Consciousness Two Ways: Using Psychophysics and Phenomenology to Explore Phenomenal Conscious Experience

Moriah S. Stendel

Department of Psychiatry
McGill University, Montréal
August 2017

A thesis submitted to McGill University in partial fulfillment of the requirements of the degree of Master of Science

Table of Contents

General Introduction 3
Contribution of authors 4
Abstract 5
Résumé 6
Acknowledgements 7

Manuscript 1
Exploring the effect of cognitive load on conscious access to visual sensory inputs
- Abstract 9
- Introduction 10
- Background 11
- Methodology 22
- Results 30
- Discussion 34
- Appendix A 37
- Appendix B 38
- Appendix C 39
- Appendix D 38
- References .... **Error! Bookmark not defined.**

Connecting Text 52

Manuscript 2
Internet sociality: an epidemiology of cultural experience in a wired world 54
- Introduction 55
- The internet and the ecological-enactivist approach 60
- The mechanisms of cyber-mediation 67
- An anthropological survey of cyber-mediated bodily experiences 66
- Conclusion 79
- References 76

General Introduction

Conscious experience is at once intimately familiar and completely mystifying. While our intuitive understanding of consciousness runs deep, the longer we ponder it the more questions arise. Scientists have slowly chipped away at these questions, but many remain a mystery, largely due to the methodological challenges of consciousness research. Until the invention of a mind-reading machine, introspection is one of our only means to investigate psychological phenomena. Philosophers have gladly embraced introspective methods, harnessing them to study conscious experience through the tradition of phenomenology. On the other hand, in the world of mainstream scientific research, introspection has a more thorny status. The ambiguous validity of introspective reports along with the rise of Behaviorism rendered the scientific study of consciousness obsolete for much of the 20th century.

The scientific inquiry of conscious experience is finally in the limelight, with the past thirty years seeing a radical resurgence in consciousness research. Pioneering cognitive scientists have revived the mission of explaining and understanding consciousness using empirical methods, which tend to follow two fundamental approaches. The first, stemming from psychophysics and computational psychology, explores the mechanisms of conscious experience through third-person experimental techniques such as perceptual discrimination, behavioural, or neurophysiological tasks. The second approach hails from the aforementioned tradition of phenomenology, with researchers incorporating first person, qualitative data about one's own experience. To elucidate the phenomenal conscious experience, the present thesis features two original manuscripts that follow these two approaches.

The first manuscript recruits the experimental approach, using classic behavioral psychophysics to explore phenomenal conscious experience. The second manuscript takes a more qualitative, theoretical approach, using first-person reports to study how people come to share inter-phenomenal experiences in the digital age. Combined, these manuscripts reflect an attempt to shed light on the mystery of conscious experience and demonstrate the multiplicity of avenues through which it can be explored.

Contribution of authors

Manuscript 1: *Exploring the effect of cognitive load on conscious access to visual sensory inputs*
Moriah Stendel: Leading and organizing the research effort, coding task, data collection and analysis, interpretation of results, creating figures, and writing of manuscript.

Mathieu Landry: Data analysis, interpretation of results, creating figures, providing guidance, commenting on the manuscript.

David Milton: Coding task.

Amir Raz: Supervising the research process, providing guidance, commenting on the manuscript.

Manuscript 2: *Internet sociality: an epidemiology of cultural experience in a wired world*

Moriah Stendel: Primary author.

Maxwell Ramstead: Secondary author, editing and commenting on the manuscript.

Samuel Veissière: Corresponding author, supervising the research process, editing and commenting on the manuscript.

Abstract

Phenomenal conscious experience – the subjective 'what-it-feels-like' – can be explored through two scholarly traditions: gathering third-person data from psychophysics or using first-person phenomenology. The present thesis follows these traditions with two original manuscripts that explore conscious experience through each method. The first manuscript is an investigation into the richness of conscious experience. The infamous question of whether our conscious experience is rich or sparse is heavily contended, with empirical evidence supporting both sides of the debate. We employ a dual-task behavioural psychophysics paradigm consisting of a modified Sperling task combined with a cognitive load to examine the richness of our conscious experience and subsequent metacognition in a methodologically rigorous manner. The second manuscript uses qualitative first-person subjective report to explore how people come to share phenomenal experiences in an increasingly digital world. In all, this thesis is a multifaceted approach to the study of conscious experience.

Keywords: *consciousness, attention, conscious experience, phenomenology, phenomenal consciousness, Sperling,*

Résumé

L'expérience consciente phénoménale - le subjectif «ce que cela fait » - peut être exploré à l'aide de deux traditions: recueillir les données d'une tache psychophysique à la troisième personne, ou utiliser la phénoménologie à la première personne. La présente thèse suit ces deux traditions avec deux manuscrits originaux qui explorent l'expérience consciente en utilisant chaque méthode. Le premier manuscrit est une enquête sur la richesse de l'expérience consciente. La fameuse question cherchant à savoir si notre expérience consciente est riche ou pauvre est fortement débattue, avec des preuves empiriques soutenant chaque parti. Nous employons un paradigme de la psychophysique dans deux tâches simultanées : une tâche Sperling modifiée, et une charge cognitive pour examiner notre expérience consciente de manière méthodologiquement rigoureuse. Le deuxième manuscrit utilise un rapport subjectif qualitatif à la première personne pour explorer comment on vient à partager des expériences phénoménales dans un monde de plus en plus numérique. Ensemble, cette thèse presente une approche multimodale de l'étude de l'expérience consciente.

Mots clés : *consciente, attention, l'expérience consciente, phenomenology, la conscience phenomenale, Sperling*

Acknowledgements

First and foremost I would like to thank my supervisor, Dr. Amir Raz, for his continuous support over the past several years. Amir, thank you for fostering a liberal, critical, and innovative research environment that provides your students the roots to grow and the wings to fly. The independence you offer truly allows us to flourish. You package sage-like wisdom into every sentence, and these advices have helped me grow into myself as both a researcher and human being.

I offer an enormous thanks to all members of the Raz Lab for cultivating such a wonderfully curious working environment. Special thanks to everyone who has generously offered their time, knowledge, and effort to this project. Mathieu Landry, I extend infinite gratitude for your mentorship over the past several years. Your insight and advice, in life and lab, have proved invaluable. Dr. Samuel Veissière and Jay Olson, thank you for your unfailingly helpful suggestions (hypnotic or otherwise). Hayley Mortin and Charlene Zhang, thank you both for your devotion to this project and the time you committed to data collection, as well as the beautiful spirit you brought to our little team. David Milton, thank you for your coding help and for always staying ever so calm, cool, and collected. Angela, David R., Eléonore, Gary, Kayla, Kian, Jason, Léah, Michael, Raquel, Rémi, Robby, I appreciate all the laughs, advice, riveting discussions, and support (both technical and emotional). It was a remarkable privilege to work alongside such bright, inspired minds. I also grateful to to Dr. Naguib Mechawar for his guidance and support as graduate director, especially for his help when my concussed brain wasn't working so well.

Finally, thank you to my friends and family for their deep well of support and love.

Manuscript 1: Experimental study

Exploring the effect of cognitive load on conscious access to visual sensory inputs

Moriah Stendel[a], Mathieu Landry[b], David Milton[c], & Amir Raz[a, c, d, e]

[a] Department of Psychiatry, McGill University
[b] Department of Neuroscience, McGill University
[c] Department of Philosophy, McGill University
[d] Departments of Neurology & Neurosurgery, McGill University
[e] Institute for Community and Family Psychiatry of the Jewish General Hospital

Address for correspondence:
Institute for Community and Family Psychiatry
4333 Côte Ste Catherine
Montréal, QC H3T 1E4
Canada
E-mail address: amir.raz@mcgill.ca
Telephone: 514-340-8210

Abstract

Our conscious experience appears to be indescribably rich, yet certain paradigms consistently defy this intuition. This debate permeates the field of consciousness literature, with ample empirical support for both sides. Given that most evidence against a rich theory of consciousness is rooted in the notion that attention is requisite for conscious experience, the present study aims to examine how a cognitive load affects the richness of consciousness at both a cognitive and metacognitive level. Our study employs a modified Sperling task in tandem with a cognitive load; participants report on colours that appear in brief presentation while either remembering a string of characters (high-load condition) or not (no-load condition). We repeated this design across three tasks that capture conscious experience along a spectrum of sensitivity, from high precision responses to gist-based responses. Mixed linear models reveal that a cognitive load seems to affect the quality of the representation, not just access mechanisms. While our findings imply that a cognitive load impairs the richness of conscious perception in tasks that require goal-driven attention, rich conscious experience is preserved in the gist-based task, regardless of cognitive load. Metacognition appears to track the quality of the representation, as it is not impaired by the cognitive load. This suggests the existence of a phenomenal conscious experience that is available to gist and metacognitive reports, but that first-order reports with high spatial precision rest on attentional mechanisms. Further work is necessary to elucidate the relationship between access mechanisms, higher order representations, and gist perception.

Keywords: *consciousness, phenomenal consciousness, access consciousness, attention, iconic memory, phenomenology*

Introduction

We are all experts of our own minds, and at first glance, our conscious experience seems to be ineffably rich. As William James (1890) lyrically writes, “Our whole cubic capacity is sensibly alive; and each morsel of it contributes its pulsations of feeling dim or sharp, pleasant, painful, or dubious, to that sense of personality that every one of us unfailingly carries with him.” This intuition of a complex, continuous, consciousness is incredibly palpable – our experience is full, there are no gaping holes or patches of nothingness. However, despite the power of this intuition, some paradigms consistently defy it. This incongruity takes form as a scholarly debate between rich and sparse consciousness, and the jury is still out with compelling evidence for both sides. The present study engages with the rich vs. sparse discourse with a design that addresses certain methodological limitations of earlier work.

Here we examine whether our conscious experience, and subsequent metacognitive reports, are rich or sparse through a dual-task psychophysics experiment that consists of a modified Sperling paradigm combined with a cognitive load. The manuscript begins by recapitulating a brief history of consciousness research, from how the phenomenon is defined to how it can be empirically examined. Next, in order to situate our work within the existing literature, we cover the current state of affairs of the rich vs. sparse debate. We then present a section on our methodology, which comprises of information about the participants and recruitment, our measures, descriptions of the stimuli, and the empirical procedure. Finally, we analyze our results, present the findings, consider the limitations of our design, and discuss future directions.

1. Background

1.1 Consciousness

Consciousness is a phenomena that we know first-hand, yet remains incredibly elusive. We have privileged access to our own minds, however trying to package this intuition into a cogent definition proves challenging. Despite this difficulty, there exists a shared intuitive understanding of what consciousness is (Dennett, 2008), even if it simply means possessing a property that non-conscious beings or matter do not. This thread of intuition is woven through various aspects of consciousness, which range from awareness, sentience, wakefulness, subjectivity, selfhood, or the ability to experience (Chalmers, 1996). This section will explore definitions of consciousness and various approaches for the scholarly exploration of this phenomenon.

1.1.1 Defining consciousness

Attempting to define consciousness has been exiled to the realm of philosophy for most of the 20th century; many mainstream scientists avoided, or even rejected, consciousness as a field of study. Truly meaningful advancements have come from the armchair, including William James' *stream of consciousness* (1892), the notion of the *unconscious* or *subconscious mind* popularized by Freud (1912) & Helmholtz (1924), and the phenomenology of Husserl (1913) and Merleau-Ponty (1945). The philosophy of consciousness continued to flourish throughout the century, with discourse centered on functionalism (Rey, 1997; Putnam, 1960), the existence of *qualia* (Byrne & Tye, 2006; Chalmers, 2005; Dennett, 1988; Churchland, 1985; Jackson, 1982; Nagel, 1974), Chalmers' (2007) notorious "hard problem", embodied cognition (Hutto & Myin, 2012; Chemero, 2011; Gallagher, 2005; Noë, 2004; Fodor, 2000; Clark & Chalmers, 1998; Varela et al., 1991), and even artificial consciousness (Kurzweil, 2005). The past three decades have seen an explosion into the scientific inquiry of consciousness, uniting a variety of fields encompassing neuroscience, physiology, physics, and psychology

(Irvine, 2013). Despite this relatively recent 'empirical' exploration of consciousness, the field still strongly rests on its philosophical backbone.

