NASHIHA AHMED A RE-EXAMINATION OF COMPUTATIONAL CREATIVITY THROUGH NON-HUMAN ANIMALS BILKENT UNIVERSITY 2020

A RE-EXAMINATION OF COMPUTATIONAL CREATIVITY THROUGH NON-HUMAN ANIMALS

A Master's Thesis

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To Anne, Papa, and Shayan

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ABSTRACT

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The advancement of artificial intelligence suggests signs of computational creativity; however, the case for computational creativity is undermined by an anthropocentric bias. In this thesis, I attempt to broaden the theory of creativity in artificial intelligence by drawing observations from examples of non-human animal creativity. I also illustrate how this works in parallel with the 4E cognition theory. I conclude that addressing the underlying anthropocentric bias in evaluation of creativity in this way (1) allows a stronger case for computational creativity and (2) develops a more informed theory of creativity.

Keywords: 4E Cognition, Animal Creativity, Artificial Intelligence, Boden, Computational Creativity

ÖZET

BİLİŞİMSEL YARATICILIĞIN BEŞERÎ OLMAYAN HAYVANSAL YARATICILIK ÜZERİNDEN TEKRAR İNCELENMESİ

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Yapay zekânın yaygınlaşması bilişimsel yaratıcılığın izlerinin yapay varlıklarda da olabileceğini düşündürmektedir, ancak bu argüman yaratıcılığın beşerî tanımıyla önyargılı bir şekilde zayıflamaktadır. Bu tezin ana amacı yapay zekâ yaratıcılığı teorisini insan-haricî hayvanların yaratıcılıklarından örnekler ile biraz daha genişletmektir. Aynı zamanda 4E Bilinç (Vücutlaştırılmış Bütünleşik Edimsel ve Uzamsal Bilinç) teorisiyle paralellerle bu argüman örneklemlendirilmiştir. Sonuç olarak, beşerî yaratıcılık önyargısının bu şekilde ele alınması ilk olarak bilişimsel yaratıcılığın olasılığını güçlendirmekte, ikinci olarak da yaratıcılık teorisinin derinleştirilmesini sağlamaktadır.

Anahtar Kelimeler: Bilişimsel Yaratıcılık, Boden, Hayvansal Yaratıcılık, Vücutlaştırılmış Bütünleşik Edimsel ve Uzamsal Bilinç, Yapay Zeka

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INTRODUCTION

A theoretical paradigm shift in philosophy and cognitive science from Cartesian materialism (Dennett, 1991) to an embodied, embedded, enactive, and extended (4E) theory of cognition has introduced novel views on the relationship between the mind and body. These novel views are reflected in the theoretical framework behind research in artificial intelligence (AI). Deep learning, a sub-field in machine learning, is one example of the results of this theoretical paradigm shift in AI. Another result is the creation of intuitive, enactive, or autonomous intelligent robots. These innovative advancements in artificial intelligence research ushered the emergence of complex features likened to features of human cognition. One of these complex features is creativity. Although feats of artificial intelligence caused by the theoretical shift are impressive, many scholars claim that it is not clear whether artificial intelligence research has achieved creativity, or whether it merely *appears* to display signs of creativity. Consequently, many scholars contest whether computational creativity is genuine.

Verifying the validity of computational creativity requires both an assessment of the nature of creativity and examining criteria for the evaluation of creativity. Leading philosophers, such as Margaret Boden, have done ample work in the intersection of the philosophy of creativity and the philosophy of artificial intelligence; however, the approach to the theory of creativity has fundamental issues. The approach to the ontology of creativity, especially with relation to artificial intelligence, is radically anthropocentric. Inquiry of the nature of computational creativity is fraught with direct comparison to human creativity, an extension of a dogma in the philosophy of artificial intelligence. This underlying anthropocentric bias leads many philosophers to dismiss computational creativity as legitimate creativity and discredit artificial intelligence agents as creative agents. Moreover, the theory is outdated and has not taken recent advancements in the field of AI into account. Thus, I will explore creativity in non-human animals in the context of 4E cognition in this thesis project. I argue that by expanding the theory of creativity to further consider non-human animals, the evaluation of creativity in AI is no longer restricted to a misinformed, anthropocentric definition of creativity. The thesis also investigates how the answer to the question is neither binary nor dependent on delving into obscure discussions in artificial intelligence, such as those about intelligence, agency, intentions, motivation, and emotion.

I aim to expand Boden's theory of computational creativity by looking at creativity in non-human animals in the context of 4E cognition. In **Chapter 1,** I start by briefly reviewing main concepts in artificial intelligence, including the definition of artificial intelligence. I discuss the debate on the possibility of *intelligence* in artificial intelligence, centering the debate on Alan Turing's theory and his intention behind developing the imitation game. I also discuss how discourse in philosophy of mind, particularly regarding the relationship between the mind and body, framed further advancements in artificial intelligence. One of the core advancements is the formulation of connectionism, which was framed by the aforementioned theoretical paradigm shift that led to the development of 4E cognition. I then discuss how this theoretical shift in artificial intelligence led to stronger evidences of computational creativity in artificial intelligence research.

Chapter 2 continues the conversation on creativity by reviewing philosopher Margaret Boden's theory of creativity. In this chapter, I discuss how Boden extends her theory of creativity to computational creativity, indicating both the challenges and feats of computational creativity. I demonstrate how Boden's conception of creativity is consistent with 4E cognition. I conclude the chapter by arguing that the conception of creativity in artificial intelligence is centered on human creativity, thereby making the approach to the theory of creativity anthropocentric. I argue that the anthropocentric view on creativity should be adjusted to explore creativity in non-human animals.

In **Chapter 3**, I argue for the legitimacy of the existence of creativity in non-human animals. I claim that the main reason that creativity in non-human animals is doubted is, again, an anthropocentric bias. Through several examples of non-human animal creativity, I draw observations on creativity that can be applied to and observed in artificial intelligence. I also demonstrate how Boden's theory of creativity applies to non-human animals, as well as how 4E cognition relates to non-human animal creativity

In **Chapter 4**, I address anticipated replies to arguments presented in my thesis. I conclude that computational creativity should be re-examined through consideration of creativity in non-human animals. I demonstrate how assessment of creativity in non-human animals is consistent with 4E cognition theory and its effects on artificial intelligence research. In this process of re-examination, I argue that there is not only a stronger case for computational creativity but also that the theory of human creativity is more informed by expanding views on creativity beyond *anthropocentrism*. Creativity is not a unique feature reserved for human cognition but a shared skill in human and non-human agents.

CHAPTER 1

THE ADVANCEMENT OF ARTIFICIAL INTELLIGENCE

The philosophical theory behind artificial intelligence (AI) has varied since the birth of the field. The changing nature of the theory is partly due to continuous practical advancements in technology. Advancements in technology have been both the causal factors and the effects of these theoretical changes. This dynamic cause-and-effect cycle of practical implementation in research and the philosophical theory underlying artificial intelligence has made it difficult to establish a concrete definition of artificial intelligence.

While the term is mostly perceived in the popular imagination as talking robots from science-fiction, real-world artificial intelligence comes in different forms. Artificial intelligence not only takes the form of machines but also the form of simulations or programs. In this thesis project, I take all forms of artificial intelligence into consideration. Moreover, I will also be focusing on strong AI rather than weak AI. Weak AI is the kind of artificial intelligence created through supervised programming. The responses of the AI to a stimulus are *pre-programmed*, meaning they are essentially decided beforehand by human programmers. Weak AI agents are more common than strong AI as well. Some examples of weak AI are personal assistants, such as Siri or Google Assistant. Strong AI, on the other hand, is a result of unsupervised programming, where the responses of strong artificial intelligence agents to stimuli can be unpredictable. One such strong AI is Google DeepMind's Agent57, which learned how to play 57 Atari 2600 games with deep reinforcement learning (Puigdomènech et al., 2020).

Scholars debate the definition and purpose of artificial intelligence. Many scholars define the purpose of artificial intelligence as making programs that work like human minds (Boden, 1990). Consequently, artificial intelligence agents would perform tasks that humans perform. Some tasks require the kind of intelligence involved in high-order operations, such as offering legal expertise, creating mathematical and scientific theorems, and writing a novel. Humans must develop skills through education and training to perform these high-order operations (Boden, 1990). Other tasks are basic. Humans may perform these irrespective of educational background and training (Boden, 1990). Non-human animals are also able to perform these tasks. These tasks include traversing an obstructed environment, scouting terrain, surveying and developing an area, gathering objects for a target goal, or basic communication.

