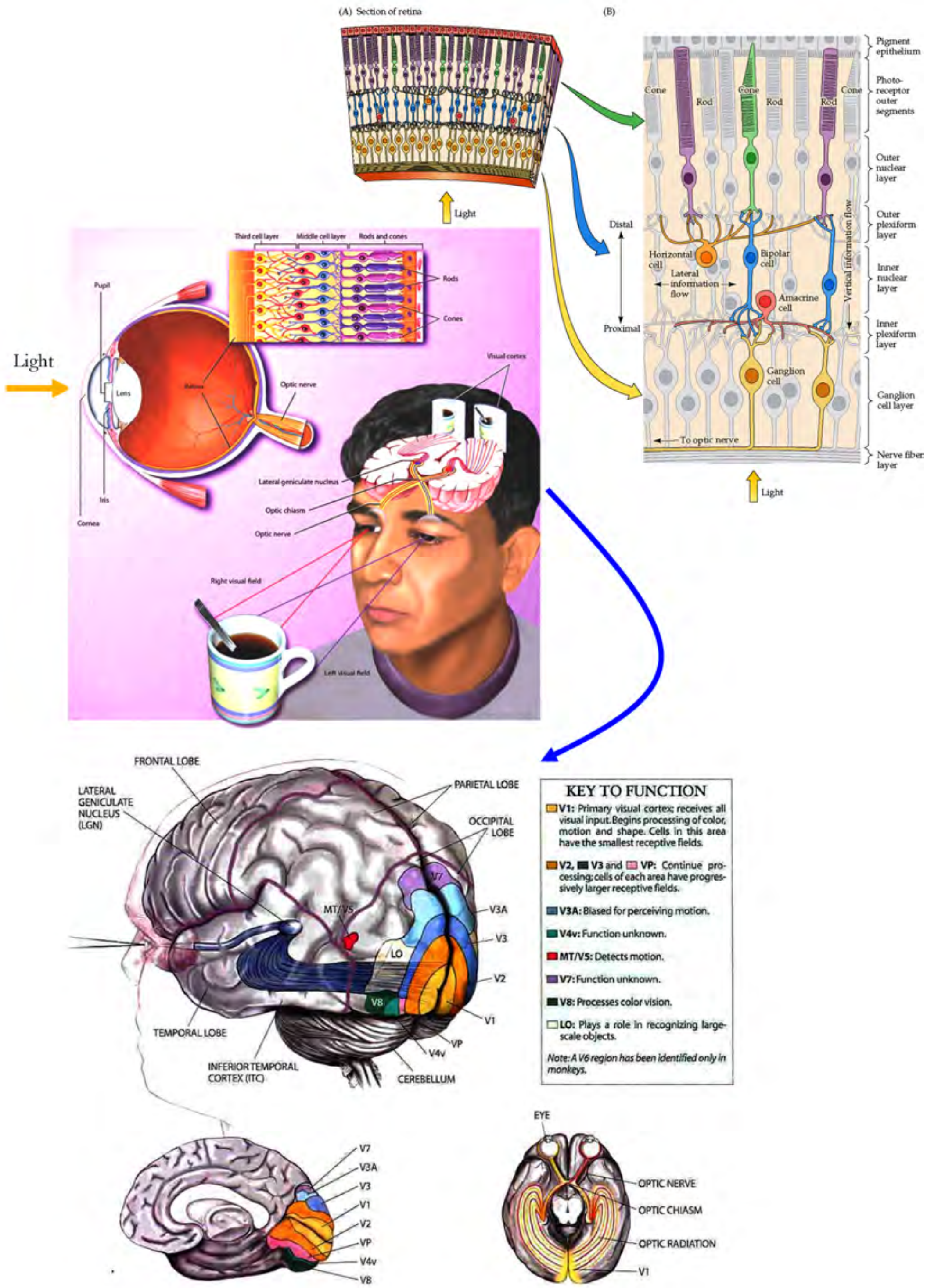
(A) Section of retina
(B)
Light
Pigment epithelium
Photo- receptor outer segments
Outer nuclear layer
Outer plexiform layer
Inner nuclear layer
Inner plexiform layer
Ganglion cell layer
Nerve fiber layer
Cone
Rod
Cone
Rod
Cone
Rod
Distal
Proximal
Horizontal cell
Lateral information flow
Bipolar cell
Amacrine cell
Vertical information flow
Ganglion cell
To optic nerve
Light
Light
Third cell layer
Middle cell layer
Rods and cones
Rods
Cones
Pupil
Lens
Retina
Optic nerve
Iris
Cornea
Visual cortex
Lateral geniculate nucleus
Optic chiasm
Optic nerve
Right visual field
Left visual field
FRONTAL LOBE
LATERAL GENICULATE NUCLEUS (LGN)
PARIETAL LOBE
OCCIPITAL LOBE
V7
MT/V5
V3A
V3
LO
V2
V8
V1
VP
V4v
TEMPORAL LOBE
INFERIOR TEMPORAL CORTEX (ITC)
CEREBELLUM
KEY TO FUNCTION
V1: Primary visual cortex; receives all visual input. Begins processing of color, motion and shape. Cells in this area have the smallest receptive fields.
V2, V3 and VP: Continue processing; cells of each area have progressively larger receptive fields.
V3A: Biased for perceiving motion.
V4v: Function unknown.
MT/V5: Detects motion.
V7: Function unknown.
V8: Processes color vision.
LO: Plays a role in recognizing large-scale objects.
Note: A V6 region has been identified only in monkeys.
V7
V3A
V3
V1
V2
VP
V4v
V8
EYE
OPTIC NERVE
OPTIC CHIASM
OPTIC RADIATION
V1

Fig. 4.3 From cones and rods in the retina up to the visual cortex, and its layers of processing. Each layer is responsible for a specific feature, as forms, colors, localization, etc. (after N. Logothetis, 1999:16; D. Purves 2004:235; SFN 2002.)

Now let us come back to Mary. *If she really knows all about neuroscience*, then *she must know the facts about color vision* just described.[35] Therefore, *if she really knows that*, then *she knows prior* (because she knows all about neuroscience) that she will see *nothing*, but black and white objects.

Mary *must* know that her cones were not correctly stimulated; that the correct neural connections in order to detect wavelength between 400 and 700 nm were not developed; that her visual cortex cannot process inputs associated with color; that the critical period for neuroplasticity and recovery has passed. In sum, that she is not able to see colors due those facts. *Ergo*, she will not learn anything new. At best she will confirm what she already knew.[36]

Again; *she will see no ripe tomato or blue banana.* She will see only black and white or at best gray scale objects. Now I ask: does it make sense the assumption that Mary after 40 years of color deprivation could actually see a red tomato? The point at issue is Mary's neurocognitive capacity. Does she can really recognize a red object? And afterwards to deduce that physicalism is false? Rather the claim that Mary could recognize colors after 40 years of color deprivation is clearly *false*.

Mary as a brilliant neuroscientist knew more than Jackson could suppose. She must know that, because she knows all about Neuroscience. That she knows everything about neuroscience is the central premise in Jackson's argument. Therefore this premise (Mary knows all about neuroscience) undermines the conclusion that she will learn or see a ripe tomato. The argument is self-contradictory since it includes its own refutation.

But one might retort: "she can adapt herself to see colors. She needs time to learn how to see color"; I would say no. She could not. Recovery after the critical period is very difficult to happen. I am talking about empirical evidences concerning visual development, not about metaphysical possibilities. Neuroplasticity[37] in

[35]This is the main premise, and I am following the premise *literatim*.

[36]Mary probably suffers from a deficiency that I will not discuss here. Probably it is acquired color blindness, due to color deprivation. Clearly she suffers from color vision deficiency, which divides into three groups: *monochromasy*, *dichromasy* and *anomalous trichromasy*; "Monochromats are typically totally colour blind and may have one cone pathway in addition to the rod pathway. Dichromats have a cone photopigment missing, therefore, they only have two cone channels. Anomalous trichromats have all three cone photopigments, however, one cone photopigment is anomalous having a shifted peak sensitivity." M. Kalloniatis and C. Luu "Psychophysics of Vision", in *Webvision*, "The Organization of retina and Visual System." http://webvision.med.utah.edu/. This is the most complete site about the theme. It is better than several books, written by specialized researchers.

[37]*Neuroplasticity* or *cortical reorganization* "refers to the capacity of the nervous system to modify its organization. Such changes may occur as a consequence of many different events, including normal development and maturation of the organism, the acquisition of new skills (learning), damage to the nervous system, and sensory deprivation." D. Bavelier "Developmental Plasticity", in: V. S. Ramachandran. (2002). For more technical details see C. A. Nelson & M. Luciana (2001).

adults is not dynamic as in children, and it cannot be compared, although it could occur elsewhere.[38] Synapses formation in children is 50% more frequent than in adult human brains (see figure 4.4). However there are little data about this topic. But the fact is that after a certain age the number of neurons decreases, and the adult brain does not work as a child's brain does. A common example is child's ability to learn language and adults' one. Children are incomparaably more skilled in language acquisition than adults.

Of course, there are some exceptional cases of color experience without stimulation by light (with the eyes closed) that Mary could take into account. For instance, subjects can experience color under the influence of migraine headaches, under the influence of certain drugs, by direct electrical stimulation of certain cells in the brain (with TMS for example), by pressing against the eyeballs or hitting the temples moderately hard, and by dreaming. But in all cases it necessitates previous experience with colors. But this is not Mary's case, because she is colorblind.

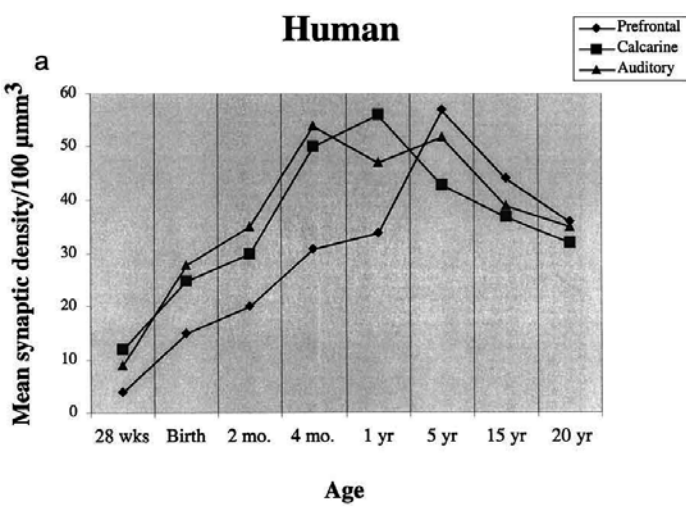

Fig. 4.4 Mean synaptic density in synapses/100 mm3 in visual, auditory, and prefrontal cortices at various ages during human development. The graphic shows clearly the decreasing of synapses with the age. V. S. Ramachandran (2002:563).

With those facts in mind, let us consider the cogency of the argument: does it make sense to believe that Mary after 40 years of color deprivation could see a red tomato? I am talking about Mary's neurocognitive capacity to recognize colors; can she really recognize a red object after the release at once? And afterwards to deduce readily that physicalism is false? What is false, physicalism or the claim

[38]In fact, there are some cases of recovery after damage in the visual system. But before the damage, the subjects were completely normal. In other words, they have already experienced several stimuli under normal conditions. In Mary's case, she had never experienced color. How could she recover what she never has experienced under normal conditions before?

that Mary could recognize colors? And what about Dennett's blue banana example, does it make sense? *Emphatically* no; it does not make any sense.

What it is incomplete and self-contradictory is Jackson's thought experiment. I call this objection the *Inability Hypothesis*. That is the typical mistake that philosophers commit when they do not take scientific knowledge seriously into account. Simple facts about eye and brain development undermine Jackson's premises.

I am not defending physicalism – that I consider an absurd thesis. On the contrary, I am just taking Jackson's premises seriously. If Mary *knows* truly all the facts about neurophysiology, then she *must* know all the facts about eye development. Thereby, *if she knows that*, then she *knows in advance* that will see *nothing but black and white objects. She will not learn anything new*, and she *already knew* that. At best she will confirm her early knowledge.

Finally some observations about "to know"; does "to know" consist only in mastering a set of propositions (language-dependent). I do concede that in part knowledge acquisition in humans requires linguistic abilities. No quarrel here. But my point is: *knowledge acquisition* is above all a *neurocognitive process* based on *neurobiological sensory systems*. Before mastering a set of propositions and rules, an organism needs *normal neurocognitive architecture* in order to survive in an unstable and changing world.

Such a neurocognitive architecture develops through interaction between organism and environment. Organisms acquire knowledge about the world from the several sensory modalities. They need to know *how* the *actual* state of affairs in the vicinities is in order to give a better response. And they do not need any linguistic ability to do that. Some primates can detect ripeness of fruits without problems.[39] Cognition is an evolutionary strategy, not exclusively language-dependent.

Jackson's epistemology says that "to know" consists only in learning sentences about the world. He is not fully wrong. But, again, before linguistic abilities, one needs normal cognitive systems in order to acquire knowledge about the world. I am arguing here for an evolutionary epistemology. That is, organisms evolved highly specialized cognitive abilities to survive in an unstable and hostile world. Detecting color is not a special ability as Jackson considers, but an evolutionary adaptation.

I am following here Quine's philosophy, who thought that knowledge is based on sensory stimulation.[40] Information about the world is acquired from sensory stimulation, not from mastering propositions about the world. Organisms detect patterns and forms spreading over the world by means of the sensory modalities.[41]

In conclusion, Jackson's thought-experiment is defective and self-contradictory, and does not prove anything. As Jackson supposes, *Mary knows all about neuro-*

[39]See P. W. Lucas et. al. (2003).

[40]Cf W. V. Quine (1969:82-83) and chapter 5.

[41]This is the theme of chapters 5 and 6 that deal with a Quinean naturalized evolutionary epistemology.

physiology of human visual system, therefore she must know previously that she will not see any color. She did not develop the neural connections necessary to recognize wavelengths between 400 and 700 nm. That is a constraint about her cognitive capacity, and since she is "a brilliant neuroscientist", she knows *previously* that is not able to see color. Therefore, Mary *knows more than Jackson could suppose.*

4.5. Zombies Dezombified

Chalmers came to the conclusion that qualia are non-physical entities instantiated by brains by means of the zombie argument. Zombies are conceivable, therefore they are possible. So runs the argument. If they are *possibly conceivable*, then they do not have qualia, since qualia do not supervene on the physical and functional subvenient basis.

As in the other thought experiments, Chalmers does not take into account what other authors overlooked: *evolutionary neurobiology.* The zombie has no evolutionary history, no memory, and no previous interaction with the world. As a sleight of hand, Chalmers makes *possible conceivability* to become *reality.* Specifically, Chalmers uses a modal argument to refute the PFP and neurobiological models of consciousness. Although his modal argument can refute the PFP, it cannot, however, refute empirical findings about consciousness such as the fact consciousness is a biological condition.

In reality, with such modal arguments one could prove anything, for instance, that werewolves do exist. Let me imagine an argument about the existence of Werewolves in the same way as Chalmers does with zombies: Werewolves are violent creatures, and used to attack humans. Werewolves are conceivable. Everything that is conceivable is possible. If werewolfs are possibly conceivable, then humans are in danger. Therefore do not go out at full moon. The argument is clearly absurd, altough the logical form is right. With such a logical tool one can create infinite examples like this one, but the fact is that they are only metaphysical possibilities, not real scenarios.

From mere possible conceivability one could prove everything one wants, like zombies without qualia or consciousness, since qualia do not supervene on the physical and functional basis. But as a matter of fact, there is not a shred of evidence for the existence of zombies *except* in Chalmers kingdom of fantasy. As Dennett says, no reasonable person today believes in the existence of zombies or Werewolves.

Furthermore the zombie argument does not work in the real world, I mean the *actual* world. Dennett express this fact in straightforward terms: "take the issue out of the philosophical fantasy land into cold reality";[42] that will reveal the weakness of such arguments. I would not choose to reply such an absurd argument,

[42] D. Dennett (2005:17).

but that is my job here. Of course it is not enough to make a replica of biological living system like a cake mixture.

Putting more simply: Having a biological brain is not like preparing a chocolate cake by adding some ingredients and waiting for the emergence of qualia. Brains are product of evolutionary processes and they are highly complex. Brains are dependent on the interaction of bodies with the environment. The fact we have still few data about how brain works[43] does not allow the invention of nonsensical thought experiements about how brains *should* work.

The issue concerns about *biology*, not about *fantastic adventure*. Organisms have an evolutionary history. The PFP is faulty for does not take into account the fact organisms are highly complex dynamic living-systems with several subsystems working in parallel that give rise to biological mechanisms and features such as synapses, digestion, memory, etc.

Consciousness does not emerge from the sheer agregation of building blocks; on the contrary, it is the result of several neurobiological processes occurring in the body, and requires interaction with the environment. Contrary to what Chalmers supposes, it is impossible to reproduce such complex biological systems as easy as he finds. Zombies do not exist, except in trash movies.

In spite of that, the critical problem for Chalmers' dualism is very different: *how could he explain in naturalistic terms the occurrence of the special properties called 'consciousness' and 'qualia'?* As Chalmers puts it, the supervenience thesis is not able to do the job. But actually, what could? Chalmers here faces Descartes' problem: *how to connect non-physical properties with physical ones*? He is not able to explain how *physical brains* generate non-physical entities such as consciousness. What does it mean for something physical to produce non-physical entities?

Chalmers' dualism is clearly indefensible. He is alone in such a quest. Since the publication of his book where he proposed such ideas, he had not yet presented a solution for the question. All current evidence is against him. It is taken for granted – by most – that consciousness is a biological adaptation. Fortunately, no one believes in dualism after all.

In summary, Chalmers misses the point in considering consciousness a special entity, something as fundamental as an atom. This is obviously false. Again, consciousness is a biological condition that appears in biological organisms. It results from millions of years of evolutionary processes. It does not exist *ad aeternum*. There are several neurobiological and neurocognitive processes that support consciousness. Those are the starting point for a scientific investigation of consciousness, not zombies.

Concerning the so-called "easy problem" versus the "hard problem", just ask to some cognitive neuroscientist if the problem of memory, of binding, emotion, of how information is encoded and stored in neurons, of how immunological system

[43]For further details concerning this point see chapter 6.

works, of synaesthesia, and so on are "easy". No scientist considers such problems 'easy problems' as Chalmers claims.

4.6. Reverting the Qualia

The inverted qualia conclusion has the same conclusion as in the other thought experiments that criticizes the PFP. It makes sense only within the context of PFP. I will not restate my criticism. The same criticisms as against Nagel, Jackson and Chalmers serve to criticise the idea of inverted qualia.

After all, Block concludes that qualia are non-physical entities that do not come about in twin systems. Block's fable is not a serious critique of a theory based on evolutionary theory and neurobiology, as is defended here.

Block uses color vision, the preferred example of philosophers, to invent arguments against the PFP. But why only color vision? Why not consider "inverted taste", "inverted sound", "inverted odor", etc.? I do not know, but the fact is that the thought experiments are built in ways only based on philosophers intuition, not on the basis of accepted neuroscientific findings (empirical evidences).

In particular, color inversion and color blindness do exist in reality. They are considered as neurological problems. For instance, between 8% and 10% of men present some deficiency in the red-green cone. This anomaly is rare in women. The explanation lies in the X-chromosome (a recessive gene), that is transmitted from father to the offspring.[44] Besides, about 8 % of males and 0.5% of females suffer from Colour Vision Deficiencies. Why not simply analyze such neurological facts in order to shed some light on the discussion, instead of inventing thought experiments?

Moreover, why not profit from the new tool available in cognitive neuroscience called TMS, *transcranial magnetic stimulation*? TMS is a noninvasive approach to stimulate specific brain areas in order to disrupt local neural processing. The technique consists in passing a coil (or coils) over the head (the scalp) which through which electrical current flows. The electrical current generates a magnetic field, which in turn induces a current in conducting structures such as axons, which can depolarize nerve cells directly or indirectly involved. Depending on stimulation intensity, duration and frequency, this may result in the temporary disruption or stimulation of brain activity.[45] The result are different transient conscious states being influenced by electrical stimulation.

It is has been reported that it can disrupt or change cognitive processes for milliseconds or more depending on the duration of stimulation. For example it has been used in the study of visual perception. Blind subjects that were subject to TMS in the visual cortices reported that they could see phosphenes (flashes of

[44]Purves et. al. (2008:124). The conclusion just stated is consequence of empirical research, not of philosophers thought experiments.
[45]See E. M. Wasserman et al. (2008).

light), and in other experiments normal subjects that received TMS in V1 reported that for milliseconds they could not see red or green. It is supposed that some type of inversion or even disruption of color vision could occur with prolonged application of TMS. TMS is basically used to study the effects of neural stimulation on cognitive processes. Therefore, why not to use the new tools in order o investigate consciousness and qualia instead of inventing thought experiments?

4.7. McGinn Demystified

Differently from Jackson, Chalmers, Block and others, McGinn does not invent a thought experiment. By contrast, his position is odder than the previously mentioned ones: he holds that we cannot explain consciousness since it is a transcendent entity; something *à la* Kantian *noumena*: "Consciousness occurs in objective reality, in a perfectly naturalistic way; we just have no access to its real inner constitution (...) consciousness is (...) [a] knowledge-transcendent constituent of reality."[46] But it seems contradictory, for how a transcendent entity could be explained in naturalistic terms? It cannot, according to McGinn.

The author defends a skeptical position. From the fact that we cannot access the "real inner constitution" McGinn concludes we are cognitively closed to such a reality. There is an uncloseable gap because of the fundamental nature of consciousness. "Consciousness" seems to exist only in *Platonia*, the kingdom of Platonic forms; where the "real forms" exist.[47] Our mundane "animal minds" are not equipped to comprehend the phenomenon of consciousness.

According to McGinn, the problem of consciousness is not insoluble in itself, but because we are limited creatures. Perhaps Plato is right after all, and after death we could see the real form of consciousness in *Platonia*.

Although McGinn recognizes that we are products of evolution; he does not accept the fact that consciousness is as well product of evolution, i.e., a biological adaptation. In his terms, consciousness does not fit into the naturalistic scientific framework. Where then? McGinn's claims are implausible and contradictory, since how could "objective mysterious consciousness" occur in this natural world? What does it mean to be "cognitively closed" to some facts?

According to McGinn a Property P is closed for the subject himself, but it is open to a third person; *what?* Is McGinn saying that only the third-person perspective can access the subjective first-person perspective of other's subject? Does the subject himself have no access to her own consciousness, but a third has? This is quite strange and preposterous. Typically the contrary is said, i.e. that the third perspective has no access to the first one. In fact, no one takes McGinn's mysterious claims seriously...

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[46]C. McGinn (2004:113).

[47]See Plato's *Allegory of the Cave* expressed in *Republic book VII.*

4.8. Paul Churchland's and Lewis' Errors

The so called *ability hypothesis* proposed by Lewis, Churchland and others is the best reply to Jackson's argument. But it fails where the others failed too: in disregarding evolutionary biology. Lewis analyses Jackson's premises carefully, and notes that in the first premise Jackson means *know-that*, and in the second *know-how*. But Jackson himself did not realize this fact, and Lewis was sharp in detecting the difference.

According to Lewis, Mary does not learn a new fact she already know, because she knows everything about neuroscience by having propositional knowledge. She did not learn a new proposition about the world, but a new ability. In particular, Mary learned *how* to do something, such as ride a bike or how to see red, rather than new propositional knowledge. That is the same point as is made by Churchland: Mary had only *knowledge by description*. After the release she gains *knowledge by acquaintance*. I see no problem with their replies, except the fact they overlook that Mary is unable to see any color, as I have shown.

It is undeniable that Mary acquires new abilities, and now Jackson recognizes this fact. The central point is that Mary will never acquire the ability to see color, because of the developmental constraints I presented in the section 4.4. Mary does not have the ability to detect wavelengths of the visible spectrum. Her cones and her visual systems were not trained to detect such patterns. Similarly Mary cannot learn how to introspect phenomenal concepts as Tye and Harman affirm. The concept of 'red' she introspects is whatever it happens to be, but not the concept of 'red' as normal people use it.

Therefore Jackson's argument is faulty at the outset, and no one has perceived that. *To know* is not only language-dependent, but it is a neurocognitive process based on sensory systems. And Churchland recognized this fact, but misses the point in trying to refute Jackson's premises. In doing that, he accepted Jackson's false premises. Moreover, the appeal to Frege's modes of presentation did not solve the problem, since as Jackson assumes, Mary has complete knowledge about the world. Consequently, she knows – I suppose – all modes of knowing or referring to a given fact in the world. Thus, the modes of presentation did not help Churchland to refute Jackson.

In reality it is not Mary's linguistic ability that is at stake, but her [non-verbal] cognitive ability to detect color. With this in mind Churchland had tried to improve his first criticisms. He states correctly that any creature with a normal cognitive system can detect red patterns in nature. He just has not developed this point. Then he failed for the second time when says that Mary does not have *knowledge about*, but *knowledge by acquaintance*. Mary is not able to actualize her previous knowledge. On the contrary, she just confirms what she already knew (since she knows all about neuroscience), namely, that she is not able to see colors.

Moreover, Mary is not able to imagine "what it is like to see red", because she had never experienced colors before. The imagined red could have various shades, but not red as normal people can see. In reality, Mary is unable to conjure up what red is like. Ask to a blind person to imagine red. Can he do this without previous experience with color?

4.9. Dennett Denied

Dennett's criticisms seem unreasonable; since he denies the very fact we have qualia. Actually no one denies that conscious experience exhibits qualitative features depending on the sensory modality. No one denies that qualia are in fact private and subjective, even the dualists recognize that. Why does Dennett deny the obvious? He is right in several points, but denying the existence of what everybody wants to know is just begging the question.

In fact, he is very destructive in his critiques. Nonetheless, with such criticisms against the *qualophile*, he inexorably denies the existence of qualia. Put in other words, Dennett *throws the baby out with the bathwater*. Such a radical position is begging the question about qualia. Although Dennett affirms he is not denying the qualitative character of qualia, notwithstanding he leaves qualia out of his model. He just makes some *en passant* observations:

> I grant (. . .) that each person's states of consciousness have properties in virtue of which those states have the experiential content that they do. That is to say, whenever someone experiences something as being one way rather than another, this is true in virtue of some property of something happening in them at the time, but these properties are so unlike the properties traditionally imputed to consciousness that it would be grossly misleading to call any of them the long-sought qualia.[48]

> Philosophers have adopted various names for the things in the beholder (or properties of the beholder) that have been supposed to provide a safe home for the colors and the rest of the properties that have been banished from the "external" world by the triumphs of physics: "raw feels", "sensa", "phenomenal qualities", "intrinsic properties of conscious experiences", "the qualitative content of mental states" and, of course, "qualia" the term I will use (. . .) *I deny that there are any such properties. But I agree wholeheartedly that there seem to be. There seem to be qualia, because it really does seem as if science has shown us that the colors can't be out there, and hence must be in here.*[49] [Emphasis added]

[48]D. Dennett (1993:382). In A. Goldman (ed.).
[49]D. Dennett (1998:141).

Dennett adds again that "there seem to be qualia". In his last book about philosophy of mind (2005), he ignores the task of explaining what qualia are, and what role they play in an organism's life. The author says only that he is denying the properties philosophers used to assign to qualia. But again: *By denying qualia, he throws the baby out with the bathwater*. He doubts whether the phenomenal character of the consciousness experience is really phenomenal. In its place he proposes *heterophenomenology*, "phenomenology of another not oneself."[50]

Heterophenomenology "is a way of interpreting behaviour (including the internal behaviour of brains)."[51] According to the author, it proposes to be a "neutral method" to study consciousness. The emphasis is on the subject's verbal self-reports about her internal world. The scientist listens carefully the reports and gathers all information (and uses as well taped records, EEG, fMRI, etc.), taking them as "sincere reports".

According to Dennett, after the process of gathering and transcription of information about the subject's world, the scientist interprets them by adopting the intentional stance, i.e., treating the subject as a "rational agent" with mental states with intentionality, and the heterophenomenological objects (or intentional) as explications. Then subject's actions are explained based on these intentional mental states:

> [T]he heterophenomenologist lets the subject's text constitute that subject's heterophenomenological world (...) in short, heterophenomenology is nothing new; it is nothing other than the method that has been used by psychophysicists, cognitive psychologists, clinical neuropsychologists, and just about everybody who has ever purported to study human consciousness in a serious, scientific way. (...) a bridge between the subjectivity of human consciousness and the natural sciences (...) heterophenomenology is the beginning of a science of consciousness (...) the organization of the data, a catalogue of *what must be explained*, not itself an explanation or a theory (...) doing justice to the *first-person* perspective.[52]

I am not fully convinced about heterophenomenology. Dennett's model clearly leaves the fundamental aspect of consciousness out, *viz*, the qualitative character. The so-called *Multiple Drafts Model of Consciousness* tries to explain several aspects associated with consciousness, but excludes the central one: *qualia*. In this sense I agree with Chalmers that Dennett does not scratch the problem.

At the best he explains only the cognitive processes underlying consciousness, not *consciousness* itself. Certainly the Standard Conception of qualia has weak

[50]D. Dennett (2003:19).
[51]D. Dennett (1991:95).
[52]D. Dennett (1987:15, 49, 73; 1991:22; 81; 2003:22-27).

points, but denying the existence of qualia, and that they are not directly recognizable, private and subjective is not solving the problem at all. This is begging the question.

According to Dennett, partisans of such conception invent diverse names for a common phenomenon, for example, raw feels, sensa, phenomenal qualities, intrinsic properties of conscious experience, the qualitative content of mental states, and qualia. All these refer to the same phenomenon: the biological mechanism of detecting changes in the internal and external environment. Such neurobiological event is experienced phenomenally by subjects, not by robots. Unfortunately Dennett does not adopt this line of argumentation.[53]

Wilfrid Sellars seems to be the first philosopher to call Dennett's attention to the qualia problem. Sellars confided to Dennett that "But Dan, qualia are what make life worth living."[54] Dennett just ignores this and tries to show how misguided are our intuitions. His criticism makes him blind for a central point: qualia are decisive in our survival in a hostile world.

Conversely to what Dennett holds, it is broadly accepted that some people are able to differentiate between several flavors and odors. Skilful people have a refined ability to carry out sensory differentiation, e.g., *sommeliers* are trained professionals who taste wines. They are able to explain the bouquet of a given wine, if the wine was oxidized due exposition to heat, if it is contaminated by *Brettanomyces* (*fungi*) that can alter the palate and bouquet, etc.

Likewise there are people who work for perfume industry. The *Perfumer* (or the Nose) is an expert trained in smelling several notes of a perfume composition. Both jobs are based on rigid studies and on vast knowledge about their fields. Those are *acquired abilities*. In other words, they are specialized people that work detecting different qualia. Common people cannot do that, but with learning and training the ability becomes refined.

