PLANT MIND THROUGH AMALGAMATED FUNCTIONALISM AND ITS IMPACT ON THE DEFINITION OF MIND

A Master's Thesis

by

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Ankara

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To My Parents and Sister and Mila

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ABSTRACT

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The definition of the mind seems to be a vague and unstable one in the philosophy of mind. This thesis aims to find some solid features through which we could define the mind or chose to remove from its definition with the aid of the analyses of plants, a species quite unlike human beings, and the cognitive capabilities they seemed to possess. After evading the recent objections against multiple realization theory, which is a theory placed at the core of functionalism, and reconciling the embodied and extended mind theses with it, functionalism (or as it is indicated in the thesis; amalgamated functionalism) has taken as the leading theory of mind. The plant mind is investigated in the light of this amalgamated functionalism. The thesis presents the familiar cognitive capabilities plants have and makes a suggestion on which features we definitely should or should not include in the general definition of the mind. In the end, a decision has been made on whether plants are beings endowed with the faculty of the mind.

Keywords: Functionalism, Plant Mind, Plant Cognition, Multiple Realizability, Mind

ÖZET

BİRLEŞTİRİLMİŞ İŞLEVSELCİLİK ÜZERİNDEN BİTKİ ZİHNİ VE BUNUN ZİHİN TANIMINA ETKİSİ

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Zihin tanımı, zihin felsefesinde, belirsiz ve tutarsızdır. Bu tez, insanlara hiç benzemeyen bir tür olan bitkiler ve bunların sahipmiş gibi göründükleri bilişsel kabiliyetlerin analizlerinden alınan yardım ile zihni tanımlayabileceğimiz ya da tanımından çıkarılmasını seçeceğimiz bazı sağlam özellikler bulmayı amaçlamaktadır. İşlevselliğin temelinde bulunan çoklu gerçekleştirilebilirlik teorisine gelen yakın zamanlı eleştiriler savuşturulduktan ve bedenlenmiş ve genişletilmiş zihin tezleri ile uzlaştırıldıktan sonra öncül zihin teorisi olarak işlevsellik (ya da tezin belirttiği gibi; birleştirilmiş işlevsellik) seçilmiştir. Bitki zihni bu birleştirilmiş işlevsellik ışığında incelenmiştir. Tez, bitkilerin sahip olduğu tanıdık bilişsel kabiliyetleri sunmuş ve hangi özelliklerin genel zihin tanımına kesinlikle dâhil edilmesi ya da edilmemesi üzerine bir öneride bulunmuştur. Sonunda, bitkilerin zihin melekesine sahip varlıklar olup olmadıkları üzerine bir karara varılmıştır.

Anahtar Kelimeler: İşlevsellik, Bitki Zihni, Bitki Bilişselliği, Çoklu Gerçekleştirilebilirlik, Zihin

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INTRODUCTION

The mind is a faculty that we, as humans, confidently claimed as having. We are also attributing this faculty to some animals, but what about plants – do plants have a mind?

Up until now philosophers sought an answer to the issue of what a mind actually is, and frankly they have often approached this question in an anthropomorphizing way (maybe necessarily), even though it is not required for a being with a mind to resemble humans in any way. They tend to eliminate beings as non-cognizers since their structures do not compare with humans. Anthropomorphizing is something that gets us away from the objective truth in that sense, and something that we should try to avoid. With plants, the probability of anthropomorphizing will decrease significantly since they don't resemble humans, and we will be forced to think outside of humanistic terms. This fact alone may play a significant role in approaching the objective truth about the mind. To see whether the adopted definition of mind would still hold, philosophers gave examples from aliens and zombies as a testing criterion in the past. My suggestion is why go this far while we have already an alien form of a possible mind bearer in this world that we could conduct experiments upon? My aim in this thesis is to look face up to this fundamental question of what mind actually might be via investigating the plant mind.

To do so, in Chapter 1, I will present functionalism as the leading theory of mind and will secure its place against the recent attacks on multiple realization – a thesis placed at the heart of functionalism.

In Chapter 2, I will introduce the recent theories of the philosophy of mind, which known as the embodied cognition. After this, I will combine functionalism with embodied cognition under the name of amalgamated functionalism.

In Chapter 3, I will investigate which beings should be called as cognizers according to the criteria of cognition supported by amalgamated functionalism. Since even the

artificial, brainless things could be labeled as cognizers, I will introduce a way to solve this renewed cognitive bloat problem.

In Chapter 4, with the help of the chapters beforehand, I will investigate whether plants have cognition as well. From there I will try to reach a conclusion what plant cognition, if there is one, could tell us about our common understanding of the mind.

CHAPTER 1

FUNCTIONALISM AND MULTIPLE REALIZATION

Before I get to a version of amalgamated mind[1] functionalism (amalgamated functionalism, hereafter), I would like to take a brief look at the theories that lead to functionalism. I will then proceed to introduce functionalism. Before ending this chapter, I will look into the most recent objections raised by Shapiro against multiple realization, which is the thesis placed at the core of functionalism and why functionalism is an appealing theory of mind in the first place. I will attempt to defend multiple realization, and indirectly functionalism, by showing that Shapiro's objections against multiple realization are invalid.

1.1. Historical Framework

How to define mental states has been a prominent question in the philosophy of mind. Dualists claim that the mind is an immaterial substance that is independent of the brain and body. In that sense, an organism with a mind, which is the thinking thing (Descartes, 2008), will continue to live on even if its body has perished. Because the thinking thing is an immaterial substance that does not allow the conduction of any physical tests, this view is not supportable by empirical evidence and since empirical evidence is required to count as a solid theory in science, dualism is eliminated as a solid theory of mind. Based on the mentioned importance of

[1] I borrowed this term from Rowlands, 2010.

empirical evidence, I shall focus on the physicalist theories of mind that came after dualism[2].

If the existence of one's mind could only be known through introspection then the knowledge of others' minds would be immune to any experimentations. Thus, the knowledge of other minds will be impossible to know with certainty. Coming after dualism, behaviorism aimed to find a solution to this bizarre consequence. Although there are different types of behaviorism, at the core of all, is the idea that exhibiting behaviors is constitutive of having a mind (Watson 1913; Skinner 1957). What pain is should be explained by the observable pain behaviors. Since pain is to exhibit or having dispositions to exhibit pain behaviors, there is neither the mind-body problem nor the other-minds problem.

Since many mental states have subjective feelings and it is possible to pretend in pain when not or pretend not in pain when in pain (Putnam, 1963), behaviorism is refutable. However, the most powerful objection that caused behaviorism to collapse is the fact that mental states do not act in isolation. This objection is based on a circularity problem that has 'belief' and 'desire' behaviors at its core. The behavior of taking an umbrella with me when it is raining outside is the showcase of my belief that it is raining outside, according to behaviorism. However, this behavior will only be executed if I have the desire to stay dry. So I believe it is raining and have a desire to stay dry is why I behave the way I did. In that case, there is a disjunction of mental states underlying my behaviors. From the fact that I cannot explain my mental states without the assistance of others, it follows that behaviorism is an inadequate thesis for explaining what mental states are.

The succeeding theory of mind coming after behaviorism is known as psychophysicalism or identity theory. According to this theory, mental states are brain states (Place 1956; Feigl 1958; Smart 1959). In humans, for example, the activation of C-fibers (C-fibers in a very simplified form) is identical to pain states. Two odd consequences follow from this thesis are, (1) if the C-fiber is not present

[2] Behaviorism and identity theory is known to be physicalist theories. Functionalism, on the other hand, need not be a physicalist, but similarly, it need not be dualistic either. For the reasons mentioned in this chapter, I will focus on the pro-physicalist side of functionalism.

then it is not possible to be in pain, and (2) to be in pain a creature must have C-fibers in its system.

Criticisms against the first conclusion came from Chalmers' philosophical zombies and Jackson's Mary's room arguments[3]. Both thought experiments aim to show that there is more to the physical constitution and physical knowledge when it comes to human mind. Our experiences have a qualitative feeling to them. Anyone who is willing to support identity theory should find a way to overcome Chalmers' and Jackson's objections first.

The second conclusion of the identity theory, which states that to have mental states, e.g. pain, an organism should have the corresponding physical state, e.g. C-fibers, has been criticized alongside the first one. It is perfectly possible for creatures that don't have C-fibers to feel pain. Many creatures in this world have different constitutions than humans. These different constitutions mean they have different physical states than humans do and many of them don't possess C-fibers. This lack of C-fibers in their system should not mean, however, that they are not able to feel pain since it seems clear that they do. Then, certain physical states are not identical with mental states. This ability to have mental states regardless of physical build-up is known as multiple realization (MR, hereafter) which is placed at the core of functionalism and is the argument that was raised against identity theory.

1.2. Functionalism

Coming after identity theory, functionalism is a theory that is still quite popular today. The theory is proposed as a solution against the liberalism of behaviorism (assigning mentality to beings that don't have mental states) and chauvinism of identity theory (denying mentality to beings that do have mental states). I, as a human being, could feel pain with my C-fibers, a dog, as an animal, could feel pain, let's say, with its D-fibers, and Ricky the Android could feel pain with its silicon-chips, and so on. In that case, we need to define pain, or any other mental states, in such a way that the definition of it will encapsulate all of those instances.

[3] See Chalmers, 1996 and Jackson, 1982).

Functionalism tries to do exactly that. For instances, an engine is defined through its ability to transform forms of energy into mechanical force or motion, rather than its physical structure. It is defined through its job description, and anything that is capable of performing this job description will count as an engine (Kim, 2011: 131). Functionalism claims that mental states should be defined by their job descriptions as well. In that sense, what makes a mental state the state that it is, is its capacity to perform some specific job description.

