The Relationship Between Aphantasia and Embodied Cognition

Ezra Wingard

Abstract

Aphantasia is a not-so-widely known phenomenon that is rapidly gaining speed within popular science. Embodied cognition, on the other hand, is a theory of cognition that has stayed tried-and-true across the years in cognitive science. We probe the idea that we can learn more about aphantasia through an embodied cognition perspective and discuss if there is a relationship between the two phenomena. We mention potential benefits from this perspective as well as some of the implications we must accept if this relationship were to be accepted.

Introduction

Within cognitive science, there exist many theories of how our minds, and thus, cognition, function. One major theory that goes against the traditional cognitive science perspective, called cognitivism, is the idea of embodied cognition. This means that we experience the world not through the mind interacting with the environment (as the cognitivist would see it), but through the brain, body, and environment interacting with each other (Tibbets, 2014). We have further expanded embodied cognition (EC) into other realms that are influenced by our cognition, such as listening to music and using our mental imagery to imagine things (Rucińska and Gallagher, 2020; Gibbs et al., 2002; Palmiero et al., 2019). In this paper, we will be focusing on the latter, with special consideration of a condition called aphantasia.

Aphantasia is a newly-named condition (Zeman et al., 2015) which describes one extreme on the spectrum of mental imagery vividness. Not much is known about the nature of aphantasia, but what is known is that the condition affects the way people imagine things – those with aphantasia have a lack of at least one kind of sensory mental imagery (Keogh and Pearson, 2018; Takahashi et al., 2022; Dawes et al., 2020). This lack of mental imagery may be complete, with absolutely no imagery at all in their mind's eye, or a severe deficiency in the ability to imagine within the sensory modalities (Zeman et al., 2015; Keogh and Pearson, 2018).

The relationship between embodied cognition and mental imagery has been widely studied and thought about (Schendan and Ganis, 2012; Rucińska and Gallagher, 2020; Gibbs et al., 2002; Palmeiro et al., 2019), however it has not been well hashed out the relationship between EC and aphantasia. In this paper, we seek to answer the questions of if aphantasia and embodied cognition are related, and how we can use pre-existing theories of EC to learn more about the condition. We will do this by using already existing theories and scholarly knowledge on embodied cognition, mental imagery, and aphantasia to synthesize new literature on the subject.

The Details of Embodied Cognition

Embodied cognition is an overarching theory in cognitive science that has many sub-theories held within the main concept of embodiment. There are many different 'flavors' of embodied cognition, but the main theories that will be discussed and considered come from Tibbets (2014), Wilson (2002), and Anderson (2003). From Tibbets' point of view, embodied cognition is 'online,' or sensory-based, and they also

back up claim that embodied cognition is unified by the extended mind-thesis, which entails cognitive systems reaching beyond the individual and into our physical and social environments (2014, p. 361). Wilson argues that there are six views of embodied cognition that are intrinsic to understanding the theory. These include things like how cognition is situated, how the environment is part of the cognitive system, and how the environment receives information that is offloaded from the cognitive system (Wilson, 2002, p. 625). They say that "Rather than continue to treat embodied cognition as a single viewpoint, we need to treat the specific claims that have been advanced, each according to its own merits" (2002, p. 635). Finally, Anderson's classic cognitive science paper discussed many facets of embodied cognition. One notable, and less widely mentioned facet of EC mentioned in Anderson's paper is that the evolutionary history of an agent is important to understanding the functions of the theory. He says that if not for evolution, we would not have reason, and without reason, we would not have embodied cognition (Anderson, 2003, p. 106).