Philosopher and scientist Margaret Boden suggests a definition of artificial intelligence that avoids assumptions underlying the definition. She claims that artificial intelligence is “the development of computers whose observable performance has features which in humans we would attribute to mental processes" (Boden, 1990: 1). Here, the anthropocentric bias underlying Boden’s approach to her theory of creativity is already apparent through a quick analysis of her statement on the definition of artificial intelligence. Some scholars suggest a general and more controversial definition of artificial intelligence: “the study of intelligence in general” or “the intellectual core of cognitive science” (Boden, 1990).

For the purposes of this thesis project and my investigation of creativity, particularly in relation to artificial intelligence, I will challenge Margaret Boden’s definition of artificial intelligence. I take a more liberal stance on the definition yet more restricted than the general definition of artificial intelligence as “the study of intelligence” (Boden, 2009: 1) or “the intellectual core of cognitive science” (Boden, 2009: 1). I remove the ascription of mental processes solely to humans from Boden’s definition in order to include mental processes by non-human agents. I also assert that mental processes are not only observed through behavior but can also be identified in an agent’s method during a mental process. The signs of such methods are not always apparent in observable performances. To restate Boden’s definition of artificial intelligence: artificial intelligence is the development of computers whose observable performance *or whose methods* have features which *in human and non-human agents* we would attribute to mental processes. Ideally, to completely remove anthropocentric notions in the definition, I could also contest the necessity of humans evaluating mental processes. However, as discussed later in the thesis, removing humans out of the evaluation process completely is not feasible as of yet.

Boden also states that the goal of artificial intelligence is to “provide a systematic theory that can explain (and perhaps enable us to replicate) both the general categories of intentionality and the diverse psychological capacities grounded in them” (Boden, 1990: 1). Traditional philosophy of artificial intelligence related to research in artificial intelligence by providing a conceptual navigation of the validity of this endeavor (Boden, 1990). In other words, philosophers of artificial intelligence theoretically investigated whether this ambitious venture was conceptually sound or misguided and futile (Boden, 1990). The goal of both the practical implementation and philosophy of artificial intelligence has diversified over the last decade, as scholars have fallen on both sides of the philosophical stance. While some researchers attempt to provide a systematic theory that can explain human cognition, and while some philosophers theoretically investigate the possibility of such an endeavor, many investigate other phenomena in the theory of artificial intelligence, setting aside the mysteries of the human mind. Yet, there is still a discrepancy between the traditional goal of artificial intelligence and its practical implementation underlying some research and philosophy in the field of artificial intelligence.

To understand this discrepancy, an analogy of modeling a bird can be helpful. One can create an exact model of a bird based on observable qualities, knowledge of the anatomy and physiology of birds, and other necessary data. However, in attempting to create an exact copy of a bird, it is highly likely that the bird will not be able to fly. On the other hand, if one wishes to model a feature exhibited by a bird, such as flight, it is possible to do so without having to create an exact model of the bird. In fact, the object that can fly will have differences in features and flight mechanisms than that of the bird, as it is in the case of an airplane. One may also attempt to model bird-like flight (as opposed to forms of flying observed in other organisms). Each case’s model will likely look different from the other. Similarly, the goals of artificial intelligence shape the practical implementation. The goal of trying to exactly replicate human cognition based on limited knowledge may undermine the process of implementing

artificial cognition. Likewise, studying the human brain and attempting to replicate it may not necessarily result in the ability to create or understand cognition.
It should not be misunderstood that any attempt at investigating the theory behind human cognition is fruitless. Investigating the theory behind objects that fly, such as the bird, is worthwhile as it would give insights on how to create an object that flies. Similarly, the process of creating an object that flies, such as the airplane, may give insights on how birds fly. Such is the case in artificial intelligence as well. The theoretical investigation in understanding human cognition may inform the practical implementation of creating cognition in artificial intelligence, comparatively the practical implementation in artificial intelligence research may provide valuable insights in understanding human cognition. However, just as a bird and an airplane do not have the same mechanism in flying, artificial intelligence agents and humans will have different mechanisms and features in exhibiting features of cognition.

The traditional goal of artificial intelligence led researchers to attempt creating consciousness in artificial intelligence that was an exact replica of what was known about human cognition. To use the analogy, this is similar to creating an exact replica of a bird that can also fly. Philosophers at the time attempted to assess whether this is a worthwhile process. Yet both attempts were futile as they depended heavily on information and technology not yet present. Restricting the goals of both research and philosophy in the field of artificial intelligence to current knowledge of human cognition impedes valuable advancement in the field. Thus, underlying assumptions and theoretical flaws must continue to be addressed to better direct research and theoretical investigation in AI.

Goals of artificial intelligence also shaped advancements in artificial intelligence by creating a new branch in AI research that gave rise to 4E cognition. The two major branches in artificial intelligence are symbolic and connectionist AI. Symbolic AI is also commonly known as GOFAI ("Good Old Fashioned AI"), which is a misleading title, as symbolic techniques are still used in the field of artificial intelligence (Bajada, 2019). This technique or branch of AI encodes the model of the problem in the program (Bajada, 2019). The program then processes input data according to the model and provides a solution (Bajada, 2019). Symbolic AI technique is straightforward. The behavior of the program is predictable and explainable, unlike connectionist AI programs. One of the most popular connectionist systems is artificial neural networks. Walter H. Pitts and Warren S. McCulloch (1943) proposed neural networks based on studies and analysis of biological neural networks in animal brains. In programming a neural network, the programmer does not specify rules or input the model of the problem in the program (Bajada, 2019). Rather, the network *trains* or *learns* how to give a solution.

The difference between IBM's Deep Blue and Google's Alpha Zero, two artificial intelligence agents programmed to play board games, explicate the distinction between symbolic AI systems and connectionist AI systems. Deep Blue was the first chess-playing computer to win a chess game against a world champion, when it beat Garry Kasparov in 1996 (Campbell, Hoane, & Hsu, 2002). It implemented a symbolic approach to playing chess. The algorithm was given the model of a chess game, which included the rules, moves, and goals of chess (Campbell et al., 2002). It played chess by using a brute-force search algorithm to search for winning moves through a solution space, looking through millions of possible moves (Campbell et al., 2002). This is unlike how a human player plays chess. On the other hand, Google's AlphaZero, which has beaten the world-champions of chess, Shogi, and Go, employs a deep learning algorithm, a type of neural network. AlphaZero is unlike Deep Blue in that it is not given the thousands of rules and heuristics of the game (Silver et al., 2018). AlphaZero is only given the basic rules of the game and uses reinforcement learning to *teach* itself how to play through trial-and-error (Silver et al., 2018). The algorithm is highly flexible and dynamic. At first, it plays completely randomly, but over time the system learns from wins, losses, and draws to adjust the parameters of the neural network, making it more likely to choose advantageous moves in the future (Silver et al., 2018).

Connectionist AI gave rise to intuitive and enactive artificial intelligence agents. A shift in the view of the human mind from a Cartesian-split-mechanistic (Overton, 2013) view, or Cartesian materialism (Dennett, 1991), to the 4E cognition theory inspired connectionist AI. Traditional cognitive science and philosophy of mind was largely inspired by the Cartesian-split-mechanistic view (Overton, 2013), whereas 4E theory is a nascent theory of cognition. The core discrepancy between traditional cognitive science and 4E cognition is how the two theories relate the brain and extracranial body processes to cognition. Traditional cognitive science maintains that cognitive processes are realized solely by brain processes.

Proponents of the 4E view, such as Shaun Gallagher and Andy Clark, have argued against the core claim of Cartesian materialism (Dennett, 1991) that cognition is situated in the brain (Newen, Gallagher, & Bruin, 2018). 4E cognition maintains that cognition is *embodied*, *embedded*, *extended*, and *enacted*. Cognition is *embodied* in the sense that it involves extracranial bodily processes (Menary, 2010). It is *embedded* in that it is dependent on extra-bodily processes in an agent's environment (Menary, 2010). Cognition is *extended* in that cognizing can extend outside the body to extra-bodily processes (Menary, 2010). Finally, cognition is *enacted* in the sense that cognizing involves the agent's *active* involvement with any component of the extra-bodily system (Menary, 2010). While proponents of embodied cognition all have different views on each of the four aspects of 4E cognition, all agree that cognition involves more than processes that occur solely in the brain. As Clark and Chalmers (2010: 29) poignantly articulate, "...the human organism is linked with an external entity in a two-way interaction, creating a *coupled system* that can be seen as a cognitive system in its own right. All the components in the system play an active causal role, and they jointly govern behavior in the same sort of way that cognition usually does."

