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Neurophenomenological Methods: Experiences Of Earth And Space In Simulation

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NEUROPHENOMENOLOGICAL METHODS: EXPERIENCES OF EARTH AND SPACE IN SIMULATION

by

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ABSTRACT

The present study explores the nature and structure of spiritual and aesthetic experiences through the interdisciplinary application of neurophenomenology (NP). This approach merges aspects of psychology, neurophysiology, and phenomenology into a unified methodology. The study is nested within a larger project, *Space, Science, and Spirituality,* and as such, it carries a common goal to use simulation to evoke spiritual and aesthetic responses similar to those expressed by astronauts and cosmonauts. Careful analysis of previous work in NP provided methodological "lessons learned", which guided the experimental design, execution, and analysis of the present study. The data collected provides support for experience as a phenomenon that can be studied through empirical means. Further, the articulation of spiritual and aesthetic experiences akin to astronaut experiences corresponds to specific neurological and psychological indicators. Among those indicators are differences in EEG measures during simulation time relative to expressions of spiritual experience following the simulation and changes in visual processing across theta, alpha, and beta signals as correlated with self-identification. These findings support an embodied theory of experience that incorporates memory, executive function, perception, and consciousness. In addition to its academic contribution, this research holds implications for commercial space flight, long-term space missions, post-traumatic stress disorder therapies, and the entertainment industry.

Dedicated to Matthew, Lily, and John…my endless inspirations for awe, wonder, curiosity and humility.

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LIST OF ACRONYMS

AWCH	Awe, wonder, curiosity, & humility
BMMRS	Brief Multi-dimensional Measurement of Religiousness and Spirituality
DFB	Difference from baseline
DRC	Dynamic reciprocal constraints
ECG	Electrocardiograph
EEG	Electroencephalograph
ESSE	Experiment-Specific Survey of Experience
fNIR	Functional near-infrared
FOC	Focal condition
GLO	Global condition
MSTAT	Multiple Stimulus Types Ambiguity Tolerance
NP	Neurophenomenology
PhC	Phenomenological clusters
PSD	Power spectral density
TAS	Tellegen Absorption Survey

CHAPTER ONE: OVERVIEW

"Now the man who is puzzled and wonders apparently does not know. Hence wonder is the movement of the man who does not know on his way to finding out, to get at the bottom of that at which he wonders and to determine its cause.... Such is the origin of philosophy" --From the Commentary on the Metaphysics of Aristotle by Thomas Aquinas's teacher, Albert the Great, as quoted by Greenblatt, 1990.

Introduction

The tension of exploration is often both push and pull; it lures outward, across seas or solar systems, and yet inward, into the depths of Earth and the depths of minds. The present study balances on this tension, with the inward-facing topic of the mind studied through the outward-facing expanse of space. Through this study, the nature of human experience is explored using techniques of neurophenomenology (NP).

In this chapter, the purpose for the present study will be articulated. The problem statement will position the present study in the scope of current trends in neuroscience, specifically the NP approach. Then, the justifications for the study will be stated, emphasizing the importance of the neurophenomenological approach in the study of human cognition. Research objectives will offer direction for the present study and serve as markers for successful completion. Research hypotheses will be listed to indicate the expectations for the research outcomes. Definitions for key terms will provide a foundational lexicon to explore critical constructs. Before closing, the impact of the results on neuroscience will be discussed, providing greater understanding about experience and clarifying the NP methodological approach.

Purpose

The purpose for the present study is to assess neurophenomenological methods for studying first-person cognitive experiences. The study examines the techniques employed within previous experiments and adapts the methods used in a baseline experiment, *Space, Science, & Spirituality* (a title shared with the project as a whole). To avoid confusion, the term "baseline" will be used to refer to the first experiment in the project, and "the present study" will be used to refer to the work presented herein. That baseline acted as a reference point from which detailed recommendations for neurophenomenological experimentation were made. The present study includes an experiment, *Viewing Earth from Space: First-Person Experiences*, in which the methodological recommendations were applied. The goal for the experiment was two-fold. First, the experiment examined the use of a simulated environment to elicit spiritual and aesthetic experiences. Second, the experiment provided a "proof of concept" through which the methodological recommendations derived from studying the baseline experiment were applied. The overarching aim was to contribute empirically through the merit of the experiment itself to the corpus of academic work regarding the study of mind and theoretically to the refinement of NP as an approach for studying human experience.

Problem Statement

While the nature of human experience has been explored throughout time, there is no consensus in the scientific community regarding methods to approach such inquiries. NP is one approach with promise, as its core purpose is to connect research in the various fields that study experience in a manner that fully integrates first-person experiential accounts. However, as a fledgling approach, the neurophenomenological methods have yet to be articulated and applied consistently across research projects.

NP is an approach to the study of mind that seeks to identify and explain the nature and structure of experience. To formulate the experiential data, NP uses techniques from cognitive science, neuroscience, and philosophy in an attempt to piece together a dynamic and inclusive picture (Gallagher & Varela, 2003; Thompson, Lutz, & Cosmelli, 2005; Varela, 1996).

The present research focuses on the use of neurophenomenological methods to examine spiritual and aesthetic experiences akin to those reported by astronauts and cosmonauts. Researchers used an immersive simulation to display images of the earth from space in an attempt to elicit awe, wonder, curiosity, and humility (AWCH). The experiment tested the efficacy of methods, refined from a prior baseline study and other NP studies. The results from the experiment were evaluated both for their inherent value to the study of human experience and for their contribution to the improvement of neurophenomenological methods. The present work will provide direction for further neurophenomenological investigation.

Background of Problem

In 1961, Yuri Alekseyevich Gagarin became the first human to venture into space and the first of us to know, firsthand, something of life beyond the blue marble. Since then, other men and women have followed, and in doing so they have entered into a distinguished population marked by the shared experience of outer space. The rare and remarkable experiences of astronauts have captured the imaginations of millions for half a century, inspiring movies, comic books, theme parks, and even Barbie dolls, as generations have matured knowing that they too could grow up to be astronauts. However, imagining what it is like to be an astronaut is very different from genuinely considering what an astronaut *experiences*. The former may involve reflection upon the training required to become an astronaut, the skill sets used in a spaceflight, or the task demands while conducting science in low gravity. The latter involves the feelings and thoughts inherent to the distance, darkness, and oddities of space. To know another's experience requires an understanding of an inner world, but it would be erroneous to assume that the hidden world of experience is impermeable. In the case of astronauts, they share some of that inner world when they return from their time in space with journals full of experiential reports; these first-person data sources are often tales of transformation and spiritual change.

First-person data can be examined through multiple disciplinary lenses. Experience can be studied by examining psychometrics, that is, the results of questionnaires and surveys designed to examine experience using the traditional methods of cognitive psychology. It can be studied in terms of neuroscience, looking closely at brain behaviors to ascertain correlates of experience. First-person data can be collected in freely-generated and unique-to-the-individual forms (e.g. journals or interviews), and then analyzed through phenomenological techniques. By applying the methods of psychology, neuroscience, and phenomenology in an integrated fashion, researchers can develop a clearer picture of the nature and structure of experience.

The present study explores the nature of astronaut experiences, religious, spiritual, and aesthetic, with an emphasis on AWCH. This study is one part of a larger interdisciplinary project, which began with hermeneutic analysis of astronaut journals and interviews and included a baseline study using a mixed-reality simulation environment.

Legacies and limitations

Human experience, broadly, has been examined through three distinct lenses. The following section includes an overview of pertinent approaches from psychology, neuroscience, and philosophy. The purpose of the present section is to provide a general sense of both how and why each discipline approaches the problem of experience in its own way.

Psychology's lens on experience

While the precise historical division between psychology and philosophy may be debatable, many historians of science point to Wilhelm Wundt for establishing a foundation for experimental psychology and with it the model of physiological psychology that would lead to behaviorism (Titchener, 1921) and the information processing model of cognition. To examine the inner world of the subject, Wundt relied heavily upon introspection, setting precedence in psychology for the management of first-person data.

Gallagher and Sørenson (2006) distilled the tradition of introspection in psychology by drawing a distinction between the "weak" and "strong" uses of introspection in research. The first sense, the weaker one according to the authors, is the sort of introspection used in the design of experiments in which the participant is expected to indicate something in response to a stimulus. For example, a participant may be told, "Click the mouse as soon as you hear the bell." In a very weak sense, this is introspection. From the participant's perspective, it is "happening to me" and therefore it is a first-person report of experience. However, the weak form of introspection is problematic for multiple reasons. It is a response to a state, in some sense, but does it require any attention turned inward to the experience? Does it indicate anything of the experience of hearing the bell? This form of introspection has advanced our understanding of cognition, particularly in information processing models (Simon, 1979), by presenting processes of a sort that fit into stimulus-response cycles. Nonetheless, it tells us nothing of what it is like to experience the sound of the bell.

In contrast to "weak" introspection, there is a stronger sense of introspection (Gallagher & Sørensen, 2006). In this sense, introspection is a mental operation that makes self-reporting possible (Zahavi, 2003). Subjects may report, in their own words, what they have experienced, and they may do so in rich and insightful detail. This form of introspection has helped researchers understand much of individual differences, contributing to a picture of human experience that is diverse and complex. However, it still falls short of saying anything about the actual nature of an experience. Therefore, while a psychologist may use the strong form of introspection to get at a unique description of an individual's thoughts and feelings, it too falls short of saying anything about the structure of an experience. If an experience is something to be examined, one ought to explore its components, the factors that constitute its essential features. However, introspection, even in this stronger sense, can only give an image of a private inner-sense and cannot ultimately describe the "invariant self-organizing structure of the experience" (Gallagher & Sørensen, 2006, p. 121).

Introspection, though not sufficient on its own, can contribute to the study of astronaut spiritual and aesthetic experiences. The caution is to take what can be reliably learned from first-person psychological reports and use them with discretion as a valuable, not exclusive, source of observation. Like all tools, it must be wielded properly. The present study relied upon surveys that touched on complementary aspects of spiritual and aesthetic experience and developed a custom survey to examine these constructs more deeply. To study such abstract and challenging experiences, the metric must comply with excellent test design. This means that to effectively study the subject (in this case, experience) the test makers must consider question order, word choice, question format, and even number scale options, as all of these have been shown to influence the outcome of questionnaires (Schwarz, 1999). If the design of the survey adequately reduces error, it may indicate something about the unique experience of the participant that can be linked to corresponding neurological and phenomenological data. For the present study, an experiment specific survey of experience (ESSE) explicitly defined the constructs under study and was administered after the phenomenological interview (described in detail in Chapter Two) to avoid priming. The ESSE and other surveys provided connections between the neural behaviors and the phenomenologically-derived categories.

Neuroscience's lens on experience

Adding to the psychological picture of experience, neuroscience provides ways to consider the biological features of experience. A tremendously broad term, neuroscience encompasses numerous tools, theories, and techniques for examining the nervous system. Progress in neural imaging, biochemistry, electrophysiology, and machine computation has advanced the study of the brain and its functions. Interdisciplinary collaborations across the social and behavioral sciences and neuroscience have supported better understanding about the dynamic networks emerging between brains, bodies, and the world. Still, the emphasis of neuroscience is *neural*. It examines the nervous system at work. Some studies involve single-unit recording (capturing the firing of a specific neuron using a micro-electrode), helping to refine brain-mapping. However, these techniques are invasive and significantly limit experimental design. Less invasive techniques include functional magnetic resonance imaging (fMRI), which provides images of hemodynamic change, depending on evidence that cerebral blood flow corresponds with neural activity. This approach also has limitations. Compromises in temporal resolution (i.e. a change in blood flow takes more time than the action potential measured by the aforementioned single-unit recording) and experimental design options (participants must be immobilized within a fMRI machine) do not make it an ideal candidate for the examination of human experience (except, perhaps, if one was to examine the experiences associated with receiving an fMRI).

There are options that can capture high temporal resolution while accommodating comfort and movement. Electroencephalography (EEG) captures electrical neural activity with high temporal resolution and wireless units (as the one used in the present study) that allow subjects mobility, thereby making an excellent tool for collection of neural data during cognition experiments. Further, functional near-infrared (fNIR) sensors collect hemodynamic oxygenation with minimal limitations on mobility. When placed on the forehead, these devices can collect information from the frontal lobes, with no more interference than an ordinary headband (Ayaz, Izzetoglu, Bunce, Heiman-Patterson, & Onaral, 2007; Chance et al., 1998). These tools can capture information about the areas of the brain that are activated, as well as electrical activity types (in brainwave frequencies) during experimental conditions.

Even with excellent data collection tools, the limitations of psychology are echoed in neuroscience. One still must ask, does this data tell us anything about the experience? It certainly says something about the body during stimulus presentation. However, one must remember that the subject of study is not the participant; it is not the experiencer at the center of the examination, but the experience. At best, the neurological data can be correlated with the psychological data to suggest neural areas and brainwaves associated with certain states. Does this tell us what awe is? Does this direct us toward the structure of wonder? Neuroscience certainly provides a portion of the story, a piece of the biological mechanics that make experience possible; but coupled with the psychological data, it is not sufficient to describe the nature of an experience.

Philosophy's lens on experience

There is another lens through which researchers may examine spiritual and aesthetic experiences like those experienced by astronauts. Philosophy, broadly, has considered all things pertinent to human consciousness, but one branch (if one may consider it such) has leveraged its own rigorous methods to study experience in depth. Phenomenology, with its traditions of systematic analysis, uses methods for examining consciousness that both challenge and complement the methods of psychology and neuroscience.

The philosophical heritage of Edmund Husserl launched a study of consciousness, including phenomenality, which took seriously the descriptive challenge of experience. Building on Husserl's tradition, Martin Heidegger (1927) and Maurice Merleau-Ponty (2002) brought perception and aspects of embodied interaction to the forefront. By the end of the 20^{th} century, neurobiologist Francisco Varela had incorporated these philosophically-derived methods for investigating cognition into the study of mind, commencing *neurophenomenology* (NP) (Varela, 1996).

Varela merged the phenomenological method with neuroscience experimentation, in an attempt to bridge cohesively neurophysiological data and first-person reports. An iconic example of the neurophenomenological approach examined experience during a visual perception task. Lutz, Lachaux, Martinerie, and Varela (2002) presented participants with a 2D image of dots. The participants looked at the image for seven seconds, and then the dots began to move, until a 3D image appeared to emerge. Participants were asked to press a button, indicating that the image had fully appeared. EEG data was collected and participants gave a short verbal report of experience immediately after pushing the button. Participants reported their experiences by using categories and terms that they had developed during a prior training session. The training gave participants the opportunity to become acclimated to the visual discrimination expectations of the task and accustomed to the exploration of their experiences. The researchers employed a refined methodological trinity, training participants to engage in three phases of awareness: suspension, redirection, and receptive openness (Thompson et al., 2005). These techniques helped participants recognize the lived quality of experience and resist judgment or self-analyzing. During the study, participants self-generated the reports or were assisted with open questions from interviewers (Petitmengin-Peugeot C., 1999). These reports created clusters of experience: steady readiness, fragmented readiness, and unreadiness (Lutz et al., 2002). The researchers considered these categories invariants and they divided individual trials into these phenomenological clusters for analysis. The resulting heuristic not only accommodated interpretations of the neural activity, but also actually helped detect activity. Consequently, neural signatures (detected via phase-synchrony and amplitude) could correlate more closely with actual experiences. Not only could the researchers find commonalities in neural behaviors across participant experiences of readiness, but they also found high degrees of variation between subjects. The variation would have been considered "noise" under classic neuroscience methods. The behaviors were demonstrated consistently within individuals for multiple days and multiple recording sessions, so with the neurophenomenological technique, the researchers could confidently retain the data and make strong claims of significance in the results. In the end, the neurophenomenological study indicated stable neural phase-synchrony during perception and that neural and behavioral responses correlated with first person experiential accounts.

NP has established itself as a method useful for studying experience, but, like psychology and neuroscience, it has challenges. These may be considered in terms of the sources: internal to NP and external. A challenge internal to NP is its history of dependence upon trained subjects.

Some participants are trained within the context of the study itself, as in the one described above. Other studies have relied upon mindfulness training of various types, such as using Tibetan monks with 10,000 to 50,000 hours of meditation experience (Lutz, Greischar, Rawlings, Ricard, & Davidson, 2004). In other instances, NP studies have trained the participants to direct their mental attention over the course of a longer experimental design (see Lutz et al., 2002). However, dependence on trained subjects raises epistemological and methodological issues. I assert that these issues are not insurmountable, and I address this internal challenge by a strategic phenomenological interview in the present study.

The external challenges are rooted in interdisciplinary tension, the institutional values and creeds, spoken or unspoken, that cling to each discipline. For example, some cognitive psychologists might not be comfortable with generalizing claims from studies with extremely low participant numbers (the visual perception study described above only had four participants). Neuroscience may not share this problem, strictly, as the experimental employment of case studies (particularly lesion studies) has been essential for the advancement of the field. Instead, some neuroscientists may take umbrage with NP's application of first-person data. This position emphasizes neutrality and insists that a first-person science be executed in a manner that collects data in the second-person and handles that data in the soundly objective third-person (Dennett, 2003). The interdisciplinary tensions raise challenges of varied sorts, but all have to do with the problems inherent in merging the traditions, methods, and tools from various academic histories.

The present study takes effort to address the challenges internal and external to NP systematically. It applies methodological lessons learned as outlined by Bockelman, Reinerman-Jones, & Gallagher (2013) to establish and maintain a shared mental model among researchers, retain experimental validity, and refine the procedures for the phenomenological interview. It is not necessary to determine the degree to which any prior neurophenomenological study did these things. The assertion is simply: untrained participants can yield generalizable and valid results when the interdisciplinary team designs the experiment with attention to the needs and expectations of the contributing disciplines. The present study uses such an approach to advance the understanding of astronaut experience.

Justification for the Study

Finding a method for examining the neural correlates of human experience is one small part of a larger quest to explore the brain and its activities. In the 2013 State of the Union address, the President stated the importance of neuroscience research (Obama, 2013). Within two months, he expanded on that comment, revealing more formalized support for efforts in brain mapping (Jacobson, 2013). These efforts have enabled the identification of neural correlates for some aspects of human behavior, but little advancement has been made about the more nuanced aspects of cognition and consciousness.

The study of experiences, including spiritual and aesthetic ones, have implications for countless aspects of social and individual welfare. For instance, spiritual and aesthetic experiences are linked to religious constructs. Spirituality and religion are not only important to individuals, their intimate and personal experiences, but they shape society as well. Spirituality and religion influence economic choices (Marshall, 2004), politics (Guétin, 2009), parenting (Lees & Horwath, 2009), and healthcare (Kline, 2011; Ruijs et al., 2012). To date, science has just begun to untangle these ties between personal experiences, feelings, beliefs, and behaviors. Researchers will benefit from refined methods that address the dynamic puzzle of experience.

Researchers will have a better understanding of what spiritual and aesthetic experiences are after the establishment of methods that successfully apply to the examination of those phenomena. Scientists must investigate connections between mind, brain, body, and environment using approaches with enough flexibility to accommodate unique experiences while maintaining the reliability of established means of empirical prediction. It is not useful to insist upon constricted research methods that push experience into a solely objective mold or rely exclusively upon externally imposed parameters (e.g. surveys, questionnaires).

NP methods incorporate objective and subjective data in ways that retain statistical power of established disciplines (like cognitive science) while embracing the inherent value of first-person reports of experience. The approach proposed herein seeks to clarify specific methods for basic NP research and test these methods within an experiment. These methods are emphasized for the type of basic research that can be conducted across cultures and replicated by interdisciplinary teams. This does not suppose that all NP must follow this example, but that future NP studies may be guided toward a more cohesive project in understanding experience if researchers endeavor to engage in complementary lines of work. The potential rewards from the experimental and methodological findings justify the investigation in the proposed manner.

The findings of this study can also apply to multiple private and public industry endeavors. The results support the preparation and care of persons engaged in commercial and long-term space missions. By examining past astronaut experience and analogous simulation based experiences, programs to prepare and care for space travelers can be better developed and implemented. Additionally, findings regarding the nature and structure of experience generally can be used to advance therapeutic interventions for trauma-induced disorders. The elicitation of AWCH has instrumental value for the entertainment industry, particularly as it is used in theme parks and digital media, as those are experiences for which audiences would pay. One of the more optimistic justifications of the study is the hope that understanding experiences, particularly those of religious and spiritual nature, will help develop strategies for addressing conflicts and human rights concerns with roots in spiritual and religious experience.

The breadth and depth of reasons to pursuit this study are expansive, so it was with these justifications in mind that objectives for a research plan were created.

Research Objectives

To examine the efficacy of specific NP methods, the present study:

1. Applied the methodological lessons derived from a baseline experiment to an experiment using a simulation environment to elicit spiritual and aesthetic experiences.
2. Compared the findings from the present experiment to the baseline discussed in the literature review.

The first objective included an assessment of the design and execution of the baseline experiment. The result was a compilation and assertion of methodological lessons learned. The second objective required experimentation to examine the efficacy of the suggested methodological improvements. In the *Viewing Earth from Space: First-person Experiences* experiment a simulated view of Earth was presented to participants from two contextual vantages, focal (FOC) and global (GLO). Participant experiences were measured using neurophysiological sensors, psychological metrics, and a phenomenological interview. The concept model for the study (Figure 1) illustrates the workflow that supported progress toward the aforementioned objectives.

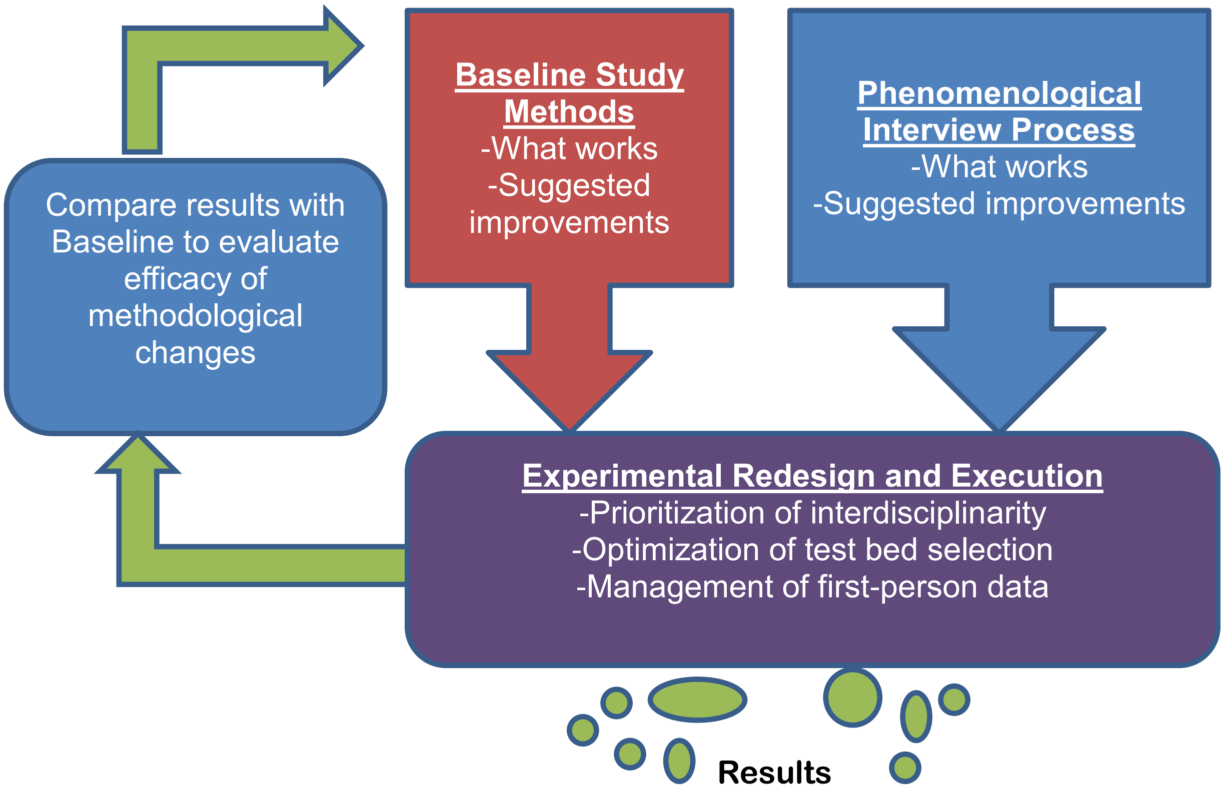

Figure 1. Concept model of study

The interdisciplinary field of Modeling and Simulation (MS) contributed to the present study in a way that, while not required for every neurophenomenological study, certainly shaped this research. In the present study, MS theories were applied to the simulation test bed design, concept mapping for collaboration and coordination between team members, data fitting, and cognitive models. To accomplish the objectives, the experiment employed specific manipulations (i.e. context), simulation test bed selection, and phenomenological interviews used to establish phenomenological clusters for analysis. Further, to accomplish the research plan, a common lexicon was established.

Definitions of Key Terms

NP comes from the merger of domains and requires ongoing interdisciplinarity to function. To collaborate and coordinate with other researchers, contributors must acknowledge that the use of a shared lexicon may require some adaptation as terms may be used differently by various disciplines. Therefore, the following definitions are operationalized to position the concepts as they are used within this study, not to assert that the definitions offered have been conclusively determined. The following definitions represent the descriptions needed to examine NP methods in this research.

Aesthetic: Pertaining to the sense of affective appreciation of the perceived, both internal to and external to the body (Reinerman-Jones et al., In press).

Awe: A *direct* and *initial feeling* when faced with something incomprehensible or sublime (Reinerman-Jones et al., In press).

Context: The circumstances or aspects of a specific event in time (Dey, 2001).

Curiosity: Wanting to know, see, experience, and/or understand *more* (Reinerman-Jones et al., In press).

First-person Data: Information generated by an experimental participant or subject that may include qualitative and narrative components (Posner, 1989).

Humility: A sense one has about one's relation to the universe (an issue of scale) or one's significance (an issue of moral aspect) (Reinerman-Jones et al., In press).

Immersion: Deep engagement or absorption in real-time circumstances or thoughts (Sherman & Craig, 2002).

Mental Awareness: The techniques and tools associated with the capacity for individuals to attend to their states, while suspending judgment or self-analysis (Petitmengin, 2006, 2010).

Methods: The practices and techniques for conducting experimentation, including design, execution, and analysis (Boden, 2006).

Mixed-reality: A subset of virtual reality environments that blends synthetic features with real-world features so that users may interact with real-world objects within the context of the simulation (Sherman & Craig, 2002).

Neurophenomenology: A study of mind, experience, and consciousness that incorporates tools and techniques from neuroscience and psychology with phenomenologically derived first-person data (Varela, 1996).