For example, what is the function, the job description, of pain? Pain plays a crucial role in the survival and adaptation of an organism. It wouldn't be possible for anything/one to survive if there is no mechanism to let them know there is something wrong within their body. Pain then is the 'tissue-damage detector'. Activation of this detector will cause some outputs relative to the organism's other mental states, such as being alert and not unconscious when they receive the pain input. As it seems, outputs regarding inputs play an important role in the definition of mental states and for this reason, functionalism is regarded as a continuation of behaviorism. Yet unlike behaviorism, functionalism includes the existence of other mental states in its definition and for this reason, it avoids the problems behaviorism couldn't. Yet, there still is a circularity problem with functionalism since to understand one mental state I need to know the meaning of another mental state. For example, think about my belief in "it's raining outside". The function of this belief is to take an umbrella with me if I have the desire to stay dry. Then to understand this sentence fully I also need to know the meaning of the "desire to stay dry". While giving the definition of a mental state, I'm using other mental states in my definition while in a definition, the defined term shouldn't be used. That's what the circularity problem is. Functionalism embraces this circularity by defining them either through the Turing machines or through Ramsey-Lewis sentences.

According to the Turing-machine type definition of mental states, systems that follow a certain machine table instructions that determine certain inputs-outputs specifications, according to other mental states, are realizing the same mental states. A Turing machine has four components (ibid: 139);

(1) A infinitely long tape divided into squares

(2) A scanner-printer (head) that reads one of the squares at a given time
(3) A finite set of internal (machine) states (q0…qn)
(4) A finite set of symbols to be written in per cell (b1…bm)

Depending on which symbol is being scanned, the machine goes into a certain machine table state, and according to the instructions given by this machine state; the machine produced a new symbol. This working style could be likened to how mental states work. For example, let's say that pain's machine table instructions are when one receives the input of their hand is pin prickled, they will go into another machine table state, e.g. the desire to be rid of the pain, according to the other machine table state they already have, e.g. being alert, and as a result, they will produce an output e.g. removing their hand from the source of distress. Then any mechanism that could realize these machine table instructions is able to feel pain. So far as a mechanism can perform the causal work assigned by the machine table, that mechanism is a physical realizer of that Turing machine regardless of its intrinsic physical nature. The Turing-machine version of functionalism claims that minds work like a computing machine is known as computationalism[4].

There is another way to avoid circularity problem other than defining mental states through Turing machine table. This second way of defining mental states is done by Ramsey-Lewis sentences, which is to define mental states through their causal roles. Causal-theoretical functionalism, as it is known, claims that there is a causal relationship between the inputs and outputs of the system that are mediated by mental states.

Let's say that I see a plate of pasta in front of me, then under normal circumstances, if I'm hungry, I will eat the pasta. At first glance, the perception of seeing the pasta, with the state of being hungry, causes me to eat may seem very simple. Yet, there are many conditions present in such a case. In addition to my perception of the plate full of food and being hungry, I should also know pasta is edible, I should like pasta, I should have a belief that the substance in the plate is pasta, etc. All those other

[4] Even though there is some controversy around whether the computer-like-human-mind idea emerged from the Turing model machines or John von Neumann model machines (Barrett 2011, 121) the difference hasn't been recognized when defining the Turing-machine version of functionalism.

mental states together cause me to eat pasta when I'm hungry at the time. To avoid using other mental states in my definition of what a mental state is, I need to restate my definition with Ramsey-Lewis sentence.

What has been done in a Ramsey-Lewis sentence is to existentially generalize over all the mental state terms and replace them with variables (Lewis, 1970). By doing so, the sentence that gives the definition of a mental state becomes topic-neutral. The mental state in question is defined solely by its inputs, outputs, and other certain states. In the definition of a mental state then there won't be other mental state terms present, hence there is no circularity.

1.3 Multiple Realization

In above, I try to give a brief introduction to functionalism and its methods to sidestep the circularity problem, but this is not the only problem that functionalism got to deal with. In this section, I will review the recent objection raised against functionalism by Shapiro, through the attack on MR.

Common to all types of functionalism, so long as a mental state plays a certain causal role in a system, that system could realize the given mental state. Multiple realization means regardless of what beings have been made of (like silicon, neurons, wood, etc.) or regardless of their constitutions, if they could fulfill a certain causal role in a system, they will realize a certain mental state. However, is MR really that ground-breaking or did we exaggerate its significance? I aim to restore the significance of MR against Shapiro's objections. Overall, at the end of the day, without MR, functionalism will lose some great part of its appeal.

According to Shapiro, there are two things that the proponents of MR should address (Shapiro, 2004: 46);

(1) Why the realizations X and Y (e.g. analog watch and digital watch) should count as the realizations of the same thing?

(2) What are the differences between X and Y that make them different types of realizations of the same functional kind?

A functionalist would answer in the following way:

(1*) An analog watch and a digital watch are both doing the job description of a watch, that is, they are both doing what makes something a watch.

(2*) The constitutions of an analog watch and a digital watch are different from each other. Still, they are both able to play the causal role described by a watch. This is what makes them different realizations of the same functional kind.

Shapiro agrees with the way a functionalist would have answered the first question. Being a functional kind is to have a certain defining capacity, and both watches realizing the same defining capacity. However, there will be some problems on how to determine whether they are actually different realizers of the same functional kind. Based on this, Shapiro has two problems with MR; the vagueness problem and the problem of different realizers (as I named them).

1.3.1 Vagueness Problem

According to the vagueness problem, the more one gives a fine-grained description of the capacities of a realizer, the more one tends to distinguish between different types of realizers. And this will make MR gain unfair evidence in favor of itself.

If one were to define the function of a corkscrew broadly, such as “pulling the cork” instead of “cork removal”, then waiter’s corkscrew, double-lever corkscrew, and a mechanism with two prongs that slid in on either side of the cork would all be counted as realizing the same function. Yet, they all would be differ from a cork removing mechanism that does not “pull the cork” but “push the cork from below”. According to this then how one defines the capacities of both the realizers and the functional kinds will affect how many realizers and functional kinds out there, and this would make MR appear as a real thing.

This objection of Shapiro seems unsatisfying and even invalid. The reason is there seem to be two different sorts of function – the permanent and temporary function of a being, and not all realizers have only one function that they realize.

A permanent function is whatever reason a mechanism has been made for (or chosen in the case of evolution for organic beings) while a temporary function is something that the realizer accidentally fulfills temporarily. We live in dynamic environments where things are required to be used according to our needs. A corkscrew's permanent function is to remove the cork, but if I'm in a situation in which my house is broken down, and I need to knock down the intruders then it might be used as a weapon which would be the temporary function of the corkscrew. Types of realizers have some capacities that needed to be defined under some functional kind. In MR, it seems we are talking about the permanent functions, but sometimes, temporal functions might be mixed up into the mix and cause confusion. There might be more than one mechanisms that realize the same functional kind and there might be more than one function a device might realize, but the differences in the capacities of different realizers that realize one function is not an objection to MR since that is the very reason why MR exists.

1.3.2 The Problem of Different Realizers

After the vagueness problem, Shapiro moves on with the second thing that proponents of MR should address which is what makes two different realizations of the same functional kind different. In his example, Shapiro says, even the two waiter's corkscrews that were produced to be the same in the same factory side by side would not be exactly identical with each other (ibid: 49). When looked up at a microscopic level they would differ in atom counts, masses, etc. Yet, these differences clearly aren't enough to make them different. These two waiter's corkscrews are still the tokens of the same type. Similarly, a waiter's corkscrew and a double-lever one might seem different at first, but they might, and probably do, share some properties. They might be made of the same material, be in the same color, have the same mass, etc. But, since those properties are not sufficient enough to make two things different, they aren't enough to make them the same either. What makes them different should be the fact that they operate differently, and since they operate differently, different laws govern their operations.

Shapiro claims this answer is arbitrary. The function of both waiter's and double-lever corkscrews is to remove the corks by causing the corks to rise then we could say rising the cork is the most proximate cause in the causal chain that results in the removal of the cork. If they were to share the most proximate cause, and their operations are governed by the same laws, then are we still going to say that they are different because of the difference in their material, color, or the like? If that is the case then a blue, aluminum waiter's corkscrew would be more similar to a blue, aluminum double-lever corkscrew than a red, metal waiter's corkscrew. Again, those properties aren't enough to make two things the same or different. Then it should be expected that one would face some difficulties while trying to differentiate between different realizers of the same functional kind.

The similarity and difference judgments of realizers should be relativized to the properties that make a difference to how a functional kind functions, that is how it brings about the defined capacity that it was defined with (ibid: 52). Those properties are known as R-properties and they could be found through functional analyses. The functional analyses of an R-property should provide us with what makes a causal contribution to the relevant functional capacity. The change of R-properties will cause the realizers to be different in type. In the case of corkscrew, for example, the R-property should be something that causally contributes to the cork removal.

Properties like color, mass, material, and the like are properties that do not have any causal power to remove the cork in the case of the corkscrew. That is why they are not R-properties and why even if two waiter's corkscrews differ in those properties are not different in type. These two corkscrews share the same R-property, having a sharp screw, that makes a causal contribution while removing the cork and since they have this property in common they are the same. A waiter's corkscrew, on the other hand, different from a double-lever one since the mechanism it embodies that work to remove corks is different.

The point in introducing R-properties is to make a distinction between significant and trivial cases of MR. Differences that do not make a causal contribution to the functional end, such as constitutive material, color, etc. aren't making a significant difference, and hence the examples taking such differences as evidence for the existence of MR don't state anything significant.

