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William James and the evolution of consciousness

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ABSTRACT

Despite having been relegated to the realm of superstition during the dominant years of behaviourism, the investigation and discussion of consciousness has again become scientifically defensible. However, attempts at describing animal consciousness continue to be criticised for lacking independent criteria that identify the presence or absence of the phenomenon. Over one hundred years ago William James recognised that mental traits are subject to the same evolutionary processes as are physical characteristics and must therefore be represented in differing levels of complexity throughout the animal kingdom. James's proposals with regard to animal consciousness are outlined and followed by a discussion of three classes of animal consciousness derived from empirical research. These classes are presented to defend both James's proposals and the position that a theory of animal consciousness can be scientifically supported. It is argued that by using particular behavioural expressions to index consciousness and by providing empirical tests by which to elicit these behavioural expressions a scientifically defensible theory of animal consciousness can be developed.

The Unexplained Puzzle.

Having lain dormant, along with other aspects of subjective experience, during the "long, dark night of behaviourism" (Eccles, 1989, p.173), psychological and philosophical debate about the nature of consciousness is again in progress. Yet, despite the astounding scientific discoveries and revelations that have occurred since the ancient Greek philosophers first puzzled over the character of this remarkable phenomenon, the nature of consciousness remains to many a perplexing and mysterious puzzle (cf. Chalmers, 1995; Crick & Koch, 1997; Dennett, 1991; Güzeldere, 1997). Furthermore, not only has consciousness in humans remained a puzzle, but the controversy surrounding it permeates the debate on consciousness in nonhuman species.

While the question of animal consciousness stretches back to Descartes, genuine psychological concern can be traced to William James (Davies & Humphreys, 1993). James argued that consciousness arose via the principles of evolution, existing throughout the animal kingdom in varying degrees of complexity. This, he maintained, resulted from the increasing heterogeneity of the brain and the need for a mechanism to select relevant stimuli from all those impinging on the organism. However, despite the vast body of research conducted since the publication of James's voluminous 'The Principles of Psychology' (1890/1981), there are some who continue to deny outright the existence of consciousness in nonhuman animals (e.g., Blumberg & Wasserman, 1995; Epstein, Lanza, & Skinner, 1980; Jaynes, 1976). There are two main reasons for this denial. First, when discussing consciousness there has been a reluctance to acknowledge that as a result of evolution consciousness can occur in gradations throughout the animal kingdom. Second, there is a degree of scepticism concerning whether a theory of animal consciousness can be defended scientifically.

Therefore, the aim of this essay is, first, to appraise James's argument that consciousness exists as a result of evolution and is present in varying degrees of complexity throughout the animal kingdom, and, second, to set out scientifically testable hypotheses by means of which the identification of animal consciousness may be achieved. Although James's concern with consciousness continued throughout his life, it ceased to be his dominant object of interest after 1895 (Bjork, 1988). Therefore, the main focus here is on James's theorising up to and including the publication of 'The Principles'. However, it should be acknowledged that James (1912/1976) published an essay entitled "Does consciousness exist?", in which he argued in favour of the negative - but only in the sense where the word is interpreted as representing something distinct from experience (Robinson, 1982). This was a response to the Neo-Kantian position that the world is a dualism between consciousness and its

objects (Taylor, 1996) and hence James's denial was of consciousness as a distinct entity but not of consciousness as a function.

The Nature of Evolution.

Life did not emerge by chance but by the slow and gradual steps of cumulative natural selection (Darwin,1859; Dawkins, 1986). It is the same process that is responsible for the survival of not only entire species but the specific recurring characteristics of individuals within a species. Evolution occurs, according to the theory of natural selection, by the non-purposive, non-random, differential selection of traits that confer on the animal a survival and reproductive capacity in its adopted ecological niche. This is best captured by Darwin's description as "descent with modification". The ecological niche of an animal includes not only its physical environment, but other animals that are predators, prey, or competitors for resources, and same-species animals that interact in a competitive or co-operative manner (Crook, 1980).

Members of a population will exhibit characteristics that conform to an average that have, in the past, enabled them to be best adapted to their environmental niche as defined by their evolutionary history. However, differing traits within species will occur as a result of random genetic variation, providing the individual with a characteristic that is outside the normal distribution. This new characteristic will invariably become more common if it provides a statistical advantage in the rate at which it is transmitted to the next generation (Gaulin, 1995). In essence, such an advantage occurs by enhancing the capacity of the individual to increase the number of progeny it can produce and hence the characteristic's relative density in the population. Conversely, if the characteristic is counter-productive to the individual it will, by the same processes, dissipate and eventually disappear. Natural selection thus favours a small proportion of individuals in a population which will eventually result in the accumulation, over generations, of favourable characteristics due to the disproportionate perpetuation of natural selection.

