Do New Evolutionary Studies of Consciousness Face Similar Methodological Problems As Evolutionary Studies of Mind?

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Abstract

Recently several prominent biologists and philosophers, including Feinberg and Mallatt, and Godfrey-Smith, have proposed evolutionary accounts of consciousness. Despite disagreements regarding the specifics, they all focused on the "primitive" form of consciousness and argued that its origin is much more ancient than previously believed. In this study, we examine these accounts based on their methodological grounds. Specifically, we examine whether one methodological criticism leveled against evolutionary psychology on the completeness of its explanations can be applied to Feinberg and Mallatt's adaptation explanations. We conclude that their explanations fall short of being complete, but fare better than those advanced by evolutionary psychologists.

Key words: consciousness, natural selection, scientific explanations, epiphenomenalism

1. Introduction

The last year (2021) marked the 150th anniversary of the publication of *The Descent of Man* by Charles Darwin (Darwin, 1871). This book set the stage for biologists and philosophers to study the evolution of the mind. Since consciousness is an important aspect of the mind, biologists and philosophers have also been studying its evolution. Over the last decade, however, a new wave of evolutionary studies of con-

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sciousness has emerged (Feinberg and Mallatt 2013, 2016, 2018; Godfrey-Smith 2016, 2020; Ginsburg and Jablonka 2019; see also Suzuki 2022).

These "new" evolutionary studies of consciousness differ from "old" studies, which are characterized by two features (See, for example, Blackmore, 2004, 2017; Mithen, 1996; Humphrey, 2002). First, until the 2010s, evolutionary accounts of consciousness have defined consciousness by rather sophisticated and complex properties. For example, Nicholas Humphrey (2002) argued that consciousness is an "inner eye" that helps us observe what is inside our mind and comprehend others' thoughts. This has a consequence on a range of animals with consciousness: if the defining feature of consciousness is as highly sophisticated as self-recognition, then only a rather narrow range of animals can afford consciousness. For example, Humphrey notes that only a few animals, such as humans and primates, have consciousness. This is another feature of the "old" evolutionary studies of consciousness.

The "new" evolutionary studies of consciousness differ in both respects. The scholars cited above defined consciousness by more "basic" properties, such as what-it-is-like-to-be-X, subjective experience, and subjective awareness from a particular perspective. This indicates that a much wider range of animals should have consciousness. Indeed, all the scholars in this group largely agree that consciousness emerged during the transition from pre-vertebrate animals to vertebrates and that all the vertebrates, arthropods such as insects, and cephalopods, including octopuses, probably display consciousness.

We have drawn a contrast between the old and new evolutionary studies of consciousness, although the latter share certain common characteristics with another school of evolutionary studies of our mind: evolutionary psychology. Since the new evolutionary studies of consciousness and evolutionary psychology concern the mind, fossil evidence is not readily available in both cases. In addition, the methodologies of both schools are by and large adaptationist in that the characteristics of the mind to be explained by each program are supposed to be adaptations.

If the commonalities between the new evolutionary studies of consciousness and evolutionary psychology are not merely apparent ones, then one may question the methodological ground of the new studies as evolutionary psychology has been subject to criticisms regarding its methodological assumptions. Among them is the adequacy of the explanations of evolutionary psychologists. For example, Robert Richardson (2007) argues that adaptation explanations (those accounting for the existence of certain traits by appealing to their adaptive advantages) advanced by evolutionary psychologists are suboptimal because they typically fail to meet the standards of ideally complete adaptation explanations proposed by Robert Brandon (1990). If this is true of evolutionary psychology in many cases, then one may ask whether we can apply this criticism to new evolutionary studies of consciousness, since those in this circle also appeal to the adaptive advantage of consciousness and its underly-

ing mechanisms to explain its emergence among early vertebrates in the Cambrian period (Feinberg and Mallatt, 2016; Ginsburg and Jablonka, 2019).

The present study aims to address this question. The remainder of this study is structured as follows. In the next section, we provide an overview of new evolutionary studies of consciousness, focusing on Feinberg and Mallatt's account. We review what their claims on the nature and origin of consciousness are and what kind of evidence they have to support them. We also examine their hypothesis on the alleged selection advantages of having consciousness in the Cambrian explosion. Subsequently, we discuss the methodological principles of evolutionary psychology and the objections to them. Although there are several objections to this discipline, we will focus on the criticism concerning the inadequacy of the explanations offered by evolutionary psychologists and examine how it is applied to the evolutionary explanation of human language presented by Steven Pinker and Paul Bloom. In the fourth section, we apply this criticism to Feinberg and Mallatt's adaptation explanation. We conclude that it fares better than Pinker and Bloom's explanation, but falls short of being a complete adaptation explanation. However, since their adaptation explanation concerns only a minor part of their entire theory, it is unlikely to negatively affect their project. This does not imply that their adaptive stories elude conceptual problems. In the concluding part of the study, we argue that their contention against epiphenomenalism based on the adaptiveness of consciousness is flawed, owing to their misunderstanding of one of the assumptions of the argument.

2. New Evolutionary Studies of Consciousness

In this section we will provide a brief overview of new evolutionary studies of consciousness, focusing on the works of Todd Feinberg and Jon Mallatt (Feinberg and Mallatt 2016, 2018; see also Suzuki 2022). There are two reasons why we focus on these and not other studies. First, Feinberg and Mallatt's work is neurologically more elaborate than Godfrey-Smith's. The principal goal of Godfrey-Smith's work is not to draw a complete neurological picture of how consciousness has emerged but to offer a broad philosophical framework of the nature and evolutionary development of consciousness. In contrast, Feinberg and Mallatt describe the neurological details of the transition from pre-conscious to conscious animals partly by depicting the nervous systems in both. They also report sufficiently elaborate adaptive stories of how consciousness was selected during the Cambrian period, while Godfrey-Smith draws only a rough sketch.

