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The Structure of Mind and the Role of Consciousness

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Abstract

The term *mind* is used here to refer to all of the mechanisms in the brain that generate one's responses including thinking and experiencing. These mechanisms may be innate, or they may be learned but based on innate abilities. Most of these mechanisms respond in a rapid but flexible way to situations that one confronts frequently; some respond to occasional threats or opportunities; some are temporary mechanisms for responding to expected situations, or for controlling intended behavioural sequences; and some are capable of more generalised problem-solving. All of these mechanisms are unconscious; there is no evidence of conscious processing, and much evidence—based on psychological research, evolutionary principles, and theoretical considerations—confirming that no mental processing occurs in consciousness. Consciousness is a changing array of information in various forms; such as sights, sounds, and felt experiences, but consciousness is adaptive, and this can only be because conscious information enhances its possessor's responses in some situations. The mechanisms of mind generally operate with unconscious information, but they sometimes benefit from access to conscious information, and some mechanisms may have evolved to function solely with conscious information or use only conscious information in some situations.

Keywords: mind, consciousness, behavioural flexibility, mechanisms of mind, evolution of mind, human behaviour.

1. Introduction

The mind is all of the mechanisms in the brain that generate one's responses including thinking and experiencing[2]. An important feature of the human mind is consciousness[3]—one's ongoing experience. In developing a hypothesised structure for the mind, an important consideration is the role of consciousness in the mind.

In particular, three questions about consciousness are relevant to understanding the structure of mind. First, is whether or not one actually experiences the manipulation of information—whether or not information is processed in consciousness. Commonsense tells us that thinking, planning and decision-making are conscious processes, but, over the years, there have been many claims that the commonsense view is wrong, and that there are no processes in consciousness (e.g., Bowers, 1984; Dehaene & Naccache, 2001; Dixon, 1981; Earl, 2014; Lashley, 1958; Miller, 1962; Oakley & Halligan, 2017; Velmans, 1991). The second question is whether consciousness is essential for humans to respond flexibly to events, or whether we can respond flexibly to events without the participation of consciousness in the selection and control of our responses. A separate, third question is, if consciousness does not incorporate processing, what is its function? Evidence related to the second and third questions—concerning whether or not the participation of consciousness is essential for responding in a flexible manner, and concerning the function of consciousness—are considered later in this article.

We begin with the question whether there are conscious processes. It is important to establish, beyond reasonable doubt, whether there is information processing in consciousness because this has a bearing on the structure of mind and on the role of consciousness within the mind. As noted above, there have been many previous claims that no processing occurs in consciousness. Against this, the commonsense view that we consciously process

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[2] This is a similar usage of *mind* to Anderson (2014, 2016).
[3] *Consciousness* is used in the sense of phenomenal consciousness (Block, 1995).

thoughts, plans, and so on, is very attractive, but there appears to be no evidence to support it, other than the subjective feeling that one's thinking and planning processes are experienced. The evidence indicates that we do not experience thought processes; we experience the *outputs* from unconscious[4] thought processes, and we think of these outputs as being the processes by which they are generated (Earl, 2014; Lashley, 1958; Miller, 1962; Umiltà, 2007). It is possible that the common view that some mental processes are conscious is an example of the illusion of explanatory depth (Rozenblit & Keil, 2002), according to which many commonsense views, and scientific assumptions that are based on intuition are erroneous. In recent decades, there has been an accumulation of published evidence that processes which were previously assumed to be conscious are actually unconscious.

After reviewing the relevant literature, and other considerations, Velmans (1991) found no evidence of conscious processing. He reported that analysis and selection of information for entry to consciousness; control of attention; learning and memory; planning what one will say; creativity; organizing one's responses; determining one's priorities; and production of voluntary responses; are all unconscious processes. Velmans concluded that information for entry into experience is selected unconsciously; there was no evidence of information processing in consciousness; and behaviour which follows on from events in consciousness is unconsciously controlled.

Over several decades, Bargh and coworkers, and others, have reported that various social cognitive processes, which previously were assumed to require conscious processing, are actually unconscious processes. They reported evidence of unconscious processing in decision-making, moral judgments, close relationships, emotional processes, face perception, social judgment, motivation and goal pursuit, conformity, and behavioural contagion (reviewed, for example, in Bargh, 1992, Bargh & Chartrand, 1999; Bargh & Ferguson, 2000; Bargh, et al, 2012).

Other evidence has been published demonstrating that actions which were previously thought to be consciously determined are under unconscious control. Hassin and coworkers (Goldstein & Hassin 2017; Hassin, 2013; Hassin & Sklar, 2014) have reviewed evidence that causal reasoning, decision-making, conflict management, metaphor comprehension, understanding and reasoning by analogies, problem-solving, self-control, inferences of various kinds, executive functions, working memory, abstract thinking, and planning, are all unconscious processes. Hassin (p. 195) claimed that "unconscious processes can carry out every fundamental high-level function that conscious processes can perform".

Earl (2014) provided evidence and a review of reports relating to various types of information processing in the mind, and found that many psychological processes which are, or were until recently, considered to be conscious appear to be unconscious. The control of attention; the selection of information for entry to consciousness; choices and decisions; the generation of thoughts and the selection of words to express them; numerical addition; problem-solving and creativity; and the initiation and control of intentional actions; are all unconscious processes.

Taken together, these reports suggest that all mental processing may be unconscious. However, as Hassin (2013) noted, very many functions have been found not to require conscious processes, but there is always the possibility that a function will be found for which conscious processing is necessary.