In considering evolutionary theory it is important to distinguish between homology and analogy. Analogy arises when phyletic and/or developmental origins are different in two species yet they both display a characteristic that performs a shared function. Analogies, like the wings of insects and birds, generally result from the convergent evolution that occurs when different animals occupy a similar ecological niche (Campbell, 1990). However, it has been argued that the best evidence for descent with modification comes from instances of *homology* rather than analogous re-invention (Dennett, 1995). Homology occurs when idiosyncratic versions of traits appear in different classes (taxa) of animals that

are derived from a common ancestral characteristic. For example, the pentadactyl limb has evolved into the different skeletal structures of the horse's hoof, the bird's wing, the bat's wing, the whale's flipper, and the human hand (Smith, 1993). In homology, and in contrast to analogy, derived traits may also serve different functions. For example, the ear-bones of mammals are homologous with the jaw-bones of reptiles (Ridley, 1985).

Establishing whether a particular trait is homologous or analogous with another is a highly complex procedure, and it is possible that both processes can occur in the same structure. There is, for example, still debate on which mammalian digits are homologous with the three remaining in the bat wing. It is not the purpose of this essay, however, to discuss whether consciousness is an homologously or analogously derived trait in particular species but, more simply, to consider it in terms of either of these processes. As physical traits evolve differentially to benefit animals dependent on their specific environmental niche so too must “mental” characteristics. It is important to note that this does not imply a kind of Cartesian dualism whereby mind and body evolve separately but rather that both are similarly subject to the principles of evolutionary theory. It is thus plausible to expect that consciousness will be represented in degrees of variation related to the particular survival and reproductive demands of separate animal species.

William James, Consciousness, and Evolution.

If we accept that our species, like all others, is subject to and part of the processes of natural selection, then we must also accept that the components of our mental functions, no matter how heterogeneous, also belong to this scheme. James (1890/1981) understood this, stating that: "It is very generally admitted, though the point would be hard to prove, that consciousness grows the more complex and intense the higher we rise in the animal kingdom. That of a man must exceed that of an oyster" (p.141). However, despite over a century of research in experimental psychology and evolutionary biology there remains an ambivalent attitude toward the possibility of nonhuman consciousness (Radner & Radner, 1989).

One reason contributing to this attitude is that references to consciousness in animals have often been framed in human anthropomorphic rather than evolutionary terms. It is therefore useful first to elaborate on what may be interpreted as the nature of human consciousness. Providing a precise and concise definition is a difficult proposition that remains one of the core problems in current literature. It is held by some to be an impossible pursuit, interpreted as being too personal and elusive to define, while, in contrast, others appear to consider consciousness to be so simple and obvious a phenomenon

that they fill descriptions with synonyms which do little to assist the reader in comprehending what is being discussed (Delacour, 1995). However, James devoted a chapter of his 'Principles' to a detailed and thoughtful analysis of the nature of consciousness, and, as his elucidation is still considered to be one of the best sources on the topic (Baars, 1997), it is his definition that will be adopted here.

In 'The Principles' James claimed that consciousness is indiscriminately connected to thought, relating to the inner life of the mind in a "teeming multiplicity of objects and relations" (1890/1981, p.219). Consciousness, according to James, consists of five main features, and these can be briefly summarised as follows. First, every thought is part of a personal consciousness, and this consciousness is self-contained and insulated from intrusion by any other. Second, within each personal consciousness states are always changing - once something such as a thought has been experienced it can not be experienced in the exact same manner again. Third, within each personal consciousness, thought is sensibly continuous, there can be no distinct breaks to consciousness within the limits of a single mind; instead there is a felt, experienced continuity. The phenomena should not be interpreted as being "chopped up in bits" (1890/1981, p.233), but should be referred to as flowing. This is related to James's oft-quoted expression that "In talking of it hereafter, let us call it the stream of consciousness " (1890/1981, p. 233). Within this continuity, there can be degrees of consciousness, from drowsiness, to extreme emotion, which, according to an inverted U-shape function, determine the degree of precision and clarity consciousness assumes. In this manner, all attentive states are conscious, but all conscious states are not attentive.

The fourth characteristic is that human consciousness appears to deal with objects independent of itself. The conscious human mind not only knows the things that appear to it, but it also "knows that it knows them" (1890/1981, p. 263). James considers that the consciousness of objects comes first, followed by the reflective condition that is our habitual state of mind. These objects of thought are always perceived in consciousness as continuous and in their entirety, despite their possible complexity. The final characteristic is that consciousness is always acting to select from the myriad of sensations impinging on the individual; it decides what is relevant and irrelevant, presenting the former and suppressing the latter. However, as James proposed, this consciousness, which is inextricable from thought, does not arrive complete in the human mind for the first time. Conversely, it must have, according to the processes of natural selection, undergone change throughout the course of evolution, emerging in different forms where needed to assist the organism in its capacity to best "fit" its environment. His interpretation of "how" and "why" this happened centred on the emergence of

the cerebrum and the need to co-ordinate an increasingly complex world for an increasingly complex organism.

