Spring 2020

Ghost in the machine; do animals have consciousness?

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Ghost in The Machine, Are Animals Conscious

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Abstract

Consciousness research in neuroscience focuses on the awareness of internal and external existence. Scientists and philosophers have spent centuries analyzing what consciousness really is. Yet, the subject of consciousness remains controversial. This is because consciousness has a subjective aspect, and as such it is difficult to test empirically. These problems are further amplified when examining whether animals are conscious. This paper addresses the philosophic and scientific views of consciousness and outlines why consciousness remains to be a hard problem in science. We will then examine arguments offered by the Francis Creek Memorial, and the advent of the Cambridge declaration which took place in 2012, to see if it resolved the question of animal consciousness. We will show that the current research, which is based on materialistic physicalist position, provides a possible pathway toward examining animal consciousness by assuming that it is being produced by brain substrates that are similar to those thought to be responsible for consciousness in humans.

Keywords: Animal consciousness, Francis Crick memorial conference, Cambridge declaration, human consciousness, materialistic physicalist position.

Introduction and Defining Consciousness

To understand what consciousness is, several aspects of the topic need to looked at. The aim of this paper would be to focus on the definition of consciousness, why it is a difficult area in science; including what the dominant view is in recent literature, how the brain generates consciousness and what parts of the brain participate in the generation of consciousness. It is only after looking at these aspects that we can begin to draw correlations with animal consciousness, and speculate if animals truly are conscious.

When dissecting the topic of consciousness, it is important to recognize that there is no universally accepted definition of consciousness and scientists are yet to reach a consensus on what consciousness is. But there are several suggestions made by scientists on what consciousness is. First, consciousness is the function of the human mind that receives and processes information, analyzes it, and either keeps or discards it with the help of the five senses, reasoning ability of the mind, imagination, emotion, and memory (Vithoulkas & Muresanu, 2014). Another suggestion on the definition of consciousness is that it is the state or condition of having an awareness of one's environment, existence, sensation, and thoughts. Due to the dynamin nature of consciousness, more recent definitions view consciousness as the processing of information that exists at various levels of awareness (Bancroft, 1998).

In order to define consciousness, it is also important to make some distinctions terminologically. Philosophically, Descarte's definition of consciousness was not clearly differentiated from the mind. To avoid confusion, it is pivotal to reserve the term "mind" for psychological states and processes that may or may not be conscious. In modern writings, consciousness is synonymous with self-consciousness. This usage seems to be narrow because there is a distinction between being conscious of one's self, and being conscious of things other

than one's self. The term consciousness is also commonly used to describe wakefulness. When sleeping, an individual can still have visual and auditory experiences. On the other hand, when awake, there are many things that one does not experience. It is important to distinguish consciousness in the sense of phenomenal consciousness from wakefulness and other states of arousal (Hatfield, 2018).

Conscious experience has been observed to depend on brain activity, so neuroscience aims at contributing to bridge the gap between brain and consciousness. There is a need to look into neural data, psychological models, and philosophical analysis to identify the principles to connect brain activity to conscious experience. A challenge for an objective science of consciousness is to break down a subjective phenomenon (Wu, 2018).

Despite anecdotal evidence suggesting conscious states in a variety of non-human animals, there are very few systematic neuroscientific investigations on animal consciousness. Questions of animal consciousness were largely neglected throughout the 20th century. This must have been in part due to only humans being capable of accurately describing their phenomenal experience. However, there is now increasing behavioral and neurophysiological evidence consistent and suggestive of conscious states in some animals (Edelman & Seth, 2009).

Other areas of study will be to look into the history and philosophy of consciousness to help the progression of our understanding of consciousness. The aim of this paper would be to look into the neuronal correlates that humans and animals share, and use this as a benchmark in speculating if animals truly have consciousness.

The history of body-consciousness concepts

There has been a debate concerning the mind and the body, the relationship between thought and consciousness in the human mind, and the brain being part of the physical body. A

variety of approaches have been proposed to handle the debate, and most are either dualist or monist. Dualism posits that there is a difference between mind and matter. Monism maintains that there is only one unifying reality to explain everything. There are two main forms of dualism (Figure 1), substance (the mind is formed by a distinct type of substance not governed by laws of physics) and property (conscious experiences are fundamental properties of mental processing) dualism. On the other hand, there are three main forms of monism, physicalism (the mind consists of matter organized in a particular way), idealism (only thought exists and matter is an illusion), and neutral monism (neither mind nor matter have a distinct essence). The limitation that seems to hinder the dualistic point of view is that there is no empirically noticeable point between the non-physical mind and the physical mind, and many modern philosophers of the mind maintain that the mind and body are not separate. This is the dominant view held in the area of consciousness today (Robinson, 2017).