1.3.3 Multiple Realization of Mind

If that is the case then think about the MR claims of the mind. Imagine someone replaces a neuron in my brain with a silicon-chip. This chip continues to do the job of a neuron it has replaced and everything continues undisturbed. Next, all the neurons in my brain are replaced with silicon-chips that are doing the exact same job of what my neurons were doing before the replacement. Such a case would surely show us the MR of the mind (Pylshyn 1980, as cited in Shapiro 2004). What makes this silicon-chip brain to be a different realizer of the mind than neurons? Material composition is not sufficient to claim the difference between realizers since they are not the R-properties. Shapiro invites us to suppose that both the neuron's and silicon-chip's R-property is their electrical property since it plays a causal role to achieve the function of realizing the mind. In that case, the difference between a neural and a silicon-chip mind would be a trivial one since they are sharing the R-property. If that is the case then there is no reason for one to differentiate these two realizations as different since the difference between them is trivial. This conclusion should make one question the MR thesis of mind. It seems the MR thesis is not that groundbreaking.

1.4 Defense for Multiple Realization

While I agree with Shapiro on his functional analyses to find R-properties, to determine whether the realizers in question are genuinely different or not, there are some problems with his claims, especially with the one that claims minds are seemingly not multiply realizable. In his examples of corkscrews, he realizes that they embodied different mechanisms to remove a cork from its place and therefore, they are different from each other since they operate differently to fulfill the same function.

Similarly, in the case of MR of minds, there are different ways to conduct electricity that needs to go through different processes. On the one hand, you have a silicon, which is an insulator in need of doping, N-type or P-type, to become enable to

conduct electricity. After that, one needs to build one chip with multiple transistors, resistors, pins and wires[5]. This square mechanism then become a conductor of electricity. On the other hand, you have an organic neuron, with an end that resembles tree branches, that pumps positively charged sodium ions out while pumping positively charged potassium ions in to conduct electricity ("How do neurons work?". 2011). Electricity conduction might be the R-property for both but how this R-property came out to be is different in both cases - that is the mechanisms operate differently to achieve a functional end (i.e. realizing a mind). Due to this fact, neurons and silicon chips are different realizers of mind. It seems even R-properties themselves are multiply realizable.

Still, let's assume that a neuron and a silicon chip goes through the exact same processes while conducting electricity. They still wouldn't realize a mind the same since it is not what makes a neuron or a silicon chip to realize a mind. To talk about the realization of a mind, we need to refer to the relationship of the neurons/silicon chips have with each other and with the system as a whole. No neuron, or a silicon chip, by themselves, could realize a mind since if that is the case a healthy human with her hundred billion neuron would have a hundred billion mind. Likewise, any silicon chip would be able to realize a mind. So, what makes something the realizer of a mind is the relationship these vital elements have with each other and with the system. The realization of a mind is the function of the relationship between neurons and neurons with the system. Neurons are connected to each other and transmits information between each other all the time while artificial layers work one by one and not as a part of a network (Nagyfi, 2008). For example, neurons form new connections between each other when someone learns something while in an artificial setting, what one knows is pre-defined and no additional neurons could be added or removed (ibid). When examined like that, this alone should be enough to show neurons and silicon chips don't realize the mind in the same way.

One last response against Shapiro's attack on MR is the following. He claims that a silicon-chip *brain* when it's replaced piece by piece with a neural one would realize the *mind*, the same way the neural *brain* does. This claim assumes identity-theory. Is realizing a brain really the same as realizing a mind? What the example tells us, the

[5] https://www.youtube.com/watch?v=VNzkhZBjo5k&t=206s

silicon-chip brain is the realization of a human brain, not the mind. In order to claim that realizing the brain is realizing the mind, one has to prove brains are identical with minds, and such identification is yet to be proven. Even if the human brains could be realized in one specific way it doesn't make a case against MR of mind since the realization of the brain doesn't necessarily make a case against MR of mind.

In this section, I gave a brief account of the theories that lead to functionalism. After that, I introduced functionalism itself. In the heart of functionalism is the MR thesis. But this thesis receives valid objections from Shapiro in the recent years. Without MR being secure, functionalism is not as appealing as it has been first introduced. In that sense, its safety is necessary. In the last sections, I attempt to secure MR against those objections. In the next chapter, I will investigate new approaches to the mind and combine them with functionalism.

CHAPTER 2

AMALGAMATED FUNCTIONALISM

To exist in the world things need to get embodied. There are two different interpretations of the embodiment when it comes to the embodiment of the mind, body as contributive and body as constitutive of the mind. The fundamental feature that divides these two interpretations is their answers to the question of whether cognition is isolated in the brain or it is just a participant in the act of cognition. While the first one rejects the possibility of cognition takes place outside of the brain, the second one accepts such possibility. Since no physicalist theory of mind would deny the contribution of body to cognition in some sort of way, to say something new and significant embodied cognition should show body is constitutive to cognition[6].

The embodied cognition thesis has four main approaches that are surprisingly not very compatible with each other. In this section, I will investigate these approaches and try to combine them in a harmonious way with the help of Rowlands. However, before that, I shall make clear how cognitive theories could help us understand the mind.

Embodied cognition is a thesis mostly about explaining how one's cognitive processes work, then what is the relationship between cognition and the mind? Cognition means information processing and for it to take place, we first need mental

[6] If one is going to take the claims of embodiment seriously then those claims *need* to say something different from the contribution theories of body to the mind (Clark 2008).

processes to supply the said information. Therefore, through the examination of cognition we might learn more about our mental states and the nature of our minds.

2.1 Four Approaches of the Embodied Cognition

Embodied cognition has four leading approaches to embodiment; embodied, extended, enacted, and embedded mind. Each of these views claims to take body and environment as constitutive to cognition in some sort of way. In this chapter, I will, first investigate whether these approaches in embodied cognition are true to their claims (i.e. embodiment constitutive to the mind), and second evaluate these approaches relations to functionalism.

Mind is embodied if the body has an irreplaceable role in cognition, and that the cognition, as it takes place within the brain, would be incomplete without the contributions of the body. The definition of the body includes anatomy, structure, and composition. A human body will affect the way one comes to perceive her world. For example, humans are beings with two eyes positioned at relative distances from each other on each side of their faces. Any difference in the number of the eyes or the distance between them would affect the way how one's brain computes the distance from parity (Shapiro, 2004). Likewise, humans are beings with two ears at each side of their head. Thanks to the distance between the ears, sound reaches faster to the ear that is positioned toward the source of the sound, and the brain uses this to determine where the sound is coming from (Rowlands, 2010).

The way our body is built also help determining the concepts about the world. Since we need concepts as we construct the mental images of the world, and since our bodies constitute these concepts, bodies play a constitutive role in cognition. Concepts like up-down, front-back, in-out, etc. are all seemed to be body-based. For example, the human body has a front and a back while a tree does not (Lackoff & Johnson, 1981). Bodies affect the content one gets, and accordingly it affects one's mental states that used in cognition. If we were to meet with an alien who overall has a human body with the only difference of the positioning of his eyes, they are placed on his knees, then the concepts we associate with 'crawling' would be dramatically different since for the alien it would be associated with torture (Shapiro, 2004: 195).

Furthermore, the hormonal and chemical changes within the body will have a considerable effect on one's mind so much so that disturbances in the body chemistry will alter one's perception, decision making, and so on (Gallagher, 2011). The neural patterns for survival get maintained through the curves of the brain stem and hypothalamus, the latter of which is regulated by both the neural signals from other brain regions and the various chemical signals received from the body (Damasio, 1994: 124). For instance, when one has a mental illness, the changes in hormones and body chemicals will affect the patient's decision-making processes[7].

If these claims are correct then the embodied mind is true. The gist of this claim is not only that body is important to cognition. The thesis literally claims that the body is constitutive of cognition. This claim seems true as the examples given above indicate. Yet the validity of this claim would cause some problems for functionalism, as it will lead to the conclusion of the mental constraint thesis, a thesis that claims the properties of the mind will tell many features of its realizer. In that sense, a humanlike mind couldn't be realized in a nonhuman body (Shapiro, 2004). Although the mental constraint thesis is not completely against functionalism, it could only support a chauvinistic version of functionalism (ibid: 174; Rowlands, 2010: 103). However, since one of the appealing side of functionalism is its claim to undermine the chauvinistic side of the identity theory through the MR thesis, accepting a chauvinistic version would devaluate functionalism. I will return to this issue and attempt to show that embodied mind is actually encouraging functionalism, let alone undermining it, thanks to MR.

Mind is extended if cognitive states are extended beyond the scope of the skull - based on the parity principle. According to the parity principle, Clark and Chalmers (C&C) claim that any activity that would have been regarded as cognitive inside the skull should count as cognitive if they were to happen outside of the skull (Clark & Chalmers 1998, 8). C&C introduces the extended mind thesis through their infamous example of Otto's notebook. One day Inga hears that there is an exhibition in the Museum of Modern Art (MoMA), which is on 53rd Street. She remembers where the

[7] The reader is invited to think whether hormonal changes are contingent to one's embodiment and cognition. Even if one comes up with the judgement that they are indeed contingent, since there are other features that bodies affect the cognition (anatomy, and structure) embodiment still seem to have an essential feature in cognition.

museum is and heads out there to see the exhibition. Inga has the belief that the MoMA is on 53rd street before she recalls her memory that contains the address of the museum. Similarly, Otto also hears about the exhibition, yet unlike Inga, Otto is an Alzheimer's patient; he forgot the whereabouts of MoMA. Fortunately, he has a notebook that he has written down his memories and is accessible to him at all times. He checks his notebook to see where MoMA is; he sets off his way. According to C&C, Otto, like Inga, has the belief that the MoMA is on 53rd street before he checks the address from his notebook. The information in the notebook has the same status as Inga's memory; it is a belief state. It is a case where the cognitive act happening outside of the skull.