In 1878 James (1988a) compiled notes for a series of lectures he had been invited to present to the Lowell Institute and it is in these notes that the genesis of James's conception of how consciousness arose as a result of its evolutionary benefit is evidenced. These arguments were to become incorporated into the chapters of his 'Principles'. James's argument revolved around his view that the lower animals, such as polyps, were best adapted to their environment having evolved a nervous system distinguished by the absence of a cerebrum. This system, he stated, is "remarkable for regularity and accuracy" and is able to respond "to few stimuli but to them strongly and well" (1988a, p. 25). In contrast, the animal in which the cerebrum has fully evolved, as is the case with humans, can "adapt his conduct to the minutest alterations in the environing circumstances, any one of which may be for him a sign, suggesting distant motives more powerful than any present solicitations of sense" (1890/1981, p. 142). Thus, the organism with a "low brain" (without cerebrum) is able to do only a few things, but with perfection, while the "high-brained" (with cerebrum) organism may do many things but in a "hit-or-miss" manner.

The higher centres of the brain thus evolved in such a way that enabled the animal better to adapt to minute variations in an increasingly complex environment. One result of this, however, was the destabilising of the nervous system. This led James to argue that "the performances of a high brain are like dice thrown forever on a table. Unless they be loaded what chance is there that the highest number will turn up oftener than the lowest?" (1890/1981, p. 143). In other words, what function may consciousness serve? James argued that it would have to be involved in the application of a constant pressure on those behaviours that are of the most permanent interest of the organism, and, similarly, the inhibition of any tendencies to engage in behaviours that are not of this type. The brain was considered an instrument of possibilities but it required consciousness to act as a guide to foresee the realisation of these possibilities, reinforcing the favourable and repressing the unfavourable. Therefore, consciousness evolved, concomitant with the evolution of the cerebrum, to function as a selective mechanism by which to guide and control a nervous system that was growing "too complex to regulate itself" (1890/1981, p.147).

This argument was presented in contrast to the Darwinian perspective, dominant at the time, that not only neglected to balance habit and spontaneity, but also viewed consciousness as a pre-constructed entity having no function as of itself (Bjork, 1988). James had thus provided an alternative position to the Darwinist's automatic, predetermined mind, championing his view that there existed a relationship,

acquired through evolution, between brain physiology and mental activity. In this manner, consciousness is not merely interpreted as being a by-product of evolution, but by acting to interpret the relevance of stimuli, is a condition equivalent to naturalistic, causal determinants (Richards, 1987; Rodríguez & González, 1990). James's concern with proving the evolution of consciousness is still relevant given that there remains little understanding about how it may have evolved through time, a point manifested in the continued debate over the possibility of this occurring at all.

The Behavioural Expression of Consciousness, and Scientific Criticism.

One of the major obstacles in attempting to explain the evolution of consciousness is that, typically, evolutionary reconstructions rely on comparisons of existing morphological and/or physiological traits in closely related species to those more distantly related, along with geological or other data on temporal relations (Parker & Mitchell, 1994). Phylogeneticists appraise the diversity of life on earth, both past and present, and attempt thereby to infer the sequence in which species and species traits have evolved (Povinelli, 1993). When extinction, for example, has occurred which may make it appear as though a particular trait has arisen through spontaneous generation, attention is given to the fossil record. However, charting psychological evolution has neither the advantage of morphology nor physiology to act as a guide, being visible only through behavioural expression (Povinelli, 1993). Therefore, in order to chart the evolution of consciousness we must first establish what behaviour characterises its expression in currently existing species and from this use the morphological record to determine when certain types of consciousness emerged and speculate on what form it might have taken in extinct species.

Assessing conscious experience according to the exhibition of particular behaviours has, however, conventionally been challenged on the grounds of scientific validity. The reason for this has its genesis in arguments derived from Hempel's (1965) positivist criterion of factual meaningfulness and Popper's (1959) criterion of demarcation (Radner & Radner, 1989). These sources have led to the generally held view that one prerequisite for the facilitation and empirical evaluation of a theory is that it must have hypotheses derived from observable, testable principles (Cohen, 1989; Povinelli, 1993). One inference drawn from these arguments is that statements of the conscious experience of non-verbal individuals are not scientific for they can be neither verified nor falsified. The counter-argument to this rests on the principle, accepted in virtually all scientific fields, that a hypothesis itself need not refer to publicly observable events so long as it has publicly observable consequences (Radner & Radner,1989). Consider laws concerning ‘unobservables’ such as molecules, genes, and magnetic waves which obtain

empirical justification (Churchland, 1988). There is no reason why this should not apply to animal consciousness.