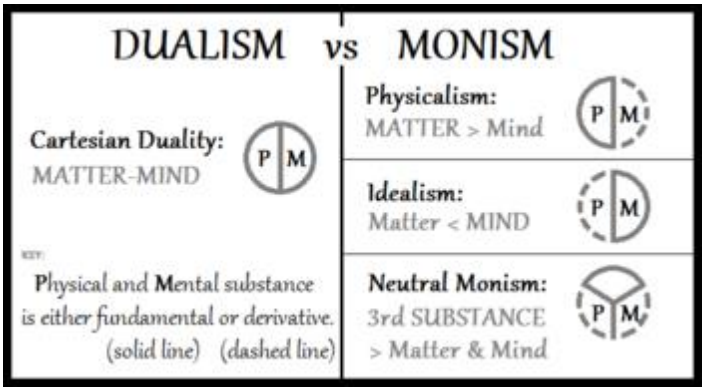


Figure 1. Different approaches towards resolving the mind body problem.

Doubts about the consciousness of animals were occasionally reported in classical antiquity. Augustine (City of God, 12.4) argued that nothing can be perceived without reason, which is needed to judge and that beasts lacking reason, therefore "lack understanding, sensation, and life together. However, pre-scientific philosophers, generally accepted without question that

a kicked dog feels pain, and a repeatedly kicked dog suffers. Animal consciousness was first questioned at the beginning of the scientific revolution by Descartes, who is attributed for giving the phenomenon of consciousness a central stay in modern philosophy. By Descartes analysis, we perceive things consciously only because we are conscious that we perceive things. Since animals "lack language," we could speculate that they cannot reflect on their sensations; therefore, they cannot be aware of them. Descartes concluded that animals could feel that there was a stimulation of a sensor and gave a mechanical response, but there was no subjective awareness (Cartmill, 2000).

The opposite school of thought holds that language contributes little to consciousness. As Charles Darwin postulated, "there is no fundamental difference between man and the higher mammals in their mental faculties" (Darwin 1889, p.66). Opponents of this claim (which is a school of thought called anthropopsychism), often condemn it as unscientific and sentimental. In the mid-19th century, the psychological and spiritual gap between people and animals was seen to be an objection to the thesis that humans evolved from apes. Darwin's theory of evolution by natural selection provides a model of how the mind might evolve from species to species. Unfortunately, it also raises doubts about the significance of expressive behaviors that Darwin pointed to as signs of various emotions and faculties.

Sober (1998) proposed that instead of giving evolutionary priority to higher or lower level processing, we can call one psychological faculty higher or lower "if and only if the behavioral capacities entailed by the former properly include the behavioral capacities entailed by the latter" (Sober, 1998, p.236). The best reason for thinking that an animal lacks some psychological faculty is that it never shows behaviors linked with that faculty. To follow Sober's principle, we need to know what behaviors are uniquely linked with consciousness.

Unfortunately, comparative evidence could not back up this principle since human beings were the only recognized conscious animals.

The nature of consciousness was also examined by psychologists. For example, Julian Jaynes postulated that consciousness was not an “innate” property of matter. He stated that to learn a skill for the first time, conscious effort was needed; which meant habits, instincts, and higher processing had to be at play. But after a while, it went into the world of the unconscious and unless attention is drawn to a particular event, an individual is not conscious to it (Greenwood, 2017). Since the 1990s, research on consciousness now contains a mixture of several perspectives and areas such as philosophy, computer science, experimental science, theoretical science, clinical science, and neuroscience as its main focus. Scientists are now trying to distinguish between conscious and unconscious perceptions, especially how it affects self-consciousness.

Consciousness as a hard problem in science

The hard problem of consciousness is a problem of explaining why and how organisms have phenomenal experiences. The existence of this hard problem is controversial and is argued by many philosophers. Different solutions have been proposed to solve this hard problem of consciousness. One is weak reductionism, which is the view that consciousness cannot be solved directly by scientific progress due to our conceptualization of the problem. Another solution is panpsychism, which views consciousness as intrinsic to matter.

Many agree that consciousness is a product of brain activity but what is not clear is why and how material activity gives rise to the subjective experience. Chalmers identified consciousness as a hard problem that will never be known or solved. Others disagree that consciousness could be reduced to brain mechanisms. These positions allow for research on how

the brain generates consciousness. It has to be recognized that these positions are philosophical and cannot be proved scientifically (Chalmers, 1995).

Human Consciousness

Current notions of neurological substrates of consciousness in humans are based on lesion studies, recording studies, and stimulation studies. Based on these studies, scientists speculate that if we know what parts of the human brain affect consciousness, we can determine how consciousness is generated, and use this as a benchmark for further research in other areas of consciousness.