The theory of embodiment and embodied cognition is extremely relevant within cognitive science, because of the contributions it has made towards our understanding of human (and non-human) cognition, in parallel with cognitivism. As stated by Tibbets, "Accordingly, evolutionary and comparative neurobiology are valuable for C/CM as well as for E/EM because "the study of diverse nonhuman brains can lead to the discovery of design rules for brains" (Striedter 2009:6) and, with any luck, the design rules underlying cognition in animals and humans as well" (2014, p. 366). Throughout their paper, Tibbets discussed the differences between embodied cognition (E/EM) and the more traditional cognitivist (C/CM) view of cognition. They made a case, like other

authors have (Anderson, 2003; Gallagher, 2011; Ziemke, 2016), that embodied cognition and cognitivism can coexist and build upon each other's theories to make more sense of how we experience the world. From helping us to understand mental imagery through an embodied perspective (Rucińska & Gallagher, 2021; Schendan & Ganis, 2012; Iachini, 2011; Palmiero et al., 2019) to general cognitive processes (Iachini, 2011; Adams, 2010; Gallagher, 2011; Anderson, 2003; Tibbets, 2014; Ziemke, 2016), embodied cognition has given the cognitive sciences a lot to think about and learn from, and we should be considering this as one of many theories that we can combine to learn a greater amount of things about our minds.

This paper, however, is going to specifically narrow down to a perspective of embodied cognition on mental imagery, and thus, aphantasia. There have been many studies, such as those mentioned above, that have done great work on studying the effects of embodied cognition on mental imagery. One study, by Schendan and Ganis, found specific neural potentials that can be used as empirical evidence for embodied mental imagery (2012). Another paper, by Gibbs & Berg, tells us "People have the phenomenological experience of having a mental image whenever a schema that is not directly relevant to the exploration of the present environment momentarily takes control of the body's exploratory apparatus" (2002, p. 9). Many studies mentioned above have provided substantial empirical evidence for embodied cognition and its relationship to mental imagery. It is also important, however, to understand the implications associated with embodied cognition, which will be delved further into in the following section.

Implications of Embodied Cognition

If we accept the theory of embodied cognition, what else do we have to know and thus accept? Firstly, we would need to embrace the body and environment as part of our cognitive states. Embodied cognition suggests that this interaction between mind, body, and environment directly influences our cognition, which means rejecting some of the hypotheses from the traditional cognitivist perspective (solely the mind is responsible for our cognition and mental states– the body merely acts as an agent to do the mind's bidding). This cognitivist perspective, as explained by Tibbetts, is that "For C/CM, the focus is on the neurally encoded representations associated with cellular, network, systems, and behavioral levels of analysis and, by implication, the neurocircuitry associated with these representations…" (2014, p. 360). Simply put, according to Tibbetts, the cognitivism theory involves the belief that our cognition comes from the neural mechanisms that underlie the mind. This isn't to say that embodied cognition doesn't have neural mechanisms that underlie our cognitive processes, but that "there are a number of overlapping theoretical frameworks that take cognition to be a genuinely biological phenomenon occurring in living organisms, and therefore emphasize the fundamental role played by the living body in general, and mechanisms of homeostatic/allostatic self-regulation in particular, in natural embodied cognition in living organisms" (Ziemke, 2016, p. 9).

There are some discrepancies between the many flavors of embodied cognition, and skepticisms of the overall theory. Firstly, some people believe that "mainstream embodied cognitive science, which still is more or less compatible with traditional computationalist and representationalist conceptions of cognition, which to some degree reduce the body to the computational mind's physical/sensorimotor interface to

the world that it represents internally" (Ziemke, 2016, p. 9). There are, according to Ziemke, some discrepancies between what is known as 'mainstream' embodied cognition, as mentioned above, and the more extreme version of EC, also known as 'radical' embodied cognition. 'Radical' embodied cognition, in Ziemke's paper, discusses EC in perception/action-dynamic terminology rather than the more traditional biological terminology.

In addition to these sorts of discrepancies between the different theories of EC, there are individuals who disagree with the general premise of embodiment or are skeptical of the evidence backing up the theory. As was noted by Adams, "I report this contra-indicating data cited by Camarazza and Mahon (2006) to record the negative results found on the other side of the EC issue. These data seem to indicate that there are at most causal correlations between perceptual-motor activity and cognition, but that such activity is not constitutive of cognition and that such activity may not even be necessary for normal levels of cognitive competence" (2010, p. 627).