In the following sections, I present experimental and theoretical evidence that there cannot be processing in consciousness, and that humans have an unconscious processing system which responds to all relevant information. This unconscious system is able to manipulate unconscious information with or without the involvement of consciousness. Consciousness is shown to be an ancillary device that is adaptive, and, therefore, must sometimes enhance the biological value of outputs from some mechanisms in the mind.

The structure of the two central arguments is shown in Figure 1. First, evidence that all mental processing is unconscious, plus evidence that consciousness is adaptive, leads to the conclusion that consciousness is solely information but must sometimes influence behaviour. Second, evidence that all mental processing is unconscious, that mental mechanisms can determine behaviour with or without conscious inputs, and that consciousness can influence behaviour, lead to the conclusion that the mind is a combination of unconscious mechanisms which generally employ unconscious information, but that some of these mechanisms make use of conscious information in some circumstances.

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[4] U*nconscious* refers to events in the brain that are not being experienced.

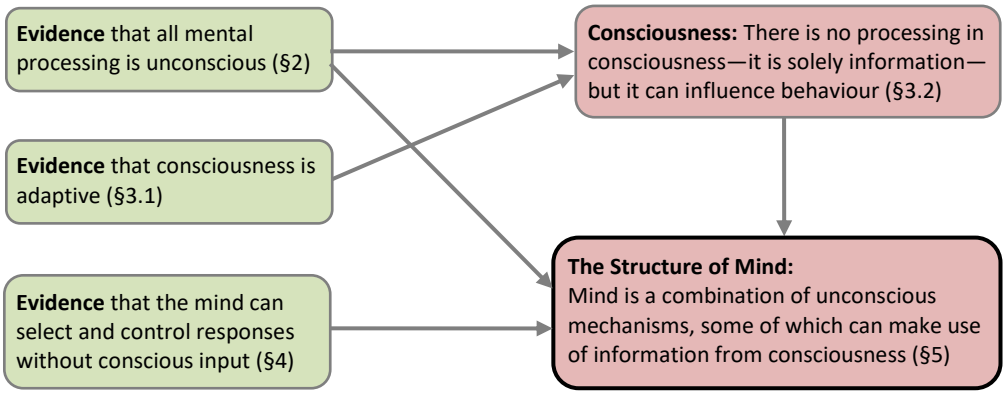

Figure 1. The three areas of evidence and conclusions drawn from them.
(§ indicates the relevant section of this article.)

2. Reasons why there can be no processing in consciousness

There are several arguments, and some ancillary support, on the basis of which it is reasonable to conclude that no information processing occurs in consciousness, and that we do not experience mental processes of any kind. The first of these arguments is based on published reports of experiments that demonstrate conscious and unconscious information being processed together. Second, there is an evolutionary argument why conscious processing is extremely unlikely, and this is discussed in §2.2 below. Third, a consideration of the properties of consciousness and general properties of processes leads to the conclusion that there can be no information processing in consciousness (§2.3).

2.1. Experimental evidence indicating that all mental mechanisms are unconscious

Evidence that conscious and unconscious information are processed together supports the view that all mental processing is unconscious, because it would not be possible to consciously manipulate information that one is not aware of. Therefore, joint processing of conscious and unconscious information can only occur unconsciously. If conscious and unconscious information are processed together unconsciously, information from consciousness would also need to be processed unconsciously, otherwise there would have to be a switch from conscious to unconscious processing as soon as any unconscious information is processed with the conscious information. This is why evidence that conscious and unconscious information are processed together constitutes evidence that all mental processing is unconscious. The following is a sample of reports which provide evidence that conscious and unconscious information are processed together.

In response to an instruction to respond with a left or right key press, depending on whether a number was greater or less than 5, a prior masked number produced a covert motor response appropriate to the conscious instruction (Dehaene et al, 1998). Unseen "stop" or "no go" primes immediately prior to an intentional motor response were found to inhibit it—instructions presented consciously were interfered with by unconscious instructions (Hughes, et al, 2009; van Gaal, et al, 2009; Wokke, et al, 2011). Determination of the sums and averages of consciously perceived numbers was influenced by unconscious digits presented just prior to the conscious numbers (Van Opstal, et al, 2011). A subliminal instruction influenced participants' speed of identifying a symbol as a number (Ric & Muller, 2012). Conscious and unconscious word pairs were processed together (Henke, et al, 2013). In an experiment utilising consciously seen and unconsciously presented shapes, instructions relating to the seen shapes were also applied to the unconscious shapes (Lin & Murray, 2014).

Continuous flash suppression (CFS) is a technique whereby a changing complex pattern presented to one eye prevents conscious awareness of a stimulus to the other eye for a period of seconds (Tsuchiya & Koch, 2005). A variant of CFS is the measurement of b-CFS (Jiang, et al, 2007), which involves studying the effects of variables on the time for the CFS-suppressed visual information to break suppression and be experienced. Words break CFS faster when they are preceded by a semantically related visible word than when they are preceded by an unrelated word, and words also break CFS sooner when preceded by visible words that share sub-word fragments compared to when

preceded by words that do not share sub-word fragments (Costello, et al, 2009). An image of a pumpkin broke through suppression sooner after observers heard the word "pumpkin" than after hearing an unrelated word (Lupyan & Ward, 2013). When participants were instructed to keep in mind some feature of a visual stimulus, CFS broke sooner when the information they had been told to remember matched the unexperienced stimulus (Gayet, et al, 2013; Pan, et al, 2014). In experiments reported by Alsius, et al, (2013), participants heard a voice speaking and were presented with an image of moving lips suppressed by CFS. When the sounds and the lip movements matched, suppression was broken sooner than when they did not match. This and other CFS reports are reviewed in Gayet et al, (2014), who wrote that a consciously accessible context prioritises unexperienced visual information which matches this context.