Contrary what Dennett says, one can identify the content of conscious experience, not by isolation but due to the refinement of the sensory modalities. The sommelier is able to distinguish *Pinot Noir* from *Chardonnay*. He even is able to distinguish between a *Pinot Noir* made in Argentina from one made in Austria. This is not a special ability, but an *acquired* (or *refined*) one. With refined sensory abilities, the qualia can be better experienced; different associations can be invoked. By contrast Dennett says that a machine can carry out such a task with more precision. Certainly it can. But can the machine experience the qualities as we do? That is, *enjoying the qualitative content* or *being disgusted by the taste a wine*?

The machine is a disembodied device without conscious experience and qualia. Although it is able to detect with precision the concentration of several substances,

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[53]Although he had written a good book about evolutionary theory and Darwinism (*Darwin's Dangerous Idea*), he did not consider the evolutionary role of qualia plays in our life.
[54]D. Dennett (1991:383).

it cannot, however, "experience qualia" as a biological living system. Qualia and consciousness are biological features that only organisms can experience. In a sentence, *qualia experiencing* presupposes that biological living systems have *sensory systems*, *specialized neuronal networks*, *a global conscious space,* and *memory-evaluative systems* – as I try to show in the second part. The machine cannot be conscious because of a simple fact: *biology.*

As far as I know, artificial intelligence (AI) does not succeed in reproducing biological systems. Even leg's simple movements are difficult to reproduce; why should we suppose that AI is able to reproduce *consciousness*, a much more complicated biological condition? In particular, the experience of drinking and enjoying a good wine is a biological one that no machine or zombie can have. Regarding this issue, J. Searle is fully right when he says that no matter how sophisticated a machine or robot could be; the experience of drinking a good beer is completely subjective and experienced by biological organisms only.[55]

Dennett's wine machine has only transducers and a database. Although it is true that such components are necessary for qualia experience, they are however insufficient for the instantiation of qualia. Central is an embodied brain receiving sensory inputs from the sensory modalities in virtue of constant interactions between organism and environment. For this reason the PFP is weak, since it does not take into account the fact that qualia and consciousness are experienced by biological organisms, not by thermostats or robots.

Experiencing qualia is an embodied phenomenon which requires numerous biological mechanisms, and mainly, interaction with the environment. Only biological organisms are able to undergo subjective experience.

Dennett's intuition pump number 7 is flawed since he denies a plain fact; that the sensory mechanisms change over the time. There is no doubt here that our sensory mechanisms deteriorate with the age. Why does Dennett not consider Chase and Sanborn's changes in the taste mechanisms? This a natural event in our life. The process of aging makes various changes in the human's body, e.g., the diminution of taste; why couldn't it happen with specialized coffee tasters?

Dennett is right about the fact that qualia are relational because they change over time through conscious experiences. But he contradicts himself in stating that Chase and Sanborn are not able to detect the difference in the gustatory mechanism. Dennett confounds *intrinsic* with *extrinsic*. The quality is intrinsic to the conscious experience, that is, pertains to that experience. But the content is extrinsic, i.e., it changes with every new experience.

Qualia present both features: they are intrinsic since they are undeniable parts of conscious experiences, but they are not unchangeable. Conversely, they change over time. Qualia are always present in conscious experience (intrinsic character), but the content (the sensory quality) changes on every new experience (extrinsic

[55] Cf. J. Searle (2004:113 ff.).

character). Chase and Sanborn detect the difference because the quale is both, intrinsic and extrinsic. Since there are changes in the content, that is a sign of degeneration of the mechanisms of tasting. The qualitative content is entirely depend on the sensory mechanisms, but Dennett misses the point and confounds this.

If Dennett wants to prove that qualia are relational, then he must accept the fact that Chase and Sanborn's gustatory apparatus has changed, and therefore the qualia must also be changed, since the change in the gustatory systems implies a change in the content of the experience. Moreover Dennett overlooks the fact that sensory mechanisms deteriorate over time.

My diagnosis is that Dennett tried to defend functionalism with behaviorist arguments, and what behaviorism denies is what biological naturalism wants to know. Dennett explains the behavior of a system not in psychological terms. His arguments are strongly influenced by Ryle, Wittgenstein and Quine philosophies. The heterophenomenological method to study consciousness is fundamentally entirely behaviorist. The mental life of the organisms is ignored. We should only interpret their behavior "as if" it were intentional.

In particular, Dennett considers the mental life as a black box. From his point of view, what are necessary are inputs, some type of interaction among cognitive states, and the external output. We could use in addition other tools such as fMRI, EEG, ERP, etc. to enrich the heterophenomenological report. What the subject feels does not matter. Dennett likes to use arguments from artificial intelligence, as in the zimbo's story. But zimboes are as absurd as zombies.

The same objections against Chalmers' zombies are valid for Dennett's zimboes. It is not enough to reproduce some biological function in order to have a biological system. Firstly, we need to understand the biological system. So far there is no complete description of a unique living system. Even bacteria and fungi, the oldest living organisms on Earth, are as yet poorly understood. Organisms are not black boxes that respond to input and produce an output as Dennett's robots. The mechanisms underlying the behavior of several organisms are yet unknown – and much of such lack of knowledge is due to behaviorism.

Although functions play a central role in biological explanations, the complete functions in given systems was not entirely understood. For example, what are the mechanisms underlying emotions, decision-making, memory, immunological systems, etc.? Having robots as models of understanding biological systems is valuable, but thinking that they are conscious or having qualia is implausible. Just saying that robots as zimboes are conscious creatures is a big mistake. Robots should count as *models of understanding* some mechanisms, and by themselves they do not have evolutionary history, and should not count as biological organisms.

Recently Dennett is complaining about the reception of his critiques against Jackson's thought experiment. It seems that the critiques were not enough to abandon Mary. Dennett impatiently insists that the argument is a complete mistake.[56] The thought experiment has an allure that attracts students and many philosophers.[57] Therefore he attacks it again, "after 10 years of many new publications about Mary and lot of confusion."

Dennett admits that, "First, I have found that some readers – maybe most – just didn't get my blue banana alternative. What was I saying? I was saying that Mary had figured out, using her vast knowledge of color science, exactly what it would be like for her to see something red, something yellow, something blue in advance of having those experiences."[58]

Dennett falls into Jackson's trap. Mary is neither able to see red, nor blue. No matter how sophisticated the thought experiment is, the fact is that Mary is colorblind, for she lacks the ability to detect color. Her visual detectors are defective, and the story ends here. Dennett's blue banana is a sad mistake committed due his disregard of basic neurobiology. He committed the same mistake as the others, *viz, Mary's inability to detect color.*

In any case, Dennett is right when he says, "I had no idea philosophers still put so much faith in the authority of their homegrown intuitions."[59] This is quite essential. For example, *Mariology*[60] is now part of philosophy of mind; there exists several versions of Mary: Mary Mary, the daughter of Mary,[61] we have also The Zombie-Mary,[62] the quantum Mary.[63] What comes up? Swamp-Mary? Zombie-Twin-Mary? Or Alien-Mary? I just ask: Does this kind of argument make sense?

I am with Dennett and P. S. Churchland, when they say that these thought experiments are the diagnostic of "feebleness and ignorance" that infest the philosophical discussion about consciousness. What is the point? Why must everyone who tries to investigate the problem of consciousness must always consider these thought experiments?

In summary, although Dennett had made good points in philosophy of mind, however he is wrong with his criticisms. He does not take into account several factors. He commits the same mistake as the others, *viz*, disregarding evolutionary neurobiology. Refined sensory systems described formerly are the result of natural selection. They were the response organisms produced in order to survive in an unstable, hostile and changing world.

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[56] Cf. D. Dennett (2005 chapter 5).
[57] D. Dennett (2005:106).
[58] Ibid.
[59] D. Dennett (2006:108).
[60] D. Dennett (2005:103).
[61] G. Graham and T. Horgan (2005). "Mary Mary, Au Contraire: Reply to Raffman." *Philosophical Studies* 122(2): 203-212;
[62] T. Vierkant (2002). "Zombie-Mary and the Blue Banana: On the Compatibility of the 'Knowledge Argument' with the Argument from Modality." *PSYCHE*, 8(19).
[63] M. Miłkowski (2007) "Quantum Mary meets Computationalism." In *Toward a Science of Consciousness 2007*, Budapest, Hungary, 23-26 July 2007. We see the several versions of Mary at the conferences about consciousness. Now there are even special sessions dedicated to *Mariology*.

The fact that qualia are both intrinsic and relational refer to evolutionary strategy. And Dennett overlooked this fact, even though he has written an interesting book about evolutionary biology. A final diagnosis is that Dennett committed such mistakes due his behaviorism. His criticisms against the Cartesian foundationlist tradition are based on analytic behaviorism, but the latter is also under attack from neuroscience. In sum, *Dennett throws the baby away with the bathwater.*

Part 2

The Neurophilosophical Perspective

Essentially philosophers often ask good questions, but they have no techniques for getting the answers. Therefore you should not pay too much attention to their discussions. And we can ask what progress they have made. A lot of problems which were once regarded as philosophical, such as what is an atom, are now regarded as part of physics. Some people have argued that the main purpose of a philosopher is to deal with the unsolved problems, but the problems eventually get solved, and they get solved in a scientific way. If you ask how many cases in the past has a philosopher been successful at solving a problem, as far as we can say there are no such cases. Essentially, their main technique is the thought experiment, and here you can argue indefinitely.

Francis Crick (2006:74 in S. Blackmore)

The strategy of treating consciousness as a variable provides a useful empirical basis. No longer are we exclusively dependent on plausible intuitions, thought experiments, or rhetorical brilliance, the bread and butter of traditional thought. We can actually test hypotheses, and the results have a plausible bearing on longstanding questions of consciousness.

Bernard Baars (2003:8)

CHAPTER 5

The Neurophilosophical Perspective

5.1. Quining Philosophy

Dennett introduced the term "quining" in the debate on qualia with the purpose of denying the properties philosophers used to assign to qualia.[1] According to Dennett "to quine" means denying "resolutely the existence or importance of something real or significant."[2] In other words, "to quine" consist in denying the existence of essences or *a priori* principles. In Quine's terms, "being real" denotes "being able to be quantified in scientific theories."

Philosophy for Quine, in particular epistemology, must be investigated within the natural sciences. Recalling Quine's famous *dictum*, "epistemology, or something like it, simply falls into place as a chapter of psychology and hence of natural science. It studies natural phenomenona, *viz* a physical human subject."[3] As is known, Quine aims for a complete naturalization of epistemology, and his project places philosophy beside psychology.

Inter alia Quine proposes that the new naturalized epistemology should investigate how sensory inputs cause behavior (the output). Such an accomplishment is done within the natural sciences. Anticipating several assumptions of cognitive neuroscience, Quine states that we acquire knowledge about the world from our sensory receptors.[4] In this sense, philosophy and science are not separated fields of investigations, but a *continuum*.[5] In general, every natural phenomenon must be explained according to current scientific knowledge. There is no need for a *first philosophy*, and there is nothing more fundamental than science itself.[6]

The natural sciences are accurately able to explain natural phenomena. Likewise, consciousness as a natural phenomenon should be investigated according to the principles of the natural sciences. In this sense, philosophy of science is within the natural sciences. Recalling another Quinean *dictum*, "Philosophy of science is philosophy enough!"

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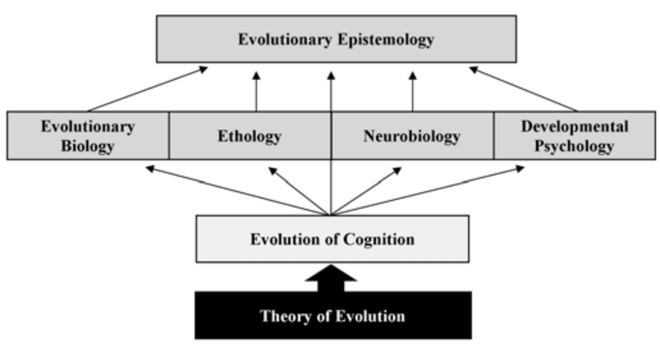
[1] Cf. chapter 4, section 4.9.
[2] D. Dennett (1993:381), in A. Goldman (ed.). Cf. too Dennett's "The Philosophical Lexicon", on line available at http://www.philosophicallexicon.com/.
[3] W. van Quine (1969:83).
[4] Cf. W. van Quine (1992:19-21).
[5] Ibid. at pages 126-127.
[6] Ibid. at page 83 and followings.

Indeed Quine was the first philosopher who tried to naturalize philosophy systematically, by arguing against foundationalist philosophy (*aprioristic* philosophy). In the same vein we could use Dennett's verb to describe this attitude to deny first philosophy, by taking natural science as the best model for the explanation of natural phenomena. In fact, Quine assumes that evolutionary theory is a plausible candidate for the explanation of human behavior.[7] In accordance with the current evolutionary theory, human beings, as the product of natural selection, are natural beings. Therefore human behavior is fully explainable in naturalistic terms.

With this in mind, Quine's naturalized epistemology can be extended to an *evolutionary epistemology program*. This new approach would be the most appropriate account of human nature, since humans are product of natural selection.[8] So that biological evolution is the only hypothesis able to explain the several adaptations and abilities that human beings have. Thus, Quinean naturalized epistemology is better designated as evolutionary epistemology, a term introduced firstly by Donald T. Campbell in 1974.[9]

Evolutionary epistemology regards human beings as products of evolution by means of natural selection. Within this framework, cognitive capacities should be recognized as genuine biological adaptations. M. Bradie and W. Harms[10] add that, "evolutionary epistemology is the attempt to address questions in the theory of knowledge from an evolutionary point of view that focuses on the development of cognitive mechanisms in animals and humans." Within this context, human knowledge results from evolutionary processes.

Hence the central problem for an evolutionary theory of knowledge is the reconstruction of the evolutionary processes that produced the huge variety of organisms and their adaptive abilities.[11] According to F. Wuketits, evolutionary epistemology comprises various disciplines, and makes use of results from several fields:[12]



[7] Cf. Ibid. at page 127.
[8] Cf. F. M. Wuketits (1990:5).
[9] M. Bradie & W. Harms (2008).
[10] Ibid.
[11] Cf. F. M. Wuketits (1990:33).
[12] Ibid. at page 184.

The new naturalized evolutionary epistemology thereby gains more widespread support. In addition, I would include cognitive neuroscience, molecular biology, and behavioral ecology. In such terms, the assumption of evolutionary epistemology is concerned with the evolutionary origins of cognition. Regarding the term 'naturalism', I will not occupy myself with its different versions. For the purposes of the current work I assume the basic assumption that natural phenomena can be accounted for according to the natural sciences.

In speaking of naturalism, I adopt the definition offered by the *Center for Naturalism*,[13] "a non-profit educational organization that seeks the understanding of human nature and a resource for those interested in scientific naturalism and its personal and social implications." Thus the *Center for Naturalism* defines 'naturalism' as:

> The understanding that there is a single, natural world as shown by science and that we are completely included in it. Naturalism holds that everything we are and do is connected to the rest of the world and derived from conditions that precede us and surround us. Each of us is an unfolding natural process, and every aspect of that process is caused, and is a cause itself. So we are fully caused creatures, and seeing just how we are caused gives us power and control, while encouraging compassion and humility. By understanding consciousness, choice, and even our highest capacities as materially based, naturalism re-enchants the physical world, allowing us to be at home in the universe. Naturalism shows our full connection to the world and others, it leads to an ethics of compassion, and it gives us far greater control over our circumstances.

In addition, we can recall John Dewey's conception of naturalism, namely naturalism as "opposed to idealistic spiritualism, but it is also opposed to super-naturalism and to that mitigated version of the latter that appeals to transcendent *a priori* principles placed in a realm above Nature and beyond experience."[14]

As one can expect, objections to naturalism are legion; the central is the so-called circular problem: how to defend naturalism from within the naturalistic perspective? Again I will not deal with this issue here. I just follow the strategy proposed by R. N. Giere, i.e., to "characterize naturalism not as a thesis, but as a method (...) for any aspect of the world, seek a naturalistic rather than a supernaturalistic (*a priori*) explanation."[15]

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[13] http://www.naturalism.org/.
[14] In P. A. Schilpp & L. E. Hahn (1989:580).
[15] R. N. Giere (2006:53).

5.2. The Neurophilosophical Tenets

The term 'neurophilosophy' was coined by the American philosopher Patricia Smith Churchland in her classical book *Neurophilosophy toward a Unified Science of the Mind-Brain*. Her aims there were to "introduce neuroscience to philosophers and philosophy to neuroscientists."[16] The book is pioneering and ambitious. It aims for the unification of neuroscience with philosophy.

Philosophy, in particular epistemology, can make more progress by adopting new neuroscientific tools and empirical data, according to Churchland. Thus old philosophical problems can be solved, or at least places on a sounder footing in the light of empirical findings. Churchland laid the basis for the new approach to old philosophical problems. She adopts explicitly Quine's naturalized philosophy, but instead of psychology for the proper science of human behavior, she proposes neuroscience.

Neuroscience or cognitive neuroscience is a new field of research. Some authors used to say that the term is an umbrella term, comprising several disciplines. Cognitive neuroscience is commonly defined as the study of brain-behavior relationships, and it consists of several integrated sub-disciplines including neurobiology, molecular biology, evolutionary biology, cognitive psychology, computational neuroscience, neurochemistry, neurolinguistics, etc.

Cognitive neuroscience makes use of some new tools as PET (Positron Emission Tomography), fMRI (functional Magnetic Resonance Imaging), EEG (Electroencephalography), and MEG (Magnetoencephalography). These new tools enable the neuroscientists to do more research into the living brain in a noninvasive manner, i.e., without the need to open up or otherwise to intervene in the brain. The research is concentrated on how living brains work, depending on the task the subject is performing. In considering such topics, neurophilosophy can benefit a great deal from the data delivered by those new tools.

Accordingly, neurophilosophy involves basic knowledge about cognitive neuroscience in order to understand how brain produces consciousness. Contrarily what is widely said, neurophilosophy does not propose the reduction or elimination of mental states, as many authors misrepresent. On the contrary, it searches for a more accurate description of conscious behavior in neuroscientific terms.

The whole quarrel concerning reduction is just dust. If a given phenomenon can be explained in a new accurate vocabulary or at a new level, why should we not abandon the old conception? Or at least integrate the old framework into the new one? For example, mental states can be referred to as brain states, which are generated by the integrated work of neuronal networks. In these terms, conscious states are susceptible to scientific methods of investigation by using the new imaging tools, and are susceptible to explanation in neural terms.[17]

[16] P. S. Churchland (1986:3-6).
[17] P. S. Churchland (2002:30).

The basic tenet of neurophilosophy is that consciousness is neurally realized by the brain. Neurophilosophical investigation considers the problems of how cognition, decision-making, moral judgments, aesthetic and religious experiences, etc. are made; in sum it addresses the question of how brains produce conscious behavior. In investigating them, neurophilosophy rejects *ab initio* dualist theories of mind and *a priori* philosophy.

The classical Cartesian mind/body problem is no longer a real problem. No one believes that consciousness or qualia are nonphysical entities independent of bodies (except Chalmers and his followers). Mind is not a separated special entity from the body, but simply what brains do. The hard task here is to understand the several mechanisms underlying conscious experience.

Since Wittgenstein's and Quine's times, it has become evident that philosophy cannot lay down *a priori* principles, in particular for the neuroscientific project. Conversely, philosophy should work in team with neuroscience toward to understanding human behavior. Currently, some philosophers are accustomed to distinguish between "neurophilosophy" and "philosophy of neuroscience"; the latter "concerns foundational issues within the neurosciences", and neurophilosophy "concerns application of neuroscientific concepts to traditional philosophical questions."[18] But as P. Mandik puts it, "neurophilosophers are also philosophers of neuroscience."[19] Concerning this issue, Churchland states that:

> Neurophilosophy arises out of the recognition that at long last, the brain sciences and their adjunct technology are sufficiently advanced that real progress can be made in understanding the mind-brain (...) it predicts that philosophy of mind conducted with no understanding of neurons and the brain is likely to be sterile. Neurophilosophy, as a result, focuses on problems at the intersection of a greening neuroscience and a graying philosophy.[20]

In other words, neurophilosophy is a new interdisciplinary field of studies about brain and consciousness. It applies neuroscientific findings to traditional epistemological problems. Neuroscience and philosophy can achieve more significant results together, that is, make more progress if they work together, with the same aims. The question of how consciousness comes about is an old philosophical issue that now can be investigated empirically, according to current neuroscientific knowledge.

Notwithstanding a global view and the logic of neuroscientific findings are not widely clear yet. New findings are being published in specialized journals by different research fields, according to several techniques, and different vocabularies.

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[18] J. Bickle, P. Madik & A. Landreth (2008).
[19] P. Mandik (2007:419), in M. Velmans (ed.).
[20] P. S. Chuchland (2002:2-3).

However for an external observer they seem very fragmentary. C. Craver calls this building work "the neuroscience mosaic."[21] The very question is *how to make sense of this new neuroscientific knowledge?* One must integrate them and achieve a global view. I see this task as one for the neurophilospher, since he is able to provide a global view by integrating and analyzing critically the practical consequences of such new knowledge. Concerning this issue, Churchland argues that:

> Neuroscience needs philosophy because ongoing research must have a synoptic vision within which the immediate research goals make sense. Such a synoptic vision, transcending disciplinary boundaries but informed by the relevant disciplines, testing the integrity of the governing paradigm and investigating alternatives, is philosophy.[22]

However, as John Bickle observes, it is largely the case that "mainstream philosophy of mind remains indifferent to the progress which has been made in the cognitive neuroscience."[23] Philosophers of mind, language, and so on still insist in ignoring such facts. Even Daniel Dennett ignores the new science of mind. He just says that it does not matter to know about neurons. By contrast, the position argued here is tha if one interested in investigating how the brain produces conscious behavior, then one should firstly begin with basic brain functional anatomy in order to grasp how anatomical parts in the brain can work in synchrony to produce conscious behavior.

With this in mind, I now ask: *how can a philosopher who is interested in consciousness ignore neuroscience?* If he is focussed on metaphysical or dualist models of mind, then it seems he is proceding in the appropriate way. But if one wants to understand consciousness neurobiologically – as more evidence suggests that we should – then that presupposes some basic knowledge of brain function.

Concerning this refusal, Bickle makes a dramatic diagnosis, namely that "qualia and subjectivity: they're not just for philosophers anymore."[24] This is a fact, and many neuroscientists are putting forward models and theories of how brain produces consciousness, regardless of what philosophers think. As many neuroscientists point out, consciousness and subjectivity remained for centuries in the hands of philosophers and little progress was made.[25]

[21]C. Craver (2007:231). He says that "the different fields that contribute to the mosaic unity of neuroscience are autonomous in that they have different central problems, use different techniques, have different theoretical vocabularies, and make different background assumptions; they are unified because each provides constraints on a mechanistic explanation."

[22]P. S. Churchland (1986:482).

[23]J. Bickle (2003:322), in S. Stich & T. A. Warfield (eds.).

[24]Ibid. at page 323.

[25]Here I could open a discussion about the concept of progress in natural sciences and in philosophy, but this is not my concern. However, I think that such theme needs further analysis, since it seems to be obvious that progress in natural science cannot be compared with progress in philosophy or social sciences.

The new trend is therefore to reject what philosophers say, and instead to carry out empirical work in several fields associated with consciousness, such as attention, memory, cognition, etc. I do wonder why philosophers ignore such work. As Churchland holds, philosophers should profit from these new tools and empirical findings in order to solve old philosophical problems, rather than ignoring them.

Some philosophers usually accuse neuroscientific methods of being reductionist. But that is the *modus operandi* in natural sciences. Scientists try to understand natural phenomena according to certain rules in a controlled and limited scope. They propose *models*, *hypothesis* and *theories* about a given phenomenon in a reductionistic manner. Numerous biological phenomena are very complex, requiring several levels of analysis. Thus the best strategy is choosing a level or a part with definite mechanisms. It is impossible to consider such a complex phenomenon as consciousness all at once. Therefore, the problem of consciousness is subdivided into several others. It can be explained at several levels, for instance at the molecular or the phenomenological level.

It is becoming clear that the basic object of study are mechanisms – as I will show in the next section. As Bickle points out, neurobiological reduction is a fact. Many psychological syndromes have been discovered to be caused by neurological problems or by the absence of some hormone. But this finding does not imply that all biological phenomena should be reduced to the molecular level.

As I have said, and that is a putative statement in the consciousness studies: the explanation of how brain produces consciousness requires *multilevel analyses*. Several disciplines take part in the achievement, and *a priori* armchair philosophy does not help, therefore will be ignored. I believe that philosophers should take part in experimental activities, in order to accompany the development of building the explanation. Why are many philosophers *neurophobics*? Not only neurophobics, but as well *biophobics*. Concerning this refusal S. Sarkar observes that:

> Professional philosophers paid very little attention to biology during the first few decades of the twentieth century, even though the advent of genetics (both population genetics and what came to be called classical genetics) was transforming biology in ways as profound as what was happening in physics. Professional biologists – including Driesch, J. B. S. Haldane, J. S. Haldane, and Hogben – wrote philosophical works of some importance. However, the only philosopher who tried to interpret developments in biology during this period was Woodger (1929, 1937), better known among philosophers as the translator of Tarski's papers into English. Philosophers paid so little attention to biology that not only the evolutionary "synthesis", but even the formulation of the double helix model for DNA, went unnoticed by

philosophers of those generations.[26]

Why do some philosophers still insist that mind and consciousness are like software and brains like hardware? They still follow the incomplete physicalist and functionalist program; brains are not computers at all, although the central task of brain is processing and integrating information.[27] But such processes do not follow the Turing Machine principles or Gödel's theorem.[28] Brains are nonlinear dynamic systems, embodied devices that maintain interaction with environment; brains undergo several constraints, and are under several influences.[29] Everyone can note the difference between the *Microsoft Windows* and a biological brain. I do not need to go further in this discussion.

Finally, contrarily what certain philosophers think (Chalmers, Nagel, Jackson, McGinn, and others), a great deal about some neurobiological mechanisms has been explained. Examples abound, but I just pick up an useful illustration: many people in the world take *Aspirin* (acetylsalicylic acid), the analgesic that relieves numerous aches and pains, and that reduces inflammation.

Some kinds of pains as migraine can have several causes, for instance, the release of hormones and neurotransmitters such as prostaglandins (an enzyme with several functions in the body). Acetylsalicylic acid acts by inhibiting the release of prostaglandins in the nervous system, which causes pain and inflammation by making receptors more sensitive. As a result of the effect of aspirin, the production of pain stops. The example shows how the neurobiological mechanisms of aspirin act in the nervous systems; by reducing the release of oxidant enzymes. The central term here is 'mechanism'; *Discovering mechanisms* is the fisrt step toward the solution of a biological problem. [30]

Pain is an example of qualia – and one of the favorite philosophers' examples. The general mechanisms that produce pain are known, and the pharmaceutical industry delivers annually lots of medicines against specific types of pains. In short, pain, similar to other sensory qualities, is generated in the brain, not in the peripheral systems. However the peripheral systems send the neural information

[26]S. Sarkar (2006:xxi) in S. Sarkar & J. Pfeifer (eds.)

[27]Cf. G. Tononi. & O. Sporns (2003).

[28]See Roger Penrose's books *The Emperor's New Mind: Concerning Computers, Minds, and The Laws of Physics* and *Shadows of the Mind: A Search for the Missing Science of Consciousness.* Penrose thinks that the brain is a quantum device operating according to Gödel's incompleteness theorem. Penrose's ideas in a nutshell: *Consciousness* cannot be mathematicized as the AI program intends, since every formal system presents an inconsistence referent to their own sentences, i.e., the axioms that determine the behavior of a system are limited by a fixed set of axioms. The AI program is incomplete since is based on classical physics and deductive systems. Human consciousness transcends logics and classical physics. Consciousness is realized by quantum oscillations in microtubules within neurons, what seems to be in contradiction to all current empirical evidence. Whether Penrose is right or not, no one can know since it is impossible to observe quantum phenomena in the brain (if such an event can occur).

[29]Cf. J. A. S Kelso. (1995) and W. J. Freeman (2000).

[30]This mechanism is well documented and understood. See for example D. Jeffreys (2005). *Aspirin: The Remarkable Story of a Wonder Drug, which presents the history of the drug.*

with "pain signals" to the brain. In spite of that, I ask you: Why should one continue to refuse acknowledgement of the fact that consciousness is a biological condition, a product of natural selection and generated by/in the brain? Why not investigate its neurobiological mechanisms by specifying such mechanisms in terms of a neurobiological basis, since organisms are biological living systems?

An additional point, that is often overlooked by philosophers, and which I need to refer to, concerns the *implications* of neuroscientific progress. In particular, an old conception of human beings has been substituted by a new one, based on findings from cognitive neuroscience; the most important change is that *conscious behavior* seems to be generated by unconscious mechanisms in the brain. For instance, in making a conscious decision, one is not really thinking *rationally* or *consciously*, since the brain has made the decision before the information become conscious.[31] What does such kind of finding mean for society?

Prima facie evolutionary epistemology as a consequence of evolutionary theory, and naturalized neurophilosophy, as a *continuum* of cognitive neuroscience, seem to be more appropriate for the theoretical issues concerning knowledge. But if we recall the old Kantian 4 questions: 1. *Was kann ich wissen?* (What can I know?), 2. *Was soll ich tun?* (What ought I to do?), 3. *Was darf ich hoffen?* (For what may I hope?), 4. *Was ist der Mensch?* (What is a human being?), it turns out evident that questions 1 and 4 demand a radical changing in our *Weltanschauung*, and the questions 2 and 3 can generate practical consequences not considered by any neurophilosopher and naturalized philosopher.

We see many authors arguing for the evolutionary paradigm, but it is rare to find someone who considers the implications of such new *revolutionary* knowledge. That is, what should we teach to our children? What should we do with our legal system? For sure, *evolution* is a fact with a large body of evidence to support it. It is therefore reasonable to consider the new findings from cognitive neuroscience, molecular genetics, neuroethology, and so on. But *how can we apply such a new body of knowledge to practical life?*

In summary, what I am saying here concerns the evolution of our knowledge and how we will apply it. This is a problem that no one has concentrated on yet. As always, theoretical philosophy and practical philosophy are distant from each other: from the theoretical field to practical life there exists an unbridgeable gap, although life goes on. How can we integrate both? Such problem make me remember the old complaints of Karl Marx and Ludwig Wittgenstein: the former diagnosed the incapacity of philosophy to make changes in practical life, and the last wondered about the philosophical pseudo-problems that block the solution of real questions, which concerns social praxis.

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[31]See B. Libet's controversial experiments about free will. I would like to discuss it in other place. Libet states that several mechanisms in the brain take the decision before we become conscious of the decision, in particular 200 milliseconds before. For more details see Libet's book *Mind time: The temporal factor in consciousness.*

To conclude this section, I would call to mind another great philosopher, who wisely posited such worry. He was one the rare philosophers who paid attention to Darwin's theory at the beginning of twentieth century. I am talking about *John Dewey*. Dewey argues that if we take Darwin seriously, then we would be forced to restructure all philosophical questions that philosophers traditionally ask.[32]

Dewey noted that not all are prepared to change the "foundationalist beliefs" they hold. In other words, if we want a proper description of human nature, then it is time to consider *Darwin's dangerous ideas* seriously. Concerning new neuroscientifc findings, I ask you: what are the consequences from the discovery that conscious behavior is caused by unconscious mechanisms in the brain? I let the question open for a while.