This claim at first seems odd and even implausible, and unsurprisingly gets many criticisms[8]. Among the most prominent objections against this thesis are (1) how could we claim that inanimate objects have mental states and (2) the problem of cognitive bloat (where to draw the boundaries of cognition). Both of these questions could be solved through some revision, provided by Miyazono and Rowlands, separately to my knowledge. According to them, what we have in the notebook is not a mental state by itself, but the notebook plays a role in the cognitive process of remembering. The cognitive process, in this case, is a system coupled with the environment –the information on the notebook- and brain (Rowlands, 2010: 93; Miyazono, 2015: 3). Otto's notebook isn't a mental state but it is constitutive of a mental process. Extended mind thesis shouldn't identify cognitive states with inanimate objects (Rowlands, 2010: 67). Granted that environmental structures aren't identical with cognitive states, there is no cognitive bloat issue. Mind is extended because the cognitive process in Otto's case is composed of the manipulation of environmental structures alongside neural processes. Mind is extended when environmental objects play an active role in cognition.

Mind is enacted if experiencing something is the same as moving through the environment. Suppose that there is a cube in front of you. To experience this cube based on how it looks, you need to move around the cube and observe how it changes according to your movements, i.e. according to your sensorimotor

[8] See Adams and Aizawa, 2001; Rupert, 2004

contingencies[9] (Noe, 2004). Many of our experiences about objects are constituted by anticipations. A blind person holding a bottle will anticipate his hold to get tighter around the bottle as he moves his hand upwards, toward the neck of the bottle (Mackay, 1967). Becoming more accurate on his assumptions on what to expect would mean he mastered that sensorimotor contingency. Cognition of this sort is known as enacted mind, and there is an issue with this thesis. The only reason why I move within my environment is not always to manipulate my surroundings. Walking around a corner provides me with information, but not all information is cognitive activity (Rowlands, 2010: 213), and not all movements are for cognition. For walking around a corner to become a cognitive activity, I need to exercise my ability to move about the world. However, this is to say that environmental structures contribute to my cognitive processes, which is the claim of the extended mind. Putting it like that enacted mind will collapse into the extended mind since for the mind to be enacted I need to actively use my ability of exploration which would couple my neural activities with the object I'm trying to experience (ibid). My cognitive activities, in that sense, are constituted by my exploration and manipulation of the environment, which is what the extended mind thesis claims.

Mind is embedded if one's cognitive processes depend on the environment one is in within her body. However, this claim is a less radical claim of embodied and extended mind thesis. Organisms exist in an environment within their bodies, and their cognitive processes will naturally depend on these broader bodily structures (ibid, 68). This sort of view seems to be a given, even for the most traditionalist view of the mind. Furthermore, dependence is not the same as constitution, meaning that cognitive processes aren't coupled with these structures when processing cognitively. "Frost is something that happens to photosynthesis, rather than something that happens with photosynthesis" (Shapiro, 2019: 18). Environmental features are like frost to photosynthesis while they have to be the sun for embedded mind thesis to say something significant about the mind. Cognition in the embedded sense might continue to process as always, without the inclusion of embodied features. It might be in a more complicated way, but it would still work. Since it fails to satisfy the

[9] Sensorimotor contingencies: Vision is relevant to the observer or some other object's movements relative to the object of observation.

constitutive interpretation of cognition, there is no need for mentioning embedded mind specifically.

Those brief introductions given above are the respective definitions of embodied, extended, enacted, and embedded mind. It seems that enacted is a version of the extended mind thesis while the embedded mind is a given in almost all theories of the mind which render it insignificant. In that sense, we are left with the embodied and extended mind, or amalgamated mind as Rowlands calls it. To show how these two theses integrate with functionalism, I first need to turn back to the embodied mind since it has some specific problems with functionalism that the extended mind hasn't and propose a solution that could overcome these problems.

2.2 Embodied Mind and Affordances

Since embodiment plays an irrevocable role in cognition, certain body types should entail certain types of cognition. For instance, to recognize a humanlike mind one would need a humanlike body. However, if this is the case, then embodiment will undermine functionalism. In this section, I will claim that the existence of embodiment doesn't affect functionalism. On the contrary, embodiment reinforces the idea of MR and hence functionalism.

When one is perceiving the "raw materials"[10] from her environment, those raw materials are processed according to the body she has. These, now sculptured, raw materials will constitute the contents that will be used during cognitive processes later on. Then, the constitution and anatomy of my body will affect how I perceive the world. For example, my nose has one channel reserved to smell both the air and the odors present in the environment. Meanwhile, dogs have separate channels in their nose that have been reserved to smell air and odor separately. In a conclusion, my ability to process various scents is considerably unqualified in comparison to dogs' ability to do so. It is no wonder that dogs could smell the scents of explosives, drugs, and even illnesses in some cases, while humans have no such capability.

[10] What I mean by 'raw material' is the environments/objects as they are. Almost in a neumanal sort of way – without being tainted by my perception, and concepts.

Similarly, the anatomy of my body will affect the concepts I have about the world; this information in return will be used during cognition and will determine my perception of the world. Granted that it is intelligent, a sphere organism will not have concepts like ‘front’ or ‘back’ since its anatomy doesn’t provide content for such concepts. For its perceptual world wouldn’t include terms as such, it wouldn’t have mental states that require the inclusion of these concepts. The reason why in different bodies, the minds would acquire different concepts could be made clear by Gibson’s term of “affordances” (1979: 119).

> The affordances of the environment are what it offers the animal, what it provides or furnishes, either for good or ill… I mean by it something that refers to both the environment and the animal in a way that no existing term does. It implies the complementarity of the animal and the environment.

Information about the environment is made available in accordance with the body. Since I do not have a sphere body, the affordances I have would differ from a sphere organism’s. While it has the affordance of “rollable”, I have the affordance of “lieable”. While a dog’s nose could afford the various amount of smells, mine could afford less. Different bodies will have different affordances. According to this, it has been claimed that different bodies afford different types of cognitions - if they could afford one. Before I claim that neither the bodies nor the concepts involved in our cognition would undermine functionalism, there is a misconception that is in need of revision.

2.3 Humanlike Minds

The main conclusion follows from the embodiment thesis is that nonhuman bodies couldn’t realize humanlike minds (Shapiro, 2004: 65; Lakoff and Johnson, 1981: 30). This claim is confusing since “humanlike” minds could be interpreted in a few ways.

The term “humanlike mind” is ill because it assumes the mind should be humanlike. From the evolutionary point of view, do humans hierarchically come on top, or are they just creatures that evolve at their own pace alongside other species? Both views are true in their own ways. There are some creatures that evolutionally inferior to us

(like apes), that we are evolved from, and there are some creatures that through time we have separated and started to evolve in our own ways (like fish) since survival required different things from each. In the former case, labeling organisms as having the ability to have "humanlike" cognitive capacities will imply the idea that evolution is geared toward the production of humanlike brains (Berrett, 2011). This conclusion is absurd since only humans would require the production of humanlike brains. Even, evolutionally, our closest cousins, apes, wouldn't require humanlike brains since they need the production of apelike brains. Moreover, this conclusion implies that some of the cognitive processes we possess shouldn't be labeled as "humanlike" since they also occur in our evolutionally inferior cousins. After all, apes have shown signs of learning, and decision-making as well (Premack and Woodruff, 1978; Berrett, 2011). If beings that come before us have the same cognitive processes as we do, then some of our cognitive skills should be labeled as "apelike" rather than "humanlike". As a result, we need to claim that sometimes we are realizing "apelike" minds, which sounds odd.

In the letter case, in which we are just creatures that evolve at their own pace separately from other species, why other organisms should have "humanlike" minds in the begin with? In that case, any type of cognition would be on its own. That is fishes would have fishlike cognitions; apes would have apelike, and humans would have humanlike cognition. There will be no 'gearing toward the production of humanlike mind. These different types of cognitions for different types of bodies seem reasonable but the key feature that turns the table here is the fact that whether in an ape or in a human the cognitive act of "remembering" is named as remembering, and not like "apelike remembering", "humanlike remembering", and so on – and there is no need for it. There is something common in those instances, which makes them the tokens of the same type of cognitive processes. This is where functionalism will come into the stage.

2.4 Embodied Cognition and Functionalism

What an embodied theorist probably have in mind, when uttering the term 'humanlike mind', is no body but a human body will cognize the way a human mind does.

(1) Cognition is about the manipulation of information
(2) Affordances available to an organism, with respect to its body and environment, will vary
(3) Thanks to (2) the information an organism receives will vary
(4) Then, there are different types of cognition that belong to different types of bodies

This seems to be the justification for rejecting the body-neutrality, and hence functionalism. Yet I think there is a key feature in this justification that is being overlooked. It was stated in (1) that cognition is about the manipulation of information, which is the job description of cognition. For a functionalist, as long as an organism's cognition fulfills this job description, it wouldn't matter how, or through what it does so – it will count as a cognitive being. Beings might use various types of concepts and they might differ in the way they cognize to process information, but at the end of the day, if we call a being a cognizer, its cognition would have the same function as others' do. There are not various types of cognitions, belong to different kinds of organisms, but there are different ways to realize cognition by different bodies, based on their affordances. This is the first reason why embodiment doesn't undermine functionalism.