In each of these experiments conscious and unconscious information were being jointly processed, including when the conscious and unconscious sensory modalities were different. Conscious and unconscious information could only be processed together in an unconscious processor, because one could not consciously process information that one was not aware of.

If there were conscious processes, they could only process conscious information, and there would have to be a switch to unconscious processing as soon as any unconscious information were used, which would seem improbable. Therefore, published reports of joint processing of conscious and unconscious information constitute indicative evidence that all information is processed unconsciously, and that there is no information processor in consciousness.

2.2. Evolutionary argument

The above conclusion that all information is processed unconsciously is what would be predicted based on evolutionary considerations. Early neural processing of sensory information, which probably evolved in the late Ediacaran Period to coordinate animals' movements (Budd, 2016), would have been unconscious. Over time, these mechanisms developed to include responses to stimuli, finding food, and avoiding predators, and eventually to very complex responses to events. At no stage would it have been adaptive for a second conscious group of mechanisms to have evolved in competition with existing unconscious mechanisms to determine behaviour.

Mental mechanisms for manipulating information can only evolve because they are adaptive, and the only way they can be adaptive is by determining behaviour. It is extremely unlikely that two processors—one conscious and one unconscious—could have evolved with the same function, which is to determine behaviour. It is especially unlikely because, in general, an optimum outcome from this processing is likely when a single processor operates with all available information, whether conscious or unconscious.

As noted above, there is a great deal of published evidence of unconscious mental processing. I am not aware of any published evidence of processing in consciousness. We know that unconscious mental processing exists, and it is unlikely that an additional processor could have evolved in consciousness.

2.3. The properties of consciousness and processes do not permit processing in consciousness

Consciousness is a property of neural structures in the brain, and consciousness—one's experience—cannot change without there being some changes within the neural structures of which it is a property (Davidson, 1970). A property of something cannot change without some change in the object of which it is a property. For example, the shape, colour or size of an object cannot be altered unless the object is altered. McLaughlin and Bennett (2018) wrote that "you cannot change the arrangement of colors and shapes on a painting's canvas without changing its microphysical properties." Similarly, no change in one's experiences can occur without a change in their underlying neural events. Therefore, processes can only occur in consciousness—can only be experienced—if they are occurring in the neural events of which consciousness is a property.

This raises a question whether, when processing occurs in neural events, it could also occur in consciousness. To resolve this question, it is necessary to define *process*, and to review some of the properties that are shared by all

processes. A process is an action[5], or a combination of actions, that leads to a change in something (Earl, 2014). Examples would be an acceleration process—the action of a force that changes the velocity of an object; a plastic moulding process—the actions of heat and pressure (and subsequent cooling) that convert plastic granules into useful objects; and growth processes—the complex of chemical and physical actions that cause a plant to produce new stems and leaves.

A property of processes that is relevant to whether processes can or cannot occur in consciousness is the fact that a process cannot be replicated. This is because an instance of a particular process occurs at a unique time and place and comprises specific actions making specific changes to something. Logically, the specific actions can only occur at a single time and place. In the present case, processes in neural structures cannot be replicated in consciousness. This is because one's experience—one's consciousness—is a property of one's brain; consciousness is a property of the brain, but consciousness is not the brain, nor is it any part of the brain. The claim that consciousness is a property of neural events means that no process can occur in consciousness, except that it also occurs in the brain, but when a process occurs in the brain it cannot also occur in consciousness, so there cannot be processing in consciousness.

Processes in neural structures cannot also occur in a property of those structures, and this is an example of the general principle that a process which occurs in an object cannot also occur in a property of the object. A process such as weathering of the paint on one's home may change its colour, but there is no process in the colour; changes in the colour are the results of chemical processes in the paint. Similarly, processes do not occur in one's experience; changes to one's experience are results of changes in the neural structures of which it is a property.

When one experiences a sequence of thoughts, the stages in a mathematical or logical argument, or the stages in the development of one's plans, these are all caused by electrochemical actions in the brain, which cannot be experienced. One may misconstrue the sequences of events as processes, and this is one reason for the intuitive but erroneous view that there is processing in consciousness.

In relation to the three examples of processes above—acceleration, plastic moulding and growth processes—we note that each of the processes acts on a material medium. The object that is accelerated, the plastic compound that is shaped, and the cells of the plant that replicate and grow are all material substrates. This is a property of processes; they are actions on, or in, a material object or substance. The transfer of energy that comprises a process is a material event that requires a material medium.

Because the actions that constitute a process require a material medium, it is impossible for processes to occur in consciousness. For example, a process in the brain which generates a particular decision cannot also occur in one's experience, in one's consciousness. This is because consciousness is a property of the brain, and, like other properties of material things, though it is part of the physical world and therefore physical (Lowe, 1992; Papineau, 2002; Smart, 1959; Tye, 1995), it is not material.

The properties of a painting illustrate that a property can be physical but not material. Referring again to the example in McLaughlin and Bennett (2018), the colours and shapes in a painting are properties of the paint, so they are part of the physical world; they are physical. But colour is the property of reflecting some frequencies of light whilst absorbing others. This property is part of the physical world, and is therefore physical, but it is not material. Similarly, shape is physical; it is the extent of an area of the material paint, but shape is not material. Colours and shapes are not material, they are *associated* with the material of the paint, but they are not themselves material. Consciousness is also physical but not material; therefore it is incapable of supporting processes, so there can be no decision process in consciousness. And, similarly, there can be no other processes in consciousness.