5.3. Mechanistic Explanations

'Mechanism' is an old philosophical term that makes reference to natural philosophers of the scientific revolution in the seventeenth century. The most influential was Descartes, who had a mechanistic conception of nature and the mind. At those times, Aristotelian natural philosophy ruled. Yet Descartes was not satisfied with Aristotle's system. The new emerging knowledge concerning mechanics, geometry and astronomy was replacing the Aristotelian conception of world. The Copernican Revolution changed our view of Earth and its place in the universe. Thus heliocentrism was the response to geocentrism.

The new natural philosophy was guided by the principles of mechanics and geometry. This mechanical philosophy laid down the *modus operandi* of the latter scientific revolutions. From the mechanical perspective, bodies are ruled by rigid principles and laws. Descartes stated that bodies are automata; their movements are generated by physiological mechanisms. In the *Principia* he writes:

> I do not recognize any difference between artifacts and natural bodies except that the operations of artifacts are for the most part performed by mechanisms which are large enough to be easily perceivable by the senses - as indeed must be the case if they are to be capable of being manufactured by human beings. The effects produced by nature, by contrast, almost always depend on structures which are so minute that they completely elude our senses.[33]

Although his ideas are seen as wrong today, Descartes' originality and pioneering efforts to understand how the mind occurs in physical bodies is impressive. I disagree with almost everything Descartes wrote, but his merit lies in the attempt to

[32] J. Dewey (1910 chapter 1).
[33] R. Descartes, *Principia* IV, §203.

replace the old Aristotelian philosophy. Descartes lacked the research tools that neuroscience nowadays has. We could imagine what Descartes' inquiring mind would do with the available neuroscientific tools we have today...

Notwithstanding the limited resources, Descartes developed a systematic view of the world and of human beings. He established the agenda for several centuries. The most remarkable issue he raised is the mind-body problem, which seems to be perennial, resisting to all attempts to undermine it.

Descartes' dualism is still widely acknowledged. His solution for the mind/body problem is a piece of geniality, although it is completely wrong. For that reason, I dare say he was the *first neurophilosopher* in the History of Philosophy, since he advocated a mechanistic philosophy and was interested in how physical brains generate behavior. Mechanics was the basis of his physiology and medicine in Descartes' time. He holds that the human body is a machine that operates by geometrical and mechanical principles.

In paticular, Descartes used to vivisect animal bodies in order to understand the mechanisms that animate them. According to him, bodies are machines constituted by mechanisms that are governed by strict laws of geometry. Hearts beat and blood circulates without any conscious effort. We respond only reflexively to external stimuli, without thought. His attempts to explain vision is one the most original models ever in physiology.[34]

Descartes' mechanistic explanations still remain as a legacy of his era. Following the Cartesian philosophy, several scientists used mechanistic explanations. Concerning this issue, R. Westfall affirms that "the mechanical philosophy was a program of explanation, not a program of investigation."[35] The Scientific Revolution of the seventeenth and the following centuries (in particular Darwin's theory of natural selection) adopted the mechanistic vocabulary.

In the nineteenth century the explanations in biology were based on vitalistic explanations. But after the work of Charles Darwin, who emphasized the mechanisms of natural selection and sexual selection as being responsible for changes in the species, mechanistic explanations acquired more visibility, and were adopted widely in biology.

However, in philosophy of science this issue remained obscure. Philosophers of science in the twentieth century insisted that scientific explanation should be accounted for within the *Hempelian reductionist view* or *deductive-nomological model*, which gave primacy to the search for universal laws. According to these approaches, scientific knowledge consists of sets of sentences (theories and laws). Reductive explanation implies that the vocabularies of two distinct theories are merged into one by formulating bridge laws and identity statements. These intertheoretical laws

[34]Descartes believed that light was a pressure that exerts pressure against the retina, and then optic the nerve transmits the stimulus to the brain. The result is vision. For further details about Descartes' mechanistic explanations see S., J Gaukroger, A. Schuster, et al. (2000), *Descartes Natural Philosophy.*

[35]R. Westfall (2000:639), in W. Applebaum (ed.).

explicitly are supposed to connect the terms of the old theory with the terms of the new in a more comprehensive theory.

According to such principles, explanations are deduced from premises. The conclusion must follow the premises in order to be true. More specifically, the premises are law-like statements. Laws are typically expressed by universal generalizations that refer to particular cases. However, the historical debate showed that "not all swans are white", to use a common illustration. For instance, it was supposed that statements like "for all x, if x is a swan, then x is white" are valid overall.

But some facts indicate that such a law is false, since one day *Petra*, the black swan (i.e., non-white) from Münster, Germany, appeared! Black swans do exist and therefore the law that there exist only white swans is false. The new statement "there is an x that is a swan, and x is non-white" impugns the former sentence. The moral is clear: not all nomologic generalizations are universally valid, since a single instance can refute such a generalization. And as I will show, in neurobiology the nomologic-deductive model does not work very well.

Typically in this field mechanistic explanations are adopted. This is so because in neurobiology and neuroscience there are several exceptions and difficulties in trying to establishing a specific law for some phenomenon. As a rule, biological phenomena can be accounted for at several levels.

Likewise, laws are rare in psychology, and mechanistic explanations do not seek laws, but mechanisms that work under different conditions and at several levels. The framework of mechanistic explanation seems to be more appropriate in trying to explain brain functions. For example, neuroscience does not base its investigation on the search for laws, but in the search for mechanisms. Why is this so? Because brains, although they are physical devices constrained by physical laws, are dynamic systems with nonlinear processes occurring at several levels. It is impossible to establish or discover how a single neuron works.[36]

The brain has a massive amount of neurons that divide into several types according to function. Furthermore, neurons behave in many ways with various responses and they make numerous interconnections. The result of such dynamic interactions is consciousness, which can be account for at different levels.

The principle of neural signalizing is simple, one might say: neural impulses going forward and backward, upward and downward in the nervous systems. But it is not enough to understand how neural activities generate consciousness, because there are several levels of analysis to take into consideration as the molecular, neural, or system level.

In biology several authors use mechanistic explanations, whereas philosophers of science still insist on claiming that all natural sciences should seek for univer-

[36]Cf. W. J. Freeman (2000).

sal laws.[37] Nonetheless, as many authors have been pointing, the explanation in cognitive neuroscience and neurobiology is essentially mechanistic.[38] W. Bechtel and C. Craver observe that scientific explanation (since the scientific revolutions of the seventieth century) often involves the identification of mechanisms responsible for a given phenomenon.[39] In other words, mechanistic explanations constitute the *basis* of all current neuroscientific explanations. To confirm what I am saying, it is enough to check the journals of biology, neuroscience, and behavioral psychology to realize that scientists use mechanistic explanations.

But what is a 'mechanism'? W. Bechtel states that "a mechanism is a structure performing a function in virtue of its component parts, component operations, and their organization. The orchestrated functioning of the mechanism is responsible for one or more phenomena."[40] In addition, P. Machamer states that mechanisms are collections of entities and activities organized in the production of regular changes from start or setup conditions to finish or termination conditions.[41] The difference between the definitions above is insignificant: while Bechtel says that mechanisms consist of parts and their interactions, Machamer considers mechanisms as activities productive of regular changes. I try to integrate both in order to build a mechanistic explanation of qualia.

But the difference is not so problematic. I would say that both are talking about the same thing with different concepts; they are after all *complementary*, not exclusive. Bechtel talks about parts that compound mechanisms, and Machamer thinks that activities and entities compose mechanisms. I would say that entities comprise parts, which constitute mechanisms. Entities combine with others to form parts that in turn organize together mereologically to support mechanisms. In such terms Bechtel's and Machamer's ideas are integrative, not exclusive. However, I need to say that Bechtel's model seems to me more comprehensive, and therefore, I will follow his claims.

As I have stated, Bechtel holds that 'mechanisms' consist of parts and operations. Parts are structural components, whereas operations refer to the processes or changes involving the parts. Parts organize in different ways according to several rules; this process gives rise to organized wholes. The brain is an organized

[37]As W. Bechtel points (2008:3), if one asks to a neuroscientist or a biologist how they describe their research, they certainly will talk about mechanisms responsible for the investigated phenomenon. C. Craver searches in the recent neuroscientific literature evidences for the fact that mechanistic explanation is widely employed. He showed that several researches are based on mechanisms. In order to confirm this claim, I made a search in the database of the *Science Direc*t by typing 'mechanism': from 1999 to the present there exist 9.891 entries found in journals of neuroscience with the word 'mechanism' in the title. Another search in the renowned journal *Nature Neuroscience*, have returned 1486 articles with 'mechanism' in the title. That is a large body of evidence that neuroscientists have been using mechanistic explanation massively and since long time, regardless of what philosophers say.

[38]Cf. C. Craver (2007), W. Bechtel (2008), P. Machamer et al. (2000), A. Revensuo (2006), J. Bickle (2003).

[39]W. Bechtel & C. Craver (2006:469) in S. Sarkar & J. Pfeifer (eds.).

[40]W. Bechtel (2008:13).

[41]P. Machamer et al. (2000:3).

whole consisting of several component parts working dynamically in parallel. The dynamic interaction among the parts generates mechanisms. The parts perform different operations in parallel with others. The main task for neuroscientists is to discover the mechanisms underlying a given neurobiological phenomenon. Since mechanisms are composed of several parts present at several levels, mechanistic explanation in neuroscience will imply multilevel explanations.

Typically, the starting point is the observation of a given phenomenon, and subsequently the specification of mechanisms that can account for it. This procedure makes use of *models*. The first step toward the understanding of a phenomenon is describing the mechanisms by means of theoretical models. As Churchland and Sejnowski states, "every successful scientific explanation begins with a model."[42] Representing mechanisms, therefore, involves the elaboration of models and diagrams (pictorial representation), and verbal reports (explanations).

A *model* consists of a set of designs made to represent some phenomenon. In cognitive neuroscience of consciousness there exist various models for the explanation of how consciousness is generated by the brain.[43] The most influential model is the so-called *Global Neurononal Workspace Model* put forward by the French neuroscientist Stanislas Dehaene. Dehaene, as I show in chapter 7, uses several experimental findings and assumptions to pinpoint his model, which consists of several parts and mechanisms. The interaction among the parts give rises to conscious phenomenon (see chapter 7).

Following the mechanistic framework, consciousness is a phenomenon based on many unconscious mechanisms in the brain. It is not a product of single mechanisms, but is the consequence of several processes occurring in the brain in parallel at several levels. These processes are described in cognitive neuroscience by using mechanistic explanations.

Several authors are working on various mechanisms towards understanding how brain generates consciousness. We see people working on memory systems, emotion, cognition, visual, auditory, and olfactory systems, and so on. They seek to understand how conscious behavior is generated by unconscious mechanisms. The first step is the observation of the phenomenon. The second is the phase of proposing a model based on mechanisms that are supposed to generate the phenomenon.

Then the model is tested and extended (in a Popperian way). Frequently, the confirmation or discovery of the mechanisms implies the discovery of another mechanisms that take part in the production of the phenomenon. This occurs because the mechanisms are interconnected, and the integrated work produces some specific behavior. Therefore, when looking at the high-level phenomenon, scientists are seeking the underlying causal mechanisms at lower-levels. Once again, one might say that this is a form of reductionism.

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[42] P. S. Churchland & T. J. Sejnowski (1992:5-6).

[43] See A. K. Seth (2007) Models of consciousness. *Scholarpedia*, 2(1):1328.

Worries about reductions have a long tradition in philosophy of science. As can be expected, if a scientist is trying to understand a given phenomenon at a low-level, we might say that he is *reducing* the phenomenon to the low-level basis. However, mechanistic explanation takes for granted the multilevel character of the phenomenon, i.e., the interdependence of its parts. Several mechanisms at different levels can be responsible for the production of the phenomenon.

Thus we need to maintain the levels in order to get a better understanding of the phenomenon. No isolated part of a system can be said to cause it. The production of the phenomenon is caused by the integrated mechanisms and parts interacting causally and dynamically. One can promptly say that this is reduction, but in practice no one excludes the high-level phenomenon. The latter is what we want understand, even though one looks at the low-level mechanisms that are supposed to generate such high-level phenomena.

For instance, memory could be explained solely in terms of the neurochemical level, but these components alone are not enough. In particular, there are macro interactions among the modular systems in the brain, although such interactions are dependent on low-level biochemical events. By using the mechanistic framework, the behavior of a system is investigated according to levels, i.e., working parts acting at a lower-level scale.

According to this approach, radical reductionism is avoided and behavior is explained according to the mechanical parts. No parts are supposed to be responsible for the production of the behavior, but the interconnection of several mechanisms does produce such behaviour. For instance, no one would say that memory is generated only by biochemical neurotransmitters; additionally there are molecular, cellular and systems levels to be considered.[44]

As Bechtel recognizes, "mechanistic explanation, in seeking to explain the behavior of a mechanism in terms of the operations of its parts, is committed to a form of reduction."[45] But it is widely taken for granted in biology that complex systems present emergent phenomena. That is, some systems generate emergence of properties that are not present in the low level parts. Some types of behavior cannot be reduced to the parts or to low level entities, since they are a consequence of the interaction of low-level parts.[46]

Furthermore, the emergent behavior generated by the parts can to some extent influence the working of the parts (top-down influence), i.e., global changes in the system's behavior (normally trigged by external factors) can change the low-level activities.[47] Each level can be accounted for according to some science. For instance, no one will wish to explain the process of decision making in terms of the release of neurotransmitters. There are additional factors that play a central

[44]For further information about the mechanisms of memory see J. D. E. Gabrieli (1998), B. Milner, L. R. Squire & E. R. Kandel (1998), and L. R. Squire & E. R. Kandel (2000).
[45]W. Bechtel (2008:129).
[46]Cf. P. L. Luisi (2006).
[47]See chapters 7 and 8 for the example of attention.

role here, e.g., the relationship with memory systems, emotion, the inputs from the external environment, etc.

In considering the multilevel explanations we think instantly in terms of *interdisciplinarity*, for instance, whenever a level cannot be explained by a specific science, another science or discipline would be able to consider it. Here an example is useful: for years depression was explained in Freudian psychoanalytic terms; it was supposed that the depressed individual had identification with the object of affection through an unconscious, narcissistic process called the *libidinal cathexis of the ego*.

However, with the rise of molecular biology, it was discovered that depression can have several causes, among them neurotransmitter imbalances within the brain, genetic drift, and neurological damages. The Freudian explanation was *reduced* or *replaced* by a more appropriated neurobiological mechanistic explanation. But the molecular level does not tell the complete story; environmental influences such as stress, deception, etc. can trigger the release or inhibition of some neuromodulators (neurotransmitters and hormones).

A depressive episode is typically characterized by persistently depressed mood or loss of interest and incentive. The causes are diverse, but all have a neurobiological origin, for instance, in some cases the depressive state is caused the abnormal release of the neurotransmitters serotonin, dopamine, noradrenalin, and others. It is supposed that damage to or a malfunction of the mechanisms of release trigger the abnormal quantity of such neurotransmitters. Thus by investigating such mechanisms, researchers come to the conclusion that other hormones could control the release of neurotransmitters.

One drug used in the treatment of depression is *Prozac*, which acts directly in the mean synaptic by inhibiting the release of enzymes that oxidate the neurotransmitters. *Prozac* regulates the release of the neurotransmitters in the nervous system back to normal.

Of course the mechanisms of inhibition of depression are more complicated than I have exposed here. But it is only an illustration of how a problem can be investigated at another level. The Freudian explanation is no longer accepted, and it was substituted or reduced to the neurobiological mechanistic explanation.

Nonetheless, the sensation of depression and its associated negative feelings can also be treated by psychological advice. The application of drugs does not work in all cases. In some exceptions straightforward therapeutical dialogue helps in the relief. Therefore, in the case of depression, neurobiology should be considered together with psychological therapy. The two approaches complement each other: when one does not work, the other can help.[48]

[48]For more details about the causes and treatment of depression see J. Licinio & M.-L. Wong (2005) *Biology of Depression: From Novel Insights to Therapeutic Strategies* (2 vol. set). Wiley-VCH; 1 ed., and S. M. Stahl & N. Muntner (2000) *Essential Psychopharmacology of Depression and Bipolar Disorder*. Cambridge University Press; 1 ed.

Typically, a theoretical explanation (such as the Freudian explanation) of some phenomenon is replaced when new empirical tools become available. Of course, one begins with a theoretical model, but such models must be tested empirically many times. Despite that, some form of reductionism is inevitable, although it is not a problem for the cognitive neuroscience of consciousness; on the contrary, it is the *modus operandi*. If a given phenomenon can be accounted for at a low-level, with no need to appeal to a higher level, why not reduce it in that way, as the old idea of *phogiston*?

The reductionist worries do not interest neuroscientists. Regarding this issue Bickle argues that contemporary neuroscience in fact exhibits a reductive trend.[49] He cites recent conference programs and journals to show that the bulk of the most exciting contemporary neuroscience is dedicated to manipulating and understanding the behaviors of cells and molecules. Putting the matter more simply, in reductionistic terms Bickle argues that it is now possible to construct explanations for many high-level phenomena in terms of molecular mechanisms. He concludes that the best explanations in neuroscience hold only at molecular level, and "higher-level neuroscience" is at best heuristically important for directing attention to the right molecular mechanisms, not to top-levels to explain the phenomenon itself.

Bickle is advocating what he calls *ruthless reductionism*, a controversial conception. According to Bickle, scientists think that explanations ought to be given in terms of cells and molecules. Though, this is far from what neuroscientists maintain. As C. Craver states, there is no doubt that molecular biologists are making progress in the field of neuroscience: "the fact that neuroscientists are increasingly pursuing molecular research does not establish that the best neuroscientific explanations are at the molecular level."[50]

I do not think that Bickle's radical reductionism is the right way to go. Although searching for neurobiological mechanisms, neuroscientists do not however exclude the high-level phenomenon that they want to understand; saying that the molecular level is the only correct way to approach the problem is missing the point and begging the question. Bickle should chat with some neuroscientists and he will perceive that they are not trying to understand phenomena such as memory and attention by considering the molecular level only. Papers and books about such themes are diverse and take several levels of analysis into consideration.

Another current example is the problem of consciousness: a glance at the conferences about consciousness will reveal that the areas involved in the achievement are various: philosophy, psychology, anthropology, sociology, neuroscience, physics, etc. To confirm what I am saying just see the two big conferences about consciousness in the world: the *Towards a Science of Consciousness* and the annual meeting of the *Association for the Scientific Studies of Consciousness*. Both events are multidisciplinary and; they are not only for molecular biologists, because most people

[49] J. Bickle (2003:280).
[50] C. Craver (200:235).

believe that the understanding of consciousness requires multi and interdisciplinary work.

In a sentence, Bickle *is fighting against the waves*; he should at least accept the fact that some areas co-evolve towards an unified vocabulary, by integrating several levels. Sometimes this happens in science, one discipline integrates the knowledge of another. The result from that is an enriched approach to a particular phenomenon.

A mechanistic explanation, although of a reductionist nature, it not trying to reduce or eliminate high-level phenomena. Contrary to this idea, it aims to understand the parts of a system (how they organize together), and how they interact with others forming mechanisms, which generate the high-level phenomenon. The behavior of a system cannot be explained by appealing only to one part or to some particular mechanism.

In particular the behavior is explained by pointing out how several particular parts interact with others. The explanation seeks to understand the causal interactions occurring at low-levels that together are responsible for the behavior of the system or the high-level phenomenon. The mechanistic framework does not reduce the phenomenon to specific parts. On the contrary, it considers mechanisms as interconnected and that they are often dependent on others to generate a given behavior or phenomenon in a system.

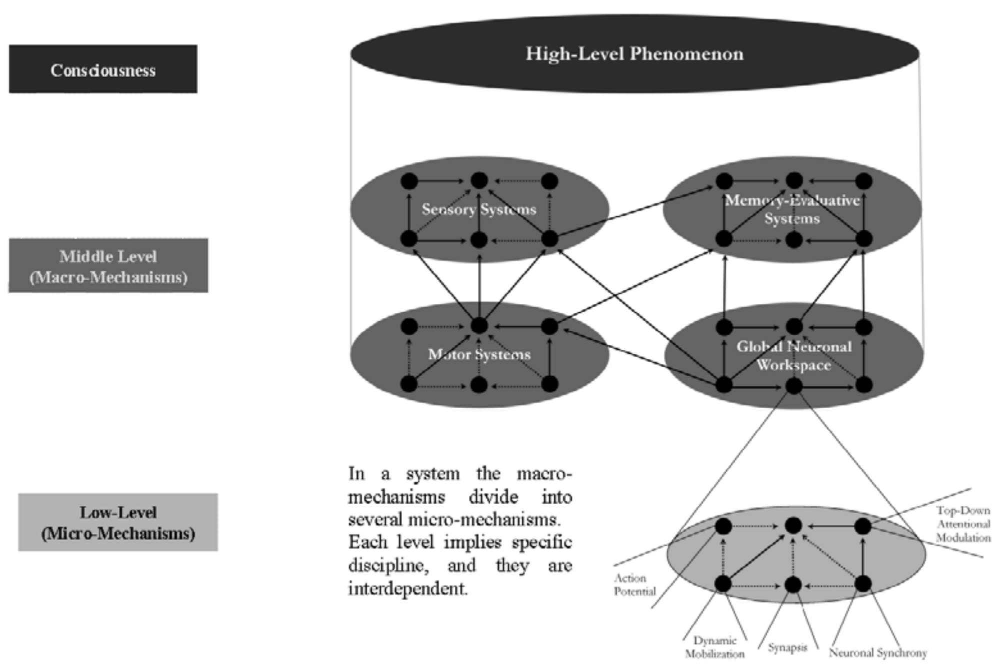

Fig. 5.1 A schematic example of the supposed mechanisms responsible for the conscious behavior. No one would say that only one part is causing the high-level behavior, or that the behavior is present at the low-level structures. There are hierarchies of levels that are dynamically interconnected. The integrated work generates the high-level phenomenon. Furthermore, a macro-mechanism can be subdivided into several other micro-mechanisms.

A given phenomenon is explainable in terms of the functioning of interconnected parts and mechanisms. Usually they are localized in the low-level structures. Bechtel observes that "parts are at lower levels, a mechanistic explanation appeals to parts and their operations to explanation the behavior of a mechanism."[51] Then to some degree, mechanistic explanations are reductionist, but not in terms of laws. Neuroscientists do not seek for laws in order to predict all further happenings in the brain – as J. Kim (1998) proposes.

In particular Kim aims for the finding of a general law that could account for all causal processes at low-level, in order to determine all future happenings in the universe. Laws are taken to determine regularities, and have nothing to do with neurobiology.[52] Neurobiology and neuroscience comprises many irregularities and exceptions. For instance, no one is able to predict how a neuronal assembly will activate based only on a set of laws. Neurons are highly plastic (they change their connections over time).

However, contrary to Kim thinks, neuroscientists work by observing and comparing. They do not try to find a general law, for example, a law that determines how neurons will activate in order to generate consciousness. This is unwise. Conversely, neuroscientists try to understand the brain in terms of the mechanisms it comprises. With these ideas in mind, the research is focused on the parts of a given system and its mechanisms. In such terms neurobiological phenomena are better understood in their original context of occurrence, i.e., locally.

For this reason, to understand how brains instantiate qualia we need firstly to understand the organization of the brain and the nervous system. Brains are composed of several modular systems that are domain-specific, i.e., they process one type of sensory information (visual, auditory, gustatory, etc.).

Neurons are the basic unity of processing (the basic component of mechanisms in the brain). They organize in many ways, by overlapping and increasing their interconnectivity, and forming complex neuronal assemblies. Neurobiology tries to understand how the mechanisms underlying cognitive processes can generate conscious behavior. The neurobiologist G. M. Shepherd presents the levels of organization that should be analyzed:[53]

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[51] W. Bechtel (2008:147-8).
[52] P. Machamer et al. (2000:7).
[53] G. M. Shepherd (1994:6-10).

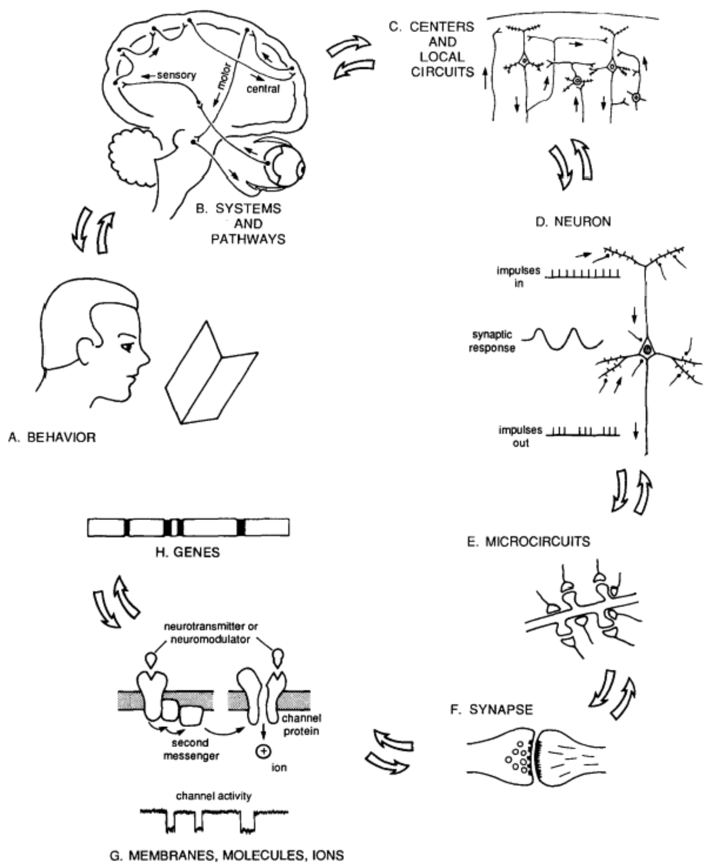

Fig. 5.2 The schematic mechanisms associated with the act of reading. There are several levels of analysis: genetic, neurochemical, neuronal, and so on. G. M. Shepherd (1994:6).

Shepherd is proposing here multilevel explanations, since he presented several levels to be considered in studying vision, not only the molecular, as Bickle holds. As I have previously commented, the best strategy to explain a mechanism is to build a model. Shepherd's figure is such a model in which he proposes the levels of organization of nervous systems. From genes, to behavior, a specific discipline should occupy itself with a level.

As we can see, each level has its own mechanisms and parts that are responsible for the behavior of reading the book. It begins with the visual system, going down to the neuronal network level, then to the level of neurons, microcircuits, synapses, molecular level, and finally genes. From genes to behavior, several mechanisms participate in the processes.

As P. S. Churchland and T. J. Sejnowiski stress "The range of structural organization implies, therefore, that there are many levels of implementation and that each has its companion task description."[54] They also consider the multilevel analysis of conscious behavior:

1 m	CNS	Anatomical approach
10 cm	Systems	Systemic approach
1 cm	Maps	Topographic approach
1 mm	Networks	Analysis of patterns of interconnectivity
100 μm	Neurons	Neuronal approach (how neurons work)
1 μm	Synapses	The nature of synapses
1 Å	Molecules	Basic level

In conclusion, mechanisms are structures which perform operations. They are composed of parts (composed of entities). Levels refer to spatial localization, a surface or context of the operation of the mechanism. Levels of analysis are important for the comprehension of a system's behavior.

Furthermore, in order to study parts and mechanisms, we could make use of *mereology*, that is, the formal study of how the parts interact. The formalization of mechanisms is very useful and employed widely in neuroscience. The explanation of a given system can be carried out by *decomposition*, i.e., the systems is decomposed into parts, and understood according the organization of the parts and its mechanisms.

As one could expect, there are problems for mechanistic explanations. A possible problem is the determination of the boundaries of the system, i.e., where a part begins and where it ends. But to solve this problem we could make use of a Wittgesteinian term: *family resemblance*. The parts organize together according to the function they perform. The boundary is ill-defined or does not exist; parts simply overlap with others. In biology it is very difficult to isolate a part and after to assert that *it is* responsible for such and such a mechanism. Normally parts are overlapped and interconnected with others.

With the conceptual tools presented in this chapter and the framework of the mechanistic explanation, I will now try to understand the neurobiological mechanisms underlying qualia generation. The remaining chapters are my attempt to make sense of qualia. But before that, I need to understand some basic neurobiology of sensory systems and why qualia have evolved. This is the task of the next chapter.

[54] P. S. Churchland and T J. Sejnowski (1990:20).

CHAPTER 6

The Evolutionary Neurobiology of Qualia

6.1. Evolution of Sensory Systems

The central claim of this chapter is that consciousness and qualia emerged from evolutionary process *only* after the appearance of *sensory systems* and *brains* with *specialized neuronal networks*. Accordingly, sensory systems detect information in the world, and the brain processes and interprets it. In doing that, organisms must be well adapted to their environment – the habitat in which they live –, since the environment poses several constraints that can jeopardize organism's survival.

Possessing highly specialized sensory systems and neuronal networks enables organisms to process incoming sensory information optimally in order to give a proper response to certain environmental stimuli. In this context, qualia emerge from those two systems as an adaptation to environmental constraints.

Aristotle once said that nothing is in the mind that does not pass through the senses.[1] Aristotle's observation makes plenty of sense if we consider the constraints

[1]Aristotle in the *De Anima* Books II and III. already speculated about what is today called *neurophysiology*. The ancient Greek philosophers were true natural philosophers dealing with several issues, and Aristotle was one of those natural philosophers. He thought that the senses provide the qualities and knowledge about the world. This claim is evidenced in several textual sequences in Aristotle's book: "Sensations is held to be a *qualitative alteration*, and nothing except what has soul in it is capable of sensation; (...) In dealing with each of the senses we shall have first to speak of the objects which are perceptible by each. The term 'object of sense' covers three kinds of objects, two kinds of which are, in our language, directly perceptible, while the remaining one is only incidentally perceptible. Of the first two kinds one (a) consists of what is perceptible by a single sense, the other (b) of what is perceptible by any and all of the senses. I call by the name of special object of this or that sense that which cannot be perceived by any other sense than that one and in respect of which no error is possible; in this sense *colour is the special object of sight, sound of hearing, flavour of taste. Touch*, indeed, *discriminates more than one set of different qualities.* Each sense has one kind of object which it discerns, and never errs in reporting that what is before it is colour or sound (though it may err as to what it is that is coloured or where that is, or what it is that is sounding or where that is.) Such objects are what we propose to call the special objects of this or that sense." (Book II, Part 4); "What can be touched are *distinctive qualities* of body as body; by such differences I mean those which characterize the elements, *viz*, hot cold, dry moist (. . .); The organ for the perception of these is that of touch – that part of the body in which primarily the sense of touch resides. This is that part which is potentially such as its object is actually: for all sense-perception is a process of being so affected; so that that which makes something such as it itself actually is makes the other such because the other is already potentially such. That is why when an object of touch is equally hot and cold or hard and soft we cannot perceive; *what we perceive must have a degree of the sensible quality lying beyond the neutral point.* This implies that the *sense itself is a 'mean' between any two opposite qualities* which determine the field of that sense. It is to this that it owes its power of discerning the objects in that field." (Book II, part XI); "*Each sense then is relative to its particular group of sensible qualities*: it is found in a sense-organ as such and discriminates the differences which exist within that group; e.g. sight discriminates white and black, taste sweet and bitter, and so

that organisms must have passed through in the course of evolutionary processes. The environment manifestly transmits patterns and forms, and organisms must be able to interpret them by distinguishing *what matters from what does not*. Their survival depends on the accuracy of the sensory of entirely new sensory modalities.[2] Most of all the known species evolved precise sensory systems that enable them to sense and perceive the world in ways which differ in relation to the specific species.

