

Disunity and asynchrony of consciousness

Dima Batenkov

August 13, 2007

Abstract

The nature of consciousness continues to puzzle researchers in cognitive and neurobiological sciences, as well as non-specialists. One of the questions is that of the unity (or the lack thereof) of consciousness on various levels. In this paper I will give a short overview of the literature on this subject and present some thoughts.

1 Introduction

The idea of some “unity” of consciousness has been dominating philosophical thought and cognitive science. It is somehow clear that the consciousness should be unified at some intuitive level. Moreover, consciousness (or awareness) is thought to be singular in some sense. It seems that only recently this view is being reevaluated on both cognitive as well as neurobiological grounds, the latter being supported by various psychophysical experiments as well as defect (lesion) studies.

2 Cognitive perspective

Quite detailed analysis of the problem of unity from the cognitive perspective is given in [OO98]. There, two models - “Monophonic” and “Polyphonic”¹ - of the unity of consciousness are discussed and criticized. In fact it is argued that what is claimed to be the singularity of consciousness is more likely to relate to attention or higher thought processes, which constitute a part of conscious experience but by no means exhaust it. We may experience many things in different modalities at once (for example, enjoying a beautiful view of a countryside, hearing sound of wind and singing of birds, feeling the ground under the feet etc.) but may not be able to react to or to think about each one of them simultaneously. So it seems that different kinds of consciousnesses are confused for each other (the phenomenal consciousness and what has been called by Ned Block “access-consciousness”²), which leads to the concept of a serial consciousness where it may only mean the seriality of one very specific part of consciousness, namely, the “inner eye” or the “self-narrative” . Nature of consciousness is suggested to resemble a “multi-track polyphony” ([OO98]), i.e. consisting of a large number of distinct and independent elements which are not “controlled” by some central

¹Some analogy is claimed to the Global Workspace Theory by Baars ([Baa88])

²In [Blo95], an access-conscious state is defined as such that the content of the state is available for verbal report, rational inference and deliberate control of behaviour.

executive process (as suggested by the “single-track” analogy) but rather made coherent and synchronized (like the various voices in a polyphonic music which are in harmony with each other but independent).

The “multi-track” aspect is further supported by evidence suggesting possibility of breaking the initial coherency of perception between modalities (as in the case of synesthesia³) as well as within a modality (a case is described when a patient with some peripheral damage experienced gradual reappearance of different visual elements such as color, shape, depth and motion).

It should be mentioned that attempts have been made to define the concept of “unity” in such a sense that speaking about the unity of consciousness is not trivially true⁴ or false but has some merit, cf. [BoA02, Alt]. It seems, however, that such attempts rather resemble philosophical discussions without any practical relevance to our understanding of consciousness.

But the strongest evidence for the distributed model of consciousness comes, not surprisingly, from neurobiological studies, which we discuss next.

3 Neurobiological perspective

It seems that the question of “unity” or “disunity”, whatever that might mean, is of great interest to the neuroscience community as well, since it concerns the very nature of consciousness. If the consciousness is unified, then a single neural correlate of consciousness may exist. In any case, the answer to the question of unity can lead to building better models (including computer models) of consciousness.

3.1 Split brains

Split brains⁵ phenomenology may be considered as some evidence in favor of the disunity hypothesis. Roughly speaking, in a split brain person the hemispheres act as separate entities, so this person can be regarded as having two separate consciousnesses. On the other hand, what is called “total consciousness state” in [BoA02] is still preserved. Cf. [Alt] for an interesting discussion.

3.2 Disunity in vision

The visual consciousness is being researched for several decades, and it is believed that most of the discovered principles of its operation are also valid for the other perceptual systems and, as a result, to the entire phenomenal consciousness (several arguments in favor of this choice are given in [CK90]).

From this research an interesting and perhaps surprising picture emerges. Semir Zeki, a neurobiologist who has been studying the visual system, puts forward a theory of visual consciousness ([ZB99]) which is based on his own and other studies. According to this theory, the brain consists of parallel, distributed

³When sensation in one modality leads to experiencing another, e.g. experiencing color as a result of hearing a musical tone

⁴For example, one might define unity as something like self-recognition or the subjective feeling of self, which is obviously true for a normal person.