Second, we can apply methodological objections from evolutionary psychology more directly to Feinberg and Mallatt's work than Ginsburg and Jablonka. In their work, Ginsburg and Jablonka drew on the theoretical framework of "evolutionary transitions" developed by John Maynard-Smith and Eörs Szathmáry (Maynard-Smith

and Szathmáry, 1995) and proposed unlimited associative learning (UAL)[1] as an evolutionary marker of consciousness. While this form of learning marks the advent of consciousness in evolutionary terms, it is not identical to consciousness. This makes the interpretation of their adaptive stories on the evolution of UAL more complicated, as it is not the story of the evolution of consciousness itself. Conversely, Feinberg and Mallatt directly discuss the evolution of consciousness and its underlying neural mechanisms. Accordingly, it is easier to apply methodological criticisms of other evolutionary studies of the mind to their study.

2.1. Feinberg and Mallatt's Account

Despite being different from the other accounts mentioned above, Feinberg and Mallatt's account shares important features with those of Godfrey-Smith, and Ginsburg and Jablonka (Feinberg and Mallatt, 2016, Chapters 2–5). For example, Feinberg and Mallatt focus on primitive features of consciousness, such as what-it-is-like-to-be-X and subjective experience. This is in a stark contrast to "older" studies, one of which describes self-recognition as an essential property of consciousness (Humphrey, 2002). Feinberg and Mallatt also agree with Godfrey-Smith and Ginsburg and Jablonka that consciousness evolved for the first time in evolutionary history when pre-vertebrats evolved into vertebrates approximately 540 million years ago.[2]

What is Feinberg and Mallatt's argument behind their claim on the evolutionary origin of consciousness? They first determine what they characterize as *special neurobiological features* (SNFs) of consciousness and subsequently, use them to decide whether organisms have consciousness. The assumption behind this move is that if organisms do not have these features (or they have them only in primordial form), they do not exhibit consciousness (Feinberg and Mallatt, 2016, p. 26)[3]. Feinberg and

[1] A simple example of associative learning is Pavlov's dog experiment. In this experiment, after a dog hears a bell ring repeatedly with food being presented, it associates the sound of a bell with food and salivates when hearing it even without food. In unlimited associative learning, one can associate a much wider variety of stimuli, such as a combined stimulus, to a response. For example, a dog with the capacity for this form of learning can associate melody comprising multiple musical notes, instead of a single bell, with a response such as salivation. See Ginsburg and Jablonka (2019), in particular Chapter 5, for details.

[2] In addition, they all agree that consciousness probably evolved in arthropods, including insects, and cephalopods such as octopuses. Since it is not relevant to our purpose in the present paper, we do not discuss this part of their accounts further.

[3] This, taken literally, suggests that they claim that SNFs are jointly the necessary conditions of consciousness. But one may doubt how literally they take the above statement. For instance, Feinberg and Mallatt judge, based on these features, that insects probably have consciousness, even though they know that insects do not meet one criterion, the complexity of the neural system (Feinberg and Mallatt, 2016, Chapter 9). This suggests that perhaps we should read SNFs as a cluster of features highly associated with consciousness, not the jointly necessary conditions of consciousness.

Table 1 A list of special neurobiological features (SNFs) for exteroceptive consciousness. Source: Feinberg and Mallatt (2016).

Features
Complex neural hierarchies; a brain
Nested and non-nested hierarchical functions
Neural hierarchies create isomorphic representations and mental images and/or affective states
Neural hierarchies create unique neural-neural interactions
Attention
Sensory consciousness may be created by diverse neural architectures

Mallatt list these features in their book (see Table 1).[4]

Owing to space constraints, we cannot describe all the features comprehensively. We focus on the third feature in the list, that is, isomorphic neural representations. Feinberg and Mallatt indicate that some neural representations maintain the same structure as the sensory input received by sensory organs. Let us imagine a bicycle. It comprises different parts, such as the front and rear wheels, saddle, frame, and pedals, which are arranged in a particular way. Therefore, the visual representation of a bicycle in the retina maintains the relative position of each part: pedals are between the front and rear wheels, the saddle is above the pedals, and so on. This configuration is largely maintained as this representation goes up through the nervous system to the brain region for processing visual information. This is because the spatial arrangement of neurons at the higher level of the nervous system largely corresponds to that of the original sensory receptors. Although this example concerns visual perception, Feinberg and Mallatt note that this also equally applies to other sensory perceptions, such as tactile and auditory sensations. This feature is important for the existence of consciousness as it helps organisms build a mental model of the world around them and the self by combining information from various sense modalities.

As mentioned above, Feinberg and Mallatt traced the evolutionary origin of consciousness in early vertebrates. They argued that when invertebrates evolved into vertebrates in the Cambrian period (540 million years ago), they acquired SNFs and thereby consciousness. They provide two kinds of evidence for this estimation: The first comes from a comparison between the so-called living fossils. Feinberg and Mallatt compared the nervous system of a model non-vertebrate (lancelet or *Amphioxus*) and a vertebrate (e.g., lamprey or *Petromyzon*) and confirmed that all vertebrates have SNFs. In particular, Feinberg and Mallatt cite Thurston Lacalli and colleagues

[4] Note that the items in the list are SNFs for exteroceptive consciousness. They also make lists of behavioral and neurological criteria for affective consciousness.