Because of these numerous philosophical approaches to understanding consciousness, the scientific inquiry has been running without a singular, united definition. In the scientific context, definitions of consciousness tend to follow three modes of exploration: level of consciousness (wakefulness), contents of consciousness (awareness), and reflexive consciousness (selfhood). The first dimension addresses consciousness as a state of vigilance, that may be disturbed, abated, or absent in certain contexts, such as being comatose or asleep. Here, the emphasis is not on the content of the mind but rather the state of the mind; for instance, an amoeba has a fundamental structure that may lead to consciousness while a rock does not. Research strategies for understanding *level* of consciousness are often apophatic: they define consciousness by negation. For instance, a common avenue of study is through the observation of disorders of consciousness, such as locked-in syndrome, unilateral spatial neglect, or vegetative states. Behavioural and neuroscientific case studies in such patient populations have helped us understand level of consciousness as a spectrum (See figure 1). Due to the methodological challenges of case studies, researchers are beginning to use anesthesia to study the level of consciousness in a more procedurally rigorous manner (Blain-Moraes et al., 2015; Mukamel et al, 2014; Purdon et. al, 2013; Lewis et al., 2012; Forman & Chin, 2008).

The second definition denotes *awareness* or *contents* of consciousness, in that our conscious experience is always about something: the subjective experience of yellow, the feeling of a pain, or the sound of wind blowing through the trees. The study of contents of consciousness is often executed with the approaches of psychophysics and related methodologies, which we will explore in more detail in the section 1.1.2.

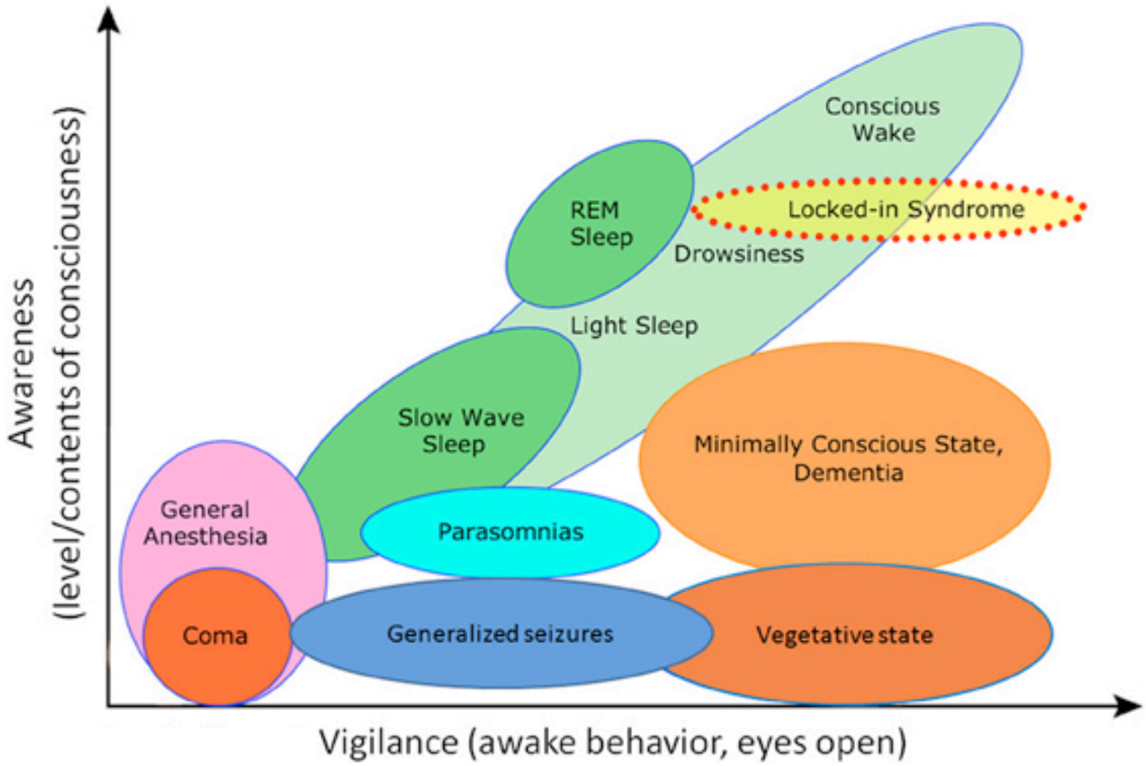


Figure 1: From Boly et al. (2013). Here we see examples of states of consciousness along two dimensions: wakefulness and awareness.

The final term considers consciousness as a locus of existence. In the centre of our mind there is a self-aware "I" that looks out at the world – the "spark that makes us *us*" (Granziano, 2013), or the "ghost in the machine" (Ryle, 1949). We live our lives as embodied subjects and agents that experience and act on the world around us. Here, the term 'consciousness' is not about how aware we are or what we are aware of, but the process of awareness itself. Research in this realm often focuses on the embodied experience, from *neurophenomenology* (Lutz & Thompson, 2003, Varela, 1996), to body ownership experiments, like the rubber hand illusion (Ehrsson et al., 2004).

While a final definition of consciousness has yet to be concretized, these various approaches have led to fruitful advances in our understanding of what it means to be conscious. In the context of this thesis, we center on the second definition of consciousness as awareness, and thus will employ the terms interchangeably. Given our focus on the contents of consciousness, the next section will provide a more detailed account of empirical strategies for research in this realm.

1.1.2 Methodological approaches to study the contents of consciousness

As for the study of *contents* of consciousness, without a "consciousness meter" that precisely measures our subjective experience (Chalmers, 1996), we rely on first-person report, using perception as a lens for human consciousness. This is often conducted through the well-developed methodology of *psychophysics*. The empirical emergence of this field is often attributed to the pioneering work of Gustav Fechner (Horst, 2010), who aimed to link subjective experience of mental contents with properties of physical stimuli (Fechner, 1860). To quantify our mental experience of a physical stimulus, psychophysics experiments vary physical properties of the stimulus and assess how these changes affect how the stimulus is experienced. For instance, a common approach is to determine a perceptual threshold by strengthening or weakening the strength of the stimulus.

Over the years, many researchers have honed in on this technique because it affords high control over the stimulus qualities, is temporally and spatially precise, provides numerous measures of experience, and lends itself well to present-day computational modeling techniques and neurophysiology. Ultimately, the principles of psychophysics provide researchers with a large playing field to explore many dimensions of conscious perception in an empirically rigorous manner.

A fundamental development in psychophysics was the mid-century application of Signal Detection Theory (SDT). Originally developed by radar researchers (Marcum, 1947), SDT was later applied to the field of psychology as a formal means of quantifying decision-making. Incorporating SDT into psychophysics allowed researchers to account for the uncertainty of binary decision-making, and that humans arrive at such decisions by discriminating the true signal from background noise (Anderson, 2015; Green and Swets, 1966).

Let us explore the basic principles of SDT with a dubious hypothetical situation. Imagine you stumble upon a completely fictional philosopher in the middle of Times Square with brightly coloured hair that appears to be either red or blue. A curious bystander asks if he had blue hair, and while you are uncertain, it either is blue (*signal present*) or is not (*signal absent*). Two factors are at play when you are trying to decide the hair colour of this hypothetical philosopher. Firstly, you must gather information in order to facilitate your decision; in this instance, your perceptual system would interpret the wavelength of light emitted from his head. *Sensory noise* interferes with this gathering of information – perhaps the bewildering lights from the billboards of Times Square temporarily blinded you, preventing you from catching a good glimpse. Signal and noise are both plotted as normalized probability distribution functions along an abstract decision axis:

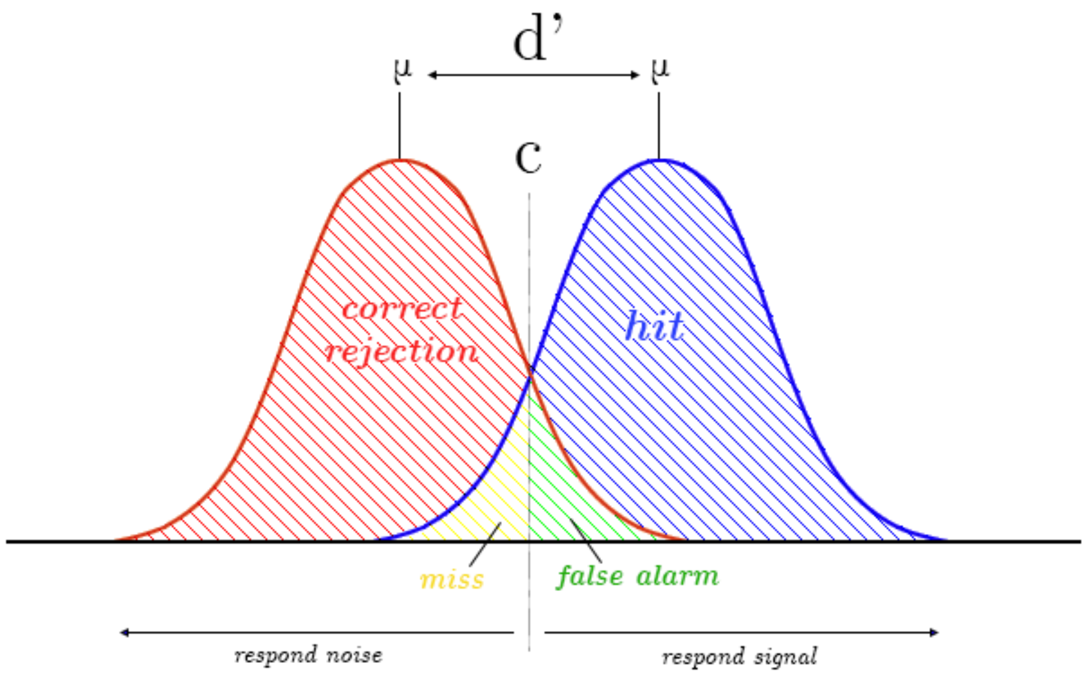


Figure 2: **Signal and noise plotted on an abstract decision axis. In the context of our example, the blue curve represents the probability distribution of the professor having blue hair, and the red curve of his hair not being blue. The difference between the means of these two curves give us our discriminability index (d'), a measure of discrimination sensitivity. To the right of the criterion (C), you respond 'blue', to the left you respond 'not blue'.**

Decisions within this structure are framed through two fundamental parameters, *discriminability index* (d') and *decision criterion*. D' denotes one's ability to discriminate between signals (Irvine, 2013) and is given by the distance between the means of the curves. For instance, if you were able to determine the hair colour of the fictitious psychologist with high accuracy (i.e., had high sensitivity to the stimulus), the d' would be higher than if there was ample sensory noise and your decision was imprecise. If a guess is no better than chance, d'=0 (Irvine, 2013). The second parameter, *decision criterion*, refers to the internal threshold by which one will say signal over noise. This component does not rest on the acquisition of information but rather personal bias or cognitive strategy. In the context of our example, you may harbor distaste for the colour blue and therefore be less likely to identify the philosopher's hair as such, regardless of the sensory signal you received.

The combination of these two parameters (d' and decision criterion) leads to four possible decision making outcomes: hit, miss, false alarm, and correct rejection (see figure 3). Or, in the case of this mythical philosopher's hair, you either 1) classify it as blue are correct (*hit*), 2) classify it red when it truly is blue (*miss*), 3) classify it as blue when it actually is red (*false alarm*), 4) correctly identify that it was red (*correct rejection*).

	RESPOND "PRESENT"	RESPOND "ABSENT"
STIMULUS PRESENT	Hit	Miss
STIMULUS ABSENT	False Alarm	Correct Rejection

Figure 3 **: Examples of the four decision-making outcomes in SDT.**

SDT does rely on report, and while some view subjective report as a methodological confound, others consider it an essential element of conscious awareness (Irvine, 2013). At present, experimental paradigms to probe the contents of consciousness rest on introspection, a notably tenuous phenomenon (Schwitzgebel, 2008; Costall, 2006; Johansson et al., 2006; Lyons, 1986; Danziger, 1970; Nisbett & Wilson, 1977).

Additionally, objective measures of performance such as SDT do not always reflect conscious experience, for instance, unconscious processing may improve task performance (Schütz et al., 2007; Todorov & Bargh, 2002). In an endeavour to address these concerns in SDT paradigms, researchers often use both *Type 1* and *Type 2* tasks. While a *Type 1* task involves discriminating the stimuli (as described above), a *Type 2* task has the participant discriminate whether their type 1 response was correct or incorrect, frequently via confidence ratings (Galvin et al., 2003; Clarke et al., 1959; Pollack, 1959). Type 2 tasks measure *metacognitive sensitivity (meta d'),* allowing researchers to paint a more comprehensive picture of a participant's conscious experience (Fleming & Lau, 2014). Beyond SDT, many researchers are developing methods to increase introspective accuracy and defend the contested validity of first-person report, with techniques like the *elicitation interview* (Froese, 2013; Petitmengin et al., 2013, Petitmengin & Bitbol, 2009), the *perceptual awareness scale* (Ramsøy and Overgaard, 2004) or even meditation (Fox et al., 2012).

