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Epistemic Challenges in Neurophenomenology: Exploring the Reliability of Knowledge and Its Ontological Implications

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Abstract: This article investigates the challenges posed by the reliability of knowledge in neurophenomenology and its connection to reality. Neurophenomenological research seeks to understand the intricate relationship between human consciousness, cognition, and the underlying neural processes. However, the subjective nature of conscious experiences presents unique epistemic challenges in determining the reliability of the knowledge generated in this research. Personal factors such as beliefs, emotions, and cultural backgrounds influence subjective experiences, which vary from individual to individual. On the other hand, scientific knowledge aims to uncover universal truths based on empirical observations and objective principles. Reconciling the subjective and objective realms presents a significant challenge in determining the reliability of knowledge generated through neurophenomenological research. This article aims to examine the inherent limitations and challenges of neurophenomenological research to shed light on the complexities involved in understanding the nature of knowledge itself. This article highlights that the ontological implications of the reliability of knowledge in neurophenomenology arise from the question of how subjective experiences relate to objective reality. Understanding the neural correlates and mechanisms behind subjective experiences can provide insight into the underlying ontological nature of consciousness.

Keywords: reliability of knowledge; neurophenomenology; subjective experiences; objective reality; consciousness; cognition; neural processes; personal factors; scientific knowledge

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1. Introduction

Philosophy has long been concerned with the nature of consciousness and the relationship between subjective experiences and objective reality. The issue of reality pertains to how consciousness can verify the existence of an object by examining its characteristics and its connection to the surrounding environment [1,2]. In the realm of scientific observation, consciousness undertakes a deliberate and methodical examination of outcomes, conveying them through iconic forms of scientific language [3]. To fully comprehend reality and reason as elements in the realm, we must consider the type of observation equipment that aligns with the object being studied, while also acknowledging the significance of observation as the fundamental starting point.

Traditionally, since the time of Aristotle, from an ontological standpoint, reality can be understood as existing independently of human consciousness, with its inherent properties and principles. This view is often associated with a realist approach, asserting that the external world exists and can be known, albeit imperfectly, through scientific inquiry and empirical observation [3–5]. The realist perspective upholds the notion of an objective reality that exists beyond subjective experiences and interpretations. However, with the advent of phenomenology, there has been a growing recognition of the role that subjective experience plays in shaping human understanding of reality. According to phenomenological approaches, reality is not solely a product of external stimuli but is also constructed through human subjective experiences and interpretations of the world [6,7]. This view challenges the notion of an objective reality that exists independently of consciousness.

Instead, it suggests that understanding reality is inherently subjective and influenced by human cognitive processes, cultural backgrounds, and personal biases.

Epistemologically, the question of reality, poses challenges to theories of knowledge and the limits of human comprehension. The evolutionary epistemological perspective recognizes that our understanding of reality is shaped by cognitive abilities, which themselves have evolved [8]. Human senses, reasoning capacities, and conceptual frameworks all contribute to the construction of reality. As such, knowledge of reality is always contingent and subject to revision.

In the broader scientific context, the issue of reality intersects with various disciplines, including physics, biology, and cognitive science [9–11]. Quantum physics, for instance, has raised profound questions about the nature of reality at the microcosmic level, challenging traditional notions of causality, determinism, and objectivity [11,12]. At the same time, biological studies have illuminated the complex interplay between organisms and their environment, highlighting the role of perception, adaptation, and cognition in shaping our understanding of reality.

Reality, as a philosophical concept, has long been a subject of contemplation and exploration, shaping how we perceive and understand the world and influencing the very nature of philosophical and scientific frameworks. The notion of reality has garnered increased attention within the realm of nonclassical theories of knowledge, particularly in the field of evolutionary epistemology [10,11,13]. This multidisciplinary area of inquiry encompasses various domains of philosophical discourse and delves into the study of the growth and development of scientific knowledge as well as the examination of ontological and epistemological questions.

In the pursuit of understanding reality, evolutionary epistemology draws upon the contributions of renowned philosophers such as Karl Popper [14,15] and Stephen Toulmin [16,17], who have offered invaluable insights into the nature of scientific knowledge. Popper's works have provided frameworks for the formation, evaluation, and evolution of scientific theories. Toulmin, on the other hand, has explored the structure of arguments and the role they play in the acquisition and validation of knowledge.

Moreover, the quest for understanding reality extends beyond the confines of the human mind and into the realm of living systems. The approach pioneered by Francisco Varela [18–20], known as the cognitive biology approach, seeks to unravel organisms' cognitive abilities and mechanisms to understand and interact with their environment. Varela's works shed light on the intricate relationship between cognition and the lived experience.

In this context, the concept of reality takes on a dynamic and evolutionary character. Reality is not merely a static entity to be discovered or represented but a subject of continuous exploration and meaning-making. The nonclassical theory of knowledge recognizes that our understanding of reality is shaped by interactions with the world, cognitive abilities, and the evolutionary processes that have molded perception over time [10,11].

The nonclassical theory of knowledge offers a profound and comprehensive framework to understand the nature and formation of our understanding of reality. It acknowledges that human perception and apprehension of the world are not mere passive reflections of external reality, but they are actively shaped by a multitude of factors, including interactions with the world, human cognitive abilities, and the evolutionary processes that have shaped perception over time [10,21,22]. This perspective challenges the traditional understanding of knowledge as a static and objective representation of external reality and instead presents knowledge as a dynamic and evolving construction that is intricately interwoven with human subjective experiences and cognitive processes.

At the heart of the nonclassical theory of knowledge lies the recognition that human understanding of reality is profoundly influenced by interactions with the world. This interaction encompasses not only human sensory perception but also active engagement with the objects, events, and phenomena that surround us. Through senses, people gather information from the external world, which serves as the foundation for cognitive processes to make sense of this information and construct a coherent understanding of reality.

However, cognitive abilities, which include processes such as perception, memory, reasoning, and conceptualization, play a crucial role in shaping our understanding of reality. Human perceptions of the world are not passive recordings of sensory input but active interpretations shaped by cognitive processes.

Furthermore, the nonclassical theory of knowledge recognizes that our understanding of reality is fundamentally shaped by the evolutionary processes that have molded cognitive abilities over time. Evolutionary biology shows that cognitive faculties have not emerged fully formed but have evolved through a gradual and cumulative process of adaptation. The development of human cognitive abilities can be seen as an ongoing negotiation between the demands of the external environment and the constraints and possibilities of biological systems. As such, cognitive processes have been shaped by natural selection to facilitate survival and reproduction within specific ecological contexts.

These evolutionary processes have endowed us with unique cognitive abilities but introduced biases, heuristics, and limitations into human perception and understanding of reality. The nonclassical theory of knowledge recognized the intricate interconnections between interactions with the world, cognitive abilities, and the evolutionary processes that have shaped human perception. This idea is a challenge for traditional notions of knowledge as a straightforward and objective representation of external reality and instead encourages us to embrace a more nuanced and dynamic understanding of knowledge as a constructive and constantly evolving process. This perspective has profound implications for scientific endeavors. Scientific knowledge is not a fixed and final representation of an external reality but is subject to ongoing investigation, revision, and refinement. Scientific theories, models, and explanations are continuously reevaluated and revised considering new evidence and theoretical developments. As human understanding of the world evolves, so too does scientific knowledge, in a perpetual cycle of discovery and refinement.

By acknowledging the influence of interactions with the world, cognitive abilities, and the evolutionary processes that have shaped perception, the nonclassical theory of knowledge challenges traditional notions of knowledge and embraces a more dynamic and nuanced understanding of knowledge as a constructive and ever-evolving process. Neurophenomenology is a relatively new interdisciplinary field that seeks to bridge this gap by combining philosophy and science. However, the inherent subjectivity and complexity of conscious experience pose significant epistemic challenges for neurophenomenology. These challenges require careful consideration of the methods and approaches used to study consciousness, as well as a critical examination of the ontological status of subjective experiences. By grappling with these challenges, neurophenomenology has the potential to deepen an understanding of the nature of consciousness and its place in the broader fabric of reality.