McCulloch and Pitts (1943) proposing the artificial neural networks system based on a model of the human mind is one example of how theories of the mind shape advancements in artificial intelligence. The claim of Cartesian materialism (Dennett, 1991), that mental activities are situated solely in the brain, influenced designs of traditional artificial intelligence algorithms. A top-down structure, heavy data-processing, and rule dependence (based on a "breakdown of intelligence to processable symbols") are some features of GOFAI techniques in AI influenced by Cartesian materialism. A program's moves and actions were directly influenced by input data, models, rules, and heuristics, coded by the programmer. As philosophers and psychologists proposed alternative views to Cartesian materialism, connectionist techniques emerged. Artificial intelligence agents that relied less on input data, models, rules, and heuristics depended more on the interaction of the agent with its environment.

Artificial intelligence agents designed to simulate human walking illustrate the impact of theoretical and philosophical changes in artificial intelligence research. Traditional robots were *instructed* exactly how to walk through models consisting of symbols and equations in the form of algorithms that represent walking. For instance, one process in the algorithm may instruct the agent to move its left leg and right arm a certain degree while keeping the agent balanced. Although these movements were based on symbol manipulation and equations that model walking in humans, the resulting movements of the agent were aberrant. The reaction to the failure in effectively simulating artificial walking was to improve the input model that captured human walking. While improving models of human locomotion enhanced the movements of the artificial intelligence agents, the robustness of the artificial movements paled in comparison to human walking. Developments in AI research mirrored the recognition of the importance of extracranial bodily processes in simple human operations like walking. Programmers allowed artificial intelligence agents to rely more on environmental factors and less on input data. In the case of simulating locomotion, one illustration is artificial intelligent robots relying on sensors placed on the "limbs" (so to speak) of the robot to detect obstacles.

Google's Deepmind Technologies designed simulations of agents that used neural networks to engage in flexible and natural locomotion (Heess, Merel, & Wang, 2017). The simulation is given only high-level objectives, such as moving forward without falling (Heess et al., 2017). It is also given the capacity to interact with its environment (Heess et al., 2017). Trial-and-error by the agent in the simulation results in the emergence of complex locomotion, resembling robust locomotion in animals (Heess et al., 2017). The kind of flexible, adaptive, and unpredictable behavior observed in artificial intelligence agents, such as the locomotion system by Google's Deepmind, proposes the possibility of the realization of other features of human cognition. Speculations on the possibility of artificial intelligence simulating human intelligence, and perhaps even surpassing it, re-emerged.

Although discussion on machine intelligence is particularly relevant to contemporary artificial intelligence, scholars have scrutinized the possibility of machine intelligence since the outset of the field of AI. The earliest debates on a machine's ability to think centered around the ideologies of Alan Turing (1990), one of the most influential figures in the field. In his paper, "Computing Machinery and Intelligence" Turing (1990) analyzes the question, "can machines think?" Turing responds with a zealous affirmation in the ability of machines to think, but he also criticizes the question and the philosophy relevant to it. Turing argues that the answer to the question must be given in a way that does not depend on a previous definition of intelligence (Turing, 1990). He thus devises an "imitation game," commonly known as the Turing test. A human questioner interrogates two respondents, a computer and a human, in the imitation game. The game tests whether a computer can reply to an interrogator "in a way indistinguishable from the way a human being might reply" (Boden, 1990: 4). By assessing the behavior of a computer to a specific game, the "meaningless" (Turing, 1990: 40) question becomes a precise and productive discussion, according to Turing (1990).

In addition to the objections Turing (1990) addresses in his paper, there are three types of attacks on his paper. The first type is the argument against behaviorism, claiming that the imitation game heavily relies on assessing the behavior of the respondents in the game. The second type of responses to Turing's paper argues that computers must satisfy a precondition to be intelligent. For instance, Dreyfus (1979) argues that computers cannot be intelligent without an animate body form. Others question whether computational approaches can actualize some essential aspects of human consciousness, such as intentionality (Boden, 1990), motivation, and emotion (Dreyfus, 1979; Haugeland, 1985), thus making the goal of achieving intelligence in AI intangible.

The third attack on Turing's argument is on his assumptions regarding the formalizability of factors required for a machine to be intelligent, such as common sense. While some share the faith in formalizability of common sense, such as Hayes (1990), Newell and Simon (1990), others argue that it is possible for machines to achieve the kind of flexibility that human minds possess without having to ascribe to a faith in formalizability. While formalizability of common sense is debated, it is still possible to imagine it being modeled when compared to aspects of human cognition such as motivation and emotion. Dreyfus (1979) and Haugeland (1985) call into question any remote possibility for motivation and emotion to be simulated artificially. This poses a problem for artificial intelligence as motivation and emotion are crucial aspects in human cognition. Motivation, intention, and emotion drive and alter actions of humans and are deeply interlinked with the perception of the human self.

Though replies to Turing's theory may pose a strong threat, I agree with Turing's (1990: 40) motivation in developing the imitation game:

> I propose to consider the question. 'Can machines think?' This should begin with definitions of the meaning of the terms 'machine' and 'think'. The definitions might be framed so as to reflect so far as possible the normal use of the words, but this attitude is dangerous. If the meaning of the words 'machine' and 'think' are to be found by examining how they are commonly used it is difficult to escape the conclusion that the meaning and the answer to the question, 'Can machines think?' is to be sought in a statistical survey such as a Gallup poll.

Here, Turing argues that the question on a machine's ability to think creates an intuitive response that leads philosophers to investigate definitions of the terms *machine* and *think*, but relying on highly debated definitions subverts the reliability of answers (1990). He also notes that colloquial usages of the terms cloud judgment on the ability of machines to think (Turing, 1990). Thus, he poses that the investigation be made more precise by observing and checking the mechanisms behind the responses of machines to tests.

One of the major issues in the question that Turing does not not directly address is the anthropocentric bias in the perception of *thinking*. In other words, the knowledge of *thinking* or of human cognition is often restricted to thinking in humans, since it is the most familiar and accessible kind of thinking. Artificial intelligence, by nature of being *artificial*, will never exactly be like human intelligence, yet the philosophy of artificial intelligence often stumbles into a pitfall of comparing and modeling artificial intelligence with human intelligence due to this preconception. Thus, I propose the recognition of cognition be expanded to include cognition in other agents, such as in non-human animals. I do not recommend forgoing definitions completely as Turing does, since the process of formalizing an abstract subject such as *thinking* can in of itself prove useful in shedding light on the topic. Understanding differences in definitions proposed by different scholars can also provide clarity in noting what should be kept and removed in the theory. As Turing (1990) points out, however, philosophers should be apprehensive about relying on definitions in the field of artificial intelligence, as much of cognition remains obscure.

In assessing the possibility of creativity in artificial intelligence, scholars encounter a similar challenge. Investigating computational creativity is all the more precarious due to (1) limited literature on the intersection of creativity and artificial intelligence and (2) the newness of the emergence of creativity in AI. Because of this, I will offer the shortcomings of the current theory of computational creativity by proposing the consideration of creativity in non-human animals in Chapter 3. However, I will first delve into the formal concepts behind a general theory of creativity and computational creativity in the next chapter.

CHAPTER 2

THE ANTHROPOCENTRIC APPROACH TO CREATIVITY

Before investigating creativity in artificial intelligence, I will provide a conceptual navigation of theories on general creativity. In particular, this thesis project focuses on the theory of creativity presented by philosopher and scientist Margaret Boden. Boden's reputation as one of the leading scholars in the philosophy of creativity is followed by her thorough work in the fields of psychology, philosophy, cognitive science, and artificial intelligence. Her theory on creativity is comprehensive of prevalent ideas in the philosophy of creativity. Boden's work on the creativity in artificial intelligence is especially relevant to this thesis investigation. Thus, I will start by providing an overview of Boden's theory of creativity, beginning with her definition of creativity.

A creative idea, according to Boden, is one that is *novel*, *surprising*, and *valuable* (Boden, 1998: 347). Creativity is a *feature* of general human cognition, not a special *faculty* reserved for a unique group of people (Boden, 1998: 347). Creativity arises in diverse areas of human behavior: the most familiar of which are the visual and performative arts, music, and literature. Creativity is present in science and mathematics in formulating theorems, as well. Boden also asserts that creativity is grounded in aspects of everyday life (Boden, 1998: 347). It can emerge in problem solving and startegizing, imagination, memory, reflection, and ideation. Although Boden provides clarity on what constitutes a creative idea, her definition of a creative idea raises questions on the topics: novelty, surprise, and value. It calls into consideration the preconditions required for an idea to be novel, surprising, and valuable, making it a *creative* idea. Boden provides answers for these concerns. She starts by characterizing two types of creativity: P-creativity and H-creativity (Boden, 1996).