To explore the contents of consciousness, the present study uses SDT to gather first-person reports of visual awareness as a proxy for conscious experience. Why vision? If I were to ask you to describe your conscious experience of this present moment, it is likely that a large proportion of your answer would be dedicated to a description of the visual world around you. The human brain reflects the predominance of sight, with nearly half of the cerebral cortex involved with vision in one way or another (Kandel et al., 2000). Given our strong understanding of the biological workings of the visual system, along with the high spatial and temporal accuracy of vision, the field of psychophysics has developed a heightened control of visual stimuli presentation and its relationship with sensation and perception. Accordingly, the present study follows the well-researched approach of psychophysics and SDT to probe the contents of conscious experience.

1.2 How rich is our conscious perception? The rich vs. sparse debate

"It is impossible to draw any sharp line of distinction between the barer and the richer consciousness…" – William James in the Principles of Psychology (1890)

William James wondered about the richness of conscious experience in 1890, and the question remains a conundrum for consciousness researchers today. So goes the lively debate of the field: is our conscious experience rich or sparse?

1.2.1 Background

Ned Block perhaps most famously operationalized the debate with his seminal definitions of *phenomenal consciousness* and *access consciousness* (Block, 2014; Block, 2011; Block, 2005). Phenomenal consciousness (p-consciousness) is the rich, high-capacity, subjective experience of sensations, perceptions, and emotions, or the 'what it's like' to *experience* qualia. Access consciousness (a-consciousness) refers to the subset of p-conscious contents that are accessed through cognitive functions such as attention or working memory. Block posits the *overflow argument*: that the contents of p-consciousness overflow the capacity of a-consciousness, i.e. we experience more than we can report. This model resonates with the human intuition that our conscious experience is rich; we do not see the world through a narrow spotlight of awareness but rather in a seemingly continuous and complex manner. This impression is amplified in certain instances; say viewing art or listening to music, where our experience feels richer than we could possibly report.

The overflow argument draws support from the work of the cognitive psychologist George Sperling. In his classic 1960 partial-report paradigm, Sperling very briefly presented participants with an array of letters in a 3x4 grid. Participants stated that they could see all of the letters, but were only able to report ~4.5 specific letters from the array of twelve. However, if Sperling played an auditory tone after the stimulus presentation that corresponded to the top, middle, or bottom row, participants were able to report ~3 letters from the four in the row that the tone signified. The participant had no way to know which row would be post-cued, therefore Sperling extrapolated that they were actually aware of ~9 letters in total – the experience was rich, but the report was sparse, limited to a capacity of ~3-5 letters. A common interpretation of the Sperling paradigm is the existence of *iconic memory,* a rapidly decaying yet high-capacity form of memory (Coltheart, 1980; Neisser, 1967). However we can also situate these findings in *overflow theory*: the phenomenal conscious experience of the entire letter array overflows cognitive access (Block, 2011).

A body of literature supports this notion that our phenomenal conscious experience is richer than, and distinct from, cognitive mechanisms. For instance, many scholars demonstrate a division between conscious awareness and attention, at the level of behavior (e.g. Bronfman et al., 2014; Dehaene et al., 2006; Woodman & Luck, 2003; Lamme, 2003; Baars, 1997; Hardcastle, 1997) and brain (e.g. Watanbe et al., 2011; Koch & Tsuchiya, 2007; Lamme, 2006; Block, 2005; Lamme, 2003; see Brascamp et al., 2010 for an overview). Recent studies are congruent with Block's p-consciousness/a-consciousness hypothesis, pointing to the existence of a rich conscious experience but a limited ability to report on it due to the restricted capacity of access mechanisms. Chen & Wyble (2015) show that despite achieving conscious awareness of a stimulus, the participant is still unable to report certain elements of it. Vandenbroucke et al. (2011) and Sligte et al. (2008) propose the notion of *fragile visual short-term memory* (fVSTM), a rich, high capacity memory store that is easily overwritten – this may correspond with Block's p-consciousness. Other studies validate the intuition of rich consciousness, from our highly detailed awareness of faces in a crowd (Kaunitz et al., 2016) to our ability to verbally describe briefly presented photographs (Fei-Fei et al., 2007).

Yet, despite all this, there are many instances when we are glaringly unaware of highly salient objects or changes in our field of vision. We fail to notice when two men in a photograph change hats or heads (*change blindness;* Simons & Levin, 1997), when the face we chose is swapped for the one we did not (*choice blindness;* Johansson et al., 2006); or even when a man in a gorilla suit walks directly through a scene (*inattentional blindness;* Simons & Chabris, 1999; Mack & Rock, 1998). Cases like this are some of the most promising evidence for the rich theory's counterargument – the sparse, or impoverished theory of consciousness. Proponents of the sparse theory do away with p-consciousness altogether, positing that access and awareness are one and the same, or that consciousness is entirely dependent on attention (Mack et al., 2016; Brown, 2014; Cohen e al., 2012; Cohen & Dennett, 2011; Prinz, 2010; Mack & Rock 1998; Posner, 1994).

According to the sparse theory, our intuitive experience of rich conscious awareness is but an illusion. This proposal is quite sensible given that perceptual illusions are abundant, especially in the visual field – for instance, the blind spot where the optic nerve meets the eyeball is filled in and we experience visual stability despite eye movements (O'Regan & Noë, 2001). The illusion that may explain the experience of richness has been coined the *refrigerator light illusion* (Block, 2011), which goes something like this: anytime we open the refrigerator, the light goes on, and so it may seem as though the light is on all the time. Likewise, every time we attend to something it instantly becomes rich and detailed, giving rise to the illusion that everything must be rich and detailed all of the time. De Gardelle et al., (2009) provide empirical support for the refrigerator light illusion. In their modified Sperling paradigm, they include unexpected pseudo-letters within the letter array, yet participants still report the subjective impression that they saw letters. This illusion is likely due to expectations and partially accessible information (De Gardelle et al., 2009).

Given the abundance of evidence for both sparse and rich consciousness, many scholars have theorized ways to mend the gap. Kouider et al. (2011) propose the *partial awareness hypothesis* to explain how our conscious experience can at once be both rich and sparse. This theory states that we can access information at different levels of hierarchical representation, where low levels (e.g. energy, geometric features, colours, etc.) and high levels (e.g. words, semantic content, etc.) are accessed independently. If this supposition holds true, such a theory could bridge the conflicting data. Alva Noë (2004) also attempts to reconcile rich and sparse consciousness via theories of embodied cognition, whereby the mind is embedded in the world around it. For Noë, the ostensible richness of experience is not due to rich mental representations but rather can be attributed to the rich world in which the mind is situated, a complex landscape abundant with details for each sensory organ to procure (Noë, 2004; see Prinz, 2009 for a discussion). Finally, others propose that gist perception (i.e. ensemble statistics) may the panacea of the rich-sparse debate (Haun et al., 2017; Ward, Bear, & Scholl, 2016; Bronfman et al., 2014). This ability to statistically summarize many components of a visual scene may explain the disparity between our phenomenal richness with the more concise summary information we can report. However, the findings in this domain still tend to favour either a rich (Ward et al., 2016) or sparse (Bronfman et al., 2014) explanatory model.

Save the invention of a mind-reading machine, the unresolved rich vs. sparse debate remains at somewhat of a methodological impasse. Block's p-consciousness is non-falsifiable and can always be explained by the *experience, lost access* (ELA) problem whereby a lack of report does not necessarily insinuate a lack of earlier experience (Aru & Bachmann, 2017, Chen & Wyble, 2015). In this case, the phenomenal conscious experience may occur without a corresponding report. This can also happen in reverse, where one gives a report without a corresponding preceding phenomenal conscious experience. For instance, confabulation occurs in change and choice blindness, where we report on a conscious experience that we never had (Moscovitch, 1995). Given these methodological challenges, there is a push in the field to move beyond binary forced choice paradigms and high-level categorical properties of visual experience (Haun et al., 2017). The present study endeavours to fulfill this call for more nuanced design while remaining rooted in the methodologically robust field of SDT.

1.2.2 The Present Study

We engage in the rich vs. sparse debate using a dual-task paradigm, whereby participants perform a modified Sperling task with colour stimuli either with or without a cognitive load. Why colours rather than the higher-order letter stimuli characteristic of most Sperling tasks? Colour is one of the most notable examples of qualia – try describing the colour red to a person with deutreranopia who has never experienced it before. While letters require higher-order cognitive mechanisms to process (we first must perceive the visual energy, the geometric figures, assemble them together into a packaged unit, and then connect this geometrical unit with an abstract concept that corresponds with a particular phoneme), colour is an immediate, non-semantic experience, and thus, an ideal tool for the exploration of p-consciousness. Colour also allows us to shift away from binary, categorical, forced-choice tasks. In one component of the present experiment, we have participants identify a colour from the array using a colour wheel, allowing for a continuous non-categorical response. When we do present participants with a forced-choice question (was a certain colour present/absent), we display the colour visually rather than as a semantic category. Additionally, unlike most modified Sperling paradigms, we have a within-subjects task manipulation, where one task has a post-cue and the other does not. This allows us to determine whether attention is necessary for the awareness of the colours or simply for their access. The present study also attempts to address inter-individual differences in the richness of conscious experience, an element that the literature has largely ignored. Ultimately, the current experience strives to test whether a cognitive load affects the phenomenal conscious experience or the subsequent access of this experience, and if inter-individual variance is at play.

2. Methodology

2.1 Participants

Participants (n=39) were McGill University students ranging in age from 18-26 (mean age of 20.5 years) and were predominately female (30 females, 9 males). We randomly assigned participants to either a No-Load condition (n=21) or a Load condition (n=18). We excluded 12 participants from the data set, 8 before data analysis and 4 afterwards (for a list of exclusion rationale, see Appendix A). Inclusion criteria consisted of having normal or corrected vision, normal visual memory, and following task instructions. To recruit participants, we used the SONA participant pool, whereby students received two course credits as compensation for their two-hour participation in our study.

2.2 Design & Measures

The present study is a mixed-design, with a between-groups cognitive load manipulation and within-group task manipulation (each participant performed three separate tasks). Furthermore, in order to explore inter-individual differences in the richness of conscious awareness, all participants completed additional measures, consisting of an abridged Big Five Questionnaire, an Artistic Experience Questionnaire, and a Navon task. Appendix B features the stimuli and example trial sequences. Appendix C features the questionnaires.

2.2.1 Cognitive Load Manipulation

In order to better understand the relationship between access mechanisms and conscious experience, we use the well-researched method of manipulating cognitive load (Swallow & Jiang, 2013; Posner, 2012). Cognitive resources are limited (Cohen et al, 2012; Posner et al., 1980; Norman & Bobrow, 1975). A cognitive load draws from these finite resources, and thus explicates whether access mechanisms are sufficient or necessary to explain phenomenal consciousness. We randomly placed half the participants in a high-load group and the other half in a no-load group. In the high load condition, every trial of each task commenced with a series of five random letters or numbers to remember throughout the trial. To ensure the participant devoted attention to the cognitive load, we performed an 'attentional check' at the end of each trial wherein we asked participants if a certain letter or number was present in the original string. Trials where the attentional check revealed that the participant was not recruiting cognitive mechanisms (i.e. answered wrong) were removed. In contrast, participants in the no-load position were presented with the letter X five times.

2.2.2 Colour Identification Task (TASK A)

According to Haun et al. (2017), "the richness of visual experience has been neglected by psychologists who traditionally emphasize button pressing and categorization, and who have focused too much on high-level, categorical properties of visual experience." In response to this, we designed the *Colour Identification Task* (Task A) with the intent of probing conscious awareness in more sensitive, precise manner. This task consists of briefly presenting participants with colour stimuli, post-cueing them to a particular location in their visual experience, and having them respond to the colour they experienced at that location. However, rather than a binary forced-choice, t`he participants report the colour by selecting a point on a colour wheel. In analysis, we can render colour in the three-dimensional, perceptually uniform CIE l*a*b colourspace and calculate the distance (ΔE) between the colour we presented and the reported colour (Robertson, 1977; see figure 4). These continuous data provide far richer information than do binary forced-choice tasks: rather than knowing whether a participant is correct or incorrect, we can determine how close or far their answer is.