Neurophenomenology is an interdisciplinary field that investigates the relationship between conscious experience and the underlying neural processes. Ch. Laughlin defines neurophenomenology as a method for determining the relationship between consciousness and the nervous system in combination with the methods of phenomenology and neuroscience [23] (p. 265). It seeks to bridge the gap between subjective first-person experiences and objective third-person scientific observations. Conscious experience is a complex phenomenon that encompasses various cognitive processes, emotions, and sensory perceptions. Understanding the neural mechanisms that give rise to these subjective experiences is crucial for unraveling the mysteries of consciousness.

However, neurophenomenology faces significant epistemic challenges due to the inherent subjectivity and multifaceted nature of conscious experience. Subjectivity refers to the individual's unique and personal perspective on reality, which can differ from person to person. This subjectivity poses limitations when attempting to establish reliable and replicable knowledge in neurophenomenology. Furthermore, the elusive nature of consciousness itself adds another layer of complexity to this endeavor.

The epistemic challenges in neurophenomenology have far-reaching implications for the understanding of knowledge and reality. To generate reliable knowledge, it is necessary

to establish a methodology that can account for subjective variability and address the interpretive challenges involved in studying conscious experiences. This article will critically examine these epistemic challenges and propose potential approaches to overcome them, thereby enhancing the reliability and objectivity of neurophenomenological knowledge. By exploring these challenges, we aim to shed light on the philosophical and scientific implications of neurophenomenology, particularly concerning the understanding of the nature of consciousness, the reliability of subjective reports, and the ontological status of subjective experiences.

This article aims to investigate the challenges posed by the reliability of knowledge in neurophenomenology and its connection to objective reality. Neurophenomenology studies the connection between subjective experiences and the physical processes underlying them. It argues that subjective experiences are valid sources of knowledge and should be integrated with objective data. This integration is crucial for a comprehensive understanding of consciousness. Neurophenomenology uses scientific methods to validate subjective experiences, but the unique nature of these experiences poses challenges. Overcoming these challenges includes developing standardized protocols and advanced technologies.

In the context of neurophenomenology, which aims to bridge the gap between subjective experience and neural processes, the reliability of knowledge becomes a central concern. How can we ensure that human understanding of consciousness is accurate and trustworthy, given the inherently subjective nature of experiences? This question raises challenges and considerations that must be addressed to make meaningful progress in the field.

Conscious experience presents a challenge for researchers because it is inherently subjective. Although neuroscience can provide objective measurements of brain activity, it cannot fully capture the richness of individual experiences. The study of consciousness relies on scientific methods and tools, such as fMRI scans, which offer valuable insights into the neural correlates of experience. However, these approaches also have their limitations and assumptions. For instance, fMRI scans only indirectly measure neural activity through changes in blood oxygenation, which may not provide a complete picture of brain function. Moreover, cognitive experiments require participants to accurately report their experiences, which can be influenced by memory biases and perceptual limitations. Furthermore, the issue of inter-individual variability adds complexity to the reliability of knowledge in neurophenomenology. Different individuals may have different subjective experiences of the same phenomenon, highlighting the subjective and idiosyncratic nature of consciousness. This variability raises questions about the generalizability and reproducibility of findings in the field.

The reliability of knowledge in neurophenomenology is a complex and challenging issue. The subjectivity of conscious experience, the inherent limitations of scientific methods, and the inter-individual variability all contribute to the difficulty of establishing accurate and trustworthy knowledge in this field. However, by acknowledging these challenges and adopting rigorous methodologies, researchers can strive toward a more reliable understanding of the mind and consciousness, enriching an understanding of the nature of reality and the relationship between subjective experience and neural processes.

2. Theoretical Framework

The field of neurophenomenology investigates the complex relationship between human consciousness, cognition, and neural processes. However, there are challenges in ensuring the reliability of the knowledge generated from this research. In this section, we will discuss the contributions of notable scholars who have made significant advancements in understanding these challenges and their implications. In the realm of neurophenomenology, significant contributions to its development have been made by Ch. Laughlin and his colleagues [24–26], including F. Varela, E. Thompson, and E. Rosch [20]. However, their works have given rise to two distinct branches within neurophenomenology, namely cognitive neurophenomenology and cultural neurophenomenology.

Cognitive neurophenomenology delves into the biological foundations of subjectivity and conscious experience. F. Varela proposed a naturalized version of epistemology, positing that cognitive processes are rooted in biological processes. He emphasized the importance of embodied experience in forming perception and cognition [20] (p. 209). According to F. Varela, the brain is not merely a passive receiver of sensory information but it actively participates in the construction of perceptual experience. Overall, Varela's theory of embodied cognition underscores the significance of the body and sensorimotor experience in shaping mental representations, as embodied experience is portrayed as the context in which living systems, including humans, reside, which determines human thoughts, feelings, and types of action [20] (p. 172).

On the other hand, cultural neurophenomenology focuses on the cultural and social factors that shape human subjective experiences. Ch. Laughlin, one of the founding figures of neurophenomenology, was interested in the cultural and religious dimensions of consciousness [27]. The distinctive feature of Laughlin's concept of embodied cognition is that cultural and social contexts influence perception and understanding of the surrounding world.

Neurophenomenology aims to bridge the gap between objective measurements and subjective experience. Traditional neuroscience methods, such as brain imaging and electrophysiology, provide objective data on neural activity but do not capture people's subjective experiences. Phenomenology, on the other hand, deals with individuals' subjective experiences but does not provide objective data on neural activity. Neurophenomenology seeks to integrate both perspectives, combining the objective measurements of neuroscience with the subjective experiences studied by phenomenology.

Neurophenomenology is an approach that combines the methodologies of neurophysiology and transcendental phenomenology of E. Husserl. Scholars build upon the work of F. Brentano [28,29] and E. Husserl [30,31], who characterized human consciousness as intentional. Recognizing the potential ambiguity surrounding the term "consciousness," Laughlin and Rock clarify their perspective by focusing on "consciousness" in the sense of conscious awareness. Consequently, they narrow their investigation to the conscious aspect of awareness [23] (p. 262).

A. Rock and S. Kripner argue that a thorough examination of the cognitive psychology literature supports E. Husserl's proposition regarding the intentionality of consciousness [32–34]. Ch. Laughlin and A. Rock introduce the concept of "phenomenal space" by linking it to Ned Block's concept of "phenomenal consciousness," equating consciousness to subjective experience [23]. The properties of phenomenal consciousness encompass the attributes of experience, including sensory perceptions, emotional states, and cognitive processes such as thoughts and desires [23] (p. 206).

Neurophenomenology is an interdisciplinary approach that integrates the principles of phenomenological research with neurobiological methods in the study of consciousness. According to F. Varela, investigating the brain necessitates a methodology that combines empirical and phenomenological approaches [35]. A fundamental concept in neurophenomenology is embodied consciousness, which posits that human perception of the world is closely linked to human physical embodiment. This is because the brain is not an isolated entity, but rather part of a larger system that includes the body and the surrounding environment [35–37]. F. Varela and E. Thomson argue that embodiment signifies the inherent integration of living beings within their physical and social surroundings, which profoundly influences their perception, actions, and cognitive processes [38].

The notion of embodied consciousness within the framework of neurophenomenology is founded on two key phenomenological concepts.

Firstly, intentionality plays a significant role in understanding embodied consciousness [20,36–38]. Intentionality refers to the inherent directedness of consciousness toward objects in the external world. As expounded by E. Husserl, intentionality encompasses how experiences are endowed with authentic features of consciousness, given that intentionality manifests through acts of awareness of something [6]. In neurophenomenology,

the study of embodied consciousness entails examining the intricate relationship between the brain, body, and subjective experience. This approach highlights the critical role played by the body in shaping and influencing conscious experiences. Intentionality is closely intertwined with the sensorimotor capabilities of the body, which enable individuals to actively and meaningfully engage with the world, thus representing a crucial facet of the discourse surrounding embodied consciousness.

Secondly, the concept of the living body holds a central position within the framework of embodied consciousness. The term "living body" denotes how bodies are subjectively experienced as entities imbued with vitality rather than merely objects subjected to scientific investigation. This lived experience is integral to comprehending embodied consciousness, as it forms the foundation for perceiving oneself as an individual and discerning one's position within the world. This experience of being in the world is inherently dynamic and continuous, aligning with Varela's assertion that consciousness is not an entity or substance but a process [19] (p. 330).