P-creativity (where “P” stands for psychological) is the kind of creativity that is creative with respect to only the mind of the creative agent concerned (Boden, 1996). In other words, the idea is novel, valuable, and surprising when considering solely the context of the creative agent (Boden, 1996). It is a *personal* creativity. An illustration of P-creativity is a toddler making a castle out of playing blocks when she has never done this before. It is not that the castle made of playing blocks has never been seen before, but it would still be regarded a creative act in some respects. The girl’s parents, in particular, would note the act as a creative one with regard to the context of the toddler. It is *novel* to the mind of the toddler. It is *surprising* since the toddler has never maneuvered blocks to make a castle before. It is *valuable* to the parents and toddler for many reasons which could include it being interesting or aesthetic.

Contrarily, H-creativity (where “H” stands for historical) is the kind of creativity that is creative with respect to current knowledge of the entirety of history (Boden, 1996). Of the two types, P-creativity is a more “fundamental notion of creativity” (Boden, 1996: 268) in that H-creativity is a special case of P-creativity (Boden, 1996). It is the kind of creativity that is more notable to a larger audience (Boden, 1996). Great works like Einstein’s theory of relativity, Van Gogh’s *Starry Night*, and Hayao Miyazaki’s *Spirited Away* are examples of H-creativity.

In addition to these categories of creativity, Boden defines three techniques in a creative process: combinatorial creativity, exploratory creativity, and transformational creativity (Boden, 2005). Combinatorial creativity is accomplished by the novel or improbable combinations of familiar ideas (Boden, 2005). An example of this is using creative analogies or metaphors in speech or writing. Exploratory creativity is the generation of novel and unexpected ideas by navigating structured conceptual spaces (Boden, 2005). Boden defines conceptual spaces as “structured styles of thought” (Boden, 2005: 4). Culture and society form and shape conceptual spaces (Boden, 2005). Thus, ideas developed from exploratory creativity are both within the confines of conceptual spaces and also novel and unique. An example of this is Pixar’s *Inside Out* which is novel in that it has a unique story and borrows frameworks from psychology, a separate conceptual space. Yet, it fits within the confines of Disney/Pixar style of storytelling as well as the conceptual space of animation. Transformational creativity is accomplished by changing one or more dimensions of the conceptual spaces, such that it opens up new avenues for instances to be generated which could not have been generated before (Boden, 2005). The birth of jazz in New Orleans, led by distinguished musicians Louis Armstrong and Buddy Bolden, can be listed as an example of transformational creativity. This is the kind of creativity where seemingly "impossible" creative ideas come about.

Boden elucidates the relation between the three techniques of creativity and P- and H-creativity as well. H-creative agents are generally noted for transformational creative acts, while combinatorial creativity is more commonly a P-creative act. Exploratory creativity lies between transformational and combinatorial creativity in its relation to H-creativity and P-creativity. Furthermore, transformational creativity often produces the highest degrees of creativity in comparison to exploratory creativity. Similarly, exploratory creativity often produces higher degrees of creativity when compared to combinatorial creativity. Yet, this relationship between the three techniques of creativity and the two categories of creativity, P- and H-creativity, does not always hold. Shakespeare revolutionized the modern English language by engaging in combinatorial creativity through his creation of new words by combining familiar concepts. Techniques in creativity are also not mutually exclusive. Shakespeare's creativity in his manipulation of language can also be classified as transformational creativity.

Boden addresses novelty and surprise through her formulation of the categories and techniques of creativity; however, she does not fully explore the *value* of an idea due to the elusive nature of the subject. Boden explicates, "Our aesthetic values are difficult to recognize, more difficult to put into words, and even more difficult to state really clearly" (Boden, 2005:10). Moreover, values change, vary across culture, and are often disputed (Boden, 2005). Yet, Boden does address the importance of positive evaluation of interest and value of a creative idea or artefact (Boden, 2005). She states that evaluation is essential in determining what is creative but also notes the difficulty in systematically explaining the criteria for evaluating an idea as creative (Boden, 2005). She remarks that an idea need not be interesting and valuable objectively but can be recognized as such in a specific period of time by a specific group of people (Boden, 2005). This is true for both H-creativity and P-creativity. In the illustration mentioned before of the toddler's creativity in building a castle out of playing blocks, one need not agree with the parents of the toddler in evaluating whether their daughter has done a creative act. Likewise, suppose one did not consider Banksy a creative artist. This disagreement would not alter his status as a creative person. The perception and evaluation of creativity also depends on popularity and acceptance, although not fully. Evaluation of creativity depends on the reliability of the assessors of creativity, as well. Suppose Banksy was not popularly known as a creative genius. If Damien Hirst, who is popularly regarded as a creative genius, endorses Banksy as a fellow creative, a stronger case is made for Banksy's creativity, regardless of whether it is popular opinion.

Other than the challenge of formulating value, one of the greatest challenges in determining whether a person or idea is creative is addressing intentionality. Does the agent have to recognize the idea as creative for the agent herself to be called creative? Does the agent have to make an active effort with the intention for the project to be creative for it to be creative? I argue that the answer to both questions is that the agent does not necessarily have to make an active effort with an intention for the project to be creative. The agent also does not have to recognize the idea or project as creative. Creative agents often come upon creative ideas without intense deliberation. As Boden stated, creativity is grounded in everyday activities. Creativity can emerge out of acts that are not intentionally targeted to be creative. Likewise, an agent that performs a creative act may not recognize the creativity of the act, even if it is evaluated as creative by others. Evaluation of an idea as creative and of an agent as creative are also distinct. It is possible to deem the agent as "creative" and the idea by the creative agent as not creative, or vice-versa. Other than these observations on the evaluation of creativity, not much is concrete. Evaluation in creativity remains vital to the concept, yet evades formal structure and definition. There is no purely psychological or ahistorical theory that can accurately and holistically explain evaluation in creativity (Boden, 1996).

Boden also stresses how creativity is interlinked with other features of human cognition, like motivation and emotion (Boden, 1990), as well as features of human behavior, such as sociality (Glăveanu, 2014; Bickhard, 2017). Creativity is interrelated with the agent's cultural context and personality as well (Boden, 1990). Creativity is not a stand alone feature of cognition. It is interlinked with features of cognition and behavior in that without the complex interaction of these features of cognition and human behaviors, creativity cannot exist. For example, motives direct and drive creative action. In the case of the toddler creating a castle out of playing blocks, her motives may have been to engage in play, call her parents' attention, or model an image of a castle she saw before among other possible options. Her motives were the driving force behind her creative expression. Behaviors such as sociality also influence an agent's creativity. An agent's creativity may emerge from interaction with other agents, such as in sparring where a contestant may creatively respond to another contestant's movements. The interrelation of creativity with other features of cognition and human behavior contest Cartesian materialism, where features of cognition are stand alone and realized by independent brain processes. Thus, Boden's views are consistent with a 4E cognition standpoint, since she views creativity as grounded in everyday capacities, where creativity can emerge in an agent's interaction with extracranial and extra-bodily processes.

Boden also specifically assesses creativity in artificial intelligence. Her research of artificial intelligence agents elucidates how difficulty in formalizing the evaluative criteria of creativity is one of the greatest challenges in computational creativity. As aforementioned, there is no holistic theory that accurately and precisely formulates human values. The complexities of human values are difficult to encapsulate, which is a bottleneck for evaluation of creativity in artificial intelligence. While there are aspects of value that are clear, such as the dependence of evaluative criteria of creativity on the domain of a proposed creative idea (i.e., evaluative criteria of creativity in traditional art depends on the traditional art conceptual space), as well as social and historical facts, some factors are still missing from the current understanding of value. Nevertheless, by assessing the *process* of an artificial intelligence agent instead of the artefacts or ideas produced by the agent, it is possible to examine the possibility of creativity by the agent.