Scientific literature consists of studies that explain the relationship between experiences reported by subjects and activity that simultaneously takes place in their brains. These studies look at the neuronal correlates of consciousness (Figure 2). The aim is to find activity of a particular part of the brain or a particular pattern of activity, which strongly predicts conscious awareness. Several brain imaging techniques such as electroencephalogram (EEG) and functional magnetic resonance imaging (fMRI), have been used as physical measures of brain activity for these studies (Rees et al., 2002)

A number of studies have shown that activity in primary sensory areas of the brain is not sufficient to produce consciousness. Therefore, higher brain areas are viewed to be more promising, especially the prefrontal cortex, which is involved in executive functions (Rees et al., 2002)

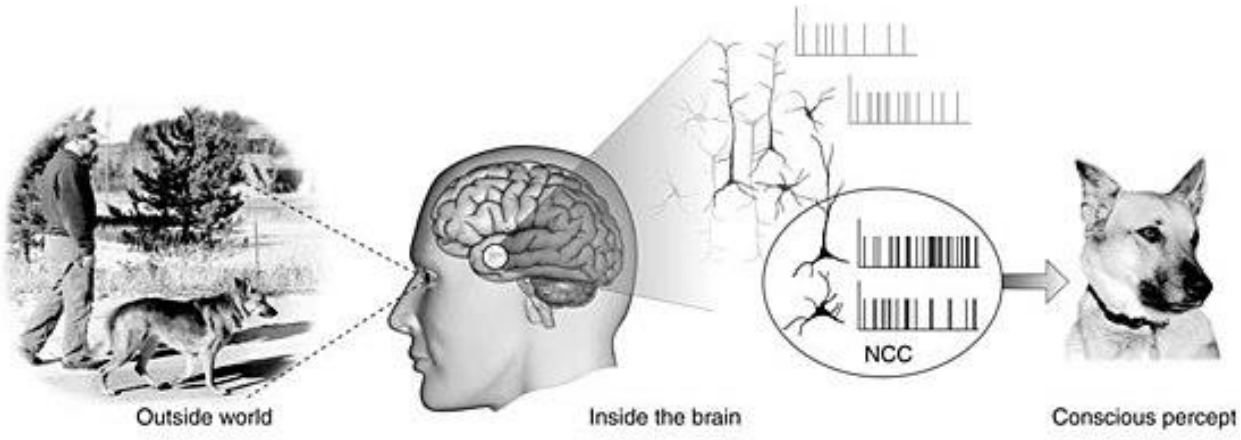


Figure 2. Schema of neural processes underlying consciousness

An example to explain the neuronal links of consciousness, could be a test with images to evaluate conscious perception. If two images are presented to a patient and are alternated several times, there is a rivalry between optical areas of the brain to correctly decipher the images; this is called “binocular rivalry.” If brain activity was measured, it will show that the parietal, occipital, and temporal regions (in the posterior cortex) are active (Figure 3).

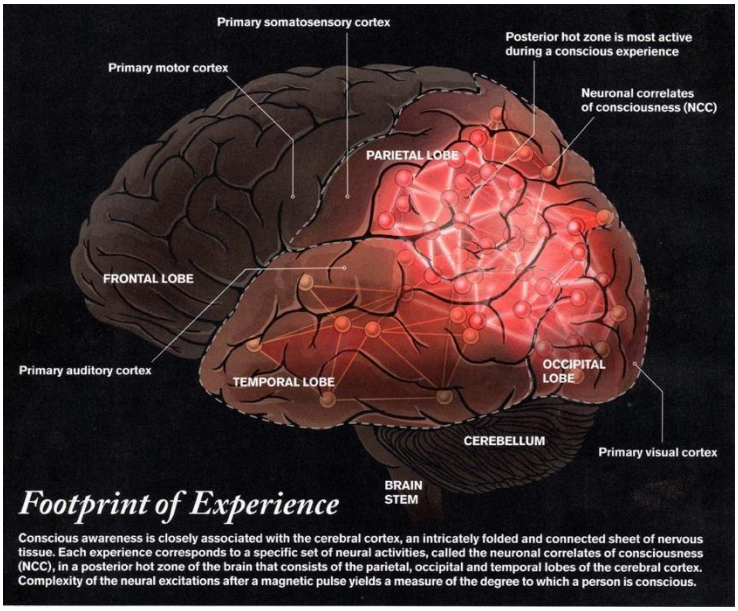


Figure 3. Neuronal correlates of consciousness.

The notion that consciousness can be separated in different nervous systems by a variety of mechanisms suggests the need to look into constraints, and therefore analyze neuroanatomical and neurophysiological evidence. The constraint to this could be the capacity for accurate report on conscious contents which signifies higher-order consciousness; which may include language. The application to using humans as a benchmark for consciousness (Figure 4) requires that: a.) at least some properties of the brain reliably occur in both humans and animals; b.) human brain areas responsible for consciousness can be placed with those areas responsible for accurate report of phenomenal consciousness; and c.) neural evidence that can be correlated with phenomenal properties of consciousness must in addition account for those properties (Edelman & Seth, 2009).