In the field of neurophenomenology, the contributions of Maurice Merleau-Ponty are crucial. Merleau-Ponty's phenomenology of perception [39] offers a distinctive perspective on phenomenology, emphasizing that perception is an active and embodied engagement with the world rather than a passive reception of sensory information. Within the neurophenomenological tradition, it is essential to underscore that perception goes beyond simply representing objective reality; it is a subjective experience that is intricately connected to the body and the surrounding environment. Physical experience is fundamentally intertwined with consciousness right from the outset, with self-awareness forming a prerequisite for the existence of consciousness. Gallagher and Zahavi [40] and Lutz and Thompson [41] highlight this aspect. Consequently, Merleau-Ponty's phenomenological ideas serve as a philosophical foundation for the concept of embodied consciousness, accentuating the role of the body in shaping conscious experiences. Merleau-Ponty argues that the body is not merely an object within the world, but rather a lived experience that is intimately linked with subjective consciousness.

The concept of embodiment in neurophenomenology highlights the significant role of bodily sensations and emotions in shaping human perception of the external world. This perspective recognizes that the body is closely intertwined with cognitive and affective processes, a phenomenon referred to as incarnation. This understanding of the mind–body relationship is a fundamental aspect of embodied consciousness.

The neurophenomenological perspective asserts that human perception of the world is not solely dependent on sensory input, but it also relies on the processing and integration of this information with bodily sensations and emotional states by the brain. The interconnectedness of the body and mind is central to the holistic human experience, and the study of embodied consciousness has led to valuable insights in areas such as psychology, neuroscience, and philosophy.

Research has demonstrated that the sensory and motor capabilities of the body play a significant role in shaping emotional experiences, decision-making processes, and self-perception. For instance, body postures, facial expressions, and other nonverbal cues have been shown to influence an individual's emotional states and self-perception. Additionally, physical sensations and movements have been found to impact cognitive processes like attention, memory [42–44], and decision-making [45–47].

Giovanni Colombetti and Evan Thompson present compelling evidence that emotions encompass more than mere mental states [48]. They argue that emotions are embodied experiences characterized by intricate interactions among bodily sensations, the environment, and social context. Colombetti and Thompson propose that emotions should be understood as a type of embodied cognition, emphasizing the critical role that bodily sensations play in influencing human perception of the world.

Michelle Maiese presents an argument that challenges the traditional separation between cognitive and bodily aspects of emotions [49] (p. 514). Maiese suggests that understanding emotions as a means of interacting with and giving meaning to the external

world can help bridge this divide. Maiese introduces the concept of affective framing as a foundational basis for emotional experiences. According to Maiese, affective framing involves the evaluation of the environment through bodily sensations of care, which leads to the merging of cognitive and bodily elements in emotions. This concept not only clarifies the relationship between the cognitive and bodily aspects of emotions but also offers a valuable framework for understanding the intentional focus and phenomenal nature of emotional experiences.

Manos Tsakiris explores the significant role of bodily sensations in shaping an individual's self-perception and perception of the world [50]. Tsakiris emphasizes the notion of embodiment and the importance of interoception in subjective experiences. The article underscores the impact of bodily sensations in the formation of personal identity and interpersonal connections with others.

Yann Coelho and Yvonne Delevoye-Turrell focus on the idea that human interaction with the world is influenced by the properties of the body [51]. The authors provide empirical evidence to support the notion that human perception of the external space is dependent on human understanding of bodily representations, both at empirical and functional levels. This suggests that human perception and categorization of the world are constrained by our knowledge of our own spatial and functional limitations, such as our understanding of our motor system. Additionally, the brain creates a mental representation of the body for effective functioning in a complex environment and acts accordingly.

Fourth, neurophenomenology proposes a relationship between intersubjectivity and the concept of embodied consciousness. Both concepts acknowledge the significance of context in understanding the world and argue that human experiences cannot be understood in isolation from the social and physical environment. Intersubjectivity, as a philosophical concept, highlights the role of social interaction and communication in shaping our experiences and understanding of the world. It questions how our perception of the world is constructed through interactions with others. In the context of embodied consciousness, intersubjectivity is closely linked to embodied social interactions that enable us to share experiences and exist within a common semantic framework.

F. Varela proposed the idea of neurophenomenology, which highlights the importance of combining first-person subjective experiences with third-person objective observations [19]. He believed that subjective experiences could offer valuable information regarding consciousness but also acknowledged that these experiences are subjective and vary from person to person.

F. Varela introduces the idea of embodied cognition, proposing that the understanding of the body forms the basis for the potential experience of consciousness [20]. Varela presents a perspective where individuals are intimately connected with their embodiment and engagement with the external world. This allows Varela to position embodiment as a fundamental characteristic of consciousness. Building on the ideas of M. Merleau-Ponty, Varela acknowledges that the concept of embodiment carries a dual meaning: it encompasses the body as a living, tangible structure and also as a context or environment for cognitive processes [20] (p. xvi). According to Varela, the empirical embodiment of consciousness occurs through the interaction between the organism and the world, resulting in a pre-reflective experience of physical subjectivity.

According to F. Varela, knowledge is intricately tied to consciousness and intuition [18]. He describes cognitive activity as the foundation for a significant distinction between the system's observed environment and the world it operates within [52] (p. 87). Varela also recognizes the paradox of cognitive activity. On one hand, the system's actions aim to establish a connection with the environment, which may disrupt internal coherence through collisions and disturbances. On the other hand, these actions simultaneously delineate and isolate the system from its environment, creating a distinct and separate world.

Another line of evidence supporting the embodied view of mental representations is derived from the concept of sensorimotor contingency. This concept posits that mental representations are shaped through the dynamic interplay between the brain, body, and

environment and are contingent upon the patterns or coincidences that emerge from the interaction between sensory and motor events. The notion of sensorimotor contingency was initially developed by Alva Noë [53–55]. Noë argues that sensorimotor contingency plays a crucial role in perception, asserting that the link between sensory inputs and bodily actions enables us to perceive objects and events. Similarly, the formation of mental representations of actions relies on sensorimotor contingencies that emerge between bodily movements and the resulting sensory feedback. These findings imply that mental representations are not solely symbolic but rather are grounded in the patterns and coincidences that arise from sensory–motor interactions.

Scientists have utilized various methods to connect personal experiences with scientific measurements. These methods strive to combine individual descriptions of experiences with data gathered from a scientific perspective.

In neurophenomenology, researchers have used a technique called "experience sampling" to capture subjective experiences in natural settings. This involves using diaries, questionnaires, or smartphone applications to prompt participants to report on their experiences at regular intervals throughout the day. By doing so, researchers can gather comprehensive and accurate data on the dynamics of subjective experience.

These approaches aim to utilize data from both subjective reports and objective measurements, such as brain imaging, to obtain a more comprehensive understanding of the subjective experience and its relationship with brain function. For instance, researchers have conducted studies on the neural correlates of meditation by combining self-reports and functional magnetic resonance imaging (fMRI) [56–58]. This imaging technique enables real-time examination of brain activity. The primary objective of these studies was to investigate the differences in brain activity among individuals with varying levels of meditation experience. Participants underwent pre- and post-meditation training scans. In a study [58], meditation practitioners with more than 10 years of experience were scanned during tasks involving attention regulation. The findings from these studies revealed that meditation is associated with increased activity in the anterior cingulate cortex and dorsolateral prefrontal cortex during attention-related tasks. These brain regions are known to be involved in attention and emotional regulation.

Studies that combine self-report and brain imaging have demonstrated that meditation is linked to increased activity in the brain regions responsible for attention and emotional regulation, specifically the anterior cingulate cortex and dorsolateral prefrontal cortex. These results suggest that meditation can be an effective tool for enhancing attention and emotion regulation in both healthy individuals and those with psychopathology.

Neurophenomenology also employs the use of phenomenological interviews, where trained interviewers systematically and structurally inquire about an individual's subjective experiences. The goal is to obtain a detailed account of the person's subjective experience and identify its essential features and themes. Francisco J. Varela, Evan Thompson, and Eleanor Rosch integrated cognitive science and phenomenology to investigate the nature of human experience [20]. As part of their methodology, they conducted phenomenological interviews to thoroughly explore participants' subjective experiences in various phenomena, including perception, emotions, and thoughts.

Researchers in the field of neurophenomenology have employed integrative methods that involve utilizing tools and techniques from both neuroscience and phenomenology. One such method involves combining neuroimaging techniques like functional magnetic resonance imaging (fMRI) or electroencephalography (EEG) with phenomenological interviews to study the neural correlates of certain subjective experiences [59–62].