Objective Data: Information that may be collected by observation (Posner, 1989).

Phenomenology: The study of experience; seeks to describe and categorize *what it is like* from a first-person perspective (Gallagher, 2007).

Religious: Pertaining to the spiritual practices in rites and belief systems that may or may not be organized in collection with other like-minded practitioners (Reinerman-Jones et al., In press).

Simulation Test Bed: A virtual environment used for experimentation (Reinerman-Jones et al., In press).

Spiritual: Pertaining to the aspects of life at the essence of human experience; transformation motivated by experience.

Subjective Data: Information reported by participants (Posner, 1989).

Virtual Reality: Realistically presented computer-generated simulation environment (Sherman & Craig, 2002).

Wonder: A reflective feeling one has when unable to put things back into a familiar conceptual framework (Reinerman-Jones et al., In press).

CHAPTER TWO: LITERATURE REVIEW

From Phenomenon to Neurophenomenology

As its name implies, NP blends data collection methods from neuroscience and phenomenology. In the 20thcentury, Husserl established phenomenology, a project to explore experience and phenomenality[1] (Husserl, 1970). The great mission of phenomenology continues to be centered on subjective experience, though the proposed means to that end vary. While it is beyond the scope of the present study to trace the various applications and interpretations of the phenomenological project, it is essential that it be made clear how this study draws from the phenomenological tradition. To do that, the following section will explore key ideas from the phenomenological traditions that most directly apply to the present study.

Broadly, phenomenology asserts that an experience can be understood, at least in part, by considering what that experience is *like.* There is something it is like to experience phenomena. This emphasizes the nature and structure of experience, as a legitimate object of scientific inquiry, with an ambition to develop models of human experience. Though phenomenology's roots were distinctly philosophical, its rigorous methods of categorization and analysis have led to its incorporation in the cognitive sciences. At its best, phenomenology has shaped experimental design, and experimental results have, in turn, shaped the phenomenological project. This symbiotic relationship between science and phenomenology is

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[1] Phenomenality and intentionality are two categories in the broader discussion of consciousness and arguably pertinent to phenomenology. For the purpose of the present discussion, it is important to establish that aspect of consciousness studies centered on describing "what it is *like*" has traditionally been characterized as phenomenality. However, one should not assume that these are rigidly drawn categories, and the phenomenological project holds promise for further clarifying the relationships between these (and potentially other) aspects of experience (Zahavi, 2003). The point at hand is that these descriptive distinctions are one portion of the larger problem of describing the nature and structure of experience.

most clearly evident in neurophenomenological research. The father of NP, Francisco Varela (1996) built on the phenomenological writings of Husserl, Heidegger, and Merleau-Ponty to shape a project of experimental philosophy in cognitive neuroscience. The objective for experimental NP was, and continues to be, the bridging of first-person experiential data and neurophysiological data (Varela, 1996). NP's naturalized phenomenology (Schmicking, 2010; Gallagher, 2003) inverts the notion that empirically derived results always drive philosophical interpretation. Instead, a naturalized phenomenology uses philosophically-derived relationships between concepts to structure the experiment *before* data is collected; the philosophy drives the experiment. Careful pre-experimental phenomenological analyses shape experimental design, by front-loading the phenomenology into the experimental design (Gallagher, 2003) or constructing heuristics to assist classifications of experimental findings. The result, according to proponents of the approach, is an experimental design that can correlate experience and brain behaviors. More importantly, the relationship between body, mind, and world can be mapped in a manner that allows the experience to be the unit of study, rather than only the experiencer.

NP has emerged as an alternative approach to studying experience, filling gaps left by other approaches, including neurophysiology and cognitive psychology. Classic neurophysiological studies typically seek correlation between performance on cognitive tasks and brain responses. Cognitive science, with research roots in psychology, treats the study of experience with the same objectivity appropriate within that field for any other aspect of cognitive behavior. That is, even when subjective data is collected, cognitive science methods require that the evidence be transformed and managed in classical statistical ways. The crux of this muddle is the manipulation of hard-to-handle information. For example, data would be collected in the form of scales and surveys, so that it may be quantified. In the rare cognitive science study, participants may be interviewed, but every participant would be exposed to identical questions. These are legitimate practices, well established in the field, and important contributors to our understanding of a great deal of psychology (Boden, 2006; Posner, 1989). However, they fall short of synthesizing data to develop any framework for experience.

Gallagher (2003) draws from the work of other neurophenomenologists (e.g. Lutz & Varela) to discuss the synthesis of data into subjective parameters (SP), claiming that they vary to such extents that researchers too often dismiss them. NP asserts that SP, which may be dismissed under the traditional neurophysiological model (Gallagher, 2003), can merge the benefits of both third-person quantitative data and first-person qualitative data in a manner that accommodates substantiated neural correlation and variability between subjects. Gallagher's subsequent NP methodology shapes experimentation with the goal for collecting both subjective and objective data and handling that information appropriately according to those distinctions.

First-person data inevitably poses problems for traditional empirical approaches and these problems are made manifest in two categories of philosophical challenge. One category of challenge is an extension of reductionism, which is the proposition that all conscious experiences can be reduced to purely physiological explanation (Churchland, 2002) [2]. The other challenge is a matter of sufficiency, which questions the capability of NP to deliver on its promises to reveal anything that traditional scientific methods cannot capture (Bayne, 2004). The concerns deserve greater attention and examination than the scope of the present paper justifies devoting, but while it is beyond this work to delve into that philosophical debate, it is necessary to acknowledge that both of those challenges matter as far as they challenge the merit of the present methodology.

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[2] For an introduction to the philosophical debate on reductionist interpretations of neuroscience, see (Bechtel, Stufflebeam, Mundale, & Mandik, 2001).

Gallagher (2007) addressed the reductionist challenge in neurophilosophy, by arguing that science strives "to explain *what there is*" (p. 311, author's emphasis). Consequently, the category of *what there is* must not omit those things that may not be reducible to neuronal processes or easily quantifiable. Researchers ought not to confine personal processes and unique experiences to the objectifying rigidities of scientific methods; rather science can expand its methods to include the phenomenological practices that capture, investigate, and explain the irreducible. Precisely by refusing to objectify the entirety of personal experience, phenomenology can allow science to encompass a broader field for methodological examination. By this reasoning, the reductionist challenge rejects the inclusive potential of phenomenological experimentation and by doing so falls short of capturing the qualitative and unique aspects of human experience. It is from this vantage that Gallagher outlines a methodology that makes space for multiple sources of data. NP values both biological description and first-person account, thereby addressing the first challenge, the reductive claim.

Philosophers of science and neuroscience researchers also have considered the second challenge, regarding the efficacy of NP to deliver meaningful results. This challenge hinges on a conflation of the varied approaches to phenomenological application. Bayne (2004) criticized NP for failing to close the explanatory gap and offering no distinct approach for doing so. This ignores the extensive variation in approaches laid out by philosophers and scientists who cover a spectrum of views on the role and methods of first-person accounts. In Bayne's view, the fact that there are gaps in our understanding of consciousness indicates that there must be no way for NP to fill those gaps (p. 361). The logical fallacy of that argument aside, the challenge raised resides in the same arena in which the rebuttal belongs: there is no one NP method. Consequently, there is merit to the argument that it, thus far, has insufficiently captured the phenomena under scrutiny. The contention of dispute is the claim that it *cannot* capture these experiential aspects of mind. To deal with this challenge, a closer look at the explanatory gap must be taken.

The techniques employed in phenomenological and introspective research are broad and adopt different components of neuroscience and psychology (cf. Dennett, 2003; Fingelkurts, Fingelkurts, Bagnato, Boccagni, & Galardi, 2012a; Lutz, Lachaux, Martinerie, & Varela, 2002; Varela, 1996). As NP matures, the methods for integrated phenomenology undergo refinement to continue closing a variety of explanatory gaps in neuroscience. Thompson, Lutz, & Cosmelli (2005) described the explanatory gaps to be addressed by NP as follows:

1. The conceptual gap involves the problem of first-person experience, the ability to report, and the manifestation of neurobiological responses.
2. The epistemological gap includes issues of meta-awareness, or the potentially deforming effects of attending to experience and re-experiencing something in memory.
3. The methodological gap involves the means by which first-person data is generated, handled, and analyzed.

The present work focuses on the methodological gap, but it would be erroneous to assume that any of these aspects of the explanatory gap work in isolation, for they depend on one another. The proposed research addresses the methodological gaps in NP, while simultaneously contributing to the body of knowledge regarding human experience.

There is reason to suggest efficacy of NP methods, although they remain broadly defined. For example, studies using phenomenological techniques in the evaluation and treatment of epilepsy and other neurophysical conditions indicate validity for the broader category of NP approaches (Fingelkurts et al., 2012; Petitmengin, 2010). However, there is a difference between applied settings and basic research, and it would behoove the NP project at large to find ways of being conducted in various settings using similar approaches. If some of the methodological gaps are addressed, NP could deliver first-person data and handle that data in an unprecedented manner, providing clarifications and classifications that are not captured by classical cognitive science approaches. A paradigmatic shift in the scientific approach to the study of mind, like the shift proposed in NP, could support breakthroughs in numerous domains involving human cognition. Of course, paradigmatic shifts are never met without resistance.

Neurophenomenology or Cognitive Science?

Some neurophilosophers challenge the assumptions of NP outright, dismissing its value to science, let alone its potential to transform the study of human cognition. One of the most vocal oppositions to NP has come from Daniel Dennett. He asserted that philosophy and biology act in tandem to illuminate aspects of consciousness. In his assertion he denied the assumption that NP contributes anything beyond the techniques and tools of cognitive science[3] (Dennett, 2007; Dennett, 2003; Dennett, 2001). He applied the moniker *heterophenomenology* to describe a type of cognitive science that incorporates various aspects of mind and body to study experience. Dennett had selected the prefix “hetero-” to evoke the inclusive nature of his stance (Dennett, 2003) and separate it from competing phenomenological approaches, such as those asserted within NP. This distinction drew a line between data collected from self-reports and that

[3] Tracing the methodological roots of cognitive science is not the focus of this literature review, as the aim herein is to position the present study in light of pertinent historical and contemporary work. Thus the following definition of cognitive science will suffice: it merges multiple disciplines, with heavy dependence on the data handling techniques of experimental psychology; it strives for objectivity in the handling of participants; it relies heavily upon the quantification of qualitative data (Boden, 2006).

which was collected based on the reports of others. He did not go so far as to claim he was offering anything revolutionary, merely an alternative way for discussing already existing approaches (Dennett, 2003).

Dennett's description of heterophenomenology drew support and criticism. Some claimed he was simply re-stating Husserl's original ideas and others said that he contradicted Husserl in every way (c.f. Dennett, 2007). Possible heresy against the traditions of phenomenology aside, Dennett was issuing a challenge for NP to demonstrate the accomplishment of anything beyond what cognitive science could deliver. Heterophenomenology was positioned in opposition to NP. Dennett emphasized neutrality and insisted that a first-person science be executed in a manner that collects data in the second-person and handles the data in the soundly objective third-person. From that vantage, much of the research conducted in NP would be absorbed into Dennett's heterophenomenological framework and subsumed under the broader category of cognitive science, or it would be dismissed outright as not offering anything of empirical value (Figure 2). Cognitive science already quantifies subjective experience, while retaining data-collection objectivity (Posner, 1989). The heterophenomenological argument continues to depend on requisite neutrality and objectivity to conduct science.

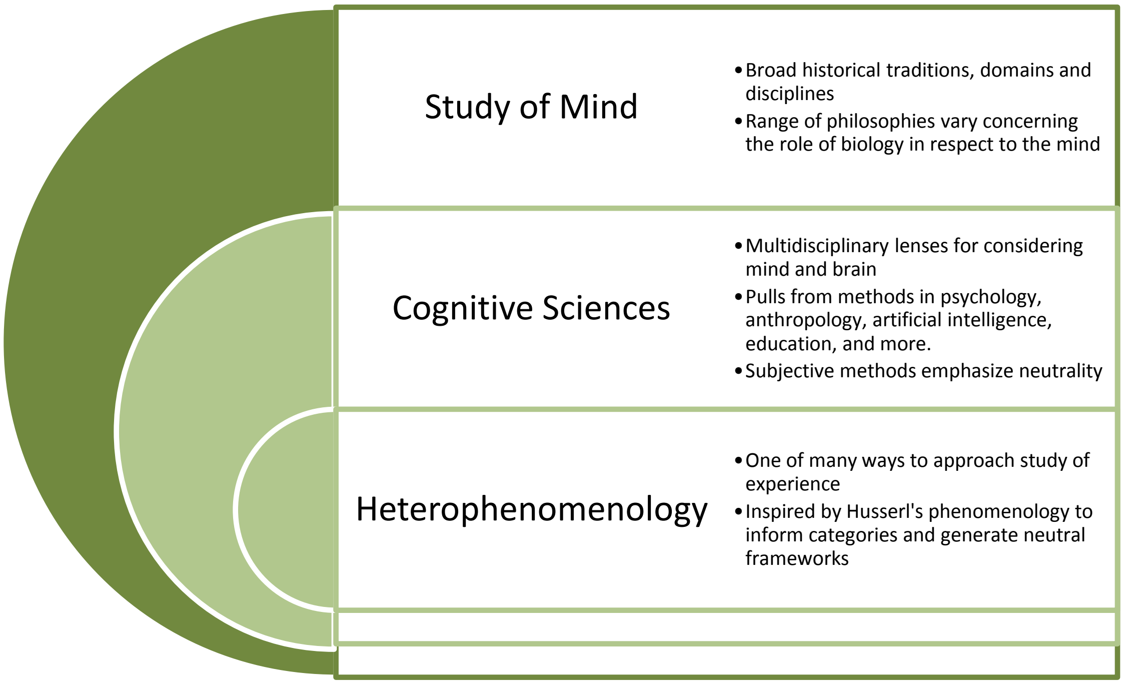


Figure 2. Nested description of heterophenomenology's place in the study of mind.

To capture the essence of the argument: some researchers assert that phenomenological approaches to studying cognitive topics are essentially cognitive science under a different name: the only differences are superficial packaging (Dennett, 2007; Dennett, 2003; Roy, 2007; Siewert, 2007). Others argue that the differences are far from superficial and that these distinctions can move neuroscience into a new realm for investigation by opening novel theories and methods (Gallagher, 2007; Ratcliffe, 2010; Thompson et al., 2005; Zahavi, 2007).

Proponents of NP reject the assumption that objective data is necessarily superior to subjective data. They also seek to avoid the transmogrifications that can result when first-person data is forced into a third-person structure. NP proponents argue that the explanatory gap can close if subjective data is handled properly. They argue that NP is not just a sub-set of cognitive science approaches, in part because the approach requires individuals to be addressed differently from one to the next. For example, large-scale brain processes often vary from trial to trial and across participants. To add to the complexity of the problem, variability of this sort has often been inadequately controlled within experimentation (Thompson et al., 2005). To face the challenges inherent to large-scale complexity, Varela (1999) hypothesized that an embodied and situated agent's nervous system generates a transient and coherent large-scale assembly and the resulting mental-cognitive state is a neural interpretation of that activity. With this understanding, NP works to test that core hypothesis by applying phenomenological investigations to neurodynamisms. To do so, NP relies on first-person methods to obtain descriptions of lived experience that could not be attained otherwise.

Varela and Shear (1999) suggested that prior research in cognitive science had been limited in part by dependence on a flawed definition of objectivity that limited the investigation of first-person data. At that point in cognitive science's history, most researchers considered the *outside world* relatively separate from the mental content of the human subject. Varela and Shear (1999) rejected that limited view of mind and encouraged neuroscientists to include subjective experience in an enactive world as an "explicit and active component" (p. 2) in consciousness. They proposed a system of *dynamic reciprocal constraints* (DRC; Varela, 1996, 1999) to illustrate this interplay of multi-source data. In the DRC model, constraints on data come, not from an externalized assumption of objectivity, but from a co-regulated interaction of first-person experiential reports and analyses of neurophysiological data (Figure 3). DRC further separated NP from other approaches to handling first-person data by establishing a model that captured the interaction of cognitive process.

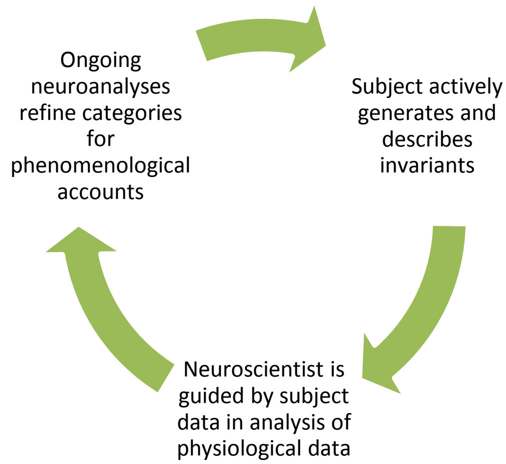


Figure 3. Illustration of DRC

<u>Handling First-Person Data</u>

One concern with the approach of cognitive psychology is the risk of conflating subjective and introspective experiences. The NP stance, in opposition to alternative approaches of cognitive science, led to an important distinction: the *content* of a mental state ought not to be conflated with the *process* through which the content appears (Varela & Shear, 1999). The content/process distinction set the precedence for training participants in becoming aware of those mental nuances. For NP to work, it was not enough for participants to recount *what* they experienced (e.g. What color did you see? What was the scent?). The goal, in true phenomenological tradition, was to capture the *lived* experience (e.g. How is it to see that color? What is that scent like?). Varela and Shear (1999) pointed out that certain Eastern practices (namely, Vedic transcendental meditation, Dzogchen and Zen Buddhism, and some practices in Vajrayana Buddhism) diminish the role of content in conscious presence. Years of mindfulness practice helps practitioners distinguish between content and process, and consequently provide richer details of their experiences. The authors maintained that, because access to one's experience is often difficult and confounded, participants in NP experimentation must be trained in mental awareness methods. From that assertion regarding the distinction between content and process, a broad assumption arose across NP research that working with mindfulness-trained participants was required.

Lutz, Lachaux, Martinerie, & Varela (2002) explored the relationship between neurological data from electroencephalograph (EEG) signals and first-person accounts from participants trained to recognize their cognitive content and processes. They focused on neural patterns associated with attention, vigilance, and expectation and assumed that cognitive contexts provided by the participants would correlate with neural behaviors. They hypothesized that specific neural patterns would condition the response to the stimulus. Trained participants engaged in a visual identification task that involved watching a random-dot image change until a three-dimensional shape appears. Participants were trained by participating in the task and answering open-ended questions to help the participants become aware of their experience just prior to the shape coming into view. The results of the training interviews provided phenomenological clusters (PhCs). Neurological data was collected on 200 to 350 trials from each person. Three PhCs were described *a posteriori* based on the aforementioned training. The PhCs of *unreadiness*, *fragmented readiness,* and *steady readiness* were used to interpret the neurodynamic measurements during the perception of the three-dimensional illusion. The authors argued that the study had broader implications for understanding consciousness. In particular, they argued that it would be important to re-examine assumptions regarding temporal intervals in neural correlates of conscious behavior because a moment of consciousness always extends from a previous one and therefore cannot be considered neutral. In that light, a brain's response to stimuli and the corresponding lived experience must extend temporally into previous experiences (Lutz et al., 2002; Lutz, Slagter, Dunne, & Davidson, 2008). Their findings supported the NP approach and provided an exemplar for the use of trained participants.

Since its earlier days, NP research has expanded to include efforts for handling untrained-participant data. Petitmengin (2006) argued that there may be ways to help an untrained participant accurately articulate subjective experience. The solution was a specific interview method. Petitmengin acknowledged that it is wrong to assume that being aware of an experience would, necessarily, improve the articulation of the experience. She suggested phenomenological interview techniques could help untrained participants attend to and articulate their experience. Testing the assertion, nine epileptic patients were interviewed over the course of eighteen months. All of the participants experienced pharma-resistant temporal lobe focal seizure epilepsy. The interviews were used to generate phenomenological clusters of preictal state experiences, which were subsequently used to interpret EEG readings in a novel manner. The results suggested that preictal experiences are manifest in epileptic patients much earlier than neuroscientists had expected (Petitmengin, 2006). While a questionnaire might have provided quantitative data that could generalize something about preictal experiences, the purpose for the phenomenological interview was to go much deeper. The interviews sought a smaller number of experiences in higher degrees of unique detail. Using phenomenological interviews in these contexts, Petitmengin collected data that fed into the DRC paradigm and yielded results that contributed to both the theoretical science of epilepsy and the therapeutic expertise of patients involved in the research program.

The co-regulation of constraints, as captured in the DRC model, combined with the application of the phenomenological interview, establish the foundation for NP methods. However, in order to carry out basic research and put the theories into laboratory practice, the NP methods must be executed across interdisciplinary teams. For example, the present study incorporates the phenomenological interview and neurophysiology using a technique borrowed from psychology: measuring individual differences. The tradition of differential psychology may trace itself most famously to the unfortunate efforts of phrenology, but as the study of individual differences has advanced, so have its methods (Zola-Morgan, 1995). The overarching goal in studying individual differences is to identify traits, characteristics, and behaviors that may be normal for that individual, but get lost in the tendencies to find generalizations in psychological research. This approach merges ideally with NP. Indeed, there is precedence for the application of individual differences to study complex topics. Individual differences have been extensively useful in advancing understanding in a number of psychological and cognitive constructs, including personality (Kluckhohn, Murray, & Schneider, 1953), intelligence (Sternberg, 2000), and developmental cognition (Demetriou, Raftopoulos, & Kargopoulos, 1999). In the study of experience, individual differences have been used to examine valence and arousal (Feldman, 1995) and emotional processes (Gohm & Clore, 2000; McCullough, Tsang, & Emmons, 2004).

The present study is positioned in the neurophenomenological tradition, leveraging the tools of neuroscience, phenomenology, and psychology. Therefore, while there is precedence for these tools and approaches, the present work aims to establish a refined methodology that can increase replicability and optimize untrained participants so that researchers can delve into the nature and structure of experience.

Toward Experience

Most research in measuring experience has been relegated to customer or user satisfaction. These metrics observe the user or the customer more than the nature and structure of the experience itself. They are motivated by a drive to use the information to change something (e.g. a marketing plan or a device's ergonomics), rather than collecting data about experience as a subject of study unto itself. Consequently, there is little work on the subject of "experience" that satisfactorily distinguishes the *experience* from the *experiencer*. The goal in this distinction is not to claim anything about an actual separation between the experience and the experiencer, but to direct the focus on the correct unit of study.

To apply NP in the present work, in any useful sense, the broad umbrella of "experience" needed to be narrowed. The present study addressed spiritual, aesthetic, and religious experiences specifically by examining the associated constructs of AWCH. This is not an assertion that AWCH has any sort of primacy, neither in a phenomenological sense nor in an applied sense when one considers spiritual and aesthetic experience. However, the study started from the accounts of spiritual experiences, and AWCH were identified as central components to those experiences. From a methodological position, focusing on specific experiences helps center the present work on the efficacy of the neurophenomenological toolbox in studying human experiences while also addressing constructs pertinent to multiple fields.

Some researchers have delved into spiritual and aesthetic research, but it is typically an objective attempt to make psychoreligious and psychospiritual diagnoses (Hackney & Sanders, 2003; Lukoff, Lu, & Turner, 1992; Murray, Cunningham, & Price, 2012). These applied contexts can and have been integrated into long-term healthcare and hospice (Holland et al., 1998; Idler et al., 2003). The problem still, however, is that the *experiencer* is the object of study, not the *experience*. Non-diagnostic research has also been conducted, but it too has missed the mark of studying the experience, as it ultimately has emphasized religious behaviors, particularly the practice of one's belief system (Johnstone, Yoon, Franklin, Schopp, & Hinkebein, 2008; King & Hunt, 1969).

The present work abandoned the historical pattern of focus on the experiencer and examined spiritual and aesthetic experiences through multiple disciplinary lenses. Consequently, the approach used herein presented practical challenges to the already theoretical difficulties inherent to the topic of experience. To delve into the interdisciplinary challenges inherent to NP examinations of spiritual and aesthetic experiences, it was essential to narrow the focus and establish a shared nomenclature.

First, the spiritual and aesthetic experiences were narrowed to further focus on AWCH. The preliminary and ongoing hermeneutic contributions from Gallagher and Janz (see Appendix D) provided scores of subcategories, constructs, and relationships between relevant experiential topics. To scope the present work, a handful of these received focus, while the data collected remains useful for further analysis of the other constructs as well. As mentioned in Chapter One, AWCH were the categories emphasized in the present study. They were selected primarily because AWCH recur in the experiential accounts collected from astronaut and cosmonaut journals and interviews. The astronauts' narratives carry a unique power for many reasons. First, their demographics consist largely of scientists. These women and men return from the experience of spaceflight changed, and their reports indicate that these changes are often spiritual in nature. They report being moved affectively in a manner that they describe as eliciting an internal change. The astronauts are empiricists, who return to earth with a sense of *something* bigger "out there." Second, they experience something that few other humans experience, *space*. This matters greatly if research is to be conducted using participants from western universities. There are numerous experiences that could elicit AWCH (e.g. witnessing birth, seeing natural spectacles like the Grand Canyon or Victoria Falls, or walking through icons of human ingenuity such as the Great Wall or the Coliseum). However, researchers could construct a study involving space, and guarantee that not a single participant had actually ever visited. Consequently, if the simulation induces AWCH, it is not likely affected by a prior experience *in* space[4].

In the past decade, scientists have promoted the cultivation of awe as a beneficial characteristic for clinical psychology (Schneider, 2005) and other areas of patient care (Evans, 2012). These advocates would propose that an awe-filled approach to interaction with their fields supports superior work for both their disciplines and the individuals under care. This perspective comes out of a larger movement that embraces an interdisciplinary approach to studying religious and spiritual experience more broadly (Taves, 2010). The larger project, as Taves would frame it, attempts to apply scientific methods to aspects of religious texts, find common ground in reductionism and extended mind, and explain human animals' senses of spirituality. This approach is distinct from previous ones aimed at naturalizing human spirituality (Dewey, 1991; Maslow, 1994) as it opts for something of an inversion. A naturalized approach would consider every aspect of a phenomenon under an objective lens, whereas the interdisciplinary approach works to incorporate the potential value of subjective data in the discussions of spiritual and aesthetic phenomena. One ambitious end of such an approach would be to elucidate the relationships between affect, reason, and experience and present those findings in an empirical manner (as opposed to leaving such inquiries to philosophers and theologians). Ultimately, interdisciplinary research, such as that conducted through NP, helps mend disparate fragments of the dynamic complexity that links the human mind and human behaviors in tasks of all sorts.