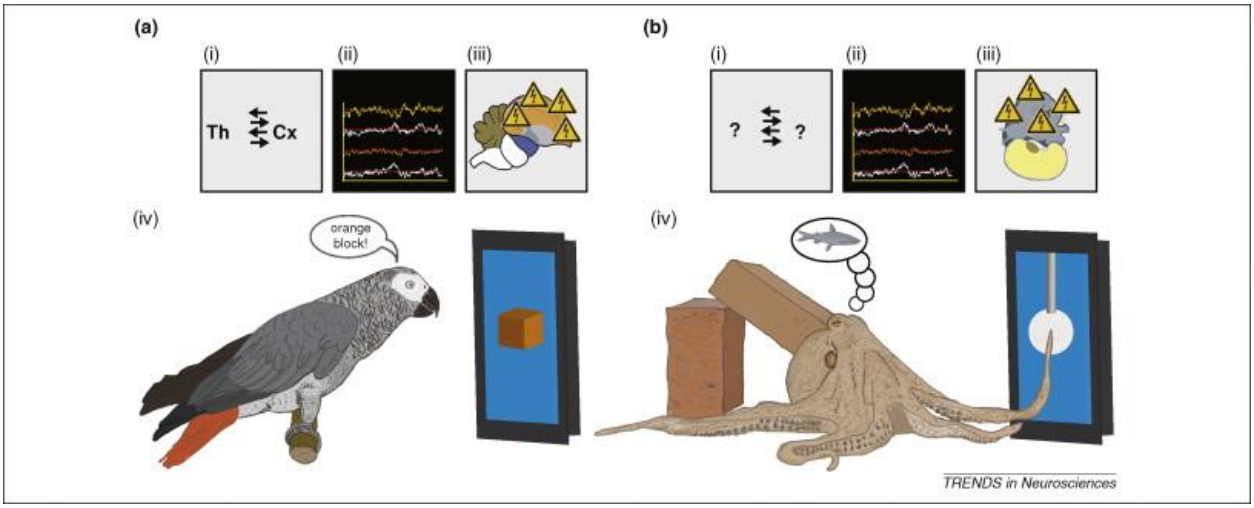


Figure 4. The investigation of possible conscious states in non-human species as disparate as birds (a) and cephalopods (b) can be informed by searching for neural properties that have been correlated with consciousness in humans, including reentrant signaling between thalamus and cortex (a, i) or putative functional analogs (b, i), fast, irregular, low-amplitude EEG signals (a and b, ii), and widespread electrical activity in cortex (a, iii) or functionally analogous structures (b, iii). Such processes in animals can best be related to consciousness when they can be correlated with accurate reports. Relevant forms of report include vocalizations in the case of African grey parrots (a, iv) or coloration and body patterning in the case of cephalopods (b, iv). In the figure, an African grey parrot and a common octopus (*O. vulgaris*) respond to salient artificial stimuli presented on video displays: an orange block in a discrimination task (a, iv) and a white ball that has been previously associated with food (herring) during training (b, iv)

Furthermore, one of the emerging studies was during world war II. It was the split-brain studies of Sperry and Michael Gazzaniga. They found out that each hemisphere of the cerebrum could perceive visual stimulus independently. Some other studies indicated that while emotions remained intact, there was a possibility that the motor system, somatosensory system, and other

cognitive systems could be split. The conclusion drawn from this study was that consciousness might not be unified.