Researchers have been exploring the potential of virtual reality (VR) technologies in neurophenomenology. By placing participants in virtual environments, researchers can control various aspects of the environment to elicit specific subjective experiences. This allows for a systematic investigation of the relationship between the perceived environment, subjective experience, and underlying neural mechanisms. Philippe Goldin and his colleagues investigated the effectiveness of using VR technology to reduce social anxiety

symptoms in individuals with social anxiety disorder [63,64]. Evan Thompson has explored the role of virtual reality in understanding consciousness [65]. Thompson discusses the potential of VR for studying altered states of consciousness and the interplay between subjective experience and neural processes.

Overall, these approaches provide researchers with tools to investigate and validate subjective experiences in neurophenomenology. By combining rigorous scientific methods with phenomenological inquiry, researchers can gain insights into the neural underpinnings of subjective experiences while also accounting for the subjective and contextual aspects that influence these experiences.

The use of various methods in neurophenomenology has the potential to enhance the comprehension of consciousness, perception, and personal experience. Researchers can address obstacles to knowledge by adopting a multidisciplinary and integrated approach, leading to a more thorough understanding of the human psyche. Furthermore, integrating neurophenomenology into clinical research and therapeutic interventions holds great promise. By understanding the subjective experiences of individuals with various neurological and psychiatric conditions, researchers and clinicians can tailor treatments and interventions to better address their specific needs and challenges. Neurophenomenological approaches could also help uncover the underlying mechanisms behind certain symptoms or experiences, leading to more effective interventions and therapies.

3. The Subjectivity of Conscious Experience

The endeavor to comprehend conscious experience poses profound inquiries concerning the essence of reality and the constraints of human perception. Subjective accounts, shaped by an array of factors encompassing biases, emotions, and cognitive processes, present challenges in establishing objective truths about consciousness. The neural correlates of human emotional embodiment not only reflect its evolution but also serve as objects of cultural practice. This premise finds resonance in studies exploring ritual spiritual practices, including meditation [66], yoga [67], and shamanism [68].

Ch. Laughlin, in collaboration with J. McManus and E. d'Aquili [69], discovered that shamanism entails the creation of higher levels of consciousness, as shamanic manifestations involve two primary states: the holistic imperative, the striving for a more complete level of consciousness, and shamanic projection, the positive projection of a more advanced stage of development onto another individual, based on the unconscious transfer of control over intentional processes. According to Ch. Laughlin, the universals of shamanism are the expressions of neurognostic structures in fundamental forms of perception, awareness, and cognition, facilitated by biological nature and organism functions [69,70].

Several theoretical findings suggest a connection between emotions, the brain, and the nervous system, which play a pivotal role in perception [66,71,72]. This situation generates a phenomenon in which the conscious experience characteristic of perception can manifest itself through the enhanced development of the neural structures of the brain underlying human incarnation. The concept of "incarnation" reflects the tangible experience of the body. It refers to the embodiment of consciousness in a physical form, where subjective experiences are rooted in the interactions between the brain, body, and the external world.

The human brain, with its intricate neural networks, plays a central role in mediating perception and generating conscious experiences. As human beings, embodied experiences are influenced by the sensory information received through the senses, which is processed and integrated by the brain. This interplay between the brain and the body gives rise to the subjective nature of human perceptions and experiences.

The concept of incarnation highlights the essential connection between the mind and the body, suggesting that conscious experiences are not separate from physical existence but are deeply intertwined with it. This framework acknowledges that conscious states are not isolated phenomena but rather arise because of the continuous interplay between our physical presence, cognitive processes, and emotional states. Human bodily sensations, motor actions, and emotional states all contribute to shaping conscious experiences. For

example, the perception of a sunset involves not only visual stimuli but also the bodily sensations of warmth or coolness, the emotions evoked by the beauty of the scene, and the motor actions involved in gazing at it. By examining the intricate relationship between the mind and the body, proponents of the embodied consciousness model contend that subjective experiences are not solely products of the mind but rather emerge through the integration of bodily states and interactions with the environment.

Moreover, interpreting these accounts necessitates making assumptions about the neural processes at play, which can be influenced by theoretical frameworks, personal biases, and prior knowledge. Given these intricacies, individuals must approach the understanding of conscious experience with humility and acknowledge the limitations of knowledge. Variances in cognitive abilities, emotional dispositions, and sensory perceptions among individuals result in disparate subjective experiences despite exposure to identical stimuli or tasks. This poses difficulties in reaching generalizable conclusions or reproducing findings across diverse individuals, thus raising doubts about the universality of neurophenomenological studies.

The pursuit of knowledge and understanding is a fundamental aspect of human existence. It is through an exploration of consciousness and the nature of experience that we can begin to unravel the mysteries of the mind. By utilizing interdisciplinary approaches and standardized protocols, we can enhance the understanding of the neural correlates of conscious experience and gain deeper insights into the complexities of the human psyche. Through this pursuit, we may come to a greater appreciation of the intricacies of consciousness and the role it plays in shaping human perceptions of the world.

To address these challenges, neurophenomenology can benefit from interdisciplinary approaches and complementary methodologies. Combining subjective reports with objective measurements, such as neuroimaging techniques, can provide a more comprehensive understanding of the neural correlates of conscious experience. Incorporating individual differences into the study design, such as personality traits, cognitive abilities, and sensory thresholds, can also help examine how they influence conscious experiences. Developing standardized protocols for introspective reporting can enhance the consistency and comparability of data across studies, minimizing biases and increasing reliability.

4. Neural Correlates and Subjective Experience

One commonly used neuroimaging technique in neurophenomenology is functional magnetic resonance imaging (fMRI), which measures changes in blood flow and oxygenation levels in the brain. By comparing brain activity during different tasks or states, researchers can identify patterns of neural activation that are associated with specific subjective experiences.

For example, studies have identified neural correlates of various subjective experiences, such as pain [73–75], visual perception [76–78], and emotional states [79–81]. These studies provide valuable insights into the neural underpinnings of subjective experiences, contributing to the understanding of how the brain processes pain, visual perception, and emotional states.

These findings [73–81] have provided insights into the brain regions and networks that are involved in generating these experiences. For instance, research has shown that the anterior cingulate cortex and insula are involved in the processing of pain, while the occipital cortex is critical for visual perception.

Another technique used in neurophenomenology is electroencephalography (EEG), which measures the electrical activity of the brain [59–62]. EEG can provide information about the timing and frequency of neural oscillations, which are associated with different cognitive processes and subjective states. For instance, alpha waves have been linked to relaxed states, while gamma waves are associated with heightened attention and cognitive processing [60,62].

Neurophenomenological research has also explored the role of specific neurotransmitter systems in subjective experiences. For example, serotonin is known to play a role

in mood regulation and has been implicated in various mental health conditions. By examining neurotransmitter levels or receptor activity using techniques such as positron emission tomography (PET), researchers can gain insights into the neurochemical basis of subjective experiences.

While neural correlates provide valuable insights, it is important to approach their interpretation with caution. The brain is a complex and dynamic system, and a one-to-one mapping between neural activity and subjective experience is unlikely. It is more likely that subjective experiences arise from the coordinated activity of multiple brain regions and networks.

Therefore, integrating subjective reports alongside neural correlates can provide a more comprehensive understanding of conscious experience. Subjective reports can offer rich insights into the qualitative aspects of experience, such as its meaning, context, and emotional valence. Combining these subjective insights with the identification of neural correlates can help bridge the gap between subjective experience and objective measurement.

Thus, investigating the neural correlates of subjective experience is a prominent approach in neurophenomenology. Techniques such as fMRI, EEG, and PET have revealed correlations between specific patterns of brain activity and subjective states. In the pursuit of understanding consciousness, it is imperative to recognize the inherent limitations of exclusively relying on neural correlates. Neural correlates, which refer to the patterns of neural activity that accompany specific conscious experiences, have provided valuable insights into the relationship between brain processes and subjective states. However, they alone do not provide a complete picture of consciousness. To address these limitations, a more comprehensive approach is required. This approach involves integrating subjective reports, derived from individuals' first-hand experiences, with neural correlates. Incorporating experiential reports allows for a more holistic understanding of consciousness and contributes to the development of a comprehensive framework in the field of neurophenomenology.