[5] A*ction* is used in this definition, as in classical physics and chemistry, to refer to when something does something to something else; it is an energy transfer from one material object or substance to another. The transfer of energy during an action is sometimes obvious, as in an acceleration process, or in heating and cooling processes.

2.4. Supplementary evidence that mental processing is unconscious

I have presented various arguments that there is no processing in consciousness; and that all mental processing must be unconscious. In this connection, it is worthy of note that research reported by Peremen and Lamy (2014) found no evidence that processing of conscious and unconscious information relied on independent mechanisms. Their research suggested that there could be a single processing system manipulating both conscious and unconscious information—which would necessarily be unconscious.

There is also considerable evidence that processes commonly assumed to be conscious are actually unconscious. As detailed in the Introduction, reviews by Bargh and co-workers (Bargh, 1992, Bargh & Chartrand, 1999; Bargh & Ferguson, 2000; Bargh et al, 2012), Hassin and coworkers (Goldstein & Hassin 2017; Hassin, 2013; Hassin & Sklar, 2014), and Earl (2014) suggested that every mental process is likely to be unconscious. These reports, from social cognitive studies, and other psychological research and observations, support the view of many researchers, as noted above, that all mental processing is unconscious or that there is no evidence of any information processing in consciousness.

2.5. Summary of arguments that there is no processing in consciousness

To, summarise, I have presented arguments that no processing can occur in consciousness based upon (1) evidence that conscious and unconscious information are processed together; (2) evolutionary considerations; and (3) the properties of consciousness and processes:

1. Conscious and unconscious information are processed together, which could only occur in an unconscious processor. If conscious information were processed in consciousness, there would need to be a switch to unconscious processing whenever unconscious information needed to be incorporated in the processing to select or control a response. This would seem unlikely, and it is reasonable to assume that all mental processing is unconscious.
2. It is almost impossible that a processor could evolve in consciousness in addition to established unconscious processing mechanisms, because both conscious and unconscious processors would have the same function, which is to determine appropriate responses. It is more adaptive to have a single mechanism that processes all information, conscious and unconscious, to achieve optimum behavioural outcomes, rather than two mechanisms—unconscious and conscious—that could generate different responses.
3. The properties of consciousness and processes are such that no processes can occur in consciousness. Information processing occurs in the brain, but consciousness is not any part of the brain; processes can only occur in, or to, material things, and consciousness is a physical property of the brain that is not material.

Many researchers have previously reported that there is no evidence of processing in consciousness. As Umiltà (2007, p. 238) wrote, "…we are never conscious of the inner workings of our cognitive processes, but only of their outputs."

No objective evidence has been reported which demonstrates that processing does occur in consciousness. Any claim of processing in consciousness needs to provide objective evidence in support of this claim. In view of the above evidence that there is no processing in consciousness, and in the absence of objective evidence of conscious processing, it seems reasonable to assume that all mental processing is unconscious.

3. The contribution of consciousness to mental functions

We have established that all mental processing is unconscious—unexperienced—and now we need to establish that consciousness has a functional role within the mind. Consciousness is a component of the mind, and mind is a complex of mechanisms that process information. The mind is a system for determining responses to events, and consists of various neural mechanisms plus the information that they process. Since consciousness is a component of mind that includes no processor it must consist solely of information.

The claim that consciousness is information is not new; there have been many previous claims that consciousness consists of information in various forms (Armstrong, 1999; Battista, 1978; Chalmers, 1996; Dretske, 1995, 2003; Earl, 2014; Lycan, 1996; Mangan, 1998; O'Brien & Opie, 2009; Smith, 1999; Tye, 1995). Conscious experiences are "about something"; they always convey information of some kind (O'Brien & Opie, 2009). There is evidence that each component of consciousness is information (Earl, 2014):

1. External sense experiences, such as sights and sounds, are information about external events.
2. "Contact feelings" such as tactile awareness of a surface texture, or awareness of the weight of an object, are information (Katz, 1925).
3. Physical state feelings, such as thirst or pain, are information about one's internal physical conditions (Chapman & Nakamura, 1999).
4. Emotional feelings are information about one's state of physical and psychological responding to events (Damasio, 2001; Schwarz & Clore, 1996).
5. Mood feelings are information concerning one's pre-existing psychological state or response bias (Schwarz, 2002).
6. "Evaluative feelings", such as liking or believing, are information about the meanings for us, our attitudes to, or our judgments about things (Clore & Bar-Anan, 2007).
7. Consciousness also incorporates information that lacks qualia, such as knowledge of the identities of objects or knowledge of one's own intentions (Heavey & Hurlburt, 2008; Siewert, 1998).

Consciousness is solely information in various forms, but all conscious information must also exist in unconscious form concurrently with, or prior to, being conscious. This raises the question whether consciousness has any effects in addition to the effects of the same information in unconscious forms. Is consciousness adaptive—does it have useful effects on the behaviour of its possessor or is it an epiphenomenon? In fact, there is clear evidence that consciousness is adaptive, and does beneficially contribute to its possessor's responses.

3.1. Evidence that consciousness is adaptive

The complexity of consciousness is the most commonly quoted reason why we can be confident that consciousness is adaptive (for example, Earl, 2014; Gray, 1971, 1995; Nichols & Grantham, 2000). This is an important argument, but there are also other lines of evidence that consciousness is adaptive and therefore must influence behaviour.