Let's say that we have encountered an intelligent Martian who has a sphere body and eyes all over its body. It wouldn't have the concepts a human does, and accordingly, the way it experiences the world will differ significantly from a human. Let's say that this Martian remembers things when it pokes all of its eyes twice. This is certainly not how a human remember things. To say that Martian is not actually remembering just because it uses a different method would be absurd. Both the Martian and the human remember their relevant past experiences after their respectively different ways to achieve this task of remembering. In the end, the reason why we call these two separate events as the same type is, even though they differ from each other significantly in content, and how to process, they both achieve the same end, which is to remember. To be different realizers, the operational mechanisms of causal

contribution to a functional end should be different. If achieving the cognitive act is the functional end, then different ways to realize this function will imply the MR of the cognitive acts. In the example above, both the human's and the Martian's cognitive task fulfill their duty. This is why we label the cognitive act as the same, and this is what functionalism has been claiming all along. So the differences in bodies and the way these bodies cognize wouldn't undermine functionalism.

More solid examples for the MR of cognitive acts might be given from humans if one doesn't want to stipulate about weird Martians. George Stratton, one of the leading psychologists in vision, had conducted an experiment with some special lenses. These lenses were allowing one to see the world upside down and inverted. He himself wore the lenses for three days and observed the world through this twisted version. Through the lenses, his arms and legs were placed up, and his left was swapped with the right. Still, after three days, he found himself getting used to this new perspective. He started to anticipate what he would come across next while moving in his environment. His environment started to make sense as things were appeared to be in constant relations with each other once again (Stratton 1896). Nowadays, those lenses improved to upside-down goggles, and people could even use bicycles with them on[11].

If the lenses are embodied in one's body in this case, it is clear that the perception of the lensed person is different from the no-lensed, normal vision-ed person. The cognitive content of these people will be different. If the difference in content affects the way they gather information from their environments then the cognitive processes are different. Still, just like in the Martian example case, we call the cognitive process that takes place in both cases the same cognitive act – in this case, as 'perception'. In both cases, cognitive act fulfills a certain job description even if it does that through different operations.

Embodiment theory is correct to claim that minds are unique to bodies. Each type of body would have different affordances, so they would have a different way to cognize information. Still, since we pile those differently cognized processes under

[11] https://upsidedowngoggles.com/

the same cognitive type, those differently cognized processes are just different realizations of the same cognitive function. Then the condition (4) above should be revised as "Therefore, cognition (cognitive act) could be realized in different ways by different types of bodies." In that sense, embodiment wouldn't undermine functionalism. On the contrary, it would encourage it. What (1)-(4), (4) as in the revised version, tells us is that cognitive acts are multiply realizable.

Unlike the embodied mind, the extended mind thesis has no issue with functionalism. Since enacted mind could be interpreted as a type of extended mind, and the embedded mind doesn't have any solid argument that embeddedness is constitutive of the mind, the only embodied cognition approaches we need are embodied and the extended mind. Rowlands combines these two theses and calls them the amalgamated mind (Rowlands, 2010). While he rules functionalism out in order to have those two theses together, I claim that these two theses are not only compatible with functionalism but they also support functionalism. In this sense, I will call the amalgamation of these theses the amalgamated functionalism.

CHAPTER 3

WHAT IT MEANS TO BE A COGNIZER

The conditions a creature should satisfy has presented in the previous chapter. But these criteria don't make any specification about which species should count as cognizers, and when applied, it is clear that many beings from different species aside from humans may count as cognizers. All a being needs to do is to fulfill the criterion given above.

Kohler, in his studies with apes, noted that when baskets filled with fruits are put in motion, apes get in motion according to those baskets – leaping to a ledge on the wall and catching the baskets just in time. This behavior of apes indicates that they are able to estimate the arrival time of the baskets and arrange their motions with respect to that (Kohler 1925, as cited in Premack and Woodruff, 1978: 515). Apes, in this case, show the signs of future planning. Another example might be given through elephants. Elephants have relatively long life spans (around seventy years), and throughout their lifetime's female elephants gather around an old, single, female elephant known as the matriarch. These makeshift groups' populations may increase and decrease over time, depending on the new groups joining in or old ones breaking up. Different groups tend to encounter each other quite a lot through time and it has been observed that if group A has encountered group B before, then they tend to get closer to this group B. On the other hand, if group A has encountered a new group C, they tend to bunch together within their own group and stay away from this unfamiliar group C. It is evident that older females tend to bunch together less than the younger ones since they came to know more females through their lifetimes and have the knowledge of whether they are friendly or not (Barrett, 2011: 88). What these observations have shown is those female elephants could store the sounds of other elephants in their memories and recall them to analyze whether the

approaching group is familiar or not. Elephants have shown the signs of the cognitive act of remembering.

3.1 Cognition in Artificial Beings

Interesting as they were, those examples of cognition in different animals are not new or surprising. Cognitive acts in those creatures are already something that is expected and accepted. Apes, in particular, due to their closeness to human beings evolutionally, are beings that we allow a great deal of mentality already. The criterion given in Chapter 2, however, has some unexpected implications about the species that might count as cognizers, such as inanimate, artificial beings like telescopes, calculators, etc., and/or plants. However, if that is the case then there might be something wrong with those criteria since labeling various kinds of beings as cognizers is what cognitive bloat objections were all about.

Based on C&C's extended mind thesis, the problem of where to draw the line between what is cognitive and what is not has been born. Rowlands and Miyazono have avoided this problem by changing cognitive states with cognitive processes and by taking these cognitive processes as a system that involves my brain, the object, and the environment. Still, they cannot avoid objections altogether since now one can restate the objection of cognitive bloat by chancing cognitive states with cognitive processes. That is, one can redefine cognitive bloat objection as many things outside of my brain may be recognized as having cognitive processes. Surely there will be fewer objects outside my brain in the sense of cognitive process than it did in cognitive states, that could be count as cognizers, but still, there would be some and recognizing brainless, and/or artificial objects as having cognitive processes seem odd in any case – regardless of their quantity. How could an inanimate, brainless, artificial object be recognized as a cognizer?

Let's suppose that I'm using a telescope. A telescope is a reflector that transforms one mirror image into another. Mirror images carry information that was determined by the specific properties of the mirror and the visual environment. A telescope in

that sense manipulates information with respect to its affordances, and it seems like it fulfills all the criteria given above. Since that is the case, the telescope itself having a cognitive process while transforming information-bearing structures. Therefore, it should be count as a cognitive being.

3.2 Personal vs. Sub-personal Level Cognition

There seem to be two paths one may choose to follow from here. Either one is going to label beings like telescopes and whatnot as cognizers since they satisfy the criterion or one is going to add some new criterion into the initial four that was given above to avoid such a conclusion. Alternatively, one might choose a more subtle way to reconcile these two.

Rowlands tries to avoid this conclusion of cognitive bloat by his claim of cognitive processes should belong to a subject with the help of his sub-personal and personal distinction (ibid). There are, as he notes, two different kinds of cognitive processes, the one that is on the personal level and the one that is on the sub-personal level. While the former makes the information available to a subject, the former makes information available to a subsequent step in the cognitive process. For example, according to Marr's theory of vision, vision starts in the retina, and in order for one to have a visual representation of the world, one's visual cognition needs to go through some processes. When the retina is stimulated, we would have a retinal image, which, unlike the three-dimensional perception that visual images provide, is flat. This implies that those retinal images must go through some processes that would turn them into the visual perceptions that we have as a result. According to the light reflected from the objects in one's environment, one's retinal image would have varying intensities of light distributed among the retina. Then, the first step of the visual processing is to provide the subject with a representation of the visible structures of those observed objects, such as their shapes, distances, etc. Marr labels this as the early visual processing. The function of the visual process is to construct a primal sketch, which represents the intensity change in the retinal image. To construct a primal sketch, one first needs to construct a raw primal sketch, which is a

representational structure flashed in the brain. This representation makes the structure of objects clear. After registering the retinal image, the brain applies some transformational rules to make such information (about structures, etc.) clear. The application of these transformational rules leads to the construction of a full primal sketch in which the brain applies some grouping principles (e.g. proximity, similarity, etc.) to it to make it clear which textures go with which other ones. After those, the brain proceeds to infer the depth, motion, etc. of the observed objects, which is known as the 2/½D sketch. This is the end result of the early visual processing which provides the subject with the layout of the structures observed. In order to recognize the objects observed, the subject needs a third layer where the layer is focused on the object. In this step, the brain tries to *guess,* based on stored information, which object satisfies the sketch provided by 2/½D sketch. The process is known as the 3D object representation (ibid; Barrett, 2011).

If we take Marr's theory of vision as correct then in the light of Rowlands' distinction of personal and sub-personal level cognition, while the visual perception is a personal level cognition, the processes one has to go through to have that visual perception (such as from primal raw sketch to 2/½D sketch) are on sub-personal level cognition. While in the personal level cognition, the information made available to the subject of these processes (this information may also be made available to subsequent processes), in the sub-personal level cognition, the information is made available only to the subsequent processes in cognition. Cognitive processes then have two kinds of functions, and even though those two functions are about made information available, they differ in who/what they make this information available to. Rowlands claims that while the personal level cognition made information available for the subject of cognitive processes on a conscious level, sub-personal level cognition made information available for unconscious cognitive processes, like in Marr's theory of vision (transforming the retinal image into the raw primal sketch – this makes the information available to other subsequent unconscious processes and not to the observer directly (Rowlands, 2010: 113). Before coming to Rowlands solution of cognitive bloat, and as I would claim that why it is not quite working, I would like to make a quick clarification on the terminology Rowlands has adopted.