[4] This by no means implies absolute equity in prior experiences. There is no assumption that the participants in this study are completely unfamiliar with space travel as presented through other media. To account for these other, less controllable experiences, demographic data included questions to find out about practices such as: attending IMAX presentations, visiting theme parks (particularly relevant was the Kennedy Space Center), and computer interaction.

For example, in the research examined herein, awe and wonder provide construct exemplars. **Awe**, as a component of spiritual and religious experience, comes from historic philosophical traditions. In the 18^{th} century, Edmund Burke's philosophical treatises struggled with the sublime and beautiful, binding these constructs conceptually with awe-filled emotions. These emotions do not imply pleasure, in its most obvious sense, but Burke asserts that people experience awe inseparably from terror, power, obscurity, and humility (Burke, 2010). Gallagher et al. (In Review) define awe as a *direct* and *initial feeling* when faced with something incomprehensible or sublime. In contrast to the directness of awe, **wonder** demands cognitive reflection. Fuller (2009) argued that wonder serves humanity by bridging emotion with the desire to apply order to the universe. It is much like the sentiment of Albert Magnus, who a millennium ago stated, "… wonder is the movement of the man who does not know on his way to finding out" (Greenblatt, 1990). Distinct from pure emotion, it elicits the verb, "wondering" (Parsons, 1969). The present research defines wonder as a more reflective feeling one has when unable to put things back into a familiar conceptual framework. Curiosity also regards a desire to piece things together, but in a different way. According to Gallagher et al. (In Review), **curiosity** involves wanting to know, see, experience, and/or understand *more*. The object of this wanting may be technical, logical, moral, or existential. In 1914, John Milton McIndoo asserted that curiosity opposes the impulse to flee in fear. That which may incite fear at first may become intriguing, as familiarity grows (McIndoo, 1914). In this respect, it acts as an important contrast to **humility**, which also may involve fear. Philosophers and theoreticians vary greatly concerning humility, attaching it to everything from psychological concerns of self-esteem, roles within cultures, and the limits of knowledge within the universe (Tangney, 2000). Regardless, humility demands a sense of perspective, where one must place oneself in scale to someone or something else. In the present study, humility is a sense one has about one's relation to the universe (an issue of scale) or one's significance (an issue of moral aspect). With these working definitions of AWCH, researchers applying an interdisciplinary NP approach can examine experiential phenomena and offer possible interpretations of the findings.

Clarifying Methods with "Lessons Learned"

The preceding sections of this chapter have outlined the philosophical and theoretical position of NP, positioning it as both complementary to some, but divergent from other aspects of cognitive science. Further, a case has been made for NP as an inherently interdisciplinary way to explore complex spiritual and aesthetic experiences. With these contributions from academic research in mind, the following section presents a review of a baseline NP study and identifies areas for methodological refinement.

The baseline study, *Space, Science, and Spirituality* was a collaborative interdisciplinary endeavor (Reinerman-Jones et al., In press). Researchers from multiple disciplines divided portions of work to create an immersive experience of space travel for the purpose of gathering neurophysiological and phenomenological data. Astronauts had captured their experiences of space travel in written journals containing details of both visual and affective experiences. Linguistic and semantic analyses were used to identify and categorize the ways astronauts verbally expressed their experiences in writing. These details informed the design of a mixed-reality immersive test environment where participants viewed images of space and provided a narrative comparison for first-person experiential accounts. In the baseline experiment (Gallagher, et al., In Review), collaborators from the *Kolleg-Forschergruppe Bildakt und Verkörperung* (College for Advanced Study of Image-act and Embodiment) used the NASA

Image Database to identify criteria for the simulation design. The analyses revealed necessary characteristics of the visual experiences from a space vantage:

- Few or no artifacts from optical refraction or lens effects
- No aged or chemical effects from film
- No visible manipulations in terms of coloring (as those found in digital editing)
- No marking and inscriptions (such as watermarks)
- Pictures should be focused and/or rich in detail
- Views should be possible from a spacecraft within the terra-lunar system and could be made by human observers

Artists used these criteria, along with two standards for manipulation: An earth view should show the earth as a visible crescent, not as an iconic blue marble and a space view should have no identifiable objects other than a high star count due to atmospheric absence resulting in clarified vision (Reinerman-Jones et al., In press). With these conditions in mind, the artists designed a set for a mixed-reality simulation wherein participants were immersed in the sounds and sights of something like a science fiction movie set. Simulation artists integrated the Bildakt group's analyses in both the baseline (Reinerman-Jones, et al., 2013) and the present study.

Both the baseline study and the present experiment use simulation technologies to generate controlled conditions. Varying degrees of realistic experiences are possible within virtual reality simulators and they can allow for NP research to be conducted with high levels of control. Designers must address immersion, point-of-view, and venue concerns to establish an effective simulation experience (Sherman & Craig, 2002). Additionally, considerations of quality and presence should be integrated into the simulation environment (Gaggioli, Bassi, & Fave, 2003). That is, the simulation should support a willing suspension of disbelief and in doing so, allow for a narrative transfer that takes the participant into the world presented within the simulation. The suggestions from the Bildakt group reflect an intention to increase immersion, clarify point-of-view, and be applicable within the limitations of the mixed-reality simulation environment used in the experiment.

Aspects of context were incorporated into the simulation design and were crucial in the experimental strategy. Participants experienced identical “launch” context narratives. In the consideration of context, all possible percepts are indefinite (Coren, Ward, & Enns, 2003), and consequently meaning of a visual stimulus is ultimately constructed by the participant. Therefore, while the contextual cues for all participants started identically, the context varied when their vantages accommodated different views of objects in space. In all research, when a stimulus is presented, contextual circumstances surrounding the presentation contribute to the experience. Dey (2001) defines context as any information that can be used to characterize the circumstances or situation of an entity. An entity might be relevant to the interaction between a participant and the simulation and may or may not be manifest within the simulation itself, but the participant determines the perception and experience of relevancy. In basic NP research, this means that control of contextual variables is of utmost importance.

The baseline study applied these principles of simulation context design in the development of the mixed-reality simulator and the conditions presented therein (Reinerman-Jones et al., In press). Participants needed to pass “backstage” to enter the simulated launch station, passing by cameras, a large green screen (used for filming digital effects), and the equipment required to conduct numerous experiences in sight and sound. The experimenters presented the study in terms of simulated space travel, and worked to support the illusion through a narrative that reinforced the idea that the participant had been selected to have the unique opportunity. Participants answered a battery of questionnaires chosen to collect information about multiple topics, including: attitudes of religiousness, dispositional tendencies, and sensitivity to simulator sickness. The experimenters worked to maintain the story narrative of an impending launch, even while placing neurophysiological sensors on the participant.

Researchers collected real-time neurophysiological measurements using EEG, ECG, and fNIR while the participants observed the space scenes (Reinerman-Jones et al., In press). When the participant was ready to "launch" (an audio and visual experience, as the chair and capsule were stationary), the experimenter sat outside of the space capsule and could only be contacted through radio control. Computer monitors embedded in the walls of the capsule opened virtual portals revealing images of space, including Earth, and expanses of stars. After the participant viewed the images, the capsule "returned to earth" (relayed through radio control) and the participant answered questionnaires, repeating some of the questions that had been asked previously and introducing questions of workload. Experimenters removed all sensors and brought the participant to meet an interviewer. The interviewers were philosophy graduate students trained in phenomenological interview techniques. Interviewers escorted participants to another area for interviewing with the succinct goal of extracting first-person reports of spiritual and aesthetic experience.

Identifying Method Improvements

At the baseline study's end, 16 males and 27 females (mean age = 20.3, SD = 2.03) had participated. From the beginning to the end, the baseline experiment was executed much like a relay race, with researchers passing the baton from one stage of the experiment to the next. The analysis of the collected data required a division of labor by the various contributing disciplines. Human factors psychology and neuroscience experts examined the results of the psychological and neurophysiological measurements. Phenomenologists reviewed the transcripts and recordings of the interviews and conducted linguistic and philosophical analyses. The astronaut journals provided information about first-person experiences of awe and wonder and that starting point was used as a comparative linguistic evaluation of the participant interviews. The results showed promise. Participants who reported higher levels of religiousness (as indicated in the questionnaires) were more likely to report awe and wonder when viewing the Earth (as opposed to only stars). The findings provided support for what the researchers hypothesized: a connection between aesthetic and spiritual practice and real-time experience (Reinerman-Jones et al., In press). In early analyses, the results of the neurophysiological data indicated engagement of frontal lobes during the feeling of wonder and parietal lobes during physical affect. Participants who reported experiencing awe, wonder, religiousness or spirituality were compared to those who did not indicate such experiences. Specifically, theta activity varied significantly between experiencers and non-experiencers. Further, the experience of the two manipulations (vantages of deep space vs. vantages of Earth) resulted in significantly different frontal lobe beta, occipital lobe beta, left hemisphere beta, and right hemisphere beta. Experiencers and non-experiencers showed no significant differences with ECG or fNIR for comparing Earth and Deep Space. Further, participants who viewed Earth were more likely to report spiritual and aesthetic experience than those who viewed deep space.

The problem is not that the results lacked merit. To the contrary, the results provided information about human phenomena that otherwise have garnered little empirical exploration to date. The results of *Space, Science, and Spirituality* contribute to a compelling case in favor of further exploration using NP. The work supports the application of open-ended interviews for a broader range of basic-research contexts. However, the methods of the baseline may have limited the reportable finding. Regardless, the experiment provides “lessons learned” for improving NP methods in hopes of generating more conclusive results.

Lesson #1

NP experimentation must purposefully and systematically include the creation and maintenance of shared mental models (SMM).

Neurophenomenological research must embrace systematic and thorough creation of SMM as part of the neurophenomenological project in the research world. Its intrinsically interdisciplinary nature demands that contributing domain experts avoid the “passing the baton” approach that can result in a mere collection of data in a non-contextualized way. While there are various approaches to establishing, articulating, and maintaining SMM (c.f. Cannon-Bowers, Salas, & Converse, 1993; Klimoski & Mohammed, 1994; Mathieu, Heffner, Goodwin, Salas, & Cannon-Bowers, 2000) all include a need for the model to facilitate elucidation, clarification, and prediction to benefit team performance (Bockelman Morrow & Fiore, 2013). SMMs support collaboration and coordination (Elias & Fiore, 2012), thereby helping the individual team members carry out roles and adapt to unexpected circumstances.

As described in the previous section, our team for the baseline experiment consisted of human factors psychologists, philosophers, art historians, astronauts, simulation developers, and computer engineers. Each contributing member adds value, but entered the collaboration with differing vocabulary or semantics for concepts and constructs.

With the varied perspectives, the team must find common ground. The neurophenomenological approach can only be accomplished with all contributing members operating with a shared lexicon and conceptual framework. That is achieved by considering specific techniques for accomplishing the SMM according to the group and its circumstances. In preparation of a second study, the following techniques were employed: concept mapping prior to experimentation, continued training of researchers regarding NP theories and methods, and preparing analyses to handle the complexities inherent to the neurophenomenological data. These are examples of techniques for addressing the needed SMM. Logistically, these take time. As is the case with most successful interdisciplinary endeavors, scheduling regular meetings for brainstorming and teaching, as well as creating a glossary and conceptual framework document should be part of NP implementation. The outcome should not only be productive experimental collaboration, but also synthesized and sensible results. These integrative results stand in contrast to the individualistic pieces of interpretation from each domain's perspective.

Lesson #2

NP experimentation should be held to the high standards of experimental design and execution to achieve variable control, reliability, generalizability, and replication of results.

In the complexities of carrying out an interdisciplinary study with multiple parts, problems can arise. In the baseline study, there were many possible variables that could have explained components of the experience (e.g. launch narrative, the mixed-reality components of the simulator, and changes in setting between experience and interview). It was therefore impossible to determine the manipulations that generated various aspects of the experiences. In part, this problem in the baseline study was the result of inadequate SMMs mentioned above. Team members, working within the confines of their own specialized disciplines, were not always able to see the whole picture, and this had an effect on the overall design of the experiment. This, of course, is not inevitable, or necessarily a characteristic of other NP experiments, but that this problem did characterize the baseline study suggests that adopting different practices is something that needs to be made explicit. Accordingly, the second methodological lesson is a reminder that psychology and the cognitive sciences already have a time-tested tradition of precision in experimentation and that neurophenomenology can benefit from attending to many of the practices involved in this tradition.

As researchers design a NP experiment, they should consider many of the questions that their counterparts in traditional cognitive science might ask. For example, does it make sense to generalize first-person data? Cognitive scientists, with a firm footing in psychology, consider the extent to which any finding can be generalized to the population at large, and that consideration may affect the manner in which the data is both collected and handled. Neurophenomenologists need to grapple with that question as well, and avoid oversimplification of the factors that contribute to the results.

In addition to generalizability, cognitive psychology also considers verification. A well-formed NP study needs to consider procedures for the verification of subjective experience. In other words, is "experience" being captured the right way? The baseline study, due to the length of experimental sessions and the uniqueness of using the NP approach, only included one aspect from each field that compose neurophenomenology. In other words, neurological and physiological measures from neuroscience were used to assess one part of the participants' experience (physiological response), questionnaires from psychology were used to assess another part of the participants' experience (demographic information, traits, and cognitive response to the immersive environment), and phenomenological interviews from philosophy assess participants' linguistic description of their experience in the simulation environment There was no overlap; no checks and balances. Strictly, this was a neurophenomenology study, but not an optimal application of NP methods, which thereby limit the power of the interpretation of the results. Again, to reiterate, the data attained from the baseline experiment is useful and informative for the phenomenon under investigation as seen from each discipline, but perhaps short of the ideal of neurophenomenology.

Depending on the study, other disciplines can provide complementary tools for verification. On its own, a Likert-scale of self-reported affect (a tool from psychology) will not capture lived experience. However, it can provide correlations and comparisons that in turn provide verification when interpreting the findings from the phenomenological interviews. When designing the experiment, researchers can incorporate established methods from psychology, taking care to avoid influencing the phenomenological interview. For example, a sliding qualitative scale of affect can be given after the phenomenological interview. The information from the scale can provide support to the textual analyses of the interviews. The scale cannot, on its own, capture unique lived experience, but it can add credence to the basic findings in neurophenomenology.

Concerning using methods from cognitive science, researchers designing NP experiments must also consider the replicability of their experiments. For example, neurophenomenology has been used to explore experience in epileptic preictal states (Le Van Quyen & Petitmengin, 2002). In this example of applied neurophenomenology, the lack of control (variation between subjects) provides an explanation for any inability to reproduce results. After all, the patients were not being studied to capture generalizable aspects of preictal experience, but to improve the identification of preictal states in epileptic patients. The study not only made a significant contribution to epilepsy research, but it has also played an immeasurably valuable role in the lives of patients who benefited directly from participating in the study. However, basic research should typically include high levels of control and produce highly predictable and reproducible results, and this can also be accomplished with NP methods. One of the key objectives of neurophenomenology is to function within experimentation. Therefore, attention must be paid to experimental rigor, precedence, and scientific acceptance. This understanding benefits the ability of a multi-disciplinary team to succeed in employing the NP approach.

To do this, NP experimental design might include the embrace of simulation technology. Simulation test beds allow for high variable control and precise stimulus/response recordings, consequently increasing successful replication. Simulations can be shared between institutions, permitting more diverse population testing (and bringing the results higher generalizability as well). For example, the present experiment used a portable simulation environment. This form of immersive simulation allows the presentation to be packed up and taken to another location, so that other locales can benefit from the technique. It also is a straight-forward and relatively cost-effective form of simulation presentation, so that laboratories with limited simulator resources can erect similar systems. A digitally controlled presentation of experimental stimuli allows for improved generalizability, replicability, and verification, and can thereby give more credence to the NP findings. Interplay between the phenomenological project and some techniques of cognitive science can generate a unique integrative methodology. As such, neurophenomenology should take the best of the practices of cognitive science, while contributing its unique techniques that have not been a common part of the cognitive science toolbox.

Lesson #3

The phenomenological interview places the impetus for training on the interviewer, not the participant, so that the interviewer may act to support the participant in precise experiential reporting.

The third lesson to extract from the baseline study is that the question of phenomenological training should shift from focusing on the participant to the interviewer.

Though Lesson #2 argued for the importance of adopting specific practices from cognitive science, Lesson #3 involves the aspect of neurophenomenology that stands in contrast to traditional cognitive science. To work through the assertion of this lesson, it is essential to describe the role of training in the interview. The "training trade-off" depicts how the line between the interviewer and interviewee can dissolve, so that the interviewer actually *participates in* the reflection and articulation of experience. This participation on the part of the interviewer is a marked difference from the objective techniques of cognitive science and as such has potential for opening forms of data collection and analyses of experience that have not yet been fully explored.

As discussed above, much NP research has been based on the idea that only a person trained in introspective or phenomenological techniques can provide details with the degree of precision required for meaningful results (cf. Lutz, Dunne, & Davidson, 2007; Varela & Shear, 1999). Petitmengin's (2006) technique strays from that position and accommodates information from untrained participants. The baseline experiment and the present experiment adhered to the general interview techniques found in Petitmengin (2006). One of the observations made from the baseline experiment is that this is not a training binary (i.e., participants either are capable of good phenomenological reflection or completely lack self-awareness), but a continuum. This observation was attained in reviewing the interview transcripts. The questions asked directly influenced the articulations from the participants. The interviewer's use of follow-up paraphrasing supports further reflection by the participants. The level of phenomenological training in terms of mental awareness on the part of the participant leads to a "training trade-off" (Figure 4) in respect to the interviewer. The less experienced the participant (to the limit of never having practiced phenomenological reflection), the more training the interviewer needs in ways to help draw out the experience while carefully avoiding any priming of the participant. The opposite is true as well: a participant well-trained in introspection, reflection, or mindfulness might not require a highly skilled interviewer to draw out the experiential data.

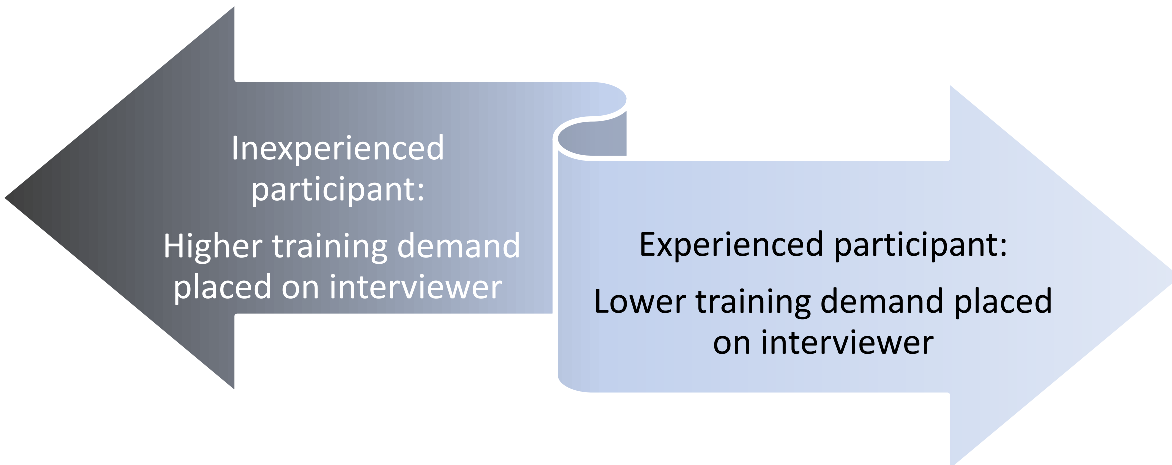


Figure 4. The training trade-off puts a greater demand on the interviewer to assist the inexperienced participant in the process of articulating lived experience.

The impact on methodology is that the emphasis shifts from a question about the degree of training a participant does or does not receive. This degree of self-awareness cannot be controlled in participants with the interview approach. Instead, the onus for training is placed on the interviewer. The training trade-off is compensatory, in that the interviewer's skill will improve the chances of the untrained participant's articulation of her experience. If the interviewer is working with Buddhist monks, she may not need to receive a great deal of training and may be able to tell the participant the focus of the study. Conversely, if the same interviewer is working with undergrads at any given university in the West, she may need to pull from a collection of tools and techniques to give the participant the capacity to access the thoughts and feelings experienced. Further, when working with an untrained participant, the interviewer might not benefit from revealing the purpose of the study, as it could easily bias a participant.

It should be noted that, while the training trade-off is presented primarily as a methodological lesson, it has important theoretical weight as well. The dynamism between interviewer and participant has value for the debate regarding phenomenological experimentation. The dynamic interaction demanded by the NP interview method is not part of traditional cognitive science. In the NP interview, a cognitive off-loading occurs by the participant onto the interviewer that traditional psychology does not always recognize. The phenomenological interviewer has the power, if executed in the manner described herein, to do some of the cognitive work of focusing the participant precisely on the participant's lived experience, a task that may be otherwise very difficult for the untrained participant. This is not one of the tools of traditional cognitive psychology. Introspection, as employed by psychologists, involves training the participant to look inward. The goal, in such cases, is not to extrapolate a description of an experience itself. Rather, interview questions are tools used, perhaps by applied psychologists/therapists, but certainly not typically by basic researchers. When neurophenomenologists employ the interview, it is a core method that is fundamentally part of the experimental approach. As such, it changes the way first-person experiential data is captured and handled.

This does not degrade the first-person experience, treating it as third person data (as Dennett [1991] suggests science requires). Instead, the interviewer actually engages (in a second-person way) to preserve the first-person experience. The goal of the interviewer is not to remain an objective third-person observer (an important aspect of cognitive science methods); the goal is to assist the participant in "opening" to her own experience. The interviewer can do the cognitive work of keeping the reflection on target, exploring the experienced thoughts, emotions, and sensations of the participant, as the participant would do on her own if she were trained to do so.

Properly trained interviewers eliminate the need for participant training. The interviewer assumes the cognitive burden necessary for reflection. The interviewer is essentially doing a share of the processing, interactively working to assist the participant in accessing her own experiences. In this process, there is no need for the interviewer to ascribe any mental states to the participant, or to engage in mindreading (understood in the standard way in social cognition); nor is there a need for the interviewer to access her own mental models or simulations of what the other's mind is. The interviewer, quite plainly, participates, interactively, in the articulation of the participant's experience. In this regard, the scientific concept of bias is important to eliminate. This requires interviewers to know the scientific method and the need for controlling extraneous variables. Language (with support of second-person pronouns used by the interviewer) directs the naïve participant toward accessing the embodied memory of the experience, just as experience in mindfulness training would allow the expert meditator to access the experience independently. Traditional cognitive science often tries to force the participant into an objective mold of predesigned conceptual frameworks. In contrast, the interactions of the interview allow a switch of directions altogether and temporarily allows the researcher to participate in the articulation of the participant's subjectivity. The resulting interview can make manifest an experiential record that traditional methods cannot reveal.

Consequently, the third lesson involves a "training trade-off" in integrating the interview into experimental design and execution. NP methods can work with this adjustment in focus from the participant to the interviewer, and the re-evaluation needed for each unique experiment. The interviewers can pull from multiple tools and techniques with the aim of eliciting the required acts of reflection and articulation. Petitmengin (2006) outlines many of the practical techniques, but in the contexts of specific experiments, one has to consider how such techniques can be put to use. Interviewers should be subjected to rigorous training and rehearsal to prepare them for the interview tasks. This training should include an assessment of the anticipated personalities and behavioral idiosyncrasies likely to be expected by a given population of participants. That assessment would direct the focus of the training, so that interviewer responses to anticipated barriers would become more natural and automatic. Training should also include mitigation of interviewer personality quirks that might otherwise influence interactions. The baseline study interview transcripts revealed that one interviewer was more extroverted and used more informal language than the other two interviewers, which seemed to elicit different responses, perhaps because of perceived rapport by the participants. The interviewer should behave as if she is a prosthetic for the participant and the questions must support that participant's exploration of her experience without imposition of the interviewer's bias. These lessons shaped the methodological changes within the present study (Table 1).

Table 1. Lessons learned during first experiment and applied to second.

	Lesson description	Lesson application
Lesson 1	NP experimentation must purposefully and systematically include the creation and maintenance of Shared Mental Models (SMM).	1. Team training to prepare research assistants in phenomenology 2. Increased communication efforts to support interdisciplinary collaboration and coordination
Lesson 2	NP experimentation should be held to the high standards of experimental design and execution to achieve control, reliability, generalizability, and replication of results.	1. Higher control of variables through simulator modifications 2. Greater sample size 3. Emphasis on portability in testbed design, for potential replication within different populations 4. Development of new metric to compare phenomenological and psychological reports of experience (ESSE)
Lesson 3	The phenomenological interview places the impetus for training on the interviewer, not the participant, so that the interviewer may act to support the participant in precise experiential reporting.	1. Implemented systemic training accountability for interviewers 2. Conceptualized the "training-tradeoff" to capture the shift of cognitive burden from participant to interviewer

Conclusion

The literature relevant to the present study comes from numerous domains and academic traditions, but there are strong commonalities. The literature reviewed herein provides a glimpse into the breadth of approaches to the problem of *experience.* The review included a history of NP, including the controversy concerning its place in the science of conscious experience. Of particular value to the present study is the question concerning cognitive science and whether NP contributes anything that is not already part of the methodological toolbox of cognitive science. Aspects of neurophenomenological methodology will be evaluated through integrating the contributing disciplines and applying the “lessons learned” to improve upon a baseline experiment. This does not assume that all NP must adopt every portion of the lessons learned, but that the present work yielded substantial results in a readily replicable manner.

The experiment acted as a “proof of concept” by providing a ground-level example of the way first-person data can be collected and handled when using a simulation test bed to examine experience. There is no assumption that the methodological approach is a one-size-fits all solution to every possible exploration of experience. However, an intentional integration of disciplines, combined with a careful application of Petitmengin’s interview approach (even if modified within the specifics of an experimental design) should be considered broadly in NP research endeavors. There is no criticism of past works implied by this statement; rather, there is a desire to build on NP’s historical successes while seeking a wider research audience in which to pursue similar endeavors. The present study offers a methodology that is a portable, replicable, and valid way to study experience that might act as a guide for further work.

CHAPTER THREE: EXPERIMENTAL METHOD

Hypotheses for Present Experiment

H1: The focal simulation condition will elicit participant reports of greater experiences of AWCH than the global simulation condition.

H2: The focal simulation condition will elicit greater changes in neurophysiological responses than the global simulation condition.

H3: AWCH experiences will correlate with neurophysiological responses.

To test the hypotheses, researchers conducted an NP experiment to evaluate multi-source neurophysiological and psychological experiential data collected during the observation of Earth from space within an immersive virtual simulator.