2.2.3 Colour Discrimination Task with Post Cue (TASK B)

This task is similar to Task A, however it follows a more classic SDT paradigm.

$$\Delta E^*_{ab} = \sqrt{(L^*_2 - L^*_1)^2 + (a^*_2 - a^*_1)^2 + (b^*_2 - b^*_1)^2}$$

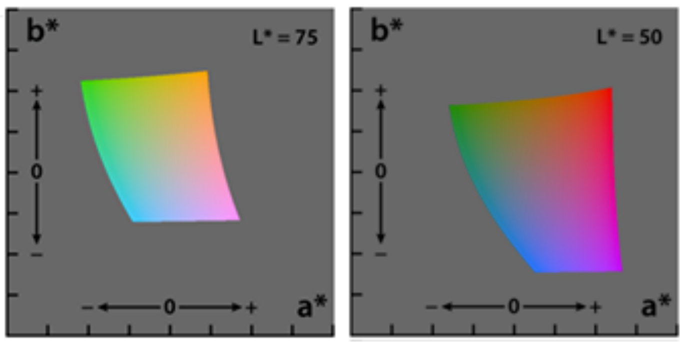


Figure 4: **(top) The 1976 ΔE colour distance formula, which calculates the distance metric between (L1, a1, b1) and (L2, a2, b2), two colours in CIE L*a*b colour space, where L designates lightness, a the colour opponents green-red, and b blue-yellow. (bottom) Two renderings of CIE L*a*b 3d colour space with respective luminance of 75 and 50 (Rus, 2007).**

We briefly present participants with colour stimuli, post-cue them to a particular location in their visual experience, and then display a colour and ask if it was present or absent at that specific location to measure their discrimination sensitivity (d'). Following that, we probe their metacognitive sensitivity (meta d'*)*, asking if they were confident or not confidence in their answer.

2.2.4 Colour Discrimination Task without post-cue (TASK C)

This task is identical to Task B except it omits the post-cue. This allows us to better understand the effect cognitive load has on conscious awareness and where this effect takes place. By comparing performance on Task B and Task C, we can determine if a cognitive load interferes with our ability to process the post-cue, or if it blocks our phenomenal conscious experience altogether. This condition can also help us better understand the effect of load on gist-based awareness compared to location-specific awareness, as in Task B.

2.2.5 Big Five

Personality traits are linked to an individual's sensory perception and phenomenological experience, such as the vibrancy of colour imagery (Hossain et al., 2015), ability to imagine objects (Vannucci & Mazzoni, 2009), experience of scents (Chen & Dalton, 2005), and the vividness of mental imagery (McDougall & Pfeifer, 2012). Given the evidence for a relationship between personality and the richness of conscious experience, we decided to assess personality as an adjunct to the Sperling task.

To measure personality, we use the five-factor model (FFM), also known as the "Big Five", the gold-standard taxonomy of traits in the field of personality research (John & Srivastava, 1999). Established by Costa & McRae in 1985, the FFM used factor analysis on personality survey data to identify five broad dimensions that explain the majority of variance: agreeableness, conscientiousness, extraversion, neuroticism, and openness to experience (see figure 5).

Big Five Dimensions	Facts (and correlated trait adjective)
Extraversion vs. introversion	Gregariousness (sociable), assertiveness (forceful), activity (energetic), excitement-seeking (adventurous), positive emotions (enthusiastic), warmth (outgoing)
Agreeableness vs. antagonism	trust (forgiving), straightforwardness (not demanding), altruism (warm), compliance (not stubborn), modesty (not show-off), tender-mindedness (sympathetic)
Conscientiousness vs. lack of direction	competence (efficient), order (organized), dutifulness (not careless), achievement striving (thorough), self-discipline (not lazy), deliberation (not impulsive)
Neuroticism vs emotional stability	anxiety (tense), angry hostility (irritable), depression (not contented), self-consciousness (shy), impulsiveness (moody), vulnerability (not self-confident)

Openness vs closedness to experience	ideas (curious), fantasy (imaginative), aesthetics (artistic), actions (wide interests), feelings (excitable), values (unconventional)

Figure 5: **From John & Srivastava, 1999. The big five dimensions and their trait adjectives.**

To assess personality along the FFM, we administered the Big Five personality inventory (BFI), a 44-item self-report inventory that measures an individual on each Big Five dimension (John & Donahue, 1991; See Appendix C). We specifically tested the trait of Openness, which is associated with artistic experience (Dollinger et al., 2004).

2.2.6 Artistic Experience Questionnaire

Previous research reveals that artists differ from non-artists in several ways, such as looking patterns or cortical integration (Ostrovsky et al., 2013; Perdreau & Cavanagh, 2013; Kozbelt, 2010; Patterson, 2010). Given that musicians can more finely distinguish musical tones than non-musicians (Parbery-Clark, 2012; Lee et al., 2009; Parbery-Clark, 2009; Musacchia, 2007; Perrot et al, 1999), it is plausible that artists possess a more complex and elaborate phenomenological experience of colour than non-artists. Following this body of literature, we administered the Art Experience Questionnaire (AEQ), a screening questionnaire to determine the art experience of each participant in a variety of domains, from fine arts, art history, art theory, and engagement with art institutions (Chatterjee et al., 2010). The AEQ is featured in Appendix C.

2.2.7 Navon's Global-Local Task

Navon's (1977) global-local task is a widely used measure of global vs. local processing style. In this classic task, participants are presented with distinct letter figures whereby a larger (*global*) letter is constructed from smaller (*local)* letters – we used the letters "H" and "S", as per Zmigrod et al. (2015). The global letter and local letters can be congruent or incongruent establishing four possible figure types: global H/local H, global S/local S, global H/local S, global S/local H (See Appendix B for figures). For half of the trials, participants complete the *global task*, where they identify the letter of the global figure. For the other half, they complete the *local task* and identify the letter at the local level. These tasks allow us to obtain three measures that are useful in understanding cognitive style.

The first measure is the *global precedence effect*: most people have quicker reaction times (RTs) and greater accuracy in the global task than the local task, but the size of this bias varies inter-individually (Zmigrod et al. 2015; Dale & Arnell, 2013). The second measure is the *global interference effect:* to what extent is performance (RTs and accuracy) on local task disrupted by incongruent information at the global level? Finally, the *local interference effect* measures the extent that the global task is affected by incongruent information at the local level.

The results of the Navon task have been linked to a variety of factors, such as culture (Colzato et al., 2010; Lao et al., 2013), mood (Gasper & Clore, 2002), age (Thomas et al., 2007), or creativity (Zmigrod et al., 2015); and abnormal Navon scores are present in clinical populations of people with autism spectrum disorder (Plaisted et al., 1999), depression (de Fockert & Cooper, 2014), schizophrenia (Johnson et al., 2005), and obsessive compulsive disorder (Moritz & Wendt, 2006). Given the spatial component of any Sperling task, assessing global vs. local processing style can provide insights into inter-individual differences in visual awareness.

2.3 Apparatus & Stimuli

Participants viewed the trial sequence on a 46-cm monitor from approximately 60cm. All stimuli were presented against a grey background. The fixation cross was black, directly centered, and 0.95° x 0.95°. The characters in the cognitive load were 2.86° tall and 2.86° wide, in the standard sans serif font Arial. The colour stimuli were presented as six squares (3.8° x 3.8°) in a circle (each 2.8° from the centre point of the screen). To abate the need for a backward-mask, which may disrupt iconic memory (Becker, et al., 2000; Sperling, 1960) we rendered the colour stimuli isoluminant with one another and the grey background. Luminance is a photometric measure of the light emitted from a particular area, thus by equalizing the luminance of the stimuli and background we selectively recruit cone photoreceptors cells, essentially rendering the stimuli invisible to the more photosensitive rod cell (Sligte et al., 2008). While rods integrate visual information slowly, cones respond to visual information with quick spikes of activity, thus solely enlisting cone receptors greatly diminishes retinal persistence (Sligte et al., 2008). The colour stimuli were randomly selected each trial from an isoluminant colour wheel, with a minimum distance of 20 degrees. Participants used this same colour wheel to input their response; it appeared on screen with an outer diameter of 10.85° and an inner diameter of 7.13°. The post-cue was the outline of a square (3.8° x 3.8°) at one of the six locations where the coloured squares appeared. All questions and responses were in the standard sans serif font Arial, all capital letters. The Navon letters were 8.5° high x 6.5° wide composed of smaller letters that were 0.95° x 0.95°.

2.4 Procedure

Upon arrival to the lab, participants gave informed consent to participate in the study. After this, they filled out the abridged Big Five questionnaire and the AEQ. Before each task, participants were given verbal instructions. Each trial began with the presentation of a fixation cross (750ms), which was replaced by the cognitive load of five characters presented one after another for 250ms each. During the presentation of the final two characters, we presented the colour stimuli for 500ms. In Task A and Task B, we displayed the post-cue for 200ms. For Task A, this was followed by the presentation of the colour-wheel, on which the participant would manipulate the mouse to select the colour that was at the location of the post-cue. We rotated the colour-wheel at a random degree each trial to prevent response bias. The color-wheel remained on the screen until the participant inputted a response. After this, we performed the cognitive load check, whereby we presented participants with a character and asked whether this character was present or absent in the original string from the start of the trial. They answered by pressing corresponding keys on the keyboard (F for the left answer, J for the right). Again, the position of the responses was counterbalanced. The answer was "present" for half the trials and "absent" for the other half. Inter-trial interval was 650ms. Participants performed 125 trials of the Task A paradigm over 5 testing blocks.

In Task B, after the post-cue, we presented the participant with a coloured square and asked them to report if this colour was either present or absent at the post cue. They answered by pressing corresponding keys on the keyboard (F for the left answer, J for the right). The position of the responses was counterbalanced. The answer was "present" for half the trials and "absent" for the other half. This question remained on the screen until the participant responded. After this, we presented the participant with a metacognitive question about their performance: "How confident were you?" in which they would press corresponding keys on the keyboard (F for the left answer, J for the right) to input the answer "confident" or "not confident". We counterbalanced the position of these answers so that "confident" appeared on the left side of the screen for half the participants and on the right side for the other half. Again, this question remained on screen until the participant responded. This followed with the cognitive load check, with the same structures as in Task A. Inter-trial interval was 650ms. Participants performed 200 trials of the Task B paradigm over 4 testing blocks.

Task C followed the same structure as Task B however without a post-cue, thus participants were asked whether a colour was present at any location or entirely absent. Inter-trial interval was 650ms. Participants performed 200 trials of the Task C paradigm over 4 testing blocks.

Task order was counterbalanced. Participants were asked to maintain central fixation and to respond as fast and accurately as possible and received a short break between each task. Participants completed 10 practice trials before each task with the opportunity to ask questions after the practice period. Appendix B contains sample trial sequences.

After each participant performed the three tasks delineated above, they completed the Navon Task – 96 of a 'local' task and 96 trials of a 'global' task, the order of which we counterbalanced. In the local task the participants would respond as to whether the smaller letters that made up the larger letters were S or H by pressing the corresponding key on the keyboard. In the global task, participants would answer whether the larger letter was an S or H by pressing the corresponding key on the keyboard. We instructed participants to answer each trial as quickly as possible.

Following the computer tasks, we debriefed participants.

3. Results

We analyzed the data with R using the lme4 package. For each variable, we fitted several models and tested them against each other using a Chi-Squared test to measure the goodness of fit of the model. All models are summarized in Appendix D.

3.1 Colour Identification Task (Task A)

We applied two linear mixed models to the ΔE scores of participants. A Chi-Squared test demonstrated that load is a significant predictor of ΔE scores ($p=0.02369$, $\beta/\text{standard error}_{(\beta)}= 2.276$). In other words, participants in the load condition had significantly higher ΔE scores than participants in the no-load condition. Given that ΔE is a score of sensitivity – a more precise response is closer to ΔE=0 – a cognitive load appears to affect the quality of one's mental representation of colour, reducing its richness.