Some readers may notice that Rowlands didn't use personal and sub-personal distinction "correctly", meaning that as it was first introduced to the literature by Dennett (Dennett, 1969). What Dennett aims to do with this distinction is to distinguish between two types of explanation rather than made a conscious-unconscious access distinction. Stich, rather than Dennett, makes this sort of distinction since Stich realizes that we have some processes that do not correspond to any of our personal explanations, such as in the case of the raw primal sketch that we do not have access to and/or experience of directly. These lower-level states, which we do not have conscious access to, are named as 'subdoxastic states' by Stich. Meanwhile, the states that we have conscious access to are named 'doxastic states' (Drayson, 2012). Since Rowlands claims that personal and sub-personal levels are about cognitive access, he seems to have Stich's, rather than Dennet's, terminology in mind.

In this paper, the definitions of the terms 'personal' and 'sub-personal' will be based on Stich's understanding. Still, since I'm giving examples through Rowlands (and since Rowlands himself seems to have Stich's distinction in mind even if he seems to mislabel them), to avoid confusion, I will continue using Rowlands' terminology. That is I will substitute the personal level cognition for doxastic and sub-personal level cognition for subdoxastic respectively. Now we can return to the cognitive bloat and its claimed solution.

Combining with this distinction, and with his claim that cognitive processes are processes of a subject, Rowlands claims to avoid the cognitive bloat objection. Cognitive processes should belong to a subject and this should be valid for two kinds of cognitive processes. While on the personal level cognition, it is clear whom the process belongs to (i.e. me), in the sub-personal level cognition, the ownership is determined through integration. A sub-personal level cognition belongs to a subject that is the owner of the personal level cognitive process in which it is constitutive of.

In the case of the telescope then, the telescope's cognitive processes are sub-personal ones and they are a subsequent step that makes information available to me, or to whomever looking through the said telescope. As Rowlands (2010: 94) put in words:

> Therefore the operation of the telescope is based on the transformation of information-bearing structures. I use these transformations to achieve cognitive tasks I could not have achieved without them - the perception of distant objects. So, the processes occurring inside the telescope are information-processing operations used to accomplish a cognitive task.

The telescope and I constitute a system in the way it was proposed in the extended mind thesis - in terms of the fixed versions of Rowlands and Miyazono. Since that is the case, the telescope doesn't have cognitive processes on its own, hence there is no cognitive bloat problem.

However, this solution still seems problematic. First of all, 'person' in sub/personal level cognition includes not only agents that is capable of reflecting and evaluating (morally) its mental states and actions, but also any organisms that invoked in the sub/personal level cognition (ibid: 145). In that sense, the owner of cognitive processes doesn't need to be a human or a being that has the reflection and evaluation capabilities that a human would have. The main claim was cognitive processes should belong to a subject. If the telescope is the subject in this case, which it seems to be, then this very well might be a case where cognition being realized in a different way. It is clear that the telescope is a different type of body that have different sorts of affordances. Even if I'm creating a cognitive system with the telescope when I look through it there still is a processed information that I have received from the telescope and then process this processed information in my own way. This solution doesn't explain whether the already processed information when I look through a telescope is a cognitive one.

3.3 What It Means to Be a Cognizer

One possible response to this claim might be something like this: in order to be the subject of the said cognitive act, the subject must have personal level cognition. A telescope doesn't have conscious access to the information it has processed – it is not aware of this information. That is, it doesn't have personal level cognition, it only has sub-personal one. Since to belong to a subject a sub-personal level cognition

needs to integrate with a personal level one, a telescope is not a subject, and since it is not a subject it doesn't have cognitive processes. One might object this solution by claiming that cognition is about information processing and whether labeled as a subject or not there is an information processing that was done by the telescope. So either we are making a mistake in our definition of what a subject is or what cognition is. The answer is neither but there is a distinction needs to be made in cognition's case. There is nothing wrong with our definition of what cognition is but there are two types of information processing, one is cognitive and one is not.

This solution based on a slightly altered versions of Adams and Aizawa's, and Rupert's attacks on C&C, in which they claimed that the information contained in Otto's notebook or in all the other objects outside me, involves only a derived content (Adams and Aizawa, 2001; Rupert, 2004). We could adjust these objections to provide a solution to the renewed cognition bloat problem by chancing cognitive states with processes and derived content with derived function. That is to say, a telescope, a notebook, a calculator, etc. are all artificial things made for fulfilling certain functions with respect to their makers' intentions. In that case, those beings have their cognitive functions derived from what sort of functions their makers want them to fulfill. An artificial being is installed with certain mechanisms that would enable it to process information that is it is imposed upon those functions. Information processing in that case is not something those beings are doing but something that is happening to them. In contrast with this, a human being has to have the ability to cognize in order to keep up with her environment to stay alive. This is the function of cognition, and what we talk about when say "cognition". The reason why we, human beings, and other organisms in the nature, start to process information is to increase our chances in survival while this is not a case for artificial beings. If being in nature causes to process information supplied by mental states for beings, and if mental states are intimately associated with minds then once one trace these steps backward, it turns out that the very reason why an organism has a mind is that to increase the chances of survival by information processing. While beings that process information to survive is minded, beings that don't aren't. Moreover, while the function of cognition in our cases is to process information, the function of 'cognition' in artificial beings cases is to reveal information – reveal whatever information its maker wants for it to reveal (it is exposed to the said information),

rather than processing the said information[12]. If the function of 'cognition' is different in both cases, then what we are talking about when say cognition isn't the same. A telescope isn't a cognizer.

[12] This, however, does not mean an artificial being couldn't have the cognition. If the said being starts to process information to increase its survival chances then it may be labeled as a cognizer.

CHAPTER 4

PLANT MIND

With all the findings in the light of previous chapters, now is the time for asking the question of plant mind. To process information one first needs to be supplied with the said information, and for this to be possible, a creature needs to be able to *sense* its environment. Common understanding states that in order for a creature to sense something, we need three basic elements; stimuli, neurons, and the nervous system. When a creature is stimulated by a transmitter, certain neurons fire throughout the nervous system and a response emerges (Baluska & Mancuso, 2009). Now, if we take this story into account, we need to eliminate plants as beings that could sense, simply because they don't have the necessary conditions to fulfill it, a.k.a. neurons, nervous system. However, as it is defended in Chapter 2, not every creature has the same affordances. The nervous system and neurons afford sensation to animals and humans, but this doesn't necessitate that these are the only ways a creature could be afforded sensation. In nature, an organism must be aware of its surroundings - otherwise, it would not be able to survive. Plant species are the eldest ones amongst all the others, and in that sense, it must have its own way to gather stimuli.

4.1 Cognition in Plants

The information about the environment is transmitted through neurons in humans and animals, thanks to the electrical impulses. Electrical impulses then carry

information in the system. As the recent studies in the field of plant neurobiology[13] suggest, plants are actually capable of producing electrical discharge, named as actual potentials, and they could articulate their responses to the stimuli by firing these actual potentials (Calvo, 2017). This system is known as the calcium signaling system in plants and its function resembles the nervous system in humans (Bose & Karmakar, 2003; Trewavas, 2003). So information transmission is made possible in plants due to this calcium signaling system. This system is what affords plants to sense their environment.

While sensation means to respond to certain stimuli, perception means to process the sensations that have been gathered (Baluska & Mancuso, 2009), hence the cognitive act of perception. In other words, we become aware of the surroundings by perception. Sensation and perception seem to be closely related but that doesn't mean one will necessarily bring the other. That is to say just because we accept that plants can sense doesn't mean that they can perceive as well. So we need to examine whether plants could perceive or not.

It is clear that plants respond to their environment. For example, sunflowers turn their faces toward the sun, trees try to overgrow each other in a forest to reach the sunlight better, a mimosa plant shuts its leaves off when touched, and a *codariocalyx motorius* starts "dancing" when hear a sound. For these behaviors to count as cognitive acts, they need to be more than mere reflexes. So, the real question is whether they are the results of reflexes or genuine cognitive processes.

4.1.1 Reflex or Cognition?

Plants search for light. They try to overgrow each other and in some cases turn their 'faces' toward the sun. If plants were to react, only to the sun, then we could claim that they only have sensations, but plants also react to the direction of the sun (Maher, 2017). In that sense, they have the perception of the location of the sun and act accordingly. One may object to this conclusion by claiming since plant growing

[13] Of course, the field's aim is not to search the nervous system in plants since plants do not have neurons to being with. It is aim is to investigate how plants process the inputs they receive from outside.

toward the sun is merely physiological it is a reflex-like behavior, it is instinctual. A patient in a vegetative state would react to sudden noises or retreat their hand when squeezed, but those behaviors are mere reflexes and wouldn't mean that they have cognitive acts. However, there is a difference between these cases. Plants don't just have passive perceptions that are gathered from their environment but they need to actively engage with their environment. A plant is actively seeking sunlight, it does not merely react to the sunlight or lack of it. In the reflex example, one is exposed to the behavior. In a vegetative state, one doesn't intend to react when hearing a sudden noise yet the same couldn't be claimed for plants' case. There is more than exposure in plants' case since if that would be the case then they wouldn't seek sunlight but just happened to react whenever they encounter it. There is a 'goal' plants have and it is to become exposed to the sun (ibid). They have a perception about the location of the sun and they arrange their behaviors according to that perception (they turn or grow toward the sun). Plants, in that sense, seem to process information.