(Lacalli 2016, Lacalli and Stach 2016, among others) to indicate that a lancelet's eyes are so small that it cannot form any image. The lack of image-forming eyes implies that there is no isomorphic neural representation in visual perception, suggesting that lancelets do not have an important SNF and may not possess consciousness. Feinberg and Mallatt also drew attention to the differences in the brain structure of invertebrates and vertebrates. Citing anatomical studies on these animals by Lacalli and others, they demonstrated that a lancelet's brain lacks the dorsal parts of important brain regions for processing sensory information, such as the large cerebrum, optic tectum, and cerebellum. Since these regions are associated with the more elaborate processing of sensory information in vertebrates, it can be inferred that complex processing of such information does not occur in invertebrates.

The second kind of evidence is the fossils of invertebrates and vertebrates. One such example is a pre-vertebrate fish-like species called *Haikouella lanceolatum*. Its anatomical structure is somewhat similar to vertebrates in that it has "a notochord, paired eyes, and a large brain with diencephalon and hindbrain parts, with all these structures in the same positions as in living fish such as lampreys" (Feinberg and Mallatt, 2016, p. 90), although it differs from vertebrates in several respects. A significant difference that Feinberg and Mallatt noticed is the eyes. The eyes of *Haikouella* are larger than those of living invertebrate species (lancelets) but are too small (only one-fifth of a millimeter in diameter) to form images.[5] This is an important feature, because there is no need for isomorphic neural representations without image-forming eyes. This, in turn, suggests that *Haikouella* does not have exteroceptive consciousness.

2.2. Adaptive Story on the Emergence of Consciousness

Supporting their hypothesis on the origin of consciousness, Feinberg and Mallatt narrate a story about what kind of selective advantage ancient consciousness had when it emerged. According to their scenario, the emergence of consciousness in early vertebrates is directly linked to the so-called Cambrian explosion. The Cambrian explosion is a geological event in which a number of new species with novel morphologies and lifestyles encompassing all the major animal phyla appeared. It is widely believed that this explosion was led by the advent of the predator-prey relationship, which in turn was driven by the remarkable development of sensory systems (e.g., vision and olfactory perceptions). While there is a controversy over which sensory perception came first (the vision-first and the smell-first hypotheses), Feinberg and Mallatt support the vision-first hypothesis and believe that the developed visual perception offered a selective advantage to early vertebrates, whether it is a predator or prey, over their competitors. Since visual perception was beneficial both to the predator

[5] For comparison, the eyes of Cambrian vertebrates measured one millimeter or more.

and prey, there was an "arms race" between them. Given the strong feedback loop formed by this arms race, visual organs and the corresponding nervous system rapidly evolved in both the predator and the prey during this period.[6]

3. Evolutionary Psychology and its Methodological Criticisms

In this section, we provide an overview of the basic tenets of evolutionary psychology and methodological criticisms against it. As mentioned earlier, we will focus on one particular criticism voiced by Robert Richardson (2007): adaptations explanations proposed by evolutionary psychologists fail to satisfy the standards of ideally complete explanations.

3.1. Basic Principles of Evolutionary Psychology

Before discussing this criticism, we briefly describe evolutionary psychology. Since the present study does not discuss evolutionary psychology *per se*, we only sketch its basic methodological assumptions (Tooby and Cosmides, 1992, 2005; Mameli, 2008; Goldfinch, 2015). In its simplest form, evolutionary psychology has two methodological assumptions. The first is that a number of psychological properties are evolutionary adaptations and most human-specific psychological adaptations evolved in Environment of Evolutionary Adaptedness (EEA). For evolutionary psychologists, the EEA refers to a particular geological period called *Pleistocene*, which began 1.8 million years ago and ended about 10,000 years back, just before the advent of agriculture. During this period, evolutionary psychologists assumed that our ancestors were basically hunter-gatherers and lived in a small group with relatives.

Another point in this assumption is that many human-specific psychological traits are adaptations for this environment. In other words, substantial parts of our psychological machinery helped our ancestors survive and reproduce in the hunter-gatherer society. In this sense, the research program of evolutionary psychologists is essentially adaptationist: they study psychological traits in terms of their adaptedness and assume that many of them are adaptations. However, it is worth noting that evolutionary psychologists do not necessarily believe that these psychological

[6] Feinberg and Mallatt also offer adaptation explanations for other evolutionary stages of animal consciousness. One example is the evolution of consciousness functions in mammals and birds. In Chapter 6 of their book, Feinberg and Mallatt claim that the region of the brain responsible for consciousness moved from optic tectum to cerebral cortex and pallium in these animals. They explain this transition from the finding that early mammals and birds lived in the forest where it was beneficial to spend more time than in other environments selecting the best behavioral alternative for them. But due to space constraints, the present paper will focus on their adaptive story on the emergence of consciousness in early vertebrates.

traits are adapted to the modern environment because the past and current environments could differ so much that adaptation to the past environment may not serve the purposes of survival and reproduction now.

The second methodological assumption of evolutionary psychology is that researchers identify selection pressures (adaptive tasks) in EEA. As already mentioned, evolutionary psychologists mainly aim to explain our psychological traits in terms of their adaptedness to EEA. Correspondingly, they must identify which adaptive task a given psychological character is a solution to. There are two ways to do so for evolutionary psychologists. First, they may identify adaptive tasks based on the information about the EEA. Evolutionary psychologists may use fossil evidence of hominin ancestors and anthropological studies of modern hunter-gatherers to infer the conditions in which our ancestors lived. From such information they could hypothesize possible adaptive tasks that the ancestors faced and their solutions. Evolutionary psychologists may then conduct an experiment to examine if modern human beings maintain the same psychological traits that are adaptive to the task. Second, evolutionary psychologists may identify adaptive tasks using the so-called reverse engineering. That is, they may examine the details of psychological properties that modern human beings have and attempt to determine "which evolutionary function they have served in the past environment?" For example, evolutionary psychologists have examined the details of nausea experienced by pregnant women and how this phenomenon has served their reproduction in the past environment (Flaxman and Sherman, 2000).