⁵Split brain is a brain in which the corpus callosum has been partially or entirely severed, thus significantly reducing the communication between the hemispheres of the cerebral cortex.

and functionally specified processing systems. Moreover, it is argued that the visual consciousness consists of several independent *micro-consciousnesses*, which are *bound* or *integrated* to generate a unified conscious percept, but nevertheless can be and are perceived separately. Various experiments have been conducted which are interpreted in favor of this view, namely, that the brain perceives different attributes (such as color, orientation and motion) at different times when compared to the time of their actual occurrence. It is concluded that there is no central “consciousness area” which is responsible for globally synchronizing the microconsciousnesses, but rather each one of the attributes can be perceived independently of others⁶. This property of consciousness is referred to as *disunity* by Zeki in [Zek03].

Zeki’s reasoning can be summarized as follows (see [Zek03, ZB99]):

- There exists a functional specialization in the visual brain. That is to say, different areas of the cortex are responsible for *processing and perception* of different visual attributes. For example, the areas V4 (color) and V5 (motion)⁷ are geographically separated, and a damage to one area does not have almost any effect on the functionality of the other (damage to V4 still does not prevent a person from perceiving motion).
- The brain areas responsible for processing visual attributes are also *perceptual* sites, i.e. the ones in which neural-conscious correlates of these attributes are generated. This is very important assumption for the formulation of the disunity thesis, since it means no special area is required for perception per se, but the *microconsciousnesses* generated in the processing-perceptual areas are rather *bound* together.
- This processing and further generation of conscious correlates have been found to occur asynchronously with respect to one another, so we perceive different attributes (for example, motion and color) at different times, in the subsecond range (on the order of tens of milliseconds). These experiments, conducted by Zeki and associates ([MZ97]) and also others ([AC02, ACW01]) suggest that there exists a correlation between the time course of perception and the time course of neural activity. That is to say, the differences in perception are explained by differences in processing times at the neuron level. The visual awareness is thought of as “an on-line monitor of visual processing” ([CAP03]).
- Consequently, the visual consciousness (and phenomenal consciousness in general) consists of *micro-consciousnesses* (a percept of a single attribute, e.g. color) which are bound to produce *macro-consciousnesses* (a percept consisting of several attributes, possibly from different qualia, e.g. a moving red bus). Zeki finally concludes ([Zek03]):

Micro- and macro-consciousnesses, with their individual temporal hierarchies, lead to the final, unified consciousness, that of myself as the perceiving person. This and this alone qualifies as the unified consciousness, and this alone can be described in the singular.

⁶Compare this with the Global Workspace theory

⁷S.Zeki is a co-discoverer of the motion area MT, or V5

There are some disagreements with the proposed theory, including both the correctness and the extent of the measured asynchrony (see [CAP03]) as well as providing alternative explanations to the “on-line model”, as in [ES00].

However, there seems to be no dispute among the neuroscientists that the consciousness has at least some distributed and parallel nature, as it is fairly obvious that neural activity is taking place at different and anatomically separated nodes in the brain and it has to be somehow *synchronized*, or *bound* to produce unified concepts. That is what the binding problem is about.

3.3 The binding problem

After accepting that different phenomenal qualia and attributes are perceived (if not consciously, then at least on some level) in anatomically different regions of the brain, and recognizing the phenomenal unity (again, at least on some level), the question arises how these different qualia are bound together to produce single, unified concepts ⁸.

It should be first noted that a clear distinction has to be made between different levels of binding. [Rev99] distinguishes between binding on

- the phenomenal level (contents of phenomenal consciousness)
- the level of neural mechanisms
- the level of cognitive mechanisms

where the last two, when discovered, should “explain” the first one and hence the unity of consciousness itself.

It seems that this question, as well as its relation to consciousness, is far from being solved. Some think ([CK90]) that it is the binding itself that generates conscious percepts. Others (e.g. Zeki in [Zek03]) think that the binding is largely post-conscious, and not necessary for generating conscious percept but only binding the “micro-” and “macro-consciousnesses” together (see above). Among the proposed mechanisms of binding are synchronized neuronal oscillations (near 40 Hz range, [CK90]), some sort of application of self-similar cortical processes (as in [SIN01]) and possibly others (cf. [Rev99]).

4 Evaluation and criticism

It seems to me that the problem of unity is still largely debated in the philosophical, cognitive and neurological communities.