According to Boden's account on creativity (Boden, 1996), an artificial intelligence agent can be creative in three ways: it can be creative by producing novel combinations of familiar ideas (combinatorial creativity), exploring the potential of conceptual spaces (exploratory creativity), and making transformations that enable the generation of previously impossible ideas (transformational creativity). Although Boden's research in artificial intelligence is outdated, and she analyzes older research in AI that exhibit weaker forms of creativity, Boden still recognizes the existence of creativity in AI. (In the following paragraph, I will explore a recent example of a creative AI, since current advancements in AI make stronger cases for the possibility of computational creativity). In her analysis of the field, Boden has found that exploratory creativity is the most successful in artificial intelligence (Boden, 1996). Combinatorial creativity is challenging for AI due to the difficulty in approaching the richness of human associative memory (Boden, 1996). Transformational creativity is also challenging for AI because of the aforementioned problem of evaluation: It is difficult to identify human social and cultural values and express them in computational form (Boden, 1996). Boden has also found that artificial intelligence models tend to focus on the cognitive aspect of creativity rather than the cultural context and personality factors involved in the creative process. Like value, this is a result of the ambiguous nature of culture and personality.

Although Boden's research provides valuable insights, an assessment of a recent creative AI, the Painting Fool, allows for an expansion of Boden's theory of creativity. The Painting Fool is an AI that creates visual art. It has three kinds of behavioral modes: skillful, appreciative, and imaginative (Colton, 2012). The skillful behaviors of the Painting Fool are based on the physical painting process (Colton, 2012). The Painting Fool abstracts regions of color based on input digital photographs and simulates non-digital or traditional media used in physical painting (Colton, 2012). One example of the Painting Fool's appreciative behavior is its artistic depiction of the Afghanistan war. It created a collage based on an article by the Guardian on the war. The Painting Fool used generative techniques from deep learning and Computer Graphics to display imaginative behaviors. It invented visual objects and scenes that have not existed before in reality through its imaginative behavior. These three behaviors are related to Boden's three creativity techniques in her account of creativity.

The Painting Fool uses a combination of all three techniques discussed by Boden: combinatorial, transformational, and exploratory creativity. The combinatorial technique is seen in its skillful behavior where it simulates the physical painting process. The exploratory technique is seen in its appreciative behavior, where it creates a collage, navigating the conceptual space of collage making and ideologies regarding war. It does this by using data from the article by the Guardian. Finally, it can be argued that The Painting Fool employs transformational creativity in its imaginative behavior. The Painting Fool explores the conceptual space and creates novel ideas, but it could even be argued that the Painting Fool transforms the dimensions of the conceptual space. It accomplishes transformational creativity by reconstructing the conceptual space of visual objects and scenes and changing one of its dimensions to create ones that do not exist in reality.

The process of evaluating creativity in AI like the Painting fool makes ambiguities in the theory of creativity even more apparent, such as the interaction of agency and intentionality with creativity. Many scholars challenge the notion that agency and intentionality can exist in AI. If an AI has a creative idea or produces a creative work, scholars challenge the attribution of agency to the AI itself. The same is true for intentionality. Many would contest whether intentionality exists in AI. Scholars may comment that the programmers and engineers behind the AI have intentionality and agency, which is reflected in the agent's work, or that creativity does not require intentionality and agency. For the time being, I will leave my comments on this topic and revisit the relationship between creativity, intentionality, and agency in Chapter 4. I opened the discussion in this chapter to highlight how considering creativity in AI can help scholars reflect on assumptions and preconceptions underlying the current theory of creativity. This is also to set the tone for Chapter 3 where ambiguities in the theory of creativity are viewed in the context of creativity in non-human animals.

The Painting Fool's goal of "being taken seriously as a creative artist in its own right" (Colton, 2012: 3) draws attention to one of the core preconceptions underlying creativity: the anthropocentric bias underlying our judgment of creativity. The judgment on AI producing creative work tends to be met with skepticism and even disregarded when consumers of the creative work discover that the work is by an artificial intelligent agent (Colton, 2008). People judge creative ideas not only by the creative artefact but also the process and its agent (Colton, 2008). The anthropocentric bias may be present for many reasons. Firstly, it is uncertain whether AI has features related to creativity, such as motivation, emotion, sociality, and flexibility. Additionally, the difficulty of formulating values makes it difficult to objectively evaluate creativity in agents. Because of this, consumers of creative work resort to intuitions. Finally, the lack of exposure to creativity in non-human agents strengthens the anthropocentric bias. Evaluators are then less likely to attribute creativity in non-human agents, creating a cycle where the bias exists and becomes a dogma of the theory of creativity.

As mentioned in the previous paragraph, human intuition plays against the legitimacy of creativity in AI due to a biased belief that creativity is unique to the human species. This adds to the anthropocentric nature of approach to the conceptualization of creativity. In the case of AI, the reference points for AI are often humans themselves. Artificial intelligence agents are often modeled after what is known about human cognition. Artefacts and processes by AI are evaluated against human artefacts and processes. While this may be an effective method in some respects, it limits our view of creativity and makes the case for computational creativity a difficult one.

Using the illustration from the previous chapter of modeling a bird, restricting the perception of creativity due to an anthropocentric bias not only undermines an evaluation of computational creativity but also hinders advancements in computational creativity. AI is, by nature, different from humans. To begin with, the inorganic structure of AI is different from the organic structure of humans. While the difference between humans and artificial intelligence may not be substantial with the future advancements, it is substantial with current and past research. This is not to say that AI is necessarily less capable of creativity than humans are, but that the process of creativity may be different, just like flight is different in birds and in airplanes. To restate, the positive evaluation that we use for humans may not necessarily apply to AI. Our intuitions and anthropocentric view of creativity cloud our judgment in assessing the creativity of AI. Thus, I argue that we must expand our view of creativity when assessing computational creativity by looking at the non-human agents familiar to humans, non-human animals.

As of yet, few philosophers, if any, have drawn the connection between non-human animal creativity and computational creativity. Even Boden, a leading scholar on computational creativity, makes no explicit mention of non-human animal creativity in her theory. By assessing non-human animal creativity, we can direct human intuition rather than try to eliminate it. Eliminating the anthropocentric bias is impossible, since humans will always be bound by a limited perception. By broadening the scope of creativity to include creativity in non-human animals, this bias is weakened and seeing creativity in artificial intelligence becomes more feasible. In the next chapter, I will address observations from creativity in non-human animals to accomplish this goal.

CHAPTER 3

CREATIVITY IN NON-HUMAN ANIMALS

As is the case with providing a definition for general creativity, scholars on non-human animal behavior report that creativity is difficult to define. Most scholars agree on a basic definition of creativity involving novelty and value (Epstein, 2015; Kaufman & Kaufman, 2015; Mitchell, 2015; Pryor, 2015), much like the definition proposed by Boden. Examples of non-human animal creativity are widespread across research and literature: the creative games of dolphins (Pryor, 2015), the creative use of man-made tools for mating advantage by Mientian tree frogs (Tan, Tsai, Lin, & Lin, 2014), the creative vocal abilities of Gray Parrots (Pepperberg, 2015), and the many examples of creativity by cephalopods like the octopus (Godfrey-Smith, 2016). The evidence is unprecedented. Nevertheless, for those still skeptical, I will briefly make the case for creativity in non-human animals by comparing it to Boden's theory of creativity. I will also discuss some observations from examples of creativity in non-human animals and the implications on the discussion on computational creativity relevant to my thesis topic.

To restate Boden's definition, a creative idea is one that is novel, surprising, and valuable. Boden discusses two types of creativity, which are P-creativity and H-creativity (Boden, 1996). She also describes three techniques in creativity which are combinatorial, exploratory, and transformational creativity (Boden, 2005). Boden emphasizes the importance of evaluation in creativity, namely that it is essential to the concept of creativity (Boden, 2005). However, she also emphasizes that evaluation poses problems for the theory of creativity, since it is challenging to formalize human values (Boden, 2005). In the previous chapter, I discussed how Boden's approach to theory of creativity, like the approaches of many other scholars, is anthropocentric. I argue that this is a limited view on creativity. In the case of non-human animal creativity, translating Boden's theory of creativity is a challenge. One example of this is what P-creativity and H-creativity would mean in the case of non-human animal creativity. Yet, there are ways in which non-human animals exemplify aspects of Boden's theory of creativity. In this process, terms in Boden's theory, such as conceptual spaces and evaluative criteria, must be thought of broader than how they are defined to evaluate human agents.