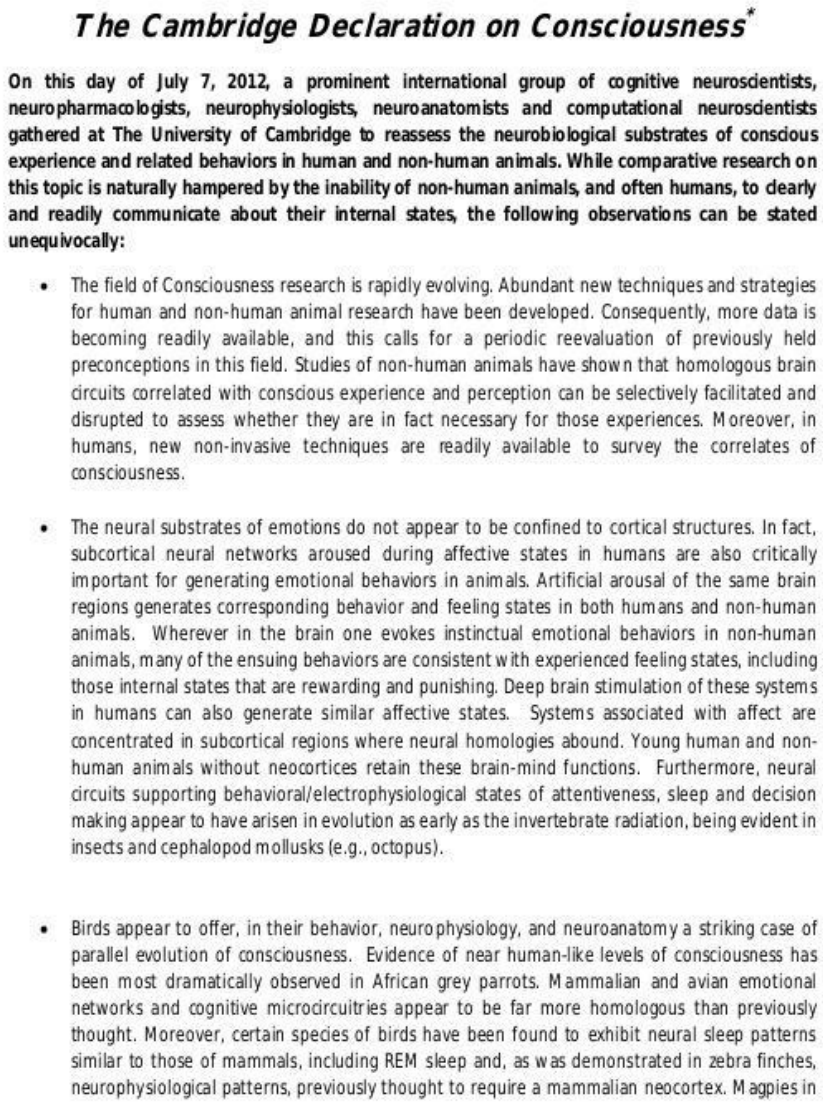
In another study carried out Corkin and Brenda Miller, these scientists performed a bilateral removal of the temporal lobe on a patient with epilepsy. It turns out that the patient was cured of epilepsy, could learn new motor skills, and had a perfect semantic memory. The patient also retained the ability to get non-conscious (implicit) memory. But the problem arose when the patient was unable to get or acquire conscious (explicit) memory. This experiment led to the conclusion that the perceived unity of the conscious mind could be fragmented because some aspects of the mind persist while some others are lost (*Consciousness: The last 50 years (and the next)—Anil K. Seth, 2018*).

Background of Animal Consciousness

Based on the different views and studies carried out, we can all agree that humans have consciousness. The big question remains if animals possess consciousness too. Since consciousness is a subjective phenomenon and we cannot communicate with animals effectively, there is a problem with figuring out if they are conscious or not. The difficulty of these questions made it an intractable problem until the Cambridge declaration. In this declaration, a group of scientists declared that animals were conscious based on their studies which showed that there were homologous brain circuits that correlated with conscious experience and perception which can be selectively facilitated or disrupted to assess whether they are in fact necessary for those experiences. The Cambridge declaration (which will be explained further), is portrayed as the scientific solution to the general question of animal consciousness.

Several neurological tests have led to the growing awareness of animal rights, and this was the major issue discussed in the Francis Crick memorial conference. The result of this

conference was the Cambridge declaration of consciousness of non-human animals. The declaration was based on the grounds of non-human animals having a conscious state and the ability to manifest behaviors. The declaration was aimed to inform the public, in order to change their attitude towards animal consciousness and animal rights. The big question opponents of the declaration might ask is why is it a declaration rather than a proven theory. To answer this, there have been suggestions that indicate the declaration was signed by mostly lab researchers and scientists who had gone into long-term studies of primates, rodents, and birds. There was an omission though; the researchers never included fish. It is important however to highlight that the statement was not released for other scientists but was aimed at the general public. There are several skeptics on the issue of animal consciousness. Dawkins claims in her book; “Why Animals Matter: Animal consciousness, animal welfare, and human well-being,” that we still don’t know if non-human animals are conscious, and does not agree with the declaration (Figure 5) using animal consciousness as a base for making welfare decisions (BEKOFF, n.d.).



The Cambridge Declaration on Consciousness[*]

On this day of July 7, 2012, a prominent international group of cognitive neuroscientists, neuropharmacologists, neurophysiologists, neuroanatomists and computational neuroscientists gathered at The University of Cambridge to reassess the neurobiological substrates of conscious experience and related behaviors in human and non-human animals. While comparative research on this topic is naturally hampered by the inability of non-human animals, and often humans, to clearly and readily communicate about their internal states, the following observations can be stated unequivocally:

- The field of Consciousness research is rapidly evolving. Abundant new techniques and strategies for human and non-human animal research have been developed. Consequently, more data is becoming readily available, and this calls for a periodic reevaluation of previously held preconceptions in this field. Studies of non-human animals have shown that homologous brain circuits correlated with conscious experience and perception can be selectively facilitated and disrupted to assess whether they are in fact necessary for those experiences. Moreover, in humans, new non-invasive techniques are readily available to survey the correlates of consciousness.