As previously noted, there are different viewpoints within the theory of embodied cognition, as well as different interpretations. Similar to what was discussed on 'mainstream' embodied cognition, Gallagher reports, "Many of these insights…may be consistent with the general principles of classical cognitivism…cognitivists could easily claim that pre-processing is in fact feeding the more central processing that is certainly more constitutive of cognition, just as post-processing is to some degree determined by instructions from the brain as central processor" (2011, p. 5). Gallagher also goes further into some other interpretations of embodied cognition, such as enactive cognition, "enactive approaches argue that cognition is not entirely "in the head," but

distributed across brain, body, and environment"(2011, p. 9). Alongside this interpretation, Wilson notes a similar claim in their paper, "The claim is this: The forces that drive cognitive activity do not reside solely inside the head of the individual, but instead are distributed across the individual and the situation as they interact. Therefore, to understand cognition we must study the situation and the situated cognizer together as a single, unified system" (2002, p. 629-630). Although there is the large, overarching theory of embodied cognition, it has been well established that there are many smaller interpretations of this major theory that can affect our understanding of cognition.

The Details of Aphantasia

It was originally noted that aphantasia is a condition that affects mental imagery vividness, and resides on one extreme of the mental imagery spectrum. It is important to note that the condition is not very well understood in terms of the origins. There have been several theories that are of note in that respect, such as Blomkvist's explanation that aphantasia is the result of an episodic memory deficiency (2022), or Zeman's hypothesis that it's in a similar vein as synaesthesia – a variant of our neuropsychological functioning as humans (2015, p.4). Along with these attempts to categorize aphantasia as a condition, there have been several notable studies that discussed how aphantasics can function despite not having complete mental imagery abilities (Zeman et al., 2015; Dance et al., 2021; Jacobs et al., 2018; Takahashi et al., 2022; Ganczarek et al., 2020). Based on previous evidence from other studies, in this paper we will argue that aphantasic individuals use different strategies than non-aphantasic individuals to conduct tasks that require mental imagery, which from an

embodied cognition perspective can be shaped from the body and mind interacting with the environment.

There have been some discrepancies noted about aphantasia through different studies. For example, some studies have argued that aphantasia is part of our memory (Blomkvist, 2022), while others argue that memory can still be intact despite having aphantasia (Ganczarek et al., 2020; Dawes et al., 2020; Jacobs, et al., 2018). In addition to that, some researchers have tended to include solely visual sensory imagery in their definitions/experiments on aphantasia or using the VVIQ (Iachini, 2011; Keogh and Pearson, 2018; Zeman et al., 2015; Jacobs et al., 2018) while others emphasize a multi-modal view of aphantasia (Takahashi et al., 2022; McNorgan, 2012). Although there are some disagreements about aphantasia, there have been some notable studies that have discussed aphantasics using different strategies in order to complete the same task that a non-aphantasic would. From an embodied cognition approach, Wilson (2002) denotes:

> Our mental representations, whether novel and sketchy or familiar and detailed, appear to be to a large extent purpose-neutral, or at least to contain information beyond that needed for the originally conceived purpose. And this is arguably an adaptive cognitive strategy. A creature that encodes the world using more or less veridical mental models has an enormous advantage in problem-solving flexibility over a creature that encodes purely in terms of presently foreseeable activities. (p. 632).

In terms of aphantasia research, Jacobs et al., Dawes et al., Ganczarek et al., and Dance et al. all discussed the potential for people with aphantasia to use different mental faculties than non-aphantasic people to complete a similar task. Through their research, they demonstrated that their aphantasic participants had differently went about the task compared to the phantasic participants. It is interesting to note that in Dance's paper, aphantasia can even affect the type of synaesthesia that the participants had. So much is still unknown about the condition, but we are learning new things about it regularly. One question that still lingers in a lot of people's minds, however, is "Why aphantasia?"

Why Aphantasia?

The reason that research has been conducted on aphantasia for others is because it is a new and exciting condition to study, that can potentially provide more insight into our cognition and minds in a way we have not thought before. For this paper, the author has aphantasia, and thus wanted to choose the condition to study over something more well-known and studied because of the personal significance it has. Although we still do not know much about aphantasia, any research that can be done to amplify our knowledge on the subject.