3.1.1. The complexity argument

Consciousness is a very complex phenomenon, comprising several sensory modalities that are combined as needed in a given situation. There are multiple aspects to this complexity (Earl, 2014), for example:

1. The existence of qualia (such as colours and sounds) to represent the quantitative and qualitative properties of various sensory information within a perceptual space.
2. Light–dark contrast, in combination with the colour spectrum, as it is employed in consciousness, is a rather complex method for differentiating objects within our visual experience. And this also applies to the complexity of sounds as combinations of volume and pitch.
3. The optimisation of qualia. For example, a system has evolved whereby the colours that one experiences are adjusted so as to give maximum differentiation between objects (Gouras, 1991; Gouras & Zrenner, 1981; Thompson, 1995).
4. The coordination of different components of an experience: one sees a dog and experiences barking as coming from the direction of the dog.

Consciousness is such a complex phenomenon that it could not have evolved without providing significant adaptive advantages to its possessor (Earl, 2014; Gray, 1971, 1995; Nichols & Grantham, 2000).

3.1.2. The evolution of conscious representations of bodily and mental states

The inclusion in consciousness of sensory information and other felt experiences relating to one's physiological and psychological state. These may be necessary, in combination with exogenous sensory information, to "complete the picture" if conscious information is used by mental processes in the selection of responses. The evolution of the various felt experiences could only have occurred because consciousness has an adaptive role in relation to processes associated with the selection of behaviour.

3.1.3. The special treatment of self-related information in consciousness

In general, there is a very clear separation in consciousness between self-related information and external sense information. Self-related information from internal sensors—such as sensations of pain and other bodily states, and awareness of our own physical boundaries—are normally perceived as self-related, and clearly differentiated from exogenous information. The fact that the perception of self-related information has evolved so as to be experienced as having the special quality of personally relating to oneself is evidence that consciousness has biological value. It is important for survival to clearly differentiate between information about oneself and information about one's environment when determining one's responses, and the evolution of this differentiation between self-related and non-self-related information in consciousness is evidence that conscious information contributes to behaviour.

3.1.4. The correlation between consciousness and actuality

One's experiences normally correlate with external reality as experienced by other people. Agreement with reality is ensured by a mechanism for reality-monitoring of experiences in our ordinary waking states, whenever that is necessary (Johnson & Raye, 1981). The evolution of this mechanism indicates that consciousness is adaptive, because if consciousness had no effects on behaviour it would not matter if our experiences had no relation to reality.

3.1.5. The association with attention

The close association between consciousness and attention (for example, Cohen, et al., 2012) is evidence that consciousness has biological value. Consciousness is drawn to every event that is judged to be important. This evolved association must be adaptive. It could only be adaptive because, in some way, conscious information can generate enhanced responding compared to unconscious information relating to the same event.

3.1.6. The existence of episodic memory

The existence of episodic memory is evidence that consciousness has biological value. Episodic memory is memory of past events that are "relived". An episodic memory is one that is reconstructed with its spatial, temporal, and self-referential, or phenomenological, context (Gardiner, 2001; Klein, 2015; Lin, 2018; Tulving, 1985).

Episodic memory is a form of single-event learning; it is learning based on a single presentation of arbitrarily-related information (Cohen, et al., 1997; Sherry & Schacter, 1987; Ullman, 2004). When an animal remembers where and when food was stored, or a predator was encountered, this is biologically valuable information (Sherry & Schacter). This suggests that the biological function of episodic memory is the benefit from remembering details of a significant event and being able to act upon them.

However, there is behavioural evidence (Sheldon & Moscovitch, 2010), and neural evidence (Waldhauser, et al, 2016), that context-specific memory reactivation, termed "ecphory" (Tulving, 1983; Waldhauser, et al), is a rapid unconscious response to incoming sensory information whose output is not consciously apprehended but can contribute to performance on a variety of tasks (Moscovitch, 2008). Subsequently, slower processes make the recovered content available to consciousness as episodic memory. Apparently, memory reactivation for episodic memory is independent of consciousness, and the unconscious mental processing of this information can contribute to a variety of tasks, which suggests that episodic memory *functionality* is independent of consciousness. That being so, the secondary stage of making conscious the recovered content must have evolved separately from the functionality of episodic memory, and must have biological value. Hence, consciousness has biological value.

3.1.7. The vision for perception system

In the brain, a vision-for-conscious-perception system—the "ventral stream"—has evolved in addition to the vision-for-action system—the "dorsal stream" (reviewed in Glover, 2004; Goodale & Humphrey, 2005; Goodale & Milner, 2004; Goodale, 2007; Rossetti & Pisella, 2002; Umiltà, 2007). It appears that a second visual mechanism has evolved to provide suitable information for visual consciousness, which could only have occurred because consciousness has biological value.

3.2. The role of consciousness in mental processes

Thus, consciousness is information in conscious formats, and consciousness is adaptive. The only way that any form of information can be adaptive is as an input to processes that determine behaviour. Therefore, when conscious forms of information are input to mechanisms that determine behaviour, they must cause the generation of responses that are biologically superior to responses that are based solely upon unconscious information.

There is a possible second aspect to the role of consciousness in the mind. The complexity of consciousness, and the integration of its components, suggests that primary consciousness must have evolved over a very long period of time. The evolution of relatively separate mechanisms for conveying visual information for perception and for action—the ventral and dorsal streams—would also be expected to have occurred only over a very long period of time. It is possible that, over that time, some mechanisms of mind could have evolved exclusively to manipulate conscious information, at least in some situations.

The incorporation of self-related information in consciousness—both the clear separation between self and non-self, and the evolution of various felt experiences referencing one's physical and psychological state—leads to a relatively "complete picture" of the external and internal situation. This would only seem to be necessary if in some mechanisms, or in some situations, conscious information may be manipulated without recourse to relevant unconscious information.