3.2. Criticisms of Evolutionary Psychology

Now, let us consider the methodological criticisms of evolutionary psychology. Different criticisms have been leveled in evolutionary psychology. The most famous is that adaptationism inherent in evolutionary psychology may prompt us to ignore the possibility that traits in question may be driven by causes other than natural selection, such as developmental constraints (Gould and Lewontin, 1979). Other theorists have pointed to the difficulty of identifying adaptive tasks in EEA. For example, Sterelny and Griffiths (1999) and others argue that it is often challenging to identify what constitutes a *single* adaptive task. For example, one might ask whether mate choice is a single problem or actually a rather nominal category for a collection of related problems, which include when to leave the current partner and when to punish infidelity.

However here we focus on one criticism expressed by Robert Richardson (2007). According to him, evolutionary psychologists' adaptation explanations, those accounting for the existence of some trait by appealing to its adaptive advantages, do not satisfy the standards for what Brandon (1990) calls *an ideally complete adaptation explanation*, while many adaptation explanations proposed in other biological fields

Table 2 A list of the standards for ideally complete adaptation explanations. Source: Brandon (1990).

Features	Description
(1) Selection	Evidence that selection did occur.
(2) Ecological factors	Ecological explanation of the fact that some types are better adapted.
(3) Heritability	Correlation of phenotypic traits between parents and offspring.
(4) Population Structure	Gene flow, size of populations, and mutation rate.
(5) Trait Polarity	Which trait is derived and primitive. Often need independently obtained phylogeny.

do satisfy them. An ideally complete adaptation explanation is an explanation that should provide complete information for a given selection episode and is thus fully justified. Brandon notes that an ideally complete explanation is what philosophers such as Phillip Kitcher (1981) and Wesley Salmon (1984) had in mind when they offered their theories of scientific explanations, although they did not particularly focus on *adaptation* explanations.

3.2.1. The Standards of Ideally Complete Adaptation Explanations

What are the standards for an ideally complete adaptation explanation of a trait? Brandon offers five standards for such an explanation (see Table 2). The first is whether a given explanation offers satisfactory evidence that a selection episode has occurred. This condition is important for any successful adaptation explanation because the trait should have been subject to natural selection if it was an adaptation. The next standard is the ecological factor. This describes the environmental factor(s) that make a difference to the survival and reproduction of organisms with and without the trait in question, thereby offering an account of *why* the selection occurred. For instance, if dark-colored moths survive predation from birds better than their light-colored counterparts owing to their pigmentation, a successful explanation should mention predators and the moths' pigmentation as ecological factors.

Heritability was used as the third standard. Even if the survival and reproduction rates of organisms differed systematically with and without the trait in question, natural selection would not occur if the trait was not heritable; that is, there was no correlation between the traits of the parents and the offspring. Brandon mentions that the types of evidence for this standard are two-fold. One could offer direct and indirect evidence that the trait in question can be inherited (for instance, an experiment showing that parents' characters are systematically correlated to the offspring provides direct evidence of heritability). The second type of evidence elucidates the underlying genetic mechanism of the trait, which Brandon admits is not always available to researchers.

The fourth standard applies to the factors concerning population structure, such as the degree of gene flow, population size, and mutation rate. Even if ecological factors favor certain organisms over others, natural selection may not result in a shift in gene frequencies if one of these factors neutralizes it: even if organisms with a trait T_1 survive better than those with T_2 in a population, the force of natural selection may be completely canceled out if a sufficient number of organisms with T_2 immigrate to the population simultaneously. Therefore, this kind of information is important to confirm that selection did work to change the frequency of traits in a population.

The final standard is trait polarity. It concerns the ancestor-descendant relationship between two or more traits, in particular whether or not one trait has been derived from another. In a typical scenario of natural selection, an adaptive trait emerges as a mutation of an extant trait in a population and eventually replaces the original trait owing to its selective advantages. Accordingly, a trait that is an adaptation should typically be a phylogenetically derived trait. If a selection account says that one trait T_1 was selected over T_2 in a lineage, but a phylogenetic analysis indicates that T_2 derived from T_1 in that lineage, we need to reconsider the original account.

An Example: Heavy Metal Tolerance Brandon (1990) (and Richardson 2007) apply these standards to a concrete example of an adaptation explanation: the heavy metal tolerance of plants. Researchers such as Antonovics et al. (1971) have studied plants that can grow well in soil contaminated with heavy metals, such as the sites on the fringes of mines. Since most plants grow poorly in such an environment, they surmise that these plants have been selected over others given their tolerance to heavy metals. Brandon and Richardson examined whether their accounts satisfy the standards described above.

- Selection. Researchers have documented that there is a fairly strong selection pressure for heavy metal tolerance. According to one study, the mortality rate for the non-tolerant type could be nearly 10 times higher than the tolerant type (Richardson 2007 cites Jain and Bradshaw 1966).
- Ecological Factors. In this case, ecological factors behind the selection episode are clear: heavy metal contamination of the soil, resulting in lower nutrient levels. We can also easily assess the level of contamination and its effects on different types of plants.
- Heritability. Here, we can access the first evidence of heritability. There is variability in the plants on heavy metal tolerance, and researchers set up an experiment to measure how much the trait is inherited in the plants and found that the trait was indeed heritable. However, Brandon notes that researchers have limited knowledge about the genetic mechanisms behind it (at least at the

time of the publication of his book).

- Population Structure. Since several factors are involved here, we will focus on gene flow. Researchers have found that there is little gene flow between the tolerant and the non-tolerant types, at least in *Anthoxanthum* plants (commonly known as hornworts and vernal grasses), as individual strains flower at different times. This implies that there are few hybrids and introgressions between the two types and that the effects of natural selection will hardly be counterbalanced by immigration.
- Trait Polarity. Since pollution of the soil by heavy metals occurred recently in most cases, it is relatively easy to identify the traits of ancestral populations. This implies that metal tolerance is a trait derived from non-tolerance.

