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Commentary

The Amazing Gap in Consciousness Research

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According to Cabanac et al. [1], consciousness emerged on a low evoluntionary level already in early amniota. This evolutionary early consciousness has been addressed by Humphrey [2] as feeling rather than thinking. It suggests a gradual evolution of the underlying, neuronal mechanisms. In this commentary, the term "consciousness" is used primarily in the sense of self-consciousness, and therefore the spelling "(self-)consciousness" is preferred to acknowledge the gradual transition during phylogenesis.

When talking about (self-)consciousness, there is (or seems to be?) a major problem called "The hard problem of consciousness" [3], as opposed to the so called "easy problems" of consciousness. While the latter are said to be about, for example, the neuronal circuits and their interconnectivity in the brain, the former is about the basic question why all those complex functionalities lead to (self-) consciousness and subjective experience.

Fair question! Although a myriad of neuroscientists, psychologists and philosophers have published a huge amount of papers on the "hard problem of consciousness", there still seems to be no generally accepted answer to this question. Is there any understandable reason for that? Actually, according to a 2020 survey [4], about 2/3 of the philosophers questioned said they consider the "hard problem" to be a real problem.

Many theories about (self-)consciousness are far apart from all what we know about biology. They may also contrast with the gradual development of mental abilities during ontogenesis, from fertilization of the non-conscious egg to the conscious, adult organism. For example, dualism holds that the mind and the body constitute seperate entities [5]. On the other hand, materialism acknowledges what is obvious from brain injuries, neurologic and psychiatric disorders, or drug effects, namely that mental states depend on their physical basis and are a function thereof [6]. Once arrived at this point, the consequent question is how the brain's neuronal networks as the underlying physical matter generate (self-)consciousness. Tononi and Koch developed the concept of "Neural Correlates of Consciousness" (NCCs) that deals with neuronal processes which parallel the subjective experience [7]. Further to this point, the Integrated Information Theory (IIT) [8] holds that "for each essential property of experience, there must be a corresponding causal property of the PSC" (PSC = "physical substrate of consciousness").

Although complex integration of information is no doubt an essential precondition for (self-)consciousness to emerge, it does not really touch the crucial point. As discussed previously [9], (self-)consciousness on whatever evolutionary level is only conceivable if an individual exists to whom something can become conscious. However, being an individual requires the capability to discriminate between the outside and the inside world. To achieve this, complex integration of information in the brain is essential but not sufficient. The crucial point is the COMPARATIVE REPRESENTATION of information originating in the environment versus information originating in the own body. This important

function is a special case of "integration". Without this ability, the organism might receive and integrate any stimuli just the same way as a dead machine does, but would not experience itself as opposed to its environment, namely, as an individual endowed with (self-) consciousness.

Thus, some obviously evident conclusions have been drawn regarding the preconditions necessary for the emergence of (self-)consciousness [9]. First, (self-)consciousness presupposes an individual to whom something can become conscious. Second, any individual (on whatever phylogenetic level) must have, at least to some extent, the capability to discriminate between its own body and its environment. Third, the brain's comparative representation of the outside versus the inside world is both, sufficient to explain, and equivalent to, (self-)consciousness.

It is in particular the third conclusion that is meant by the "gap in consciousness research", because this central aspect has not been explicitly and sufficiently dealt with in the literature. Although several authors, for example Fabbro et al. [10] and Newen [11], refer to "self- and world consciousness" and "self-world distinction", respectively, it still remains obscure how this discrimination is brought about, and how it leads to (self-)consciousness. While neuronal networks can represent and map the impressions from inside and outside the own body, there is no indication to be found in neurosciences that neuronal networks can do more than process, interconnect and represent their input, though in an extremely complex way. Therefore, the comparative representation (as such!) of neuronal input fom inside and outside one's own body may in fact be EQUATED with (self-)consciousness [9].

Kandel [12] held that understanding the NCCs would not solve the so called "hard problem of consciousness", but in contrast to his notion the above statement on the basic nature of consciousness seems to be quite plausible. The concepts of the NCC and the IIT do not explicitly address this possibility. Although Tononi et al. [8] mentioned that "the IIT framework […] emphasizes the information matching between intrinsic and extrinsic causal structures" and "external inputs […] maintain adequate excitability", this is not the same as to equate comparative, neuronal representation of internal versus external stimuli with (self-)consciousness.

The latter implies a comparative, neuronal function. Kunzendorf [13] introduced such a comparator function with reference to consciousness. He argues in his "Theory of Source Monitoring": "While physically monitoring either the peripheral or central source of sensations, the brain's monitoring mechanism is subjectively paralleled by the generic knowledge that all monitored sensations should be treated as 'belonging to oneself' and by the resulting illusion of a 'self' as subject having these sensations". Kunzendorf's "source monitoring mechanism" identifies the brain ("central") versus the environment ("peripheral") as the two relevant sources of sensations, i.e., sensations based on, for example, "visually imagined" contents versus sensations "externally generated or perceived". Contrary to that, the argument offered here is based on the comparison between sensations originating in one's own body with sensations originating in the environment. Sensations originating in the brain may be subject to mental illness as well as erratic input from outside the body and will therefore not provide any sound basis for the constitution of "self". By contrast, bodily sensations will be perceived by any individual as "own" because any part of the body is experienced in the context with the rest of the body. Any change over time or due to a failure of one or the other part of the body will take place still embedded in this continuity of the complex scenario of bodily sensations which can be considered the most reliable basis of "self". As it is evident from introspection, conscious perception of the environment is always paralleled by sensation of one's own body.

In any theory, the brain must have any function that allows for a decision about "self". In Kunzendorf's theory, this is an axiomatical construct termed "generic knowledge" which results in the "illusion" of self and which escapes any empirical proof. By contrast, the argument discussed here refers to a neuronal mechanism, namely the comparative representation of external versus internal sensory impressions. Such a neuronal mechanism can be approached empirically, for example by techniques for neurobehavioral assessment combined with neuroimaging [14]. There is no theoretical construct required.

Krauss and Maier [15] summarized in their review on "conscious machines" and on theories of consciousness in general: "In all theories that we touched in this article, the notion of self is fundamental and the emergence of consciousness crucially requires embodiment". This notion of "embodiment" as being crucial to consciousness meets the present notion that (self-)consciousness requires a personal entity depending on the comparative processing and representation of the inside versus the outside world.

In conclusion, the crucial points to be made are, first, that any theory on the basic nature of (self-)consciousness should take the brain's comparative representation of stimuli from outside versus inside one's own body into account, which has not been explicitly and sufficiently addressed in the literature. Second, and irrespective of the neuronal mechanisms involved, this comparative representation (as such!) may be equated with (self-)consciousness.

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