While studying the neural activity associated with subjective experiences is essential for capturing objective measurements, it is equally important to incorporate experiential reports. These reports offer unique insights into the subjective aspects of consciousness that cannot be fully captured by neural measurements alone. Relying solely on neural activity neglects the richness of individuals' conscious experiences and limits understanding of the phenomenological aspects of consciousness.

Qualitative methods play a crucial role in integrating experiential reports. By employing techniques such as interviews, questionnaires, and phenomenological analysis, researchers can gain a deeper understanding of subjective experiences. This comprehensive exploration allows for a more nuanced understanding of consciousness, taking into account the qualitative aspects of individuals' experiences.

By combining both objective neural correlates and subjective experiential reports, researchers can develop a more robust framework for studying consciousness. This integration allows for a more holistic and multidimensional understanding of the conscious experience, encompassing both the objective and subjective facets. This, in turn, enhances the ability to elucidate the mechanisms underlying consciousness and contributes to the advancement of neurophenomenological research.

5. Challenges in Interpreting Neural Data in the Context of Subjective Experience

Investigating the neural correlates of subjective experience presents many challenges that must be addressed for a comprehensive understanding of the complex relationship between brain activity and subjective phenomena. This article aims to provide a comprehensive overview of the challenges encountered in interpreting neural data and highlights the need for interdisciplinary collaboration and transparent research practices. The discussion covers a range of challenges, including the interpretation of neural data, establishing causation, multimodal integration, neural plasticity, ethical considerations, interdisciplinary communication, and the reproducibility crisis. By recognizing and addressing these chal-

lenges, researchers can advance the field of neurophenomenology and contribute to the understanding of the neural basis of subjective experience.

5.1. Interpretation of Neural Data

Understanding subjective experience using neural data is not a straightforward task. This is because of the complexity of neural activity, which varies between individuals, making it challenging to identify specific neural correlates of subjective phenomena [41,82]. Moreover, different brain regions may be involved in multiple processes simultaneously, making it hard to attribute specific functions to particular neural patterns.

The brain is made up of billions of neurons connected in intricate networks that give rise to cognitive processes and subjective experiences. However, the relationship between specific patterns of neural activity and subjective experience is not yet fully understood. Researchers must navigate this complexity and determine which aspects of neural activity are most relevant to the subjective experience they are investigating.

Neural activity is not static, but it fluctuates dynamically over time [83]. Different factors, such as task demands, environmental context, and individual differences, can influence patterns of neural activity. This temporal variability adds another layer of complexity to the interpretation of neural data concerning subjective experience. Researchers must carefully consider the temporal dynamics and context in which neural activity occurs to accurately understand its relationship to subjective experience.

Individual differences in brain structure and function can also influence subjective experiences and their neural correlates. Each person has a unique brain architecture shaped by genetics and life experiences. These individual differences can result in variability in the neural correlates of subjective experiences across different individuals. Understanding how individual differences influence the relationship between neural activity and subjective experience is a challenging task for neurophenomenology.

5.2. Establishing Causation

In neuroscience research, it is crucial to establish causation to understand the relationship between neural activity and subjective experience. However, the complexity of the brain and the multifaceted nature of subjective phenomena make it challenging to determine a direct causal relationship between the two [20,23,35]. Correlated neural patterns observed in studies do not necessarily imply causation [84–86]. Therefore, it is important to differentiate between causation and correlation to avoid drawing incorrect conclusions. Causation refers to the direct influence of one variable on the other, while correlation refers to a statistical relationship between the two variables.

To establish causation, researchers must use careful experimental designs that allow for the manipulation of neural activity and observe the resulting changes in subjective experience [84–86]. This is done by employing techniques such as transcranial magnetic stimulation (TMS) or deep brain stimulation (DBS) to stimulate or inhibit specific brain regions. By directly manipulating neural activity and observing the corresponding changes in subjective experience, researchers can begin to establish causation.

Control conditions are an essential part of experimental designs to ensure that the observed effects are due to manipulated neural activity. Comparing the effects of stimulation or inhibition to a baseline condition where no manipulation occurs allows researchers to determine if the observed changes in subjective experience are specific to the manipulated neural activity or if they can be attributed to other factors.

It is also crucial to consider alternative explanations when attempting to establish causation. Researchers must identify and control for confounding variables that may influence the relationship between neural activity and subjective experience. Factors such as attention, mood, and external stimuli can all potentially affect both neural activity and subjective experience, leading to spurious correlations. By carefully controlling for these variables, researchers can increase the likelihood of establishing a causal relationship.

In addition to experimental manipulation and control conditions, converging evidence from multiple studies and methodologies can help strengthen the case for causation. Cross-validation of findings using different techniques, such as neuroimaging, electrophysiology, and behavioral measures, can provide a more comprehensive understanding of the causal relationship between neural activity and subjective experience.

It is important to note that establishing causation in neuroscience is an ongoing process that requires continuous refinement and validation. Despite the inherent challenges posed by the brain's complexity and the subjective nature of experience, researchers can make significant strides in establishing causal relationships by employing rigorous experimental designs, controlling for confounding variables, and considering alternative explanations.

5.3. Technical and Methodological Challenges in Multimodal Integration

Combining data from various modalities, such as fMRI, EEG, and behavioral measures, presents numerous technical and methodological challenges. One significant obstacle is the heterogeneity of the data. Each modality provides unique and complementary information but has inherent differences in temporal and spatial resolution, sensitivity, and signal-to-noise ratio [87–90].

To successfully integrate multimodal data, researchers must align and normalize the different data sources. This process involves accounting for variations in data acquisition parameters, preprocessing steps, and statistical analyses. Harmonizing data across modalities often requires sophisticated techniques such as image registration, sensor-level fusion, and feature extraction to align the spatial, temporal, and spectral information.

Another challenge is the interpretation of multimodal findings [91–93]. Combining data from multiple sources can lead to complex and sometimes contradictory results. Researchers must develop robust statistical methods and analytical frameworks to extract meaningful information from the integrated data. Techniques such as multivariate pattern analysis, machine learning, and network analysis are often employed to identify patterns, relationships, and associations between different modalities.

Methodological considerations extend to experimental designs. To ensure valid and reliable multimodal integration, researchers must carefully design their studies to account for confounding variables and control for potential biases. This involves employing appropriate control conditions, counterbalancing experimental conditions, randomizing stimulus presentation, and estimating sample size.

Additionally, researchers must exercise caution when interpreting multimodal integration results. It is essential to consider the limitations and assumptions associated with each modality and the integration techniques employed. Researchers must be aware of potential confounds, such as motion artifacts in fMRI [94,95] or volume conduction in EEG [96–98], and account for these factors in their analysis.

Despite the challenges involved, multimodal integration offers several advantages in understanding subjective experiences. By combining data from multiple modalities, researchers can obtain a more comprehensive and nuanced understanding of the underlying neural processes and mechanisms involved in subjective phenomena.

Multimodal integration allows for a more robust interpretation of the findings. The convergence of evidence across different modalities can provide greater confidence in the observed effects and increase the reliability of the results. Moreover, multimodal approaches can help overcome limitations or biases inherent in individual modalities by compensating for their weaknesses and leveraging their strengths.

Integrating data from various modalities can also provide a more holistic and context-dependent understanding of subjective experiences. For example, examining the interplay between brain activity, physiological responses, and behavioral measures can shed light on the complex interactions between cognitive, emotional, and sensory processes.

Furthermore, multimodal integration promotes interdisciplinary collaboration among researchers with expertise in different modalities. By combining knowledge and methodologies

from neuroscience, psychology, computer science, and statistics, researchers can tackle complex research questions and develop innovative approaches to studying subjective experiences.

5.4. Neural Plasticity and Adaptation

Studies have shown that the brain's ability to adapt and reorganize itself, known as neural plasticity, plays a crucial role in shaping subjective experiences [99–101]. This fundamental mechanism underlies learning, memory, and cognitive processes. To examine the dynamics of neural plasticity and its influence on subjective phenomena, longitudinal studies that track individuals over an extended period are essential. This allows researchers to investigate how neural activity and organization change over time in response to various factors, such as learning, training, or exposure to specific stimuli [102].

One example of the impact of neural plasticity on subjective experience is in the field of sensory perception [103–105]. Prolonged exposure to certain sensory stimuli can lead to neural adaptation and perceptual learning. This can result in enhanced perceptual abilities, such as identifying subtle visual or auditory cues, because of neural plasticity.