- The neural substrates of emotions do not appear to be confined to cortical structures. In fact, subcortical neural networks aroused during affective states in humans are also critically important for generating emotional behaviors in animals. Artificial arousal of the same brain regions generates corresponding behavior and feeling states in both humans and non-human animals. Wherever in the brain one evokes instinctual emotional behaviors in non-human animals, many of the ensuing behaviors are consistent with experienced feeling states, including those internal states that are rewarding and punishing. Deep brain stimulation of these systems in humans can also generate similar affective states. Systems associated with affect are concentrated in subcortical regions where neural homologies abound. Young human and non-human animals without neocortices retain these brain-mind functions. Furthermore, neural circuits supporting behavioral/electrophysiological states of attentiveness, sleep and decision making appear to have arisen in evolution as early as the invertebrate radiation, being evident in insects and cephalopod mollusks (e.g., octopus).

- Birds appear to offer, in their behavior, neurophysiology, and neuroanatomy a striking case of parallel evolution of consciousness. Evidence of near human-like levels of consciousness has been most dramatically observed in African grey parrots. Mammalian and avian emotional networks and cognitive microcircuitries appear to be far more homologous than previously thought. Moreover, certain species of birds have been found to exhibit neural sleep patterns similar to those of mammals, including REM sleep and, as was demonstrated in zebra finches, neurophysiological patterns, previously thought to require a mammalian neocortex. Magpies in

Figure 5. The Francis Crick Memorial Declaration itself.

The fact of the matter is that the declaration is airing on the side of protecting animals from pain and cruel handling, and it is really not a study on how non-human animals communicate. This stems from historical ideas according the French philosopher René

Descartes. He first thought that only humans had consciousness, and only humans had a body and soul. Descartes claimed that other animals were like robots, and lacked the soul. Descartes and his followers performed some cruel experiments on animals but they still maintained their stance. Based on this, many scientists were still influenced to think that only humans have consciousness, not until the declaration was publicly announced in 2012 (Figure 6).

Figure 6. Francis Crick Memorial advertisement.

The aim of the conference was to produce data that showed neural correlates of consciousness. They claimed to use the best quantitative techniques for measuring and keeping track of consciousness. The conference also focuses on several aspects of neurology ranging from the study of neurons, to cerebral patients in comatose patients (which there is still an argument to whether such patients are unconscious or not). Given that animals cannot communicate their perspective of consciousness, it is up to the scientists to carefully observe and address the disparity between human consciousness, and animal consciousness (Shanta, 2015).

Using Animal Studies and Metamemory to Explain Animal Consciousness

In order to understand the world of animal consciousness, scientists have divided the topic into two categories. The first assumes that there is consciousness in non-human primates, human consciousness studies used as models or benchmarks for this. The other category is aimed at establishing whether a particular animal species has conscious experiences or not.

To study and understand non-human consciousness, a frequently used model is the rhesus macaques monkeys. They have similarities with humans. For example, they have the same anatomical and functional organization as that of the human brain. Scientists aim to find neuronal correlates of consciousness by linking activities in this species of monkeys, to humans. Some studies especially with the lateral geniculate nuclei; which is a thalamic nucleus, which is thought to play a major role in consciousness (emphasis placed on visual perception), have been carried out to show the neural correlates of conscious perception. Although some studies have shown different signals in several areas of the brain, there is still a lack of a comprehensive model which suggests how sparse networks contribute to visual consciousness.

Another area of study scientists are looking at, is the combination of pharmacological agents and neuroimaging. Using the same models as discussed above, some studies have used agents to reverse neuronal activities, and monitor these activities using an MRI. An application of this method, is the study of spatial neglect, which is a common disorder of visual awareness in humans. There is more research to be carried out in this regard, but these are just a few suggestions to help analyze how animal consciousness works (Boly et al., 2013).

Metamemory is another school of thought that was used to explain if animals displayed signs of consciousness. Metamemory was used to predict whether a monkey could be successful

matching several tasks after delayed onset of a stimulus. There are two novel studies on metacognition.

In the first study, Cowey and Storeig looked at monkeys which had unilateral lesions on their primary visual cortex. This was done because when a human has a lesion to this area, they begin to voluntarily respond to visual stimuli while they lack phenomenal consciousness. This is known as blindsight. The lesioned monkeys were compared with controls on two tasks. In the first task, the monkeys were given a reward if they successfully touched the target they were shown. The results showed that the lesioned animals could touch the correct target given a specific intensity of stimuli even with their lesioned cortex. For the next task, it was termed the commentary key method. Half of the trial was used as a test, while the other half of the subjects were controlled. The results from the two tests showed that when there was a reward involved, monkeys with a lesioned cortex could localize a stimulus in their blind spots but when there was an option of receiving a reward without localization of the stimulus, they could still hit the right target as they have learnt to do over time, even when there was no stimulus. Although this study does not strongly identify the roots of non-human consciousness, it just goes to show that when a humans respond to a visual stimulus, that person tends to be more conscious of the stimulus. Therefore, when a monkey responds to the same stimulus, we assume that the monkey is also conscious of the stimulus.