Furthermore, by using embodied cognition as a byway to learn more about aphantasia, we can draw upon something extremely well studied and well known to enhance our understanding of something we know little about. We can take facets of embodied cognition, such as already existing theories of mental imagery and their relation to EC, and build up on them by inference to abstract to the level that aphantasia

is on. It is not uncommon to use this sort of technique for other types of review papers in order to gain understanding of a concept. As discussed in previous sections, embodied cognition can provide us with a greater understanding of aphantasia, which will be probed further in the next few sections.

Mental Imagery in Sensory Modalities

It is important to note that mental imagery in aphantasia is not solely based on visual imagery, but also sensorimotor experiences gained from the environment through embodied cognition. Although this statement is controversial in some sectors of aphantasia research, there is empirical evidence for this fact. There exists a questionnaire to determine if someone has aphantasia, or a lack of mental imagery, in multiple sensory modalities – called the QMI (Questionnaire of Mental Imagery). This questionnaire provided a way to capture aphantasia across multiple senses, including touch, smell, hearing, and taste. It was also validated as a shortened form of a longer questionnaire that measured the same variables, "Results established that the shortened form measures a general ability to image in a variety of sensory modalities. Analysis of the scale indicated that when 43 components were extracted, one single component accounted for as much as 39% of the total variance of scores on the test. All 35 items in the scale loaded highly on the factor, with an average loading of .57" (Sheehan, 1967, p. 388).

Another study found that by using solely the VVIQ like most notable studies on aphantasia (Zeman et al., 2015; Keogh and Pearson, 2018), you can only distinguish between types of visual aphantasia, while not being able to determine other existing

types of aphantasia within a person – such as in other sensory modalities. They noted, "We can observe multiple types of visual aphantasia by using self-identification of the absence of visual imagery in addition to the VVIQ. Moreover, we can classify multi-sensory aphantasia and visual aphantasia by using multi-sensory imagery (QMI)." (Takahashi et al., 2022, p. 24). The inclusion of multiple sensory modalities in research on aphantasia can help us further understand the relationship between aphantasia and sensorimotor processing – which is vital to embodied cognition. Gibbs and Berg asserted that "However, mental imagery is intimately tied to the ongoing activity of perceptual/motor exploration of the environment. People have the phenomenological experience of having a mental image whenever a schema that is not directly relevant to the exploration of the present environment momentarily takes control of the body's exploratory apparatus" (2002, p. 9). They directly accepted the notion that sensorimotor experiences gained from the environment can affect our mental imagery (and thus, aphantasia as well).

As said above, the fact that aphantasia may be common across multiple senses (Takahashi et al., 2022) is controversial for a few reasons. One of them being that the QMI and other tools to measure multi-sensory aphantasia are rarely used – whether it be because they are unknown to researchers doing work on the subject, or because most tools other than the VVIQ are not standard and thus may have issues related to validity. Another reason for this may be that aphantasia research has not been widely documented yet, so the phenomenon of multi-sensory cases of the condition may not be well known to researchers on the subject. The true reason(s) for the lack of methodologies accounting for multiple senses in aphantasia are unknown, and further

research using tests like the QMI would be extremely beneficial for future research to help better understand how aphantasia can affect cognition.

The above mentions of multi-sensory aphantasia being controversial is surprising because of the inherently multi-sensory nature of mental imagery. Non-aphantasics may enjoy a wide variety of vivid images through their mind's eye, but also mental imagery involving their auditory senses (getting a song stuck in their head), tactile senses (remembering and simulating the touch of a loved one), and gustatory/olfactory senses (the smell/taste of chocolate from your childhood). In the case of aphantasia, it has been hypothesized that since it is based on imagination, aphantasic individuals may also not be able to synthesize new mental images. For example, a person with aphantasia in the auditory sense may not be able to create new songs in their head using a sort of mentalese. If they are also afflicted with lack of visual mental imagery, they may not be able to "see" a purple spotted elephant in their mind's eye. There may be any combination of aphantasia affecting the individuals' senses.

