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Qualia in a contemporary neurobiological perspective

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Qualia are defined as subjective or private feelings associated with sensory and other experiences. This article argues that private feelings might be expressed by or in a personal brain and discusses possible neurobiological implications. Four issues are considered:

1) Functional dualism implies that mental functions are realized as emergent properties of the brain. In practice, functional dualism is compatible with both substance dualism and pan-psychism.

2) The (adult) human brain is the product of biological and environmental processes, including cultural influences, and is individually unique. Part of the cerebral neuronal processing is molded by individual memories and previous experiences.

3) Biological processes underlying the realization of qualia, including neural activities, escape conscious control. The temporal expression of qualia is in part consciously channeled by, for instance, actual situations and cultural habits.

4) Neuroscientific explanations refer to general principles of nature, rather than to individual phenomena. Hence, future neurobiological approaches might aim to identify which neuronal processes are involved in qualia and how. It seems illusory to explain each quale.

Keywords: *qualia, consciousness, functional dualism, feelings, emergence.*

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INTRODUCTION

Qualia are conventionally defined as the feelings of sensory and other experiences. They are subjective and private and cannot be exchanged directly with other persons, except through bodily expressions and linguistic communication (as a third-person: “I feel that ...”). A variant of this definition is that qualia (and consciousness) have a what-it-is-like aspect: a subjective experience that can only be described as something that is more or less similar, hence incommunicable (Nagel, 1974; 2012). Because of its subjectivity, a scientific or objective investigation of qualia has often been considered impossible (references in Chalmers, 2012; Nagel, 2012). Hence, qualia have been denoted as the ‘hard’ problem in both philosophical and neuroscientific disciplines. Several authors (e.g. Chalmers, 1996; Nagel, 2012; Kauffman, 2008) have claimed that consciousness and qualia should not be understood neurobiologically; instead, they prefer a dualistic conceptualization. Some have included quantum-mechanical theorizing and assumed that consciousness is an integral aspect of the universe (critically discussed by Earp, 2012). Such theories have been criticized, partly because of lacking direct scientific evidence and partly because they are incompatible with prevailing biological theories such as evolution and emerging individuality while growing up (arguments in -among other- Baars and Edelman, 2012; and Korf, 2014).

The reference framework is a major obstacle to describing qualia. Nature is primarily conceptualized as the world outside us that can be described in terms of observable processes or as properties deducible from them as, for instance, visual observation together with muscular force. Physics can illustrate this. Newtonian and Einsteinian physics were concerned with observable features that were initially interpreted in terms of forces, velocity or interactions. Contemporary physics and astrophysics try to understand the universe and its smallest particles in terms of interactions and probabilities. These principles have more or less consistently been applied to neurophysiology. The prevailing ideas use neuron properties ascertained in vitro as the basis of functional in vivo characteristics. Accordingly, neuronal action potentials and synaptic neurotransmission are considered the main vehicles

of intra-cerebral information transfer. I advocate here the idea that understanding qualia requires knowledge about the current state of the brain and its neurons. This is to some extent realized individually - a prerequisite for appreciating the private character of qualia. Moreover, as will be argued, feelings are initially independent from language, although interpersonal communication shapes qualia in a cultural context. We consider the mind as a system emerged from interacting neural brain elements. Emergent properties can often or principally, not deduced from the properties of the constituting elements.

The present communication aims to delineate the problem of qualia in a contemporary neuroscientific context. The conclusion reached here is that certain assumptions about brain functioning have to be made to accommodate for the subjectivity of qualia. First and above all, the brain should be regarded as a personal universe with individually specific properties and attributes, in addition to conditional genetic and other biological programming. Moreover, the limited scope of scientific theories to interpret nature in terms of underlying processes or laws must be accepted. They often describe general processes that do not explain aspects of the individual or subjective processes. We discuss possible research approaches to assess the individual uniqueness of the brain and associated mental processes.