With regard to this theme, let me recast the example of the first chapter: while you watch the beautiful colored sunset on the Copacabana beach, your dog is probably sniffing around the bushes and listening for the many sounds inaudible to humans. Unlike us, dogs cannot see colors but they have a far keener sense of hearing and smell. Humans can hear sounds only in the frequency range 20 to 20,000 Hz, while dogs are able to hear sounds of more than 20,000 Hz, and the auditory perception of dolphins extends to more than 150,0000 Hz![3]

Concerning the sense of smell, humans have approximately 12 million olfactory receptor cells, dogs in general approximately 1 billion, and the bloodhound 4 billion such cells. It is clear that dogs are capable of discerning more olfactory qualities than humans, but on the other hand humans are able to sense the qualities of the color palette in a sunset which are inaccessible to dogs.

Taken for granted is the claim that all organisms *were* and *continue* to be subject to the pressure of natural selection and other evolutionary mechanisms. Such mechanisms shape all organisms, *morphologically*, *physiologically*, *psychologically*, and *behaviorally*. There are no two individuals that are exactly the same, even though we humans are 99.6% identical in our DNA structure; but the remaining 0.4% makes the great difference. The variability of individuals in some cases is useful, because it can enhance *survival* and *reproduction opportunities*.

In particular, by means of evolutionary processes traits are generated and can be passed to the next generation by the offspring, given that such a trait increases the organism's survivorship and reproducibility. Individuals who are in possession of particular traits which increase the chances of mating thereby can pass that trait on to the next generation.

That is the main idea expounded in the theory of evolution[4] by means of natural and sexual selection, proposed by Charles Darwin 150 years ago. The theory

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in all cases. Since we also discriminate white from sweet, and indeed each sensible quality from every other, with what do we perceive that they are different? It must be by sense; for what is before us is sensible objects."(Book III, part II). Emphasis added.

[2]W. Hodos & A. B. Butler (2001:113), in G. Roth & M. F. Wullimann (eds.).

[3]Data available at http://faculty.washington.edu/chudler/facts.html.

[4]However Darwin himself never used the word 'evolution' in the book .Darwin's term is "descent with modification", i.e., all species arise from others pre-existent. 'Natural selection' and 'evolution' are not synonyms. Very often the concepts are misused. 'Natural selection' is a process, whereas 'evolution' is the consequence of the process (the outcome), that is the historical record of change through the time. There exist other processes that can produce evolution, such as sexual selection, mutation, migration, gene flow, and others. The idea of 'evolution' is an old one, and it have other meanings. Several authors before Darwin – including Darwin's grandfather – used the term in different contexts. For more details see R. J. Richards, 1992:94-105, in E. F. Keller & E. A. Lloyd (eds.).

is simple in its essence, but has a large power of explanation. The main principles of natural selection as proposed by Darwin can be summarized as follows: (1) *variability* of characteristics among a population, (2) *heritability* of such characteristics, and (3) *reproduction*.

Organisms evolve under numerous constraints, and must evolve in a way which enables them deal with many problems. In order to be successful in these tasks, natural selection endows organisms with highly specialized sensory systems that enable them to detect inexhaustible information in the environment (internal and external). Sensory systems are the interface between an organism's environment and its central nervous system. The sensory receptors at the extremities of the body receive environmental called *transduction*.[5] Sensory systems are composed of sensory receptors, i.e., specialized sensory cells that transduce physical and chemical stimuli into neural impulses (electrical signals).

Those are transmitted to the central nervous system (CNS). After the sensory information being processed and interpreted in the brain by several modular systems (specialized neuronal networks). K. Sterelny points out that "we have complex and subtle systems through which we register features of our environment and control our actions. (...) Virtually all organisms can register and respond adaptively to some features of their environment."[6] Quine once commented that "creatures inveterately wrong in their inductions have a pathetic but praiseworthy tendency to die before reproducing their kind."[7]

In other words, animals that make bad predictions of the future tend to die before they can pass their genes on to the next generation. Therefore, evolutionary mechanisms will pass on an organism's fitness adaptations to the next generations, and at the same time will extinguish those that are costly or useless.[8] Specialized sensory systems are one type of such advantageous adaptations that evolved.

Herbert Spencer introduced the term "survival of the fittest" in reference to the ability that some individuals have in enhancing survival and reproduction. According to George C. Williams, 'fitness' in evolutionary contexts relates to the organism's success in producing offspring that survive to reproductive age.[9] Apart from natural selection, Darwin discovered that sexual selection is the additional mechanism responsible for changes over the time.

Sexual selection consists of competition among individuals for mating opportunities, which divides into *intrasexual competition* (competition between members of the same sex for sexual access to members of the opposite sex) and *intersexual selection* (differential mate choice of members of the opposite sex). As a rule males compete more strongly for access to females, while females choose the more

[5] See section 6.4.
[6] K. Sterelny (2003:4-11).
[7] W. van Quine (1969:126).
[8] Cf. D. M. Raup (1991).
[9] G. C. Williams (1966).

"fit" male. Through this mechanism some traits are reinforced as a response to the female's preferences.

Several studies suggest that various traits evolved by means of sexual selections.[10] There are countless examples such as: pheromones in moths, song in crickets, frogs and birds, salient colors and other visual ornaments in butterflies, fish and birds, and so on. Such traits do not in principle have any neurobiological function except to attract females. Some are deeply extravagant and costly when related to the organism's survival. They evolved in spite of that fact. A putative example is the peacock's tail. Some studies have shown that peacocks with large and dotted (eye spots) tails have more reproductive success than those with small tails or fewer dots.[11]

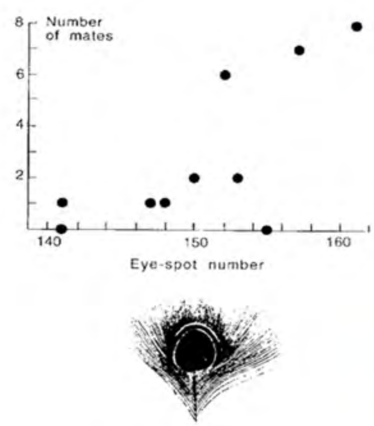

Fig. 6.1 The mating success of peacocks increases with the number of eye spots in the males' tail. Female's choice therefore favors such traits. M. Andersson (1994:336).

Fig. 6.2 The male peacock is trying to impress the female. Observe the difference in size and ornaments; the male has clearly a large and costly tail in comparison with the female. This is called in evolutionary biology as *Sexual dimorphism,* and it is generated by means of sexual selection.

The peacock's tail does not play a direct role in the process of insemination. Biologists say that such traits are secondary. In practice such a large tail tends to reduce the male's survivorship, since peacocks are not able to fly or to flee fast, i.e., the tail reduces their maneuverability. The peacock becomes more visible to predators, and keeping the tail is in consequence highly costly. In this context, a question is raised: why has such a trait evolved? And why are males and females so different? The answer lies in the issue of *sexual selection.*

[10]See M. B. Andersson (1994).
[11]M. B. Andersson (1994:334-335).

Roughly speaking, males need to detect the female's ovulation in order to mate, while females must be able to detect "good genes" in the potential partner. In doing that, organisms must be endowed with specialized sensory systems to have reproductive success. In other words, *mating systems are very dependent on the accuracy of sensory systems.*

If a change in a trait increases the lifetime reproductive success by improving the ability of an individual to attract mates and reproduce with them, it may be selected even though it lowers survival probability. For example, although the peacock's large tail is costly, it nevertheless reveals that the male is able to survive in spite of the costly tail.[12]

Putting more simply, females tend to choose males with large and dotted tails. The more colorful, symmetric and dotted the tail, the higher the probabilities of mating. Females detect "good genes" by scanning the male's tail, checking whether it is free of parasites, colorful, symmetric, long and large. This is called *sensory exploitation*, i.e., the ability females have of executing sensory scanning of potential partners in order to detect "good genes".[13]

Such a cognitive process requires refined visual systems. *Coevolution* occurs in this contex since males evolve traits in response to female's preferences, and females evolve refined visual systems that detect positive and negative properties of males. According to Darwin, the compensation of having a long costly tail is the *reproductive success*: males with extravagant tails have more chance to mate than those that do not have such a tail. In sum, male attractiveness to females increases with the tail's size.

At the time of Darwin, genetics did not exist as a science. Darwin did not understand how the mechanism of inheritance worked, i.e., how traits are passed from parents to offspring. Only after the publication of Gregor Mendel' inheritance of traits in pea plants it became clearer how inheritance functioned. Mendel showed that the inheritance of traits is based on the exchange of genes among different individuals. This discovery extended the Darwinian program and was termed by biologists the *Modern Synthesis.*

In the twenty century, evolutionary theory was developed, extended and acquired more evidence and plausibility. Now it is the only available scientific hypothesis which is able to explain how organisms evolve and survive. John A. Endler defines the current evolutionary theory by natural selection as follows:

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[12] Traits like the peacock's tail with bright colors, birds with loud vocalizations, and other species with odorant signals allow males to be located more easily by females. However, they also expose males to predators able to exploit these clues to locate their prey. As at the same time males must mate, they need to be aware of potential predators. Therefore, they are also in need of refined sensory systems to detect imminent danger in the vicinities.

[13] For more details about this and other extravagant traits in several species see M. B. Andersson (1994).

> A process that occurs if and only if these three conditions are present: the population has (a) variation among individuals in some attribute or trait (phenotypic variation); (b) a consistent relationship between that trait and mating ability, fertilizing ability, fertility, fecundity, and/or survivorship (fitness variation); and (c) a consistent relationship, for that trait, between parents and their offspring, which is at least partially independent of common environment effects (inheritance). If these three conditions are met, then one or both outcomes will occur: (1) the trait frequency distribution will differ among age classes or life-history stages to an extent beyond that expected from ontogeny (growth and development); (2) if the population is not at equilibrium, then the trait distribution of all offspring in the population will be predictably different from that of all parents, beyond that expected from conditions (a) and (c) alone. Conditions a (phenotypic variation), b (fitness variation), and c (inheritance) contain all of the biology, and the process (outcomes 1 and 2) results purely from probability and statistics, the correlated effects of the biological conditions.[14]

Such principles are responsible for *evolutionary change* over the time. Nevertheless, there are other agents operating in the process of evolutionary change: *mutation*, *gene flow*, *nonrandom mating*, and *genetic drift*. Mutation is a change in the DNA structure (in particular in a single DNA nucleotide) that can be passed to the offspring. Most mutations arise from errors during DNA replication, and rarely do mutations enhance the reproductive success. A single gene may mutate about 1 to 10 times per 100,000 cellular divisions.

Gene flow is the movement of alleles from one population to another. It occurs when individuals from population A migrate to another location with population B. If the A individual reproduces, its genes can be distributed through the gene pool of B, or at least it may change the frequencies of relevant alleles.

Nonrandom mating happens when individuals with certain genotypes mate with one another rather than with others from outside of that specific population. Mating in this case is nonrandom. For instance, inbreeding (mating with relatives) causes more occurrences of particular genotypes (recessive homozygote), e.g., carriers of sickle cell anemia. In spite of that, natural selection is the only mechanism capable of generating adaptions.

Typically, evolutionary explanation is based on those four evolutionary agents listed above. Moreover, according to the biologist Nikko Tinbergen[15] evolutionary explanation refers to some specific questions: (1) under *what* conditions did a trait

[14] J. A. Endler (1992:220), in E. F. Keller & E. A. Lloyd (eds.).
[15] *Apud* J. R. Krebs &- N. B. Davies (1997:3).

evolve, (2) *what* are the *causes* of the development, (3) *how* such particular trait evolved, (4) *what* is the *function* or adaptive value of a trait, and (5) *which* mechanisms produce the behavior. The investigation should be conducted within a set of disciplines: evolutionary theory (as the main paradigm), anatomy, neurobiology, molecular biology, genetics, paleobiology, and so on.

Sometimes Tinbergen's proposals are known as "the four Cs" of evolutionary explanation: *Conditions*, *Causes*, *Constraints* and *Consequences*. Conditions refer to the context in which natural selection occurred, or the context of competition that can be environmental, social, behavioral or anatomical. Causes refer to the selective pressures operating in the background of a particular trait, especially those that promote reproductive success. The selective pressures are constraints that organisms face, for example, biochemical, physiological, anatomical or ecological constraints. The consequences from such constraints are the current adaptations which are considered a product of evolutionary processes.

With these ideas in mind, I will put forward an explanation of qualia as biological mechanisms for detecting changes. In these terms, the questions to pose are: what are qualia? How do they evolve? How are they generated, i.e. by which mechanisms? A plausible answer should take evolutionary theory and neurobiology into consideration, since qualia are generated by sensory systems and by the brain. The main assumption is that organisms, in this particular case, human organisms, must deal with the problem of interacting with an unstable and changing world, and yet still having reproductive success.

One can say that environmental changes pose selective pressures, and organisms must be well adapted to such changes. Living in a "hostile world" requires the ability to detect, select, encode, process and interpret incoming information.[16] It is hardly necessary to point out that all organisms on Earth have developed sensory systems to carry out the task. Survival and reproduction depends on the *accuracy* of information and an optimal behavioral response.

Thus the evolution of sensory modalities tends to increase the ability to sense the environmental changes occurring constantly in the surroundings. If some trait related to detection of such environmental changes is effective in doing some cognitive task in a specific environment, then there is a trend that such a trait will pass through to the next generation, establishing a trend in the evolutionary record. Such an evolutionary change occurs within a pre-existent organization and architecture.

Organisms need to innovate by adapting to numerous and changing environmental constraints. Theoretically, current sensory receptors may have arisen out of a modification of former existing receptors that permitted organisms to detect a different range of stimuli within the same modality. There are some studies pointing

[16] Cf. K. Sterelny (2003).

out evidence for the assumption that the earliest sensory receptors were mechanoreceptors[17] and chemoreceptors.[18] From such primitive sensory receptors, the highly specialized sensory systems evolved.[19]

The main reason for the evolution of sensory systems is that autonomous animals need to be able to assess situations in their surroundings and rapidly develop strategies to deal with them. Failure to do so successfully can mean death, and thereby failure to help continue the species. As a result, there must be mechanisms to take visual and other sensory cues, and compute from them strategies that prove successful. K. Sterelny observes that sensory systems are ubiquitous in nature; from the cockroach to humans, all organisms are equipped with "detection systems".[20]

For animals with simple brain structures, such operations are believed to be performed automatically, without any conscious aspects. For social animals living in groups many new problems arise: how to interrelate among members, when to share food and with whom, if and when to join defensive or offensive alliances (cooperation), when to stay and when to move on, and countless more. Animal brain structures must be more complex and larger to successfully deal with issues of this kind and to respond suitably to an environmental stimulus. But at some point the organism no longer operates in robotic fashion, on the contrary it develops *consciousness* and *self-awareness*.

In this context consciousness means the *possibility of remembering things from the past*, and *using such memories consciously in dealing with a given situation*, a similar version of which we have experienced in the past. Even though many of our actions are automatic and instinctive and we perform them without knowing why; there are others where we can use *memory* and *conscious cognition* to come to a decision. For instance, the last time I ate a fruit of this shape, color, and smell, I suffered a digestive upset and therefore I no longer eat this fruit; my sweetheart likes only red roses, not white or yellow ones, as I learned from pleasant or painful past experiences.

Other animals such as hummingbirds and bees are unaware of the memory of red. There may be a neural network making them fly toward spots with a given spectral signature, genetically based and trained by actual experiences. In our case we have the ability of conscious cognition and memory of red. This is represented by what philosophers call a *quale*. For us the quale of red is something we can recall from past experience into consciousness.

Of course, we do not have to think about this any longer; it happens rapidly and seemingly automatically. We learn the name for red early in our life (as Wittgenstein wisely argued in the *Philosophical Investigations*) and in whatever language we speak, but the quale itself presumably has a genetic basis, *viz*, sensory systems.

[17]Sensory receptors that respond to mechanical pressure.
[18]Sensory receptors that detect certain chemical stimuli in the environment.
[19]See G. Roth & M. F. Wullimann (2001).
[20]K. Sterelny (2003:14).

Therefore, the *first place* qualia arise are in the *sensory modalities*. But they are not enough, since the sensory information must become conscious for the subject and receive further qualities.

The development of highly specialized sensory modalities requires at the same time the development of neuronal pathways from the peripheral sensory systems to the sensory cortices and other areas such as the thalamus and the hippocampi (memory-evaluative systems). Consequently more complex brains are need to process incoming sensory information. Thus the organization of the brain underwent a strong selective pressure towards optimization of the behavioral response to environmental constraints. Some studies suggest that the growth of the brain correlates with behavioral adaptation.[21]

In other words, *having specialized sensory systems requires an effective processor*. The solution that mammals found was the enlargement of the cerebral cortex in order to accommodate the new specialized areas responsible for processing sensory information. That is a task for the *neocortex*, a recent structure, present only in species with large brains – species that have complex social behavior such as great apes, dolphins, humans, and whales. In comparison with other species, the brain size of humans, for example seems disproportionally large. The reason is simple: *detecting and processing several types of sensory information at the same time and relating it to memory systems requires an optimal processor*.

Because of the evolution of sensory systems, the brain was organized into *topographic sensory maps*, (tonotopic, retinotopic, somatopic, chemotopic, etc.), i.e., specialized areas in processing specific sensory information. Each sensory modality is interconnected with those maps and has a specialized area responsible for the processing of a specific stimulus. The cost for such adaptation was large brains that present real risk to the survival of the mother, since her pelvic cavity constrains the head size of the offspring.

In order to solve such constraint, there was selection for the *fontanelle*, an anatomical flexible feature of an infant's skull that enables him to pass through the pelvic cavity of the mother. Furthermore, there was selection for a massive and compact brain by compression and folding into layers. It has been estimated that within $1mm^3$ of human cortex there exist about 50,000 neurons that contain 150 m of dendrites and 100 m of axons. The estimated number of synapses in this small area is about 50×10^6.[22] Such a complexity evidences the difficulty in investigating such biological systems – which philosophers such as Chalmers and Jackson do not take into account.

The cerebral cortex has a massive population of neurons interconnected in many ways, which enable organisms to be informed about the current state in the surroundings. The result is a compact device with fast and short cortical connections. The size of the modular units increases with the associated function,

[21] See J. H. Kaas (1989, 2004, 2006, 2008) and R. A. Barton (2007).
[22] Cf. C. Cherniak (1990).

for example, since humans are visual animals, their visual cortex occupies a large area in the occipital region.

The cerebral cortex is hierarchically organized according to the function of neurons. Clusters of neurons specialized in processing one type of information associate with similar clusters, giving rise to neuronal assemblies. Furthermore, a bigger brain is physiologically only viable because of the cardiovascular systems that enable the transport of oxygen by the blood at greater pressure to meet the increased demand.[23]

As more information is acquired by the eyes and other sensory organs, the brain evolves in parallel to process this information and transmit it to the effector organs, like the muscles, which gives rise to behavioral responses. About this theme W. Hodos and A. B. Butler point out that:

> Sensory systems are essentially the same in their intrinsic organization and processing, as may be seen in the strikingly similar bipolar and first-order multipolar cell populations present in all sensory systems. The differences that are observed among them occur as a result of differences imposed by the physical properties of their stimuli and the transduction process of their processors.[24]

Survival and reproduction require the exploration of a variety of elements, for instance, water, food, time and space, and so on. These things are called resources, and they can contribute towards the fitness of the organism. In order to detect such resources, organisms need sensory modalities, since they must search for prey, escape from predators, match climate conditions, find sexual partners, and so on. This requires suitable sensory mechanisms in order to detect resource distribution, sexual partners, competition, etc. Following these principles I consider five central causes for the evolution of sensory systems:

(1) **Detection of environmental changes such as temperature, pressure, seasons, colors, sounds;**
(2) **Detection of resources as food, water, niches;**
(3) **Detection of preys and predators;**
(4) **Detection of sexual partners;**
(5) **Communication among the members of the same species.**

The reasons for the evolution of sensory systems seem evident: since the world changes constantly, organisms must adapt to such changes, by detecting when a change is happening. In doing that, they need *to keep information always on line in order to give a better behavioral response.* Furthermore, *information always*

[23]Cf. J. H. Kaas *supra* note 21.
[24]W. Hodos & A. B. Butler (2001:130), in G. Roth & M. F. Wullimann (eds.).

comes with specific qualities that enable organisms to evaluate the current state of affairs in the surroundings.

6.2. Environmental Constraints

The environment played a central role in the evolution of sensory systems. Several factors in the physical environment determine the survival of organisms. The key elements are: temperature, pressure, water, light and food that create selective pressures on the survival of organisms. Examples of selective pressure are drastic environmental changes, limited resources, and competition between individuals.

It is take for granted that organisms develop adaptations in order to survive in different environments. An adaptation, in particular, consists of phenotypic changes that can enhance an organism's ability to survive and reproduce. Some adaptations are inherited since they are revealed to be *economic*, *efficient* and *reliable* in solving specific adaptive problems.

J. Tooby and L. Cosmides define an adaptive problem the obstacles posed by the environment that could affect the organism's survival and reproduction. An adaptive problem can be the identification of regularities in the physical, chemical, ecological, demographic, social environment faced by the organism.[25]

However not all adaptations evolved for specific purposes, as Tooby and Cosmides argue. Each adaptation in principle was selected for a unique environment, but it can reveal itself to be useful in another context or environment. That is, the *ability to enjoy qualia* (the qualitative content arising from conscious experience) today could be considered as a "byproduct" of the original function. Its original function was not enjoying, but *to optimize the survivorship and reproduction of organisms*. In other words, the pleasant taste of an apple *is a signal to the consciousness* that an apple is good. Maybe "enjoyments" are themselves a feature of such evolutionary processes, i.e., an element of self-regulation in an organism.

In the "struggle for existence" organisms must be *well attuned to environmental changes generation-by-generation*. That is, generation by generation a given trait that enables an organism to have reproductive success and survival, will be favorable and passed to the offspring. Then this trait tends to become more common in the population. If the environmental condition remains constant, the trait remains constant too; if environmental conditions change, there will be evolution towards a more suitable trait.

In sum, several factors count as influencing the evolutionary processes; the most important are the resources availability, the environmental conditions in general and competition for sexual partners. However geographical factors seem to have played a central role in evolution, determining the geographic distribution of the species over different regions, and the current sensory modalities. Each region requires

[25] J. Tooby & L. Cosmides (1992:62), in J. H. Barkow & L. Cosmides, et al. (eds.).

specific sensory systems, according to the necessities of the organisms. Thus we see bats with specialized sensory systems to navigate in the dark, humans with color vision, dogs with refined olfactory systems, and so on.

As is already evident, organisms perceive the world through the sensory systems. The environment presents numerous stimuli: temperature, pressure, food, light, smells, sounds, and so on. R. Potts argues that environmental instability has been the single constant shaping our interaction with nature, i.e., *Earth's ecology is constantly changing*.[26] Thus different species evolved different sensory modalities in order to be informed about the actual state of affairs in the habitat they live. In other words, organisms must "decide" if some stimulus should be detected or ignored.

Evolving in an unstable and changing environment *does not allow philosophical doubts about the external world*. As Giere holds, "for early humans there never was a general "problem of the external world."[27] For evolving living systems there are only two aims: survival and reproduction. When environmental changes occur, organisms are constrained and need to give a response to such change in an appropriate manner.

Typically the responses consist in development of specific adaptations such as sensory systems that detect a minimal changes in the surroundings. With this, ability organisms can behave in response to the detected stimuli. In humans and other primates color vision is a fundamental modality. As I argue in the next section, color vision evolved in response to several environmental constraints: foraging, detecting resources, predators, sexual partners, etc.

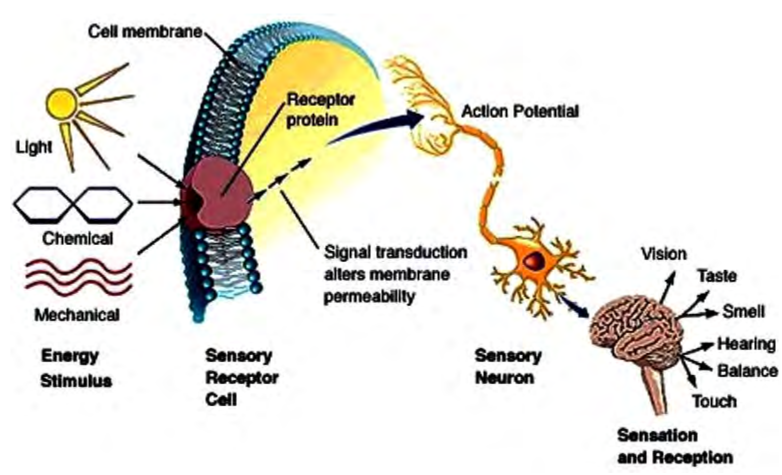

Fig. 6.3 Environmental stimuli are ubiquities and reach our sensory systems constantly.

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[26]R. Potts (1997).
[27]R. N. Giere (2008:216), in S. Psillos & M. Curd (eds.).

6.3. Evolution of Color Vision

Vision is the most important modality for several species, especially for Great Primates, humans and birds. For 5 billion years, sunlight has been the most potent selective force to control the evolution of living organisms. Organisms evolved eyes in response to the light, which enable them to see the world, and numerous spatial animals have vision as the principal sensory detector. But eyes evolved in several types and degrees of complexity. I will not consider the complete history of eye evolution, but only the recent evolution of color vision in humans, the specialists in color vision.[28]

Vision is an old modality present in almost all species, and it is highly developed in old world primates. They have color vision, an adaptation that enhance the visibility of objects from their background, such as food objects (distinguishing between ripe and unripe fruits), discrimination between toxic and nontoxic insects and plants, discrimination between males and females, predators, and others aspects of the visual environment that could enhance survival. The most important property of color, for the survival of the species, is *not to lead to pleasurable sensations* or otherwise that it gives (the quale), but the fact that *it helps to recognize objects*.

The visual system has evolved so that the color of an object remains constant when illuminated by different sources of illumination, and against different backgrounds. This is known as object color constancy. What the brain recognizes is a property of the object, namely the percentage of each wavelength that is reflected by the object (reflection spectrum). The composition of the wavelengths reaching the eye from the object is the product of the reflection spectrum and the illumination falling on the object – what the visual system does, as H. von Helmholtz put it, is to "discount the source of illumination."[29]

Color vision ability is a recent adaptation in response to environmental constraints. Although there are controversies concerning the evolution of trichromatic animals, some assumptions are well established. Even Darwin investigated the evolution of eyes, but he did not have the tools available today. Darwin made comparisons among the visual systems of several species and proposed a hypothesis. However he doubted whether natural selection could generate an organ of "extreme perfection and complication".

Nowadays by using molecular genetics one can determine accurately the history of the gene associated with tricromacy in mammals[30] (the functional X-linked opsin gene, present in old world monkeys). This gene is supposed to be a mutation from

[28]For more details about the evolution of eyes in several species see M. F. Land. & R. D. Fernald (1992); J. H. Kaas (1989); W. J. Gehring (2005), B. C. Regan et al. (2001). For a synoptic view of the current hypothesis of eye evolution see T. R. Gregory (2008:373-374).

[29]H. von Helmholtz *Treatise on Physiological Optics* (1910). More information about color vision see chapter 4.

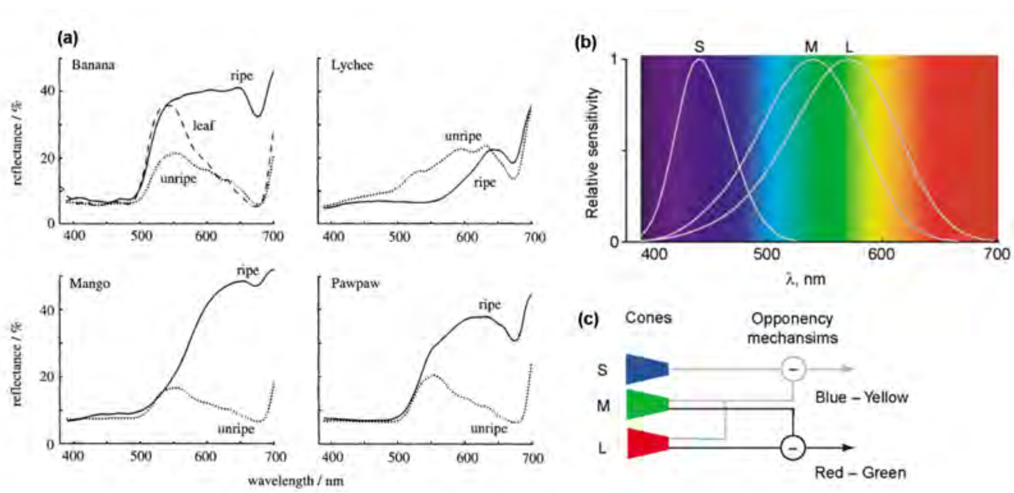
[30]Cf. D. Osorio. & M. Vorobyev (1996), D. M. Hunt & K. S. Dulai, et al. (1998), A. K Surridge, D. Osorio, et al. (2003).

a dichromatic gene. In other words, trichromatic animals evolved from dichromatic ones, for all living primate species that have been studied possess a functional X-linked opsin gene and an autosomal short-wave opsin gene.[31]

The evolution of color vision must be linked with the environmental constraints that imposed adaptive problems on the species. Furthermore, the evolution of color vision is also associated with the evolution of plants, predators, and mate competition. Fruits constitute the diet of several old world apes, e.g., the chimpanzee's diet consist of 68% of fruits and for gibbons it is 62%. Fruits are one of the favorite resources of great primates. In a given niche, there is competition for such resources. In consequence, some organisms evolved the ability to detect the ripeness of fruits by using color vision.

At the same time, plants that have more varied color patterns can have their seeds more efficiently dispersed in space and time. That is, the reproductive success of plant depends on the dispersal of their seeds, which in turn depends on their color patterns. Thus plants evolved (co-evolution) the several color patterns and the edible taste that attract primates in response to the primate's evolving ability to see colors.

One of the most common adaptations in flowering plants to secure seed dispersal is to produce edible fruits, and the plants that produce them benefit from this mutual interaction: the plants provide nutritious tissues closely associated with the seeds, and the animals that eat the fruits may then drop, spit, regurgitate or defecate the seeds at a distance from the parent plant. Furthermore, edible fruits act directly on the reward systems (limbic system). The result is the enjoying or of some tastes and odors, or otherwise.