If a theory of animal consciousness is to be "scientific" there must be independent criteria for identifying the presence or absence of the phenomena that the theory are trying to explain, and these must have empirically falsifiable consequences (Toribio, 1993). Historically, attempts at interpreting animal behaviour in terms of conscious thought rapidly reverted to profound anthropomorphism that lacked any supporting data (Baenninger, 1990). This helped pave the way for the mechanists and behaviourists of the twentieth century who disregarded any reference to mental states, especially those of nonhuman animals. However, as modern scientists now accept discussion of consciousness, recent attempts to demonstrate this in nonhuman animals has been characterised by a zeal similar to that of the pre-behaviourists. In this sense the most vehement arguments against animal consciousness have been directed at the most ambitious arguments in its favour.

One such argument is associated with a branch of animal experimentation called 'cognitive ethology', which attempts to model mental states in animals through passive observation of behaviour in free-living environments (Griffin 1981, 1984, 1985; Whiten & Byrne, 1987). Griffin (1981, 1984, 1985) has provided an impressive catalogue of behaviours he interprets as providing evidence of animal consciousness, such as sea otters using stones to break open shellfish or the killdeer bird feigning injury in order to lead a predator away from their nests. Such observations have been strongly criticised on the scientific grounds of using unmanipulable events, and this has led to the conclusion that it is misleading to use conscious thought to explain behaviour based only on observation without the performance of a single direct experiment (Blumberg & Wasserman, 1995; Heyes & Dickinson, 1993). Therefore, if the attribution of conscious thought to animals is to be made via behaviour this should be based upon specific criteria manipulated through scientific intervention in a controlled environment.

It may be suggested, in the tradition of theorists such as Nagel (1974) and Searle (1992), that any attempt to anchor consciousness to behaviour will discount its very nature - its subjective, phenomenological feel - and reveal nothing of what it is like to be another animal. Yet despite some impressive attempts (see Block, Flanagan, & Güzeldere, 1997) we currently have no means by which to conduct such an investigation and, although we may acknowledge that it is our ultimate goal, it is only through determining the observable manifestations of consciousness that we can arrive at a means by which to predict its internal essence. As Hilgard (1980) stated: "It is the task of the scientist to use the most available techniques for verification of the data base and for validation of the inferences from these data" (p.15). It is not anticipated that the arguments delineated here will enable the reader to

know “what it like to be a bat” (Nagel, 1974) but rather it is hoped that by pursuing empirical investigation in the manner outlined below we may gain at least some insight into the inner life of other animals.

The constraint of scientific defensibility according to empirical consequences becomes more complex when considering historical paradigms. During James's time, he did not have at his disposal the scientific tools necessary to test his ideas. In this context, it is suggested that it may be premature to entirely discard theories that have proposed untestable arguments. Rather, it is by envoking a synthesis of historical ideas with modern methods that new perspectives may result to clarify hitherto unexplained phenomenon and add to our scientific knowledge. It is this rationale that will now be pursued here both to develop scientifically defensible hypotheses regarding animal consciousness and to defend the perspectives of William James.

Consciousness and Visual Perception.

In constructing support for a Jamesian view of evolved animal consciousness, further complication is presented by James's (1890/1981) argument that the focus of consciousness is derived from the character of the currents passing through the brain. In this respect, it is mainly of things seen if the occipital lobes are primarily involved, or of things heard if the temporal lobes, etc. Given this sense-determined difference in consciousness, in order to make initial intra-species comparisons, evidence also needs to be limited to behaviour that is associated primarily with one type of perception. To achieve this, discussion will focus on experiments that depend on the visual system. Vision is chosen because the emergence of conscious mental experiences has been recently proposed to be matched not only by the evolution of the cerebrum, but also the evolution of the visual processing mechanism (Eccles, 1989). Also, given James's assertion that human consciousness is of the most complex kind, vision is the dominant human sense and the one which has been most widely studied by psychologists (Humphreys, 1992).

Therefore, in order to demonstrate the presence of animal consciousness and the plausibility of this existing throughout the animal kingdom according to the concepts of natural selection and the theory of William James, three classes of visually-dependent behaviour assessed by experimentation will be discussed. These behaviours will be presented in context of the evolution of the brain and that, according to James, could be expected to provide both an index of early vestiges of consciousness in the lower species and differences in a more complex consciousness in the higher species.

Primitive Brain, Primitive Behaviour, and Primitive Consciousness.

Evidence of the emergence of a prominent brain occurred first in bilateral invertebrates such as annelids (earthworms, leeches) and arthropods (insects, crustaceans, spiders, centipedes, millipedes). These animals show increasing centralisation of the nervous system where, in contrast to the diffuse, ladderlike system of flatworms, a well-defined ventral nerve chord with a much larger and complex brain at the anterior end occurs. The increasing complexity of the nervous system is correlated not only with natural history and phylogeny but also behaviour, and molluscs provide a good example (Campbell, 1990). Sessile or slow-moving gastropods have little or no cephalization, an evolutionary trend corresponding to the activity of the whole animal becoming co-ordinated by superordinate controls in the central nervous system (Crook, 1980). They also have only simple sense organs with their central nervous system in the form of a chain of ganglia circling the body. One such animal is *Aplysia californica*, a large marine snail commonly known as the 'seahare'. Vision in *Aplysia* depends on "photosensitive" eyes and posterior tentacles called rhinophores, a reduced photosensory system that is associated with only a few behavioural responses (Keunzi & Carew, 1991; Willows,1973).