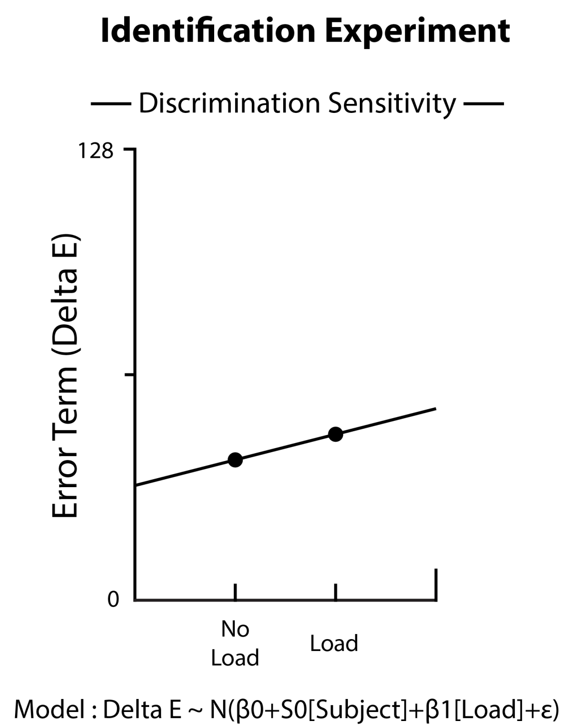


Figure 6: **Main effect of load on delta E scores, where participants had less precise responses when faced with a cognitive load.**

3.2 Colour Discrimination Tasks (Task B and Task C)

3.2.1 Decision Criterion

We applied four linear mixed models to the decision criterion of participants. A Chi-Squared test revealed that task was a highly significant predictor of decision criterion, $\chi^2(1) = 46.4699$, $p = 9.304 \times 10^{-12}$. Thus, participants used a more conservative decision criteria in Task B, the post-cued task, than in Task C, the non-cued task.

3.2.2 D'

We applied four linear mixed models to find the parameters that best predicted d'. A Chi-Squared test showed that the most predictive model (m2) included the parameters task and load ($\chi^2(1) = 4.0028$, $p = 0.04537$). In other words, the between-groups load manipulation (no load vs. high load) and within-groups task manipulation (task B vs. task C) predict participants' discrimination sensitivity, although load is a far stronger predictor (β/standard $\text{error}_{(\beta)}$= -2.00) than task (β/standard $\text{error}_{(\beta)}$= 1.022). Given this, and the fact that the fourth model (m3) trends toward significance (p=0.07303), it is unclear as to whether or not a task by load interaction is driving this effect.

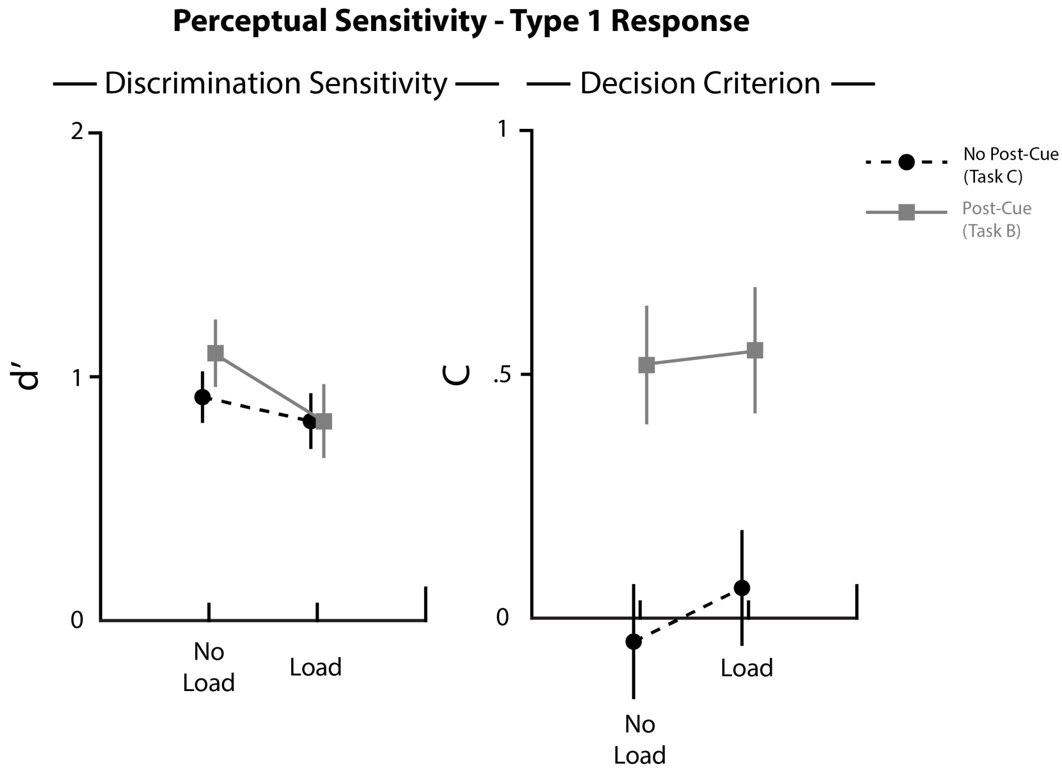


Figure 7: **(left) This figure demonstrates the Sperling partial report effect – accuracy of report is boosted by a post-cue. Additionally, participants have poorer discrimination sensitivity (d') under a cognitive load manipulation, i.e., it is more difficult for them to discern between signal and load when their attention is engaged. The graph indicates a possible task by load interaction that we lack the statistical power to pull out. (right) Here we see the different decision criteria used between tasks, with a stricter criterion in Task B.**

3.2.3 Metacognitive Sensitivity as a Predictor of Discrimination Accuracy

We applied seven linear mixed models to determine whether we can use meta d' to predict discrimination accuracy of participants, i.e. their ability to accurately discriminate whether a certain colour was present or absent. A Chi-Squared test revealed that a model with the following parameters best predicts accuracy: meta d', task, load, accuracy-by-task interaction, accuracy-by-load interaction, and task-by-load interaction ($\chi^2(1) = 16.7031$, $p = 4.371 \times 10^{-5}$). The significant predictors of this model include the parameters of meta d' (β/standard $error_{(\beta)} = 2 \times 10^{-16}$, meta d' by task interaction (β/standard $error_{(\beta)} = 0.0140$), and a task by load interaction (β/standard $error_{(\beta)} = 4.43 \times 10^{-5}$). However, meta d' is a notoriously difficult model to fit, therefore this model lacks precision; it is difficult to disentangle whether a change in slope is due to metacognitive sensitivity or metacognitive criterion.

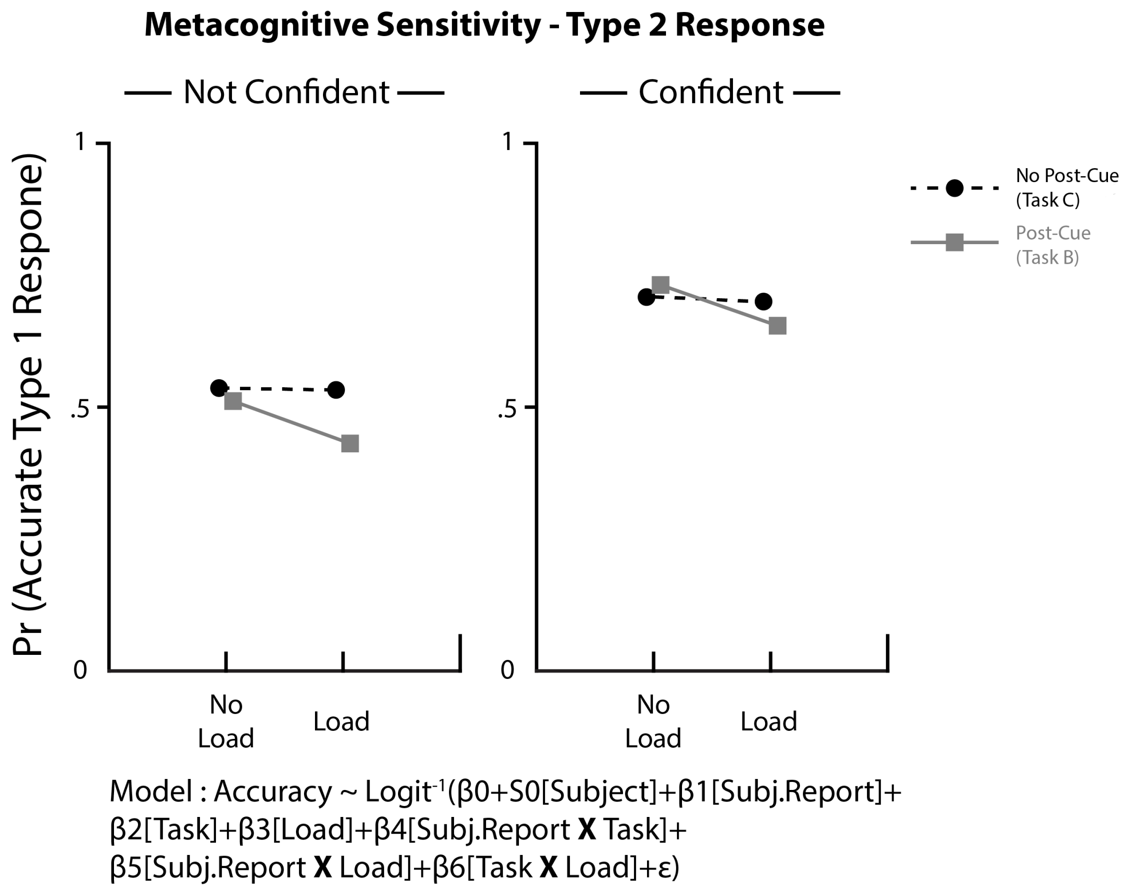


Figure 8: **Here we see that metacognitive responses (confidence ratings) significantly predict an accurate type 1 response.**

3.2.4 Inter-individual differences

We attempted to use the Navon global precedence score as a predictor of d' however the only significant model (p=0.03998) also included the parameters of task and load, and the fixed effect of the Navon global precedence score was low (β/standard $\text{error}_{(\beta)}$= 0.446), insinuating that global precedence does not predict d'.

We applied six linear mixed models to determine if the Big Five trait of Openness can predict discrimination sensitivity of participants. A Chi-Squared test revealed that a model with the parameters of task, load, and openness best predict d' (p=0.0449).

However, the fixed effect of Openness was low (β/standard $error_{(\beta)}$= 0.239), therefore being higher on the trait of Openness does not predict d'.

Finally, we applied six linear mixed models to determine if AEQ score could predict d'. A Chi-Squared test showed that the most predictive model included the parameters AEQ, task, and load (p= 0.02523). However, once again the fixed effects of our inter-individual measure, AEQ score, was low (β/standard $error_{(\beta)}$= 1.421), indicating that higher AEQ scores do not predict better discrimination sensitivity.

4. Discussion

The three tasks in our experimental paradigm represent a spectrum of sensitivity, ranging from high precision to a more gist-based approach. Task A has participants select the precise colour they experienced via a colour wheel, providing a highly sensitive continuous measure. Task B still requires participants to report about a particular spatial location of their visual experience, however through a less sensitive binary forced choice. Task C captures a gist-like form of perception, wherein participants report about their experience in a more holistic manner.

Given that the cognitive load manipulation reliably interacted with d' on Task B but not Task C, load seems to affect access mechanisms only under conditions where we post-cue. The higher d' in the post-cued task (B) is consistent with the Sperling paradigm (1960) whereby a post-cue toward a specific aspect of one's conscious experience boosts performance. This finding is also consistent with previous work in the field, which demonstrates that goal-driven attention is sensitive to cognitive load (Jonides, 1981). Our access mechanism is a post-cue, thus relies on combined attention (Landry & Ristic, 2015), and therefore is affected by our cognitive load manipulation. More specifically, we demonstrate the mechanism a participant uses to access the iconic memory representation is different between the two tasks, resting more on the impeded goal-driven attention in Task B. One may speculate that whereas the post-cue rests on attention, the response in Task C rests on a probability estimate (explored in section 1.2.1, see also Haun et al., 2017; Ward et al., 2016; Bronfman et al., 2014). This speculation is further supported by our findings that indicate that participants adopt different cognitive strategies as a function of task, holding a more conservative decision criterion when attention was oriented to a post-cued location.

We extend our replication of the Sperling effect with our findings from the identification task (task A) where participants were required to provide a highly sensitivity response measured by ΔE. As mentioned earlier, this continuous response provides us with a more precise measure of mental representation. The data clearly demonstrate that load affects the quality of the representation, not only access mechanisms.

