Research Proposal – PhD Philosophy

For

Episodic Memory: Uniquely Human Project

&

EMUH PhD Scholarship

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I. Introduction

The ability to remember past personal experiences, known as episodic memory, is a crucial aspect of human cognition (Tulving, 1972; Eichenbaum et al., 2005). Episodic memory allows individuals to recall specific events that have occurred in their lives, including the time, place, and other contextual information of the event (Tulving, 1983). Mental imagery, specifically visual mental imagery, is a quasi-perceptual experience we have when we see from the "mind's eye". The ability to create and manipulate mental images, is closely linked to episodic memory, as it is thought to play a key role in the encoding, storage, and retrieval of episodic memories (Paivio, 1971; Kosslyn, 1980; Pylyshyn, 1973). However, a gap in the current understanding of episodic memory is the phenomenon of aphantasia, the congenital inability to form mental images (Zeman et al., 2015). Aphantasia has been found to be associated with defects in episodic memory (Cacace et al., 2018), and the relationship between mental imagery and episodic memory in individuals with aphantasia is not well understood.

This research aims to investigate the relationship between episodic memory and mental imagery in individuals with aphantasia, specifically by proposing a dual-process theory of mental imagery, examining how the fast and slow systems interact to form and manipulate mental imagery and how this relationship is affected by the absence of conscious mental imagery. The proposed study will take an interdisciplinary and comparative approach, examining behavioral experiments, neuroimaging and philosophical theories to explore this question.

The goal of this project is to fill the gap in the current understanding of episodic memory by investigating the relationship between mental imagery and episodic memory in individuals with aphantasia, and to provide a deeper understanding of the nature of episodic memory and mental imagery by using a dual-process theory of mental imagery as a framework. The expected outcome of this research is to provide new insights into the mechanisms underlying episodic memory and its relationship with mental imagery, and to further our understanding of the relationship between mental imagery and episodic memory in individuals with aphantasia.

II. Towards a dual-process theory of mental imagery

In the current literature, a very limited number of attempts have been made to explain the phenomenon of aphantasia and the ability of aphantasics to achieve certain tasks that are considered to rely on conscious mental imagery. One noticeable feature of the current existing discussion is that many arguments appeal to characteristic categorisations and create dichotomies to explain the different functions of mental imagery. This proposal will take two dominating arguments to illustrate the point.

Bence Nanay, argues for a dichotomy of "unconscious vs conscious mental imagery" (Nanay, 2016) stating that a significant part of mental imagery is unconscious, in the sense that we are not aware of it, and yet it still influences our perception and behaviour. He suggests that unconscious mental imagery is primarily responsible for the rapid and efficient encoding and retrieval of information.

On the other hand, Joel Pearson differentiates between dorsal vs ventral mental imagery (Pearson, 2019, Keogh & Pearson, 2017) suggesting that mental imagery can come in the form of simulating spatial relations, which is crucial for certain kinds of tasks such as spatial navigation and manipulation. He argues that dorsal mental imagery is responsible for the manipulation of information in working memory.

Both Nanay and Pearson's arguments suggest that different forms of mental imagery are mediated by different neural systems, with different characteristics and functions. However, as these theories are relatively recent, and the evidence to support them is limited (Nanay, 2016; Pearson, 2019), it is important to approach them with a critical and open-minded perspective.

However, a single dichotomy or a binary distinction based on a singular set of features often is incapable of fully capturing the complexity and nuances of a certain phenomenon or concept, in this case, mental imagery. For instance, in the case of the arguments made by Nanay and Pearson, the idea of "unconscious mental imagery" and "dorsal mental imagery" are simple dichotomies, as they propose two distinct forms of mental imagery that are mediated by different neural systems and have different characteristics and functions, they imply that there are only two characteristic differentiation of mental imagery and neglect the fact that mental imagery takes on many properties and have many variations. These dichotomies may also oversimplify the relationship between different functions of mental imagery and their neural mechanisms. For example, the argument of "unconscious mental imagery" might be true that some form of mental imagery could be unconscious and have different characteristics, but it is unlikely that all forms of mental imagery are either conscious or unconscious, and neglecting the fact that there might be other forms of mental imagery that are partially conscious or that there might be gradations of consciousness. The characteristic of being unconscious might only be an unnecessary property to a certain process of mental imagery, instead of a differentiating factor of a certain type of mental imagery. Furthermore, both philosophers considered other possible distinctions of mental imagery, such as voluntary vs involuntary, it is unclear how this distinction would integrate conceptually with other types of mental imagery. Therefore, having a dual-process theory of mental imagery will offer a better explanation by taking into consideration the complexity of the features and functions of mental imagery.

Additionally, the simple dichotomies of "unconscious mental imagery" and "dorsal mental imagery" also suggest that mental imagery is mediated by two distinct neural systems that are mutually exclusive. This might not be the case. Mental imagery could involve multiple neural systems, and different forms of mental imagery might involve different combinations of neural systems.

Therefore, these characteristic dichotomies are limited in their ability to fully capture the complexity and nuances of mental imagery, and they should be approached with a critical and open-minded perspective and considered in the context of existing literature and research on mental imagery and the dual-process theory of episodic memory. A dual-process theory of mental imagery offers a more nuanced and comprehensive framework for understanding the different processes of mental imagery, how they interact with each other, and how they are related to episodic memory.