Participants

Recruitment Methods

The researchers recruited a total of 74 participants from the University of Central Florida (UCF) via the psychology SONA system. The ages ranged between 18 and 32 years. The research targeted no vulnerable populations. Total participation time was approximately 2.5 hours. Individual speed of questionnaire completion, time for acquiring appropriate impedance levels on the EEG, and individual differences in interview discourse contributed to variation in time to complete the experiment. Participants were healthy, fluent English speaking adults over 18 years old from the UCF community. Research restrictions (Appendix A) controlled for certain individual differences by excluding some participants from the study. Participation required normal or corrected to normal vision, as visual immersion was critical to the simulation experience. Alcohol consumption within 24 hours or caffeine consumption within 2 hours prior to the study excluded participation, as these substances could influence performance and/or perceptual sensitivity. The SONA registration system communicated the restriction criteria to participants prior to registration.

Experimental Equipment

Researchers conducted experimentation within Northrup Grumman's Virtual Immersive Portable Environment (VIPE, Figure 5). The VIPE space provided a 7ft. tall, 120° view. The participants were in a low-profile (gaming-style) chair during the visual simulation, so that the natural vertical and horizontal range of view surrounded the periphery within the panoramic projection.

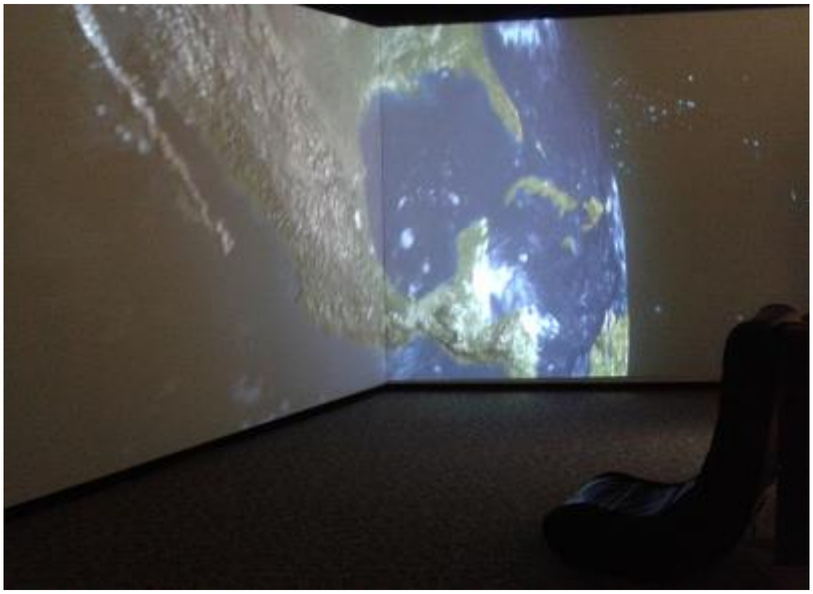


Figure 5. VIPE space used for immersive simulations.

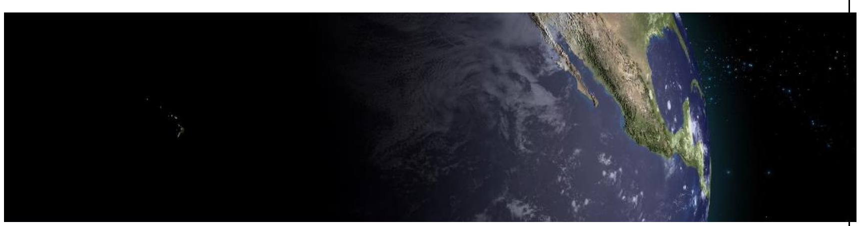
Independent Variables

In a 1×1 experimental design (groups assigned between either a focal or a global view of Earth) with repeated measures on the first variable, each participant received a control and counterbalanced condition. Participants completed a familiarization period in order to acclimate to the environment, and then one of two experimental conditions. That presentation order was consistent for the optimization of recall and the control of effect size from the magnitude of the viewing area. During the familiarization period, participants viewed a geometric shape moving distally with the same rate and direction and similar light contrast as was used in the experimental visuals. In experimental condition 1 (FOC), participants viewed an image of the earth moving distally, with a starting point near-earth and finishing with the entire globe in view from space (Figure 6). Specifically, participants' perspective began at UCF using satellite images perspective, and slowly withdrew from the earth, completing with a space-view of Earth. In experimental condition 2 (Global), participants viewed the earth from near-space, with the eastern hemisphere in partial view. This condition began with a near-space vantage and move outward to the same space-view of Earth as the first group. In both experimental conditions, the image moved at the same pace in both orbit and trajectory, and contained similar light/dark. All conditions lasted for 7 minutes each. All simulation conditions used original digital animation that incorporated actual satellite images with artistry. All imagery projected onto the VIPE.

FOC TIME= 0:06

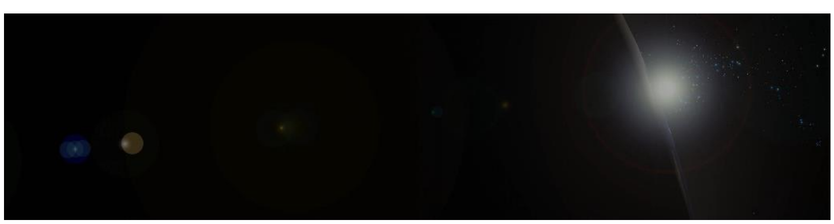
FOC TIME = 1:00

FOC TIME = 3:30



FOC TIME = 6:45

GLO TIME= 0:06



GLO TIME = 1:00

GLO TIME = 3:30

GLO TIME = 6:45

Figure 6. Panoramic images for space simulator

<u>Dependent Variables</u>

Measurements were collected through neurophysiological, psychological (i.e. surveys and questionnaires), and phenomenological sources. Dependent variables were measured along three disciplinary lines: Physiology, Psychology, and Phenomenology. A description of the interdisciplinary tools follows.

Neurophysiology

Neurophysiological measurements used multiple sources of input: Electroencephalography (EEG), electrocardiography (ECG), and functional near-infrared (fNIR). These tools provided high degrees of temporal sensitivity to change without interference with the first-person experiences during stimulus presentation. The B-Alert X10 wireless EEG (Figure 7) collected data from brain activity across nine channels, with sensors placed bihemispherically in frontal, parietal, and occipital lobes. Specifically, alpha, beta, and theta waves were recorded for EEG and Heart Rate Variability (HRV) and Interbeat Interval (IBI) were recorded for ECG.

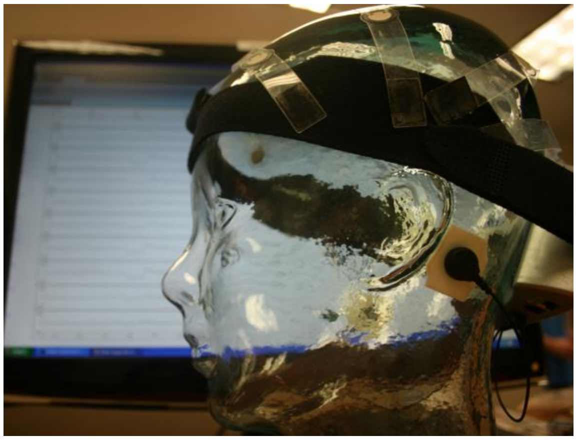


Figure 7. The B-Alert nine channel EEG.

The left and right hemisphere oxygenation was recorded using the Somantec INVOS oximeter (Figure 8).

Figure 8. fNIR display showing two-channel output.

Psychology

A variety of questionnaires from the psychology domain were used. At the beginning of the session, participants complete the Ishihara Color Blindness Test (Ishihara, 2010) to ensure typical color vision.

Prior to stimulus presentation, participants completed a computerized series of questionnaires. The questionnaires issued prior to the experimental conditions were selected to avoid priming and focused on personality traits pertinent to the present study. The Multiple Stimulus Types Ambiguity Tolerance scale (MSTAT; McClain, 2009) is a 22 item measure that determines an individuals' tolerance for ambiguity. The Tellegen Absorption Scale (TAS; Tellegen & Atkinson, 1974) is a 34-item instrument that measures participants' openness to absorbing self-altering experiences in seven scales: Responsiveness to Engaging Stimuli, Synesthesia, Enhanced Cognition, Oblivious/Dissociative Involvement, Vivid Reminiscence, and Enhanced Awareness.

After all conditions were presented, participants completed the Experiment-Specific Survey of Experience (ESSE), which is a demographic and experiential survey designed in-house to provide quantitative data of the first-person experience. This questionnaire was developed to provide additional quantitative support for the pertinent aesthetic and spiritual constructs specific to the present study. The ESSE was a computer administered questionnaire that asked explicitly about the hermeneutically-derived categories. The ESSE explicitly asked participants the degree to which they self-identify as a "spiritual person", "logical person", and "religious person." Then, participants were given the formal definitions (as described in Chapter One). They were asked to what extent they agreed with a statement such as "While viewing the presentation today, I experienced AWE." They indicated the degree to which they experienced

AWCH on a 100-point sliding Likert-scale. If participants indicated an experience greater than 10 (on the 100 scale), then they were issued an automatic follow-up regarding the time in the simulation when they experienced that category. For example, the prompt would read, “I experienced AWE the most when viewing: a) close images of the Earth (toward the beginning of the video); b) distant images of the Earth (toward the end of the video); c) the image of the geometric shape.

Finally, participants completed the Brief Multidimensional Measure of Religiousness/Spirituality (BMMRS; Idler et al., 2003), a 34-item measure that evaluates religiousness/spirituality in seven areas: Experiential Comforting Faith, Negative Religious Interaction, Personal Spirituality, Punishing God, Religious Community Support, Private Religious Practices, and Forgiveness. The BMMRS is a reverse-scored survey, and the categorical questions included items where the participant was asked to agree/disagree with statements about private religious practices (e.g. “Besides religious services, how often do you take part in other activities of a religious nature?”). Therefore, the higher score on the part of the awe experiencers indicates that they indicated lower levels of private religious practices. See Appendix B for a collection of all surveys and questionnaires used.

Phenomenology

A post-stimulus interview, based on Petitmengin (2010), was conducted to collect first-person recollections of the experience during the simulation. Immediately following the simulation, a research assistant interviewed the participant to collect the first-person experiential data.

Interviews

To support continuity, the research assistants responsible for conducting the neurophysiological and psychological aspects of the experiment also conducted the post-stimuli interview. Interviewers were trained to focus on descriptive terms and seek clarity of those terms. Researchers led the interviewee to avoid judgments and self-analysis, as the desired report did not concern their opinions of their experiences, rather descriptors of the experience. The research assistants used the phenomenological guide (Appendix C) to provide support during the interview. Interviewers listened to the experiential descriptions, and ask questions such as, "What did that feel like?" to elicit the category and orientation responses. When a participant indicated an experience, the interviewer would ask for more detail. These methods allowed the participants to describe all of the experiences in the simulation in detail and provided first-person qualitative data. A textual analysis method categorized expressions into abstract categories and orientation of experience.Participant responses were categorized according to the articulated experiences (spiritual, religious, aesthetic, AWCH). The groups were clustered by using the hermeneutic categories and subcategories of related constructs. For example, the group of awe experiencers would include those persons who explicitly used language including "awe" and those who experienced component subcategory constructs such as fascination, surprise, and overwhelm. To be clustered as a religious-experiencer, the participant needed to mention God or another distinctly religious construct explicitly while talking about the experience of viewing the experimental condition. For the other categories, participants expressed constructs listed in Appendix D.

Procedure

The inclusion criteria was provided to potential participants on Sona (the University of Central Florida's participant database) before a person registers for participation. Upon arrival participants were confirmed for meeting the inclusion criteria and read the consent form. Informed Consent was provided to the participants before neurophysiological sensors applied. A research assistant then equipped the participants with the neurophysiological sensors. The EEG cap with ECG electrodes were applied. Additionally, the research assistant fitted participants with fNIR sensors. Next, participants completed a five-minute resting baseline for the neurophysiological measures. This was required to calculate change scores for the neurophysiological measures during the scenarios. The baseline was conducted with eyes open, and participants were instructed to maintain a relaxed focus forward.

Participants completed the MSTAT, TAS and demographic questionnaires prior to the simulation. The participants observed two visual simulations. First, all participants completed a familiarization period to become acclimated to the simulation space. Then, an experimental condition was presented, counterbalanced from the two manipulations of imagery of earth.

Upon completed viewing of the specified visual display, the neurophysiological sensors were removed and a phenomenological interview was conducted to ask the participants about their experience during the simulation. The interview was audio recorded and saved for later transcription. The study was completed with participants answering the ESSE and BMMRS.

CHAPTER FOUR: RESULTS

After the data was collected, it was analyzed by methods from each contributing domain. The goal was to use the tools of the three main lenses to re-focus the results from a distinctly NP perspective (Figure 9). The results section is organized by these links. First the psychological surveys are connected to the neurophysiological findings. Then, the neurophysiological results are presented with the phenomenological findings. Finally, the phenomenological and psychological results are presented in light of one another. These dyadic connections allow for an integrated analytic method, appropriate to the form of NP engaged herein.

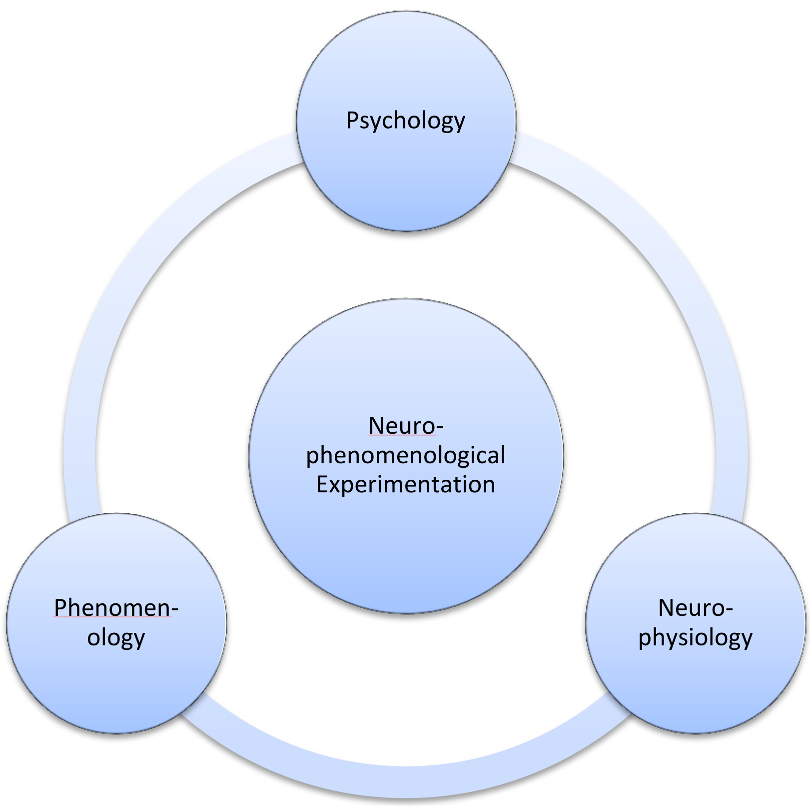


Figure 9. NP "lenses" focused both the collection and interpretation of data.

Psychological and Neurophysiological Results

The following section provides an overview of the experimental results regarding neurophysiological activity during the observation of the space simulation. First, analyses were conducted to examine the effect of the condition on neurophysiological behaviors over simulation time. This addresses the experimental manipulations. Then, the neurophysiology is compared to self-reports from the psychological metrics. These analyses address the questions of the nature and structure of experience, as posed by the neurophenomenological method, by using psychological reports to assist in the interpretation of the neurophysiological findings.

Condition by Minute for Hemisphere

A 2x7 (condition: focal and global by minute: 1-7 min of simulation viewing) mixed ANOVA with repeated measures on the last factor was conducted for each EEG hemisphere by frequency (alpha, beta, and theta) and for each fNIR hemisphere RO^2 to identify any physiological difference between conditions and processing requirements for the duration of the simulation. This will be used to consider the efficacy of the methodological changes. The results also help determine the impact of the visual stimuli on processing requirements and the influence of time on cognitive resource demands. Due to technical challenges, the sample size for EEG was 68 and for fNIR was 72.

First, the effect of condition by minute on left hemisphere was examined by frequency. For left hemisphere alpha, SPSS's Greenhouse-Geisser was applied to correct for violations of sphericity. The main effect for minute during simulation time was significant, F (3.634, 239.864), $p < .001$. The main effect for condition on left hemisphere alpha was not significant. The interaction for minute by condition was not significant. Data from the left hemisphere beta also showed a violation of sphericity and was corrected using SPSS's Greenhouse-Geisser. The main effect for minute during simulation time was not significant. However, the main effect of condition on left hemisphere beta was significant, F (1, 66), $p = .016$ and interaction for minute by condition was significant, F (3.560, 234.961), $p < .001$. The third frequency, theta, also demonstrated a need to correct sphericity. Consequently, degrees of freedom were corrected using SPSS's Greenhouse-Geisser estimate.No significance was found for main effect of minute, condition, nor interaction for minute by condition.

For the right hemisphere, the effect of condition by minute was also analyzed. Violation of sphericity was corrected using SPSS's Greenhouse-Geisser estimate. The main effect of minute during simulation time was significant, F (2.393, 157.965), $p < .001$. The main effect of condition on right hemisphere alpha was not significant. The interaction for minute by condition was not significant. For beta, sphericity was corrected using SPSS's Greenhouse-Geisser estimate. The main effect of minute during simulation time was not significant. The main effect of group on right hemisphere beta was not significant. In right hemisphere beta, the interaction for minute by condition was significant, F (3.560, 114.864), $p < .022$. For theta DFB, sphericity had been violated, therefore degrees of freedom were corrected using SPSS's Greenhouse-Geisser estimate ($\epsilon = .340$). The main effect of minute was not significant. The main effect of group on right hemisphere theta was not significant. The interaction for minute by condition was not significant.

For fNIR data, left frontal lobe data was corrected for violation of sphericity using SPSS's Greenhouse-Geisser estimate The main effect of minute during simulation time was significant, F (2.328, 153.627), $p = .006$. The main effect of group on left hemispheric oxygenation was not significant. The interaction for minute by condition was not significant.

Likewise, right frontal lobe data was corrected for spericity using SPSS's Greenhouse-Geisser estimate . The main effect of minute during simulation time was not significant. The main effect of group on right hemispheric oxygenation was not significant. The interaction for minute by condition was not significant.

To determine the condition and minute most influential to physiological experience, significant EEG results were further analyzed by post-hoc comparisons using one-way between subjects ANOVAs with Welch's F correction applied when needed to correct for non-homogeneity of variance. The following takes a closer look at alpha, beta, and theta by minutes one through seven.

EEG

EEG data was reported as difference from baseline (DFB), unless otherwise noted.

Left Hemisphere

The left hemisphere alpha differences between the FOC and GLO conditions were significant during the second minute F (1, 67) = 4.423, p = .039; FOC (M= -8006.92) < GLO (M= -4997.41). Significant differences were also recorded during the seventh minute: F (1, 66) =4.040, p = .049; FOC (M= -6458.06) < GLO (M= -3731.10). No other minutes were significantly different between conditions for alpha left hemisphere.

During the second, third, and seventh minutes, there was a significant effect of condition presentation on left hemisphere beta. Left hemisphere beta during minute two was significantly different between conditions, F (1, 67) = 18.639, p .001; FOC (M= -1342.86) < GLO (M= 388.10). A difference was found in this region during the third minute, F (1, 67) = 14.238, p = .035; FOC (M = -755.83) < GLO (M = -133.070) and seventh minute F (1, 67) = 6.368, p = .014;

FOC (M = -914.825) < GLO (M = -184.498). No significant differences were found for minutes one, four, five, and six.

No significant differences were reported between conditions by minute for the left hemisphere theta.

Right Hemisphere

No significant differences were reported between conditions by minute for the right hemisphere alpha.

Significant differences between conditions by minute for the right hemisphere beta were found for minutes two and three. In minute two, the difference was significant F (1, 67) = 17.245; p < .001; FOC (M = -1128.564) < GLO (M = 623.349) and minute three F (1, 67) = 5.647; p = .020; FOC (M = -609.296) < GLO (M =103.237). No other minutes showed significant differences between conditions for right hemisphere beta.

No significant differences were recorded between conditions by minute for the right hemisphere theta.

Condition by Psychological Self-Reports

Between groups (condition: FOC and GLO) ANOVAs were run to determine if the visuals of the condition had an impact on spiritual and aesthetic reports. This was an important analysis to run because modifications in the methodology from the baseline experiment suggested that earth views were more engaging and elicited greater affective responses. Therefore, this analysis helps determine the role of the image of earth itself in eliciting these responses. No significant effects were found for the ESSE metrics on self-identification as “spiritual person,” “logical person,” “religious person,” or “reflective person.” AWCH also had no significant differences by group. There was no significant difference reported for familiarity.

Hemispheric Behavior by Psychological Reports

As the driving questions for the present study focus on the nature and structure of aesthetic and spiritual experiences, including AWCH, and because no significant effect on the elicitation of those experiences were found from the conditions as reported on the ESSE, it is important to examine other influences. Therefore, the following analyses collapsed across both conditions to understand the relation between time, physiological response, and reported experience. This extends the assertion from the baseline study that time is a factor in having aesthetic and spiritual experiences.

Correlations were run between self-identified spiritual, religious, and logical persons to check for construct independence to better understand the difference, or lack thereof. These correlations will also become important later in discussing the phenomenological interviews.

Participants who self-identified as “spiritual” also identified themselves as “religious” at a significant level ($r = .764$, $p < .001$). They also significantly indicated experiencing wonder ($r = .253$, $p = .037$), but there was no significant correlation with the awe, curiosity, or humility.

Self-identification as “spiritual” (**Error! Reference source not found.**) correlated with FB changes in theta activity in the left hemisphere during the second minute ($r = .259$, $p = .033$) and the sixth minute ($r = .264$, $p = .029$). Theta differences from baseline were correlated in the right hemisphere for the “spiritual” participants. Significant correlations were recorded for the second minute ($r = .334$, $p = .005$), fifth minute ($r = .282$, $p = .020$), sixth minute ($r = .267$, $p = .028$), and the seventh ($r = .291$, $p = .016$).

The self-identification of “religious” correlated with awe ($r = .290$, $p = .016$), but not wonder, curiosity, or humility.

"Religious" self-identification correlated significantly with theta changes in the left hemisphere during the fourth minute (*r* = .242, *p* = .047), fifth minute (*r* = .281, *p* = .020), sixth minute (*r* = .320, *p* = .008), and seventh minute (*r* = .257, *p* = .034). In the right hemisphere, there were significant correlations with alpha DFB during the first minute, (*r* = .246, *p* = .043) and second minute (*r* = .252, *p* = .038). There were also significant correlations between self-identification as "religious" and right hemisphere theta changes during the second minute (*r* = .298, *p* = .013), fifth minute (*r* = .282, *p* = .020), sixth minute (*r* = .277, *p* = .022) and seventh minute (*r* = .269, *p* = .027).

Like "religious", self-identification as "logical" correlated significantly with the survey-reported experience of awe (*r* = .267, *p* = .028). "Logical" (**Error! Reference source not ound.**) also had a significant correlation with reported indications of familiarity (*r* = -.328, *p* = .006), whereas "spiritual" and "religious" did not. It also had a negative correlation with right hemisphere theta (*r* = -.249, *p* = .040).

Visual Process Analysis Using Psychological Survey and Neurophysiology

To demonstrate the potential improvements in the methodology, specifically the intersection of visual stimuli with time in the simulation, descriptive visualization of the ESSE data and distance from earth (associated with time in the simulation) are provided.

The baseline demonstrated that a mixed-reality environment could elicit spiritual and aesthetic experiences. The present study, in response to the second "lesson learned" (see Chapter Two), reduced the sensory variables to only a visual stimulus. Consequently, it was critical to re-establish the capacity of the new simulation to trigger experiences, like AWCH. The data collected in the present study confirmed that participants did experience AWCH, although they did not report significantly different degrees of these experiences on the ESSE. Of the total sample (n = 74, male = 39, female = 35), reports from the ESSE indicated awe experiencers = 70, wonder experiencers = 72, curiosity experiencers = 74, and humility experiencers = 62.

Like the baseline, the present simulation did elicit AWCH, however, the between-subjects design demanded consideration of the influences of the simulation timeline on the outcome. Because the central interest of the present study is experience and because the experimental conditions and the familiarization period occurred prior to the phenomenological interview, it was important to consider the elicitation of AWCH along the simulation timeline. The following descriptive data provides details regarding the role of simulation time on reported experience, because physiological results, when compared by group, must be understood in the context of *what* is being seen at any given moment.

The results indicated that awe (Figure 10) and wonder (**Error! Reference source not found.**) emerge with a more distal view of the earth.

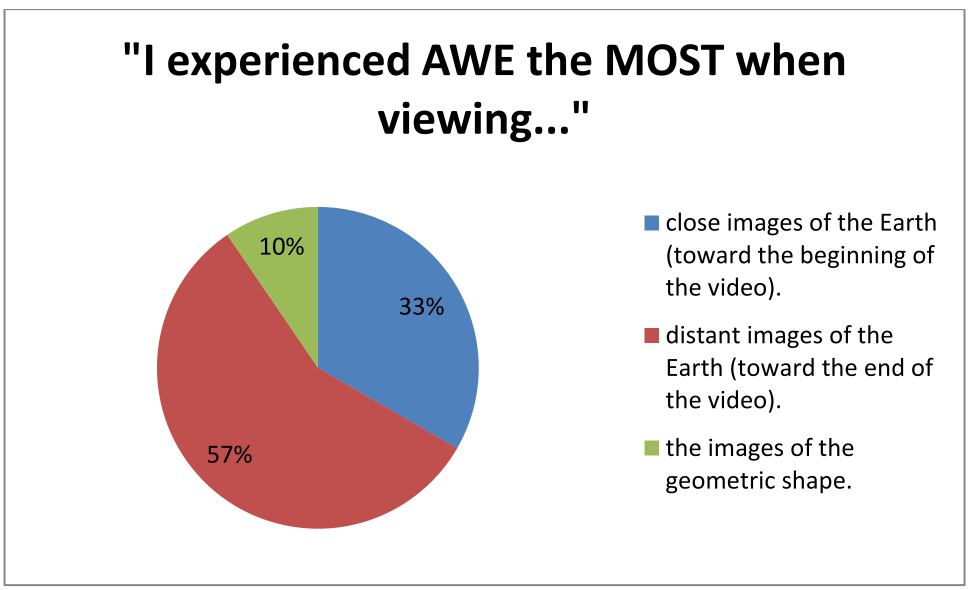


Figure 10. Simulation time for experience of awe.