In the other experiment carried out by Hampton, he started with the disclaimer that experiences associated with remembrance could not be carried out in non-human animals but could be used as a base for understanding how non-human animals experience their surroundings. Hampton also used rhesus monkeys for his experiment, and the monkeys were shown four pictures on the screen. After the presentation, there was a slight delay, when the

screen went blank. Two flags then came up after some time. Correctly touching the test flag meant that the monkeys received a good reward because all the four pictures presented earlier in the experiment came up but by touching the other flag (the escape flag), the monkey received a lesser reward. The result showed that the monkey chose the escape flag more than the test flag when there was an increased time of delay (Figure 7).

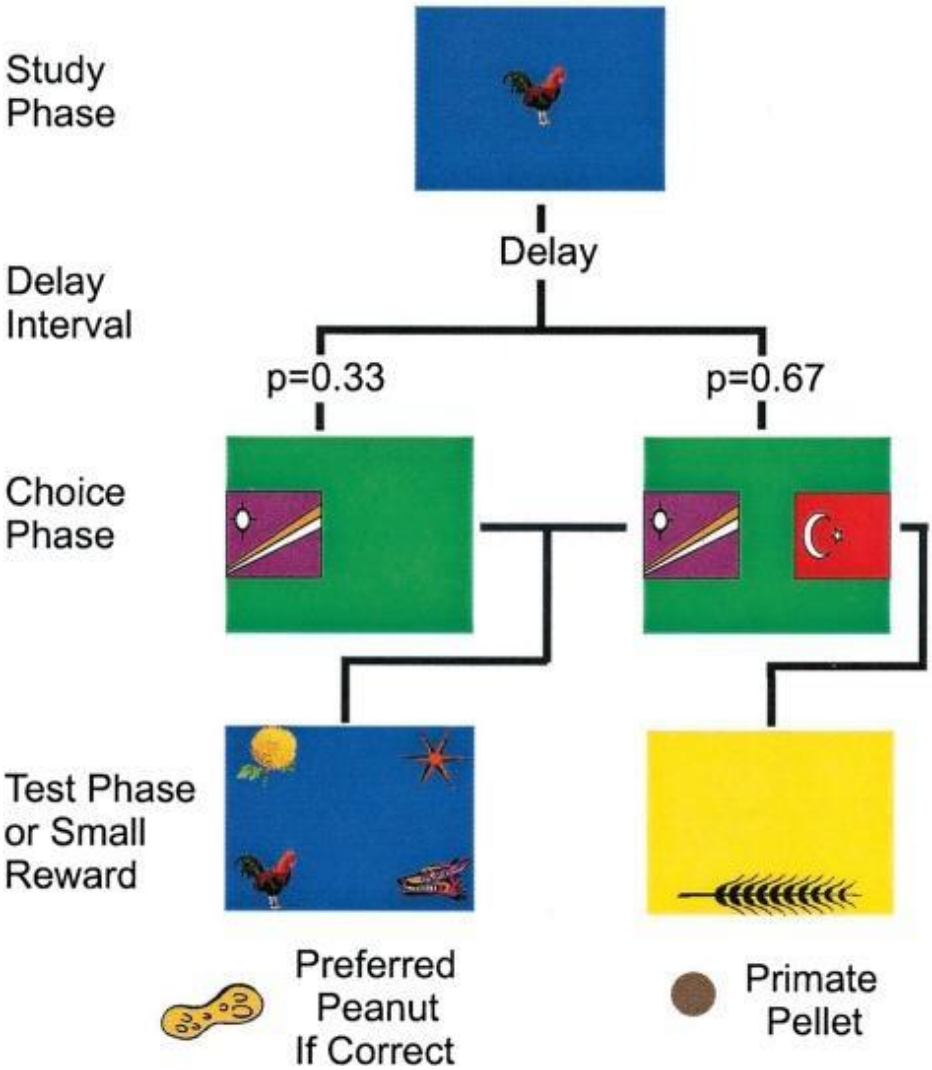


Figure 7. Hampton test on Rhesus monkeys to explain meta-representation.

This is closely associated with perceptual memory which means that when memories dissipate over time, the probability of touching the escape flag increases. There was a little caveat to the experiment. The longer the delay, the lesser the reward for the monkey even if the monkey chose the test flags. However, hitting the escape flag meant shorter delay time and faster reward. That means the monkey must have made this association therefore, touching the escape flag with increased frequency.

Conclusion

The aim of this paper was to; look at the definition of consciousness to see if there was a universally accepted one, check why consciousness is a difficult problem in science, look at human consciousness to see what parts of the brain generate consciousness and if so check for similarities in structure and function in animals and try to answer the most important question of if animals are conscious. Based on the views and studies observed, and based on the Francis Crick memorial declaration, I am led to believe and can speculate that animals do have consciousness. The Cambridge declaration posits that since there are similarities in structure and function between human and animal brains, this can be used as evidence for animal consciousness. If there are substrates in animals as seen in humans, it is only logical to say that animals are conscious. Although, it is important to note that this is not a proven theory and is a speculation because consciousness is a subjective experience, and this still makes it an unsolved problem.