Some support for the possibility of mechanisms that evolved to function solely with conscious information comes from studies of "blindsight" (Kentridge, et al, 1999; Persaud & Cowey, 2008; Weiskrantz, 1986) and "blind-touch" (Paillard et al, 1983). Blindsight can occur with patients who have a scotoma—who have lost part of their conscious visual field. These patients deny visual experience of anything in the region of the scotoma and cannot say what was there, but when asked to guess about these visual events, they generally guess correctly. Thus, information from their scotoma is available unconsciously but is not available for responding to the experimenter's question. In analogous observations concerning unperceived tactile information—so-called "blind-touch"—Paillard et al., studied a person who had suffered neurological damage that resulted in the total loss of experienced sensation on her right side. The experimenters blindfolded the woman and then touched points on her right hand. She could not say where her hand was being touched but was easily able to touch the point of contact with her left hand when asked to do so.

In these experiments unperceived visual and tactile information could not be reported, though they were unconsciously known. The mechanisms for generating responses to the experimenter's questions made use of conscious information but did not have access to relevant unconscious information. They appeared to demonstrate that some mechanisms may only utilise conscious information to generate responses.

Thus, the primary adaptive role of consciousness is to enable biologically superior responses to be achieved by jointly processing unconscious information with information from consciousness. However, because of the likely existence of some form of consciousness for very long evolutionary time, it is possible that some unconscious mechanisms have evolved so as to operate solely with conscious information.

4. Unconscious mechanisms process unconscious information without conscious input

The various reports of conscious and unconscious information being jointly processed that were discussed in §2 suggest that the mind probably can process unconscious information without conscious input. It is important to establish whether unconscious mechanisms can manipulate unconscious information alone, because this would mean that consciousness is not essential for complex, or flexible, responses.

This is because any changes in neural mechanisms can only be selected for, or against, if they affect biological fitness, which, in this situation, can only occur by influencing behaviour. Complex mechanisms in the mind must have evolved in many stages, each of which were selected for because they were biologically beneficial for their possessor. Therefore, if neural mechanisms can manipulate unconscious information without conscious input, this ability can only have evolved because it generates behaviour that is biologically appropriate.

The reports described in §2.1 provided no direct evidence that the mind can process unconscious information in the absence of consciousness. In each of the experiments the processing of unconscious information was not isolated from any effects of conscious information. In very many experiments this occurs as a direct result of the experimental conditions—participants are instructed to do something, and this engages processes operating with conscious information. However, there are some reports of manipulation of unconscious information in conditions where consciousness is occupied elsewhere. When auditory attention is strongly engaged, as in dichotic listening, or when visual attention is strongly engaged, as in CFS, and in other conditions where a person is distracted, the published evidence demonstrates that unattended auditory or visual information is being processed whilst consciousness is occupied with other matters.

4.1 Evidence from dichotic listening experiments

In dichotic listening experiments reported by Cherry (1953), different spoken messages were fed to each of the participant's ears, and participants were told to repeat one of the messages aloud at the same time as it was heard, and try to make no errors; a process referred to as "shadowing". Subsequently, participants could not recall any aspect of the unattended message, and when, during the test, the language of the unattended message was changed from English to German for a period of time, participants did not notice the change, and afterwards were not aware it had changed. When the unattended message changed from a male to a female voice the change was generally noticed, and when the unattended message changed to a 400Hz tone, it was always noticed. The fact that the attention of participants was drawn to biologically significant information—the gender of the speaker or an unexpected sound—demonstrated that the unexperienced information at the unattended ear was being processed unconsciously, that is, outside of participants' awareness.

Shadowing experiments reported by Moray (1959) confirmed that the unattended message is blocked from conscious perception, but found that some participants responded to their own name, and this observation was replicated by Wood and Cowan (1995). Sexually explicit information presented to the unattended ear also entered awareness (Nielson & Sarason, 1981). Other researchers have reported some evidence of semantic processing of the unattended message in dichotic listening (for example, Lewis 1970; Treisman, et al, 1974). These data from dichotic listening experiments support the view that unexperienced—unconscious—information is processed even when conscious attention is strongly engaged elsewhere. Unconscious auditory information is being analysed and responded to without the involvement of consciousness.

4.2 Evidence from continuous flash suppression experiments

Some experiments measuring the time for CFS-suppressed visual information to break suppression also appear to demonstrate unconscious processing without conscious influences. For example, Mudrik, et al, (2011) reported that scenes which included incongruent objects escaped perceptual suppression faster than congruent scenes. This suggested that the integration of objects with their background scenes was being accomplished without awareness of either, because when images that differ on some dimension break suppression at different times, this difference must have been processed (Mudrik & Koch, 2013).

Jiang et al, (2007) showed that for Chinese readers, Chinese characters were faster to break suppression than Hebrew words, whereas for Hebrew readers, the reverse was true. Sklar, et al. (2012) used CFS to show that incongruent sentences ('I ironed coffee') break through interocular suppression sooner than congruent sentences ('I ironed clothes'), suggesting that meaningful characters are processed, multiple words can be integrated, and semantic violations can be detected unconsciously without the need for conscious awareness of these stimuli.

Images of human faces (Jiang, et al, 2007; Stein, et al, 2012) and images of human bodies (Stein et al., 2012) break suppression in CFS faster when presented upright than when inverted, and personally familiar faces break CFS sooner than faces of strangers (Gobbini, et al., 2013). The results from each of these b-CFS experiments provide support for the view that the mind manipulates or analyses information that is not being experienced, and responds to it, without any requirement for the involvement of consciousness.