[31]B. C. Regan et al. (2001:232).

Fig. 6.4 (a) Fruit spectra showing the wavelengths of the fruits that are part of primates' diet. From D. Osorio & M. Vorobyev (1996:594), (b) and (c) show the visible spectrum and the cones specificities.

Human spectral sensitivity of cones can detect the wavelength associated with ripeness and unripness. Thus the spectral range of color in fruits should tune in with the spectral sensitivity of humans and primates. Cone sensibility in humans ranges from 400 to 700 nm.

The spectral sensitivity of a photoreceptor cell is defined as the (relative) likelihood of a photon of given wavelength being transduced to produce a neural signal. The two types of cone receptor are called long- (L) and short-wavelength (S) sensitive, whereas trichromatic eyes have an additional middle-wavelength (M) sensitive receptor. L, M and S receptors are sometimes called 'red', 'green' and 'blue' respectively.

Figure 6.4b and c illustrates the normalized spectral sensitivities of the three photoreceptors in the catarrhines and howler monkeys, which have separate M and L opsins. The spectrum indicates the approximate color as a function of wavelength. Spectral information encoded by an eye with spectral types of photoreceptor can be represented by one 'achromatic' (or brightness) mechanism. Figures b and c illustrate these chromatic interactions in a trichromatic primate.[32]

Certain tropical plants produce vividly colored fruits (see figure 6.4a), apparently in order to attract primates, and trichromatic color vision helps primates to detect these fruits. Then plants attract animals with a conspicuous stimulus that signals an edible reward. Concerning this topic S. Polyak affirms that:

> The evolution of colored fruits, of course, was a process parallel to the evolution of the color sense in the animals to be attracted. This relationship became beneficial to both partners, which profited from it: the animals in getting food, the plants in perpetuating themselves and spreading into new regions.[33]

In addition, R. Gregory showed that objects that differ in color from their background attract attention to themselves.[34] The search is rapid and independent of the number of items in the visual array, when the target item is of a unique color among distractors of a different color, provided that the difference is of moderate size.

Color-defective human, for instance, experience real difficulty in the natural visual search task of detecting fruit amongst foliage on trees and shrubs, suggesting that normal trichromatic color vision conveys an advantage in this task. If

[32] A. K. Surridge, D. Osorio, et al. (2003:199).
[33] S. L. Polyak (1957:973-974).
[34] R. Gregory (1998).

trichromatic color vision reveals the presence of fruit at a distance, it should have considerable survival value for primates. For example, see the next two figures and tell me which kind of vision is better to detect ripeness: black and white or color vision?

Fig. 6.5 The appearance of a potential food is likely to serve as an important physical feature cueing long-range foraging by primates. The color of a potential food item is one of its most salient features. The search for ripe fruits and vegetables become an easy task with color vision.

Primate color vision and the reflectance functions of the fruits they eat have, therefore, coevolved. According to D. Janzen, co-evolution requires that a trait of one species has evolved in response to a trait in another species, which trait itself has evolved in response to the trait in the first.[35] From the primates' point of view, color vision helps to detect not only fruits, but any object colored differently from the background, such as flowers, young leaves (which are often yellowish or reddish) and other animals.

P. W. Lucas et al. argues that the need to detect reddish young leaves, in times when fruits are scarce, has exerted a stronger selection pressure on primates for trichromacy than has the need to detect brightly colored fruits.[36] Moreover primate color vision also plays a role in visual communication: color is important

[35] D. Janzen (1980).
[36] P. W. Lucas et al. (1998).

to some primates in socio-sexual signals and threat displays.[37] So the evolution of primate trichromacy may have been influenced by several factors in order confer advantage at detecting resources, preys and predators, and so on. Primate trichromacy could first have evolved to detect any fruit against leaves (rather than specifically those disseminated by primates), to detect edible yellow or red young leaves against mature leaves, or to detect co-species.[38]

6.4. Neurobiology of Sensory Systems

The brain is the organ of consciousness. In particular the human brain constitutes less than 2% of the body mass (2 Kg), but it consumes about 15% of the total metabolic activity. The capacity for processing information is proportional to the number of connections neurons can make. An adult human brain contains about 100 billion neurons that make more than 3 trillion synapses.[39] The whole neuronal networks have more than 100,000 Km of connections. However, the brain would be useless without the sensory systems, which enable the flow of information from the internal and external environment.

Putting more simply, we experience the world through the sensory systems. So that qualia are generated by the brain, not in the peripheral sensory systems. But without sensory systems there would be no qualia at all. In reality, the brain does not sense or perceive anything – there are no sensory cells in the brain. The sensory information incoming from the several sensory modalities is sent to the brain that processes and interprets that input. The result is conscious sensation and perception of a given stimulus. The brain and its multiple neuronal network process sensory information provided by the sensory systems, and the brain produces the conscious sensation and its qualia.

A sensation is defined as the awareness and the localization of a stimulus caused by a change in the internal or external environment. The stimulation leads to a response. Once aware of the stimulus, the brain interprets it as producing the perception of that sensation. Therefore, perception is the process of becoming aware of the sensation. But the perception can remain as pre-conscious or become conscious. Conscious perception depends on the attentional processes (as I argue in chapter 7). For instance, burning your hand while you are cooking causes an immediate sensation of pain, whereas the awareness of being injured is the conscious perception. Then you give a response based on what is conscious to you: namely avoiding the fire. But the mechanisms that assign qualitative features to these

[37] J. R. Krebs & N. B. Davies (1997 chapters 2, 4, 7).
[38] Cf. P. W. Lucas et al. (1998) and D. Janzen (1980).
[39] This number will probably be reconsidered. A new study executed by Brazilian neuroscientists suggests that we have fewer neurons: 86 billions. The study concludes that human brain is not so large and different from other mammals. In particular human brain is a typical mammal brain proportionally to the size of the body. See S. Herculano-Houzel, C. E. Collins, et al. (2007) and F. A. Azevedo et al. (2009).

sensations in the brain are not well explained. A hypothesis is put forward in the last chapter.

Natural and social environments present several stimuli in various forms: light, sounds, forms, tastes, and so on. In order to detect such inexhaustible patterns, in spreading over the world organisms developed specialized adaptations, *viz* sensory systems. More accurately, what organisms detect in the environment is the energy of a stimulus that is converted into neural energy to be processed in the several neural networks. How do organisms execute such a task? By means of specialized sensory systems, i.e., the different sensory modalities responsible for detecting specific energy in the environment.

Sensory cells respond to environmental stimulation, and the type of energy able to evoke such a neuronal response differs according to the sensory modality. For example, in the auditory system of mammals hair cells of the cochlea transduce mechanical energy; in the visual system, rods and cones of the retina transduce light energy. Sensory nerve endings are generally sensitive to stimulation of a small patch of the surroundings. This patch is known as the receptive field (RF) of the sensory fiber. These cells transmit information to ganglion cells that send axons to the central nervous system.

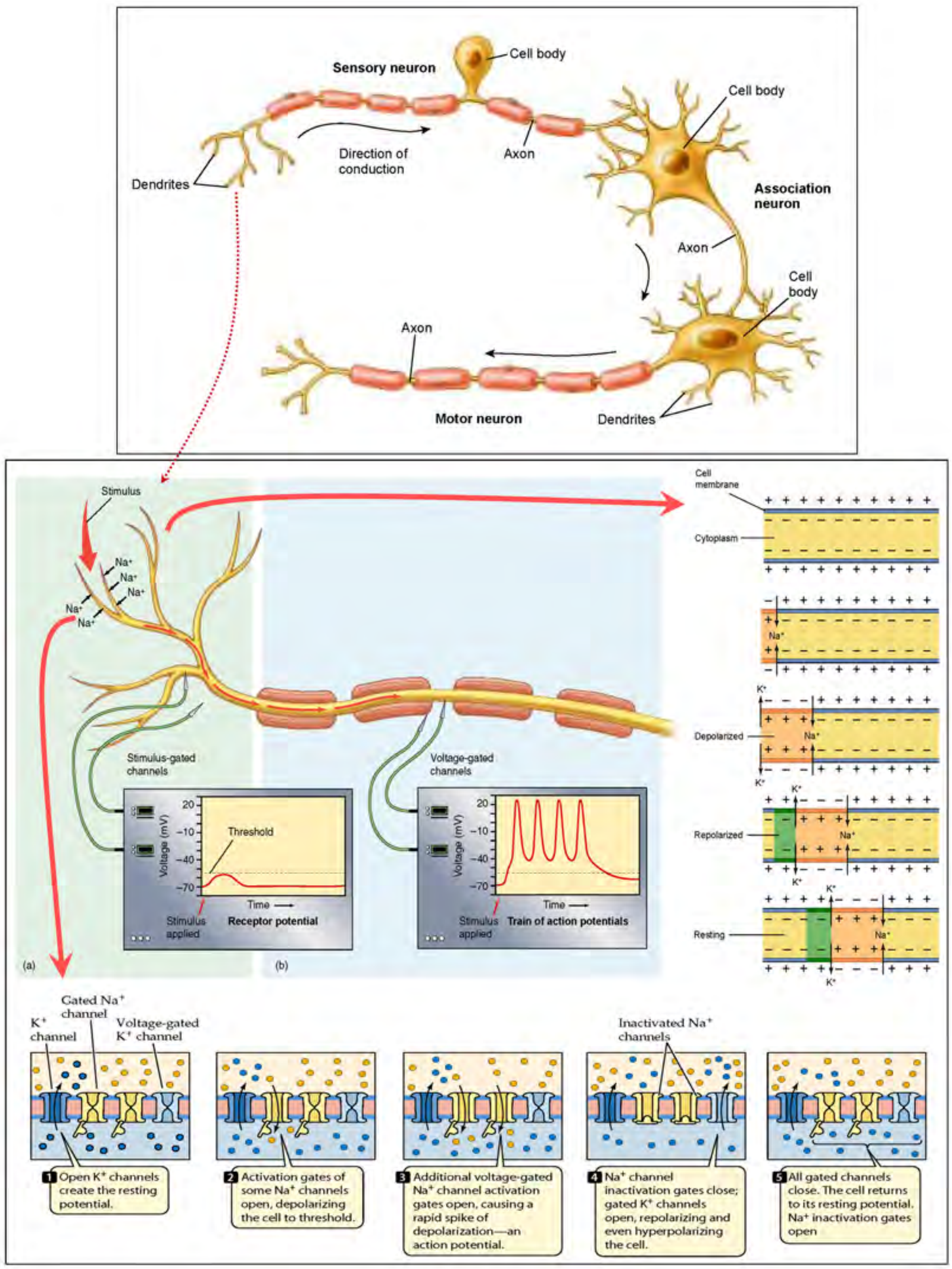


Fig 6.6 The anatomical structure of the sensory cells and the mechanism of transduction of environmental energy into neural signals. D. Purves (2004, 2008).

Sensory receptors are anatomical structures made up of special cells that respond to specific changes in their environment (stimuli). Sensory cells distributed throughout the body detect, select and convert packs of energy (patterns and forms) by unifying them into sensory information according to the sensory modality. Sensory information detected in the environment (internal or external) is converted into electrical signals that are conducted by neurons to the central nervous system (CNS).

Sensory neurons (afferent) carry impulses from the sensory receptors to the (CNS); motor neurons (efferent) carry impulses from the CNS to the sensory cortex. A third type of neuron located in the brain and spinal cord, called association interneurons, help to provide more complex reflexes and higher associative functions, including learning and memory. Then sensory information is processed by modular systems specialized in specific features.

The mechanisms of sensory transduction are well known (see figure 6.6): a physical stimulus causes a change in the cell membrane permeability to ions (the cell opens or closes), depending on the sensory systems involved. The sensory stimulation produces a depolarization of the receptor cell (receptor potential), that in turn can be spread locally over the neural circuits. If the threshold level of polarization is reached (about –55mV in mammalian axons), the receptor potential produces action potentials that travel down by means of long-range axons to the CNS.[40]

The magnitude of a receptor potential is directly related to how strong the stimulus is. If a receptor potential is large enough, it may result in a conscious sensation in the brain.[41] Action potential can be reproduced at different points along the axon membrane and are conducted without decreasing in amplitude, thus the last action potential at the end of the axon is just as large as the first one. At the end of the axon are other neurons. Such cellular junctions are called *synapses*, and neurons communicate by means of synaptic mechanisms (see figure 6.7). The neuron whose axons transmit action potentials to the synapse is the *presynaptic cell*, while the cell on the other side of the synapse is the *postsynaptic cell*.

The end of each presynaptic axon contains numerous synaptic vesicles packed with chemical called neurotransmitters. When action potentials arrive at the extremities of the axon, they stimulate the opening of voltage-gated Ca^+channels, causing a rapid inward diffusion of Ca^+. Then the vesicles release neurotransmitters. The higher the frequency of action potentials in the presynaptic axon, the more the vesicles which will release contents of neurotransmitters.

The quantity of synaptic transmissions in a single neuron in the spinal cord, for instance, can be above of 50,000 connections! I would say that the complexity of such mechanisms and how they interact are the main constraint to the development

[40]An axon can be quite long, e.g., axons that control muscles in the feet are more than a meter long.

[41]I develop this idea in the chapter 7.

of an adequate theory of consciousness, not dualist tales or the problem of the external world.

In some cases, the sensory cells diminish gradually their responses to a repeated stimulus. Then we become habituated with the stimulus. For example, very often we ignore several stimuli in the background or unchanging conditions in the vicinity, while on the other hand we become highly sensitive to unexpected changes or to new information. When we are walking on the street, we do not used to feel the ground under our feet; we do not feel the shoes and the clothes, and many other irrelevant stimuli that are present in the surroundings. They are *irrelevant* and do not present a minimum degree of novelty. I would say they lack evolutionary value, i.e., do not pose a threat to our survival.

This ability to become accustomed to repeated stimuli is called adaptation. But in contrast, we become immediately aware when we tread on a hole in the street, when a car crash occurs, or when is getting colder, we note that our jacket is open, and then we zip it immediately. The mechanisms underlying the action are completely unconscious. On the other hand, the change of the current conditions in the vicinities calls on our attention immediately, and then we become conscious of the change.

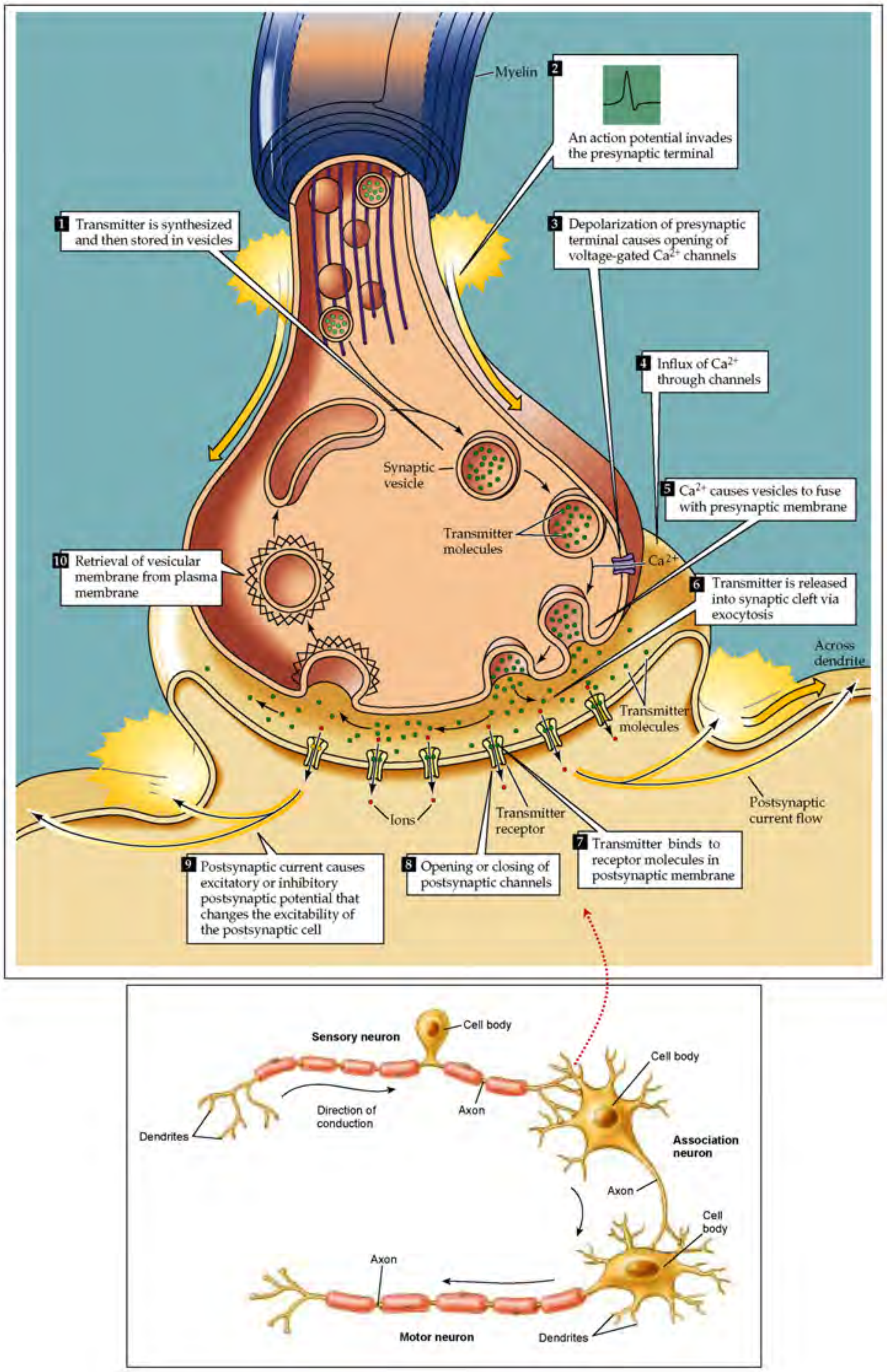


Fig. 6.7 The mechanism of synapsis. D. Purves (2004, 2008).

The examples show a variety of environmental stimuli. All of them reach our sensory receptors, but only some do reach consciousness (as I argue the next chapter). Organisms are able to distinguish a variety of sensory stimuli because each kind of stimulus activates different types of receptor cells. The term 'modality' refers to the type of sensation a stimulus produces. That is, each category of sensation – such as touch, taste, or sound – is a sensory modality.

The features that characterize stimuli within a certain modality are called qualities, or in philosophers' terms qualia. For instance, light can be red or blue, taste can be sweet or sour, and sounds can be high or low in pitch.

Different organisms have evolved different types of sensory systems. But the principle is the same, and can be summarized as follows: sensory information is conveyed to the CNS according to four-steps processes: (1) *stimulation*, a physical stimulus impinges on a sensory neuron; (2) *transduction* (the changes of one form of energy into another) the stimulus energy is converted into electrochemical nerve impulses in the dendrites of the sensory neuron; (3) *transmission*, the axon of the sensory neuron conducts action potentials (spikes or electrical impulses) along an afferent pathway to the CNS; and (4) *interpretation*, the brain creates a sensory perception from electrochemical events produced by afferent stimulation. The result is a qualitative content experienced subjectively.

Each receptor responds only to specific stimuli, for instance, photoreceptors in the retina react only to specific wavelengths, taste receptors respond only to chemical solutions and so on. The former does not respond to the latter and *vice versa*. In other words, sensory receptors respond only to specific physical and chemical stimuli. This ability is called *receptor specificity*. Sensory receptors are classified according to the modality. Such specialization is the basis of the so-called "law of specific sense energy" propounded by J. Müller in 1826. He states that the quality of a sensation is not due to the stimulus, but to the special sensory organ stimulated (the modality).[42]

Müller was the first to observe the specificity of sensory modalities and the application of qualities by them. Müller divided sensory modalities into sub-modalities (see the tables below). The term 'modality' refers to the specific sensory receptor, and the qualities are associated with the sub-classes within a modality, such as visual system that has specific qualities (see tables below).

The process of transduction converts an environmental stimulus into neural signals that become identical in nature. This is necessary in order to be transmitted by neuronal networks and processed and interpreted by the brain. But if all sensory inputs are identical in terms of neural impulses, how does the brain distinguish between different modalities? The sensory neural pathways are relayed in the brain in specific areas responsible for the processing of specific sensory information. That is, the brain is divided into specific sensory areas (sensory cortices).

Such areas receive the information from the sensory systems. Currently the brain is considered to be a modular system with several sensory maps. The topographic map of the cerebral cortex is divided according to the modality: so-

[42] J. Müller (1840:106).

matosensory cortex, gustatory cortex, olfactory cortex, auditory cortex, and visual cortex. The brain integrates the sensory information by unifying them in a single "representation".

Stimulus	Receptor	Location	Structure	Transduction	Quality
			Interoceptors		
Temperature	Heat receptors and cold receptors	Skin, hypothalamus	Free nerve ending	Temperature change opens/closes ion channels in membrane	Cold, hot (warm)
Touch	Meissner's corpuscles, Merkel cells	Surface of skin	Nerve ending within elastic capsule	Rapid or extended change in pressure deforms membrane	Soft, pleasant, heavy, unpleasant, location
Vibration	Pacinian corpuscles	Deep within skin	Nerve ending within elastic capsule	Severe change in pressure deforms membrane	Intensity (weak, strong, fast, slow) location
Pain	Nociceptors	Throughout body	Free nerve ending	Chemicals or changes in pressure or temperature open/close ion channels in membrane	Duration (fast or slow) Intensity, location
Muscle stretch	Stretch receptors	Within muscles	Spiral nerve endings wrapped around muscle spindle	Stretch of spindle deforms membrane	
Blood pressure	Baroreceptors	Arterial branches	Nerve endings over thin part of arterial wall	Stretch of arterial wall deforms membrane	
			Exteroceptors		
Gravity	Statocysts	Outer chambers of inner ear	Otoliths and hair cells	Otoliths deform hair cells	
Motion	Cupula and Lateral line organ	Semicircular canals of inner ear Within grooves on body surface of fish	Collection of hair cells	Fluid movement deforms hair cells	Duration (fast or slow) location
Taste	Taste bud cells	Mouth; skin of fish	Chemoreceptors: epithelial cells with microvilli	Chemicals bind to membrane receptors	Sweet, salty, sour, bitter, umani
Smell	Olfactory neurons	Nasal passages	Chemoreceptors: ciliated neurons	Chemicals bind to membrane receptors	Intensity (weak or strong)
Hearing	Organ of Corti	Cochlea of inner ear	Hair cells between basilar and tectorial membranes	Sound waves in fluid deform Membranes	Pitchy (frequency and intensity), loudness, timbre
Vision	Rod and cone cells	Retina of eye	Array of photosensitive pigments	Light initiates process that closes ion channels	Brightness, contrast, hue, saturation, depth
Heat	Pit organ	Face of snake	Temperature receptors in two Chambers	Receptors compare temperatures of surface and interior chambers	
Electricity	Ampullae of Lorenzini	Within skin of fishes	Closed vesicles with asymmetrical ion channel distribution	Electrical field alters ion distribution on membranes	

Tab. 6.1a and b The modalities and submodalities with their specific qualities.

Neural impulses arriving the cerebral cortex are sent to the specific sensory area in virtue of the sensory stimulation. For example, if photoreceptors are stimulated at a certain threshold, the visual cortex is activated, and the sensation is a visual scene; if the auditory cortex is stimulated at other threshold, then the auditory cortex is activated and the result is a sound, and so on. The sunset and the sound of the waves on the beach are distinguished by the brain only in terms of action potentials and the frequencies of these impulses.

After the processing, the sensory information becomes globally available for several neuronal networks that enter in *neuronal synchrony*. The result is generation of a global neuronal workspace, where such information becomes conscious. The next step is the relationship with the memory systems, but this is the theme for the last chapter.

As the table shows, environmental stimuli detected by sensory systems divide into three classes: (1) mechanical forces which stimulate mechanoreceptors; (2) chemical which stimulate chemoreceptors; and (3) electromagnetic and thermal energy, which stimulate a variety of receptors, including the photoreceptors of the eyes. Sensory systems inform about the actual state of affairs in the environment and can divide according to the locus of stimulus. *Exteroreceptors* detect information in the external environment, and *interoreceptors* sense stimuli that arise from within the body, e.g., stimuli related to muscle length and tension, limb position, pain, blood chemistry, volume and pressure, and body temperature.

After this introduction to basic neurobiology of sensory systems, the next step is the presentation of the *Global Neuronal Workspace Model of Consciousness* and how qualia are generated in it. The mechanisms of sensory modalities are central in the understanding of how qualia are generated, since sensory modalities apply the first raw qualities at the moment of the transduction of environmental stimuli into neural signals. Such signals receive further processing in the brain and give rise to the subjective qualia.

CHAPTER 7

The Global Neuronal Workspace Model

7.1. Theoretical Foundations

First of all: *consciousness is not a single phenomenon; it has several facets*; one of them is the *qualitative aspect we experience everyday.* The additional factors are the purposefulness of behavior, the state of being awake (not sleeping), emotions, attention, self-consciousness (consciousness of self as a human being and the world), decision-making and reasoning, and so on. Currently, the scientific study of consciousness follows the assumption that consciousness is entailed by neuronal activities in the brain. Few philosophers accept this fact, but there is a tendency to converge into a science of consciousness considering it as neurally realized.

Today, there is no doubt that consciousness is brain-based. In consequence *investigating brain mechanisms means investigating processes that give rise to consciousness.* However such an enterprise still lacks a theoretical framework with a common conceptual basis. The empirical and theoretical data still need to be integrated into a reliable paradigm. Notwithstanding, an attempt exists, as I show in this chapter. The tentative framework introduced here needs to be extended in order to accommodate the several disciplines involved in the search for an explanation of *how brain mechanisms generate consciousness and qualia.*

Before introducing the model, I need to specify the concept of consciousness that supports the hypothesis. In the first chapter I have introduced some features associated with consciousness. Now I present the working concept of consciousness. *Consciousness* refers to *the different intermittent states generated by neuronal events in response to environmental stimuli (intern and extern). Conscious responses are necessary in order to optimize organism's behavior in an unchanging and instable world.*

More specifically, a response to the problem of consciousness requires an investigation of neuronal mechanisms underlying conscious states. As I have shown in the chapter 5, neuroscience adopts mechanistic explanations, i.e., it investigates the underlying mechanisms of a given phenomenon, by considering its parts and how they interact with others. The central objects of study are *mechanisms.*

As one could expect, difficulties have been resolved, but new ones have emerged. Some aspects of consciousness seem to remain outside of the neuroscientific framework. The most controversial is qualia. Few neuroscientists concentrate on qualia.

Unfortunately qualia still remain in philosophical hands. Most neuroscientists investigate vision, memory, audition, olfaction, and so on, but none develop a theory of how the brain generates qualia.

Qualia are present in every conscious experience, why should we ignore them? The neurobiological mechanisms of detecting information in the environment are well known, but how the brain generates the conscious qualitative content is an unclear theme. With this in mind, I do put forward a hypothesis of qualia based on some reliable data concerning consciousness and brain.

Several empirical findings converge to some extent with regard to the candidates for the underlying mechanisms and brain areas associated with conscious behavior. Thus it is widely recognized that consciousness needs *selective attention*, that it is based on *neural dynamics* (ongoing neural firings), *neuronal synchronization* and *oscillatory rhythms* (gamma, theta, beta), *thalamo-cortical interconnectivity*, *memory-evaluative systems*, and a *global network of neurons*. Patterns of neuronal firings can be matched with specific conscious tasks by using EEG, MEG, fMRI and ERP.

Such new tools can measure the neural activity during the performance of conscious tasks. In other words, the objective perspective is well known. The remaining task consists in the investigation of the subjective perspective: how to make sense of subjective data? Such work requires more experimental research and theoretical investigation. The subject's subjective experiences will not remain unknown and mysterious forever.

A science of consciousness is possible only if the objective perspective is matched with the subjective one. In doing that, we need trained subjects who can report their qualitative states accurately. With the subjective data in our hands, we can have a rich description of the content of consciousness.[1] The basic features associated with consciousness that require further empirical investigation and theoretical explanations are listed below by G. Edelman:[2]

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[1]A. Lutz. & E. Thompson (2003:32) propose the neurophenomenological method in order to investigate subjective states. According to the authors, neurophenomenology consists in "gathering first-person data from phenomenologically trained subjects as a heuristic strategy for describing and quantifying the physiological processes relevant to consciousness. The general approach, at a methodological level, is (i) to obtain richer first-person data through disciplined phenomenological explorations of experience, and (ii) to use these original first-person data to uncover new third-person data about the physiological processes crucial for consciousness. Thus one central aim of neurophenomenology is to generate new data by incorporating refined and rigorous phenomenological explorations of experience into the experimental protocols of cognitive neuroscientific research on consciousness."

[2]G. M. Edelman (2003).

General Characteristics	
1.	Conscious states are unitary, integrated, and constructed by the brain.
2.	They can be enormously diverse and differentiated.
3.	They are temporally ordered, serial, and changeable.
4.	They reflect binding of diverse modalities.
5.	They have constructive properties including gestalt, closure, and phenomena of filling in.
Informational (Objective)	
1.	They show intentionality with wide-ranging contents.
2.	They have widespread access and associativity.
3.	They have center periphery, surround, and fringe aspects.
4.	They are subject to attentional modulation, from focal to diffuse.
Phenomenal (Subjective)	
1.	They reflect subjective feelings, qualia, phenomenality, mood, pleasure, and unpleasure.
2.	They are concerned with situatedness and placement in the world.
3.	They give rise to feelings of familiarity or its lack.

Accordingly, a plausible model of consciousness should take into account such features, i.e., objective feature (neural) and subjective (phenomenal). The analyses of the different characteristics require the identification of levels, i.e., mechanistic explanations that concentrate on levels and how they connect with others. As one could expect, two levels in the studies of consciousness are central: the *neural* and the *phenomenal*.

But the difficulty is the connection between them. Based on such problems, some philosophers point out an unbridgeable gap which it is not due the problem, but to the understanding of its nature.[3] Here we are talking about biological systems, not about metaphysical possibilities. Dualism is ruled out from the current research about consciousness. Instead, neurobiological models are proposed. With this in mind, let us continue the introduction of a neurophilosophical analysis of qualia.

There exist some models of consciousness that aim to bridge such a gap. A model is a formal representation that proposes a theoretical explanation based on some hypothesis. The objective is to gather together the molecular, neuronal, behavioral and subjective levels in a coherent and noncontradictory manner.[4] In the cognitive neuroscience of consciousness the most comprehensive model is the *Global Neuronal Workspace Model of Consciousness* (hereafter GNW). It includes recognized theoretical and empirical data. Furthermore it has acquired high plausibility among neuroscientists and neurophilosohers.[5] But as with every philosophical and scientific achievement, it presents problems, as I will point out.