The terms Boden uses to define creativity (novel, surprising, and valuable) must be re-imagined when analyzing creativity in non-human animals, since the terms are described in relation to human creativity. Any genuine example of creativity by non-human animals would be novel and surprising to the human eye, regardless of whether or not the creative non-human animal recognizes it as such. It could be argued, though, that novelty and surprise are expressed differently in non-human animals. The spread of a creative idea or behavior through a non-human animal population is recognition of novelty and surprise. Assessing the environment in which a creative act by a non-human animal emerges is another way to grasp novelty and value in the context of non-human animals. Scholars also analyze the purpose and goals of behavior in non-human animals, which are other factors in understanding novelty and value. I consider all these factors in my analysis of examples of non-human animal creativity for this thesis project. These examples are found through observations of non-human animals in the wild, laboratory experiments, and anecdotes. Although many contest the legitimacy of personal anecdotes, I analyse anecdotes by seasoned scholars. Pryor (2015) also argues that anecdotes are legitimate examples in their own right.

Non-human animals exhibit creativity in many areas of behavior. Non-human animals show creativity in tool usage, as in the example of Blond Capuchin Monkeys that manipulate sticks to form "screwdrivers" in order to capture termites (Lee, & Moura, 2015). Scholars observe creativity in non-human animals' search for resources, such as in the case of insects like butterflies that use chemical feedback from landing on a range of host plants to search for nectar (Snell-Rood, Swanson, & Jaumann, 2015). These butterflies creatively refine the resource search process through trial-and-error (Snell-Rood et al., 2015). Problem-solving is one of the most studied areas of non-human animal creativity. None are more famously genius in problem-solving as corvids. Carrion crows in Sendai city, Japan drop difficult-to-open nuts on the road, effectively using automobiles as nutcrackers as the automobiles drive over the dropped nuts (Nihei & Higuchi, 2001). This example of the Carrion crows is also a form of adaptation to a novel environment.

Non-human animals use creativity in courtship as well. Male bowerbirds make unique, brightly colored, and artistic displays called *bowers,* to attract female bowerbirds for mating (Endler, 2012). Bowers are made by using all kinds of objects, such as fruits, flowers, sticks, and even plastic toys in order to seduce female bowerbirds (BBC Earth, 2014). Bowerbirds will go as far as painting their bowers using their saliva and leaves (BBC Earth, 2014). This ritual of using art for the purpose of mating is not limited to the bowerbirds, as it is also observed in male pufferfish creating precise, artistic geometric circles using their fins in the sand in courting females (Kawase, Okata, & Ito, 2013). Non-human animals exhibit creative ideas in adaptation to new, challenging environments as well. In his book *Other Minds*, Peter Godfrey-Smith (2016) shares stories of octopuses kept in labs creatively using resources in their possession and manipulating their environment to create more favorable conditions. One of these cases reports an octopus squirting water at a light source to short circuit the light bulb because of its distaste for bright lights (Godfrey-Smith, 2016). Another example from observations of non-human animal creativity in the wild is of African elephants filling water holes with chewing barks and sand during dry seasons in order to slow down the process of evaporation and conserve more water (Sol, 2015).

Non-human animal creativity does not only emerge for practical goals. Dolphins are recognized as one of the foremost species in non-human creativity, and many examples of dolphin creativity are in dolphin play. A Sea Life Park researcher trained dolphins to display creative tricks with their bodies (Pryor, 2015). The researcher also observed untrained behaviors as well, like dolphins adorning “jewelery” using plants to attract the attention of guests (Pryor, 2015). Non-human animals exhibit creativity out of curiosity as well. Researchers recorded octopuses using coconut shells as stilts as well as for protection (Godfrey-Smith, 2016). The vocal abilities of Grey Parrots in experimenting with English words (Pepperberg, 2015) is another example of creativity out of curiosity. Animal art is also an example of creativity in non-practical situations. In University College London's Grant Museum of Zoology (2012), an art exhibition by non-human animals displayed pieces from elephants, gorillas, chimpanzees, and bowerbirds (as cited in Epstein, 2015).

These examples of diverse non-human animal behavior actions show that creativity emerges in the everyday activities of non-human animals. These activities show *value* as it pertains to non-human animals. Even if one is not convinced of non-human animal creativity through these examples, the argument of creativity being a necessary feature for evolution is another approach to arguing for creativity in non-human animals. In Epstein's (2015) explanation of the "Generativity Theory", he argues that creativity is necessary for non-human animals in evolution. O'Hearn, Kaufman, and Kaufman state, "Creativity here is like a behavioral mutation that allows animals to climb an environmental wall" (2015: 501). Creativity is necessary for non-human animals to adapt to novel environments and further the species.

These examples do not just comply with the definitions of creativity given by Boden and many other scholars but fill in the limitations of the existing theory of creativity by subverting the anthropocentric bias. This follows for the techniques laid out by Boden as well. An old orangutan that was taught sign language signed a new word "candy fruit" after eating a watermelon for the first time (Pryor, 2015). The orangutan used combinatorial creativity by using familiar concepts to create a novel word, much like poets or writers. To adequately assess exploratory and transformational creativity in non-human animals, the idea of conceptual spaces should be re-evaluated.

Conceptual spaces as defined by Boden are determined by human history, culture, and thinking styles and, therefore, do not directly translate to non-human animals. New Caledonian crows, for example, use exploratory creativity to solve intricate puzzles (Taylor, Knaeba, & Gray, 2012). They explore the conceptual space of already familiar puzzles to solve a new puzzle. One can even argue that crows in Sendai City used the transformational creativity technique to crack nuts using automobiles as nutcrackers (Nihei & Higuchi, 2001). These crows changed a dimension of their conceptual space as a response to a completely unfamiliar environment created by humans.

Observations from studying non-human creativity not only affirm findings in humans, but also add to the theory of creativity. Insect resource-searching shows that creative ideas can arise out of trial-and-error, where insects, like the aforementioned butterfly example, test various resources and refine their search process through learning (Snell-Rood et al., 2015: 462).

Non-human animals can also be creative through training. Trainers at the Sea Life Zoo used reinforcement learning to enhance the creativity of dolphins. As in the examples of African elephants filling water holes and octopuses in captivity in the labs, creativity also arises in flexibility and adaptation to new, challenging environments. This behavior is also observed in human creativity. Another aspect of non-human animal creativity that is common to humans is the social nature of creativity. For instance, creativity is seen in social interactions in the spread of a creative behavior across a population. Examples of this include blue and great tits piercing milk bottle lids to drink cream and Japanese macaques washing off sweet potatoes (Chappell et al., 2015). The crows in Sendai city using cars to crack nuts are also an example of this kind of behavior. Though not all creative ideas are spread across a community, such as in the case of a Japanese macaque flossing its teeth using strands of hair (Chappell et al., 2015).

The social nature of creativity is also seen in non-human animal communication, as in the case of the orangutan signing "candy-fruit" when it first encountered a watermelon (Pryor, 2015). Godfrey-Smith reports an octopus creatively communicating its dislike of the food provided by the lab. After waiting for the lab researcher to pass by, the octopus glared at the researcher as it swam over to a drain and dumped a squid down the drain (Godfrey-Smith, 2016). The octopus displayed emotion in this act. Motivation and emotion also influence non-human animal creativity, although they are expressed in a different way than human expression of motivation and emotion.

Other forms of human and non-human animal interaction also exemplify the social nature of creativity in non-human animals. One example of this is in the case of dog and human play (Mitchell, 2015), one of the most common examples of non-human animal and human interactions. Robert W. Mitchell (2015) makes a comparison between creativity in human sports and creativity in dog-human social play. He reports that creativity emerges as a natural result of unexpected behaviors arising in both agents engaged in “simultaneously supportive but mutually disruptive projects” (Mitchell, 2015: 32). In his research, he notes flexibility in behavior as essential to creativity. He quotes, “Creative acts (such as deception) in sports, as in non-human animal play, need not indicate that ‘well thought reason’...directs the action, but [rather] an unconscious realization of the possible movements of the adversary” (as quoted in Mitchell, 2015: 34). Many scholars will find this surprising due to a common misconception in the theory of creativity, influenced by a Cartesian materialistic perspective. If Cartesian materialists believe creativity to be a part of human cognition and human cognition solely isolated in the brain, well-thought-out reason not directing creative action is incompatible with a Cartesian materialistic framework. Yet, creativity emerges in situations not directed by well-thought-out reason, as seen in dog-human play, supporting a 4E cognition theory.

Through observations of dog-human play, researchers noted that the dog is creative through spontaneous improvisation, synchronized with the movements of the human companion. The dog has a less than split-second reaction, indicating that the kind of creativity in its response does not require intense forethought, as is often suggested in creative acts. It is also not intentionally thinking to do a creative act, yet it is an active agent in creativity, sharing the goal of sparring in play with its human companion. The dog is also exhibiting some degrees of exploration in its movements as it tries to fake-out its human companion by doing an unexpected move. The dog’s creativity emerges in interaction with its environment.