A NEUROBIOLOGICAL FRAMEWORK

Living cells are separated from their environment through their outer membranes, thereby realizing an internal milieu. Mammalian cells are the vehicles of progeny: DNA provides much of the coding of the protein constituents, whereas the entire cell allows the genetic code to become (intracellularly) expressed. Mammals are formed out of a single cell, they develop prenatally in the womb and after birth in a physical environment. Consequently, a unique person emerges via genetic and environmental influences. The environmental influences include the formation of memories of individual experiences. Qualia must be discussed in the context of the individual's uniqueness. From a biological point of view, humans are very similar, as are the composition and anatomy of their bodies and brains. Of course we distinguish sex differences, both in terms of physical appearances and in terms of personal agendas in life. On the other hand, because of the similarity of their brains, virtually all individuals of a community learn the same spoken and written language and will sooner or later conform to cultural norms. Through socializing, the subject learns to channel their instincts, starting with toilet-training, regular eating habits etc., and to verbalize their inner and outer world. The youngster learns to verbalize their emotions and understands what the adult is saying, although, at a young age, they may not yet understand all the emotions of an adult. Several emotions (such as for instance, sadness, pain, pleasure and joy) are mutually understood already at a very young age. In other words, youngsters 'understand' many qualia before being able to express them in language.

The feelings associated with qualia do not necessarily remain similar or constant during life. An organism is never the same at any time: we change continuously and irreversibly during aging as the result of genetic and epigenetic processes. Our capacity of memorizing and our focus of attention change over time: the impact of the same stimulus or quale will vary. The differential impact will be substantial when the functional capacity of the brain deteriorates, as for instance in Alzheimer's dementia, when recent experiences fade and early life experiences become more prominent. In less devastating disorders such as depressive and bipolar disorders, the 'flavor' of a quale depends on the actual state of a person: its impact might even change during the various phases of the disorder. This does not show that qualia are either present or absent, rather their subjective quality may fluctuate (in Chalmers' (1996) terms "dancing" or "fading").

Subjects suffering from a disorder known as dissociation identity disorder have often experienced brutalities (sexual abuse, violence) in their childhood. These experiences might be recalled only in one of the dissociated states, whereas no emotional responses are evoked when the subject is in another, apparently normal, state (e.g. Reinders et al., 2006). But also in the absence of disease or disorder, the quality of experiences changes. For instance, the impact of art might evoke different feelings when viewed for the

first time (sometimes denoted as 'staggering' or 'flabbergasting') as compared to later observations: the later feelings might often be less intense or, the opposite, deeper. But also (non-pathological) variations of mood affect a subjective experience: in a sad or depressive mood, the sunflowers painted by van Gogh might deepen the negative effect, whereas in a cheerful mood the sunflowers might strengthen optimistic feelings (or vice versa, of course).

These examples demonstrate that the feelings associated with particular experiences, i.e. qualia, depend on previous experiences and on the actual state of the nervous system. On the other hand, irrespective of the condition of the subject, the associated personal feelings and their subjective quality, qualia as a private noncommunicable aspect are still to be explained in neurobiological terms.

EMERGENCE AND QUALIA

Many if not all sensations are private: we are able to report verbally about our pains and indicate its location and severity. Perhaps another person experiences some emotions (e.g. shivering) through our report, but the pain itself is not transferred. Very similar arguments hold for smell, taste, feeling happy, etc. As indicated, many of these feelings, if not all, are already present well before one is able to speak. It is as if we are reporting on feelings of a personality that is indirectly linked to cognition. An indirect link seems possible because the brain structures involved in language/cognition (cerebral cortex) are largely dissociated from those causing feelings (subcortical structures): the cortex becomes involved only later. Qualia may be regarded as a conscious quality. First, the subject must be conscious and aware of its body and its environment. In addition, continuity of the brain functions is essential, not only because the processing of primary neuronal signals takes time, but also because of subsequent integration into a conscious experience. Moreover, the brain is constantly changing its configuration of electrophysiological and molecular characteristics. In other words, a living organism is never in a steady-state and it never regains the same configuration again: qualia must be considered as being realized in an irreversibly active and functioning brain.

Searle considers consciousness and presumably qualia as an acausally emergent feature of the central nervous system in the same way as solidity and liquidity emerge from clusters of molecules (Searle, 1992, p.112).

Indeed, water molecules must interact to result in fluidity (bottom-up emergence) and moreover fluidity determines to a large extend the behavior of individual molecules (top-down functionality). Fluidity (or solidity; Searle, 2010; Searle, 1992, pp.17-18 and pp.122-123) is an emergent property of an ensemble of water molecules. Searle continues:

> "Unlike solidity, consciousness cannot be redefined in terms of an underlying microstructure, and the surface features then treated as mere effects of real consciousness, without losing the point of having the concept of consciousness in the first place."