From this analysis, Brandon (and Richardson) concludes that the adaptation explanation of heavy metal tolerance largely satisfies all the standards of an ideally complete explanation and is thus sufficiently satisfactory. Richardson notes that this also shows that those standards are not too strict to meet.

3.3. Application to an Account by Evolutionary Psychologists: The Evolution of Human Language

Richardson (2007) subsequently applies these standards to adaptation explanations offered by evolutionary psychologists. One of the examples is the evolutionary account of human language advanced mainly by Steven Pinker and Paul Bloom (Pinker and Bloom, 1992).[7] This analysis is aimed to determine whether such accounts meet the aforementioned standards.[8]

There is one point worth noting before considering Richardson's analysis. In his book Richardson modifies one of the original standards for an ideal explanation: the one concerning natural selection. For Brandon, this standard is about evidence that selection regarding the trait occurred. Richardson makes this condition stricter by requiring additional information——regarding variations in fitness and the character and extent of variation in ancestral forms. This is more stringent as a requirement since Brandon accepts the fossil record showing that organisms with a trait replace those with another as legitimate, if not direct, evidence of selection (Brandon, 1990, p. 166). This type of evidence may not be sufficient for Richardson.

Having this in mind, we will examine Richardson's analysis of Pinker and Bloom's evolutionary account of language. In their study, Pinker and Bloom largely draw on

[7] Richardson also mentions other studies, such as Pinker (1985).

[8] Since the target article was published thirty years ago, one may wonder if Richardson's diagnosis is nevertheless true of the current state of the studies of the evolution of language. However, this is not relevant to the purpose of the present paper. Our purpose here is not to evaluate evolutionary psychology, but to see how *some* studies of evolutionary psychology can fail to satisfy the standards of an ideal explanation.

the Chomskyan view that language is a product of a unique mental organ and that there is the "universal grammar" common to all human languages. They then offer what they call "an argument for design in language": languages are designed "for communication of propositional structures over a serial channel" (Pinker and Bloom, 1992, p. 459). Correspondingly, Pinker and Bloom argue that natural selection can explain various features of language better than other hypotheses, such as the one that human language is a byproduct of having a larger brain. They also respond to the objections raised by various theorists to their hypotheses. Richardson examines whether their account satisfies the five standards of an ideal explanation:

- Selection. Richardson does not deny that selection may have occurred during the course of the evolution of human language but indicates that Pinker and Bloom reveal limited details of the selection episode. First, they provide limited information on the natural variation in proto-linguistic communities and do not reveal the strength of the selection. They just mention that it is surprising if certain hominids did not have languages given that their brain size grew significantly.
- Ecological Factors. Pinker and Bloom state that the function of language is to facilitate communication. However, since there are different forms of communication in the animal world, "facilitating communication" is not enough to elucidate the evolution of human language. Richardson maintains that their explanation would not be satisfactory without clarifying the details of the environment in which the form of communication made possible by language was particularly helpful for our ancestors. Undoubtedly, their accounts leave too many unanswered questions, including "Which aspects of the ancestral environment fostered verbal communication?" "Were they different from those of our ancestors?" and "Are there any differences in linguistic abilities between *Homo sapiens* and other hominins?"
- Heritability. As mentioned above, Pinker and Bloom broadly endorse the Chomskyan assumption that the deep structure of language is universal and innate among human beings, although they note that there is an apparent variation in the command of language. This assumption runs afoul of the heritability condition, because a trait's heritability is technically undefined if it is possessed by all the organisms in a population and there is no variance in the trait.[9] In addition, they do not provide empirically grounded estimates for this assumption. Richardson also points to the lack of information on the state of variation in

[9] In a definition of a "broad" sense of heritability, heritability (h^2) is the proportion of the total variance of a trait (V) that is due to the genetic variance (V_g): $h^2 = V_g/V$ (Richardson 2007, p. 101; see also Rice 2004). Accordingly, if every organism in a population has the same phenotype, then V and V_g are zero, which suggests that h^2 is undefined.

ancestral populations.

- Population Structure. Richardson mentions that we have vastly underspecified knowledge about the population structure of past *Homo* species. Although they certainly lived in groups, but there is limited information on the various aspects of the population structure, including monogamy, outcrossing, immigration, and matrilineality.
- Trait Polarity. The overall direction of evolution is clear: language is a derived trait in the *Homo* lineage. However, we could not perform any comparative analysis because no corresponding features or brain regions were found in other primates. We could not trace the evolution of interesting features of language, such as lexical and phrasal categories and dominance rules, since Pinker and Bloom do not offer any evolutionary explanation of them.

In conclusion, Richardson finds Pinker and Bloom's account of the evolution of human language wanting in detail. Although Richardson does not deny the overall conclusion that human language is an adaptation for facilitating communication, their account has limited information on the evolution of interesting features of language and the overall situation in which our proto-linguistic ancestors lived.[10]

4. Do Adaptive Conjectures in New Evolutionary Studies of Consciousness Suffer from Poverty of Evidence?

In the last section we have seen Richardson's analysis of the adaptation explanations of evolutionary psychologists. Although he agrees with Pinker and Bloom's overall thesis, he concludes that their account presents limited detail on the evolution of various features of languages and thus fails to satisfy the five standards of an ideally complete adaptation explanation.