However, while type 1 error is affected by load, type 2 responses are not – meta-d' is different across tasks but there is no effect of load. We found that the post-cue improves metacognition; possibly because the post-cue reduces variance enormously therefore a participant can build a more reliable higher order representation. Moreover, the absence of interaction with load suggests that this higher order representation does not rely on goal-driven, endogenous access mechanisms but rather some form of holistic representation or computation of variance. In addition, because we found that load affected the strength of the evidence (i.e. accuracy and d'), our findings support this idea that higher order representation rests on the quality of the representation and not necessarily the strength of evidence, because otherwise the load should impair metacognition. Our findings clearly demonstrate that there is no effect of load and that higher order representations rest on a phenomenal conscious experience – metacognition tracks the Sperling effect.

None of our inter-individual measures – Navon, AEQ, and Big 5 scores – predicted discrimination accuracy. This may be due to our sample size or the fact that these are not very precise measures. Further work with more pointed hypotheses may employ multiple questionnaires or increased trial numbers in the Navon task.

Ultimately, our findings support a rich view of conscious experience, whereby p-consciousness is available to gist or metacognitive reports, but that first-order reports with high spatial precision rest on attentional mechanisms.

Limitations

A main limitation of our study design is the fact that both elements of our dual-task are relevant: although the cognitive load ostensibly consumes the attentional resources of a participant, the Sperling paradigm is still task-relevant, and thus one devotes attentional resources to it, even if only minimally. In this sense, the Sperling task in the high-load condition is not ‘attention-free’. Although many studies on the relationship between attention and consciousness use a cognitive load strategy (Lavie et al., 2014; Cohen et al., 2012; Cartwright-Finch & Lavie, 2007; Koch & Tsuchiya, 2007), alternative methodological approaches do exist, for instance the task-ratio approach of Mack, Erol & Clarke (2015).

Another limitation is that the study features a high number of exclusions. While we feel as though our exclusion rationale is justified (see Appendix A), the more participants are excluded, the harder it is to see whether the results are from the data or due to arbitrary exclusion criteria (Simmons, 2011).

More generally, our study falls prey to what is sometimes coined the W.E.I.R.D. problem: like many psychology experiments, our sample is based on a population that is overwhelmingly Western, educated, and from industrialized, rich, and democratic countries (Brookshire, 2013). This restricted sample population limits the extent to which we can extrapolate our findings.

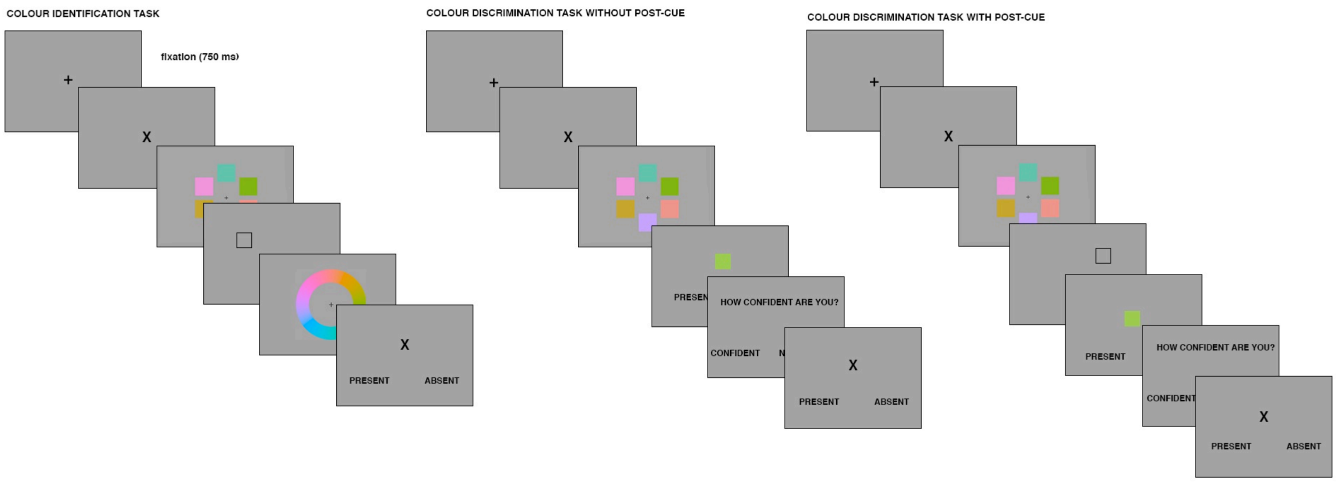
Future Directions

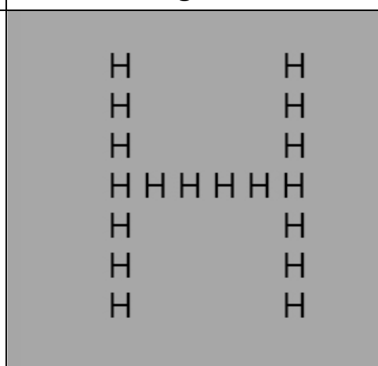
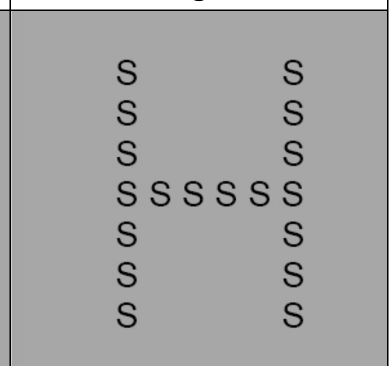
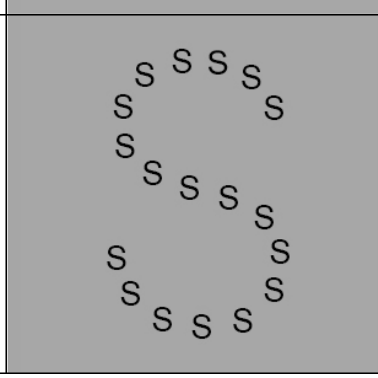
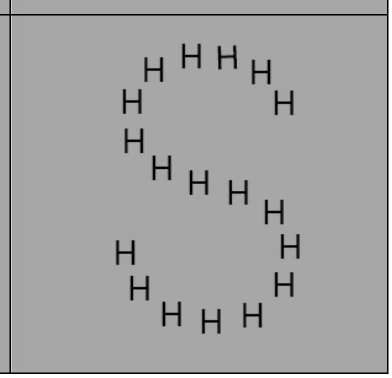
This study opened the possibility that load manipulations not only affect access mechanisms but also the quality of the representation itself. Given this, it may be interesting for further research to explore the relationship between these two components. More generally, our colour-wheel task represents a shift towards continuous decision-making paradigms in contrast with the forced choice binary that is conventional in the field. Future studies that examine the richness of conscious awareness can implement similar non-binary strategies in order to gain more precise and sensitive information about one’s conscious experience.

APPENDIX A - Exclusion Rational

Exclusion Rational		
Number of participants excluded	**Reason for exclusion**	**Excluded before or after data analysis**
3	Below chance accuracy on attention task, therefore we could not ensure that the cognitive load manipulation was effective	After
2	Fell asleep	Before
2	Experimenter ran the wrong task	Before
1	Reported strong afterimages	Before
1	Answered ‘not confident’ for every trial	After
1	Reported that they did not understand the instructions at the end of the study	Before
1	Ran out of time to perform the final task	Before
1	Reported a visual memory learning disability	Before

APPENDIX B- Trial Sequences & Stimuli Examples



NAVON FIGURES		
	Congruent	**Incongruent**
H		
S		

APPENDIX C – Questionnaires

C1. Art Experience Questionnaire:

1. How many studio art classes have you taken at the high school level or above?
   0 1 2 3 4 5 6 or above

2. How many art history classes have you taken at the high school level or above?
   0 1 2 3 4 5 6 or above

3. How many art theory or aesthetics classes have you taken at the high school level or above?
   0 1 2 3 4 5 6 or above

4. On average, you visit art museums about once every:

Almost never	year	6 months	2 months	month	week
(0)	(1)	(2)	(3)	(4)	(5)

5. On average, you visit art galleries about once every:

Almost never	year	6 months	2 months	month	week
(0)	(1)	(2)	(3)	(4)	(5)

6. In the average week how many hours do you spend making visual art?
   0 1 2 3 4 5 6 or more

7. In the average week how many hours do you spend reading a publication that is related to visual art?
   0 1 2 3 4 5 6 or more

8. In the average week how many hours do you spend each week looking at visual art?
   0 1 2 3 4 5 6 or more

9. What is your gender?
   M F

10. What is your age?
    ____

11. What is the highest level of education that you have completed?
    ____

12. Do you have any visual impairments?
    ____

C2. Big Five Inventory

How I am in general

Here are a number of characteristics that may or may not apply to you. For example, do you agree that you are someone who *likes to spend time with others*? Please write a number next to each statement to indicate the extent to which **you agree or disagree with that statement.**

1 Disagree Strongly	2 Disagree a little	3 Neither agree nor disagree	4 Agree a little	5 Agree strongly

I am someone who…

1. _____ Is talkative
2. _____ Tends to find fault with others
3. _____ Does a thorough job
4. _____ Is depressed, blue
5. _____ Is original, comes up with new ideas
6. _____ Is reserved
7. _____ Is helpful and unselfish with others
8. _____ Can be somewhat careless
9. _____ Is relaxed, handles stress well.
10. _____ Is curious about many different things
11. _____ Is full of energy
12. _____ Starts quarrels with others
13. _____ Is a reliable worker
14. _____ Can be tense
15. _____ Is ingenious, a deep thinker
16. _____ Generates a lot of enthusiasm
17. _____ Has a forgiving nature
18. _____ Tends to be disorganized
19. _____ Worries a lot
20. _____ Has an active imagination
21. _____ Tends to be quiet
22. _____ Is generally trusting
23. _____ Tends to be lazy
24. _____ Is emotionally stable, not easily upset
25. _____ Is inventive
26. _____ Has an assertive personality
27. _____ Can be cold and aloof
28. _____ Perseveres until the task is finished
29. _____ Can be moody
30. _____ Values artistic, aesthetic experiences
31. _____ Is sometimes shy, inhibited
32. _____ Is considerate and kind to almost everyone
33. _____ Does things efficiently
34. _____ Remains calm in tense situations
35. _____ Prefers work that is routine
36. _____ Is outgoing, sociable
37. _____ Is sometimes rude to others
38. _____ Makes plans and follows through with them
39. _____ Gets nervous easily
40. _____ Likes to reflect, play with ideas
41. _____ Has few artistic interests
42. _____ Likes to cooperate with others
43. _____ Is easily distracted
44. _____ Is sophisticated in art, music, or literature

APPENDIX D – Mixed Linear Models

Delta E				
Model	**Parameters**	**BIC**	**CHI 2**	**P – value**
M0	Subject	45998		
M1	Load + Subject	46001	5.1174	0.02369*

Decision Criterion				
Model	Parameters	BIC	CHI 2	P – value
M0	Subject	88.195		
M1	Task + Subject	46.082	46.4699	9.304×10^{-12} ***
M2	Task + Load + Subject	49.596	0.8430	0.3585
M3	Task + Load + Task:Load + Subject	52.528	1.4246	0.2327

D’				
Model	**Parameters**	**BIC**	**CHI 2**	**P – value**
M0	Subject	62.743		
M1	Task + Subject	66.043	1.0569	0.30392
M2	Task + Load + Subject	66.394	4.0048	0.04537*
M3	Task + Load + Task:Load + Subject	67.538	2.2135	0.07303

Accuracy as a function of meta-d’				
Model	**Parameters**	**BIC**	**CHI 2**	**P – value**
M0	Meta-d’ + Subject	15.882		
M1	Meta d’ + Task + Subject	15.889	2.8211	0.093035
M2	Meta d’ + Task + Load + Subject	15.890	8.0728	0.004493 **
M3	Meta d’ + Task + Load + meta d’:Task + Subject	15.894	6.0600	0.013827*
M4	Meta d’ + Task + Load + Meta d’:Task + meta d’: load + Subject	15.903	0.0737	0.786024
M5	Meta d’ + Task + Load + Meta d’:Task + meta d’:load + task:load + Subject	15.896	16.7031	4.371×10^{-5} ***
M6	Meta d’ + Task + Load + Meta d’:Task + meta d’:load + task:load + Subject	15.905	0.3913	0.531608