The contrast between the irreducibility of consciousness and the reducibility of color etc. is only apparent. Like pain, consciousness and qualia must be seen in a functioning brain, as an experience, rather than as a collection of neural activities. When considering fluidity Searle (quoted in Vicari, 2008, p.54) formulated emergence as "*bottom-up micro macro no time gap* where cause and effect are simultaneously realized and the effect (macro) is realized as a macrofeature of the system made out of that microstructure (micro) that in turn explains the existence and causal powers of higher-level or system features." This might seem plausible when considering water, but does this idea work in other systems, including the brain and mind? Important here is the assumption that emergence is instantaneously realized, without a time gap (Searle, 1992, pp.87-89). Such a time gap may indeed be extremely short when relatively simple entities (water molecules) interact. Without external forces, such an instantaneously realized quality has little if any causal power over the constituting elements. Qualities are often supervening, in the sense of Jaegwon Kim (2005), without causal properties; causation is rather a core aspect of the physical brain (discussed in depth by Crisp and Warfield, 2001). In a functioning brain it takes at least 150 milliseconds for an experience to become conscious, i.e. to realize a quale. Such a time course is compatible with the idea that the mind and qualia are processes, rather than an instantaneous a-temporal

appearance of a quality.

Chalmers (1996; 2012) discusses whether (strong) artificial intelligence can replace consciousness and therefore also the subjectivity of qualia. He assessed his idea by gradually replacing brain neurons by electronic (micro) devices with the same properties as the original neurons. These devices are supposed to react exactly as the original neurons. The question is now whether and when they affect consciousness and qualia. Chalmers suggests that consciousness is not bound to particular media but can be carried or evoked by any medium instead, although a working electronic device has as yet not been created. However, this is according to Chalmers not a principal argument against his ideas. But let me mention some objections. Electronic devices have no history similar to neurons, whereas qualia are shaped by neurons susceptible to past experiences (examples in Voss et al., 2012; Krugers et al., 2012). The huge capacity for information processing and simulation of natural processes is the strength of contemporary artificial intelligence. Of course, one can argue that an electronic device will be labeled with similar historical marks, but remember that these may to a large extent be specific to the individual brain: the brain is irreversibly molded throughout life. Another, but related, issue is rather conceptual: is it possible to mimic (natural) processes with all their properties and capacities through another medium or can they be represented only partially? Consider for instance a falling autumn leaf: one can easily describe which forces determine its downward tract, the probability of other possible tracts and explain the leaf's autumn colors. But no such model or hypothesis describes the appearance or tract of an individual leaf. Moreover, the computer does not realize the leaf as an object, even if it is modeled perfectly by a 3D-printer. In nature the real thing (including qualia) happens only once.

Chalmers (1996; 2012) uses other supporting arguments that consciousness and qualia can be realized by other media, i.e. computers. He poses the question whether consciousness and qualia fade away after a substantial replacement of neurons; his answer is negative. Similarly, he uses the metaphor of 'dancing' qualia (intermittently present or absent) to illustrate the continuity of feelings, irrespective of the replacing (electronic) devices. My answer is that the manner of analysis depends on the alleged role or functioning of neurons. This seems a reasonable idea if their activity is purely information processing irrespective of memories and previous experiences. If, however, the functioning of neurons in vivo depends on aging-acquired modifications, then the artificial neurons should be programmed accordingly. There are few if any ideas about the latter; in fact, it might even be impossible. Despite the elegance of Chalmers' thought-experiments, their applicability to real life seems questionable because the underlying assumptions are unknown.

Emergent properties are assumed to differ from the properties of the constituting elements: they are neither reducible from them, nor to be predicted through them. To realize new properties, the elements have to interact, the outcome of which becomes unpredictable and fragile following loose interactions. If the interaction is too strong, the emergent properties become predictable; if too weak, the system no longer acts as a unity. We want to emphasize again that we do not consider substance dualism, only functional dualism, i.e. that a system has system-specific dynamics. Despite their conceptually different assumptions, from a practical, and neurobiological view there are little if any practical differences between a dualistic and an emergent view. Both concepts imply top-down causality: the emerged system determines or regulates at least some properties and activities of the constituting elements. The difference between the two concepts is that newly emerged properties can either in principle not (substance dualism) be explained and understood or only (functional dualism) after development of novel neurobiological concepts on the constituting elements.

In summary, qualia must be regarded as an emergent brain process, rather than as an instantaneously realized quality. Robots and artificial intelligence might well simulate functional aspects of the brain, but the real thing (including qualia) cannot fully be expressed through another medium. We argue that qualia are realized by information processing that is associated with past experiences and the memories thereof.