4.1.2 Carrying Information

Not only do plants process information, but they also seemingly carry information to each other. In the Savannah, in the late 1980s, during a drought, large numbers of healthy kudus started to die with no clues about why. The postmortem tests showed no sign of attack or parasite that might kill them. When scientists looked at the stomach content of kudus, they found out that kudus have a high amount of tannin in their bodies. Tannin is a molecule plants use as a chemical defense to fight parasites. Usually, it is at a low level, so animals could throw it out of their system. However, in this case, the tannin level on the dead kudus was observed to be too high to be thrown out of the system. Since tannin only occurred in plants, those tannins found in kudus must come from a plant – but which plant and why? To figure that out scientists went to the ranges to take samples from each plant habituated there and measured the tannin levels. The results have shown that the acacia trees had four times higher tannin than normal. It turned out, due to the draught; the number of animals feeding on acacia trees has increased which causes the plant to defend itself by increasing the tannin level in its system. Moreover, the tannin level of nearby acacia trees that were untouched was observed to be high as well. The sample from

the air has shown that as soon as kudus started overgrazing from an acacia tree, the tree emitted ethylene, a colorless and odorless gas. Thanks to this chemical gas released by the injured plant, the neighboring plants could also protect themselves (Mitsch 2008, 0:49).

Information has been carried to neighboring plants but cold we say this is genuine communication? According to the experiments conducted by Heil and Bueno, volatiles released from one part of the plant affects both the other plants and the plant that releases volatiles itself. Experimented on a lima bean, they induced volatile emission from two leaves and then wound a second shoot of the same plant near the induced one. A day later leaves from both shoots were observed to produce more extrafloral nectar on their undamaged leaves. Yet, when the damaged leaves were wrapped in plastic bags, this effect vanished. The nectar production is then triggered by an airborne signal emission from the damaged leaves externally, rather than a communication happening inside the plant system. Furthermore, to be on the safe side, another lima bean is planted in a greenhouse (to cancel any possible effect of root signaling and other volatiles of other plants) and then damaged from the two leaves. Undamaged leaves on the same stem produce more extrafloral nectar when they are placed near those damaged leaves or when the air from those damaged leaves blown toward them but not when the air is blown away (Heil and Bueno as mentioned in Gershenzon, 2007).

From these results, there are two interpretations available to interpret the first example, that of the acacia trees. The first interpretation is that plants do not ‘intend’ to warn their neighbors but themselves. If the neighbor plants are close enough, they could also receive this information of assault and adjust their behaviors accordingly, but this information exchange isn’t a result of communication but a result of the impact of chemical gasses a plant emits (in either case it should be clear that plants process the said information). The second interpretation is that the exchange of information might still be regard as a genuine communication, for two reasons. First, not all the leaves of a plant are connected with each other, so they have to release the gas to warn themselves but that doesn’t necessarily exclude the possibility of them trying to warn the neighboring plants. Second, herbivore-induced volatiles aren’t

only meant for a private message for the plant but also used to signal nearby organisms such as other organisms that would be eaten by the said herbivore and hence help defend the plant. If the second interpretation is the case, then using an external signal to alert both the other organisms (plant and insect alike) and the plant itself would be more efficient, in which case we could talk about communication in plants and communication of plants with other organisms.

4.1.3 Rule-following or Cognition?

These claims mentioned above might be contradicted by someone who claims that the complexity in behavior wouldn't necessitate mental complexity (Barrett, 2011). This goal of to be exposed to the sun and alert the nearby organisms might be a rule that plants have. In such a case, plants are only rule-following. A rule-following behavior wouldn't need much information processing. For example, if the rule for a plant is to "seek sunlight", then the behaviors of that plant couldn't be labeled as cognitive. To see whether plants are only following rules or their behaviors are genuinely cognitive, we need to examine behavior that might be regarded as "rule-following" in detail. If a plant would behave the same at all times, under the same conditions, according to a given rule then its behavior should count as rule-following rather than genuine behavior, which would require the plant to adjust its behaviors according to the inputs.

For such an examination, I will take the behavior of the Mimosa plant as an example. Mimosa is known for folding its leaves shut whenever it gets touched. If 'fold your leaf when presented with danger' is a rule for Mimosa, then this behavior should present itself (folding the leaves) whenever this input (touching the leaves) is gathered under normal circumstances (if the plant isn't exhausted). Galiano et al. (2013) devised a couple of experiments on this said plant. For starters, to see whether low light (LL) and high light (HL) conditions a Mimosa is exposed to affect the trade-off between predation risk and energy demand (closing leafs shut requires lots of energy), they assign random Mimosa plants to LL and HL conditions and made them wait under this conditions for 5 days. After this period of time, during which plants had been left undisturbed, they started to experiment on plants with a custom-

made controlled drop system to maintain a standard stimulus. They experimented by dropping the plants from a certain height, first in the morning, then 8 hours later, 60 times for one day. To see whether the response gathered from Mimosa (the decrease in leaf folding) is due to exhaustion of the leaves, they also perform a dishabituation experiment to recover the original behavioral response by placing the plants into a fitting foam container that was attached to a shaker plate. To examine short-term effects after one-day training on the retention of the habituated response, the plants from both light treatments got re-tested 6 days after by exposing them to one training of 60 drops. To examine the effects of changing the environment, 13 plants, including 5 control plants, that were previously exposed to LL transferred to HL and vice versa. Additionally some plants receive full training, 7 trains of 60 drops in a day, and tested after 28 days. While the short-term experiments didn't have much effect on the behavior of leaf closing the long-term experiments have some interesting results. The leaves of the plants that receive full training start opening right after they were dropped or even not being closed at all. Plants that were exposed to LL conditions were observed to open quicker. Gagliano et al. (2013: 66) summarize the conclusions as the following:

> The result shows that a greater ability to ignore a recurrent, yet harmless stimulus, in order to minimize energy waste and optimize opportunities to forage for light is to be expected in environments where the available energy is more limited… We found that the habituated response returned to original baseline levels when the novel stimulus was applied… This is an important result because it rules out the alternative explanation for a decrease in re-opening response due to exhaustion of energy or other resources.

As it was mentioned before, leaf folding is a behavior that requires lots of energy. Still, if a plant is exposed to the triggering stimuli that would cause it to close its leaves for enough times, 'seeing' that it is harmless, the plant will readjust its behaviors accordingly. If it were merely rule-following behaviors, then the plant wouldn't be able to adjust its behaviors since a rule-following mechanism wouldn't be able to make a distinction between harmful vs. harmless stimuli. Plants' behaviors then have something more to themselves than merely being rule-following or reflexes. They actively process information to behave in accordance with their environments.

Moreover, this experiment implies that plants have memories since they learn not to close their leaves, and learning requires memories. They are adjusting their behaviors according to their past experiences, and this isn't the only experiment that indicates memory in plants. As Trewavas (2005: 403) mentions in his paper;

> Since the phenotype differs with each new neighbour, the ecological niche is not a fixed quantity but like the phenotype itself, is plastic in character and changes as growth continues. Turkington (Evans and Turkington 1988; Turkington et al. 1991) indicates that even after moved to different soils, plants retain the memory of their original neighbours for several months up to a year.

Likewise, Volkmann, a professor of Cellular and Molecular Botany, planted two pea seedlings horizontal rather than vertical in an experiment. The things in plants that are responsible to keep them on balance are called filaments (we have similar things in our ears with the same role). After a while, during which plants had left in a horizontal position, they 'figured' out which way up was and started growing up on that way. Volkmann left these two pea seedlings in a horizontal position for 30 minutes and then he cooled them down to the 4 degree Celsius, which made them fall asleep. The aim was to see if they would remember the positions they were in. Several days after, he took them out of the refrigerator. After warming up and waking up, he observed the response of those plants. The plants seemingly remembered the stimulation before they were put into sleep, as after they woke up, both of them started growing horizontal. Moreover, the response was different in both plants. As one of them was more bent down while the other was not, which could be interpreted as one having stronger memory than the other (Mitsch 2008, 14:55). In this experiment, the indications of plants act according to their past experiences is found.

For humans, learning and memory are interrelated, and the neural network of a human will learn when pathways that connect signals to response are reinforced. Increasing the strength of existing synaptic connections between neurons is one way this reinforcement could occur. In a calcium signaling system, like in the plants, learning and memory are also interrelated, and the mechanical functioning of this

system is similar to the nervous system (Bose & Karmakar, 2003). So, the system that would enable one to have memory might be intact in plants as well. It seems logically possible (and experiments show that this is actually the case) that plants could have memory.

4.2 Plants as Cognizers

In the examples we have seen above plants are processing information. Yet this information processing is what we would call as cognition or are they exposed to the said information? In Chapter 3, we saw that cognitive processes should belong to a subject. To be a subject, a being must have personal level cognition. Furthermore, not all information processing should count as cognitive since there are two kinds of information processing that have different functions from each other. While in the first one, the function of information processing is to increase the chances of survival, in the second one, the function of information processing is not something a being does but something that is happening to it, and it has nothing to do with its survival. We have reached the conclusion that to be counted as a cognizer, a being should process information like in the former case. If plants have personal level cognition and they are processing the information in the first functional way, then they should be labeled as a cognizer. It is clear that the reason why a plant process information is to increase the chances of its survival in nature. The thing that requires our attention is the second issue mentioned above – are plants subjects (have personal level cognition)? Personal level cognition is about conscious access to the information one has been supplied with. What is meant by consciousness here is to be aware of the information a being has supplied, so it shouldn't be confused with qualia or the questions of freewill.

How could we make sure that plants are aware of the information they get? If a subject adjusts their behaviors according to the sensory input, then this should indicate the awareness of the said information. In all the cases mentioned above, one thing was for sure: according to the stimulation they gathered from their environment, plants adjust their behaviors accordingly. If plant behaviors were just rule-following, then these adjustments in their behaviors wouldn't occur. Even if one

says plants exchange one reflex or rule-following behavior for another, they still need to be aware of the changes in the environment to adjust to it in the most suitable way. In that sense, plants do have personal level cognition. Therefore, plants are cognizers.