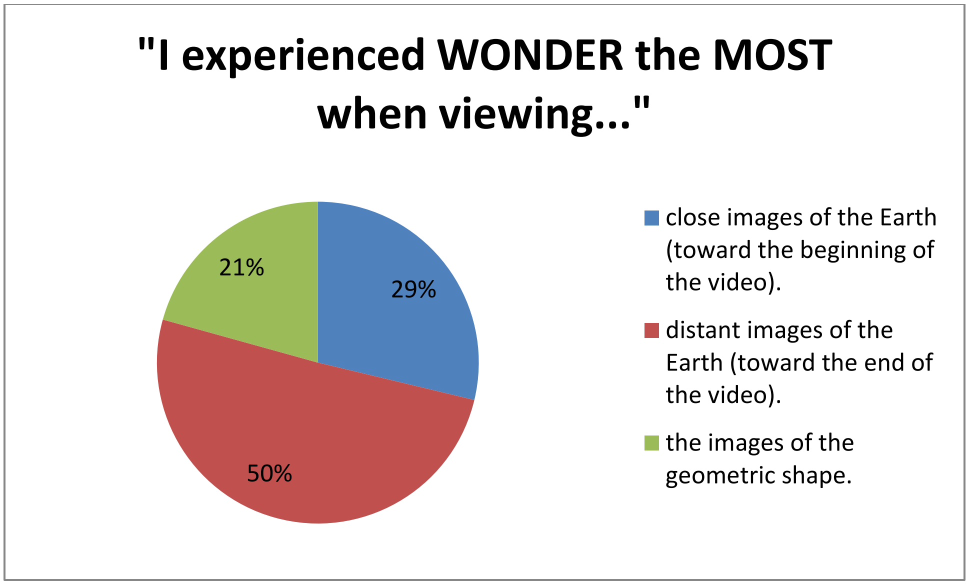


Figure 11. Simulation time for experience of wonder.

Curiosity, however related less to the vantage of the earth, with a similar number of participants falling into each category (Figure 12). Every single participant, regardless of group, reported experiencing curiosity. This was the only category from the core AWCH categories that was unanimously reported through the psychological survey.

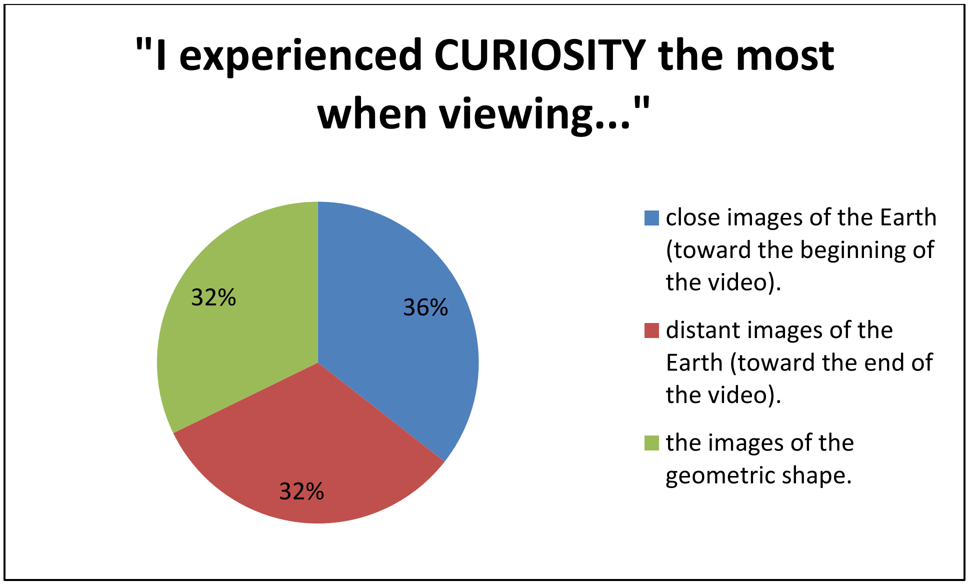


Figure 12. Simulation time for experience of curiosity.

Humility had the highest percentage of participants in agreement as to its elicitation along the simulation timeline (Figure 13). Participants were very unlikely to report that they had experienced it while viewing the control condition and most reported experiencing it when viewing the earth from afar, regardless of experimental condition.

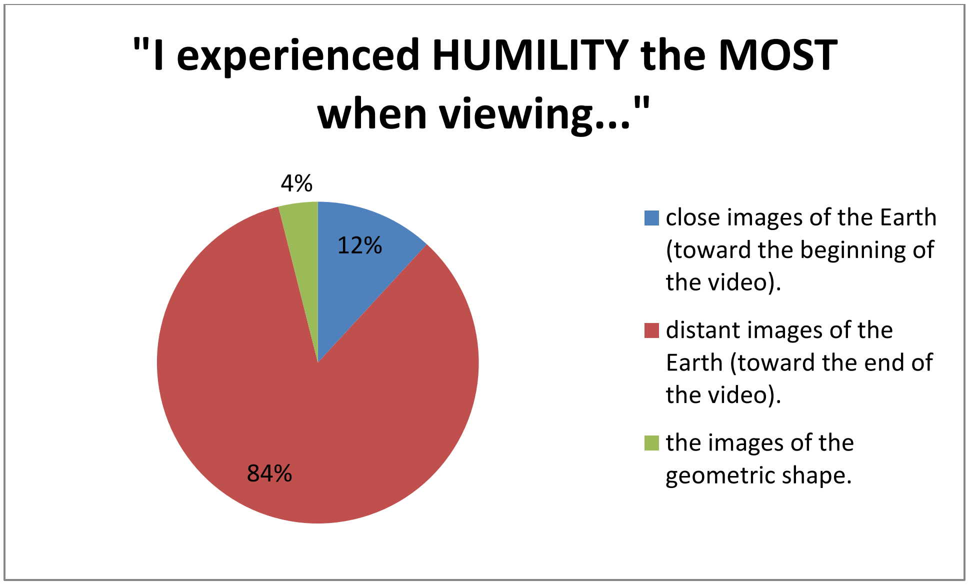


Figure 13. Simulation time for experience of humility.

To deliver a more cohesive account of experience (one that merges physiological and psychological data), correlations were conducted to capture aspects of the relationship between visual processing and first-person reports in the ESSE. This is different from the above LH and RH analyses. As the stimulus was exclusively visual, the researchers also analyzed areas involved in the processing of visual information, specifically the posterior parietal and anterior occipital lobes as collected from the P3, P4, and POz EEG sensors.

Participant self-identification as “spiritual” in the ESSE correlated with changes in alpha during the first minute (r = .244, p = .045), second minute (r = .280, p = .021), sixth minute (r = .267, p = .028) and seventh minute (r = .330, p = .006). Changes from baseline in theta also significantly correlated with “spiritual” self-identification for the second minute (r = .319, p = .008), fifth minute (r = .315, p = .009), sixth minute (r = .267, p = .028), and seventh minute (r = .282, p = .020). There were no significant correlations for any beta signals in this region with “spiritual” self-identification.

Participant self-identification as "religious" in the ESSE correlated with alpha in the posterior parietal and anterior occipital lobes during the first minute ($r = .245$, $p = .044$) and second minute ($r = .249$, $p = .040$). Beta changes correlated with this category during the seventh minute ($r = .277$, $p = .022$). Significant correlations also were found in this region between "religious persons" and those who did not self-identify as "religious" for theta DFB during the fifth minute ($r = .291$, $p = .016$) and seventh minute ($r = .270$, $p = .026$).

Self-identification as "logical" in the ESSE negatively correlated with DFB alpha for this region during the seventh minute ($r = -.241$, $p = .048$). There was also a negative correlation with the last two minutes in theta change: sixth minute ($r = -.262$, $p = .031$) and seventh minute ($r = -.288$, $p = .017$). There was no significance found for a relationship with alpha in the posterior parietal and anterior occipital lobes and "logical" self-identification.

Neurophysiological and Phenomenological Results

Value of Individual Differences

The following results draw from the methodological practices of using individual differences to examine phenomena, while also integrating the phenomenological analyses. They are examples in the tradition of case studies and necessarily cannot be extended as generalizable to the whole population, but that is not the goal in this form of analysis. Rather, this technique allows for researchers to take seriously individual experiences as evident in the interview. To do this, participant interviews were analyzed, using the categories from the aforementioned hermeneutic analyses. These analyses revealed that some participants had articulated various degrees of spiritual and aesthetic experience.

High AWCH Experience vs. No AWCH, Examples

Participant 14 (P14), a twenty-years-old female in the FOC group, expressed levels of experience in multiple hermeneutic categories including awe, contentment (e.g. tranquility, relaxation), overwhelmed, perspectival change, bodily sensations of floating, and scale effects (e.g. vastness of universe, feeling of smallness within the vast). During the interview process, the interviewers employed reflective language and open-ended questions that avoided the prompting and biasing of participants from using vocabulary from any of the spiritual and aesthetic categories. The following interview excerpts provide examples of these expressions:

"I think it was centered in on UCF and it comes out...and... I kind of like that feeling that it makes, I guess…. I don't know, I just like the way you feel when you feel like you are floating …I'm comparing the earth to the stars, like what we see from earth type of thing. Um…and how we are just this little planet around all these stars, like it's weird to me…I guess just like how small the earth is compared to everything in the universe. I guess I was also thinking of like how different it looks looking into Earth compared to being on Earth and looking up…just kind of uh, overwhelming, I guess...Cause it's, I don't know how exactly to describe it, it was just kind of surreal I guess how small earth is compared to everything else… The main thing that I was focusing on is, to me being on Earth it seems so big, but when you are really looking at Earth it's just, it's really small so it um…it was just kind of like a "awe" moment type of thing…how small the earth really is and how I think everything is so big and important when really we're like the small little planet."

Participant 44 (P44), a nineteen-years-old female in the FOC condition, also indicated spiritual and aesthetic experiences during her interview. Her articulations included indications of all four AWCH, in addition to various related categories in spiritual, religious, and aesthetic experience.

"I was enjoying the different colors... like each star had like a different color, some were blue and some were like a white color. Then I noticed some of the other blue ones were moving...I just thought that they were really pretty and that, um, I kind of... I guess I wondered if those were real stars or if they were, um, just kind of a picture. I actually thought about the Hubbell telescope once and wondered if this was like a real picture from like the Hubbell telescope?...I guess I was wondering where... what was taking this picture and, like making the formation.

"It's kind of interesting to see because obviously you don't get that experience often because you're on Earth and so you're looking at Earth from being on Earth and walking around on it, but you don't really get that experience of looking down on it because very few people actually get to go into space so...

"It's almost overwhelming to just see everything you're experiencing, the stars and the water and the different continents all at once, and so just looking... you're looking at pictures and saying, oh, this is China and, oh, this is what the sun looks like, and so instead you see like all of it all at once and you think, oh, this is what everything looks like put together…

"… I guess when you see like a really pretty part of nature, like a waterfall or something. I guess, um, I kind of connect it to religion. I'm a Christian so I kind of connect it to God and how He's created these different places and He created the beauty, I guess, in your surroundings and stuff and there's just kind of a different perspective on the beauty that He's created, in my opinion…Um, I feel like for a split second I thought of, this must be like what God sees when He looks down on Earth, but I don't think I... I didn't linger on the God aspect of it, no.

"…when everything is changing so quickly, you have so many thoughts all at once and you're kind of thinking about everything and you kind of, in a way, you get over...you get overwhelmed with thoughts, but then at the end when nothing's...everything's pretty much the same and it's just now zooming out, you just kind of relax and you just take in the full picture instead of just little things at once."

Not every participant shared these experiences. For example, participant 64 (P64), a twenty-years-old male in the FOC condition, reported nothing that the reviewers could categorize into any of the determined hermeneutic categories. The same held for participant 65 (P65), a twenty-years-old female who also indicated no spiritual, religious, or aesthetic experience. Such a high discrepancy in the reports could be dismissed as purely behavioral (i.e. the "non-experiencers" could not or would not report unique experience), but the physiological results should be similar as those from the participants. This is a question for individual differences. The following graphs provide comparisons between the example "experiencers" and "non-experiencers." Each graph represents the participant EEG DFB in average power spectral density (PSD) shown over the one-minute simulation time blocks. The power spectrum refers to the frequency and amplitude of each signal.

The frontal EEG sensors collected readings from the alpha, beta, and theta wavelengths. In frontal alpha (Figure 14), the experiencers (P14 & P44) showed greater suppression of frontal alpha than the non-experiencers (P64 & P65) did. The experiencers were both below the mean for frontal lobe DFB, whereas the non-experiencers had higher frontal alpha. The alpha readings were less distinct by experience over the central region (Figure 15). Alpha oscillations in the posterior regions (Figure 16) followed a similar pattern to those recorded from the frontal sensors, with the experiencers showing consistently lower alpha in the occipital/parietal areas.

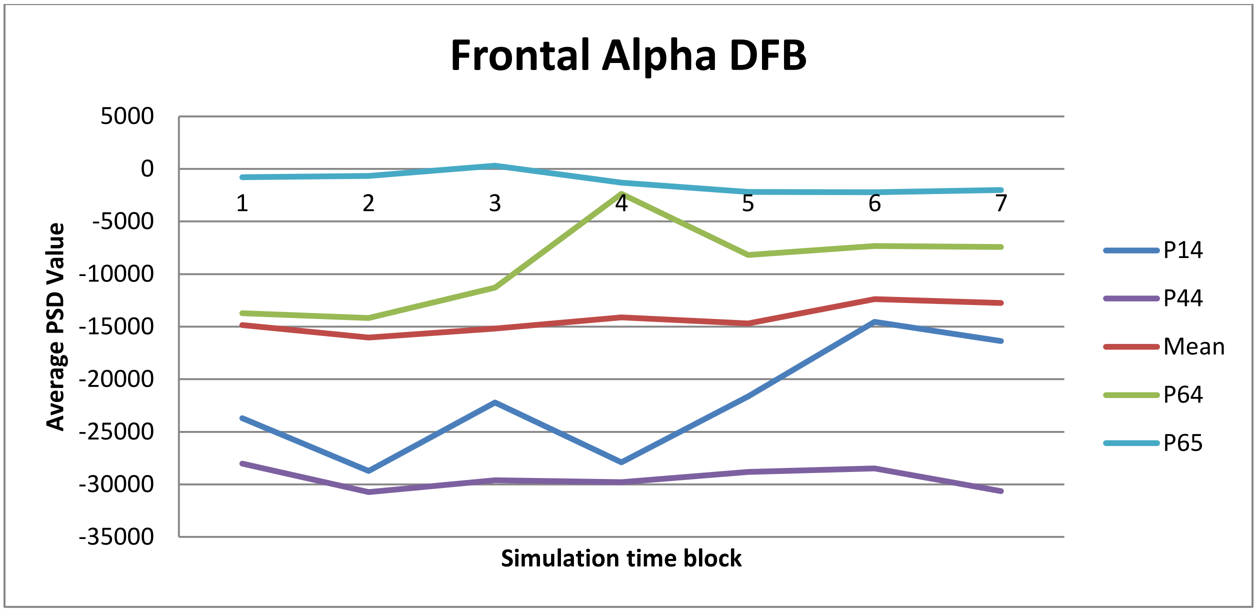


Figure 14. Individual differences examples for EEG frontal alpha.

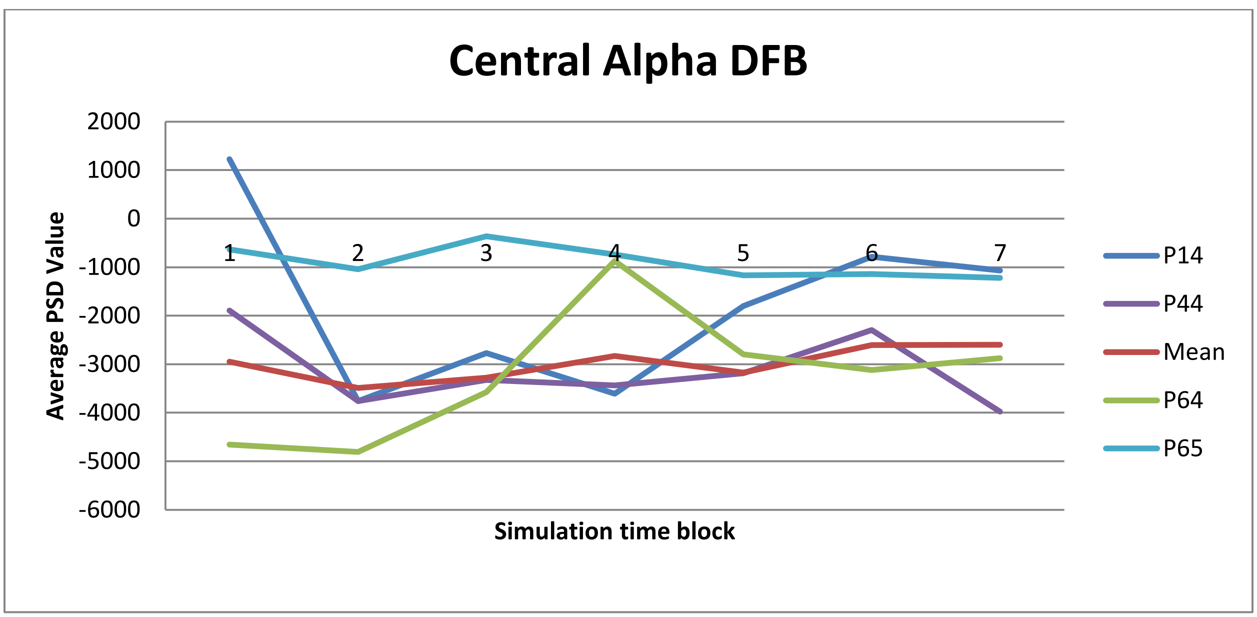


Figure 15. Individual differences for EEG central alpha.

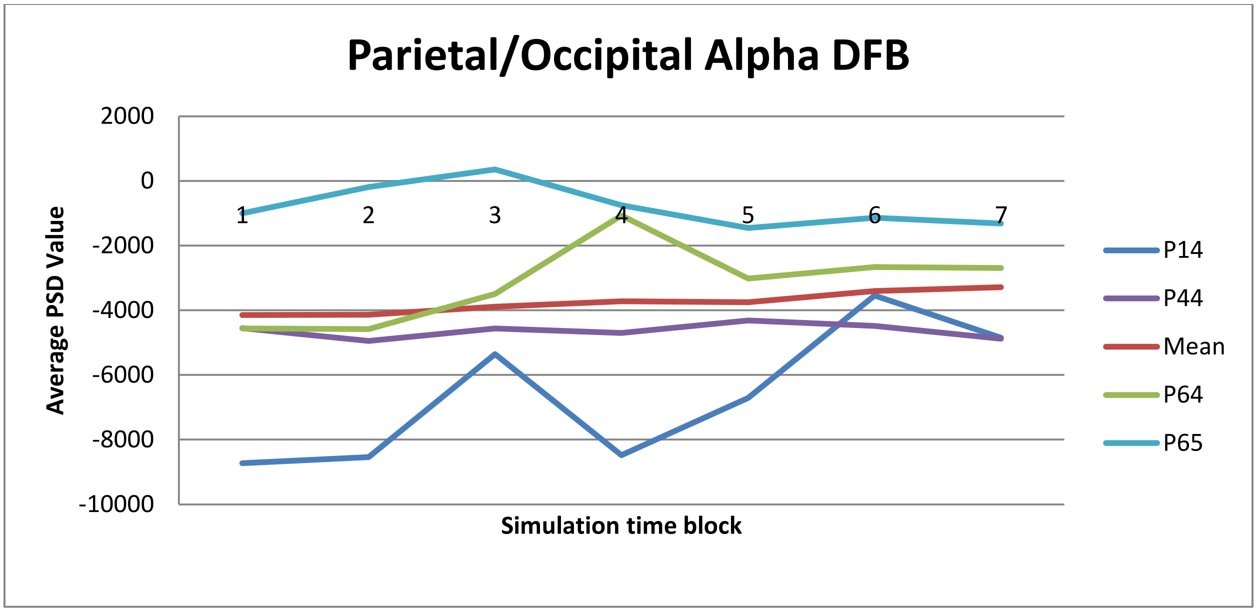


Figure 16. Individual differences for EEG parietal/occipital alpha.

The alpha findings were similar when analyzed by hemisphere. Alpha in the left and right hemispheres was above the mean (and closer to baseline) for the non-experiencers and below the mean for the experiencers. Of note were P65, whose alpha readings by hemisphere were statistically even with the baseline and P44 whose alpha stayed consistently below the baseline and mean by hemisphere. For the left hemisphere (Figure 17), P65 (*M* = 421.65) stayed statistically even with her baseline, whereas P44 (*M* = - 22,026.54) was below both her own baseline and the population mean (*M* = -7,748.91; *SD* = -11,515.40). Similar results were found in the right hemisphere (Figure 18), where P65 (*M* = -115.58) stayed statistically even with her baseline, whereas P44 (*M* = - 11,653.96) was below both her own baseline and the population mean (*M* = -5794.17; *SD* = -10,331.16).

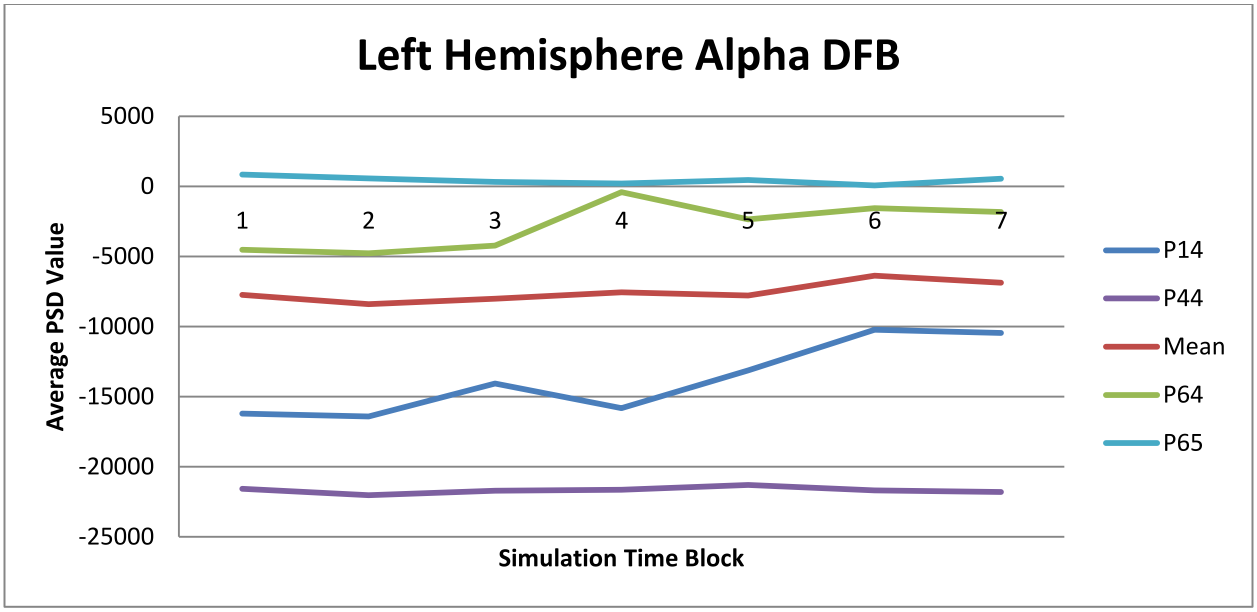


Figure 17. Individual differences for EEG left hemisphere alpha.

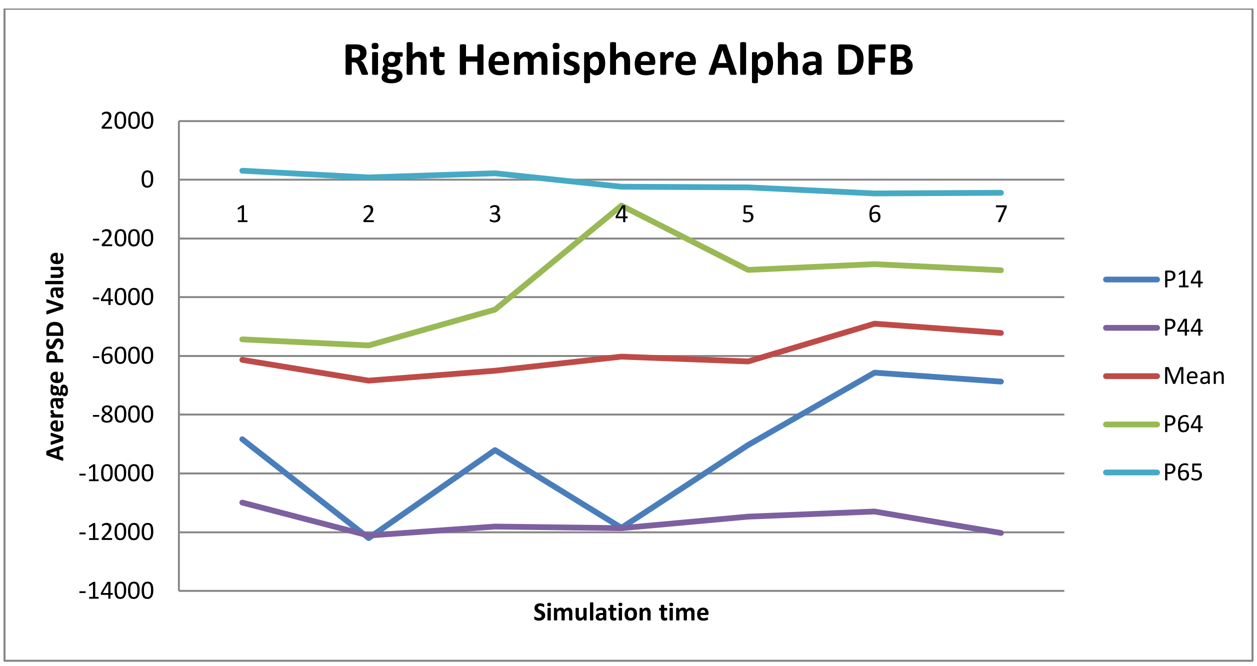


Figure 18. Individual differences for EEG right hemisphere alpha.

For the beta and theta wavelengths, the differences from baseline were not as ordered, with these experiencers and non-experiencers showing no significant difference or consistency across sides of the mean. These results suggest the functional utility of phenomenological data from the interviews in exploring individual differences for "experiencers" and "non-experiencers."