DISCUSSION

Are qualia beyond the scientific scope? Most researchers consider that a personal experience or feeling cannot be formalized as a third-person observation. In my mind, this is only partially true. One has to acknowledge the limitations of the scope or capacity to understand observations in scientific terms or models. If personal feelings exist, the brain provides a basis for them. In other words, private feelings or experiences require an individually specific and private brain. This is indeed the case: as argued, our (adult) brain is the product of biology, environment and, accordingly, of cultural influences. By far most of the biological determinants escape conscious control, their temporal expressions are limited by the situational and cultural environment. Despite their biological determinacy, the associated feelings (the qualia) are and remain private. The feelings can be expressed as hormonal responses following feelings such as love, fear, joy or reflexes due to, for example, pain (Damasio 1999). Feelings of pleasure can also be evoked by drugs. In many cases, the evoked personal feelings have been attributed to specific brain circuitry (e.g. opioids, dopamine, oxytocin), but this is only a partial explanation. None of these circuits are in direct contact with the extra-corporeal environment; hence, environmental stimuli must first be recognized by other neural networks in the individual brain. These provide the neural input to the mentioned circuits, the activity of which is the product of intra-cerebral processing. In addicted persons the influence of the mediating processes might have partially faded.

One may ask what the character is of the feelings associated with qualia. To evoke qualia, the brain must be susceptible to a variety of inputs, which depends on previous experiences together with biological and cultural parameters. Neurobiological support for this point of view would be provided by demonstrating permanent alterations in the brain following previous qualia, which are unlikely to be detectable in vitro. In vivo brain activity involved in qualia might be ascertained by exposing the individual to situations or conditions associated with private experiences, more or less similar as used in psycho-trauma research (Damasio, 1999). But here particularly fast detection or imaging technologies are required. The current in vivo neuroimaging techniques usually based on blood flow or energy consumption are too slow to show the brain activities leading to the perception of qualia, which are in the millisecond range (Korf, 2012; 2014). Moreover, the resolution of the current scanning technologies, such as electro- and magnetic encephalography (EEG and MEG, respectively), might be insufficient to detect temporal and spatial patterns of neural activity preceding the realization of qualia and their associated feelings (Korf, 2012, 2013). There are even more obstacles to detecting qualia: it is as yet unknown whether particular brain functions are expressed similarly in different individuals and whether the expression of brain functions in the same person remains similar over time. This seems unlikely considering the continuous and irreversible molecular turnover of brain molecules. A better-founded stance on the latter issues should be based on advanced technologies and methodologies.

The feelings evoked by qualia are due to association with memories of previous experiences (e.g. Damasio, 1999) to become conscious shortly thereafter (within seconds). Psychophysiological experiments have shown that these association processes are indeed very rapid and might be modeled with mathematical formulas derived from quantum mechanics (Bruza and Busemeyer, 2012; Korf, 2014). These models describe these processes as stochastic (or random) transitions: they are relatively fast compared to the duration of the preceding state of the brain and their timing is rather unpredictable and independent of the duration of previous processes (Bruza and Busemeyer, 2012). Although the timing of the association of feelings to a sensory experience is unpredictable, its transition time is fast (less than 100 milliseconds). The neuronal activities underlying the association process are too fast to be detected with current imaging technologies; it is possible they do not depend primarily on neuronal action potentials and neurotransmission but on protein configuration changes instead (discussed in Korf, 2013; 2014). To develop a better understanding of the underlying mechanisms, modeling of timing and transitions might give clues about the brain processes involved.

CONCLUDING REMARKS

Scientific theories interpret nature, including the human brain, in terms of general laws or processes that do not necessarily explain individual or subjective characteristics or behavior. This statement might suggest that, as many philosophers and scientists assume, qualia cannot be captured in scientific terms. Despite this stance, the present article explores how to approach qualia systematically and scientifically and the possible neurobiological implications of this are discussed here. Our basic assumption is that private feelings are expressed by a personal brain. Neurobiological study designs might focus on more individual and subjective influences on brain neurophysiology, which is likely to be assessed more successfully in situ (and in vivo) than in vitro, i.e. without a functioning cerebral context. Future neurobiological approaches might identify the neuronal processes involved in qualia and how they are involved, but it seems illusory to us to explain the individual quale.

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