There have been reports that information which is excluded from consciousness by CFS may only be processed to a limited extent (for example, Breitmeyer, 2015; Rothkirch & Hesselmann, 2017). However, for the following three reasons, any such deficiencies do not necessarily mean that the mind cannot process information to generate responses in the absence of consciousness:

1. The experimental techniques—dichotic listening and CFS—demand attention very strongly; a situation that is unlikely to occur naturally except in response to extreme events; and this may drain processing resources from the experimentally suppressed sensory information, and limit its processing.

2. If animals that do not possess consciousness can process sensory information, they are likely to use attention to select and enhance the most important sensory information (Hawkins, et al., 1990; Kentridge, et al, 2004). The CFS and dichotic listening protocols prevent this, which may lead to some deficiencies in processing compared with what would occur if attention were available for the selection and enhancement of the unexperienced sensory information. According to Cohen, et al (2012, p. 413), "varying degrees of attention can determine the extent to which stimuli will be unconsciously processed."

3. b-CFS data demonstrate that the unexperienced sensory information is being processed sufficiently for attention to be transferred to it, which presumably would allow enhanced processing of the information whether or not it became conscious.

The evidence from b-CFS experiments is that unconscious information can be processed without consciousness to the stage of attracting attention to it. The ability to respond to unconscious information can only have evolved because it can influence behaviour in a biologically advantageous way. That being so, any limit to processing of unconscious information during CFS must be an artefact of the technique. The fact that unconscious information is processed sufficiently to bring it to attention is an indication that, but for the experimental conditions, this information would be processed to generate behaviour, as appropriate in the circumstances.

4.3 Other evidence that mental processes controlling behaviour do not require consciousness

In a very different situation, Harms, et al (2019) demonstrated behaviour in response to a visual stimulus that was not experienced. They described an experiment in which an obstruction, in the form of a sign, was placed on a pavement, so that pedestrians had to deviate in their path to avoid the obstruction. After passing the obstruction, pedestrians were asked if they had been involved in another task at the time they passed it, and were tested for awareness of the sign through recall and recognition of the signboard and its text. More than half of the participants (53.8%) were involved in other matters—mind wandering, talking to a companion, listening to music, or using a mobile phone—and had no awareness of the sign at the time of passing it, but none walked into it. Unconscious knowledge of the presence of the sign was being processed sufficiently for them to avoid it.

Goodale and co-workers (Goodale & Milner, 2004; Goodale, et al, 1991) reported observations of patient DF, who suffered brain damage from carbon monoxide poisoning. She could not state the orientation of a "letter box", but she could post a letter through it. She could not perceive the size, shape and orientation of objects but walked around furniture in a cluttered room and walked confidently up a rough track avoiding overhanging branches. Patient DF's ability to respond to unexperienced visual information is further evidence that behaviour can be determined by mechanisms that do not require conscious input.

4.4. Mental mechanisms do not require consciousness for adaptive responses

The evidence from dichotic listening demonstrates that unconscious mechanisms process auditory information that is not experienced. CFS experiments, and other evidence, support the view that unconscious visual information can be processed and acted upon. It seems reasonable to assume that other unconscious sensory information can also be processed without conscious input.

The ability to process unconscious information without the involvement of conscious information can only have evolved because it enables the beneficial selection, or modification, of responses to events. Therefore, unconscious processes must be able to generate adaptive responses solely based upon the processing of unconscious information, as exemplified by the pedestrians who walked around an obstacle that they were not consciously aware of, and the case of DF, who had suffered brain damage from carbon monoxide poisoning, and who had no conscious awareness of the shapes of objects, but could confidently negotiate a crowded room or a rough track.

5. The structure of mind

The mind is a complex of unconscious mechanisms, and consciousness is a special form of information that, in some circumstances, allows the mechanisms of mind to select more adaptive responses than is possible with unconscious information. This is the basic structure of the mind.

Webb (2012), in discussing the behaviour of insects, wrote that it would seem efficient for each animal species to have specialist mechanisms for responding to situations that it confronts frequently and which only differ in their details, and mechanisms for responding in situations that occur from time to time and present a significant risk or opportunity. This principle would be expected to apply generally to complex mobile organisms with nervous systems, including humans.

An example of a mechanism for responding to situations that occur from time to time which present a significant risk or opportunity could be context-specific memory reactivation—ecphory—referred to above in §3.1.6. This is the rapid unconscious response to stored data concerning a significant past event at a particular time and place, that is triggered by incoming sensory information (Moscovitch, 2008).

The frequently-confronted condition might apply, for example, to various specialised mechanisms of the mind that allow humans to pick up a cup, or avoid walking into an obstacle that they are not necessarily aware of (Bridgeman, 2002; Goodale & Milner, 1992, 2004; Goodale et al, 1991; Goodale, 2007; Harms et al., 2019; Jeannerod, et al, 1995; Rossetti & Pisella, 2002); and to rapidly extract environmental information that may be biologically, socially or personally important, such as the gist of a scene (Bacon-Macé, et al, 2005; Friedman, 1979; Potter, 1976), or the presence of people or animals (Fabre-Thorpe, et al, 2001; Haxby, et al, 2000; New, et al, 2007; Öhman, 2009; Öhman, et al, 2001; Stein et al., 2012), or to rapidly recognise human faces generally, and specific faces (Crouzet, et al, 2010; Farah, et al, 1998; Maurer, et al, 2002). According to Faustino, et al (2015), in fluctuating environments, mobile organisms require mechanisms that enable rapid context-dependent responses.