To begin with, an undisputed definition of unity is apparently missing⁹. My personal opinion is that whatever the definition may be, the question or the concept of unity might be just an illusion (analogous to free will). It is a notion which we possibly impose on ourselves (our brains) because we find it necessary that the apparent coherence of our highest cognitive processes (our apprehension of the surroundings and complex objects in particular, the singularity of

⁸Following an example in [CK90], while talking to a friend, various neuronal activities such as in area MT responding to the motion of his face, in area V4 responding to its hue, in auditory cortex responding to the words coming from his face etc. have to be bound together to produce a unified percept of the friend’s talking face

⁹Not mentioning that the concept of consciousness itself is often loosely defined.

our inner voice) must somehow be explicit on the neuronal level. So it is possible that this “unity” exists only as a concept and a metaphor, while not having any *global* “imprint” on the functioning of the brain. The apparent unity may be only a part of the analysis process which the brain applies to its own operation ([SIN01]). There is no obvious *a priori* need for any unity (or neuron synchronization) to exist. Some neural synchronization should (and does) exist at fast rates, but the implication of this for global synchronization leading to appearance of “unified” concepts (such as a red moving bus) are uncertain at best.

The neurobiological evidence presented in the overviewed literature seems to convince me that the generation of conscious percepts is largely asynchronous and distributed across different brain regions, although the extent of this asynchrony is not entirely clear. First experiments by Zeki and associates ([MZ97]) suggested an approximate figure of 80 ms between color and motion, but subsequent experiments ([CAP03, AC02, ACW01]) seem to put this under question and claim that the lag may even disappear under certain conditions. The neural mechanisms leading to the asynchrony are also not well-understood. The rate of the asynchronous effects seems to be too fast to have any significant implications for perception under usual everyday conditions.

The various psychophysical experiments described have been conducted on too small a number of subjects (usually less than 10), so one might (and should) question the universality of the conclusions drawn from these experiments. Indeed, some of the experiments were conducted by the authors on themselves as the subjects. It makes me wonder whether the empirical methods employed are entirely adequate.

While having, in my opinion, many problems, the disunity thesis as formulated by Zeki in [Zek03] (consisting of micro- and macro-consciousnesses) is a valid working hypothesis, being somewhat backed up from cognitive side (see Section 2). There seems to be some convergence of ideas, but as long as there exists a large explanatory gap in the science of consciousness, we will be always having contradictory and incomplete theories.

References

- [AC02] D.H. ARNOLD and C.W.G. CLIFFORD. Determinants of asynchronous processing in vision. *Proceedings- Royal Society of London. Biological sciences*, 269(1491):579–583, 2002.
- [ACW01] D.H. Arnold, C.W.G. Clifford, and P. Wenderoth. Asynchronous processing in vision Color leads motion. *Current Biology*, 11(8):596–600, 2001.
- [Alt] T. Alter. What do split-brain cases show about the unity of consciousness?
- [Baa88] B.J. Baars. *A Cognitive Theory of Consciousness*. Cambridge University Press, 1988.
- [Blo95] N. Block. On a confusion about a function of consciousness. *Behavioral and Brain Sciences*, 18(2):227–287, 1995.

- [BoA02] T.J. Bayne and The University of Arizona. *The Unity of Consciousness*. The University of Arizona, 2002.
- [CAP03] C.W.G. Clifford, D.H. Arnold, and J. Pearson. A paradox of temporal perception revealed by a stimulus oscillating in colour and orientation. *Vision Research*, 43(21):2245–2253, 2003.
- [CK90] F. Crick and C. Koch. Towards a neurobiological theory of consciousness. *Seminars in the Neurosciences*, 2(263-275):203, 1990.
- [ES00] D.M. Eagleman and T.J. Sejnowski. Motion Integration and Postdiction in Visual Awareness. *Science*, 287(5460):2036–2038, 2000.
- [MZ97] K. Moutoussis and S. Zeki. A direct demonstration of perceptual asynchrony in vision. *Proc R Soc Lond B Biol Sci*, 264(1380):393–9, 1997.
- [OO98] G. O’Brien and J. Opie. The disunity of consciousness. *Australasian Journal of Philosophy*, 76(3):378–395, 1998.
- [Rev99] A. Revonsuo. Binding and the Phenomenal Unity of Consciousness. *Consciousness and Cognition*, 8(2):173–185, 1999.
- [SIN01] W. SINGER. Consciousness and the Binding Problem. *Annals of the New York Academy of Sciences*, 929(1):123–146, 2001.
- [ZB99] S. Zeki and A. Bartels. Toward a Theory of Visual Consciousness. *Consciousness and Cognition*, 8(2):225–259, 1999.
- [Zek03] S. Zeki. The disunity of consciousness. *Trends Cogn Sci*, 7(5):214–218, 2003.