It should be noted that this alpha pattern was not found in all participants who reported AWCH experiences. For example, P27 articulated experiences of AWCH, yet alpha DFB (left hemisphere $M = -6616.48$) was close to the population mean ($M = -7355.37$, $SD = 11460.96$) throughout the simulation. Inversely, P4 displayed alpha-suppression ($M = -26699.76$), yet did not explicitly articulate AWCH experiences. P4 did indicate in the ESSE that he experienced wonder, curiosity, and humility, each at 50 points on the 100 point scale. He also indicated on the ESSE that the simulation felt familiar (90 out of 100) and self-identified as a "reflective person" (60 out of 100) and "logical person" (100 out of 100). The Discussion chapter of the present work will explore possible explanations for these discrepancies.

Phenomenological and Psychological Results

The broad categories of "experiencer" and "non-experiencer" helped identify participants for individual difference analyses. However, the phenomenological categories also lend themselves to a refined analysis of the psychological data. Researchers conducted independent samples t-tests comparing experiencers or non-experiences of hermeneutic categories (AWCH, spiritual, religious, and aesthetic) with the responses to the psychological surveys. In other words, individuals were grouped as experiencers or non-experiences for each hermeneutical category based on the interview analysis. That grouping then served as a new independent variable to determine whether being an experiencer or not for each category leads to a difference in reporting the experience within the scales of the ESSE, TAS, or BMMRS. This comparison helps to identify relationships between the phenomenological data and the, psychological data, thereby contributing both to the understanding of the constructs AWCH and the validation of the methodological changes from the baseline study.

Spiritual, Religious, and Aesthetic experiences

Participants who, during the phenomenological interview, articulated simulation-time experiences that were spiritual in nature were significantly less likely to describe themselves as "logical" in the ESSE; $t(44.759) = 3.435$, $p = .001$; spiritual-experiencers ($n = 45$, $M = 72.13$, $SE = 3.292$) < non-experiencers ($n = 16$, $M = 88.13$, $SE = 3.291$). There were no significant findings between the logical category and any of the other psychological metrics from the ESSE, TAS, or BMMRS.

Due to the rigorous categorical limitations, religious-experiencers occurred less frequently than spiritual-experiencers, but when they did, these participants were less likely to self-report being a "reflective person" in the ESSE; $t(27.161) = -2.773$, $p = .010$; religious-experiencers ($n = 6$, $M = 84.67$, $SE = 2.472$),< non-experiencers ($n = 55$, $M = 73.64$, $SE = 3.116$). These participants reported higher levels of curiosity in response to the stimuli; t (11.581) = -2.871, $p = .015$, religious-experiencers ($M = 89.17$, $SE = 4.167$),> non-experiencers ($M = 74.31$, $SE = 3.069$). Participants who described their experiences in religious terms had higher rates of negative religious interactions in the BMMRS (Idler et al., 2003) than their counterparts who did not use religious language during the interviews; $t(21.423) = -2.486$, $p = .021$; religious-experiencers ($M = 7.83$, SE = .167),< non-experiencers ($M = 7.22$, $SE = .183$).

Aesthetic-experiencers spoke of their experiences while viewing Earth in terms of the sublime, sensations, and pleasure. However, these participants scored significantly lower in the “sensory perceptual absorption” category of the TAS (Tellegen & Atkinson, 1974); $t(59) = 2.292$, $p = .025$; aesthetic-experiencers ($n = 37$, $M = 14.38$, $SE = .407$), < non-experiencers ($n = 24$, $M = 15.83$, $SE = .477$). There were no other significant results of the t-tests for aesthetic experience.

AWCH

After the phenomenological interview, participants who had expressed experiences of awe while viewing the experimental condition were categorized as “awe-experiencers” ($n = 39$) or non-experiencers ($n = 22$). The participants who expressed an experience of awe during the phenomenological interview were significantly more likely to have reported awe in their psychological surveys as well, t (34.018) = -2.374, $p = .023$; Awe experiencers ($M = 19.69$, $SE = 3.626$) < non-experiencers ($M = 20.91$, $SE = 6.564$). While there was no significant relationship to wonder and curiosity, participants who expressed awe reported greater levels of humility in their psychological surveys; t (39.00) = -2.356, $p = .024$; awe experiencers ($M = 63.74$, $SE = 4.843$) < non- experiencers ($M = 42.95$, $SE = 7.377$).

Participants who articulated awe during their interviews also had higher scores in “private religious practice” in the BMMRS (Idler et al., 2003); t (27.808) = -2.061, $p = .049$; awe experiencers ($M = 21.77$, $SE = .514$), > non-experiencers ($M = 18.91$, $SE = 1.289$). No other area on the BMMRS showed significance with the interview expressions of awe.

Participants who expressed experiences of awe in the phenomenological interview also scored significantly lower in the “sensory perceptual absorption” category of the TAS (Tellegen & Atkinson, 1974); $t(47.350) = 2.767$, $p = .008$; awe experiencers ($M = 14.33$, $SE = .477$) < non-experiencers ($M = 16.05$, $SE = .395$). The awe-experiencing participants were more likely to answer “false” to questions like, “Textures- such as wool, sand, and wood- sometimes remind me of colors and music,” and “The crackle and flames of wood fire stimulate my imagination.”

Participants who expressed wonder (n = 26) to their interviewers reported higher levels of awe in the ESSE; t (58.910) = -2.022, p = .048; wonder-experiencers (M = 67.88, SE = 4.382), > non-experiencers (n = 35, M = 54.57, SE = .4.913). There was no significance found when comparing the groups to reports of wonder, curiosity, and humility in the ESSE, nor any of the other psychometrics.

There was no significance found comparing the phenomenological articulations of curiosity and any of the psychometric results.

Like the experiencers of awe, humility-experiencers (n = 26) scored lower in the TAS (Tellegen & Atkinson, 1974) category of “sensory perceptual absorption” than non-experiencers (n=35); t(59) = 2.562, p = .013; humility-experiencers (M = 14.04, SE = .442), < non-experiencers (M = 15.63, SE = .422). There was no significance found across the other psychometric categories.

CHAPTER FIVE: DISCUSSION

The present work is framed in a challenge to improve upon the methods employed by the baseline experiment. In this framework, the following discussion will examine the experimental results from the present study in light of the findings from the baseline.

To begin piecing together the relationships between the psychological findings of experience and the physiological behaviors, the results of the survey need to be compared to the EEG and fNIR data. To look at this relationship between the body and the psychological reports, an analysis of variance was conducted to look for physiological differences between the FOC and GLO conditions. This was to examine the effect of the condition category on the physiological behaviors. Then, the physiological results were correlated with experiential indicators in the ESSE.

The data from the two experiments suggests a complicated interplay of body and world in the generation and articulation of experience and these suggestions indicate aspects of the nature and structure of experience. The methodological approach applied herein created a picture of experience that integrates memory, perception, consciousness, and executive function (Table 2).

Table 2. Influences on experience.

Categorical influence	Supporting results
Memory	Cortical responses to context manipulation are evident in simulation time and create significant differences when viewing similar stimuli.
Perception	Differences in self-identification as a logical or spiritual person are evident in visual processing of simulation to opposing degrees of significance.
Consciousness	Some participants with greater alpha suppression DFBs articulated more spiritual and aesthetic experiences, likely due to more cortical interaction, than those with DFBs closer to their baseline values. Further, results suggest different biological mechanisms may be responsible for the complex manifestations of experience.
Executive Function	Working memory and attention while viewing Earth are suggested from frontal lobe behaviors during simulation time.

The following sections aim to piece together the roles of memory, perception, consciousness, and executive function. As these relationships are considered, the influence of perception (both visual perception of the world and the internal perception of the self) are considered in respect to their influences on experience. First, results connecting visual perception and context are discussed. This leads into the self-identification indicators and the influence of self-perception on experience. Then, the results are considered for their contributions to moving forward in the larger neurophenomenological project by directing the field toward a clearer picture of the nature and structure of experience. Lastly, one final look at the experimental hypotheses will lead to the closing of the discussion including inferences from comparing the present and baseline experiments.

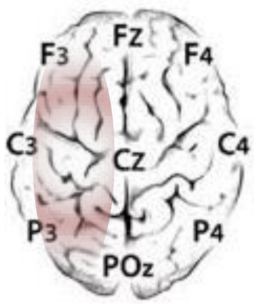
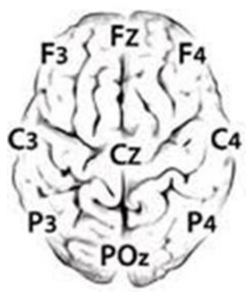
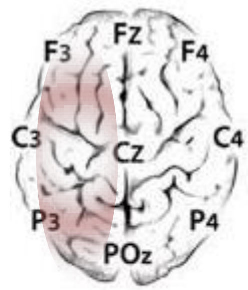
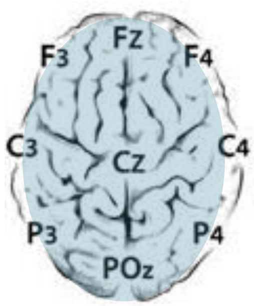
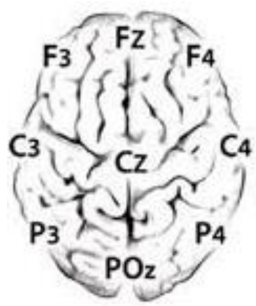
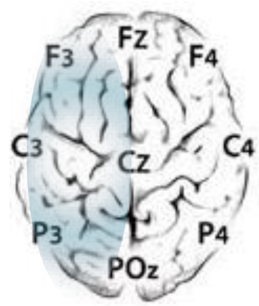
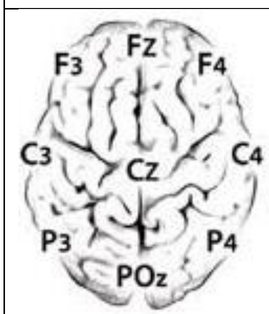
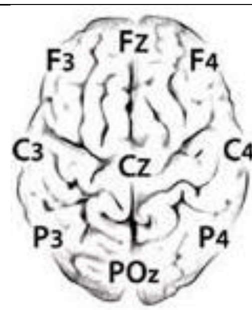
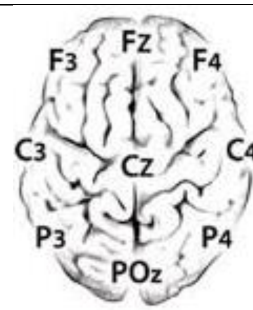
Perceiving Context, Experiencing World

Methodological adjustments from the baseline study culminated in a more tightly-controlled experiment with an emphasis on the role that visual stimulus plays in experience. The visual manipulation implicated context, attempting to elicit different experiences by controlling for a sense of location prior to the distant view of Earth. In the following section, the results are interpreted with the aim of merging the physiological, psychological, and phenomenological data to provide a clearer sense of the relationship between viewing Earth from space and spiritual constructs in articulated experience.

To begin, the timeline plays an important role. While the proximal vantages of the earth in the GLO condition are the more distal vantages in the FOC condition, there was no statistically significant difference between groups for their ESSE experiential indications. Participants reported experiencing awe, wonder, and humility at later points in the simulation. Curiosity showed the least context-dependence, being implicated in relatively proportionate degrees during the acclimation and experimental times.

The EEG results indicated that there was a difference for participants who began their simulation with a near-earth focal vantage and those who started the simulation with a broader view of the globe. To interpret these findings, each brainwave category (alpha, beta, and theta) will be discussed in light of the difference in the simulation context cues (Table 3).

Table 3. Summary of significant EEG findings for FOC and GLO conditions during the observation of the earth for a simulated space perspective. Artist representations of the involved regions are included to represent the cortical regions that showed significance

Time Segment 1	Time Segment 2	Time Segment 3	Observation
 **Alpha**	 Alpha	 Alpha	Both groups experienced decreases in alpha, but the FOC group had a greater decrease during the second and seventh minutes.
 **Beta**	 Beta	 Beta	While beta decreased globally for the recipients of the FOC condition, beta increased for GLO during the first time segment. There was no difference during the middle portion of the simulation. Both groups experienced drops in beta activity in the seventh minute, with the FOC decreasing significantly more in the left hemisphere.
 **Theta**	 Theta	 Theta	Theta signals were not significantly different by condition group.

With left hemispheric EEG significance captured at various times and across both alpha and beta frequencies, a discussion regarding the role of the manipulation should start with consideration of the left hemisphere itself. First, the left hemisphere refers to multiple regions of the brain left of the lateral fissure that are associated with a broad range of functions. The most useful approach, then, is to consider the functional associations most relevant to the work at hand. Perhaps, the most well-known contribution of the left hemisphere is its functional role in language (Vigneau et al., 2006). Both Wernike's and Broca's areas are located in the left hemisphere, associated with both receptive and expressive language function in approximately 90% of all right-handed persons (Purves, 2008). Consequently, future studies ought to consider the role of the left-hemisphere during the encoding of experience and its subsequent role in the articulation of experience. From the theoretical vantage, this contributes to a picture of experience that is coupled to language, as one may experience in a manner that prepares for the later articulation of that experience.

In addition to showing hemispheric shifts, Table 6 also presents the time segments by specific frequencies. It is useful to consider what might be implied by these differences.

Alpha activity has been associated with a broad spectrum of conscious cortical activity, so there are numerous ways to explain the significance found along this bandwidth. The following aims to disentangle some likely explanatory candidates.

Traditionally, alpha has been observed in "cortical idle" (Pfurtscheller & Lopes da Silva, 1999), meaning alpha activity oscillates during alert awake states when one is not engaged in a task. In terms of the contextual change in conditions, the greater change of left hemisphere alpha in the FOC group suggests integration of context and perception. The vehicle for the contextual integration may be a combination of lexical and embodied factors. Changes in alpha signal in the left hemisphere (Weems, Zaidel, Berman, & Mandelkern, 2004) have been associated with lexical retrieval. During the phenomenological interviews, participants recalled engaging in impromptu “gamification” of the stimuli while viewing the simulation, which may have been connected to lexical retrieval. The participants described trying to remember the names of landforms and bodies of water as the earth rotated. The alpha levels in the FOC group may also be explained in relationship to unpleasant visual movement (i.e. the rotation and lift simulated as the vantage moved from the earth to space) (de Toffol, Autret, Degiovanni, & Roux, 1990).

Viewing negative stimuli can also cause a depression in alpha (Makarchouk, Maksimovich, Kravchenko, & Kryzhanovskii, 2011), possibly linked to limbic response. There was a drop in both groups, with a greater drop in FOC, potentially indicating an unpleasant affective response to the grounding of the experiential context to the local campus starting point. The early presence of this effect may be attributed to the sense of dizziness that some participants reported when the simulation moved quickly over land. However, the discrepancy also appeared at the end of the experiment, when the visual stimuli were quite similar. Participants were not informed how long the simulation would last. In another interpretation, alpha differences at the beginning and end of the simulation may be related to changes in lateral gaze as the simulation moved from a full screen image to focus in the center of the visual field (de Toffol, Autret, Degiovanni, & Roux, 1990). A final interpretation of these findings would be that the changes in alpha indicate shifts of task attention (Bonnefond & Jensen, 2012). In consideration of the role of context, the view of the campus may have helped the FOC group generate and maintain attention. This interpretation has important implications for research in vigilance work, as introducing contextual grounding into vigilance tasks may increase neurological attentive behaviors.

Global beta changes have been implicated in suppression of motor activity (Pogosyan, Gaynor, Eusebio, & Brown, 2009). GLO participants had a significantly higher beta at both the beginning and the end of the simulation experience. GLO participants may have experienced a reduction of motor response while viewing the condition, perhaps due to fewer physical affordances within the stimulus compared to the near-earth vantage of the FOC condition. The significant differences during the final minutes of the simulation are important. By the end of the simulation, the participants are viewing similar images with similar affordances (or the lack thereof). If the beta changes are indicators of motor suppression, this also suggests that context has some influence on subsequent motor action.

Theta poses interesting interpretive challenges for studies involving quiet contemplation, like the present study, as it is associated with both meditation and sleep. This ambiguity was one of the primary motivators for the methodological clarifications concerning experimental design. As mentioned in Chapter Two, the findings from the baseline study showed significant findings in theta activity, but the researchers could not conclusively say whether these were the results of relaxed and thoughtful states or transitions to sleep. The baseline study is not alone in struggling with the interpretation of theta. In some cases, left hemisphere theta reduction has been recorded during hypnosis (Taddei-Ferretti & Musio, 1999) and suggests an increase in cognitive effort. Theta changes have been associated with meditative states, though studies conflict on the directionality of the changes for certain types of meditation (Cahn & Polich, 2006). The present study reduced the length of simulation time, hoping to reduce the likelihood of sleep. In the present work, drowsiness may explain the similar theta findings between groups as the simulation progressed, keeping in mind that for both conditions, the last few minutes were of a quiet, tranquil view of a slowly turning planet. The phenomenological interviews indicated that many participants felt relaxed, and even sleepy, by the end of the experiment. The conditions of the experiment were relaxing, with no audio stimulation, low lighting, and, according to most participants, pleasurable visuals. Future work should disentangle the phases between thoughtful relaxation and drowsiness as it pertains to the first-person articulation of experience.

FNIR measurements in the right frontal lobe also showed significant differences between groups during the two conditions. Again, the key is the timing. In the first minute, the significant differences are to be expected. The images are different, with the FOC containing various familiar images that, during the interviews, participants said they recognized. Many participants who received the focal condition also reported looking for places, (e.g. trying to locate a girlfriend’s apartment building or the route they take home). This type of engagement, or *gamification* could account for the differences in the frontal lobe behaviors, which are typically associated with executive function. Interviews from the GLO participants indicated a different sort of cognitive task, as they experienced a less familiar starting point. They started in darkness (similar to baseline, so it is not a surprise that there is less change from baseline here), and the first landscape images were not familiar. The vantage was over a red-toned landscape of Africa, and some participants reported thinking they were on Mars. The lack of familiarity at this stage may have made it more difficult to engage cognitively (Tulving, Markowitsch, Craik, Habib, & Houle, 1996). A similar issue of novelty versus familiarity may explain the differences during the fourth minute as well. However, this trend appeared throughout the experiment, even though the significance was only found during minutes one and four, suggesting an enduring effect of the initial contextual grounding on the subsequent frontal lobe behaviors.

Neurological responses to context differences between the FOC and GLO conditions indicate previously unexplored features of experience as it applies to the observation of Earth in a simulation environment. First, this contribution confirms the value of adhering to the second lesson learned by tightly controlling the variables. Additionally, there are implications for astronaut experience. These findings suggest that the grounded context, the notion of coming from “home” and moving into space, increase the neurological behaviors associated with both attention and relaxation. As the astronaut reports indicated experiences of peace and beauty, it is possible that the types of neural behaviors observed during the experiment are neural behaviors involved in transitioning from the anxiety of launch into a state that allows for more positive spiritual and affective experiences while in space. Astronauts maintain a contextual awareness that they are leaving a specific location on earth and they will return to a location. Results of the experiment suggest that contextual grounding is associated with differences in brain areas involved in attention, memory, and relaxation. However, while these findings begin to paint a picture of the neurological conditions associated with the experience of looking at Earth from space, they alone are not sufficient for describing the astronaut *experiences* of AWCH. To explore the nature of the spiritual and aesthetic experiences, these findings must be considered in their relationship to self-reports of the experiencers while viewing the simulation.

Perceiving Self, Experiencing World

To flesh out the fuller figure of AWCH (and retain focus on metheodological improvements by making a clear contribution to phenomenology of astronaut experience) it is essential to add the information collected from the participants in the form of their survey results. As the ESSE explicitly asked participants to report aspects of spirituality and AWCH, these reports were correlated to with the neural results. Among the more intriguing findings are the opposing correlative directions for visual processing-associated beta and theta behaviors in self-identified “logical” people versus “spiritual” or “religious”. It seems that the spiritually inclined person not only sees the world differently figuratively, but quite literally. In this study, person who considers herself "spiritual" or "religious" will largely behave differently on a neurophysical level than a person who more strongly identifies as "logical". In interpreting these results, one must remember that the participants were free to identify with every, or no, category; that is, participants never needed to choose "spiritual" or "logical". Consequently, the self-identifications bound to neural behaviors are all the more intriguing.

It raises numerous questions for further study: What are the implications of such literally different worldviews for sociological and political progress? Do other sensory modalities demonstrate such discrepancies (e.g. Does auditory processing vary in a similar pattern?). It will be valuable to replicate these findings. It is one thing to acknowledge that different cultures "see the world differently," but it is an entirely new realm for investigation to consider evidence implying that our views of ourselves are so closely bound to our sensory experiences. Future work should examine causality: Do I see the world differently because I am a spiritual person? Alternatively, am I a spiritual person, because of the world I see? Perhaps, in such matters, traditional notions of causality begin to deteriorate altogether, and the act of exploring the relationship opens non-linear explanations for these relationships.

More to the endeavor at hand, what does this self-perception say about the astronaut's experience? One's self-identification as spiritual, religious, and/or logical is bound to history, inseparable from episodic memories, schema for each construct, and culture. The neurological behaviors associated with experience are only *partially* the result of the stimulus. A large portion of the experience has to do with those things beyond the experimenter's control, the things unique to each individual. However, being beyond the experimenter's control does not mean that they are beyond the experimenter's grasp. That is where the phenomenological interview rounds out the toolkit of exploring experience. The tools of psychology and neuroscience tell us much, but they fall short of describing the experiences in the depth and fullness required. The phenomenological interviews support a broader sketch, an image of experience with movement, taking into account the complexities of individual differences.

In this case, the physiological and psychological findings are supported by the phenomenological examination, in that participants who self-identified as “logical” were significantly less likely to express themselves in spiritual terms. Consequently, the issue extends into the nature of the interview itself. If a speaker gives a personal account from his or her personal perspective, in a way, the listener is exposed to a worldview that is more or less “spiritual” in experiential terms and that worldview is connected to the speaker’s self-view. Self-identification may act as a type of perceptual filter for others and ourselves and as such, the interactive aspect of understanding others may allow us to frame other’s experiential accounts. Social signals indicating personality, culture, and other markers of self-identity, may give listeners some sort of information about speaker’s experience. For example, if social signals indicate something about my interlocutor, then I may more accurately frame and understand an experience that the speaker is sharing with me because I have direct access to those social signals even though I don’t have direct access to the experience. This is in line with the assertions of direct perception as articulated by Gallagher (2008) and Noë (2004). The self-described “logical” person not only sees something different, but also in conversation, invites the listener into a world that is shaped by that experience, so if the listener is not exposed to the stimuli, then the shape of the perceptual filter influences the second-person reception of the experience. The neurophenomenological approach contributes to a ground-level mapping of these difficult and entangled aspects of experience in an interactive world.

Toward the Structure of Experience

As the larger project of phenomenology seeks to describe and explore the nature and structure of experience, the approaches of the present study must accomplish something toward that end. For the present work, the contributions toward the phenomenological project are arranged in terms of: categorical components, relational factors, and mechanisms of experience.

Categorical Components

The present study's hermeneutic work clarifies the language used to represent and discuss the phenomena at hand while indicating components of experience. For example, the findings regarding awe showed a predictable connection between the ESSE's indications of awe and those interpreted in the transcript analyses. However, these relationships did not hold so tightly for the other constructs of focus, wonder, curiosity, spirituality, and religion. This beneficial discrepancy points phenomenology in a certain direction; it holds a light up to specific categories that can be refined further in the attempt to capture a phenomena. There are two possibilities for why the discrepancies between the psychological and phenomenological first-person accounts might occur. First, the psychological tool may be considered a blunt instrument, and a straight-forward question about AWCH may not provide the nuances of the hermeneutic categories; consequently, the constructs would not be as highly correlated. A second possibility is that there is ambiguity in the method of transcript analysis. Although the hermeneutic analyses were developed using inter-rater reliability methods, the transcripts were analyzed by single-rater experts. The use of expert evaluation has been validated across multiple fields, with highly successful results (Bevan, 1995; Hardesty & Bearden, 2004; Stufflebeam & Webster, 1983), so the concern is not necessarily with the single-rater, but with the discrete scoring that the single rater method created in this circumstance. With multiple raters, the scores and values can be presented in ranges or averages, which could allow for more flexible statistical comparisons with the Likert-scale values used in the ESSE.

Further, the variances in experiential scale, as reported in the ESSE, suggest intensity is a factor in the ultimate experience. In future application, the interview analysis should include perceived intensity so that the categorical findings might be scaled. This would yield thresholds, so that experiential ranges may be more accurately identified. Intensity appears to be relevant to each category and subcategory of experience, even though it had been omitted from the hermeneutic models used. The present study contributes to the phenomenological project by capturing the value of intensity to the structural aspect of experience.

In addition to intensity, the present study contributes categorical guidance by highlighting nuanced differences between components of experience. For instance, people who articulated an experience of awe were significantly more likely have indicated experiencing humility on their psychological survey. A finding like this is very important. The articulation of the markers of awe may not have correlated to an articulation of humility, but that sense of humility was still present and became something reportable through the ESSE. As there had been no significant relationship between experiencers of awe and experiencers of humility in the ESSE alone, it is through the analysis of the two data sources together that the connection in the articulation of some constructs and the underlying experiences emerges. These combinatorial analyses help to refine the hermeneutic categories, but more importantly, they direct researchers for future exploration to consider more closely the conditions under which these related phenomena co-occur.

Relational Factors

It is one thing to recognize pieces of a whole, but that is not enough to understand. That is, one can have all of the pieces for an automobile, but it takes an understanding of how those pieces fit together and their effects on one another when they do. So, as the previous section discussed the present contribution to identifying and clarifying categories of spiritual and aesthetic experience, now the discussion must shift to the relationships between categories.

The relationships between categories of experience and other factors indicate that experience is highly dynamic and expressed in different ways. An example comes from the integration of the TAS results regarding sensory absorption and the phenomenological groupings. Researchers use the TAS (See Appendix B) to capture the types of conditions that might elicit absorption, and the category of "sensory perceptual absorption" identifies sensory/perception conditions. Contrary to what one might assume, aesthetic, awe, and humility experiencers scored significantly lower in sensory perceptual absorption. There are two possible explanations for this discrepancy, the first being methodological and the second, ontological. To the methodological explanation, this may be a simple difference between what the metrics aim to measure and what they actually measure. This explanation could be explored by refining the metric, perhaps through isolating exclusively visual absorption (as opposed to multi-modal absorption) for visually-exclusive stimuli. However, the fact that none of the other absorption categories were flagged for significance should elicit caution before dismissing the use of the metric. After all, the category "nature and language" seems just as likely a candidate for correlation when the items being discussed are articulations of the experience of viewing a natural phenomenon. Likewise, one might assume that a tendency toward "imaginative involvement" would play a role in the experience of viewing a simulation. So, one must take seriously the second explanation. The relationships between these constructs should be more closely examined to parse out the structural commonalities for AWCH, and the other spiritual, religious, and aesthetic constructs.