The specialist mechanisms may be innate—such as the looming response (Schiff, 1965; Regan & Vincent, 1995); and they can incorporate learning, such as when catching a baseball or a cricket ball (McLeod & Dienes, 1993, 1996), walking in the street (Harms et al., 2019), or driving a car (Charlton & Starkey, 2013). They may be temporary mechanisms prepared for expected situations, as in reaction time (RT) tests (Day et al, 1989; Taylor & McCloskey, 1990), and other predetermined responses to expected stimuli (Bridgeman, et al, 1979; Goodale, et al, 1986; Hansen & Skavensky, 1985; Pélisson, et al, 1986; Prablanc & Martin, 1992).

Reaction time tests and many other tests require that the participant "agrees", "accepts", "decides", or "intends" to do as required by the experimental protocol. We can use *intend* to represent all of these forms of agreement to behave as requested. Without the participant intending the behaviour, no temporary mechanism will be generated and no appropriate response will occur. Therefore, it appears that the intention to act is associated with generation of a temporary response-mechanism. That being so, it is expected that the ability to generate temporary mechanisms would extend to the initiation and control of other intended single-event behaviour. Note that we cannot say whether or not the generation of temporary mechanisms requires conscious inputs—just that the examples we know about involve consciousness—it is possible that the experience of intention merely indicates that a temporary mechanism has been generated.

The existence of such temporary mechanisms is supported by the possibility for participants in an experimental procedure to select rapidly (in approximately 250ms) one of two responses depending on which of two stimuli are presented (Taylor & McCloskey, 1996).

Further evidence for temporary mechanisms is provided by the phenomenon of "capture errors". A capture error can occur when an intended series of actions aligns at some stage with an established pattern of actions that has another purpose. If attention is elsewhere, the temporary mechanism may be overtaken by the established mechanism, resulting in an unwanted outcome (James, 1890; Norman, 1981; Reason, 1984). William James reported an instance when he was expecting visitors for dinner. His wife told him to go upstairs, have a shower, and dress suitably. His established practice in late evening was to have a shower before bed. After some time his wife came to see how he was going, and found him asleep in bed—apparently James had been thinking about other matters during his shower and the temporary mechanism—preparing for the dinner—was usurped by his established bedtime routine. Attention is sometimes needed to sustain a temporary behavioural mechanism, but note that this does not necessarily mean that *consciousness* is essential for this purpose.

It is likely that the mind comprises a collection of mechanisms for responding to frequently confronted situations, mechanisms for situations of special risk or opportunity, mechanisms set up in preparation for expected events and other intended behaviours, plus a relatively generalised ability to solve problems. This would seem to be the most adaptive combination of cognitive abilities (Buss, 1991, 2005; Cosmides & Tooby, 2013; Tooby & Cosmides, 1992).

Consciousness is information that can contribute to the selection of more adaptive responses by some of these mechanisms. As noted above, it is also possible that some mechanisms of mind may have evolved that function exclusively with conscious information, or may function exclusively with conscious information in some situations.

6. Conclusions

There is a commonly held view that many mental processes—such as when one makes decisions, plans, or thinks—are conscious. However, there is no objective evidence in support of this view, but there is a great deal of evidence that it is an incorrect view. Three kinds of evidence demonstrate that mental processes for manipulating conscious or unconscious information are never experienced. First, there is experimental evidence that conscious and

unconscious information are commonly processed together, which must occur unconsciously. Second, it is extremely unlikely that two separate conscious and unconscious systems, for processing conscious and unconscious information, could have evolved with the same biological function—the selection of adaptive responses. And, third, the nature of processes and consciousness do not permit processing to occur in consciousness. Hence, the mind is a complex of unconscious mechanisms that determine all responses.

Every mind appears to consist primarily of mechanisms to generate frequently required actions that are adjusted according to the circumstances of the moment, or to respond to serious risks or opportunities. These mechanisms allow us to pick up a cup, or avoid walking into an obstacle; to rapidly respond to the gist of a scene; to avoid looming objects; and to quickly detect, and respond to, other personally, socially, or biologically significant matters, such as the presence of people or animals. Other mechanisms are temporary and enable rapid responses to expected events, or are generated to initiate and control intended behaviours. Each of these mechanisms includes information processing, and may combine information from different sense modalities.

There is no information processor in consciousness, which therefore must consist solely of a changing array of information in various forms. However, the ability to convert selected information to conscious forms—which we experience as sights sounds and so on—is adaptive, and must therefore confer biological benefits. In order to be adaptive, conscious information must permit enhanced responding to events. On average, or in situations with special risks or opportunities, the conversion of information to conscious forms enables the mind to select more adaptive responses to events than is possible without consciousness.

The complexity of consciousness, and other evidence, suggests that consciousness, in some form, may have existed over long evolutionary time. This leads to the possibility that, over this period, mechanisms may have evolved that have special relationships with consciousness. Some features of primary consciousness—the inclusion of felt experiences, the clear separation between self and non-self—and other evidence, lead to the possibility that some mechanisms of the mind may have evolved solely for manipulating conscious information, or may sometimes manipulate conscious information without recourse to relevant unconscious information.

The proposed structure of mind developed here is based upon human data. However, it is expected that other species will be found to have similarly-organised minds, but with a combination of response mechanisms appropriate to their lifestyle and abilities. Thus, the proposed structure of mind offers the possibility of understanding the minds of many complex multicellular mobile animals with nervous systems as having a common structure, as might be expected in terms of Darwinian evolution. Some of these species would be expected to possess consciousness. Many other species may not possess consciousness, but their mental mechanisms would enable them to respond in an appropriate, relatively flexible, manner in some situations.

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