The next question is whether this also holds true of the new evolutionary studies of consciousness. Specifically, do the adaptive conjectures advanced by the new evolutionary studies of consciousness fare better than Pinker and Bloom's account from the five standards? There are two reasons why this question is significant. First, since both are evolutionary studies of the mind, they may face similar methodological problems. Furthermore, both research programs may suffer from "poverty of evidence." Language and consciousness are behavioral traits in the broad term. Since there is no direct fossil evidence for behavioral traits, it is often difficult to trace their evolution, irrespective of whether it concerns human beings or animals. Therefore, one could expect that new evolutionary studies of consciousness will be plagued with the same

[10] Richardson also applies the five standards to the evolutionary accounts of human rationality supported by Cosmides and Tooby (Cosmides and Tooby, 1992, and others) and others. He arrives at a similar conclusion.

methodological problem as evolutionary psychology.

4.1. Analysis of Feinberg and Mallatt's Selection Story

In this section we will analyze Feinberg and Mallatt's selection story on the emergence of animal consciousness in early vertebrates from five standards. According to their story, in a nutshell, an arms race between predators and prey in the Cambrian period facilitated the evolution of complex nervous systems in animals, leading to the emergence of consciousness, since consciousness allowed them to have a multimodal mental model of themselves and their surroundings, and thereby react swiftly to changes in their environment (see Section 2.2 for details). Then let us see whether this account satisfies the five standards of an ideally complete adaptation explanation:

- Selection. Feinberg and Mallatt's account does not satisfy Richardson's version of this standard, as it does not provide any information on variation in either the relevant characters or fitness among pre-conscious animals. However, Feinberg and Mallatt identified more neurological and phylogenetic properties of proto-conscious animals (see Section 2). This helps trace the transition from pre-vertebrates to early vertebrates in terms of the properties relevant to consciousness.[11] This is in a stark contrast to the neurological evidence for the evolution of language (at least at the time of the publication of Pinker and Bloom's paper). We know that there are brain regions responsible for linguistic information processing, such as Broca's and Wernicke's areas. However, Richardson indicates that there are many other areas involved in linguistic information processing and that it is difficult to identify precisely how those areas are different from each other. Also notable is that Feinberg and Mallatt trace the evolution of some neural components (SNFs) of consciousness. In Section 2, we have seen how isomorphic neural representations and their underlying anatomical architecture emerged during the transition to early vertebrates. In contrast, Pinker and Bloom provide limited information on the evolution of interesting features of language including semantics and the syntax of human language.
- Ecological Factors. As illustrated, Feinberg and Mallatt propose certain selection scenarios for consciousness, in which a positive feedback loop between predators and preys on the need for more accurate and comprehensive visual perception drove the neurological architecture for consciousness (SNFs) in the Cambrian explosion. Their scenario is more comprehensive than Pinker and Bloom's vis-à-vis

[11] Brandon may consider this as doubly indirect evidence of the existence of natural selection. He took the replacement of one morphological trait with another recorded in fossils as indirect evidence of natural selection (Brandon, 1990, p. 166). Since Feinberg and Mallatt's evidence partly comes from the paleontological study of relevant neural structures for a behavioral trait (consciousness) found in fossils, their evidence is even more indirect.

the evolution of human language because the latter did not specify the features of the past environment that prompted a communication device with the features of human language.[12]

- Heritability. Overall, Feinberg and Mallatt do not reveal much about the heritability of consciousness and its components in pre-conscious animals. However, their account fares better than Pinker and Bloom's because they do not assume the universality of the trait in question the way Pinker and Bloom do. Feinberg and Mallatt note that some arthropod species may have lost consciousness after their ancestors acquired it as they evolved a parasitic lifestyle (Feinberg and Mallatt, 2016, p. 220). Moreover, they discuss genes for neural components of consciousness in some places (Feinberg and Mallatt, 2013, 2016). For example, they cite Knöll and Drescher (2002) and others to refer to the *Eph/ephrin* genes, which signal isomorphic organization across various sensory modalities including visual and auditory sensations in vertebrates (Feinberg and Mallatt, 2016, p. 116). Given that Pinker and Bloom provide limited information on the underlying mechanism of our linguistic faculty, Feinberg and Mallatt perform a better job in this regard.
- Population Structure. To the best of our knowledge, Feinberg and Mallatt offer limited information on various components of this standard in pre-conscious invertebrates and early vertebrates: gene flow (interbreeding and immigration), the effective size of populations, and mutation rate.[13] Therefore, we can judge that Feinberg and Mallatt's account is no better than Pinker and Bloom's regarding this criterion.
- Trait Polarity. As in the case of language evolution, the overall evolutionary trend is clear on consciousness: consciousness is a derived trait while its non-existence is a primitive character state. However, one difference from Pinker and Bloom's account is that Feinberg and Mallatt's argument is based on comparison between pre-invertebrates and vertebrates, as comparative evidence is not available to Pinker and Bloom. Moreover, whereas evolutionary psychologists can

[12] In addition, Feinberg and Mallatt discuss the evolutionary development of consciousness after the Cambrian period in early amniotes (mammals and birds; Feinberg and Mallatt, 2016, Chapter 6). Since we focus on their account on the transition from pre-vertebrates to early vertebrates in the present paper, we cannot have an extensive discussion here; however, in this account they provide a detailed description of the environment in which those groups of animals developed more sophisticated forms of consciousness with the brain regions newly developing in those groups, although the plausibility of their scenario is yet to be examined (See Ota et al., 2022, for possible problems of their scenario).

[13] To be fair to Feinberg and Mallatt, it is always difficult to reconstruct the population structure in which any trait of such an ancient origin appeared in the evolutionary history (Suzuki, 2021).

only provide a sketch of the evolution of language without mentioning the evolution of its interesting features, Feinberg and Mallatt's account can depict how ancestral neural conditions were modified to produce SNFs and consciousness in early vertebrates.