Through my evaluation of creativity in non-human animals, I observe that non-human animals need not be intentional with the specific goal of producing a creative idea in order to be creative, but that creativity can emerge in mundane activities with intentions such as in tool usage, resource search, problem-solving, curiosity, adaptation to a novel environment, play, courtship, and art. Non-human animals also show that creativity is social. It is social in that a single non-human animal agent’s creative idea can influence an entire community of the same species to adopt the idea. It is social in that non-human animals are creative in communication with each other and with other species. It is also social in interaction, whether it be interaction within the same species or with others. Creativity arises out of trial-and-error as well or can emerge out of training through reinforcement learning, showing that creativity need not be an inherent quality but can be a learned skill.

In this chapter, I have argued that non-human animals are not only creative but challenge the anthropocentric definition of creativity. This is especially necessary in the field of computational creativity, as artificial intelligence, though often modeled after humans, is after all, still a non-human agent. Through the broadening of the scope of creativity to include non-human animals, the evaluation of computational creativity is more informed and less biased. It is indeed impossible to completely remove human notions in evaluating creativity, since humans are still main agents evaluating. Humans will always see through the human lens, but nevertheless it is a worthwhile endeavor to move towards less anthropocentric perspectives. Thus, to subvert the anthropocentric bias and make a proper assessment of computational creativity, it is imperative to consider creativity in non-human animals.

CHAPTER 4

COMPUTATIONAL CREATIVITY RE-EXAMINED

In the previous chapter, I explored creativity in non-human animals as a response to the observation made in Chapter 2: the view on creativity, especially in computational creativity, is radically anthropocentric because of the anthropocentric approach to the theory of creativity. It is thereby driven by an intuition that creativity is a uniquely human trait. In the first chapter**,** I demonstrated that this anthropocentric bias underlies the philosophy of artificial intelligence as a whole. I also discussed how the anthropocentric bias is reinforced by solely relying on definitions, as Turing noted, in the case of evaluating the intelligence of AI. While the intuitive response to addressing this problem would be to use the Turing test to test for creativity in artificial intelligence, the Turing test is not an appropriate indicator for computational creativity (Pease, & Colton, 2011). Additionally, the Turing test has been contested as an adequate measure for intelligence in artificial intelligence as I argued in the first chapter.

Perhaps then, one may suggest a modification of the original Turing test that addresses the issues that scholars pose. However, this is difficult with our current knowledge of creativity, as core aspects of creativity such as the evaluative criteria of creativity, motivation, and emotion are difficult to express in formal structures needed for such a test. Moreover, one runs into the same issue of facing the anthropocentric bias in the test. The Turing test, even with modifications, would not capture the complexities of evaluating creativity holistically as well. The Turing test attempts to condense facets of creativity into a single feature and does not account for essential aspects of creativity such as the context and background of a creative idea (Pease, & Colton, 2011).

The current definition of creativity is not entirely incorrect; I suggest that the response to finding limitations in the definition is not to throw out the definition altogether, but to work with the current theory of computational creativity by addressing the anthropocentric bias. By expanding the view of computational creativity to include non-human animal creativity, one can adequately subvert the anthropocentric bias in evaluation of creative work. In this final chapter, I address some anticipated responses to my thesis, make connections between computational creativity and non-human animal creativity in the context of 4E cognition, and suggest ways in which computational creativity can move forward with an additional perspective on creativity through looking at non-human animals.

One could argue that the notion of creativity I suggest is flexible and behavioristic. A challenge to the view could be a thought experiment of the following kind: Suppose a marine biologist dove down to the depths of the ocean and saw a geometric formation in the sand on the ocean floor. Looking at the formation, the biologist concludes that it is a creative work and thus must be made by a creative agent, such as male pufferfish known to do so in courting female pufferfish. The biologist remembers that she happened to install a camera a week ago at this very location, overlooking the area of the ocean floor where the geometric formation was formed. When she looks at the footage later to see what formed the geometric formation, she sees that it was actually some rocks. The ocean currents moved some rocks in the sand on the ocean floor creating the geometric formation. Either she has to conclude that rocks are creative agents or admit that she was incorrect to jump to her former deduction that a creative agent must have made the creative geometric pattern in the ocean floor.

This reply resembles replies to the Design Argument for the existence of a creator. My main counter to this argument is that one need not be consequentialist in one's assessment of the previous illustration. The illustration draws out the need to evaluate the methods leading to a creative idea. This can be done by assessing the agent's method with theories of methods in creativity, such as those proposed by Margaret

Boden. Comparing the questioned agent's method with that of an agent who has been deemed creative or whose idea has been deemed creative is another effective way of assessing creativity. I suggest that the most reliable way to evaluate the methods leading to a creative idea is to do both. Most importantly, it is essential to evaluate the process of the agent in question not just by comparison to human examples of creativity but examples of creativity in non-human agents as well.
Furthermore, the core question behind the illustration is as follows: "What makes the rocks that form the geometric pattern different from pufferfish that create geometric patterns in courting?"

To answer this question, I cannot argue that creativity is limited to organic creatures because it undermines my argument for creativity in AI. Similarly, I cannot discuss creativity as unique to living or animate agents, as what defines a "living" AI is debated. Perhaps the better response is to bring back the discussion on the nature of agency, intentionality, and consciously driven actions of an agent in creative work. Through my examination of creativity in non-human animals, one may recall that creativity in both non-human animals and humans is not always the result of a "well-thought out reason or consciously driven action" (as quoted in Mitchell, 2015: 34). It is plausible to have an agent engage in a creative idea without it being actively intentional as well. An agent can also be creative without it being driven by the motivation to be creative or make a creative idea. On the other hand, it is not necessarily that evaluators judge the agent as "creative" just by merit of the creativity of the idea produced by the agent. However, an agent without any agency, intentionality, or motives, such as the rock (verified by examining the process of the rocks forming the pattern in the sand), cannot possibly be creative. When one examines the process of a creative agent, the agent has some intention, goal, or motive, albeit not be directly related to creativity.

To further respond to the previous criticism, I will use the following illustration where four agents use combinatorial creativity in language to respond to the question proposed in the previous paragraph. My friend's two-year old son is bilingual in Turkish and English. Once when my friend asked him to come to the kitchen, he replied "Come on-meyeceğim!" He created this unique phrase by combining the Turkish suffix for "I will not" to the English phrase "Come on". The reader may recall the example of the orangutan, who used a similar method to describe watermelon when she was introduced to it for the first time and signed for “candy-fruit”. The orangutan, like my friend’s son, combined two words or parts of words in her already existing word database and created a new expression. Remarkably, Shakespeare used a similar method to create over 1700 words in the English language. Shakespeare created many simply by conjoining two words or by adding suffixes and prefixes to words, much like the orangutan and my friend’s son. Yet, human intuition and bias causes evaluators of each act to weigh the creativity of the act differently. Of course, my friend’s son, the orangutan, and Shakespeare are not creative in the same way or to the same degree, yet they engage in similar processes to produce similar creative ideas. To add to this illustration, the program JAPE (Binsted, 2000) successfully creates punning riddles using combinatorial creativity in a similar way as my friend’s son, the old orangutan, and Shakespeare.

There are a few points to be made here. The first point is regarding human bias in evaluating each creative act. The illustration makes apparent how prevalent the anthropocentric bias is and how it misguides evaluation on creativity. Since evaluation is a vital part of the theory of creativity, this issue is critical. In the illustration, it is clear that most people would mark the creative act by Shakespeare as clearly creative but would question whether the act is creative in the other cases, especially in the case of the orangutan, the non-human animal, and JAPE, the program. Thus, most judgments on creativity by agents other than humans are negatively biased. This must be taken into consideration when discussing creativity in non-human agents, such as non-human animals and artificial intelligence. Additionally, if all four agents anonymously showed their work, the creative idea and attribution of creativity to the agent would be relatively equal.

The second point is that although all four agents use the similar process of combinatorial creativity and make creative use of language, evaluators may not necessarily recognize all four as wholly creative, as in the sense of *labeling* a creative agent as creative. Shakespeare is given the label of a creative individual not only because of one or two instances of using combinatorial creativity to create words, but because he does this over 1700 times. A creative agent is not always recognized as creative because of one instance but the combination of many instances. In addition to this, of course, Shakespeare has other instances of creative acts, such as his poetry and plays that add legitimacy to the title of being a creative individual. My friend's son, on the other hand, has exhibited far fewer instances of creative ideas, and the orangutan even fewer than my friend's son. Nevertheless, one can still recognize these agents as creative in these specific instances. My friend's son can be recognized as a creative for creating a new phrase to express his desire to not do what his father asks, but may not necessarily be recognized as a creative child overall when looking at him as a whole, considering all his actions.