Given these different forms of mental imagery suggested by Nanay and Pearson and the limitations of simple dichotomies to explain them, we propose a dual-process theory of mental imagery (Kosslyn, 1994; Finke, 1989; Paivio, 1971; Pylyshyn, 1973). This theory suggests that there are two cognitive processes involved in mental imagery: a bottom-up process that is driven by the perceptual information to be present in the image and a top-down process that is driven by prior knowledge and. A hypothesis to be examined is that the bottom-up process is associated with the fast, automatic memory system and responsible for the rapid and efficient encoding, storage and retrieval of visual information, while the top-down process is associated with the slow, controlled memory system, responsible for the interpretation, manipulation and organization of the perceptual information in accordance with the prior knowledge. This dual-process theory of mental imagery could explain how the different processes of mental imagery interact with each other, and it allows us to better understand the relationship between mental imagery and episodic memory, specifically in the context of aphantasia where the absence of conscious mental imagery is present.

In addition, this dual-process theory of mental imagery could provide a framework for future research on the neural mechanisms underlying mental imagery and its relationship to episodic memory. By considering both bottom-up and top-down processes, we can investigate how the different forms of mental imagery interact with each other at the neural level and how they are mediated by different brain regions and systems (Kosslyn, 1994; Finke, 1989; Paivio, 1971; Pylyshyn, 1973). Additionally, by examining the neural mechanisms of mental imagery in individuals with aphantasia (Zeman et al., 2015), we can better understand how the absence of conscious mental imagery affects the neural processes involved in mental imagery and episodic memory (Cacace, McQuiggan, & Husain, 2018). Furthermore, this dual-process theory of mental imagery has potential implications for memory-related disorders and conditions, such as aphantasia. By understanding how the different forms of mental imagery interact with each other and how they are mediated by different neural systems, we may be able to develop new interventions and therapies that target specific forms of mental imagery in order to improve episodic memory in individuals with memory disorders.

In summary, in this section, I discussed Nanay and Pearson's arguments regarding different forms of mental imagery, the limitations of simple dichotomies to explain them and will suggest a dual-process theory of mental imagery as a framework that can be used to investigate the relationship

between mental imagery and episodic memory in individuals with aphantasia (Tulving, 1972; Eichenbaum, Yonelinas, & Ranganath, 2005; Cacace, McQuiggan, & Husain, 2018; Zeman et al., 2015). This theory could provide a deeper understanding of the neural mechanisms underlying mental imagery and episodic memory, and may have potential implications for memory-related disorders and conditions (Cowan, 1988; Bodner & Masson, 2011)

III. Some advantages of a dual-process theory of mental imagery

This research project aims to contribute to the Episodic Memory: Uniquely Human?' project, its goal is to offer insight for comparative research in episodic memory of humans, non-human animals, and AI. To achieve this goal, a dual-process theory of mental imagery has many advantages that come from the fruitful philosophical discussion and empirical research outcomes:

From an evolutionary perspective, the dual-process theory of mental imagery can provide insight into how mental imagery evolved and how it serves adaptive functions (Fitch, 2010; Kosslyn, 1994; Finke, 1989; Paivio, 1971; Pylyshyn, 1973). The bottom-up process, associated with the fast, automatic memory system, can be seen as a mechanism for rapidly and efficiently processing and encoding visual information, providing an advantage for survival and reproduction (Cosmides & Tooby, 2000; Gallistel & King, 2009). The top-down process, associated with the slow, controlled memory system, can be seen as a mechanism for using prior knowledge and expectations to guide mental images and make predictions, providing an advantage for problem-solving and decision-making (Tooby & Cosmides, 1992; Cosmides & Tooby, 1996).

From a developmental perspective, the dual-process theory of mental imagery can provide insight into how mental imagery develops and how it is related to other cognitive abilities (Kosslyn, 1994; Finke, 1989; Paivio, 1971; Pylyshyn, 1973). The bottom-up process, associated with the fast, automatic memory system, can be seen as a basic ability that develops early in life, and is closely related to perceptual abilities (Bornstein & Arterberry, 2003; Spelke, 1994; Kosslyn, Thompson, & Alpert, 1995). The top-down process, associated with the slow, controlled memory system, can be seen as a more advanced ability that develops later in life, and is closely related to higher cognitive abilities such as language, reasoning, and problem-solving (Carey, 1985; Piaget, 1952; Karmiloff-Smith, 1992).

In terms of research in animal and AI episodic memory, the dual-process theory of mental imagery can provide a framework for investigating how animals and AI systems form and manipulate mental images (Shepherd, 2010; Kosslyn, 1994; Finke, 1989; Paivio, 1971; Pylyshyn, 1973). Studies on animal models can investigate the neural mechanisms underlying the bottom-up and top-down processes of mental imagery, and how they relate to episodic memory. Additionally, by understanding the underlying neural mechanisms of mental imagery in animals, we can better understand the evolution of mental imagery across different species and how it differs in human and non-human animals (Fitch, 2010; Kosslyn, 1994; Finke, 1989; Paivio, 1971; Pylyshyn, 1973). Similarly, AI research can use the dual-process theory of mental imagery to design AI systems that can form and manipulate mental images in a way that is similar to how humans do (Shepherd, 2010; Kosslyn, 1994; Finke, 1989; Paivio, 1971; Pylyshyn, 1973), comparative research has also shown algorithmic and computational advantages of dual-process system (Kelly&Barron, 2022). This could lead to the development of AI systems that can perform tasks that require mental

imagery, such as visual recognition, problem-solving, and decision-making (Marr, 1982; Kosslyn, 1994; Finke, 1989; Paivio, 1971; Pylyshyn, 1973).

In summary, the project will explore the potential advantages of the dual-process theory of mental imagery from an evolutionary and developmental perspective and how it could improve the understanding of animal and AI episodic memory. By providing a framework for understanding the different processes of mental imagery and how they interact with each other, this theory could improve the understanding of how mental imagery and episodic memory develop, evolve and function in animals, as well as the unique features and functions presented in humans. Also, By understanding the neural mechanisms underlying the multi-process of mental imagery, it could have implications for the design and development of more advanced AI systems.

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