Neural plasticity also plays a crucial role in the recovery or compensation of function following brain injury or neurological disorders [106,107]. The brain can reorganize its neural networks to compensate for lost functions, such as by recruiting neighboring brain areas to take on new functions or strengthening existing connections.

When studying subjective phenomena, it is important to consider individual differences in neural plasticity. Not all individuals exhibit the same extent or rate of neural adaptation in response to a given stimulus or experience. Factors such as age, genetics, environmental factors, and prior experiences can all influence the degree of plasticity exhibited by an individual.

Thus, to fully understand neural plasticity and its impact on subjective experiences, researchers must examine changes in brain structure and activity at both macroscopic and microscopic levels. This multi-level approach is crucial for understanding the complex interactions and mechanisms underlying neural plasticity.

5.5. Ethical Considerations in Neural Phenomenology Research

Exploring subjective experiences through analyzing neural data raises important ethical concerns that require thoughtful consideration. As researchers investigate the intricate relationship between brain activity and subjective phenomena, it is essential to prioritize participants' privacy and informed consent and minimize any potential harm or distress [108,109]. Preserving the privacy and autonomy of research participants is paramount in any scientific study, including neurophenomenology research [110–112].

Participants must have a clear understanding of the study's purpose, procedures, and potential risks and benefits before giving their consent to participate. Informed consent must be obtained clearly and understandably, allowing participants to ask questions and make informed decisions about their involvement.

Maintaining the confidentiality and anonymity of research participants is another ethical obligation. Due to the personal and sensitive nature of subjective experiences, researchers must take appropriate measures to ensure that participants cannot be identified through the data collected or any subsequent publications or presentations. Data should be securely stored and only accessed by authorized individuals, with identifying information carefully removed or anonymized.

The secure storage and controlled access of data, while ensuring the careful removal or anonymization of identifying information, is a crucial aspect that deserves further discussion. Open science practices and the sharing of data play a pivotal role in enhancing the reproducibility and reliability of research in the field.

Open science practices, which involve making research data available to the scientific community, have gained considerable momentum in recent years. By providing access to the raw data, other researchers can attempt to replicate and validate the findings, thereby enhancing the credibility and robustness of scientific conclusions.

While the benefits of data sharing are evident, concerns surrounding privacy and confidentiality must also be addressed. It is crucial to safeguard the privacy of research participants and ensure that their sensitive information is protected. Therefore, before sharing data, it is imperative to carefully remove or anonymize any identifying information to prevent the possibility of re-identification.

In considering the ethical implications of data sharing, it is necessary to evaluate the potential risks that participants may face. Any research involving human subjects should adhere to strict ethical guidelines and prioritize the well-being and confidentiality of participants. Researchers should make a comprehensive and transparent assessment of the potential risks and benefits of data sharing for each study, taking into account the specific context and the nature of the data being shared.

Reducing harm or distress to participants is a crucial ethical consideration in neurophenomenology research. Although the collection of neural data is typically non-invasive, the exploration of subjective experiences can potentially evoke sensitive or distressing emotions or memories. Researchers must create a supportive and comfortable environment for participants, offer support and debriefing after data collection, and be prepared to provide appropriate resources or referrals if participants experience any negative emotional reactions.

Ethical guidelines and institutional review boards play a vital role in overseeing and ensuring the ethical conduct of neurophenomenology research. Researchers must adhere to established ethical standards, which may vary depending on the specific country or institution. IRBs review research protocols to assess potential risks and benefits to participants, evaluate the informed consent process, and ensure that appropriate safeguards protect participant rights and welfare.

Ongoing dialogue and collaboration among researchers, ethicists, and other stakeholders are necessary to address the unique ethical challenges presented by neurophenomenology research. As the understanding of the brain's role in subjective experiences continues to evolve, it is crucial to regularly revisit and update ethical guidelines to account for new advancements and potential ethical dilemmas.

In summary, ethical considerations are essential to ensure that neurophenomenology research respects the rights, well-being, and autonomy of study participants. By upholding high ethical standards, researchers can illuminate the complex interplay between neural activity and subjective experiences while maintaining the highest level of integrity and respect for human participants.

5.6. Interdisciplinary Communication

Effective interdisciplinary communication is essential in neurophenomenology research, which involves researchers from various fields like neuroscience, psychology, philosophy, and cognitive science. Different disciplines have unique terminologies, methodologies, and theoretical frameworks that can make communication and collaboration challenging.

One of the main obstacles to interdisciplinary communication is the differences in language and terminology used by researchers from various disciplines. Each field has its own jargon and specialized vocabulary, which can make it challenging for researchers to comprehend and integrate knowledge from other fields. For instance, a neuroscientist may use terms such as neural networks and neurotransmitters, while a philosopher may use terms like phenomenal consciousness and qualia. These differences can create barriers to effective communication and hinder interdisciplinary collaboration.

Another challenge in interdisciplinary communication is the differences in methodologies and research approaches. Neuroscientists use quantitative methods like functional magnetic resonance imaging (fMRI) and electroencephalography (EEG) to measure neural activity and analyze data, whereas philosophers and phenomenologists may rely more on qualitative methods such as in-depth interviews and reflective analysis to explore subjective experiences. These differences can lead to misunderstandings and difficulties in integrating findings from different fields.

Furthermore, interdisciplinary communication requires researchers to appreciate and understand the theoretical frameworks and perspectives of other disciplines. Each field has its set of theories and conceptual frameworks to explain and understand neural and subjective phenomena. For instance, a cognitive scientist may approach subjective experiences from a computational perspective, whereas a philosopher may adopt a phenomenological or existentialist standpoint. Understanding these diverse theoretical frameworks is crucial for fruitful interdisciplinary collaboration and the development of a comprehensive understanding of neurophenomenology.

6. Contextual Factors and Subjective Experience

In the field of neurophenomenology, it is important to acknowledge the role that contextual factors play in shaping subjective experiences. These factors consist of cultural background, language, and personal history, which all impact how individuals interpret and express their experiences [23–25]. By taking into account these contextual factors during research studies, neurophenomenologists can obtain a deeper understanding of the intricate relationship between neural activity and subjective experiences.

Cultural background stands out as a significant contextual factor that shapes subjective experiences. Various cultures have unique beliefs, values, and practices that affect how individuals perceive and understand the world around them [113,114]. For instance, the concept of self and identity differs across cultures, leading to variations in how individuals experience and express their subjective experiences. By conducting cross-cultural studies, neurophenomenologists can delve into the effect of cultural background on subjective experiences and obtain insights into the universality and cultural specificity of conscious experiences [115,116].

Language is another crucial contextual factor that shapes subjective experiences. Language is not only a medium for communication but also influences how individuals think and comprehend the world [117–119]. Linguistic differences, such as the availability of specific concepts or distinctions in languages, can impact the richness and nuances of subjective experiences. By taking into consideration the linguistic context, neurophenomenologists can have a better understanding of how language shapes subjective experiences and develop more accurate ways of capturing and describing these experiences.

Personal history is a third contextual factor that influences subjective experiences [120,121]. Each individual has a unique set of life experiences, including personal memories, traumas, and upbringing, which shape their perception and interpretation of the world. By recognizing and incorporating these personal histories into neurophenomenological research, researchers can gain deeper insights into individual differences in subjective experiences. This can contribute to a more nuanced understanding of how neural activity and personal history interact to create subjective experiences.

Integrating these contextual factors into neurophenomenological research can enhance the reliability and validity of knowledge generated in the field. By accounting for the cultural, linguistic, and personal variations in subjective experiences, researchers can avoid generalizations and develop a more comprehensive understanding of the diversity and complexity of conscious experiences. This circumstance can lead to the development of more inclusive and culturally sensitive theories and models in neurophenomenology.

Integrating individual and cultural differences, as well as contextual factors, into neurophenomenological research is of critical importance for advancing the understanding of the human brain and mind. This approach acknowledges that cognitive processes and subjective experiences are not solely determined by universal mechanisms but are also influenced by factors such as personal traits, cultural backgrounds, and situational contexts.

Collaborative and cross-cultural studies are particularly crucial in exploring the impact of contextual factors on subjective experiences. By bringing together researchers from different cultural backgrounds and disciplines, these studies provide opportunities for knowledge sharing, cross-pollination of ideas, and the examination of the universality and cultural specificity of conscious experiences. Collaborations between neuroscientists,

philosophers, psychologists, and anthropologists, for example, can offer diverse perspectives and expertise in exploring the influence of context on subjective experiences.