WORK CITED

About - The Basic Theory of the Mind: The Physical Theory of the Mind. (n.d.). The Basic Theory of the Mind. Retrieved January 25, 2020, from https://mindtheory.net/

Allen, C., & Trestman, M. (2017). Animal Consciousness. In E. N. Zalta (Ed.), *The Stanford Encyclopedia of Philosophy* (Winter 2017). Metaphysics Research Lab, Stanford University. https://plato.stanford.edu/archives/win2017/entries/consciousness-animal/

What Is Consciousness. (n.d.). Retrieved April 1, 2020, from https://www.markbancroft.com/info/what-is-consciousness

BEKOFF, M. (n.d.). *Animals are conscious and should be treated as such*. New Scientist. Retrieved February 17, 2020, from https://www.newscientist.com/article/mg21528836-200-animals-are-conscious-and-should-be-treated-as-such/

Boly, M., Seth, A. K., Wilke, M., Ingmundson, P., Baars, B., Laureys, S., Edelman, D., & Tsuchiya, N. (2013). Consciousness in humans and non-human animals: Recent advances and future directions. *Frontiers in Psychology*, *4*. https://doi.org/10.3389/fpsyg.2013.00625

Chalmers, D. J. (1995, March 1). *Facing up to the problem of consciousness* [Text]. Imprint Academic. https://www.ingentaconnect.com/content/imp/jcs/1995/00000002/00000003/653

Consciousness in Other Animals. (n.d.). Psychology Today. Retrieved February 16, 2020, from https://www.psychologytoday.com/blog/theory-consciousness/201704/consciousness-in-other-animals

Consciousness: The last 50 years (and the next)—Anil K. Seth, 2018. Retrieved January 15, 2020, from https://journals.sagepub.com/doi/full/10.1177/2398212818816019

Darwin, C. 1889. *The descent of man, and selection in relation to sex. 2nd ed. appleton, New York.*

Dennett, D. C. (2018). Facing up to the hard question of consciousness. *Philosophical Transactions of the Royal Society B: Biological Sciences*, *373*(1755). https://doi.org/10.1098/rstb.2017.0342

Edelman, D. B., & Seth, A. K. (2009). Animal consciousness: A synthetic approach. *Trends in Neurosciences*, *32*(9), 476–484. https://doi.org/10.1016/j.tins.2009.05.008

Greenwood, V. (2017, November 9). *Consciousness Began When the Gods Stopped Speaking*. Nautilus. http://nautil.us/issue/54/the-unspoken/consciousness-began-when-the-gods-stopped-speaking-rp

Hatfield, G. (2018). René Descartes. In E. N. Zalta (Ed.), *The Stanford Encyclopedia of Philosophy* (Summer 2018). Metaphysics Research Lab, Stanford University. https://plato.stanford.edu/archives/sum2018/entries/descartes/

Koch, C. (n.d.). *What Is Consciousness?* Scientific American. https://doi.org/10.1038/scientificamerican0618-60

Kotchoubey, B. (2018). Human Consciousness: Where Is It From and What Is It for. *Frontiers in Psychology*, *9*. https://doi.org/10.3389/fpsyg.2018.00567

Rees, G., Kreiman, G., & Koch, C. (2002). Neural correlates of consciousness in humans. *Nature Reviews Neuroscience*, *3*(4), 261–270. https://doi.org/10.1038/nrn783

Robinson, H. (2017). Dualism. In E. N. Zalta (Ed.), *The Stanford Encyclopedia of Philosophy* (Fall 2017). Metaphysics Research Lab, Stanford University. https://plato.stanford.edu/archives/fall2017/entries/dualism/

Ruediger, W. C. (1924). Monism and Consciousness. *The Journal of Philosophy*, *21*(13), 347–352. JSTOR. https://doi.org/10.2307/2014848

Shea, N., & Heyes, C. (2010). Metamemory as evidence of animal consciousness: The type that does the trick. *Biology & Philosophy*, *25*(1), 95–110. https://doi.org/10.1007/s10539-009-9171-0

Sober, E. 1998. Morgan's cannon. In D. D. Cummins and C. Allen (eds.), *The evolution of mind*, pp. 224-242. Oxford University Press, New York.

Vithoulkas, G., & Muresanu, D. (2014). Conscience and Consciousness: A definition. *Journal of Medicine and Life*, *7*(1), 104–108.

What Is Consciousness. (n.d.). Retrieved April 1, 2020, from https://www.markbancroft.com/info/what-is-consciousness

Wu, W. (2018). The Neuroscience of Consciousness. In E. N. Zalta (Ed.), *The Stanford Encyclopedia of Philosophy*(Winter 2018). Metaphysics Research Lab, Stanford University. https://plato.stanford.edu/archives/win2018/entries/consciousness-neuroscience/