A similar relational issue is raised by the phenomenological results of religious-experiencers self-identifying as less “reflective persons”. For example, P4, demonstrated alpha-suppression, did not articulate spiritual experiences, and also identified as “reflective”. What is the relationship between considering oneself reflective and a decreased likelihood of speaking in religious terms? First, one must take seriously methodological points that should be addressed to validate these findings (e.g. replication, larger data samples). However, the neurophenomenological approach can take existing findings as directions for ontological refinement. For example, the data presented here can direct further phenomenological analysis into the role of meta-cognitive factors (like reflection) in real-time experience. Meta-cognition as a broad category was not part of the hermeneutic analysis from the original astronaut texts, but the current findings implicate contributions from neural correlates for working and episodic memory. Pieced together, meta-cognitive features from the psychological, physiological, and phenomenological data sources can be used to create a clearer picture of spiritual and aesthetic experiences. Beyond the methodological and ontological questions raised, these correlations suggest that the structure of experience may also be a function of narrative capacity and social norms. A “reflective” person may be more inclined to take time before articulating an experience, particularly to a stranger and especially in terms that may be considered intimate or culturally charged, such as AWCH. Reflection, in and of itself, may interfere with immediate articulation, but might render a richer account over time. The present study has offered insight into the specific spiritual and aesthetic experiences, but it has also contributed to the larger phenomenological project by bringing to light relationships between categories.

Mechanisms of Experience

The interviews did successfully create clusters for analysis and these clusters, as reflected in neurophysiological data, indicate mechanisms involved in experience. The clusters were particularly critical for interpreting the physiological data in individuals. The "experiencers" identified by the transcript analyses used as examples in the present paper would not have been identified by the ESSE (a traditional psychological survey). The trends visible in the individual differences analyses of brain behaviors in correlation with the phenomenological reports of aesthetic and spiritual constructs revealed a compelling case for the role of alpha brain activity differences. More recently, the alpha behaviors have been linked to a gating or inhibition of areas not related to a task (Jensen & Mazaheri, 2010; Klimesch, Sauseng, & Hanslmayr, 2007). The results indicate that the phenomenologically-determined categories of AWCH can be used to cluster the participants into groups that coincide with distinct neural behaviors. In this case, the greater alpha-suppression rates in the "experiencers" indicate the broader cortical activation required to synthesize consciousness, perception, and working memory. While the results of this form of analysis are not considered generalizable to the population, they suggest that some individuals may exploit the neural interactions facilitated by alpha suppression. The higher degree of neural interaction may be linked to the subsequent articulation of experience in spiritual terms.

It cannot go unmentioned that some participants with high alpha suppression did not discuss their experiences in spiritual or aesthetic terms. This is not surprising, as the picture of experience that has taken shape from this study is far more complex that a one-to-one physiological-phenomenological corollary. P4, who demonstrated alpha-suppression, but did not articulate a spiritual experience during interview, indicated in the ESSE that he did experience wonder, curiosity, and humility. He also indicated on the ESSE that the simulation felt familiar and self-identified as a “reflective person” and “logical person”. Because the information on P4’s experience was collected from the three lenses, it fits into the model of experience being a multi-dimensional phenomenon. In addition to the roles described above, alpha oscillations are also implicated in active processing related to memory maintenance (Palva & Palva, 2007). Knowing that P4 experienced familiarity (a demand on memory), it is not a surprise to see the alpha findings. This may also indicate a difference between *experiencing* and *articulating* experience. P4’s self-identification as logical and reflective may decrease the likeliness for religious articulations (this is discussed in more detail below). While the phenomenological interview is a powerful tool, and it successfully led to clusters of data otherwise not available, like the other lenses, it is optimized through integration with other tools in the neurophenomenological suite. It was the cohesive NP applied herein that generated these insights into the nature and structure of experience through testing the present research hypotheses.

Revisiting the Hypotheses and Objectives

Returning to the Hypotheses

The first hypothesis postulated a significant experiential difference between the participants who received the FOC condition and those who received the GLO condition. This hypothesis was not supported, as no significance was found between the first person reports of experience as gathered in the ESSE. However, the second hypothesis (that there would be a significant difference between the groups in neurophysical response) was confirmed. This disconnect makes more sense when integrating the data from the phenomenological, psychological and neurophysiological lenses. The observed differences in the neurophysiology are only part of the experience, as there is a complex interplay between the body, the stimulus, executive functioning and memory. The third hypothesis that AWCH experiencers will correlate with neurophysiological responses was confirmed with the examination of individual differences, as those analyses indicate trends comparing experiencers to non-experiencers.

These hypotheses rest within the larger methodological question; can methodological adjustments refine NP so that experiential research projects may be expanded to support the project of understanding experience? Again, the present study suggests concerted efforts can drive a research agenda with replicable techniques in an interdisciplinary context. The methods described within this project are replicable, so that the project may have future expansions. It should be noted that the categories of “experiencer” or “non-experiencer” would have been absolutely different had the analysis relied exclusively on the self-reports in the psychological survey. As Figure 19 shows, the participants identified as “experiencers” (P14 &44) in the phenomenological analysis would not have been categorized as such based on their survey alone; the “non-experiencers” also would not have been considered in such terms. For example, P14 gave a score of 12 out of 100 for awe (M = 57.11, SD = 28.288). On the other extreme, P64 reported a score of 90 in agreement with the experience of awe (M = 57.11, SD = 28.288), and 100 for wonder (M = 67.75, SD = 25.962) curiosity (M = 75.64, SD = 22.098), and humility (M = 54.64, SD = 34.015). The following will explain how this contradiction adds to creating a more nuanced and accurate account of experience across multiple disciplines.

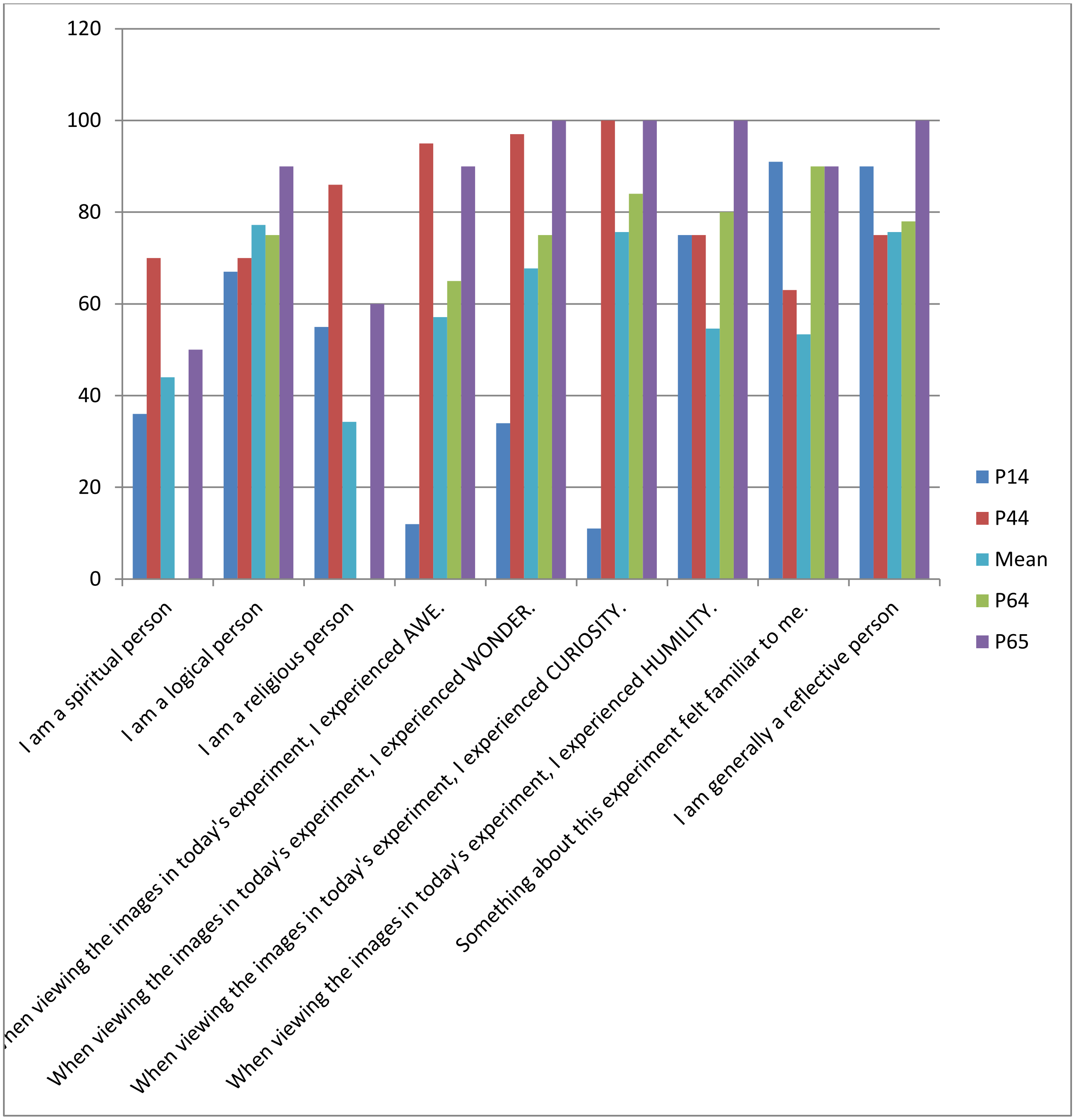


Figure 19. Self-reports of experience in ESSE. P14 and P44 were classified as "experiencers" in the phenomenological analysis; P64 and P65 were not.

The methods employed herein generated other challenging results respective of the language used to describe spiritual, aesthetic, and religious experiences. Participants who discussed their experience in explicitly religious terms were less likely to indicate that they were “reflective”, an unanticipated finding. However, only six participants spoke in religious terms, reducing the power of the statistics for inference. It will be important to consider the role the methodology may have played in either reducing the number of people who spoke in these terms (e.g. Did the academic environment make it socially inappropriate to speak in theological language?). Further, participants who used aesthetic language to describe their experiences had significantly lower “sensory perception absorption” scores. Likewise, “Awe” included hermeneutic categories of being captured by the view or lost in the image, items that would typically be tightly associated with the TAS category of “sensory perceptual absorption”. At first, these appear in opposition to the hermeneutic categories regarding perception as an aspect of aesthetic experience. At closer examination, the questions of the TAS focus on potentially synesthetic qualities (e.g. “Textures- such as wool, sand, wood- sometimes remind me of colors and music. Textures- such as wool, sand, wood- sometimes remind me of colors and music”). The apparent disconnect between the hermeneutic analyses and the psychometrics support the integration of these tools used in the present study. It is the method of combined NP approaches that allowed for the research to identify specific areas, including the language categories, that need refinement from multiple disciplinary angles. Future work can help inform better psychological tools for capturing experience while also contributing to the philosophical examination of the categories used for the present work.

Returning to the Objectives

The present work applied the methodological lessons derived from a baseline experiment to an experiment using a simulation environment to elicit spiritual and aesthetic experiences and compare the subsequent findings from the present experiment to the baseline discussed in the literature review. The lessons learned shaped the methodology described above and the consequential results helped clarify some issues that were unclear in the baseline study. One of the original concerns was over the theta findings, which resisted interpretation due to the ambiguity between contemplative/meditative and fatigue/drowsiness theta behaviors. Because the experiment was designed to take fatigue into account (according to Lesson #2), confidence in the interpretation of theta differences is greater. Further, the integration of the disciplinary lenses (Lesson #1) to create the dyadic analysis for interpreting data allowed for more precise clustering and cross-checking of results across domains. Lesson #3, in its observation of the training trade-off, does not lend itself toward a statistical comparison to the first experiment. Rather, this is a theoretical contribution that takes into account the role of "the other" in assisting the reflection required for the articulation of experience. Therefore, in lieu of a statistical metric of comparison for this aspect of the methodology, one can consider that the interview as practiced in the present study provided were more consistent and controlled, improving the collection of first-person data as evidenced in the volume collected and reported on in Chapter Four and its contribution to the project as a whole. This returns the present work to the starting point, a serious consideration of the value of the methodological changes to the study of experience.

As a whole, the lessons learned from the baseline did not generate a radically different toolset, but refined existing ones, so the data collected grew in breadth and depth. The application of lessons learned helped direct the interpretation of the results in a manner contributes to the study of experience. Table 4 shows some key features of the baseline experiment and the counterpart changes in the present study, demonstrating how interpretive challenges became points of contribution to NP.

Table 4. Contributions to the study of experience.

	Baseline Experiment	Interpretive Challenges	Present Study's Changes	Present Study's Contribution
Experiment Design	• Mixed reality simulation • Multiple-vantage manipulation	Determining the role of multiple variables as contributors to experience	• Visual immersion simulation • Context manipulation	Demonstrated that reduced sensory stimuli could elicit experiences akin to those reported by astronauts
Significant Findings	• Cortical theta responses differed between experiencers and non-experiencers of awe during the earth condition	Ambiguity regarding theta associated with tiredness vs. meditation	• Cortical responses to context are evident in simulation time and create significant differences	Clarification of theta involvement. Role of MEMORY, particularly engaged in context
	• Cortical beta responses differed between the earth and deep space conditions	The baseline found beta activity, associated with arousal, but could not determine whether the visual cues alone were eliciting the arousal	• Differences in self-identification as a logical or spiritual person are evident in visual processing opposing degrees of significance	Clarification of beta, as the groups had equitable levels of sensory arousal. Role of PERCEPTION as an individually unique process
	• Earth condition elicited higher responses of awe, wonder, and religiousness compared to the deep space condition	No indication of the mechanisms involved in the generation of AWCH	• Some participants with alpha suppression DFB articulated more spiritual and aesthetic experiences, likely due to more cortical interaction, than others	Results suggest that individuals use different mechanisms to generate similarly articulated experiences. Role of CONSCIOUSNESS, and interaction of brain areas involved in complex processes
	• Limited implication of frontal lobe activity in experimental conditions	Could not examine the role of real-time online executive functions	• Working memory and attention while viewing Earth are suggested from frontal lobe behaviors during simulation time	Role of EXECUTIVE FUNCTION, connecting experience to cognitively engaged, non-passive, neural activity

Limitations

The limitations of the present study fall into three categories: analysis, the role of the interviewer, and the role of embodiment.

The present work reflects the findings from three disciplinary lenses: psychology, neurophysiology, and philosophy; while this triad has yielded compelling results, the method of paired analysis between the disciplines is novel. Future studies should include alternative analytic approaches. For example, the psychological analysis could take account of intensity of experience. Further, the impressions of the interviewer may be of particular value. In the context of interaction, the phenomenological interview allows for participatory sense-making (De Jaegher & Paolo, 2007). As such, the impressions of the interview in respect to the participant's experience may be valuable. Future clarifications in the hermeneutic categories and the methods used to identify them in first-person accounts should be clearly articulated and rigorously applied in other studies to develop a consistent and reliable means for interpreting experience. Finally, the role of the body in experience cannot be over-emphasized. The visual stimulus restricted, by design, interaction. As such, one should exercise restraint in generalizing the results to circumstances in which the participant is interacting more directly with the environment until further investigation warrants. The aforementioned limitations all pertain to potential improvements on future experiments or caution for the interpretation of the present results, but they in no measure undermine the value of the present study as it thoroughly tested each hypothesis and improved upon existing protocols in NP research.

Conclusion

The realm of the spiritual poses profound problems for research; present study included. William James, philosopher, psychologist, and physician, took on the problem of this kind of experience in *The Varieties of Religious Experience* (James, 1902). His findings, over a century ago, align in some ways to the highly personal picture that the present study paints, but they stop short of explaining the nature and structure of these experiences. According to William James, religion is something of a work of egoism, in that, there is a level in which some are fortunate enough to be called, chosen, or otherwise receive revelation. Egoism may be part of the present account as well, only so much as it ties into the complex interplay of mind and body. For example, there may be those who see the world in an exclusive manner. However, what the data indicates is not James' so-called "dreams, hallucinations, revelations, and cock-and-bull stories" (near footnote 335). Rather, these differences in perception, manifested in experiential accounts, reflect real varieties of experience. The present study and its results suggest that religious and spiritual differences (observed in the laboratory and the world at large) are not the result of pure imagination, but the manifestations of complex interactive systems including executive function, memory, consciousness, and perception.

How can a stripped-down, straight-forward single-stimulus experiment tell us anything about the textured, rich, and complex experiences of astronauts? Are we attempting to learn about the nuances of a delicate soufflé from studying the composition of an egg? To follow that analogy, if we only looked at the egg, it wouldn't tell us anything about the soufflé. Yet, if we examined the soufflé from the start, it might follow that we could begin to examine the ingredients individually and then look at how those ingredients interacted with one another. Then, as we put the ingredients back together, we would begin to see how different ratios and slight substitutions begin to create a plethora of goods, from crackers, to cakes, to papier-mâché paste. No one would suggest that knowledge of the egg is sufficient, but anyone who has made a soufflé will attest that it is essential to understand how that egg behaves in relationship to air, flour, and heat if you want to make any sense of the delectable soufflé.

This provides an analogy, though inherently limited, in which to explain the way I have isolated one component of the astronaut experience (viewing the earth from space) to explore that component's role in the spiritual experiences of astronauts. The inquiry begins, and continues, anchored in the fact that actual astronaut experience is accessible, describable, and subject to empirical investigation. It was with those experiences that the study began, using the hermeneutic analysis to frame the problem at hand. The visual component of the astronaut experience is only one component, something mentioned explicitly by astronauts and something possible to simulate in a laboratory. However, in isolation of that one controllable stimulus, it becomes possible to take a closer look at its relationship with the factors individuals bring to their experiences. The results indicate that the nature of astronaut experiences is not any different from any other human experiences. That is, the *nature*, the structures and tendencies of the experiences themselves, are like other experiences in that they are a function of dynamic interactions of cognitive, affective, and physiological engagement in the world. In the case of astronauts, their prior knowledge is complex. The demands on astronaut bodies are remarkable, with extreme sensations in sound, touch, and sight. Yet, with all of the extraordinary components, the ways in which the experiences emerge can be considered as extensions of ordinary human experience. What takes shape is the dynamic relationship between histories, bodies, and environment. In the present study, emphasizing the role of visual perception in relationship to context revealed phenomenological nuances of experience that would have gone unnoticed in traditional cognitive science. Subsequently, these relationships can be mapped to a model of experience, directly contributing to the project of phenomenology and supporting the larger inquiry into the study of mind, moving us closer to understanding the nature of experiences whether on this Earth or beyond.

APPENDIX A: RESTRICTIONS CHECKLIST

	Yes	No		
Are you less than 18 years old?				
Are you greater than 40 years old?				
Have you had any caffeine in the last 2 hours?				If more than one of these is checked do not run participant. But one check is ok to run. Please ask participant to clarify when substance was taken. If close (within 15 minutes or so) to the time period, then run participant.
Have you had any nicotine in the last 2 hours?				
Have you had any alcohol in the last 24 hours?				
Have you had any sedatives or tranquilizers in the last 24 hours?				
Have you had any aspirin, tylenol, or similar medications in the last 24 hours?				
Have you had any antihistamines or decongestants in the last 24 hours?				
Have you had any anti-psychotics or anti-depressants in the last 24 hours?				
Based on your current knowledge, are you pregnant?				
Do you have any metal plates in your head?				
Do you lack normal or corrected to normal vision?				
Are you colorblind?				
Do you feel moderate discomfort, dizziness, fatigue, headache, eye strain, difficulty focusing, increased salivation, sweating, nausea, difficulty consentrating, fullness of head, blurred vision, vertigo, stomach awareness or burping?				It is ok to run if this is checked. Please ask participant to clarify.
Do you have a history of epilepsy or seizures?				
Do you have wet or woven hair?				
Are you currently in the military?				

Answering "Left" or "Either" to questions below may prohibit participation in the study

	Yes	NO		
Do you have any impairment of your dominant arm or hand?				Must be right handed
Are you right handed?				
	Left	**Right**	**Either**	
Which hand do you use to write with?				If more than one do not run.
Which hand do you use to throw a ball?				
Which hand do you hold a toothbrush with?				
Which hand holds a knife when you cut things?				
Which hand holds a hammer when you nail things?				

APPENDIX B: QUESTIONNAIRES

Tellegen Absorption Scale

(Tellegen & Atkinson, 1974)

This questionnaire consists of questions about experiences that you may have had in your life. We are interested in how often you have these experiences. It is important, however, that your answers show how often these experiences happen to you when you are *not* under the influence of alcohol or drugs. All questions are True/False.

1. Sometimes I feel and experience things as I did when I was a child.
2. I can be greatly moved by eloquent or poetic language.
3. While watching a movie, a TV show, or play, I may become so involved that I may forget about myself and my surroundings and experience the movie as if it were real and as if I were taking part in it.
4. If I stare at a picture and then look away from it, I can sometimes "see" an image of the picture almost as if I were still looking at it.
5. Sometimes I feel as if my mind could envelop the whole world.
6. I like to watch cloud shapes change in the sky.
7. If I wish I can imagine (or daydream) some things so vividly that they hold my attention as a good movie or story does.
8. I think I really know what some people mean when they talk about mystical experiences.
9. I sometimes "step outside" my usual self and experience an entirely different state of being.
10. Textures- such as wool, sand, wood- sometimes remind me of colors and music.

11. Sometimes I experience things as if they were doubly real.
12. When I listen to music I can get so caught up in it that I don't notice anything else.
13. If I wish I can imagine that my body is so heavy that I could not move it if I wanted to.
14. I can often somehow sense the presence of another person before I can actually see or hear her/him.
15. The crackle and flames of wood fire stimulate my imagination.
16. It is sometimes possible for me to be completely immersed in nature or in art and to feel as if my whole state of consciousness has somehow been temporarily altered.
17. Different colors have distinctive and special meanings for me.
18. I am able to wander off into my thoughts while doing a routine task and actually forget that I am doing the task, and find a few minutes later that I have completed it.
19. I can sometimes recollect certain past experiences in my life with such clarity and vividness that it is like living them again or almost so.
20. Things that might seem meaningless to others often make sense to me.
21. While acting in a play I think I could really feel the emotions of the character and "become" her/him for the time being, forgetting both myself and the audience.
22. My thoughts often don't occur as words but as visual images.
23. I often take delight in small thing (like the five-pointed star shape that appears when you cut an apple across the core or the colors of soap bubbles).
24. When listening to organ music or other powerful music I sometimes feel as if I am being lifted into the air.
25. Sometimes I can change noise into music by the way I listen to it.

26. Some of my most vivid memories are called up by scents and smells.

27. Some music reminds me of pictures or changing color patterns.

28. I often know what someone is going to say before he or she says it.

29. I often have “physical memories”; for example, after I have been swimming I may still feel as if I am in the water.

30. The sound of a voice can be so fascinating to me that I can just go on listening to it.

31. At times I somehow feel the presence of someone who is not physically there.

32. Sometimes thoughts and images come to me without the slightest effort.

33. I find that different odors have different colors.

34. I can be deeply moved by a sunset.

Scoring

Sum of all items. No items are reversed scored. Broken into 5 factors:

1. Sensory/Perceptual Absorption
    a. Items # 10, 15, 16, 17, 24, 25, 26, 27, 29, 33
2. Intuition
    a. Items # 14, 19, 20, 28, 30, 31, 32
3. Imaginative Involvement
    a. Items # 3, 4, 7, 12, 18, 21, 22
4. Trance
    a. Items # 5, 8, 9, 11, 13
5. Nature and Language
    a. Items # 1, 2, 6, 23, 34

Multiple Stimulus Types Ambiguity Tolerance

(McLain, 2009)

Scale:

1 = Strongly Disagree

2 = Somewhat Disagree

3 = Neither Agree nor Disagree

4 = Somewhat Agree

5 = Strongly Agree

Items

1. I don't tolerate ambiguous situations well.
2. I find it difficult to respond when faced with an unexpected event.
3. I don't think new situations are any more threatening than familiar situations.
4. I'm drawn to situations which can be interpreted in more than one way.
5. I would rather avoid solving a problem that must be viewed from several different perspectives.
6. I try to avoid situations which are ambiguous.
7. I am good at managing unpredictable situations.
8. I prefer similar situations to new ones.
9. Problems which cannot be considered from just one point of view are a little threatening.
10. I avoid situations which are too complicated for me to easily understand.
11. I am tolerant of ambiguous situations.
12. I enjoy tackling problems which are complex enough to be ambiguous.
13. I try to avoid problems which don't seem to have only one "best" solution.
14. I often find myself looking for something new, rather than trying to hold things constant in my life.
15. I generally prefer novelty over familiarity.
16. I dislike ambiguous situations.

17. Some problems are so complex that just trying to understand them is fun.

18. I have little trouble coping with unexpected events.

19. I pursue problem situations which are so complex some people call them “mind boggling.”

20. I find it hard to make a choice when the outcome is uncertain.

21. I enjoy an occasional surprise.

22. I prefer a situation in which there is some ambiguity.

Brief Multidimensional Measure of Religiousness/Spirituality

(Idler et al., 2003)

1. I feel God's presence.

    1 - Many times a day

    2 - Every day

    3 - Most days

    4 - Some days

    5 - Once in a while

    6 - Never or almost never

2. I find strength and comfort in my religion.

    1 - Many times a day

    2 - Every day

    3 - Most days

    4 - Some days

    5 - Once in a while

    6 - Never or almost never

3. I feel deep inner peace or harmony.

    1 - Many times a day

    2 - Every day

    3 - Most days

    4 - Some days

    5 - Once in a while

    6 - Never or almost never

4. I desire to be closer to or in union with God.

1 - Many times a day

2 - Every day

3 - Most days

4 - Some days

5 - Once in a while

6 - Never or almost never

5. I feel God's love for me, directly or through others.

1 - Many times a day

2 - Every day

3 - Most days

4 - Some days

5 - Once in a while

6 - Never or almost never

6. I am spiritually touched by the beauty of creation.

1 - Many times a day

2 - Every day

3 - Most days

4 - Some days

5 - Once in a while

6 - Never or almost never

7. I believe in a God who watches over me.

1 - Strongly agree

2 - Agree

3 – Disagree

4 - Strongly disagree

8. I feel a deep sense of responsibility for reducing pain and suffering in the world.

1 - Strongly agree

2 - Agree

3 – Disagree

4 - Strongly disagree

9. I try hard to carry my religious beliefs over into all my other dealings in life.

1 - Strongly agree

2 - Agree

3 – Disagree

4 - Strongly disagree

10. Because of my religious or spiritual beliefs I have forgiven myself for things that I have done wrong.

1 - Always or almost always

2 - Often

3 – Seldom

4 – Never

11. Because of my religious or spiritual beliefs I have forgiven those who hurt me

1 - Always or almost always

2 - Often

3 – Seldom

4 - Never

12. Because of my religious or spiritual beliefs I know that God forgives me.

1 - Always or almost always

2 - Often

3 – Seldom

4 - Never

13. How often do you pray privately; that is, how often do you pray in settings other than a church, synagogue, mosque or other place of worship and at times when you are not attending functions of a religiously based group?