Given the primitive brain of *Aplysia*, at the stage of evolution where the cerebrum has yet to emerge, what type of consciousness could be expected to be exhibited? Following Aristotle, James (1988b) suggested that the first step in developing a conscious mind is for an initial sensation or feeling to be registered by the organism. This first sensation, which must be distinct from those that are constantly registered by the animal, is then able to develop into a minimal knowledge such that the organism can feel the initial sensation as distinct from not feeling it. James (1988b) argues that, at this stage, the genesis of consciousness is evident, although the distinction between object and subject is not yet involved. In this sense, the differentiation of knowledge from sensation is "simply to feel, not feel in this manner or that" (p.75). It thus needs to be demonstrated that *Aplysia*, with a primitive, cerebrum-deprived brain evinces a capacity to distinguish the presentation of a sensation from "not the sensation".

One behaviour commonly exhibited by *Aplysia* is a phenomenon known as head-waving. This occurs naturally when the animal sweeps its head and anterior body from side to side in order to engage in behaviours such as feeding and mating. However, head-waving can be released by isolating the animal from the substrate. Keunzi and Carew (1991) have reported that, upon suspending *Aplysia* in a dark environment, these animals will consistently turn their heads to face a directional light presented at the side, followed by either a biasing of head waving to the illuminated side of the test apparatus or maintenance of this posture well beyond the normal period of free head-waving. In

addition, Cook and Carew (1989 a,b,c) demonstrated that, in a similar substrate-deprived environment, head waving in *Aplysia* could be modified by punishing waving to one side with presentation of light as a whole-field illumination (as opposed to the directional stimulus used by Keunzi & Carew). Therefore, orientation of head waving can be elicited by directional light or negatively reinforced by whole-field illumination.

The experiments by Carew and his colleagues (Cook & Carew, 1989 a,b,c; Keunzi & Carew, 1991) demonstrate the ability of *Aplysia* to distinguish the sensation of light from the sensation of no-light and that the reaction to this stimulus can be modified by operant conditioning. However, *Aplysia* does not demonstrate behaviour that can be considered anything beyond than this ability. Such consciousness is its most primitive form, and we are, in the words of William James, "so far close down to the roots of things in this inquiry, and the elements to be discriminated so few" that such proposals "sound at first like mere puns and shufflings of words. And yet a moments reflection shows them to be full of relevancy" (1988b, p. 70). *Aplysia*, as one of the lower animals, is best adapted to its environment having evolved a nervous system that is able to respond "to few stimuli but to them strongly and well" (James, 1988a, p.25). It may be argued that such reflexive behaviour should not be ascribed to even a primitive mental state. However, the proposal is that an organism that is capable of detecting stimuli and having its reaction to that stimuli modified by operant conditioning possesses the pure vestige of an emerging consciousness.

According to James (1988b), following the development of sensation into a minimal knowledge, the next major mental step towards a more "complete" consciousness is the emergence of "thought", which, in humans, is considered to be inextricable from consciousness proper. The animal must not only remember something as experienced in the past, but must identify this with something experienced in the present. One behaviour that has been considered preliminary to conceptual thought is the capacity to copy a model, that is, to imitate (Fiorito & Scotto,1992) [1]. There is no evidence that *Aplysia* is capable of this. We therefore need to appraise this ability in an animal with a more developed brain.

A More Complex Brain and a More Complex Consciousness.

Following the type of brain exhibited in the sessile or slow-moving molluscs, the next major evolutionary step is exhibited within this phylum by cephalopods, an animal class that has the most sophisticated nervous systems of any invertebrates, rivalling even those of some vertebrates (Campbell,

1990). One of these species is the common octopus (*Octopus vulgaris*), a highly specialised predator, with, large, well developed eyes providing remarkably accurate vision (Bradley & Messenger, 1977; Sanders, 1975). In addition, the vertical-superior frontal lobe system (necessary for an effective short term memory), with its large input from the optic lobes, is well developed in most coleoids (the mollusc sub-class to which octopuses belong). This indicates that they probably all seek their prey and avoid their predators by sight and that learning about things seen must play an important part in their life. The octopus, when compared to the sea hare, has both a more complex brain and visual system. It is in this species that we can observe a progression to a more complex consciousness reflected by the ability to copy a model.