The third point is regarding the issue of the roles of agency, intentionality, and consciously driven action in creativity. In each of these cases, it is safe to argue that the agents indeed have agency. The agents have specific goals that they were trying to achieve in the process of which creativity emerged. It is vital to note that not all these agents had goals to do with creativity. As in the case of non-human animals, the goal can be play, curiosity, sociality, or adaptation. The agents may not even be directly or consciously targeting their goals. The creative act can emerge in interaction or social circumstance, as was probable in the case of my friend's son and the orangutan. This nature of creativity (that it can be a subconscious act that emerges in complex interaction with other facets of consciousness such as sociality, flexibility, randomness, spontaneity, motivation, emotion, and intuition) merges well with the 4E cognition. As artificial intelligence adopts and models after 4E cognition, the case for more genuinely creative acts coming out of the interaction of various facets of cognition is convincing. Intuitive robots and deep-learning algorithms already display this kind of interaction in randomness, spontaneity, and flexibility, which are all facets of cognition required in creativity.

Another popular argument against the intelligence of artificial intelligence can be applied to this theory of computational creativity as well. This is that robots are unlike humans in that they are pre-programmed to do exactly what they are told to do. While this was the case in most traditional AI, programmers give little to no information to neural networks like Google DeepMind's AlphaGo. This is to the point that the researchers were surprised by the moves the program was making and why it was making them (Silver et al., 2018). AI has developed features independent of the inputs given by the programmer that give rise to creativity. Additionally, the algorithm learned how to play Go through reinforcement learning (Silver et al., 2018). In the previous chapter, I observed how non-human animals could also be trained using reinforcement learning to exhibit creative ideas, as was in the case of the dolphins at the Sea Life Zoo (Pryor, 2015). Research on insects (Snell-Rood et al., 2015) showed that creativity and innovation can arise out of trial-and-error. Similarly AlphaZero uses trial-and-error (Silver et al., 2018) to exhibit creativity. Thus, just as humans, non-human animals and artificial intelligence use trial-and-error, training, and learning to develop creativity.

One may also argue that creativity in human agents is convincing because human agents have the capacity to be creative in many different areas, whereas non-human agents are less likely to be *widely creative* and exhibit creativity mostly when trained. In the case of non-human animals, this argument falls completely flat. Simply giving one example from the previous chapter in which octopuses are creative, such as squirting water at light bulbs or using coconut shells as stilts without any training, is enough to contest this argument. In the case of artificial intelligence, it is true that so far most examples of creative AI tend to be creative in only one aspect and are not given the capacity to be creative in others. However, just because AI cannot extend its capacity to be creative in other areas than its expertise, does not mean that it cannot be recognized for creativity in that one area. Shakespeare's creativity would not be eliminated based on the fact that he was not creative in other areas, such as sports or war tactics. It is indeed impressive that human agents can be creative in other areas, but that observation is unrelated to judging non-human agents as creative agents. Moreover, it is not difficult to imagine or implement a program being extended with additional code or through collaboration with the work in other fields of research in artificial intelligence to give it the capacity to be widely creative.

Another kind of argument can be made against my thesis, which is along similar lines as the second response to Turing's argument mentioned in Chapter 1. In particular, Dreyfus's response that artificial intelligence cannot be intelligent without an animate body form (Dreyfus, 1979) can be a counter-argument to my thesis. One can contend that artificial intelligence cannot be creative without an animate body form. At first glance, this seems to work well with the theory of the mind and body posed by 4E cognition, which challenges my thesis even more, but this is a false parallel. 4E cognition illustrates that the relationship between the brain, mind, and body is more complicated than traditional Cartesian materialism states it to be; however, not all proponents of 4E cognition argue that the human body is necessary for cognition. The human body is deeply interrelated with human cognition, just as a non-human animal's body is interrelated with its cognition. The body of the agent is specific to the cognition of the agent. A non-human body need not have a human body to have cognition or to be creative.

The octopus is a perfect illustration of this point. The octopus's body is radically different from the human body, and yet it displays a sophisticated cognition. Moreover, an octopus's cognition is unique precisely because of the unique features of its body. The structure of its nervous system functions like a "body-distributed brain" such that its arms make decisions, allowing it to react to its environment much more quickly than other species (American Geophysical Union, 2019). To this, one may point out the gap in my reply in that Dreyfus argues for an animate body form, which both octopuses and humans have, but artificial intelligence may not.

However, the example of the octopus contests the notion that cognition is restricted to only the human body. It does not necessarily assert that cognition is restricted to animate body forms. If the octopus gives a surprising understanding of the diversity of cognition and how that diversity is related to the form of the agent, it could be similarly surprising to widen the notion of cognition to other "body" forms. The diversity of cognition is interrelated to the diversity of body forms. Similarly, the diversity of creativity is interrelated to the diversity of body forms, whether that be the form of a human, non-human animal, or artificial intelligence. Instead of restricting creativity in artificial intelligence to be imagined through the human body form, the unique distributed nervous system of the octopus can be taken as a guide in research in computational creativity. Regardless, researchers can bring about computational creativity through other unimagined "body forms" as well, which may lead to the emergence of unique creative methods or examples of creativity.

Having addressed the major potential objections to my argument, I return to the overall contention of this thesis project. In the spirit of Turing's response to "Can machines think?" I pose the question "Can AI be creative?" In Chapter 2, I argued that scholars must address the anthropocentric bias underlying the current theory of creativity to give a reliable response to the question. Chapter 3 demonstrated that expanding philosophy on computational creativity to include non-human animal creativity subverts the anthropocentric bias, and Chapter 1 showed that 4E cognition fits with the observations made through research of non-human animal creativity.

4E cognition theory holds that features of cognition are not solely brain-driven activities, independent of the rest of the body or an agent's environment. They emerge in interaction with other facets of cognition, other agents, and the environment. Creativity, therefore, is not a brain-driven feature of cognition, as confirmed by examples in non-human animal creativity. Examples of creativity in non-human animals show that creativity can emerge through activities where the agent has a purpose different than to be creative, such as tool usage, resource search, problem-solving, curiosity, adaptation, mating, and play. They also show that creativity may emerge in social interaction, such as through communication or through the spreading of a creative idea in a population. Creativity may emerge in trial-and-error, or, conversely, an agent can be trained through reinforcement learning to be creative. Additionally, creativity emerges as agents adapt to novel environments in evolution. All these observations of non-human animal creativity show the diverse manners through which creativity may emerge. These observations on creativity are not unique to non-human animals, as they are also relevant to creativity in humans and artificial intelligence. Non-human animal creativity complies with the theory of human creativity, presented by Boden. I demonstrated how non-human animal creativity exhibits and challenges the two categories of creativity and the three techniques of creativity. With these philosophical considerations in mind, I will conclude the re-examination of the issue of computational creativity.

By limiting AI to the human models of creativity, we not only fail to adequately recognize the feats of AI, but also limit its capabilities. Research in artificial intelligence replicating or following solely human models may be restricting advancement in computational creativity. Artificial intelligence, modeled after new theories of cognition, such as Google DeepMind's AlphaZero, is able to exhibit features of creativity that non-human animals exhibit. These AI are able to engage in trial-and-error and reinforcement learning. Computational creativity arises in an AI's activity for many different purposes, such as the Painting Fool's exploration of the Guardian article on the Afghanistan War. Moreover, AI that uses deep learning techniques or AI through the form of intuitive robots is able to implement features of creativity, such as flexibility, adaptation to novel environments, improvisation, and randomness.

The case for the legitimacy of computational creativity is clear. It is not radical to state that AI can be creative. Many artificial intelligence agents, such as the Painting Fool, already are creative. The impulse to disregard computational creativity is driven by an anthropocentric bias. Moreover, creativity in non-human agents, such as non-human animals and artificial intelligence, elucidate many aspects of human creativity. They also challenge misconceptions in the theory of creativity. Creativity is not a uniquely human-trait. It is also not the output of a brain-driven process. Creativity is an emergent feature that surfaces in interaction with other facets of cognition, the environment, and other agents. Creativity is a feature shared with other non-human agents, including artificial intelligence.

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