The GNW is an extension of the *Global Workspace Theory of Consciousness* (GW), a cognitive architecture put forward 20 years ago by Bernard Baars. The GW consists of modules that are specialized information-processing systems. Baars associates consciousness with a global broadcasting workspace that disseminates

[3]See chapter 3 the section about Patricia Churchland.
[4]S. Dehaene & J-P. Changeux (2003) in M. Gazzaniga (ed.).
[5]See B. Baars (2002).

information throughout the brain. He used to say that the GW is like a theater with *unconscious audience* (the distributed neural networks processors).

Baars observes that "consciousness in the metaphor corresponds to the bright spot on stage, while unconscious systems operate in the dark backstage and in the audience (...) Consciousness seems to be the publicity organ of the brain. It is a facility *for accessing, disseminating and exchange information*, and for *exercising global coordination and control*."[6] However Baars' Model does not take qualia into account. In fact, some critics point out that the model explains only the cognitive informational aspect, leaving the phenomenal character of conscious out.[7]

Baars' GW works as an integrator and propagator of information. Information comes from the sensory systems and is processed by several neural networks. Such neural networks *compete for* or *cooperate to* access the global workspace. When some information reaches the GW, it is automatically distributed for the whole system. In addition, Baars says that *contexts* (other neural processors) shape conscious events or constrain them. Contexts "are coalitions of expert processors that provide the director, playwright, and stagehands behind the scenes."[8]

According to Baars only the bright spot on stage is conscious, because consciousness is very limited in capacity. In other words, while the processing in the neural networks is distributed and parallel, the access to the processed information is serial, internally-consistent and unitary, and limited in capacity. A subject can store only some piece of information in working memory (the underlying mechanism supporting the global workspace) In order to illustrate the stream character (informational flow), Baars calls the Jamesian idea of flux of consciousness: GW is like a stream, where information flows from unconscious processors to the conscious stage.

[6]B. Baars (1997: 299; 1998:269-278).

[7]See D. Chalmers (1996).

[8]B. Baars (2007:196).

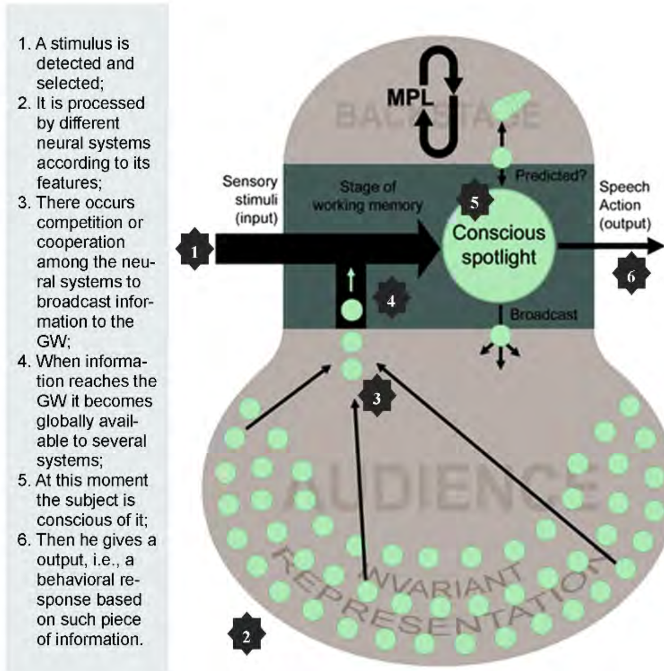

Fig.7.1 The Global Workspace Model of Consciousness proposed by Bernard Baars.

The absence of qualia or phenomenal features is evident. Baars does not take them into consideration. Due this failure, Chalmers criticized the GW by inventing the Zombie argument: one can reproduce such a system, but it never instantiates qualia, since qualia are out of the model.[9] However, one needs to be careful with Chalmers' critiques, in so far as he aims to prove that qualia are nonphysical entities.

The critiques make sense in part; obviously such a cognitive architecture will never generate qualia or consciousness, since it lacks neurobiological plausibility. This is a problem for Baars, because the GW is a model based only on formal-computational processing (classical cognitive science). Baars does not support his theory with neurobiological evidence, and for that reason he has been subject to various criticisms.[10] The mistake is that the GW rules out subjectivity, the principal feature of consciousness.

Thus, in order to support Baars' ideas, the GNW was proposed by the French neuroscientist Stanislas Dehaene *et al.* The GNW is a neurobiological implementation of the GW. Baars' ideas are in fact interesting, but the model lacks of neurobiological evidences for its support. Thus Dehaene underpins the GNW with recent experimental data by taking seriously the introspective subjective world of

[9]See chapter 2.
[10]D. Dennett also criticizes Baars' GW. See Dennett 2006.

conscious states, although he himself does not speak explicitly about qualia. In fact, it seems to me that he bypasses the qualia, by postponing the task.[11]

Notwithstanding, his GNW can be extended in order to get some insights of how qualia are generated by neuronal networks in the brain, but this is a task I take up in the next chapter. Here I just present Dehaene's model of consciousness.

7.2. The Global Neuronal Workspace Model of Consciousness

The GNW is a theoretical framework based on neurobiological and neuroscientific findings. It should count as a platform, i.e., a set of assumptions about how consciousness should be investigated. Three empirical findings support the model: firstly, several cognitive processes occur without consciousness, e.g., perceptual, motor, and semantic processes. Some experiments indicate they are executed by unconscious networks. For example, patients with lesions in the visual cortical areas can detect visual stimuli presented in their blind field (*blindsight*), although they report that could not see any stimuli. Accordingly, lacking of phenomenal consciousness does not impair their actions.

Secondly, attention is the central prerequisite of consciousness and can influence conscious states. For instance, a given stimulus becomes conscious if it is attended to for a minimal duration (between 30 and 200 milliseconds). Then the stimulus can be detected and can reach the GNW. Evidences in favor of this idea come from experimental psychology, for example, the phenomenon of *inattentional blindness* that occurs when people are not able to see things in a scene.

A classic study is the basketball example: a group of subjects was recruited to watch a video with two teams of playing basketball. One team wears black and the other white T-shirts. Then the subjects watching the video should count the number of passes made by one of the teams. Subsequently, either a women carrying an umbrella or a gorilla enter into the scene. After having watched the video the subjects were asked if they have seen something more than the game itself appearing in the scenes. Fifty percent of subjects reported that did not notice the woman or the gorilla.[12]

Based on this experiment, some authors conclude that attentional processes are serial, and when we attend to some features we automatically exclude others. In other words, you are conscious only of such features that you *attend to*.

Thirdly, specific mental operations require consciousness.[13] This third point subdivides in three parts: (3a) duration and maintenance of information, (3b)

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[11] Dehaene himself states that does not believe in qualia, what seems to me contradictory. He says that we have access to conscious information, but he ignores the qualities that such information can have. He does not provide further reasons. But I think his refusal is due to philosophical confusion about qualia, (personal communication).

[12] For more details about the experiment see Daniel J. Simons (2007) *Inattentional blindness*. Scholarpedia, 2(5):3244 at http://www.scholarpedia.org/article/Inattentional_blindness. The video can be seen in Internet by searching for 'Ìnattentional or Change Blindness Video'.

[13] The experiments can be accessed in Dehaene et al. (2001, 2003, 2006).

novelty, and (3c) intentional behavior. The first concerns the ability to maintain representations in an active state for a durable period of time without stimulation. In this case, *on-line* information requires consciousness, that is, the neuronal basis must be active for a certain time in order to activate the whole neuronal system.

The second point is that the ability of perform some tasks requires consciousness. Dealing with conflict, planning, evaluating and unexpected situations are typical candidates that require consciousness. Faced with novel situations, we typically become conscious of the main features presented, i.e., a large quantity of information is available to assess. The third feature associated with consciousness is the "spontaneous generation of intentional behavior". In order to carry out some task (i.e., act intentionally or driven), one must first have conscious information available. Then it is said that the subject behaves intentionally, i.e., there is something in his mind that guides his action.

7.3. Components of the GNW

The GNW is composed of some specific parts and mechanisms: firstly, modular systems, i.e., distributed and specialized neuronal processors. They divide into low-level automatized systems responsible for automatized tasks, e.g., the control of body temperature, body localization in space (motor functions), peristaltic movements, blood circulation, etc.; and high-level autonomous systems responsible for executive tasks, e.g., memory retrieval, decision, evaluation, and so on. Putting simply, each processor is attuned to processing a particular type of information. That is known as the "modularity of mind."

The claim is based on J. Fodor's *Modularity of Mind Theory*[14] and T. Shallice's *Working Memory Theory.*[15] The claim says that "automatic or unconscious cognitive processing rests on multiple dedicated processors or 'modules.'"[16] 'Modules' are specialized neural circuits that process only specific information. The brain is composed of several such functional specialized subsystems. Mental operations are executed by these unconscious systems that are into a great extent interconnected by local or medium-range connections.

Furthermore, the multiple unconscious operations proceed in parallel. Examples are face recognition processing, word reading, and postural control which do not require attention, and are performed by specialized neural subsystems. Conversely, non-automatized operations with novel contents such as decision-making and planning require conscious states.

[14]According to Fodor, *modules* have nine central characteristics: (1) Domain specificity, (2) Mandatory operation, (3) Limited central accessibility, (4) Fast processing, (5) Informational encapsulation, (6) 'Shallow' outputs, (7) Fixed neural architecture, (8) Characteristic and specific breakdown patterns, (9) Characteristic ontogenetic pace and sequencing (J. Fodor, 1983:37).

[15]See T. Shallice (1988) *From neuropsychology to mental structure*, Cambridge University Press.

[16]S. Dehaene & L. Naccache (2001:12).

The second component is the *global neuronal workspace* composed of cortico-cortical and thalamo-cortical neurons that send and receive projections to many distant areas through *long-range axons*. Such long-range neurons interconnect several parts of the brain. Due to this interconnectivity of distant brain areas, a global neuronal workspace can emerge when a set of conditions are fulfilled; firstly, activation must reach a minimum threshold; secondly, activation must be amplified by other neuronal networks; thirdly, such amplified activations must generate dynamic mobilization, i.e., it must generate neuronal synchrony in order to create the neuronal workspace.

Then, when a stimulus is strong enough, it will generate a cascade of activations (neuronal firings at the same threshold). As result, a global neuronal workspace emerges from the activation of several brain areas. By means of this process the modularity is broken, allowing the broadcasting of information to multiple neural systems.[17] The essential factor is the *global synchrony*, which is responsible for emergence of the GNW. The result is a conscious experience able to be reported by the subject.

The idea implicit in the model is that the *global workspace integrates and exchanges information among several neural modules*, and by doing that, the whole neural system *gain access* to such information. We then have a "global workspace" that works as a platform where information becomes globally available, integrated and distributed throughout the several systems in the brain.

As stated by the authors, "the global workspace thus provides a common 'communication protocol' through which a particularly large potential for the combination of multiple input, output, and internal systems becomes available."

In sum, we have two types of systems: the modular neural systems that process unconscious information (automatic behavior) and the global workspace that integrates the information processed in the neural systems, making it globally available. The mechanisms responsible for the availability of conscious information consist of five categories of neural systems: (1) perceptual systems (the sensory systems); (2) motor circuits (execution of actions); (3) long-term memory circuits (recall of past workspace states); (4) evaluation circuits (comparison of previous experience with novel); (5) attentional or top-down circuits (focalization or directedness). According to Dehaene, the interconnection of those five systems can explain the subjective nature of consciousness.

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[17] S. Dehaene et al. (2001:13, 1998:1146).

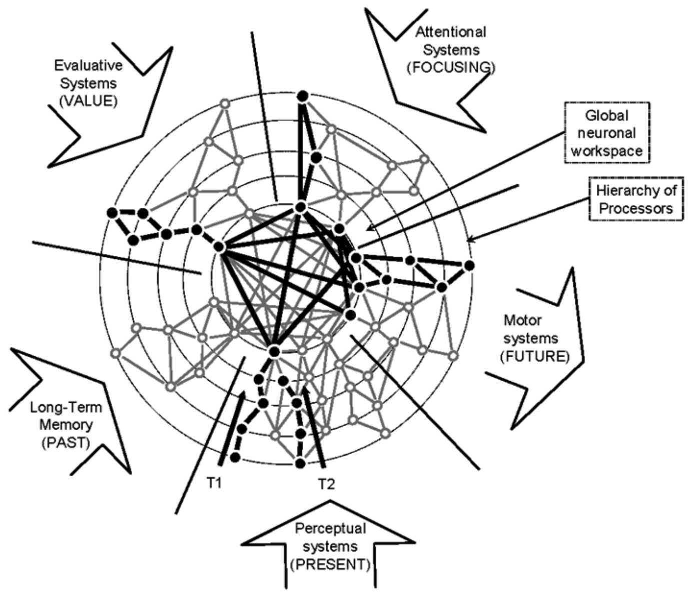


Fig. 7.2 The Global Neuronal Workspace Model of Consciousness schematically represented that is proposed by Stanislas Dehaene.

7.4. Top-Down Attentional Amplification and Dynamic Mobilization

The role of attention is central in the GNW, since attention is required for information to enter into consciousness. Roughly speaking, attention defines *which content accesses* the GNW *by blocking automatically* other ones. When one is paying attention to an object, one becomes conscious of its various features; when one shifts attention away, the object fades from consciousness.

The idea of top-down attentional processes is based on M. Posner's hypothesis of *attentional amplification*. Posner points out that attention is realized by a network of separated (modular) anatomical areas involved in selection of sensory information, activation of working memory and maintaining alert states.[18] Those mechanisms are unconscious and underlie conscious states.

Moreover Posner states that "Attention to sensory information amplifies brain areas used to processes that modality; similarly, attention to motor output activates brain areas used to generate the movement."[19] Posner however does not explain how amplification occurs. Thus Dehaene integrates Posner's hypothesis with some additional observations: "*top-down attentional amplification is the mechanism by which modular processes can be temporarily mobilized and made available to the global workspace, and therefore to consciousness.*"[20]

[18]M. Posner (1994), M. Posner & S. Dehaene (1994).
[19]M. Posner (1994).
[20]S. Dehaene & L. Naccache (2001). Author emphasis.

In addition, those processes may, at different times, contribute to the content of consciousness or not. To enter in the GNW, information must be amplified and maintained over a sufficient duration in order to become accessible to other processes. Such processes of amplification and maintaining of information are called 'dynamic mobilization'.[21] But the mechanisms behind the GNW are totally unconscious. There is no self or central part in charge. All mechanisms are unconscious, but such mechanisms underpin the GNW (the conscious space). Attention determines which sensory information does access the GNW.

Such top-down attentional amplification could be provided by means of reverberatory circuits between the somatosensory system and the parietal cortex,[22] since such processes are reciprocally interconnected. Anatomically these areas realize the process due the long-range connectivity of neurons; the afferent and efferent connections of systems activate workspace neurons by sending top-down amplification signals that boost the currently active processor neurons, whose bottom-up signals in turn help to maintain workspace activity.[23]

In this context, 'top-down' may refer to the brain regions that mediate executive functions, and 'bottom-up', to those that contain active perceptual representations or motor programs. Since the system is interconnected by long-distance neurons, the activation is *automatic* and *reciprocal*.

Examples on behalf of the amplification are visual perception in which visual information, after first being received in the retina, passes along the successive modules of the visual system (that are supposed to be 6 layers).[24] Each module both sends information further up the line (bottom-up) and receives information back (top-down) from these later modules. The activation of one layer automatically activates others by the processes of top-down amplification. Since such processes are distributed over the brain, then there is no specific place where the GNW can be found.

The GNW emerges when different neuronal networks are active and therefore information is amplified and mobilized by other neuronal networks; "the contours of the workspace fluctuate as different brain circuits are temporally mobilized, then demobilized. It would therefore be incorrect to identify the workspace, and therefore consciousness, with a fixed set of brain areas."[25] But what connects the brain areas? Again since they contain workspace neurons with long-distance and widespread connectivity, they can activate distant areas in the brain. At any given time, a set of neurons is activated and mobilized creating a workspace area and consequently activating other areas.

[21] Cf. S. Dehaene et al. (2003).
[22] Cf. T. Womelsdorf, K. Anton-Erxleben, et al. (2006), S. J. Luck., L. Chelazzi, et al. (1997) and C. Buia & P. Tiesinga (2006).
[23] Cf. S. Dehaene & L. Naccache (2001).
[24] Cf. G. Leslie & R. D. Ungerleider (1986) and D. J. Felleman & D. C. Van Essen (1991).
[25] Ibid.

According to Dehaene, the workspace neurons seem to be more abundant in the prefrontal cortices and anterior cingulate (frontal lobe or the front of brain associated with executive functions, for instance, planning, navigation, decision-making, social skills, etc.). Because these areas present more activations, then they are supposed to play a dominant role in the GNW, although such areas *should not* be identified with or believed to be responsible for consciousness.

Put in other words, what characterizes consciousness in this model is the *dynamic long-distance mobilization* by means of *neuronal synchronization*, rather than cerebral localization.[26] Neurons widely distributed over the cerebral cortex and the thalamic areas generate coherent assemblies that enter in synchronization due the activation in cascade. Such activations correlate typically with oscillatory activities in the beta and gamma band frequencies. It is already known that synchronization occurs in distinct frequency bands in the sensory modalities. Based on these findings, some authors suggest that neuronal synchronization binds the several features of a perception and create a network of synchronized activated neurons.[27]

Lesions in the mechanisms that bind the distant neuronal networks can interfere in the establishment of the global neuronal workspace. In particular, lesions in specific brain regions do not compromise the emergence of the GNW, but if the *mechanisms* that bind the neuronal synchrony are affected, then consciousness is impaired.[28] However the question that arises here concerns the nature of the mechanisms of binding. Experimental findings suggest that during the process of binding gamma oscillations are always present in conscious perception. Due this fact Wolf Singer concludes that:

> Conscious processing requires a particular dynamical state of cortical networks that is characterized by a brief episode of very precise phase locking of high frequency oscillatory activity [gamma frequency]. We propose that this particular state, because of its short latency and because of its global coherence, serves as trigger event for the access to conscious processing. This view is compatible with the hypothesis, that the global workspace for conscious processing is accessible only for activity patterns that fulfil certain threshold criteria. Precise temporal coherence could be such a criterion.[29]

Singer and Dehaene make it explicit that the attempt to identify a single central region in the brain responsible for consciousness is an error. Consciousness, instead

[26]Cf. W. Singer (1999) and P. Engel & W. Singer (2001).
[27]See W. Singer (2004) in J. S. Werner & L. M. Chalupa (eds.).
[28]Several experiments with patients with split-brain show that even if the brain is split (the corpus callosum is cut), the high functions associated with consciousness remain unaltered. But when cortical lesions occur, the coordination of several processes that underlay the global workspace is blocked and consciousness is abolished. For more details see L. Itti et al. (2005).
[29]W. Singer (2009:49-50), in S. Laureys & G. Tononi (eds.).

of being identified with the activation of particular group of neurons in a particular region of the brain, seems to be an emergent phenomenon of neuronal synchronization in several neuronal networks in the cerebral cortex and hippocampus.

An important feature is that information available for several modular systems does not imply representation or some kind of ‘conscious audience’, since what matters is the dynamic mobilization of distant areas, in which the workspace is generated. The emergence of the GNW can happen everywhere, depending on the sensory information incoming from the sensory modalities and the synchronized neuronal networks.

Furthermore Dehaene emphasizes the inexistence of an internal homunculus, thus avoiding Cartesian dualism. Mobilization does not require supervision, it results from spontaneous generation of stochastic activity patterns in workspace neurons, and the current content determines what region in the brain is activated or not.

In turn, the stochastic fluctuations in workspace neurons can result in the spontaneous activation in a coherent auto-catalytic manner. The active workspace state is constrained and selected by the activation of surrounding processors that encode the behavioral context, goals, and rewards of the organism. Then, from this dynamic transient self-sustained workspace, specific states follow one another in a constant stream,[30] similar to James' idea of flux of consciousness.

7.5. Structural and Dynamic Conditions for Conscious Information

The framework says that information becomes conscious (available at the global neuronal network) because of the neuronal synchrony of several neuronal networks. Moreover, the anatomical structures of brain play a role in the emergence of the GNW, since they are interconnected by long-distance neurons. Neurons with long-range axons interconnect several brain areas, for instance, pyramidal neurons[31] can extend from amygdala and hippocampus to the cerebral cortex and are proposed as candidate for the long-distance interconnectivity of several areas. They extend from posterior to anterior brain regions, forming an “entanglement of wires”.

However some further conditions must be fulfilled in order that information becomes conscious. Firstly, information in the neuronal networks must be active and must last some time in order to activate the surrounding assemblies of neurons. Secondly, reciprocal interconnectivity with workspace neurons; it is necessary that there be bidirectional (reciprocal) connections between these assemblies and the set of workspace neurons so that sustained amplification loops can be established.

According to these assumptions, there is a dynamic constraint that regulates the informational processing by establishing a minimal threshold for information

[30] Cf. S. Dehaene & L. Naccache (2001).
[31] See S. Dehaene et al. (2001, 2003) and D. LaBerge & R. Kasevich (2007).

to reach consciousness, which corresponds to longer duration for such neural representation to be mobilized in the workspace through a *self-sustained long-distance loop* (reciprocal activations). For this to happen it needs a minimal duration for the neural activation and longer duration of those neural activations in order to give conditions for the self-sustained loop and the consequent mobilization of long-distance neurons.

The workspace neurons activate above the stimulus minimal threshold and cause transient changes in the neuronal firings. Such activity can be propagated through multiple systems, but they cannot take part in the conscious state, they *support* them instead. The workspace neurons activate by means of self-sustained loops that in turn amplify such activity through other neuronal systems. The consequence of this process is activation in cascade and neuronal synchronization of the activations. These mechanisms sustain the GNW.

Although the sensory activation in the cerebral cortex is necessary, it is not however sufficient for a given sensory information to access the conscious workspace. It needs top-down attentional processes (modulation, i.e., external interference in the current brain state). In this case, selective attention counts as a modulator by specifying *which* information will access the GNW. The attended object boosts the neural activation generating a cascade of activations that immediately are amplified through various neuronal systems.

In other words, attention is the prerequisite for a given stimulus to become conscious. Such a process depends on the features of the objects (I would say their degree of novelty and importance). Dehaene investigates these mechanisms during visual perception. He noted that *stimuli* can attain various levels: *subliminal* or *unattended*, *attended*, *preconscious*, and *conscious*.

Subliminal stimulus is typically below the threshold necessary for the activation of neurons. A stimulus must be strong enough to reach the minimum threshold. When such a condition is fulfilled, the activation grows quickly. The first result is the activation in cascade, then such activations are amplified through the neural systems, and the second result is neural synchrony. At this stage, the information becomes *preconscious* (it is about to access the GNW since it is temporally buffered in a non-conscious store). But it is still unclear under which threshold a stimulus triggers such global activation.

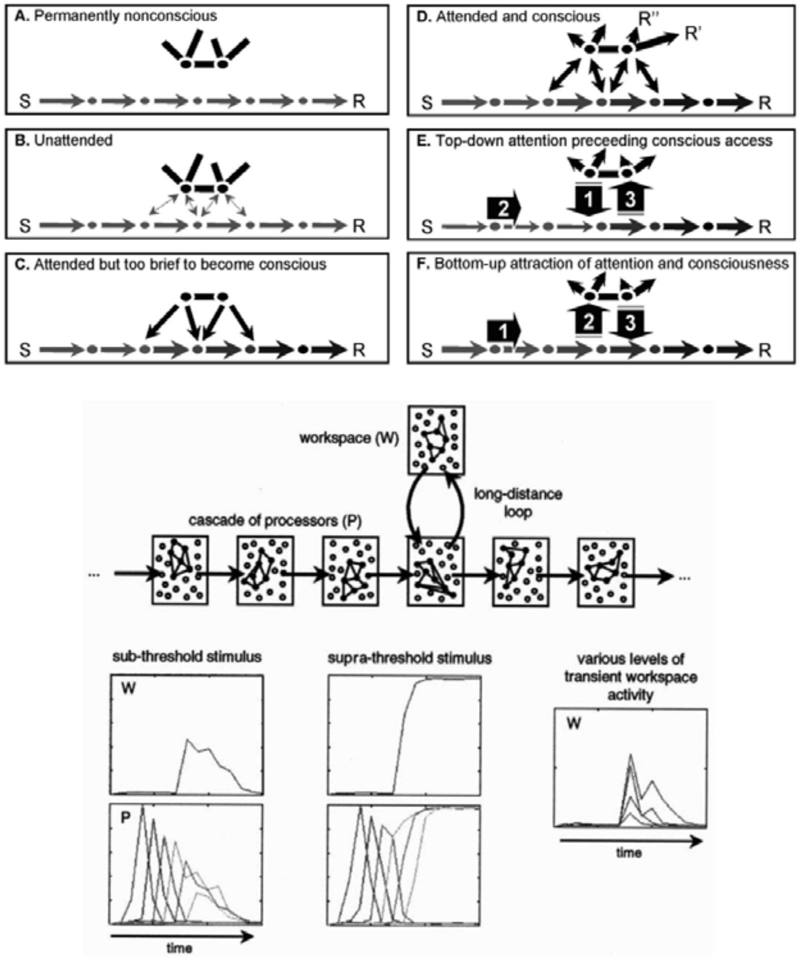


Fig.7.3 The transformation of subliminal or preconscious stimulus into conscious will depend on the intensity of the stimulus and on the attentionnal processes. If the stimulus is strong enough it will activate specific neural networks, then if it is attended by the subject, the activations is propagated by self-contained loops. The result is activation in cascade that generates a global workspace. S. Dehaene et al. (2001, 2006).

Figure 7.3 is a simple illustrative example of the idea: a cascade of feed-forward processes initiate at some minimal threshold, some can enter in a self-sustained reciprocal loop propagating the activation and activating distant neurons. When the conditions are fulfilled, (activation, duration and top-down amplification) the workspace neurons generate the workspace, the place where information becomes conscious.

At the first level, all processes are unconscious and the organism does not have access to them, at the second level (the level of GNW) information enter into consciousness and the organism access it and can make an action based on such information.

An example of this process is your reading of these sentences; your attention is fully concentrated on this text, but at the same time, various stimuli are bombarding your sensory systems: people are chatting, *toing and froing*, there are many smells in the air, and so on. Observe that you are conscious of this text, but at the same time you are preconscious of the other environmental stimuli. They can become stronger and gain access to the conscious space if they are attended to. That is, when the conditions in your vicinity suddenly changes, and an unexpected event occurs, then you shift your attention to it. Then the preconscious stimulus becomes conscious due the shift of attention.

Technically speaking, top-down attentional processes trigger the activation of the preconscious information, which is instantly propagated over the neural systems. In Dehaene's words, "such stimuli are potentially accessible (they could quickly gain access to consciousness report if they were attended), but they are not consciously accessed at the moment."[32] This mechanism is called by the author as *tripartite character*, since a given stimulus can be subliminal, preconscious or conscious.

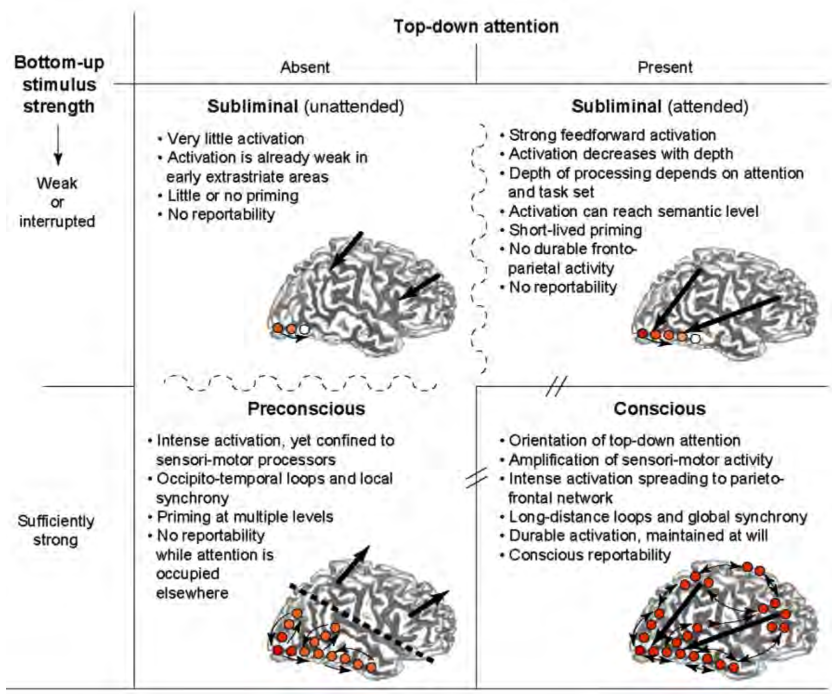


Fig. 7.4 Brain areas active that take part in the process of becoming conscious of sensory information. Top-down attentiononal processes distribute information throughout the brain. When the stimulus is attended to, it generates a cascade of activations that are immediately amplified through several neuronal systems. S. Dehaene et al. (2006).

[32] S. Dehaene & J-P. Changeux (2006).

As the figures indicate, the access of sensory information to the GNW is serial, whereas the informational processing underlying the neuronal networks is distributed and parallel. The stimuli from the sensory systems compete for access the GNW; only a stimulus with strong activation and duration is amplified through the neuronal systems. At the same time, a stimulus gains access to the GNW, and others are automatically blocked and remain preconscious or unconscious. This characteristic is known as *bottle-neck effect* or *all-or-none mechanism*, since only one stimulus is able to access the GNW each time.

But the duration of a conscious stimulus at the GNW is very transitory; the emergence of a GNW consists of a dynamic process, i.e., the states of the brain change quickly according to incoming information and the top-down attentional processes. According to Dehaene and Singer, such dynamical processes can be measured by using fMRI, EEG and ERP.

Typically the emergence of the GNW correlates with specific brain areas during the performance of conscious tasks. The main areas active in the brain are in the cerebral cortex (depending on the sensory information), the thalamus (the supposed place of the evaluative systems), the hippocampus (where the memory systems are localized), and amygdala (associated with the limbic system responsible for emotion). Such areas are mainly active during conscious experiences and correlate with frequencies band from beta to high gamma oscillations (measured with EEG and ERP).[33]

[33] Cf. L. M. Ward (2003), Fries, P., J. H. Reynolds, et al. (2001), Engel, A. K., P. Fries, et al. (2001), E. Niebur, S. S. Hsiao, et al. (2002), C. Börgers, S. Epstein, et al. (2008), O. Jensen, J. Kaiser, et al. (2007), C. Börgers & N. J. Kopell (2008).

