

A Physical Framework for Explaining Consciousness

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David Chalmers (1995) states that "The ultimate goal of a theory of consciousness is a simple and elegant set of fundamental laws, analogous to the fundamental laws of physics." He goes on to suggest that certain psychophysical laws, like higher level principles, are "unlikely to be fundamental . . . analogous to macroscopic principles in physics such as those of thermodynamics or kinematics." and that more fundamental laws "may centrally involve the concept of information." Crick and Koch (Chalmers, 1995) acknowledge that information "may indeed be the key concept, as Chalmers suspects".

If we take information to be fundamental here, then there is a problem: information is, in general, an intuitive notion with little, if any, consensus on just how to scientifically define it (Bunge and Ardila, 1987). Surely we cannot hope to construct an objective theory of consciousness if the foundation on which it rests is abstract and poorly defined. If information is the key to understanding consciousness, then those characteristics of the brain that give rise to it will only be revealed when we have grounded information and information processing.

But how do we go about grounding these? I claim it cannot be done simply by looking at the hardware architectures of systems we consider to be processing information, like digital computers and brains. Rather, it requires a broader and more fundamental physical understanding of information and its processing. To this end I offer a physical framework that classifies object interactions in such a way that different kinds of information processing are identified with different kinds of interactions. This framework is an extension of traditional physical state descriptions used to describe lawfully-determined changes in the values of measured attributes of interacting objects. It could very well be what Chalmers is looking for when he offers "how [information] is physically processed" as the possible explanation for how some information might have an experiential aspect.

The framework is based on the observation that physical objects have two and only two physical aspects: extended structure and measurable properties like mass and velocity. Since everything consists of physical objects, unless information and its processing are non-physical, it must be embodied by one or both of these aspects. We have information about the world because physical objects interact with our sensory systems. Thus objects are informational in that they "inform" us through interactions.

The framework differentiates between physical interactions according to which of the two physical aspects of inter-

acting objects cause the resulting changes. All physical interactions are classified into four types: nomologically-determined change, nomologically-triggered change, pattern matching, and structure-preserving superposition (SPS). The first two result in changes caused by measured attributes and the last two result in changes caused by extended structure.

If we assume that objects are informational through their physical aspects, then we can consider that the different types of physical interactions are the physical basis for different kinds of information processing: nomologically-determined change describes the information processing in analog computers; pattern matching describes the information processing in digital computers; and, I claim, SPS describes the information processing in the brain (Boyle, 1995).

What does this have to do with consciousness? First, information, if it is fundamental, is now grounded in the basic physical interactions that make up all physical processes. Second, one of these basic interaction types, SPS, is so different from the physical interactions that underlie the functioning of all other complex physical systems, that it makes the brain unique, over and above its own enormous complexity. I believe SPS is responsible in part for the brain's remarkable characteristics, such as its intrinsic capacity for reference and, I put forward here, consciousness, and that without SPS there would be no consciousness. Consciousness may require the presence of other physical phenomena, such as electric currents, but SPS is a necessary and fundamental ingredient.

References

- Boyle, C.F. (1995) Information as an Intrinsic Property. *Minds and Machines*, 4: 451-467.
- Bunge M. and Ardila, R. (1987) *Philosophy of Psychology*. New York, NY: Springer-Verlag.
- Chalmers, D.J. (1995) The Puzzle of Conscious Experience. *Scientific American*, 273 (6): 80-86.