CONCLUSION

What plant mind could tell us about cognition and mind? For the former, it says brainless cognition (or mindless mastery (Trewavas, 2002)) is possible. It also says a lot about the functional roles and affordances. If being a realizer is to be able to fulfill a certain job description, then in the realizers, what we should look for is how they could fulfill a certain function according to their affordances, rather than how they could fulfill a function based on how a human would fulfill it. Other organs than a brain could realize the functions that are traditionally associated with a brain, and other systems than the nervous system could fulfill the function of the nervous system.

What plant mind could tell us about the mind? Would being a cognizer is enough to count as a being with mentality? The definition of mind encapsulates many features, such as qualia, and freewill – and cognition is just one of them. It might be said that cognition is the most basic feature for a being, whether it has all those other features of mentality or not, to have since information processing is required for all the other features. In that sense, it is possible to claim that plants have a very basic mind. A mind that could achieve the bare minimum, which is to process information from its environment.

What made humans and some animals more sophisticated in terms of having mentality then appear to be their ability to realize more functions of the mind than the plants do. If the mind is a faculty that could be exercised to get better, that is for all beings it is possible to evolve more to realize its other features, then the reason why those beings are more sophisticated is their minds' could function better, based on their affordances. Since evolution basically reveals new affordances (those affordances might uncover different ways to realize a specific function than how other beings realize it) for a being, it seems likely. For example, an alien that lives in the 4^{th} dimension, that could bend space-time, would have affordances available to it that are unavailable to humans. If bending space-time is a mental feature that could

be achieved by humans, if they were to evolve more, then these aliens realize mind better than humans do.

As a conclusion, what this thesis seemingly indicates is that there are levels of being minded; a being that could cognize; a being that has a conscious choice; a being that could bend space-time through some force of mind and body, etc. If that is the case, then the more a being could realize more features of the mind, the better its mind is functioning. Even if cognition might be accepted as the fundamental basis for having a mind, it is still unclear which forces are in play when it comes to realizing the other features of mentality, such as qualitative feelings. In our case, since the experiments mentioned in Chapter 4 don't state anything specific regarding these other mental features but cognition, plants have mentality but it is in a very basic sense – that is, if we accept being a cognizer is sufficient enough to count as a minded being.

It turns out that being a cognizer isn't entirely equal to being minded, at least in both the traditional sense that involves qualia, consciousness, etc. and the sense I introduced just now. Is the mind a unity of all those features, including cognition, or having at least one of them would be enough to be labeled as a minded being is open for discussion (maybe there should be distinctions between cognizer beings, freewill-ed beings, etc.). Whatever the answer to this issue might be, there is solid evidence that the feature of cognition is present in plants, and in that sense, they are "somewhat" minded beings.

REFERENCES

Adams, F.& Aizawa, K. (2001). The Bounds of Cognition. Philosophical Psychology. 14. doi: 10.1080/09515080120033571.

Baluska, F. & Mancuso, S. (2009). 'Plants and Animals: Convergent Evolution in Action?', F. Baluska (ed.) *Plant-Environment Interactions: From Sensory Plant Biology to Active Plant Behavior*. Switzerland: Springer, p. 286. doi: 10.1007/978-3-540-89230-4_15.

Barrett, L. (2011). *Beyond the Brain: How Body and Environment Shape Animal and Human Minds*. Princenton:Oxford. Princeton University Press. doi:10.2307/j.ctt7rvqf

Bose, I. & Karmakar, R. (2003). Simple Models of Plant Learning and Memory. Physica Scripta. 101617. 9-12. 10.1238/Physica.Topical.106a00009.

Calvo, P. (2017). What is it like to be a plant? *Journal of Consciousness Studies*, 24 (9-10), 205-227

Chalmers, D. J., (1996), *The Conscious Mind: In Search of a Fundamental Theory*, New York and Oxford: Oxford University Pres

Clark, A. (2008), Pressing the Flesh: A Tension in the Study of the Embodied, Embedded Mind?. Philosophy and Phenomenological Research, 76: 37-59. doi: 10.1111/j.1933-1592.2007.00114.x

Clark, A. and Chalmers, D. (1998), The Extended Mind. Analysis, 58: 7-19. doi: 10.1111/1467-8284.00096

Damasio, A. R. (1994). Descartes' error: emotion, reason, and the human brain. New York: G.P. Putnam.

Dennett, D. C. (1969). *Content and consciousness.* Humanities Press.

Descartes, R. (2008). *Meditations on first philosophy* (M. Moriarty, Trans.). Oxford University Press.

Drayson, Z. (2012), The Uses and Abuses of The Personal/Subpersonal Distinction.

Philosophical Perspectives, 26: 1-18. doi: 10.1111/phpe.12014

Feigl, H., (1958).“The ‘Mental’ and the ‘Physical’”, in Feigl, H., Scriven, M. and Maxwell, G., Minnesota Studies in the Philosophy of Science: Concepts, Theories, and the Mind-Body Problem, Minneapolis: Minnesota University Press, 370–409.

Gagliano, M., Renton, M., Depczynski, M. *et al.* Experience teaches plants to learn faster and forget slower in environments where it matters. *Oecologia* 175, 63–72 (2014). doi: 10.1007/s00442-013-2873-7

Gallagher, S. (2011). *Interpretations of embodied cognition.* In W. Tschacher & C. Bergomi (Eds.), *The implications of embodiment: Cognition and communication* (p. 59–71). Imprint Academic

Gershenzon J. (2007). Plant volatiles carry both public and private messages. *Proceedings of the National Academy of Sciences of the United States of America*, *104*(13), 5257–5258. doi: 10.1073/pnas.0700906104

Gibson, J. J. (1979). The ecological approach to visual perception. Boston: Houghton Mifflin.

HACKADAY. (2019, May 20). *Uncovering the Silicon: Demystifying How Chips are Built and How They Work*. [Video]. Youtube. https://www.youtube.com/watch?v=VNzkhZBjo5k&t=206s

How Do Neurons Work?. (2011). Retrieved from http://www.bris.ac.uk/synaptic/basics/basics2.html#:~:text=Neurons%20conduct%20electrical%20impulses%20by,ions%20across%20the%20neuronal%20membrane.&text=Thus%20there%20is%20a%20high,concentration%20of%20potassium%20ions%20inside

Jackson, F. (1982). Epiphenomenal Qualia. *The Philosophical Quarterly (1950-), 32*(127), 127-136. doi:10.2307/2960077

Kim, J. (2011). Philosophy of Mind. Boulder, CO: Westview Press.

Lakoff, G. & Johnson, M. (1981). *Metaphors we live by*. University of Chicago Press.

Lewis D. (1970). How to define theoretical terms. The journal of philosophy, Bohnert, H. (1971). vol. 67, pp. 427–446. *Journal of Symbolic Logic, 36*(2), 321-321. doi:10.2307/22702721

Mackay, D. (1967). Ways of looking at perception. In Models for the Perception of

Speech and Visual Form, ed. W. Watthen-Dunn. Cambridge, Mass.: MIT Press.

Maher, C. (2017). *Plant Mind: A Philosophical Defense.* New York, NY: Routledge.

Mitsch, J. (Director). (2008). *In the Mind of Plants* [Documentary]. France: MacellanTV

Miyazano, K. (2017). Does functionalism entail extended mind?. *Synthese* 194, 3523-3541 doi: 10.1007/s11229-015-0971-2

Nagyfi, R. (2018). *The differences between Artificial and Biologcal Neural Networks*. Retrieved from https://towardsdatascience.com/the-differences-between-artificial-and-biological-neural-networks-a8b46db828b7

Noë, A. (2004). *Representation and mind.Action in perception.* MIT Press.

Place, U.T., (1956). "Is Consciousness a Brain Process?" British Journal of Psychology, 47: 44–50.

Premack, D., & Woodruff, G. (1978). Does the chimpanzee have a theory of mind? *Behavioral and Brain Sciences, 1*(4), 515–526. doi:10.1017/S0140525X00076512

Putnam, H. (1963). Brains and behavior. In Ronald J. Butler (ed.), Analytical Philosophy: Second Series. Blackwell.

Rowlands, J. M. (2010). The New Science of the Mind: From Extended Mind to Embodied Phenomenology. MIT Press.

Rupert, R. (2004). Challenges to the Hypothesis of Extended Cognition. *The Journal of Philosophy, 101*(8), 389-428. Retrieved from http://www.jstor.org/stable/3655517

Shapiro, L. A. (2004). The Mind Incarnate. MIT Press.

Shapiro, L. A. (2019). Flesh matters: The body in cognition. *Mind Lang*. ; 34: 3– 20. doi: 10.1111/mila.12203

Skinner, B., F. (1957). *Verbal Behavior*. New York: Appleton-Century-Crofts Print.

Smart, J.J.C., (1959). "Sensations and Brain Processes", Philosophical Review, 68: 141–156.

Stratton, G. M. (1896). Some preliminary experiments on vision without inversion of the retinal image. *Psychological Review, 3*(6), 611–617. doi: 10.1037/h0072918

Trewavas A. (2005). Plant intelligence. Naturwissenschaften. Sep;92(9):401-13. doi: 10.1007/s00114-005-0014-9. PMID: 16142448.

Trewavas, A. (2003). Aspects of Plant Intelligence, *Annals of Botany*, 92(1), 1–20

Trewavas, A. (2002). Plant intelligence: Mindless mastery. *Nature* 415**,** 841 doi: 10.1038/415841a

Watson, J. (1913). "Psychology as a Behaviorist Views It," *Psychological Review*, 20: 158-77.