From the above analysis, we can conclude that Feinberg and Mallatt's adaptation explanation is significantly better than Pinker and Bloom's in various important aspects. This advantage comes from the fact that Feinberg and Mallatt have a better understanding of the neural architecture underlying SNFs based on fossil evidence and the analysis of both model organisms and phylogenetic relationships between pre-conscious invertebrates and conscious vertebrates. Meanwhile, it is also the case that their explanations do not satisfy all standards. For instance, Feinberg and Mallatt hardly elucidated variation in fitness among pre-conscious animal populations and the population structure of ancient invertebrates. Their explanation is not complete in this sense and worse than the explanation of heavy metal tolerance.

4.2. Does This Cause Big Trouble to New Evolutionary Studies of Consciousness?

We have seen that Feinberg and Mallatt's adaptation explanation of the emergence of consciousness does not meet all the standards of an ideally complete explanation. Therefore, it is imperative to assess how much this affects the evaluation of their entire account of the evolution of consciousness in early vertebrates.

We do not believe that this caused any major trouble to Feinberg and Mallatt's entire theory for two reasons. First, after all, their adaptive conjecture forms only a small part of the theory. Their entire theory of the evolution of consciousness comprises several major parts: reviewing the phenomenological features of consciousness, identifying the neurobiological features (SNFs) that make consciousness possible and its biological basis, determining how and when SNFs evolved, and estimating why SNFs and consciousness evolved. In other words, evidence for their entire account comes from a wide range of places, and the adaptive conjecture is only one of them. Therefore, even if we have only fairly indirect evidence that natural selection facilitated the emergence of consciousness in the Cambrian period, this does not necessarily imply that we should change the evaluation of other parts of their theory, including the claim that the neurological architecture for SNFs appeared at a particular time in evolutionary history.

Second, and related to the point above, Feinberg and Mallatt's adaptation explanation and the rest of their theory actually answer different kinds of questions. As we have suggested, most parts of their theory are supposed to answer the "when" and "what" questions of the evolution of consciousness——"When did consciousness occur during the course of evolution?" and "What happened to the first conscious

animals when they acquired consciousness?" Meanwhile, their adaptive conjecture is supposed to answer the "why" question——"Why did consciousness occur when it did?"[14]

Importantly, given the research background against which Feinberg and Mallatt (and other researchers of the new evolutionary studies of consciousness) conducted their research, answering the former questions is more important than the latter for their project. The "old" evolutionary studies of consciousness define consciousness by sophisticated properties, such as self-recognition, and thus conclude that the range of conscious animals is significantly smaller and its origin was evolutionarily quite late. This is their answer to the "when" question. As for the "what" question ("What happened to the first conscious animals?"), these researchers typically cite the features of various hominin species and their relatives, such as chimpanzees, and speculate what happened to our ancestors and their cousins when they acquired consciousness. For example, Mithen (1996) describes the intellectual abilities of chimpanzees, *Homo habilis* and early humans (Neanderthals, *Homo erectus*, *Homo heidelbegensis*) and traces their development leading up to the emergence of consciousness. As illustrated, Feinberg and Mallatt (and others in the same research tradition) provide very different answers to these questions. Since the "why P?" question pragmatically assumes the truth of some proposition P (otherwise asking "why P?" has no point), answering the "when" and "what" questions is more important than answering the "why" question when two groups of scholars have very different answers to them.[15]

4.3. Failure of Feinberg and Mallatt's Adaptive Argument Against Epiphenomenalism

We have argued that their failure to meet all the standards of a complete adaptation explanation does not pose a serious threat to Feinberg and Mallatt's entire project

[14] Or the "how possibly" question ("How possibly did consciousness evolve at that time?"). Brandon notes that even "incomplete" adaptation explanations ——those which do not meet all the standards in a satisfying way—— could answer this type of question (Brandon, 1990).

[15] Furthermore, our discussion in the last section may not even lead us to the conclusion that Feinberg and Mallatt's explanation is flawed. Notice that completeness is not the only criterion for assessing a scientific explanation, because we can compare an explanation in question with others in terms of the degree of accommodation with the evidence available to us. For example, even if Feinberg and Mallatt's adaptation explanation on the emergence of consciousness is not complete, we could judge that their explanation accommodates evidence better than a non-adaptive explanation that consciousness emerged only as a byproduct of other brain functions. It is also worth recalling that even Richardson does not deny the possibility that the faculty for language evolved due to its function in facilitating communication. Put it another way, the fact that Feinberg and Mallatt's adaptation explanation is incomplete does not necessarily destroy its credibility as a legitimate explanation (we thank Daichi Suzuki for drawing our attention to this point).

on the evolution of consciousness. However, this does not mean that their use of adaptation stories avoids conceptual problems.

In the last chapter of their book (Feinberg and Mallatt, 2016), Feinberg and Mallatt presented an adaptation argument against what they call the epiphenomenalism of consciousness. Their target is the view that consciousness is just a byproduct of other brain functions, such as increased cognition and learning capacity.[16] While these functions have been adaptive by themselves, consciousness does not have any evolutionary function; it is due to the evolutionary advantages of other brain functions, not its own advantages, that consciousness has evolved.[17]

Feinberg and Mallatt objected to this position. The outline of their argument is as follows: (i) if consciousness were only a byproduct of other brain functions, then we would have lost it during the course of evolution owing to its evolutionary cost. (ii) However, we have retained consciousness for an extremely long period (more than 500 million years for vertebrates). (iii) Therefore, consciousness is not an inert byproduct of other brain functions. To support the claim about the evolutionary cost of consciousness, Feinberg and Mallatt cite Nichols and Grantham (2000) and argue that the brain structure behind consciousness is highly complex ——recall that a vertebrate's brain is made up of dozens of regions and that there are complex interactions among them—— and that it takes an enormous amount of energy to maintain any organ with this level of complexity. Therefore, if consciousness was of no use for survival and reproduction, then any organism with it would have been easily selected against.[18]

However, there is a problem with the first premise of this argument. Primarily, note that this premise only holds when consciousness and the complex neural structure behind sophisticated brain functions can evolve independently. If both are capable of evolving independently and consciousness has no or few evolutionary func-

[16] This is not a standard definition of epiphenomenalism. In the philosophy of mind, epiphenomenalism is usually taken to be the view that consciousness is causally inert. Being causally inert is not identical to being an evolutionary byproduct or accident (Robinson et al., 2015). For one, it may be the case that the trait in question does have some effects and these effects are neutral in terms of natural selection. However, since both the views are closely related (a trait being causally inert implies it being an evolutionary byproduct or accident), we will use Feinberg and Mallatt's terminology here (we thank Koji Ota for drawing our attention to this point).