Therefore, contextual factors such as cultural background, language, and personal history significantly shape subjective experiences. Taking these factors into account during neurophenomenological research is crucial for understanding the diversity and complexity of conscious experiences. Collaborative and cross-cultural studies offer avenues for exploring the universality and cultural specificity of subjective experiences, contributing to a more robust and comprehensive understanding of neurophenomenology. To effectively incorporate these factors into neurophenomenological research, it becomes imperative to consider larger sample sizes in studies and potentially engage in collaborative efforts across multiple laboratories or cultures. The inclusion of a larger and more diverse sample can help capture a broader range of individual and cultural variations, thereby enhancing the generalizability and validity of the findings.

Larger sample sizes offer several advantages in neurophenomenological research. First, they provide a more comprehensive representation of the target population, leading to findings that are more applicable and relevant to a broader range of individuals. This inclusiveness facilitates the exploration of individual differences, enabling researchers to examine the impact of various factors on brain function and subjective experiences. Furthermore, a larger sample size increases statistical power, allowing for the detection of smaller effects that may otherwise go unnoticed in smaller studies. This enhances the precision and reliability of the findings, leading to more robust conclusions.

Collaborations can offer access to unique expertise, resources, and perspectives, enriching the research and enhancing its validity. By pooling data from different labs or cultures, researchers can overcome the limitations associated with homogeneous samples and identify patterns and relationships that may be specific to certain demographic or cultural groups. However, multi-lab or cross-cultural collaborations do come with their own set of challenges. Coordination and standardization of data collection procedures, experimental protocols, and analysis methods are crucial to ensuring comparability and consistency across different research sites. Additionally, cultural sensitivity and awareness of potential biases or cultural differences in research practices must be taken into account. This requires open communication, mutual understanding, and respect for diverse perspectives and practices.

7. Technological Advancements as Tools for Understanding the Reliability of Neurophenomenological Knowledge

The use of wearable devices, such as EEG devices and biometric sensors, is essential in neurophenomenology research [60–62]. These devices can measure brain activity, heart rate, skin conductivity, and other physiological signals, providing objective data on the neural processes associated with subjective experiences. By combining these data with self-reported subjective experiences, researchers can gain a better understanding of the relationship between neural activity and conscious experiences.

Virtual reality (VR) simulations provide another avenue for studying subjective experiences in a controlled and immersive environment [63–65]. By creating virtual environments that mimic real-world scenarios or manipulate specific stimuli, researchers can induce and study subjective experiences in a more standardized manner. VR simulations also allow for real-time data collection and manipulation, contributing to the reliability of neurophenomenological knowledge.

Brain–computer interfaces allow for direct communication between the brain and external devices, which can be used to investigate the neural correlates of subjective experiences. For example, BCIs can decode and interpret neural activity patterns associated with attention, perception, and emotional responses [122–124], providing insights into the neural mechanisms underlying conscious experiences. BCIs can also improve the accuracy of self-reporting as they provide objective measures of subjective experiences [125,126].

Advancements in neuroimaging techniques, computational modeling, and machine learning algorithms also contribute to understanding the reliability of neurophenomenological knowledge. Neuroimaging techniques allow researchers to visualize and map brain activity associated with specific subjective experiences, while computational modeling and machine learning algorithms can analyze large datasets and uncover patterns. These methods can help identify reliable biomarkers or neural signatures associated with specific subjective experiences, enhancing the validity and replicability of research findings. Sophisticated statistical techniques, such as multivariate pattern analysis and data-driven approaches, play a crucial role in enhancing the reliability of neurophenomenological knowledge [127–129]. These methods can help identify meaningful patterns in complex datasets, improving the validity and replicability of research findings.

It is important to note that while technological advancements are valuable tools for understanding the reliability of neurophenomenological knowledge, they should be used alongside careful interpretation and integration of subjective experiences. Objective data should be seen as complementary to subjective reports, rather than a replacement for them. A comprehensive approach that combines objective data with subjective reports is crucial for advancing the understanding of consciousness and ensuring the reliability of neurophenomenological knowledge.

While there are generally accepted standards and protocols for the preprocessing and analysis of brain imaging and electrophysiological data, there is always room for improvement. Despite the existence of established protocols, there can be variations in preprocessing and analysis methods across different research groups. Increased standardization and agreement on specific methods and parameters would enhance the comparability and reproducibility of results. Encouraging data sharing and open science practices can support the validation and replication of findings. This situation allows other researchers to reproduce the results and explore alternative analysis approaches or parameter settings. Confirmatory studies should be accompanied by efforts to replicate the findings in independent datasets. Replication studies reduce the likelihood of spurious or false-positive results and increase confidence in the generalizability of the findings. Including replication as a standard part of confirmatory studies would strengthen the overall scientific rigor.

8. The ontological Implications of the Reliability of Knowledge in Neurophenomenology

Neurophenomenology is a field that investigates the neural mechanisms behind conscious experiences. It challenges the traditional understanding of reality, as it considers subjective experiences to be an integral part of it. This approach requires a more nuanced perspective that incorporates both subjective experiences and objective scientific observations to gain a comprehensive understanding of reality.

The reliability of knowledge derived from studying subjective experiences is essential to understanding reality. However, it is challenging to ensure the validity of this knowledge due to the subjective and personal nature of these experiences. Neurophenomenology employs rigorous methodologies, such as careful experimental design, validation against objective measures, and statistical analysis, to address these challenges.

Neurophenomenology recognizes the significance of subjective experiences and their role in shaping our understanding of reality. It highlights the interplay between the subjective and the objective, emphasizing the need to integrate both perspectives for a complete understanding of consciousness. The field employs advanced technologies like neuroimaging to capture and analyze neural correlates of subjective experiences.

Thus, the ontological implications of the reliability of knowledge in neurophenomenology require recognizing the significance of subjective experiences and their role in shaping reality. The field employs rigorous methodologies to validate the knowledge derived from studying subjective experiences and provides a new framework for understanding consciousness.

According to F. Varela, cognitive processes are not confined to the brain but are closely connected to the body and surroundings. He introduced the idea of "enaction," which

proposes that cognitive systems actively create and modify their own experiences by interacting with the world.

F. Varela understands consciousness as awakening in the world based on the most characteristic of the scientist who conducts cognitive research and occupies a phenomenological position: "Minds awaken in a world. We did not design our world. We simply found ourselves with it; we awoke both to ourselves and to the world we inhabit. We come to reflect on that world as we grow and live. We reflect on a world that is not made but found, and yet it is also our structure that enables us to reflect upon this world. Thus, in reflection, we find ourselves in a circle: we are in a world that seems to be there before reflection begins, but that world is not separate from us" [20] (p. 3).

F. Varela argued that embodiment is not limited to individuals but exists at various levels of organization, including social and cultural levels. He believed that cognition is not solely a result of the brain's workings but rather emerges from the interaction between the organism and its environment. This perspective challenges the traditional view that cognition is purely a mental or computational process that is detached from physical and social surroundings. Embodiment involves cycles of interaction and adaptation between organisms and their environments, which give rise to cognitive processes characterized by constant coupling and mutual influence between the agent and the world. This view suggests that cognition is a continuously evolving process that emerges as a result of ongoing interactions between the organism and its environment.

Varela and his colleagues developed the concept of autopoiesis to explain the self-organizing processes that support cognitive activity in the context of cognition and embodiment. They argued that cognitive systems, like living organisms, are autopoietic in nature and consistently engage in self-organization and adaptive interaction with their environment. The cycles of organizational embodiment, as described by Varela, emphasize the interdependent relationship between an organism and its environment. As an organism interacts with its environment, it continuously adjusts and adapts its cognitive processes and structures to align with the regularities and demands of the environment. This cyclical interaction involves the organism perceiving and acting upon the environment, influencing it, and being influenced by it in a continuous loop.

The concept of autopoiesis is closely related to the cycles of organizational embodiment, as autopoietic processes enable the continual self-creation and self-maintenance of the organism's cognitive structures. Through autopoiesis, the organism maintains its cognitive organization, adapts to its surroundings, and engages in sensorimotor coupling to sustain its embodiment and cognitive activity.