D’ as a function of Navon global precedence score				
Model	**Parameters**	**BIC**	**CHI 2**	**P – value**
M0	Navon + Subject	67.099		
M1	Navon + Task + Subject	70.339	1.0569	0.30392
M2	Navon + Task + Load + Subject	70.537	4.2189	0.03998*
M3	Navon + Task + Load + Navon:Task + Subject	73.113	1.7807	0.18207
M4	Navon + Task + Load + Navon:Task + Navon:Load + Subject	77.448	0.0216	0.88308
M5	Navon + Task + Load + Navon:Task + Navon:Load + Task:Load + Subject	79.328	2.4763	0.11557
M6	Navon + Task + Load + Navon:Task + Navon:Load + Task:Load + Navon:Task:Load + Subject	83.325	0.3594	0.54884

D’ as a function of Openness				
Model	**Parameters**	**BIC**	**CHI 2**	**P – value**
M0	O Score + Subject	67.040		
M1	O Score + Task + Subject	70.339	1.0569	0.3039
M2	O Score + Task + Load + Subject	70.674	4.0225	0.0449*
M3	O Score + Task + Load + O Score:Task + Subject	74.045	0.9848	0.3210
M4	O Score + Task + Load + O Score:Task + O Score:Load + Subject	77.353	1.0487	0.3058
M5	O Score + Task + Load + O Score:Task + O Score:Load + Task:Load + Subject	78.861	2.8495	0.0914

D’ as a function of AEQ Score				
Model	**Parameters**	**BIC**	**CHI 2**	**P – value**
M0	AEQ + Subject	65.973		
M1	AEQ + Task + Subject	69.273	1.0569	0.30392
M2	AEQ + Task + Load + Subject	68.622	5.0077	0.02523*
M3	AEQ + Task + Load + AEQ:Task + Subject	72.961	0.0174	0.89511
M4	AEQ + Task + Load + AEQ:Task + AEQ:Load + Subject	76.856	0.4620	0.49667
M5	AEQ + Task + Load + AEQ:Task + AEQ:Load + Task:Load + Subject	79.730	1.4826	0.22337

References

Anderson, N. D. (2015). Teaching signal detection theory with pseudoscience, *Frontiers in Psychology, 6*, 762 .

Aru, J., & Bachmann, T. (2017). Expectation creates something out of nothing: The role of attention in iconic memory reconsidered. *Consciousness and Cognition*.

Baars, B. J. (1997). Some essential differences between consciousness and attention, perception, and working memory. *Consciousness and cognition*, *6*(2), 363-371.

Becker, M. W., Pashler, H., & Anstis, S. M. (2000). The role of iconic memory in change-detection tasks. *Perception*, *29(3),* 273–286.

Blain-Moraes, S., Tarnal, V., Vanini, G., Alexander, A., Rosen, D., Shortal, B., ... & Mashour, G. A. (2015). Neurophysiological correlates of sevoflurane-induced unconsciousness. *Anesthesiology: The Journal of the American Society of Anesthesiologists*, *122*(2), 307-316.

Block, N. (2005). Two neural correlates of consciousness. *Trends in cognitive sciences*, *9*(2), 46-52.

Block, N. (2011). “Perceptual Consciousness Overflows Cognitive Access,” Trends in Cognitive Science 12, pp. 567–575.

Block, N. (2014). “Rich Conscious Attention Outside Focal Attention,” Trends in Cognitive Sciences 18, pp. 445–447

Boly, M., Seth, A. K., Wilke, M., Ingmundson, P., Baars, B., Laureys, S., ... & Tsuchiya, N. (2013). Consciousness in humans and non-human animals: recent advances and future directions. *Frontiers in psychology*, *4*.

Brascamp, J. W., Van Boxtel, J. J., Knapen, T. H., & Blake, R. (2010). A dissociation of attention and awareness in phase-sensitive but not phase-insensitive visual channels. *Journal of Cognitive Neuroscience*, *22*(10), 2326-2344.

Brookshire, B. (2013). Psychology is WEIRD. Slate Magazine.

Bronfman, Z. Z., Brezis, N., Jacobson, H., & Usher, M. (2014). We See More Than We Can Report: “Cost Free” Color Phenomenality Outside Focal Attention. *Psychological science*, *25*(7), 1394-1403.

Brown, R. (2014). Consciousness doesn't overflow cognition. *Frontiers in psychology*, *5*.

Byrne, A. and Tye, M. (2006), “Qualia ain't in the Head,” *Noûs*, 40: 241–255.

Cartwright-Finch, U., & Lavie, N. (2007). The role of perceptual load in inattentional blindness. *Cognition*, *102*(3), 321-340.

Chalmers, D. (2007). The hard problem of consciousness. *The Blackwell companion to consciousness*, 225-235.

Chalmers, D. (2005), "Phenomenal Concepts and the Explanatory Gap," in *Phenomenal Concepts and Phenomenal Knowledge: New Essays on Consciousness and Physicalism*, T. Alter and W. Walter (eds.), Oxford: Oxford University Press.

Chalmers, D. J. (1996). *The conscious mind: In search of a fundamental theory*. Oxford University Press.

Chatterjee, A., Widick, P., Sternschein, R., Smith, W. B., & Bromberger, B. (2010). The assessment of art attributes. *Empirical Studies of the Arts*, *28*(2), 207-222.

Chemero, A. (2011). *Radical embodied cognitive science*. MIT press.

Chen, H., & Wyble, B. (2015). Amnesia for object attributes: Failure to report attended information that had just reached conscious awareness. *Psychological science*, *26*(2), 203-210.

Chen, D., & Dalton, P. (2005). The effect of emotion and personality on olfactory perception. *Chemical Senses, 30*(4), 345-351.

Churchland, P. M. (1985). Reduction, qualia, and the direct introspection of brain states. *The Journal of Philosophy*, *82*(1), 8-28.

Clark, A., & Chalmers, D. (1998). The extended mind. *analysis*, *58*(1), 7-19.

Clarke, F. R., Birdsall, T. G., & Tanner Jr, W. P. (1959). Two types of ROC curves and definitions of parameters. *The Journal of the Acoustical Society of America*, *31*(5), 629-630.

Cohen, M. A., Cavanagh, P., Chun, M. M., & Nakayama, K. (2012). The attentional requirements of consciousness. *Trends in cognitive sciences*, *16*(8), 411-417.

Cohen, M. A., & Dennett, D. C. (2011). Consciousness cannot be separated from function. *Trends in cognitive sciences*, *15*(8), 358-364.

Coltheart, M. (1980). Iconic memory and visible persistence. *Perception & psychophysics*, *27*(3), 183-228.

Colzato, L. S., van Beest, I., van den Wildenberg, W. P., Scorolli, C., Dorchin, S., Meiran, N., ... & Hommel, B. (2010). God: Do I have your attention?. *Cognition*, *117*(1), 87-94.

Costa Jr, P. T., & McCrae, R. R. (1985). NEO: Five-Factor personality inventory. Tallahassee, FL: *Psychological Assessment Resources*.

Costall, A. (2006). 'Introspectionism' and the mythical origins of scientific psychology. *Consciousness and Cognition*, 15, 634–654.

Dale, G., & Arnell, K. M. (2013). Investigating the stability of and relationships among global/local processing measures. *Attention, Perception, & Psychophysics*, *75*(3), 394-406.

Danziger, K. (1980). The history of introspection reconsidered. *Journal of the History of the Behavioral Sciences*, 16, 241–262.

De Gardelle, V., Sackur, J., & Kouider, S. (2009). Perceptual illusions in brief visual presentations. *Consciousness and cognition*, *18*(3), 569-577.

de Fockert, J. W., & Cooper, A. (2014). Higher levels of depression are associated with reduced global bias in visual processing. *Cognition & emotion*, *28*(3), 541-549.

Dehaene, S., Changeux, J. P., Naccache, L., Sackur, J., & Sergent, C. (2006). Conscious, preconscious, and subliminal processing: a testable taxonomy. *Trends in cognitive sciences*, *10*(5), 204-211.

Dennett, D. C. (2008). *Kinds of minds: Toward an understanding of consciousness*. Basic Books.

Dennett, D. C. (1988). Quining qualia. In *Consciousness in modern science*. Oxford University Press.

Dollinger, S. J., Urban, K. K., & James, T. A. (2004). Creativity and openness: Further validation of two creative product measures. *Creativity Research Journal*, *16*(1), 35-47.

Ehrsson, H. H., Spence, C., & Passingham, R. E. (2004). That's my hand! Activity in premotor cortex reflects feeling of ownership of a limb. *Science*, *305*(5685), 875-877.

Fechner, G.T. (1860). *Elemente der Psychophysik*. Leipzig, Breitkopf and Härtel.

Fei-Fei, L., Iyer, A., Koch, C., & Perona, P. (2007). What do we perceive in a glance of a real-world scene?. *Journal of vision*, *7*(1), 10-10.

Fleming, S. M., & Lau, H. C. (2014). How to measure metacognition. *Frontiers in human neuroscience*, *8*.

Fodor, J. A. (2001). *The mind doesn't work that way: The scope and limits of computational psychology*. MIT press.

Forman, S. A., & Chin, V. A. (2008). General anesthetics and molecular mechanisms of unconsciousness. *International anesthesiology clinics*, *46*(3), 43.

Fox, K. C., Zakarauskas, P., Dixon, M., Ellamil, M., Thompson, E., & Christoff, K. (2012). Meditation experience predicts introspective accuracy. *PloS one*, *7*(9), e45370.

Freud, S. (1912). A note on the unconscious in psycho-analysis.

Froese, T. (2013). Interactively guided introspection is getting science closer to an effective consciousness meter. *Consciousness and cognition*, *22*(2), 672-676.

Gallagher, S. (2005). How the body shapes the mind: Oxford University Press.

Galvin, S. J., Podd, J. V., Drga, V., & Whitmore, J. (2003). Type 2 tasks in the theory of signal detectability: Discrimination between correct and incorrect decisions. *Psychonomic Bulletin & Review*, *10*(4), 843-876.

Gasper, K., & Clore, G. L. (2002). Attending to the big picture: Mood and global versus local processing of visual information. *Psychological science*, *13*(1), 34-40.

Graziano, M. S. (2013). *Consciousness and the social brain*. Oxford University Press.

Green, D. M., & Swets, J. A. (1966). Signal detection theory and psychophysics.

Hardcastle, V. G. (1997). Attention versus consciousness: a distinction with a difference. *Cognitive Studies*, *4*(3), 3_56-3_66.

Haun, A. M., Tononi, G., Koch, C., & Tsuchiya, N. (2017). Are we underestimating the richness of visual experience?. *Neuroscience of Consciousness*, *3*(1).

Helmholtz, H., & Southall, J. P. (1924). Helmholtz's treatise on physiological optics, Vol. 1, Trans.

Horst, S. (2010). The Role of Phenomenology in Psychophysics. In *Handbook of Phenomenology and Cognitive Science* (pp. 446-469). Springer Netherlands.

Hossain, S. R., Simner, J., & Ipser, A. (2017). Personality predicts the vibrancy of colour imagery: The case of synaesthesia. *Cortex*.

Husserl, E. (1913). Ideen zu einer reinen Phänomenologie und phänomenologischen Philosophie. *Erstes Buch: Allgemeine Einführung in die reine Phänomenologie*.

Hutto, D. D., & Myin, E. (2012). *Radicalizing enactivism: Basic minds without content*. MIT Press.

Irvine, E. (2013). *Consciousness as a scientific concept a philosophy of science perspective*. Dordrecht: Springer.

Jackson, F. (1982) "Epiphenomenal Qualia", *Philosophical Quarterly*, 32: 127–136.

James, W. (1890). *The principles of psychology*.

James, W. (1892). The stream of consciousness.

Johansson, P., Hall, L., Sikström, S., Tärning, B., & Lind, A. (2006). How something can be said about telling more than we can know: On choice blindness and introspection. *Consciousness and cognition*, *15*(4), 673-692.

John, O. P., Donahue, E. M., & Kentle, R. L. (1991). The Big Five Inventory – Versions 4a and 54.

John, O. P., & Srivastava, S. (1999). The Big Five trait taxonomy: History, measurement, and theoretical perspectives. *Handbook of personality: Theory and research, 2*, 102-138.

Johnson, S. C., Lowery, N., Kohler, C., & Turetsky, B. I. (2005). Global–local visual processing in schizophrenia: evidence for an early visual processing deficit. *Biological psychiatry*, *58*(12), 937-946.