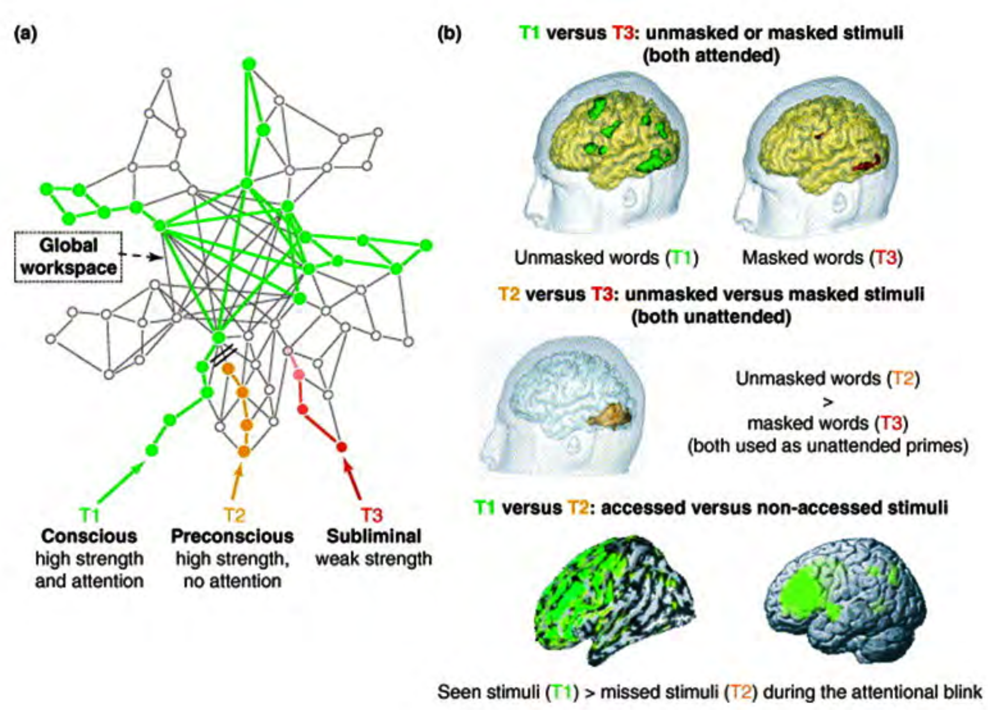


Fig.7.5a Schematic representation of the global neuronal workspace model. A visual target T1 (in green) is consciously accessed when it activates, in a synchronized, reciprocal and long-lasting manner, a set of 'central workspace' neurons particularly dense in parietal, prefrontal and cingulate cortices, and whose long-distance connections enable broadcasting to many distant areas. A stimulus can fail to become conscious for two reasons: (1) it might not have enough bottom-up strength, for example, owing to low-level masking or presentation close to threshold (subliminal stimulus T3, in red); or (2) it might have enough strength to be visible, but still fail to be seen by losing the competition for central access relative to other concurrent stimuli or task sets (preconscious stimulus T2, in orange). (b) Reinterpretation of neuroimaging experiments in this framework. When masked and unmasked stimuli are contrasted while subjects are attending (top right), a major difference in brain activation is seen, with both early sensory and late parieto-frontal enhancements for seen stimuli. When masked and unmasked stimuli are contrasted while attention is drawn elsewhere (middle right), the effect of masking is confined to early occipito-temporal cortices. When stimuli are above the masking threshold, and conscious access is manipulated by drawing attention to or away from the stimuli (bottom right), the difference in activation is late and confined to higher association cortices, particular parietal and prefrontal regions. Cf. S. Dehaene et al. (2006).

According to Dehaene;

> The mobilization of any information into consciousness should be characterized by the simultaneous, coherent activation of multiple distant areas to form a single, brain-scale workspace. Areas rich in workspace neurons should be seen as 'active' with brain-imagining methods whenever subjects perform a task which is only in a conscious state, such as one requiring a novel combination of mental operations. Finally, conscious processing should be accompanied by a temporary top-down amplification of activity in neural circuits encoding the current content of consciousness.[34]

In sum, the basic requirements for the GNW are (1) neuronal activation, (2) neuronal synchrony, (3) top-down attentional processes, (4) dynamic mobilization and amplification of the activation (4) participation of at least five categories of circuits in the emergence of a global neuronal workspace (high-level perceptual, motor, long-term memory, evaluative and attentional networks), and (5) minimal duration of the neural activation that gives rise to the self-sustained loops which will activate distant areas.

Long-distance connectivity is based on long-range cortico-cortical tangential connections originating principally from the pyramidal cells of layers 2 and 3 of the cortex. Since workspace neurons are distributed in a widespread fashion in brain areas, a lesion in the pre-frontal areas does not suppress consciousness, but can interfere in some conscious tasks. Impairments into several areas can cause global adulteration of conscious workspace activity. But consciousness is interrupted if the mechanisms of binding are damaged. The search for such mechanisms requires further investigation.

In spite of that, an apparent mystery arises: some information does not reach the GNW and it therefore remains unconscious. In some cases information can be temporary inaccessible to consciousness for purely dynamic reasons. According to the workspace theory, conscious access requires the temporary dynamical mobilization of an active processor into a self-contained loop of activation: active workspace neurons send top-down amplification signals that boost the currently active processor neurons, whose bottom-up signals in turn help maintain workspace activity.

But other information remains completely unconscious. This is a question that requires more experimental work; concerning this problem I follow Dehaene's idea: "whether or not a given category of information is accessible to consciousness cannot be decided a priori, but must be submitted to an empirical investigation."[35]

[34] S. Dehaene & L. Naccache (2001).
[35] Ibid.

And the Qualia? Dehaene just says the following:

> According to the workspace hypothesis, a large variety of perceptual areas can be mobilized into consciousness. At a microscopic scale, each area in turn contains a complex anatomical circuitry that can support a diversity of activity patterns. The repertoire of possible contents of consciousness is thus characterized by an enormous combinatorial diversity: each workspace state is 'highly differentiated' and of 'high complexity', (...) Thus, the flux of neuronal workspace states associated with a perceptual experience is vastly beyond accurate verbal description or long-term memory storage. Furthermore, although the major organization of this repertoire is shared by all members of the species, its details result from a developmental process of epigenesis and are therefore specific to each individual. Thus, the contents of perceptual awareness are complex, dynamic, multi-faceted neural states that cannot be memorized or transmitted to others in their entirety. These biological properties seem potentially capable of substantiating philosophers' intuitions about the 'qualia' of conscious experience, although considerable neuroscientific research will be needed before they are thoroughly understood.[36]

This is begging the question about the qualities of conscious states, because he thinks that 'complexity' is the central aspect that determines the content of conscious experience. The author does not explain *how qualia are generated*, and thinks wrongly that with his GNW he can "substantiate philosophers' intuitions". The complexity of brain is a plain fact, not a response to the problem of qualia. After all, the problem remains open. Although Dehaene does not say anything concrete about qualia, his GNW can be used to build a hypothesis of how brains generate qualitative states.[37]

Finally, Dehaene continues by saying that the workspace model leads to a distinction between three levels of accessibility: the level of nervous systems that is permanently inaccessible (information I_1), the level in-between the workspace and the neural systems where information could be consciously amplified if it is attended to (I_2) and the level of the workspace properly said (I_3). However, where the qualitative features emerge is not clear. How does sensory information become qualitative features that are experienced phenomenally by the subject? Dehaene's model is incomplete, since it does not say anything about qualia, and it needs further developments.

[36]Ibid.

[37]See the next chapter.

7.6. Phenomenal x Access Consciousness: Block Critiques

Ned Block introduces a criticism about the failure of GNW to accommodate the phenomenal character or the qualia.[38] In Dehaene's model, qualia are not clearly explained. In fact, qualia are absent from Dehaene's model. Dehaene does not explain how the conscious information available at the GNW acquires qualitative properties. He says that information gains access to the GNW and this is consciousness enough (or access consciousness). Block profits from this omission by pointing out that Dehaene takes into account only the *access consciousness* (how information becomes conscious, i.e., available for the several neuronal systems), not the *phenomenal consciousness* (how such conscious information acquires qualitative features).

Because Dehaene speaks only about conscious access to the sensory information, Block has argued that phenomenal consciousness is out of the model. Block then identifies the existence of two different types of consciousness, phenomenal (P) and access (A) consciousness. *P-consciousness* is the qualitative feeling of seeing yellow, which is different from the feeling of seeing green and that is excluded from the GNW. *A-Consciousness*, on the other hand, refers to the processes of accessing this information and doing something with it, such as verbal or motor report or working memory.

Block argues that phenomenal conscious states are distinct from cognitive processes, for the former are sensed in the conscious experience, and the latter remain unconscious at the low-level informational processing; they may sometimes not be cognitively accessible, in the sense that they are *consciously experienced* but that subjects may only have limited access to their attribute as assayed by recall or alternative-forced choice judgments. Then Block states that P-consciousness does not access the GNW. Block indeed doubts whether P-consciousness could be studied empirically, since introspective reports (subjective) cannot be reliable reports.[39]

Dehaene replies by saying that "what Block sees as a difference in essence could merely be a qualitative difference due to the discrepancy between the size of potentially accessible information (I_2) and the paucity of information that can actually be reported at any given time (I_3)."[40] But in my opinion this is not a good answer to Block's criticisms. Dehaene just repeats the slogan of complexity and dynamicity of workspace states and that the accessed information is the only type of conscious information that exists. This tells us nothing about qualia. For Dehaene, Block's distinction is only "faces of the same underlying phenomenon." I would not agree with that. I cannot see two types of consciousness.

I consider Block's distinction as illusory, because he tries to identify consciousness with a thing, susceptible of being counted (*Consciousness* 1, 2, 3, and so on). How many types of consciousnesses can exist in the brain? If in fact two types of

[38] N. Block (1995, 2005).
[39] N. Block (2005).
[40] S. Dehaene & N. Naccache (2001:30).

consciousness do exist, what is their respective neural basis? Are there separate or identical neural bases realizing both types of consciousness? If so, how does the split occur? When does one type of information become P or A, and how? Block does not tell us anything about that.

Block would be right if he had held the information available at the GNW, not the information at the unconscious neuronal networks. Dehaene says that information at the GNW is accessible, but about the qualities associated with such information he is silent. Thus the criticisms should consider this point, not the existence of two types of consciousness, where one is A-consciousness and the other P-consciousness, i.e., qualitative. Block's questions are pseudo-questions; the cognitive processes underlying the GNW are the *prerequisites* (the *realizers*) of consciousness. Cognitive processes are *supporters* of the GNW, *not* special phenomena occurring separate from consciousness.

Contrary to that, cognitive processes *underlie* consciousness. By themselves they do not generate qualia, but cognitive processes are necessary for the occurrence of qualia. In order to receive information from the environment, one needs to have a cognitive apparatus which is based on the sensory systems. Cognition occurs in virtue of informational exchanges between the environment and the brain. When one experiences something, there is no such a distinction between P and A consciousness. The qualities arise instantaneously; there is no two steps for experiencing qualia, firstly A and after P. The qualia come automatically.

Furthermore, no experimental evidence confirms the existence of two types of consciousness in the brain. If it were possible to measure such a distinction, how could one identify P-consciousness and the A-consciousness? Could there be different neural activations when a subject is having P consciousness, instead of A-consciousness? How could the subject know if he is having P instead of A? As far I know, no one doing experimental work identified A and P consciousness, because of the simple fact that *consciousness is not a thing*, but the *result* of dynamic states based on various brain mechanisms distributed at several levels.

In summary, I see Block's argument to isolate the "phenomenality" in the brain as an attempt to argue for a special role to qualia. Block wants apparently to protect qualia from neuroscience by assigning a special status to them. I would say he just obscures a complicated theme by multiplying entities. Why insist in more pseudo-questions? The use of *Occam's Razor* on Block's distinction is what should be done, that is *do not multiply consciousness!*

Dehaene recognizes the existence of three forms of sensory information: unconscious, preconscious and conscious. Some information can remain unattended (i.e., non phenomenal) and therefore unconscious, and therefore not experienced phenomenally. But this is information can become conscious and receive a qualitative character. The result is the phenomenal experience. The attended sensory information has qualities that come firstly in virtue of the modality specificity. Further qualities come from the attentional processes, and with the relationship with the memory-evaluative systems.

Why does Block supposes that the same information can be P or A? The accessed sensory information has qualities and is experienced phenomenally, although Dehaene does not talk about it. After all, qualia are not properties separate from the brain or of the GNW. They are experienced due to their availability at the GNW. Dehaene himself recognizes that some information can be reported and others not.[41]

The sensory information available at the GNW can only be there if it has been previously processed. The incoming sensory information is unique; it does not divide into A-information and P-Information. Information at the GNW is the same as at the low-level neuronal processors, the difference is that it was attended to and for this reason it has gained access to the conscious space.

But the unconscious information can becomes conscious at any time, since the conscious states changes dynamically according to the attention. Again Block's distinction does not make sense, because he supposes the existence of two types of consciousness, when consciousness is not a thing, but the result of several neurobiological processes taking place in the brain at several levels.

The sensory information does not divides into A and P consciousness; as I have shown, information can be subliminal, preconscious or conscious, not A or P consciousness. The subliminal information is neither phenomenal nor access, because it is at low-level structures (in particular at the neuronal networks being processed and competing to access the GNW). Therefore, there is no place where P or A could exist. What does exist is only the conscious information and the non-conscious.

The tripartite character of information is *continual*, *progressive* and *linear*, rather than dual features of information. As I will argue in the next chapter, the sensory information at the GNW receives its qualitative character after the relationship with the memory-evaluative systems. The sensory information receives the qualitative aspect according to the sensory modalities, and further qualifications come after the global availability of information. Subsequently it is related to the memory-evaluative systems.

In sum, there cannot exist two types of sensory information (except the differentiation according to the modality and according to the tripartite character), since a type of sensory information does not divide into two sub-types. As I have shown in the chapter 6, sensory information is at bottom only a matter of *neural signals*. The distinction is based on which sensory cell is stimulated, and then the brain *understands* it is visual information, when the cones and rods are stimulated; or when olfactory bulbs are activated the olfactory cortex automatically activates, then the message for the whole system is olfactory information.

[41] Cf. S. Dehaene & L. Naccache (2001).

The question that remains for further investigation is how does the sensory information acquire the qualitative character at the GNW? Why does some sensory information access the GNW and other information never? And why do some types of sensory information remain unconscious for ever. In the next chapter I try to answer the first question. The others are not within the scope of this text.

CHAPTER 8

Qualifying Qualia: A Testable Hypothesis

8.1. Conditions for the Instantiation of Qualia

Until now I have been giving some clues about the main hypothesis, namely that *qualia are based on neurobiological mechanisms of detecting changes in the environment (internal and external). Qualia are generated by the sensory modalities and by the GNW plus attentional processes.* Now I introduce the third component that underpins the hypothesis: the *memory-evaluative systems*, which imprint singular subjective qualities onto the sensory information available at the GNW.

In the first part of the dissertation I tried to refute the idea that qualia are special mental properties separate from the brain. In doing that, I argue against the dualistic temptation. Dualism does not make sense because its overlooks the fact that qualia are first of all *neurobiological phenomena generated by sensory systems and by the brain.* This was the idea of the second part, where there is an attempt to understand what are the main mechanisms responsible for qualia generation, or at least, I have tried to discover such mechanisms.

In the former chapters I have presented the basic neurobiology of sensory systems and the Global Neuronal Workspace Model of Consciousness. But the components are not sufficient to explain how the conversion of objective information captured in the environment into subjective information occurs. For that purpose, I put forward a testable hypothesis about how qualia could be generated. According to this hypothesis, there exist three necessary interconnected mechanisms working in parallel, which apply qualitative features to the sensory information. I propose that qualia receive the main features through the sensory modalities mechanisms, by means of the GNW plus attention, and the further qualities arise from the relationship of sensory information with the memory-evaluative systems.

The *register* in the memory (where subjective information is stored) is unique and exclusive. One might characterize such aspect as purely *subjective.* No matter which word is used, the subject's memory is *unique*, *singular* and *private.* Each organism has its own register in the memory that is built through successive and individual conscious experiences over the time. The result is a singular and subjective register which can attach exclusive qualities to the sensory information.

This chapter deals with the main hypothesis that I term *triangular modulation*, i.e., the participation of three central macro-mechanisms that support qualia generation. They are necessary for the qualia instantiation. As I have already suggested, the mechanisms are: sensory modalities, the GNW plus top-down attentional processes and the dynamic relationship with memory-evaluative systems. With these three basic components we could acquire a reasonable understanding of how qualia could be generated by brains.

Thus, in the light of the ideas just expounded in the former chapters, let us consider a hypothetic evolutionary scenario: consider an ancestor of human beings in the evolutionary jungle; he has to handle several signals incoming from his surroundings. He is foraging and he is able to see the ripeness of the fruits against the green leafs because he has color vision; he is able to smell the several odors in the vicinities in virtue of the olfactory system, and he is able to hear the different sounds echoing through the forest due to auditory systems, and so on. Each modal sensation presents specific qualities.

In brief, his sensory systems are highly active in order to detect resources and potential predators. Suddenly his senses perceive a change in the environment: a different sound appears, and it becomes louder and closer. If our ancestor had experienced such a situation before, he is able to predict or to suppose that those signals could mean danger. He then figures out the best strategy for action based on the information he has available. In particular, the information comes from the environment through the sensory systems. As the signals come closer, he suspects that some predator is approaching. He then decides to flee, even though the danger is not so obvious.

Why does he act in that way? One could imagine that he had compared past experience with that new experience. Because the last time he faced a similar situation, a bear had appeared, and therefore the connection between the past situation and the current was established. Thus the identification of such a situation became *automatic*. In other words, he compared the current sensory information with similar information stored in the register. By means of such a process the register imprints specific qualities onto the sensory information by modulating the way he perceives the current state of affairs. Now let me ask you: what are the conditions or constraints to be fulfilled in order to be successful in doing that? The answer is not so difficult: sensory systems, neuronal networks and memory-evaluative systems.

The event can be even analyzed by pointing out the several underlying mechanisms of the behavior: (1) he senses the surrounds by means of the sensory modalities, in particular, by using *visual* and *auditory* systems; (2) he becomes conscious of some types of information by ignoring at the same time others; (3) he compares the incoming sensory information with the memory systems; (4) based on the comparison he judges, i.e., thinks about the best strategy of action; (5) next he makes a decision (*fleeing*). It is unnecessary to say that additional mechanisms correlate with his behavior, for instance the preparation of the body for the fight-or-flight responses.

At the moment of the event, the state of arousal increases in response to the danger; the heart rate also increases, the airways in the hugs dilate, the pupils dilates and the peripheral vision decreases, at that moment there is the release of glucose, oxygen, epinephrine (adrenaline) and other hormones in order to hurry up and accelerate the motor reflexes for muscular responses: the digestive system also slows down in order to preserve energy for the potential struggle, and so on.

There is an underlying mechanism behind each step, which can subdivide into several other low-level or micro-mechanisms. But for the purposes of this dissertation I will consider only the sensory systems, memory-evaluative systems and the Global Neuronal Workspace since those macro-mechanisms are necessary for the conscious behavior. I would say that they are also necessary for the instantiation of qualia. In this context, my task consists in the attempt to understand how the three mechanisms interact together to give rise to qualia. It seems clear that qualia are based on such mechanisms, but how do they work together?

In the chapter 5 I have introduced the idea of a mechanistic explanation. A mechanism is a dynamic device composed of working parts organized to produce a specific phenomenon.[1] I adopt the mechanistic framework because it considers several levels of analysis without radical reduction or elimination of high-level phenomena. For instance, the qualitative aspect sensed by the subject during conscious experience is a high-level phenomenon not present in any particular part or mechanism. The phenomenal qualia as experienced, result from the triangular modulation, that is, through the interaction of three basic macro-mechanisms.

A central concept is present from the sensory modalities through to the phenomenal level, namely, *sensory information*, the detected environmental stimuli converted into neural signals according to the sensory modality. After all, sensory information is the basis of qualia, or the raw sensory qualities. The sensory information passes through the three macro-mechanisms and acquires the qualitative aspect.

Every conscious experience presents specific qualia that are generated by those mechanisms. Without such parts it would be impossible to have qualia. For instance, studies about neurological patients suggest that if the sensory modalities are damaged, the GNW does not receive sensory information (e.g., different types of agnosia and degenerative diseases as Alzheimer), and then no conscious qualia are generated. Patients with Alzheimer's disease for instance do not only have loss of memory (the main symptom), but also loss of taste and olfaction.

Recent studies of Alzheimer's disease point out that there occurs an olfactory deficit during conscious experience due to the damage in the olfactory neuroepthelium (the olfactory sensory cell). As a consequence, the olfactory nerve axons do not reach the olfactory bulbs (where olfactory information is processed). The causes of such degeneration are still unknown, but the symptoms are frequently reported

[1] Cf. W. Bechtel (2008:4).

in the neurological literature. The study suggests also that the olfactory bulb and tracts are damaged early in the Alzheimer's disease process.

Furthermore, it was observed that the pathology seems to spread from the olfactory cortex to other sensory cortices such as the gustatory. This example is simply an illustration of how the absence of interconnectivity between sensory system and cerebral cortex can block the sensory experience. In the Alzheimer's case, the necessary pathways from the sensory olfactory cells do not connect with the olfactory cortex. Therefore there is no processing, and consequently no qualitative olfactory sensation.[2]

If the GNW does not emerge, the sensory information does not become globally available and cannot be related with the memory-evaluative systems. If in turn the memory systems are not working normally, the sensory information cannot be compared and evaluated; then it cannot receive further qualities. Sensory modalities, GNW and memory-evaluative systems are necessary for the qualia instantiation. After being passed through the three systems, sensory information is endowed with the subjective character. Let me elaborate on this idea.

8.2. Triangular Modulation

Triangular modulation changes the nature of sensory information. But before introducing the idea, I need to say something about *modulation*. Modulation refers to an *alteration in the state of the brain* or *in the content of conscious states*. It is influenced by several processes, such as attention and through biochemical neurotransmitters (neuromodulation).

For the purposes of this text, I use the term 'modulation' to refer to the change or influence of external factors in the conscious states. For example, the current content of the GNW can be modulated by attention; if you are watching a film, your attention probably will be concentrated on the screen, but if someone passes in front of the screen, your conscious content will change quickly, and it will be modulated, although you certainly will continue to watch the film.[3]

But such an external bias shifts your attention for some milliseconds and that shift in attention gained access to your GNW for that length of time. Even though your focus of attention is not on the person passing by, but it is concentrated on the film itself. If the film reveals itself to be uninteresting, you become sleepy. Suddenly an advertising spot for Coke appears on the screen, and then you automatically go to buy a Coke.

[2]T. G. Ohm & H. Braak (1987), H. Ferreyra-Moyano &. E Barragan (1989), R. I. Mesholam et al. (1998), G. Perry, R. Castellani, et al. (2003), D. A. Kareken et al. (2001).

[3]Empirical evidences in favor of this idea come from various sources: J. B. Hopfinger, M. H. Buonocore, et al. (2000), M. Saenz, G. T. Buracas, et al. (2002), T. A. Polk, R. M. Drake, et al. (2008), M. Corbetta, F. M. Miezin, et al. (1991), J. H. Reynolds & J. Chelazzi, (2004), M. Posner at al. (1980).

The Coke contains caffeine, a natural stimulant that enhances cognitive ability by modulating the mean synaptic (biochemical neuromodulation). The result is a higher state of alertness and concentration. Your attention is enhanced and the qualia generated seem to be more vivid. Consequently, the attended stimulus is experienced more vividly, i.e., with more vivid qualia than if you had not attended to it.

The hypothesis in this chapter says that qualia receive qualitative features by means of the triangular modulation. But what does that mean? By triangular modulation I mean the *process of changing the nature of sensory information in virtue of three basic mechanisms.* The first modulation occurs in the sensory modalities that assign the raw qualities. Depending on the modality, sensory information receives specific raw qualities. For instance, the sunset on the beach seems to be orange and the sound of the tidal waves are loud, i.e., the modality is able to detect the intensity of the stimulus and imprint some raw qualities. Further qualities will arise in the brain.

The neural impulses that carry such sensory information are sent to the brain that executes further processing. Then the several specialized neuronal networks will process specific features of the stimuli (the roundness of the sun, the color of the setting, the pitch of the sounds, and so on). Such features are then unified[4] into a single representation through *neuronal synchrony.*[5] The next step is the broadcasting of sensory information into the GNW, where such information can receive further modulation by top-down attentional processes. The last step in this complex process is the relationship of conscious sensory information with the memory-evaluative systems.

8.2.1. Sensory Modalities.

I have already shown how sensory modalities work. I will not repeat myself here. What I have to say is that the first modulation is applied by the sensory modalities, as I have presented in chapter 6. The stimuli detected in the environment are converted according to the sensory modality (see table of sensory modalities in the chapter 6).

Then the elementary qualities arise according to the intensity of the stimulus. After that, conversion of the detected stimulus into neural signals occurs (transduction). The sensation is direct and sometimes does not require further consciousness.

However, the ability of *enjoying* or *disliking* a sensation requires not only normal sensory systems, but also further mechanisms, i.e., the GNW and the memory-evaluative systems. This is conditional upon the sensory systems operating without

[4]Cf. W. Singer (2007). *Binding by synchrony*, Scholarpedia, 2(12):1657.
[5]Cf. W. Singer (1998, 1999), T. Womelsdorf at al. (2007), P. Fries et al. (1997, 2002), C. M. Gray et al. (1989), A. K. Engel et al. (2001).

damage or deficit, since such damage can prevent the distribution of sensory information to the sensory cortex.

Patients with damage in the sensory systems are not able to experience some qualities correctly. Damage in the sensory cortex also can change the content of the sensory experience.[6] A subject is able to enjoy the qualities of a sensation if he has suitable sensory systems and if he attends to the properties of the experience, as I present in the next section.

8.2.2. The GNW and Attention.

According to Dehaene's tripartite description, information can be unconscious, preconscious or conscious. The top-down attentional processes trigged by relevant features of the stimulus are necessary for an information to become conscious. When a stimulus is attended to, the neural signals are propagated through the several neuronal networks that process specific features of the stimulus. Next there occurs the process of competition or cooperation among the neuronal networks[7] to send information to the GNW..

If the stimulus is strong enough to reach the minimum threshold, the neuronal networks that process the features of such stimuli will enter in synchrony, generating a global workspace where the unconscious or preconscious information can enter. When this happens, information gains access to the GNW and it becomes available for several neuronal systems in the brain. The consequence is that the stimulus becomes conscious, i.e., subject has the access to it.

Neuronal synchrony is proposed as the mechanism that enables the activation of several neuronal networks. This occurs in virtue of the interconnectivity of the nervous systems by means of long-range axons (thalamo-cortical connections). Such axons can be up to 1 m long, and they interconnect different brain regions, mostly the thalamo-cortical systems,[8] which are mainly active during conscious experiences.

If a stimulus is relevant (it presents a novelty) and salient (it pops out in the conscious scene), it probably will be attended to. Attention then tends to shift to it, and automatically generates the activation of attentional systems.

Moreover, if the stimulus is strong enough and lasts a minimal time, then it will activate adjacent neurons (recurrent processing). By doing that, activation is amplified through other neural systems, generating activation in cascade at the same

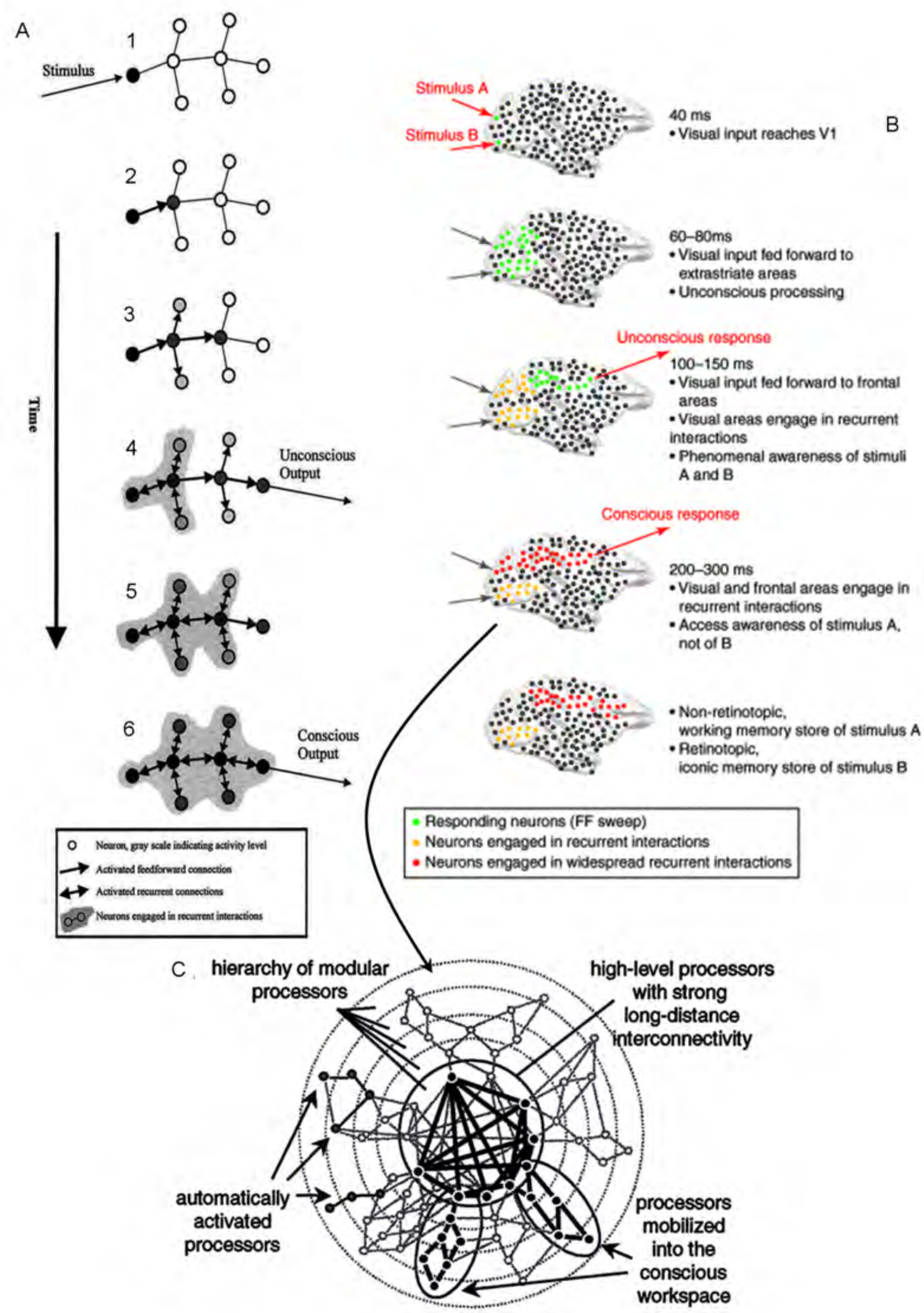
[6]For further details concerning this issue see A. G. Reeves & R. S. Swenson (2004). *Disorders of the Nervous System: A Primer.* On line available at http://www.dartmouth.edu/~dons/index.html, and A. Møller (2000). *Neural Plasticity and Disorders of the Nervous System*, Cambridge University Press.

[7]Cf. D. M. Beck & S. Kastner (2005).

[8]Cf. R. H. Granger & R. A. Hearn (2007). *Models of thalamocortical system.* Scholarpedia, 2(11):1796.

threshold. The result is the state of synchronicity of the gamma band associated with conscious tasks (which can be measured by using EEG and MEG)..