In an experiment conducted by Fiorito and Scotto (1992) octopuses (*Octopus vulgaris*) were conditioned to discriminate attack between two identically shaped balls, one being red the other white (this was considered a brightness discrimination as octopus are colour deficient). Following the conditioning phase, untrained octopuses were housed in an adjacent tank with a transparent wall dividing the two. The conditioned octopuses were nominated as "demonstrators", the untrained octopuses as "observers". The testing phase was then implemented in which the observers watched four trials of the demonstrators attacking the ball they had been conditioned to attack, an act performed without error. Following this the observers were exposed to a session of five trials of simultaneous presentation of both balls. The octopuses that observed demonstrators attacking the red ball chose the red ball significantly more often than they did the white ball. Animals that observed demonstrators of the white group chose the white ball. The results suggest that an untrained *Octopus vulgaris* can learn a task by observing, for a short period of time (four trials), the behaviour of a conspecific. Furthermore, observational learning was significantly faster than the learning of the demonstrators trained with classical conditioning techniques.

It could be argued that the behaviour of the octopuses should not be attributed to an elaborate mental state such as consciousness, regardless of degree. The response by the observer is nothing more than either an example of a genetically determined programme to copy an attacking pattern of a conspecific or a case of simple learning, where in the animal's past it has been reinforced for such behaviour. First, *Octopus vulgaris* is not a social animal, therefore it is unlikely that the observers had much experience in observing the behaviour of conspecifics and hence the opportunity to learn in this manner (Fiorito & Scotto, 1991). Second, neither learning nor genetics can explain the fact that the observer octopuses still chose, on occasions, to strike the ball they had not witnessed their

demonstrator attack and even if it is at a minimalist level the octopus still has to make a choice - and choice is inextricably intertwined with consciousness (Baenninger, 1990).

The above examples have been included to demonstrate that consciousness exists, albeit in primitive form, even in invertebrates and that this "consciousness" can be seen to increase in complexity concomitant with an increase in brain complexity. However, while the octopus exhibits behaviour that can be considered an index of conceptual “thought”, the essential form of consciousness in its most complex guise occurs when the organism is able to make the distinction of "not me from me" (James, 1988b, p. 73). In this sense, there is nothing in the behaviour of the octopuses to suggest such self-consciousness. Therefore analysis of animal consciousness needs to be conducted at the level of the higher species where the cerebrum - the structure that William James identified as being responsible for the emergence of consciousness proper - has become dominant .

Consciousness and the Cerebrum-Dominant Brain.

As the vertebrate brain evolved from the invertebrate it became more complex, with adaptations being made in order to provide greater ability to integrate increasingly complex activities (Campbell, 1990). Among mammals, more sophisticated behaviour is associated with the relative size of the cerebrum and the presence of folds, or convolutions, which increase its surface area, becoming what is termed the neocortex (O'Leary, 1993). The most suitable parameter for defining the evolutionary level of brain development is neocortical volume (Zilles & Rehkämper, 1988), and the greatest neocortical volume is found in the great-apes (gorillas, orang-utans, chimpanzees), humans, and cetaceans (whales, porpoises, dolphins). Given the close evolutionary relationship and the relative ease with which research can be conducted on these animals compared to cetaceans, the focus in these cases is on the human/great-ape clade.

Importantly, the members of the human/great-ape clade have a distinctive visual system. Common to all primates and distinct from most other mammals is the presence of colour vision along with the evolutionary trends of an enlargement in the specific areas of the brain concerned with sight and an emphasis on frontality, resulting in the axis of the eyeballs being greatly reduced (Campbell, 1990). It is worth noting that, being homologously derived, the primate eye is representative of other vertebrate species in most of its basic characteristics (Levine & Shefner, 1991). However, while the cephalopod eye functions similarly to the vertebrate eye, it evolved independently and is thus an analogous structure. Regardless of any intra-species differences, when compared to both octopus and

Aplysia, the members of the human/great-ape clade possess both a more complex brain and elaborated visual system.

If the hypothesis is correct that an increasingly complex cerebrum, reflected by the development of the neocortex, is responsible for an increasingly complex consciousness, we would expect to find this trend reflected in humans and the great-apes. The most complex form of consciousness according to James (1890/1981, 1988b) is self-consciousness, having a perception of oneself that can be reflected upon. If an animal has even a minimal conception of self then it should be capable of recognising who or what it is, and if can be demonstrated whether or not an animal can recognise itself we can at least have gained an index of broader aspects of self-consciousness (Moses, 1994). Despite assumptions to the contrary, historic use of mirrors to assess self-consciousness (Darwin, 1877; Dixon, 1957; Gessell & Thompson, 1934; Preyer, 1893) did not provide a means by which to determine whether the mirror behaviour of human infants indicated that they understood the relationship between the reflection and its origin. Furthermore, philosophers continued to deny non-human animals the ability for mirror self-recognition (e.g., Merleau-Ponty, 1964). However, a revolutionary method to investigate this ability was introduced by Gallup (1970), and has since become the principle procedure in research on self-consciousness.