F. Varela presented the autopoietic system as a living organization, continually producing the components that determine it. The identity of the autopoietic system is achieved both in relationships and through opposition to the environment. The meeting of the autopoietic system with the environment can be realized as a disturbance, a shock, and establishing a connection. In this case, the system itself refers to encounters with the environment from its position that is not conditioned by the nature of the meetings [52] (p. 86). At the same time, the components of the system realize this system as a concrete unity in space and time. On this basis, the component production network is implemented. Varela suggests a more specific definition: "An autopoietic system is organized (defined as unity) as a network of processes of production (synthesis and destruction) of components such that these components: (i) continuously regenerate and realize the network that produces them, and (ii) constitute the system as a distinguishable unity in the domain in which they exist" [52] (p. 81).

Thompson and Varela start with the notion of interdependent causal-explanatory relationships between nervous events and conscious events when conscious events are viewed as parameters of the order of large-scale brain dynamics. Scientists suggest that the processes that cross the brain and body divisions are crucial for understanding the mind. Consciousness is not limited to nervous events in the head [38] (pp. 421–422).

Therefore, the area of the constitution of consciousness is not reduced to cerebral neuronal events [38] (p. 425). F. Varela introduces "operation cycles" to link neural dynamics and conscious agents. The concept of «operation cycles» is described by Thompson and Varela concerning the participation of neural processes in the «operation cycles» that make up the agent's life. For the higher primates, it is necessary to distinguish three types of cycles: (1) cycles of organismic regulation of the whole body; (2) cycles of sensorimotor communication between the body and the environment; and (3) cycles of intersubjective interaction, including recognition of the intentional meaning of actions and human linguistic communication [38] (p. 424). Thus, the cycles of organizational embodiment at various levels of description are as follows:

1. Sensorimotor Coupling: Cognition emerges from the continuous sensorimotor coupling between an organism and its environment. This coupling involves the reciprocal interaction between the organism's sensory and motor systems and the affordances or possibilities for action provided by the environment.
2. Organism–Environment Interaction: Cognition is seen as an ongoing cycle of interaction between the organism and its environment. The organism engages with the environment, perceiving and acting upon it, which in turn influences the organism's subsequent perceptions and actions.
3. Structural Coupling: Through repeated sensorimotor interactions, an organism becomes structurally coupled with its environment. This coupling refers to the reciprocal influence and adaptation that occur between the organism and the environment. The organism's cognitive processes and skills become aligned with the regularities and patterns present in the environment, enabling more effective engagement with the surroundings.
4. Circular Causality: The cycles of sensorimotor coupling and structural coupling create a circular causal relationship where the organism's actions are influenced by the environment and the environment is shaped by the organism's actions. This circularity allows for the emergence of cognitive processes that are inherently embodied and embedded in the environment.

The intricate interplay between the brain and the body encompasses a multitude of interactions that occur at various levels, including biochemical processes and the molecular constituents of the endocrine, immune, and nervous systems. These interactions serve as the foundation for the seamless coordination and integration of physiological functions, allowing the body to respond and adapt to the ever-changing internal and external environments. Regulatory cycles involving the brain and body at several levels determine the integrity of the whole organism. Cycles of sensorimotor communication with the environment are one of the processes that make up the feeling of one's own body. The body depends on how it moves. However, the converse is also true. Then, as the organism moves, it is a function of what it feels. The sensorimotor pathways of the body are the substrates of these cycles. Several neocortical regions and subcortical structures mediate these cycles in the brain [38] (p. 424). The person is included in the environment by the subject, as mediated by transitional neural assemblies of coordination of sensory and motor surfaces. The role of sensorimotor communication is to limit the environment and modulate these neural dynamics.

The ontological implications of the reliability of knowledge in this context lie in the understanding that knowledge is not simply an objective representation of external reality but rather a construction that arises from the dynamic interaction between the individual and their environment. This perspective challenges the traditional view that knowledge is solely derived from passive observation or abstract reasoning. Instead, neurophenomenology suggests that knowledge is grounded in the embodied and situated nature of human experience. It highlights the active role of the subject and the continuous interplay between sensory perception, motor action, and the environment. This understanding has profound implications for the philosophical understanding of reality, suggesting that knowledge is deeply intertwined with the subjective engagement of the individual with their surroundings.

Overall, this perspective emphasizes the inseparability of the individual and the environment in the acquisition and construction of knowledge. It recognizes the active nature of knowing, highlighting the significance of sensorimotor communication and the role of neural dynamics in shaping understanding of reality.

9. Conclusions

Neurophenomenology is a field that explores the relationship between subjective experience and the underlying neural processes. In this context, the reliability of knowledge refers to the extent to which our understanding of the mind and consciousness can be considered trustworthy or accurate. Examining the reliability of knowledge in neurophenomenology has ontological implications, as it raises questions about the nature of reality and the validity of subjective experience.

One aspect to consider is the subjectivity of conscious experience. The experience of consciousness is subjective and unique to each individual. Phenomenology, a philosophical discipline, emphasizes the significance of subjective experience in comprehending reality. Nevertheless, this subjectivity raises concerns about the reliability and objectivity of knowledge gained from neurophenomenology. Bridging the gap between the subjective and the objective necessitates careful consideration of epistemic implications.

While neuroscientific research can provide objective measurements of brain activity, it cannot directly access subjective states such as thoughts, emotions, or qualia. This raises questions about the reliability of our knowledge about subjective experience. Can we trust our own introspective reports, or are they prone to biases and inaccuracies? Additionally, different individuals may have different subjective experiences of the same phenomenon, further complicating the issue of reliability.

Another consideration is the reliability of scientific methods and tools in studying consciousness. Neurophenomenology relies on various techniques like neuroimaging, electrophysiology, and cognitive experiments to study the neural correlates of subjective experience. However, these methods have their limitations and assumptions, which can influence the reliability of the knowledge gained.

The ontological implications of exploring the reliability of knowledge in neurophenomenology lie in the nature of reality and the relationship between the subjective and objective realms. If subjective experience is considered a valid source of knowledge, it raises questions about the objectivity of reality and the extent to which understanding is shaped by individual perspectives. This challenges traditional views that prioritize objective knowledge and raises the possibility of multiple valid perspectives on reality.

Furthermore, the reliability of knowledge in neurophenomenology has implications for philosophical debates on the mind–body problem and the nature of consciousness. Understanding the neural basis of subjective experience can shed light on the relationship between the physical brain and the subjective mind. It can inform theories about the emergence of consciousness and potentially bridge the gap between objective and subjective domains.

Context plays a significant role in shaping subjective experiences. Cultural background, language, and personal history influence how individuals interpret and report their experiences. Incorporating these contextual factors in neurophenomenological research can enhance the reliability of knowledge.

To address the challenges of reliability and objectivity, interdisciplinary collaboration is necessary. Integrating neuroscientific methods with philosophical and social sciences can provide a comprehensive understanding of subjective experiences. Long-term studies involving diverse participants can establish patterns and regularities in subjective states, enhancing the reliability and generalizability of neurophenomenological knowledge.

Technological advancements offer promising tools for understanding the reliability of neurophenomenological knowledge. Wearable devices, virtual reality simulations, and brain–computer interfaces provide opportunities to capture and analyze subjective experiences objectively. Real-time feedback facilitated by these technologies allows researchers to

validate and refine their hypotheses and theories, further advancing the understanding of consciousness.

Thus, the epistemic challenges regarding the reliability of knowledge and its connection with reality in neurophenomenology are intricate and multifaceted. Subjectivity, interpretation, and contextual factors present inherent limitations to establishing objective truths about conscious experiences. However, by embracing interdisciplinary collaboration, leveraging technology, and conducting long-term studies, neurophenomenology holds the potential to overcome these challenges, significantly contributing to the understanding of the human mind and the nature of reality.

The ontological implications of the reliability of knowledge in neurophenomenology involve a shift in the understanding of reality and consciousness. It highlights the importance of subjective experiences as part of the nature of reality and challenges the traditional understanding of objective reality. By integrating subjective and objective observations, neurophenomenology seeks to enhance the understanding of consciousness and provide a more comprehensive view of reality. The reliability of knowledge in this field is ensured through rigorous methodologies that validate subjective experiences against objective measures. Through these efforts, neurophenomenology contributes to a deeper understanding of the interplay between subjective experiences and the nature of reality itself.

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