Due to the long-range interconnectivity, the activation in cascade produces neuronal synchrony. In this way, different neural systems in different regions are activated. The final result is the emergence of a global neuronal workspace that lasts while the stimulus is attended to. The attended stimulus can become conscious if it activates at a level above the threshold, in which case it enters in the GNW. At the phenomenal level, it is said that the subject has access to the information, i.e., he is conscious of it.



A
Stimulus
1
2
3
4
5
6
Time
Unconscious Output
Conscious Output
Neuron, gray scale indicating activity level
Activated feedforward connection
Activated recurrent connections
Neurons engaged in recurrent interactions
Stimulus A
Stimulus B
B
40 ms
• Visual input reaches V1
60–80ms
• Visual input fed forward to extrastriate areas
• Unconscious processing
Unconscious response
100–150 ms
• Visual input fed forward to frontal areas
• Visual areas engage in recurrent interactions
• Phenomenal awareness of stimuli A and B
Conscious response
200–300 ms
• Visual and frontal areas engage in recurrent interactions
• Access awareness of stimulus A, not of B
• Non-retinotopic, working memory store of stimulus A
• Retinotopic, iconic memory store of stimulus B
• Responding neurons (FF sweep)
• Neurons engaged in recurrent interactions
• Neurons engaged in widespread recurrent interactions
C
hierarchy of modular processors
high-level processors with strong long-distance interconnectivity
automatically activated processors
processors mobilized into the conscious workspace

Fig. 8.1 (A1) Stimulus is presented. If it is strong enough it activates some neuronal networks; (A2) stimulus is attended and activates others; (A3) the activation is strong enough and initiates a cascade of activations (recurrent processing); (A4) the amplified recurrent activation results in neuronal synchrony of several neural systems; (A5) the synchronization enables the emergence of a global neuronal workspace, where sensory information becomes available to several neural systems; (A6) the result is a conscious space where the subject access the information and he gives a conscious response. B shows the presentation of two concurrent stimuli to the visual receptive field: (B1) visual stimuli are presented; (B2) there occurs competition between stimuli a and b to access the GNW; (B3) the stronger stimulus results in neuronal activation in cascade. It gains access to the GNW; (B4) the consequence is the conscious access to the winner stimulus. C represents schematically the GNW resultant from such processes with the modular systems involved in the processing. The strong lines indicate the active neural processes and where conscious information is active. After V. Lamme (2003, 2004) and S. Dehaene et al. (2001, 2006).

Why do we attend to some features of a conscious scene and not to others? The answer is as follows: specific features are more salient than others, i.e., they present more relevancy in virtue of the degree of *novelty.* Furthermore, it is an evolutionary strategy that enables organisms to become conscious of what can enhance survival. This is a simple rule of thumb: *pay attention to what matters and ignore what does not.*

Moreover, attention is not only a selective process, but if we observe carefully, we can note that attention is a serial process. Putting it more simply, *we can consciously attend to one specific feature in a conscious scene at a time.* We cannot be conscious of two information available at the GNW simultaneously.

As Dehaene observes, sensory information can be unconscious, pre-conscious or conscious. The competition or cooperation betweem the processes of sending sensory information to the GNW occurs at low-level neural systems, not at the GNW. Once information is available at the GNW, it automatically excludes access of other information, but the "excluded" information can gain access if it has stronger activation due to the attentional processes that enhance the activation.[9] This aspect of a serial access of information is called by Dehaene the *winner-takes-all.*

The *triune* character (unconscious, pre-conscious and conscious) of sensory information is broken by the *top-down attentional processes.* For instance, you cannot enjoy the taste of popcorn while simultaneously fully attending to the film on the screen. One sensory information will override the other. If you decide to attend to the film, then you probably will devour the popcorn so fast that suddenly you will become conscious that it is gone (you will sense that the popcorn bucket

[9]Cf. T. A. Polk., R. M. Drake, et al. (2008), M. S. Bendiksby, Jarman, A. F., & Platt, M. L. (2004), E. P. Cook & J. H. R. Maunsell (2002) and H. Spitzer, R. Desimone, et al. (1988).

is empty by groping in the bucket), and then your attention shifts to the empty bucket.

As we can see, information is conscious *sequentially*, not all at once. The processing is *distributed* and *parallel*, but conscious access is *serial*. When information is broadcasted to the GNW it automatically blocks the access of other information. But such a process is dynamic and changes every time attention enters into play. Thus, attention can change the activation by enhancing it.

In the example, you have eaten the popcorn unconsciously, I would say without enjoying the qualitative features, because you were not attentive to the popcorn, but to the film on the screen.[10] The ability of enjoying requires *attention* and *consciousness*. The best example of the refinement of such ability is the sommelier, as I have introduced in the chapter 4. The ability of enjoying a good wine requires attention and consciousness. A sommelier smells, tastes, compares the current experience with the memory systems, and afterwards he evaluates the quality of the wine. This is an *acquired ability* that requires learning, attention and consciousness; attention and consciousness are necessary to experience the qualitative features.

With the exposed ideas in mind, let us recall the example of the chapter 1 one last time: although you are able to sense the numerous qualities incoming from the surroundings through your sensory systems, you are not able to experience them simultaneously. Why not? Because you need attention and this is a serial process. Attention can enhance (modulate) the content of the experience. On the other hand, subjects with deficit or damage in the attentional systems fail to sense such qualities.[11]

[10]This fact reveals the *selectivity* of attention. Attention is by nature a selective process. A well studied example in cognitive psychology is the so-called *cocktail party effect*, a situation with various conversations and other sounds occurring simultaneously in the background. However the listener can focus only on one voice or conversation. At the least, he can "tune out" the others. For further information about the theme see B. Arons (1992) "A Review of the Cocktail Party Effect" on line available at http://www.media.mit.edu/speech/papers/1992/arons_AVIOSJ92_cocktail_party_effect.pdf. Concerning the definition of attention, W. James gave the best accepted definition: "Everyone knows what attention is. It is the taking possession of the mind, in clear and vivid form, of one out of what seem several simultaneously possible objects or trains of thought (...) It implies withdrawal from some things in order to deal effectively with others." (W. James 1890:403-404, *Principles of Psychology*, Vol. 1).

[11]For instance, patients with attentional deficits due to strokes, tumors, traumatic injury, etc. fail to attend to specific characteristic in a conscious scene. Balint's syndrome patients present *inter alia*, an inability to attend to multiple qualities in a conscious scene. If objects with two colors are exhibited at random in the space, the patient cannot attend to the qualities associated with the two colors, but only to one. But when the objects are attached they seem to be the same, then the patients can attend to the colors present in the scene. The distributed qualities in the conscious scene cannot be attended to if the objects are exhibited randomly. The study concludes that the deficit lies in the attentional system that hinderss the patient from detecting multiple qualities in a scene with several qualities (See A. C. Cooper G. and G. W. Humphreys (2000).

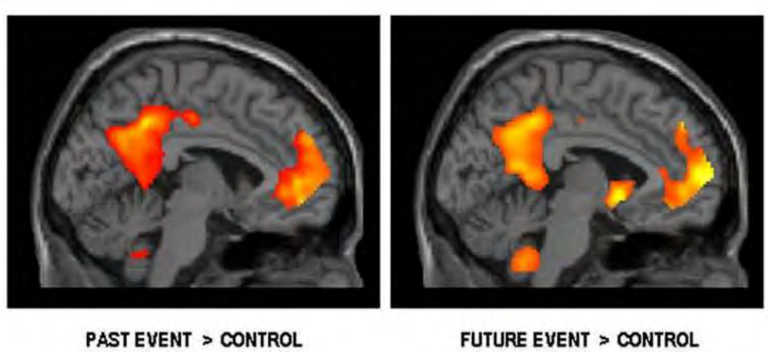
8.2.3. Memory and Evaluative Systems.

After information becomes globally available for several neuronal systems, it is related to the memory-evaluative systems. It is assumed that they localize in the medial temporal lobe (a complex structure composed of the hippocampus, rhinal cortex, parahippocampal cortex, and amygdala). Studies concerning memory and emotion show that such areas are mainly active during memory access and retrieval.

Recent fMRI studies suggest that the amygadala and the hippocampus are mainly active during memory retrieval.[12] The activation of these areas correlate with conscious episodes accessed from memory. Thus there is some evidence in favor of the hypothesis that memory modulates current conscious information.

Patients with damage to temporal medial lobes are not able to recollect new qualitative memories; H. M. for instance, a patient who suffered from epilepsy had his temporal lobes on both sides removed. Although his epilepsy was relieved, H. M. was not able to form certain types of new memories. His cognitive abilities remained normal, and his IQ even improved a bit. But H. M. was able to remember only events that happened before the surgery. H. M. was unable to store new events in his memory. Even qualities he had just experienced could not be remembered, although during the conscious experience he was able to access the qualities. His sensory modalities were not impaired, but the memory for new qualia was.

In brief, H. M. cannot recall his qualitative memories into consciousness, although he was able to experience new qualities. But he was not able to form new qualitative memories, since the connections were removed (specifically neural pathways from the sensory cells to the hippocampus and amygdala). That is, his old qualia remain intact, while the new one cannot be stored in the long-term memory. Each new quale was always restricted to the working memory (or short-memory), it did not remain through the successive experiences. In sum, the case of H. M. showed that the medial temporal lobes are fundamental for memory.[13]



[12]See T. Canli, Z. Zhao, et al. (2000), A. P. R. Smith, K. E. Stephan, et al. (2006), G. Richter-Levin (2004), J. G. Pelletier & D. Paré (2004), F. Dolcos, K. S. LaBar, et al. (2004), E. M. Maguire (2001).

[13]For further information about H. M. case see H. Eichenbaum and N. J. Cohen (2001).

Fig 8.2 The fMRI study shows clearly activations of hippocampal areas, amygdala (in which memory systems suppose to be anatomically localized), and the prefrontal cortex (in which executive functions such as *evaluation*, *prediction*, and *expectation* are performed). The current study reveals hippocampal activation during recollection of qualitative memories (left-hippocampus was commonly engaged by past and future event construction along with posterior visuospatial regions). Furthermore, the activation of amygdala reveals the emotional degree associated with the information retrieved from the memory. That is, each conscious information regardless of new or from the memory, it will always present qualities with emotional charge. In the task the subjects must retrieve past events. The conclusion was that past events can also modulate incoming new information. Therefore, amplified information receives additional qualities when is associated with the memory systems. D. R. Addis et al. 2007.

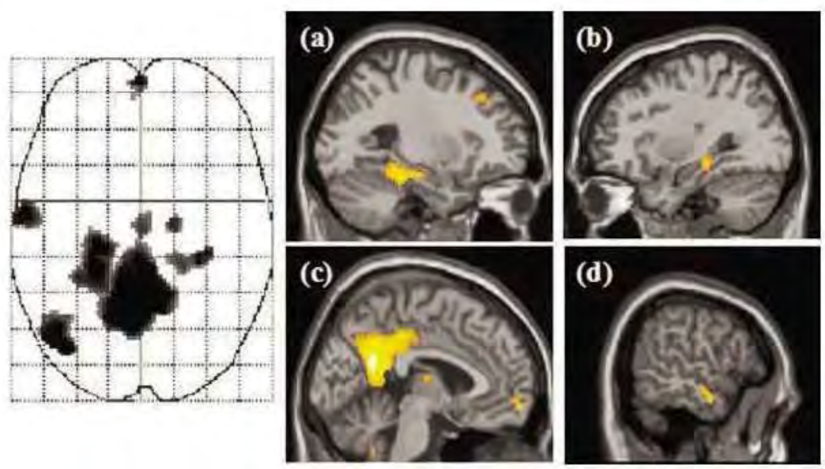


Fig. 8.3 fMRI showing activations associated with the retrieval of autobiographical memories (singular and personal). D. R. Addis et al. 2004.

The studies suggest that, although memory-evaluative systems are not necessary to experience the direct qualia arising from conscious experience, they can at least, influence (I mean modulate) the current experience in virtue of the singularity of the memory systems. The register in the memory is unique and singular. For this reason it imprints specific qualities according to its organization. The subject's memory is built through countless conscious experiences that are unique and exclusive.

The existence of two identical registers is impossible; even identical twins or Siamese twins (conjoined) do not have the same memory. Thus the singularity of the register plays also a central role in the attribution of singular subjective qualities associated with the subject's registers in the memory. In particular, information is related to the memory-evaluative systems according to *family resemblances* that are built through successive experiences.

Since each subject is able to experience the world only in his own way (remember of the fourth chapter, only you can access and experience the world in the way you do). The next three pictures indicate how the register in the memory can modulate current conscious experience. I ask you to observe attentively and try to discover what it is:

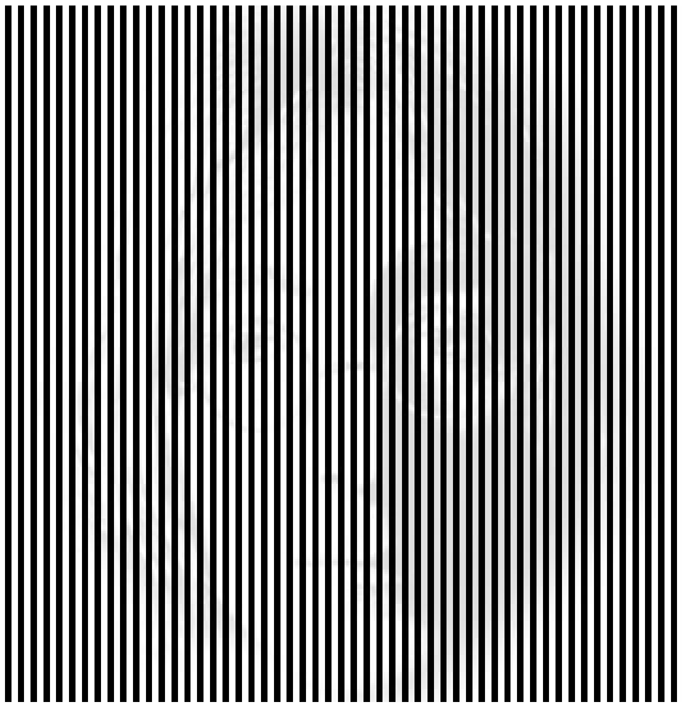


Fig. 8.4 Only parallel lines or there is something extra? What do you see?

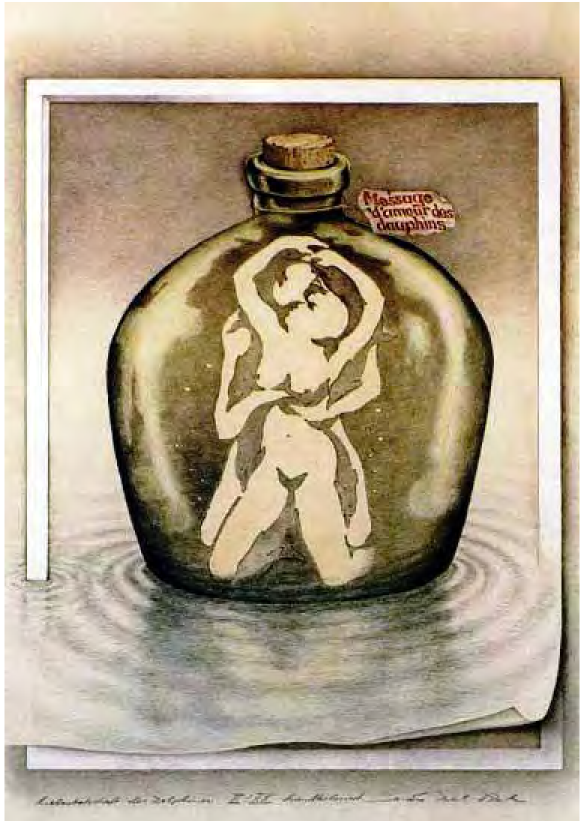


Fig. 8.5 The picture is a known visual illusion. It is a painting made by the Swiss painter Sandro del Prete called "Liebesbotschaft der Delphine" (Message of Love from the Dolphins). Del Prete paints only illusory paintings. His pictures are good examples of how the memory-evaluative systems can modulate the current qualia. For further paintings by Del Prete visit his website http://www.del-prete.ch/.

Fig. 8.6 What do you see: Mary's apparition or just an optical illusion?

The pictures above can confirm the hypothesis that the register in the memory modulates current conscious experience. Furthermore, attention can influence the way we see. If I tell you to attend to definite features, your current conscious state will probably change. But before "priming" your conscious perception, let me introduce the experiment. The pictures were shown to children and adults. The result was interesting: most of adults reported that they have seen: (1) John Lennon's face popping out from the lines, (2) a couple in an erotic position, (3) the apparition of Mary.

On the other hand, children until 10 years old were able to see in picture 1 an unknown face; in picture 2 nine dolphins or a woman, and with the third they had various answers such as a rainbow, a house with trees, or a painting. Both adults and children answered spontaneously and without priming. In particular picture two is more interesting, since it is a dual picture. In fact there are two forms: the *couple* and nine *dolphins*. Can you see the dolphins? But when I ask for adults to look attentively at the picture (to specific forms) most of them cannot recognize the dolphins. Then I needed to point where the dolphins are.[14]

The reactions after the discovery of the dolphins were of astonishment: no one detected the dolphins except for the couple. Even people that are used to doing experimental work were unable to detect the dolphins. On the other hand, children did not see the couple, but only the dolphins, or at best a woman; the man was ignored. Such a experiment was made informally by me in order to confirm whether memory can really modulate the current qualia or not.

I have received some criticism concerning the modulation of conscious qualia, since memory is not considered an important part of qualia generation, say the critics. But the direct experience with the pictures says on the contrary, that the memory-evaluative system can modulate the conscious qualia. Just look at the picture: first time you see it you detect only a couple. When I say that there are also nine dolphins you do not believe me. Then you probably will scan the picture in order to find the dolphins. But if you attend to specific features you are able to see, then your qualia change.

What does such a result show? Firstly, since children do not have the memory for sex contexts, they are unable to see the couple. Adults in turn see only the couple because they have a register in the memory for sexual contexts. I interpret it as an evidence for modulation by the memory-evaluative systems. I guess that the explanation is that since children did not have sexual experiences (or should not have!), therefore they cannot recognize erotic scenes because they do not have the register for sexual events. "Dolphins" they know from films, cartoons, zoos,

[14]See the last page of this chapter to know how your memory-evaluative systems can modulate your current conscious experience and its qualia.

etc., but the register for sexual positions I suppose they do not have yet – although today they can see sex on TV freely.

In other words, the memory-evaluative systems modulate the current conscious experience by imprinting specific qualities due to the register's singularity built through successive past experiences. Adults have past experience with sex, and therefore they have a category for "sex" in the register.

I have only presented those pictures to some friends without and with children. The experiment was very informally executed. A better result could be acquired if the experiment was conduced formally with unknown participants, but I have no time and no resources to do that.

There are several other interesting illusions (not only visual, but auditory, gustatory and somatic) that could be used to investigate how the memory-evaluative systems modulate current conscious qualia. The explanation is that your memory system seeks the more familiar identification in the register and imputes those specific qualities to the perception. However, the informal experiment has revealed a curious fact, *viz* that adults see only the couple, and children dolphins or a woman.

Moreover the cases 1 and 3 confirm my hypothesis that the memory register modulates current conscious experience. "John Lennon" and "Mary" have famous faces; they are present in the collective minds. People who know them recognize their faces immediately, although, to the surprise of the people, it there exists no face in the pictures. I do not know why, and it should be investigated, why such patterns emerges as John Lennon's face.

The picture consists only of parallel lines, but the face pops out. The case of Mary is more impressive, the face of Mary is the effect of the solar lights reflecting on the glasses. There is no face of Mary there at all. The image results from the position of the light reflecting in the surface of the building that is made of glass. As it is widely known in optics, glass has a high reflexibility. But believers in Mary insist in recognizing her apparition and ignoring such scientific facts.

Such cases are known in cognitive psychology as optical illusions. The eyes are frequently bombarded with several stimuli, and the brain must recognize patterns in order to give a better response. This is a well known phenomenon in Gestalt psychology. The conclusion from those cases is that the perceived image depends on the eye of the beholder. Some kinds of perceptual information predominate over other kinds in perceptual experience. That is, some sorts of sensory information appear more salient in the content of consciousness than other sorts.

This phenomenal preponderance is subjectively observable as I have shown: when you perceive something, what aspects tend to most fully occupy your conscious awareness? I suppose those that have more familiarity with your register in the memory. The perception will depend on what are you attending to and what you have in your memory.

In sum, the three examples exposed above suggest that the memory-evaluative systems can also influence our current conscious experience. The way we experience them will depend on our background knowledge stored in the memory systems. Since the register in the memory is unique and exclusive, it can apply specific qualities to the current conscious experience.

Further research should be carried out in order to shed more light in this issue, for example, which areas in the brain are active when adults see the couple and after when they recognize the dolphins? Is there a difference in the activation? Which mechanisms take part in such processes? How the top-down attentional influence work?

8.3. Emergence of Qualia

Now it is time to provide a complete description of qualia. Since the first chapter I have been presenting the underpinning parts of the central argument, namely, that qualia are neurobiological mechanisms generated by the triangular modulation of sensory systems, the GNW and the memory-evaluative systems. Now I try to conjoin the parts in order to give a global view of qualia.

First of all, qualia are *qualitative features present in every conscious experience*, e.g., the experience of drinking a cappuccino, of listening Wagner's *Tannhäuser* conducted by Toscanini, of seeing the sunset on the Copacabana beach, and so on. *Qualia evolved in response to environmental constraints*, since our ancestors were required to deal with several constraints such as the search for resources, identification of predators and potential sexual partners, and the need for social communication. In being successful in these tasks, one needs to be in possession of *highly specialized sensory systems* and *complex brains* that processes the incoming information optimally.

The content-general neural circuits which feed output from any of several cortical areas as input into other cortical areas are the very same circuits which sustain conscious experience. Subjective experience therefore arises by virtue of indirect neural communication between the numerous brain areas devoted to sensory, motor, and other domains of cortical-thalamical processing. In this view, consciousness depends on the sharing of information between several parts of the brain, excluding the cases in which the sharing is entirely conducted by direct connections between content-specific neural networks (the modular systems).

Since the content of consciousness is largely supplied by cortical representations, the organization of sensory information in the cortex may influence the psychological structure of perceptual awareness. As a greater proportion of cortical circuits have become increasingly devoted to a single sense modality, the route by which sensory information enters the nervous system may now be more readily identified in conscious awareness than in our evolutionary past.

Distinct sense modalities are easily discernible because each encompasses unique qualities not shared with other modalities. In the human brain, many neural circuits in frontal, temporal and parietal lobes of the cortex receive information from the different senses which has already been pre-processed by modality-specific cortical areas.

The sensory modalities are specific-driven, i.e., they detect specific types of environmental stimuli, such as visual, auditory, olfactory and so on. In a sentence, sensory modalities are the interface between the organism and the environment; they deliver sensory information to the brain. Environmental stimuli are transduced into neural impulses.

By the conversion into sensory information, sensory modalities imprint the first raw qualitative features onto the information detected, which depends on the modality. Each specific modality applies specific qualities; however sensory modalities mechanisms are not enough for the emergence of subjective qualia. Further processing is needed.

In spite the evolution of qualia being a fact, qualia did not evolve as a specific function to enable the organism to enjoy the contents of experience, but qualia evolved as *a response to environmental constraints*. The evolution of specialized sensory systems that convert environmental stimuli into sensory information with specific raw qualities has a *survival value*, i.e., it refers firstly to organism's *reproduction* and *survivorship* in an unstable and changing environment. By having specialized sensory systems, organisms can identify several patterns spreading over the world and apply singular qualities in order to give a better response.

But the ability of enjoying or being disgusted by some contents is a "by-product", i.e., it comes later. The first priority is survival, and only after that the enjoyment of the various qualitative contents present in every conscious experience occurs. Therefore, the *qualia have evolutionary origins*, since organisms must *be informed about the actual state of affairs in the surrounds*. With the detection of environmental stimuli some *qualities emerge simultaneously* due to the modality specificity and further processing in the brain by neuronal networks.

In order to perceive further qualities, consciousness and attention to the sensory stimuli are necessary. This is carried out by means of the *Global Neuronal Workspace*, a set of neuronal networks distributed over the sensory cortices with ascending and descending interconnections with the medial temporal lobe (thalamus, hippocampi, amygdala, and memory-evaluative systems). Sensory information in the neuronal networks is unconscious, but it can become preconscious or conscious, depending on the top-down attentional processes, i.e., whether the subject attends to the specific features that are salient (novel) in comparison with others, or ignores them.

If the subject attends to an object and its features, then top-down attentional modulation occurs, i.e., the activation of several neuronal networks due to the attention to particular features present in a conscious scene. Such features associated with the conscious scene are processed by specialized modular systems (neuronal networks). Afterwards the features are bound together by the *synchronization of several neuronal systems and by the GNW*.

The conversion of the unconscious information into conscious occurs if the activation is above the minimal threshold; it will then generate activation in cascade (recurrent processing), having as a result the activation of distributed neuronal systems interconnected by long-range axons. The result is the synchronization of several hierarchical neural systems involved in the processing of the sensory information. The response to those activities is the *emergence of a global neuronal workspace where the sensory information gains access*.

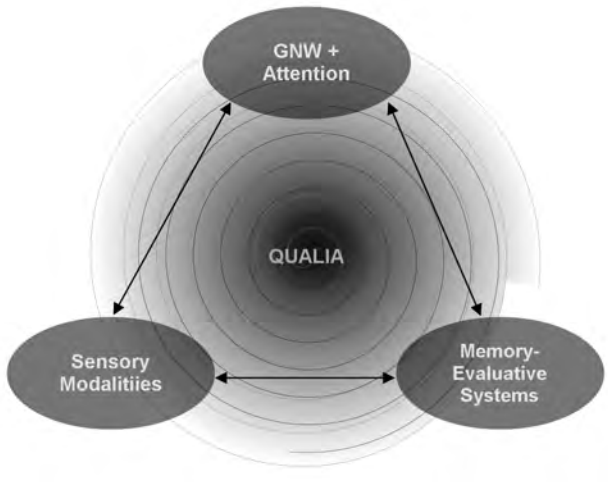
At the phenomenal level it is said that the subject is conscious of that information or he has access to it. But this is not the complete story: further modulation can be applied by the memory-evaluative systems.

The memory-evaluative systems are unique to each organism; they are built and organized through successive conscious experiences over the time. Due to this fact, the subject's register is singular and exclusive (and therefore subjective). In virtue of such singular organization, when sensory information available at the conscious space is related with the register, it receives singular subjective qualities that only the subject has. Sensory information available at the GNW therefore receives further modulations by the memory-evaluative systems that imprint singular and unique qualities.

The register in the memory is unique. Every subject has its own *singular*, *private* and *personal register* with his singular memories. Depending on the current experience, the memory-evaluative systems can modulate the sensory information. Since memory is private and personal, i.e., only one subject can have them, then the *subjective character emerges from the triangular modulation as the result of several micro-mechanisms*.

The phenomenal conscious content arising in the experience depends on the interaction of three basic macro-mechanisms: sensory modalities, the Global Neuronal Workspace plus attention and the memory evaluative-systems. Furthermore the current qualitative state that the subject experiences can be measured by means of EEG (by detecting high gamma band frequencies) and by using fMRI (with the identification of the areas mainly active in the brain during the conscious experience) and with MEG.

Then we could say with some degree of certainty that the subject is experiencing a visual or auditory quale (depending on the areas activated one can predict the content and say if is olfactory, visual, and so on). The map of activation can reveal the type of experience one is having. Of course to access the subjective content of thought seems to be impossible, since the experience is sensed by the subject and not by the tools. But the fact that he is experiencing qualia can be detected. In other words the hypothesis is testable.



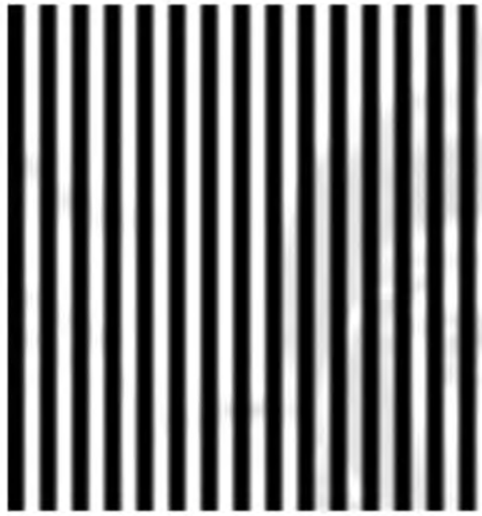
8.4. Conclusion

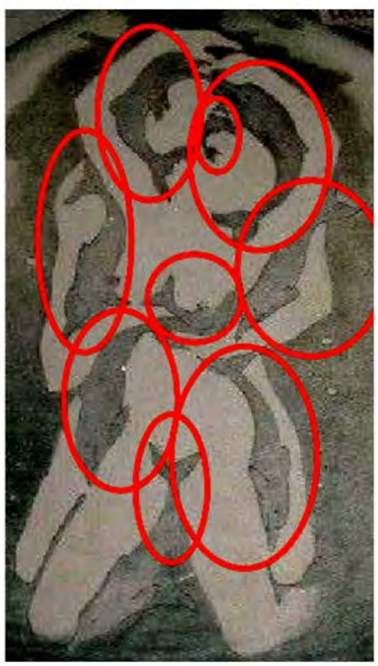
Now I think it is clear why consciousness is always associated with qualia: *in every conscious experience, specific qualia are present.* The conscious experience is based on the sensory systems (sub-divided into the various modalities), which detect information in the world. Even information coming from the memory presents singular qualia. When you recollect past events, they typically come with some qualities (and emotional charge), for instance the taste of German beer, Italian pizza, the smell of my grandparent's house, the smell of my baby when she born, and so on. In every recollected information from memory there is a singular quale present.

Qualia and consciousness will be always linked because every conscious experience has specific qualia, except in the cases of damage in the sensory systems or in the cerebral cortices when qualia do not emerge or are sensed in a different way. But under normal circumstances everyone is able to experience qualia: do not yet believe this? Just pay attention to your conscious experience, regardless of what it is; probably you are hearing something, sensing this book in your hand, seeing the different colors in the surroundings, sensing the smell of your last meal, accessing your memories that do not cease to come into your conscious space, etc. All these examples will certainly present some specific quale that is sensed by you.

In sum, qualia do exist, are real, not special or mysterious entities, and they are not a philosophical illusion. Qualia and consciousness are old philosophical problems that nowadays can be investigated scientifically. Dualism is not an acceptable position when all evidence point out massively that consciousness is neurally realized. A science of consciousness is possible if one bears this in mind. Epistemological philosophical problems can be investigated by neuroscience, and the best explanations in the history of science are based on mechanisms.

Therefore, by discovering the underlying mechanisms of consciousness we will reach a better understanding of such biological phenomenon and how the brain generates conscious behaviour. Qualia are after all sensory qualities generated by the sensory modalities and by the neuronal processing that enable the emergence of a conscious space, the GNW, where you access such sensory information. Further qualities come when such sensory information is related with the memory-evaluative system.





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