1 - More than once a day

2 - Once a day

3 - A few times a week

4 - Once a week

5 - A few times a month

6 - Once a month

7 - Less than once a month

8 – Never

14. Within your religious or spiritual tradition, how often do you meditate?

1 - More than once a day

2 - Once a day

3 - A few times a week

4 - Once a week

5 - A few times a month

6 - Once a month

7 - Less than once a month

8 - Never

15. How often do you watch or listen to religious programs on TV or radio?

1 - More than once a day

2 - Once a day

3 - A few times a week

4 - Once a week

5 - A few times a month

6 - Once a month

7 - Less than once a month

8 - Never

16. How often do you read sacred religious texts (e.g., Bible, Torah, Talmud, Koran, etc.) or other religious literature?

1 - More than once a day

2 - Once a day

3 - A few times a week

4 - Once a week

5 - A few times a month

6 - Once a month

7 - Less than once a month

8 – Never

17. How often are prayers or grace said before or after meals in your home?

1 - At all meals

2 - Once a day

3 - At least once a week

4 - Only on special occasions

5 - Never

18. I think about how my life is part of a larger spiritual force.

1 - A great deal

2 - Quite a bit

3 – Somewhat

4 - Not at all

19. I work together with God as partners.

1 - A great deal

2 - Quite a bit

3 - Somewhat

4 - Not at all

20. I look to God for strength, support, and guidance.

1 - A great deal

2 - Quite a bit

3 - Somewhat

4 - Not at all

21. I feel God is punishing me for my sins or lack of spirituality.

1 - A great deal

2 - Quite a bit

3 - Somewhat

4 - Not at all

22. I wonder whether God has abandoned me.

1 - A great deal

2 - Quite a bit

3 - Somewhat

4 - Not at all

23. I try to make sense of the situation and decide what to do without relying on God.

1 - A great deal

2 - Quite a bit

3 - Somewhat

4 - Not at all

24. To what extent is your religion involved in understanding or dealing with stressful situations in any way?

1 - Very involved

2 - Somewhat involved

3 - Not very involved

4 - Not involved at all

25. If you were ill, how much would the people in your congregation help you out?

1 - A great deal

2 - Some

3 - A little

4 – None

26. If you had a problem or were faced with a difficult situation, how much comfort would the people in your congregation be willing to give you?

1 - A great deal

2 - Some

3 - A little

4 – None

27. How often do the people in your congregation make too many demands on you?

1 - Very often

2 - Fairly often

3 - Once in a while

4 - Never

28. How often are the people in your congregation critical of you and the things you do?

1 - Very often

2 - Fairly often

3 - Once in a while

4 – Never

29. How often do you go to religious services?

1 - More than once a week

2 - Every week or more often

3 - Once or twice a month

4 - Every month or so

5 - Once or twice a year

6 - Never

30. Besides religious services, how often do you take part in other activities of a religious nature?

1 - More than once a week

2 - Every week or more often

3 - Once or twice a month

4 - Every month or so

5 - Once or twice a year

6 – Never

31. The events in my life unfold according to a divine or greater plan.

1 - Strongly agree

2 - Agree

3 - Disagree

4 - Strongly disagree

32. I have a sense of mission or calling in my own life.

1 - Strongly agree

2 - Agree

3 - Disagree

4 - Strongly disagree

33. To what extent do you consider yourself a religious person?

1 - Very religious

2 - Moderately religious

3 - Slightly religious

4 - Not religious at all

34. To what extent do you consider yourself a spiritual person?

1 - Very spiritual

2 - Moderately spiritual

3 - Slightly spiritual

4 - Not spiritual at all

Experiment-Specific Survey of Experience

Please answer each of the questions to your best ability.

STOP! The research assistant must verify that your PARTICIPANT IDENTIFICATION NUMBER is entered correctly.

Demographics Questionnaire for *Viewing Earth from Space: First-Person Experiences*

What is your sex?

○ Male

○ Female

What is your age?

What is the HIGHEST level of education you have COMPLETED?

○ High School

○ Associates Degree or 2 years of College/University

○ Bachelors Degree

○ Masters Degree

○ Doctoral Degree

When did you use computers in your education? *Select all that apply*.

☐ Preschool

☐ Grade School

☐ Junior High/ Middle School

☐ High School

☐ Technical School

☐ College

☐ Did not use

What is your major?

[ ]

What is your minor? Please enter "NA" if you don't have one.

[ ]

Are you in your usual state of physical health?

- Yes
- No (please explain) ____

Where do you currently use a computer? *Select all that apply.*

- Home
- Work
- Library
- Other (specify) ____
- Do not use

Is English your native (first) language?

- Yes
- No

At what age did you begin speaking English?

____

Would you consider yourself a fluent speaker of English?

- Yes
- No

Would you consider yourself a fluent reader of English?

- Yes
- No

Do you typically understand spoken English without difficulty?

- Yes
- No

What was your first language?

How many hours per day do you spend WORKING on a computer?

- 0
- <1
- 1-2
- 3-4
- 4-5
- 5-6
- 7+

How many hours per day do you spend READING?

- 0
- <1
- 1-2
- 3-4
- 5-6
- 7+

How many hours per day do you spend WATCHING TV?

- 0
- <1
- 1-2
- 3-4
- 5-6
- 7+

Approximately how many hours of sleep did you get last night?

Which of the following best describes your expertise with computers?

- Novice
- Good with one type of software package (such as word processing or slide shows)
- Good with several software packages
- Can program in one language and use several software packages
- Can program in several languages and use several software packages

How often do you...

	Never	Less than Once a Month	Once a Month	2-3 Times a Month	Once a Week	2-3 Times a Week	Daily
Use graphics or drawing features in software packages?	○	○	○	○	○	○	○
Go to movies?	○	○	○	○	○	○	○
Watch IMAX or surround-screen movies?	○	○	○	○	○	○	○
Go to theme parks/amusement parks?	○	○	○	○	○	○	○
Play video/computer games?	○	○	○	○	○	○	○
Visit a museum?	○	○	○	○	○	○	○
Visit a planetarium?	○	○	○	○	○	○	○
Attend faith-based or religious activities?	○	○	○	○	○	○	○
Watch Science Fiction movies or television programs	○	○	○	○	○	○	○

Which types of computer/video games do you most often play? *Select all that apply*.

- ☐ Action (First person shooter, fighting, etc.)
- ☐ Adventure, Real-time 3D
- ☐ Role Playing (including MMOs)
- ☐ Simulation (Sims, Civilization, etc.)
- ☐ Strategy/Puzzle
- ☐ Party, dance, or music
- ☐ Sports
- ☐ Other

When you do PLAY VIDEO GAMES, how many hours per day do you spend?

- ○ 0
- ○ <1
- ○ 1-2
- ○ 3-4
- ○ 5-6

7+

Which of the following amusement/entertainment sites have you visited?

- Disney parks (i.e. Disneyworld, Disneyland, Euro-Disney)
- Disney Quest
- Universal Studios/ Islands of Adventure
- Kennedy Space Center
- Busch Gardens
- Sea World
- Six Flags

Rank your own level of competency with graphics or drawing software.

Rank your own level of competency with graphics or drawing software.

	Minimal skill or experience	Moderate skill level	Advanced or professional level of skill in at least one graphic or drawing software
My level of experience/competency with graphic software is...	○	○	○

STOP!

You have completed the demographic portion of this questionnaire. Wait for the research assistant to give you further instructions.

Research Assistant Code

The Research Assistant will read the following aloud. Wait until it is read before continuing:

The following questions will help us interpret the results from your interview and physical readings more accurately. We will be looking especially at indicators of emotional experiences. To help you describe your experience, we ask that you make the following distinctions:

When we use the word AWE, we mean: *a direct and initial feeling when faced with something incomprehensible or sublime.*

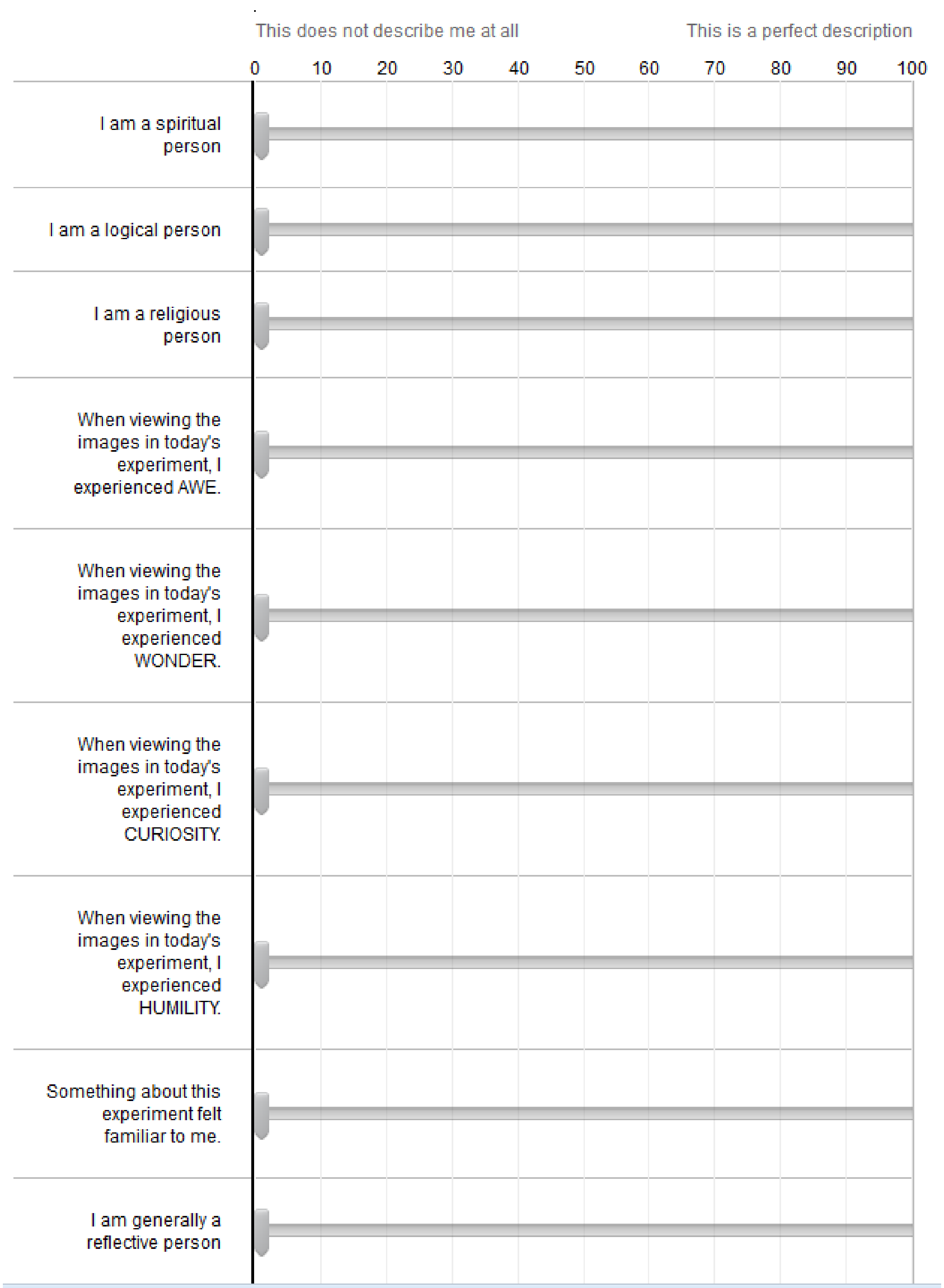
When we use the word WONDER, we mean: *a more reflective feeling one has when unable to put things back into a familiar conceptual framework*.

When we use the word CURIOSITY, we mean: *wanting to know*, see, experience, understand more.

When we use the word HUMILITY, we mean: a sensation about *one's relation to the universe or one's significance.*

While there may be other ways to use these terms, these are the definitions we are using in the following questions.

Use the sliding scale to show the degree to which each statement describes you.



Which best describes your experience?

I experienced AWE the MOST when viewing...

- ○ close images of the Earth (toward the beginning of the video).
- ○ distant images of the Earth (toward the end of the video).
- ○ the images of the geometric shape.

Which best describes your experience?

I experienced WONDER the MOST when viewing...

- ○ close images of the Earth (toward the beginning of the video).
- ○ distant images of the Earth (toward the end of the video).
- ○ the images of the geometric shape.

Which best describes your experience?

I experienced CURIOSITY the MOST when viewing...

- ○ close images of the Earth (toward the beginning of the video).
- ○ distant images of the Earth (toward the end of the video).
- ○ the images of the geometric shape.

Which best describes your experience?

I experienced HUMILITY the MOST when viewing...

- close images of the Earth (toward the beginning of the video).
- distant images of the Earth (toward the end of the video).
- the images of the geometric shape.

APPENDIX C: PHENOMENOLOGICAL INTERVIEW GUIDE

Guide for Phenomenological Interview

Objective: The phenomenological interview seeks to draw out first-person experience, emotionally and physically.

Do	Example
Encourage open-mindedness (this begins EARLY in the experiment)	Whatever is your honest experience is what we are looking for. Don't worry about what you think you should say or should have experienced.
Ask open questions	What was that like? Did you feel anything then? How did you know that…?
Attend to gesture	What does this mean when you move your hands like that? Can you show me, where you saw this?
Ask for time-related experiences	You said…, was there anything you remember happening before that? What happens next?
Move to present tense	So, let's go back to the moment you noticed the stars. What is happening to you now? Describe what you are

	seeing.
Use reflective language	I'm going to repeat back what you said. Feel free to interrupt me to correct something or add anything to what I say.
Don't	
Focus on judgments, rationalization, and opinions	Instead of saying, "Cool" or "That's interesting", try, "I understand that you were excited. What does that feel like? "
Ask leading or loaded questions (ones that offer potential answers)	Instead of "were you bored?" or "did you see the stars pulse?" try, "describe the way you felt at the beginning…middle…end" and "tell me more about the visual experience."
Try to fill the quiet	Give the participant time to reflect. Give yourself time to collect your thoughts so that you do not say something impulsively.

Sample opening:

Now we are going to talk about your experiences while viewing the simulation. We are interested in your unique experience, what it was *like* to see what you saw. During our conversation, I will repeat things I hear, just to make sure that I understand what you mean. The interview will probably last for about 30 minutes.

Let's start by going back to the beginning of the simulations and outlining for me what you experienced.

So you mentioned…what did that feel like?

When was that?

Did anything feel familiar?

When the interview time is up (approximately 30 minutes), say thank you and let the participant know that you have some survey questions.

Example closing:

I appreciate you sharing your experience with me. There is one final step, which is to complete one more questionnaire. While I pull it up, do you have any other questions for me?

APPENDIX D: HERMENEUTIC CATEGORIES

The following reflects the refinement and maturation of the experiential categories as throughout the hermeneutic process. These are entirely from the unpublished notes of Drs. Shaun Gallagher (Lillian and Morrie Moss Chair of Excellence in Philosophy, University of Memphis; Research Professor of Philosophy and Cognitive Science, University of Hertfordshire, UK) and Bruce Janz (Professor and Chair of the Department of Philosophy, University of Central Florida). The shifts within the enumeration and relationships correspond with the ongoing analysis researchers collaborate to better understand the nature and structure of spiritual, religious, and aesthetic experiences.

Concrete Categories

Initial consensus list

1. Appreciation (aesthetic; aesthetic impression; vs. intellectual appreciation)
2. Brotherhood
3. Captured by view/ drawn to phenomenon
4. Change (external)
5. Change (internal)
6. Closing down of curiosity
7. Confirming of perspective
8. Connected (feeling connected with, but different from, everything – cf unity)
9. Contentment
10. Curiosity
11. Disorientation
12. ~~[Drawn to the phenomenon= 3]~~

13. Dream-like (feeling of unreality)
14. Elation
15. Emotional (general)
16. Empathy
17. Experience-hungry (wanting more, setting up to have experience, positive about taking risk of exploring; captured by possibilities of exploring)
18. Fascination (getting lost in object)
19. Floating (bodily – related to weightlessness)
20. Floating in void (not related to weightlessness)
21. Fragility
22. Fulfillment
23. Harmony
24. Home, feeling of being at…
25. Inspired
26. Intellectual (Rich descript. of objects; none of his feelings; order; analytic appreciation; appreciation of complexity)
27. Joy
28. Love
29. Minimal affect
30. Moral implications
31. Nostalgia (Anticipated)
32. Overwhelmed -- loss for words, etc.
33. Perspectival change (spatial)

34. Perspectival shift (moral)

35. Physiological response (internal bodily changes)

36. Peace

37. Pleasure

38. Poetic expression

39. Responsibility (towards others)

40. Sensory (visual, silence)

41. Sensory overload (heightened sensory awareness)

42. Surprise

43. Unity-with (feeling of oneness with; holistic feeling, melting into everything).

44. Unity of external (earth, universe, people on earth, oneness of everything; interrelatedness/ complex unity)

45. Sublime

46. Totality (wholeness of what is experienced)

47. Vastness of ... (universe;Feeling of smallness within the vast)

48. Worry (about the earth)

Verified list of 37 categories

(verified by 6 grad students and 5 undergrads in blind reviews)

- Appreciation (aesthetic; aesthetic impression; vs. intellectual appreciation)
- Intellectual (Rich descript. of objects; none of his feelings; order; analytic appreciation; appreciation of complexity)
- Captured by view/ drawn to phenomenon
- Overwhelmed -- loss for words, etc.

- Poetic expression
- Sensory (visual, silence)
- Perspectival change (spatial)
- Surprise
- Vastness of ... (universe; Feeling of smallness within the vast)
- Pleasure
- Fascination (getting lost in object)
- Unity of external (earth, universe, people on earth, oneness of everything; interrelatedness/ complex unity)
- Dream-like (feeling of unreality)
- Elation
- Floating in void (not related to weightlessness)
- Sublime
- Curiosity
- Moral implications
- Experience-hungry (wanting more, setting up to have experience, positive about taking risk of exploring; captured by possibilities of exploring)
- Perspectival shift (moral)
- Fulfillment
- Floating(bodily - related to weightlessness)
- Home, feeling of being at… ,
- Inspired

- Nostalgia (Anticipated)
- Sensory overload (heightened sensory awareness)
- Change (internal)
- Joy
- Peace
- Responsibility (towards others)
- Contentment
- Disorientation
- Emotional (general)
- Totality (wholeness of what is experienced)
- Brotherhood
- Connected (feeling connected with, but different from, everything - cf unity)
- Unity-with (feeling of oneness with; holistic feeling, melting into everything).

Verified list of 37 with original numeration.

1. Appreciation (aesthetic; aesthetic impression; vs. intellectual appreciation)

26. Intellectual (Rich descript. of objects; none of his feelings; order; analytic appreciation; appreciation of complexity)

3. Captured by view/ drawn to phenomenon

32. Overwhelmed -- loss for words, etc.

38. Poetic expression

40. Sensory (visual, silence)

33. Perspectival change (spatial)

42. Surprise

47. Vastness of ... (universe; Feeling of smallness within the vast)

37. Pleasure

18. Fascination (getting lost in object)

44. Unity of external (earth, universe, people on earth, oneness of everything; interrelatedness/ complex unity)

13. Dream-like (feeling of unreality)

14. Elation

20. Floating in void (not related to weightlessness)

45. Sublime

10. Curiosity

30. Moral implications

17. Experience-hungry (wanting more, setting up to have experience, positive about taking risk of exploring; captured by possibilities of exploring)

34. Perspectival shift (moral)

22. Fulfillment

19. Floating (bodily - related to weightlessness)

24. Home, feeling of being at… ,

25. Inspired

31. Nostalgia (Anticipated)

41. Sensory overload (heightened sensory awareness)

5. Change (internal)

27. Joy

36. Peace

39. Responsibility (towards others)

9. Contentment

11. Disorientation

15. Emotional (general)

46. Totality (wholeness of what is experienced)

2. Brotherhood

8. Connected (feeling connected with, but different from, everything - cf unity)

43. Unity-with (feeling of oneness with; holistic feeling, melting into everything).

Verified list of 37 categories numerically reordered.

1. Appreciation (aesthetic; aesthetic impression; vs. intellectual appreciation)

2. Brotherhood

3. Captured by view/ drawn to phenomenon

5. Change (internal)

8. Connected (feeling connected with, but different from, everything - cf unity)

9. Contentment

10. Curiosity

11. Disorientation

14. Elation

15. Emotional (general)

17. Experience-hungry (wanting more, setting up to have experience, positive about taking risk of exploring; captured by possibilities of exploring

18. Fascination (getting lost in object)

19. Floating (bodily - related to weightlessness)

20. Floating in void (not related to weightlessness)

22. Fulfillment

24. Home, feeling of being at… ,

25. Inspired

26. Intellectual (Rich descript. of objects; none of his feelings; order; analytic appreciation; appreciation of complexity)

27. Joy

30. Moral implications

31. Nostalgia (Anticipated)

32. Overwhelmed -- loss for words, etc.

33. Perspectival change (spatial)

34. Perspectival shift (moral)

36. Peace

37. Pleasure

38. Poetic expression

39. Responsibility (towards others)

40. Sensory (visual, silence)

42. Surprise

43. Unity-with (feeling of oneness with; holistic feeling, melting into everything).

44. Unity of external (earth, universe, people on earth, oneness of everything; interrelatedness/ complex unity)

45. Sublime

46. Totality (wholeness of what is experienced)

47. Vastness of ... (universe; Feeling of smallness within the vast)13. Dream-like (feeling of unreality)

41. Sensory overload (heightened sensory awareness)

Cross Categorization

Aesthetic

1. Appreciation (aesthetic; aesthetic impression; vs. intellectual appreciation)

3. Captured by view/ drawn to phenomenon

13. Dream-like (feeling of unreality)

15. Emotional (general)

17. Experience-hungry (wanting more, setting up to have experience, positive about taking risk of exploring; captured by possibilities of exploring

18. Fascination (getting lost in object)

19. Floating (bodily - related to weightlessness)

27. Joy

36. Peace

37. Pleasure

38. Poetic expression

40. Sensory (visual, silence)

45. Sublime

46. Totality (wholeness of what is experienced)

47. Vastness of ... (universe; Feeling of smallness within the vast)

41. Sensory overload (heightened sensory awareness)

43. Unity-with (feeling of oneness with; holistic feeling, melting into everything).

Intellectual

18. Fascination (getting lost in object)

26. Intellectual (Rich descript. of objects; none of his feelings; order; analytic appreciation; appreciation of complexity)

Spiritual

2. Brotherhood

5. Change (internal)

8. Connected (feeling connected with, but different from, everything - cf unity)

9. Contentment

11. Disorientation

22. Fulfillment

24. Home, feeling of being at… ,

30. Moral implications

31. Nostalgia (Anticipated)

34. Perspectival shift (moral)

44. Unity of external (earth, universe, people on earth, oneness of everything; interrelatedness/ complex unity)

39. Responsibility (towards others)

Religious

[explicit mentions of God, creation, etc.]

43. Unity-with (feeling of oneness with; holistic feeling, melting into everything).

44. Unity of external (earth, universe, people on earth, oneness of everything; interrelatedness/ complex unity)

Awe

3. Captured by view/ drawn to phenomenon

14. Elation

17. Experience-hungry (wanting more, setting up to have experience, positive about taking risk of exploring; captured by possibilities of exploring

18. Fascination (getting lost in object)

32. Overwhelmed -- loss for words, etc.

42. Surprise

47. Vastness of ... (universe; Feeling of smallness within the vast)

Wonder

25. Inspired

30. Moral implications

31. Nostalgia (Anticipated)

34. Perspectival shift (moral)

43. Unity-with (feeling of oneness with; holistic feeling, melting into everything).

44. Unity of external (earth, universe, people on earth, oneness of everything; interrelatedness/ complex unity)

39. Responsibility (towards others)

Curiosity

10. Curiosity

26. Intellectual (Rich descript. of objects; none of his feelings; order; analytic appreciation; appreciation of complexity)

Humility

39. Responsibility (towards others)

43. Unity-with (feeling of oneness with; holistic feeling, melting into everything).

47. Vastness of ... (universe; Feeling of smallness within the vast)

APPENDIX E: UCF IRB LETTER

University of Central Florida Institutional Review Board
Office of Research & Commercialization
12201 Research Parkway, Suite 501
Orlando, Florida 32826-3246
Telephone: 407-823-2901 or 407-882-2276 www.research.ucf.edu/compliance/irb.html

University of Central Florida

Approval of Human Research

From: **UCF Institutional Review Board #1**
FWA00000351, IRB00001138

To: **Lauren Reinerman**

Date: **January 23, 2013**

Dear Researcher:

On 1/23/2013, the IRB approved the following human participant research until 1/22/2014 inclusive:

Type of Review:	UCF Initial Review Submission Form
Project Title:	Viewing Earth from Space: First Person Experiences
Investigator:	Lauren Reinerman
IRB Number:	SBE-13-09042
Funding Agency:	John Templeton Foundation
Grant Title:	Space, Science, and Spirituality
Research ID:	1052292

The scientific merit of the research was considered during the IRB review. The Continuing Review Application must be submitted 30days prior to the expiration date for studies that were previously expedited, and 60 days prior to the expiration date for research that was previously reviewed at a convened meeting. Do not make changes to the study (i.e., protocol, methodology, consent form, personnel, site, etc.) before obtaining IRB approval. A Modification Form **cannot** be used to extend the approval period of a study. All forms may be completed and submitted online at https://iris.research.ucf.edu .

If continuing review approval is not granted before the expiration date of 1/22/2014, approval of this research expires on that date. When you have completed your research, please submit a Study Closure request in iRIS so that IRB records will be accurate.

Use of the approved, stamped consent document(s) is required. The new form supersedes all previous versions, which are now invalid for further use. Only approved investigators (or other approved key study personnel) may solicit consent for research participation. Participants or their representatives must receive a copy of the consent form(s).

In the conduct of this research, you are responsible to follow the requirements of the Investigator Manual.

On behalf of Sophia Dziegielewski, Ph.D., L.C.S.W., UCF IRB Chair, this letter is signed by:

Signature applied by Joanne Muratori on 01/23/2013 10:20:34 AM EST

Joanne Muratori

IRB Coordinator

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