In its original design Gallup (1970) presented chimpanzees and several species of monkeys with mirrors. Monkeys and chimpanzees belong to distinct primate families, *Cercopithecidae* and *Pongidae* respectively, with members of the *Pongidae* (or great-ape) family considered to be more cognitively advanced than any other non-human primate (Anderson, 1996). Following a 10 day acquaintance period, the animals were anaesthetised and a bright red, odourless, alcohol-soluble dye was placed on the forehead in a position that could only be seen with the aid of a mirror. When the animals awoke Gallup re-presented the mirror to them and observed their subsequent reaction to the surreptitiously applied red dot. The rationale pursued was that if the animals recognised the image as themselves they would react by touching and exploring the marked region. However, if they did not make this association, they would display insignificant mark-directed behaviour. Gallup found that the chimpanzees would almost instantaneously touch the mark on their foreheads, using the mirror to guide their hands to their face. In contrast, the monkeys failed to present any evidence of self-recognition.

Subsequent research has established that the capacity for mirror self-recognition is limited to the great-apes and human infants older than 15-months-of-age (Amsterdam, 1972; Lewis & Brooks-Gunn, 1979; Parker, Mitchell, & Boccia, 1994). When the mark test is applied to animals outside the

human/great-ape clade they consistently display an inability to recognise the mirror image as themselves, either failing to acknowledge the mirror at all or acting as if the reflection is a conspecific (Boccia, 1994; Pepperberg, Garcia, Jackson, & Marconi, 1995; Povinelli, 1989). Thus, accompanying the development of the neocortex in the human/great-ape clade, there is empirical data to suggest a level of consciousness that is clearly different from that of other animals[2].

It is important to note that there is a continuing debate with regard to whether or not mirror self-recognition should be taken as an index of self-consciousness (cf. Gallup & Povinelli, 1993; Mitchell, 1992, 1993a,b, 1997a,b; Povinelli, 1995). Part of the reason for this debate may rest on a confusion about the definition *self*-consciousness. That is, while recognising oneself in a mirror may indicate an appreciation that it is oneself that one is seeing, this is not the same as being aware of one's own thoughts (Block, 1997; Corballis, 1991). Therefore, chimpanzees may know that they are looking at themselves in a mirror but may not know that they know. This line of reasoning in Western thought which attempts to differentiate humans from other animals has been traced by Sorabji (1993) to Aristotle and , in particular, the Stoic philosophers. According to Sorabji, the Stoics allowed non-human animals the ability to "enjoy the appearance *that* something is the case" (p.25) but denied them the ability to engage in inner discourse and to make inferences of the form "if this, then that". Thus animals were denied the recursiveness of thought and the capacity to entertain symbolic representations that Corballis (1991) has argued is derived from the evolution of a left-hemisphere-located generative language.

Given the arguments linking it to generative language, a class of consciousness should be evident that distinguishes humans from non-humans. Evidence of such a class of consciousness may be derived from work on "theory of mind". The term "theory of mind" refers to ones knowledge of the mental states of self and others and the appreciation that it is these mental states that determine behaviour. It is widely acknowledged that a theory of mind develops between three- and four-years-of-age in human infants (Gopnik & Astington, 1988; Wimmer & Perner, 1983). However, the presence of a theory of mind in even our closest evolutionary relative, the chimpanzee, remains a contentious issue (see Heyes, 1998). While it is beyond the scope of this paper to cover the complex debate regarding the presence of a theory of mind in nonhuman primates it is worth acknowledging that there is as yet no evidence in the great-apes of a theory of mind that is comparable to that of the 4-year-old child (Call & Tomasello, in press; Suddendorf, in press, 1998). Thus, although members of the great-ape clade exhibit the capacity for mirror self-recognition there is as yet no unequivocal evidence that these

animals have any knowledge with regard to mental states. This may place constraints on the type of self-consciousness that can be ascribed to non-human animals and is deserving of continued investigation[3].

Conclusion: How to Avoid Condemned Repetition.

It has been argued here that consciousness be conceptualised as a phenomenon that exists throughout the animal kingdom, occurring in different forms which, according to evolutionary principle, are dependent on the needs of particular animals to be best adapted to their ecological niche. Three different classes of animal consciousness (the capacity to detect stimuli and have that reaction modified by operant conditioning, the ability to imitate, and self-consciousness) have been reviewed which indicate the plausibility of this, leading to the inference that it is an adaptation affording evolutionary benefit and not a "free-rider" (Radner & Radner, 1989) on the natural selection of other traits. Description of these three classes of animal consciousness has been accompanied by the level of brain development interpreted as being prerequisite for their occurrence, descriptions of their behavioural referents, and empirical means by which to establish their presence. By linking consciousness to publicly observable consequences the approach outlined above demonstrates the conceivability of formulating scientifically defensible hypotheses regarding consciousness in the same manner as other “unobservables” such as molecules, genes, and magnetic waves.