Mental Imagery and Embodied Cognition

Several studies in the past have been conducted on mental imagery and embodied cognition (Iachini, 2011; Gibbs & Berg, 2002; Schendan & Ganis, 2012; Palmiero et al., 2019). There have been several demonstrated ways that mental imagery can be embodied/grounded within the environment. One example is from Gibbs & Berg (2002),

> Our claim that there are fundamental links between embodied activity and mental imagery rests on the idea that perception itself is fundamentally based on

> kinesthetic action. As Gibson (1979) famously argued, movement is essential to perception. When people merely touch an object, they understand little of what is perceived unless they move their hands and explore its contours and texture. Although our hands contain sensory transducers, the musculature with which we control movement allows us to explore objects in ways that make it easy to identify what is being felt. When we lift an object, this reveals something about its weight, rubbing our fingers across it tells us about its texture, and its overall shape, and squeezing it says something about its compressibility (p. 2).

Another great example of this is from Iachini's paper, "Cognition is grounded in the body in two ways: it emerges from the brain; and, it emerges from the dynamic body/environment interaction. A transversal argument in embodied cognition theories is that cognition is grounded in the brain" (2011, p. 11) . As noted above, mental imagery may be affected by memory. We can think that mental imagery stems from perception of the senses stored in memory, which in embodied cognition is grounded in brain/body/environment interaction. This hypothesis is supported by research done by Iachini and . Firstly, Iachini states, "More precisely, mental images are voluntarily generated and maintained in a system of short-term memory called the visual buffer, which is conceived of as a spatial array similar to a surface matrix composed of pixels. Images are depicted in this medium by filling in pixels on the basis of information stored in long-term memory. " (2011, p. 6). She additionally states, "The neural theory distinguishes between low level visual perception (a bottom-up process that is driven by on-line external stimulation) and high level visual perception (a top-down process that

is driven by information stored in long-term memory). Mental imagery belongs to the latter category" (2011, p. 9).

In an embodied cognition perspective, Wilson (2002) states "Because of limits on our information-processing abilities (e.g., limits on attention and working memory), we exploit the environment to reduce the cognitive workload.We make the environment hold or even manipulate information for us, and we harvest that information only on a need-to-know basis" (p. 626). Wilson argues that embodied cognition allows us to 'offload' some of our cognition into the environment, allowing us to spread (or ground) or mental imagery within the environment and not solely within the brain/mind.

Embodied cognition and mental imagery are related through a number of avenues. Some authors may have different opinions, but the general consensus is that we wouldn't have mental imagery without embodied cognition. Mental imagery is fueled by our mind, body, and environment interacting, and we wouldn't experience mental imagery the same without some sort of grounding of our cognition in our environment. As Wilson expertly stated, "This approach to memory helps make sense of a variety of observations, formal and informal, that we conceptualize objects and situations in terms of their functional relevance to us, rather than neutrally or 'as they really are'" (2002, p. 631). Not only can we make the case, as Wilson did there, that memory and embodied cognition are intricately intertwined, but we can also argue that mental imagery is intrinsically attached to memory. If we accept the notion that mental imagery and memory are attached, we must then accept that embodied cognition allows us to experience mental imagery.

How are EC and Aphantasia Related?

As previously discussed, mental imagery and embodied cognition are intricately related. Thus, because aphantasia is a condition affecting mental imagery, we can assert that aphantasia (the lack of mental imagery) is related to embodied cognition. Because embodied cognition allows us to experience mental imagery (by grounding mental images in our environment), we can speculate the effect that embodied cognition has on aphantasia– would it mean that aphantasics are unable/less able to ground their mental images into the environment through an offloading process? Or, rather, would it mean that the 'off-line' aspects of our cognition are distorted in our retrieval of mental imagery for the mind's use?

There are certain statements that relate to these two hypotheses about the nature of embodied cognition and aphantasia. Palmiero et al. discussed mental imagery below:

> Since mental images generally rely on representations of things that are not actually present to senses, their activation vary widely according to two characteristics: the individual ability to evoke subjective perceptual and motor experiences manifested in terms of differences in the vividness of images, and the strategy preferentially used in the individual processing of the related sensory information (2019, p. 6).