[17] They cite Block (1995), Jackson (1982), Robinson (2007) and others as supporters of this view.

[18] Nichols and Grantham are not the first to give this type of argument. Indeed, Humphrey (2002) cites the following passage from Lloyd Morgan (1908, p. 308): "It is nothing less than pure assumption to say that the consciousness, which is admitted to be present, has practically no effect whatever upon the behaviour. And we must ask any evolutionist who accepts this conclusion, how he accounts on evolutionary grounds for the existence of a useless adjunct to neural processes."

tions despite its considerable cost, then eliminating it would definitely be adaptive. However, if consciousness and complex neural structures are biologically and developmentally connected, it is impossible to eliminate consciousness from organisms with complex neural structures, even if consciousness is an evolutionary burden to them. This concern is particularly pressing to Feinberg and Mallatt when they refer to Mark Bradley's point (Bradley, 2011) that qualia are tightly connected to neural activity among other things as a *support* for their adaptation argument:

> In chapter 2, we presented Nichols and Grantham's rebuttal to the idea of consciousness as by-product ... To this, we add the argument of Mark Bradley. He pointed out that specific experiences (qualia) are *too tightly correlated* ... to specific brain structures and neural activities (such as activating the amygdala), ... to be coincidental by-products with no causal role. (Feinberg and Mallatt, 2016, p. 218; italics in original)

However, if Bradley is right that the biological connection between subjective experience and the neural structure is very close, then it would be biologically impossible to discard consciousness while retaining the complex neural structure in the first place, whether or not it is adaptive. Therefore, we can conclude that Feinberg and Mallatt's adaptation argument against epiphenomenalism does not work.

In response, supporters of Feinberg and Mallatt may call our attention to the fact that Bradley refers to the correlation between qualia and *specific* neural activities, not the functions pertaining to the entire brain activities, which are the domain of their argument. However, this defense cuts both ways for Feinberg and Mallatt. On the one hand, this implies that we cannot use Bradley's point to criticize their argument. On the other hand, Feinberg and Mallatt's reference to Bradley would not be considered as a support of their argument because the kind of epiphenomenalism in question is a thesis concerning the relationship between consciousness and these "global" brain functions. In addition, Feinberg and Mallatt suggested that global brain functions are tightly connected to consciousness, because some SNFs, such as the complexity and hierarchy of the neural system, are the global properties of the neural system.

5. Conclusions

In this study, we have examined the degree of comparison between new evolutionary studies of consciousness and other evolutionary studies of the mind, whether it is about our mind (evolutionary psychology) or the animal mind in general (old evolutionary studies of consciousness). Correspondingly, we reviewed one specific methodological criticism of evolutionary psychology: that it fails to provide satisfactory complete adaptation explanations. After seeing how the explanations of heavy metal

tolerance and the evolution of language work according to the standards advanced by Brandon and Richardson, we applied them to Feinberg and Mallatt's adaptive conjecture on the emergence of consciousness in early vertebrate animals during the Cambrian period.

The analysis revealed the following: First, owing to neurological evidence from their analysis of both model organisms and fossils of non-conscious invertebrates and conscious vertebrates, Feinberg and Mallatt's explanation fares better than the one offered by Pinker and Bloom on the evolution of language. Feinberg and Mallatt's explanation is nevertheless inadequate vis-à-vis certain important standards of a complete explanation. In particular, their account provides limited information on the population structure of ancient, non-conscious animals. The next question is whether or not this presents a fatal blow to Feinberg and Mallatt's theory of the evolution of consciousness. Our answer is no. After all, the adaptive conjecture is only a minor part of the entire theory. Moreover, given the research background against which their study has been conducted, the novelty and importance primarily lie in their answers to the "when" and "what" questions of the evolution of consciousness, but not to the "why" question.

This does not imply that their explanations do not have any conceptual challenge. To explore this, we examined Feinberg and Mallatt's counterargument toward epiphenomenalism. They argue that if consciousness does not have any evolutionary function, then we would have lost it due to the energy cost carried by the neural mechanism underlying consciousness. We indicated that this argument holds only when consciousness and its underlying neural system are biologically independent. Feinberg and Mallatt, however, have emphasized that they are closely connected.

In conclusion, we can say that Feinberg and Mallatt's adaptation explanation does not encounter a serious methodological problem, although their criticism of epiphenomenalism does not work. Then one may ask what the difference is between Feinberg and Mallatt's and Pinker and Bloom's explanations. A notable difference is the use of neurological and phylogenetic evidence (or lack thereof) in their explanations. Both groups of researchers potentially face the problem of "poverty of evidence" in their explanations. The emergence of consciousness is an ancient event, and certain kind of evidence is not available to researchers. Since language is arguably a faculty unique to human beings, we cannot conduct any comparative study on it. However, one group of researchers (Feinberg and Mallatt) had access to the neurological structure of related biological groups differing in the existence of key features of the trait in question, whereas the other group did not. This is partly what divides the two groups of researchers.

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