It is, therefore, further proposed that future attempts at revealing consciousness in animals must follow a prediction-to-data collection approach (Povinelli, 1993). This proposal presents a major challenge to the field of animal consciousness. The three classes of animal consciousness presented in this essay are only preliminary steps, and it must be acknowledged that they represent an oversimplification of the diversity of conscious minds that exist throughout the animal kingdom. Thus, not only are further classes in need of elucidation, but these need to be accompanied by descriptions of the behaviour interpreted as reflecting them and methods by which to test for their presence. Furthermore, these, along with those discussed here, all need to be adapted to different species with different environmental and sensory demands (not just vision) and associations made between species to determine whether certain types of consciousness are homologous or analogous. It is through this process that we can begin to use the morphological record to determine when certain types of consciousness emerged and speculate on what form it may have taken in extinct species.

The arguments presented in support of the notion that consciousness is subject to the same evolutionary determinants as physical attributes has implications for the debate about its presence in humans. Current literature lacks agreement on what human consciousness is and specifically what it does. By accepting the suggestion that mental states evolve by descent with modification it must also be accepted that either in the present or in the past consciousness confers some form of benefit on the individual. The benefit, according to James, is to act as a selecting agency, pervasively choosing, out of all the stimuli sensed by the organism, those which are assessed as worthy of attention while suppressing the remainder. Unfortunately, although other authors have espoused similar, and sometimes eloquent, ideas (e.g., Baars, 1997; Carlsson, 1992; Hirst, 1995), at present we do not have sufficiently precise methods with which to test such a proposal. Nevertheless, evidence derived from work on 'blindsight' (Weiskrantz, 1995a,b) and visual masking and word recognition (Forster & Davis, 1984; Marcel, 1983a,b) renders this position plausible. It is by coupling the theories of James with emerging methods and data that we may in due course arrive at an explanation of one of the more perplexing aspects of mental life.

It is relevant here to acknowledge the perspective recently championed by McGinn (1991) that we are not cognitively equipped to understand how brain mechanisms give rise to subjective states. James (1890/1981) had elucidated a similar argument when he wrote that “nature in her unfathomable designs has mixed us of clay and flame, of brain and mind, that the two things hang indubitably together and determine each other’s being, but how or why, no mortal may ever know” (p. 182). There is no dispute that consciousness is reliant on brain states but what remains as great a mystery now as it was to James is precisely *how* the brain gives rise to consciousness (cf. Dennett, 1991; Searle, 1992). However, if we treat this problem with the pessimism of James and McGinn much research in the disciplines of psychology, artificial intelligence, and neurophysiology should be abandoned as a pursuit of the unattainable. Yet, as Akins (1993) eloquently points out, we cannot know where our empirical investigations of mental representation may lead nor what insights it may reveal. To be overly defeatist with regard to our capacity to comprehend the brain-consciousness connection will be to do ourselves an injustice. It is in this sense that we disagree with James and argue that through systematic and detailed research we may begin to draw closer the gap between what we know about the functions of the brain and how such functions give rise to phenomenological experience - we mortals may come to know how clay and flame are mixed together.

Finally, as debate will no doubt continue regarding consciousness, if we are willing to accept the application of this concept to explain human behaviour then it is nothing less than "speciesism"

(Singer, 1975) to deny the same to animals (Baenninger, 1990). Although we may never directly observe consciousness, by conceptualising it in a manner that accounts for its evolutionary history we may reach a greater understanding of not only its presence and function in other animals but also in ourselves. James possessed a remarkable foresight in his contemplation of consciousness, providing an enormous wealth of data and logical analysis pertaining to the nature of this phenomena that deserves continued scrutiny. It is thus of continuing relevance that the concepts of William James be maintained along with those of other pioneers of modern psychology. Through extrapolating their intuition to emerging scientific methods greater progress might be made and repetitive mistakes avoided. To quote the philosopher, and one time pupil of James, George Santayana (1905/1980): "Progress, far from consisting of change, depends on retentiveness ... Those who cannot remember the past are condemned to repeat it" (p.284).

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1. There remains debate with regard to what behaviour constitutes imitation and which animals are capable of producing it (see Byrne & Russon, 1998; Russon, Mitchell, Lefebvre, & Abravanel, 1998). Therefore, for the purposes of this paper, imitation is defined as occurring when:

> B (a behaviour) is produced by an organism, where B is similar to something else M (the model); registration of M is necessary for the production of B; and B is intended to be similar to M (derived from Mitchell, 1987).

2. A further aspect of research with the mark-test is in need of elaboration. As their neocortical development is comparable to the great-apes it is reasonable to expect that cetaceans should also exhibit some degree of self-consciousness. However, the method involved in successfully translating the mark-test for use with cetaceans is challenging, to say the least. Despite this, preliminary attempts indicate that dolphins are capable of exhibiting self-recognition (Marino, Reiss, & Gallup, 1994; Marten & Psarakos, 1994, 1995).

3. It is necessary to stress that we do not wish to place human consciousness above that of non-human animals nor imply that it is in any way superior. We are simply proposing that human consciousness may differ in certain ways from other animals, even that of our closest evolutionary relatives.