This argument from Palmeiro et al. brings to our attention that in our processing of sensory information, we may get mental imagery. In terms of the hypotheses listed below, when we retrieve sensory data from the body and process it in the mind, and the information then those offline aspects of our cognition becomes mental imagery, it may

be distorted and thus interrupt how the mental imagery is supposed to be represented. Iachini also states, “Mental imagery can be characterized as a form of deliberate, conscious simulation of multimodal experiences. This simulation mechanism relies on partial re-activation of sensorimotor neural areas supporting previous real experiences.” (2011, 19). This statement supports the idea that aphantasics offline cognition may be distorted upon retrieval of mental images, thus affecting the imagery that they can experience – during what Iachini called ‘conscious simulation of multimodal experiences.’

Based on these statements, we can infer that embodied cognition directly affects the mental imagery that we experience; in the case of aphantasia, it becomes distorted upon retrieval from the body/environment. Our body first intakes sensory information by interacting with our environment. Then, that information is processed by the mind. However, there has been a distortion within the information during the exchange between body, environment, and mind. Thus, the mental imagery is negatively affected, and aphantasic individuals are not able to either experience vivid imagery, or in extreme cases, imagery at all. Because of the assumption that embodied cognition is intrinsically related to mental imagery, and thus aphantasia, we can assume that this relationship may be what affects mental imagery in aphantasic individuals.

The Lessons from Aphantasia and EC

As was discussed above, embodied cognition can allow us to learn more about the way aphantasia works. We stated that it may be so that aphantasia comes about because of a distortion in the interaction between mind, body, and environment in embodied

cognition. Based on literature on mental imagery and embodied cognition, or mental imagery and aphantasia, we were able to synthesize new literature on aphantasia and embodied cognition; to our knowledge this is the first paper to do so.

Because of our combined knowledge on aphantasia and embodied cognition, we were able to discuss the relationship between the two and have thus formed a hypothesis about potential origins of the condition. Mental imagery is a large part of people's lives, and so by viewing it in an embodied cognition we can learn a lot more about the two of them together. Keeping in mind that aphantasia is part of mental imagery, we have been able to think deeper about the condition and learn more interesting ideas related to it from an embodied cognition perspective.

We now know that EC plays a major role in mental imagery, and by extension, aphantasia. It is also important to note that although aphantasia may be caused by a distortion in our embodied cognition, it doesn't detract from our working memory, or other cognitive functions/conditions such as the ability to complete tasks like non-aphantasics. Further research into the true role that embodied cognition plays in the formation or intensification of aphantasia would be extremely beneficial in order to further probe the relationship between the two.

Conclusion

As is now evident, there is a relationship between embodied cognition and aphantasia. We have used pre-existing knowledge on the theories of EC to formulate a hypothesis about the potential origins of aphantasia. By synthesizing new literature and knowledge on aphantasia and EC, we hope that it helps the undergraduate cognitive science

community to better understand the two ideas. Although there is still much research to be done to further confirm our hypothesis, the knowledge gained from this paper is a great step in the right direction for research on cognitive processes involving mental imagery.

It has been shown in our paper that mental imagery (and aphantasia) play a large part in our memory and sensorimotor experiences in embodied cognition. In addition, aphantasia is a multisensory condition that makes the individual rely on different strategies in order to complete a task that someone with mental imagery could easily complete. From an embodied cognition perspective, we have taken a lot of the facets that make up aphantasia and explained them in terminology that makes use of the mind, body, and environment interaction.

Future research needs to be done on the subject of aphantasia and embodied cognition in order to probe the relationship further. Generally, there is a lack of research surrounding aphantasia because the condition is relatively newly named and studied. By using a theory that is more well-understood (embodied cognition), we can learn more novel things about the less understood condition (aphantasia) in ways that we wouldn't have known before. Understanding aphantasia is nowhere near complete, but by using novel approaches to studying cognition like this paper has done, we may be able to learn more information about this condition and similar cognitive processes.

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