Jonides, J. (1981). Voluntary versus automatic control over the mind's eye. *Attention and performance*, *9*, 187-203.

Kandel, E., Schwartz, J.H., Jessell, T. (2000). *Principles of Neural Science (4th edition)*. McGraw-Hill, New York.

Kaunitz, L. N., Rowe, E. G., & Tsuchiya, N. (2016). Large capacity of conscious access for incidental memories in natural scenes. *Psychological science*, *27*(9), 1266-1277.

Koch, C., & Tsuchiya, N. (2007). Attention and consciousness: two distinct brain processes. *Trends in cognitive sciences*, *11*(1), 16-22.

Kouider, S., De Gardelle, V., Sackur, J., & Dupoux, E. (2010). How rich is consciousness? The partial awareness hypothesis. *Trends in cognitive sciences*, *14*(7), 301-307.

Kozbelt, A. (2010). Artists as experts in visual cognition. *Visual Cognition*, *8*(6), 705-723.

Kurzweil, R. (2005). *The singularity is near: When humans transcend biology*. Penguin.

Lamme, V. A. (2003). Why visual attention and awareness are different. *Trends in cognitive sciences*, *7*(1), 12-18.

Lamme, V. A. (2006). Towards a true neural stance on consciousness. *Trends in cognitive sciences*, *10*(11), 494-501.

Landry, M. & Ristic, J. (2015). Combining attention: a novel way of conceptualizing the links between attention, sensory processing, and behavior. *Attention, Perception, & Psychophysics*, *77*(1), 36-49.

Lao, J., Vizioli, L., & Caldara, R. (2013). Culture modulates the temporal dynamics of global/local processing. *Culture and Brain*, *1*(2-4), 158-174.

Lavie, N., Beck, D. M., & Konstantinou, N. (2014). Blinded by the load: attention, awareness and the role of perceptual load. *Phil. Trans. R. Soc. B*, *369*(1641), 20130205.

Lee, K. M., Skoe, E., Kraus, N., & Ashley, R. (2009). Selective subcortical enhancement of musical intervals in musicians. *Journal of Neuroscience*, *29*(18), 5832-5840.

Lewis, L. D., Weiner, V. S., Mukamel, E. A., Donoghue, J. A., Eskandar, E. N., Madsen, J. R., ... & Purdon, P. L. (2012). Rapid fragmentation of neuronal networks at the onset of propofol-induced unconsciousness. *Proceedings of the National Academy of Sciences*, *109*(49).

Lutz, A., & Thompson, E. (2003). Neurophenomenology integrating subjective experience and brain dynamics in the neuroscience of consciousness. *Journal of consciousness studies*, *10*(9-10), 31-52.

Lyons, W. (1986). The Disappearance of Introspection. Cambridge, MA: MIT Press.

Mack, A., and Rock, I. (1998). *Inattentional Blindness*. Cambridge, MA: MIT Press.

Mack, A., Erol, M., & Clarke, J. (2015). Iconic memory is not a case of attention-free awareness. *Consciousness and cognition*, *33*, 291-299.

Mack, A., Erol, M., Clarke, J., & Bert, J. (2016). No iconic memory without attention. *Consciousness and cognition*, *40*, 1-8.

Marcum, J. I. (1947). *A statistical theory of target detection by pulsed radar*.

Mcdougall, S., & Pfeifer, G. (2012). Personality differences in mental imagery and the effects on verbal memory. *British Journal of Psychology*, 103(4), 556–573.

Merleau-Ponty, M. (1945). Phénoménologie de la perception.

Moritz, S., & Wendt, M. (2006). Processing of local and global visual features in obsessive-compulsive disorder. *Journal of the International Neuropsychological Society*, *12*(4), 566-569.

Moscovitch, M. (1995). Confabulation.

Mukamel, E. A., Pirondini, E., Babadi, B., Wong, K. F. K., Pierce, E. T., Harrell, P. G., ... & Weiner, V. S. (2014). A transition in brain state during propofol-induced unconsciousness. *Journal of Neuroscience*, *34*(3), 839-845.

Musacchia, G., Sams, M., Skoe, E., & Kraus, N. (2007). Musicians have enhanced subcortical auditory and audiovisual processing of speech and music. *Proceedings of the National Academy of Sciences*, *104*(40), 15894-15898.

Nagel, T. (1974). What is it like to be a bat?. *The philosophical review*, *83*(4), 435-450.

Neisser, U. (1967). Cognitive psychology. Appleton-Century-Crofts.[aAC] Nelson, K.(2003) Self and social functions: Individual autobiographical memory and collective narrative. *Memory*, *11*(2), 12536.

Nisbett, R. E., & Wilson, T. D. (1977). Telling more than we can know: Verbal reports on mental processes. *Psychological review*, *84*(3), 231.

Noë, A. (2004). *Action in perception*. MIT press.

Norman, D. A., & Bobrow, D. G. (1975). On data-limited and resource-limited processes. *Cognitive psychology*, *7*(1), 44-64.

O'Regan, J. K., & Noë, A. (2001). A sensorimotor account of vision and visual consciousness. *Behavioral and brain sciences*, *24*(5), 939-973.

Ostrofsky, J., Kozbelt, A., & Kurylo, D. D. (2013). Perceptual grouping in artists and non-artists: A psychophysical comparison. *Empirical Studies of the Arts*, *31*(2), 131-143.

Parbery-Clark, A., Skoe, E., Lam, C., & Kraus, N. (2009). Musician enhancement for speech-in-noise. *Ear and hearing*, *30*(6), 653-661.

Parbery-Clark, A., Tierney, A., Strait, D. L., & Kraus, N. (2012). Musicians have fine-tuned neural distinction of speech syllables. *Neuroscience*, *219*, 111-119.

Patterson, A. (2010). Art, ideology, and introspection. *International Journal of Culture, Tourism and Hospitality Research*, *4*(1), 57-69.

Perdreau, F., & Cavanagh, P. (2013). Is artists' perception more veridical?. *Frontiers in neuroscience*, *7*.

Perrot, X., Micheyl, C., Khalfa, S., & Collet, L. (1999). Stronger bilateral efferent influences on cochlear biomechanical activity in musicians than in non-musicians. *Neuroscience letters*, *262*(3), 167-170.

Petitmengin, C. & Bitbol, M. (2009). The validity of first-person descriptions as authenticity and coherence. *Journal of Consciousness Studies*, *16*(10-1), 252-284.

Petitmengin, C., Remillieux, A., Cahour, B., & Carter-Thomas, S. (2013). A gap in Nisbett and Wilson's findings? A first-person access to our cognitive processes. *Consciousness and cognition*, *22*(2), 654-669.

Plaisted, K., Swettenham, J., & Rees, L. (1999). Children with autism show local precedence in a divided attention task and global precedence in a selective attention task. *The Journal of Child Psychology and Psychiatry and Allied Disciplines*, *40*(5), 733-742.

Pollack, I. (1959) On indices of signal and response discriminability. Journal of the Acoustical Society of America, 31, 1031.

Posner, M. I., Snyder, C. R., & Davidson, B. J. (1980). Attention and the detection of signals. *Journal of experimental psychology: General*, *109*(2), 160.

Posner, M. I. (1994). Attention: the mechanisms of consciousness. *Proceedings of the National Academy of Sciences*, *91*(16), 7398-7403.

Posner, M. I. (2012). Attentional networks and consciousness. *Frontiers in psychology*, *3*.

Prinz, J. (2009). Is consciousness embodied. *The Cambridge handbook of situated cognition*, 419-437.

Prinz, J. (2010)."When is perception conscious?" in *Perceiving the World: New Essays on Perception*, ed. B. Nanay (New York: Oxford University Press), 310–332.

Purdon, P. L., Pierce, E. T., Mukamel, E. A., Prerau, M. J., Walsh, J. L., Wong, K. F. K., ... & Ching, S. (2013). Electroencephalogram signatures of loss and recovery of consciousness from propofol. *Proceedings of the National Academy of Sciences*, *110*(12), 1142-1151.

Putnam, H. (1960). *Minds and Machines*. reprinted in Putnam 1975, 362–385.

Ramsøy, T. Z., & Overgaard, M. (2004). Introspection and subliminal perception. *Phenomenology and the Cognitive Sciences*, *3*(1), 1-23.

Rey, G. (1997). *Contemporary Philosophy of Mind*, Cambridge, MA: Blackwell.

Robertson, A. R. (1977). The CIE 1976 Color-Difference Formulae. *Color Research & Application*, *2*(1), 7-11.

Rus, Jacob. (2007). *Lab Colour Space* [CIE L*a*b three-dimensional colour space rendering]. Retrieved from Wikimedia commons database.

Ryle, G. (1949). *The Will*.

Schwitzgebel, E. (2008). The unreliability of naïve introspection. *Philosophical Review*, 117, 245– 273.

Schütz, K., Schendzielarz, I., Zwitserlood, P., & Vorberg, D. (2007). Nice wor_ if you can get the wor_: Subliminal semantic and form priming in fragment completion. *Consciousness and cognition*, *16*(2), 520-532.

Simmons, J. P., Nelson, L. D., & Simonsohn, U. (2011). False-positive psychology: Undisclosed flexibility in data collection and analysis allows presenting anything as significant. *Psychological science*, *22*(11), 1359-1366.

Simons, D. J., & Levin, D. T. (1997). Change blindness. *Trends in cognitive sciences*, *1*(7), 261-267.

Simons, D. J. & Chabris, C. F. (1999). Gorillas in our midst: Sustained inattentional blindness for dynamic events. *Perception, 9*, 1059-1074.

Sligte, I. G., Scholte, H. S., & Lamme, V. A. (2008). Are there multiple visual short-term memory stores?. *PLOS one*, *3*(2), e1699.

Sperling, G. (1960). The information available in brief visual presentations. *Psychological monographs: General and applied*, *74*(11), 1.

Swallow, K. M., & Jiang, Y. V. (2013). Attentional load and attentional boost: a review of data and theory. *Frontiers in psychology*, *4*.

Thomas, R. C., Kim, S., Goldstein, D., Hasher, L., Wong, K., & Ghai, A. (2007). Do you see what I see? The impact of age differences in time perspective on visual attention. *The Journals of Gerontology Series B: Psychological Sciences and Social Sciences*, *62*(5), 247-252.

Todorov, A., & Bargh, J. A. (2002). Automatic sources of aggression. *Aggression and violent behavior*, *7*(1), 53-68.

Vandenbroucke, A. R., Sligte, I. G., & Lamme, V. A. (2011). Manipulations of attention dissociate fragile visual short-term memory from visual working memory. *Neuropsychologia*, *49*(6), 1559-1568.

Vannucci, M., & Mazzoni, G. (2009). Individual differences in object and spatial imagery: Personality correlates. *Personality and Individual Differences, 46(4)*, 402–405.

Varela, F. J., Thompson, E., & Rosch, E. (1991). *The embodied mind: Cognitive science and human experience*. MIT press.

Varela, F. J. (1996). Neurophenomenology: A methodological remedy for the hard problem. *Journal of consciousness studies*, *3*(4), 330-349.

Ward, E. J., Bear, A., & Scholl, B. J. (2016). Can you perceive ensembles without perceiving individuals?: The role of statistical perception in determining whether awareness overflows access. *Cognition*, *152*, 78-86.

Watanabe, M., Cheng, K., Murayama, Y., Ueno, K., Asamizuya, T., Tanaka, K., & Logothetis, N. (2011). Attention but not awareness modulates the BOLD signal in the human V1 during binocular suppression. *Science*, *334*(6057), 829-831.

Woodman, G. F., & Luck, S. J. (2003). Dissociations among attention, perception, and awareness during object-substitution masking. *Psychological Science*, *14*(6), 605-61

Zmigrod, S., Zmigrod, L., & Hommel, B. (2015). Zooming into creativity: individual differences in attentional global-local biases are linked to creative thinking. *Frontiers in psychology*, *6*.

Connecting Text

Rooted in the empirically rigorous methodology of behavioural psychophysics, the previous manuscript explored phenomenal conscious experience using a highly controlled experimental design. While our unique paradigm represents a shift away from binary, button-pressing tasks, it is still grounded in a reductionist approach that examines elementary constituents of conscious experience in attempt to better understand the phenomenon as a whole. Yes, psychophysics affords a methodologically scrupulous approach to the study of consciousness, however, what does it tell us about conscious experience outside of the lab? Our day-to-day conscious experience is not within a highly controlled research setting but rather is complex, interactive, embodied, and enactive – "The body is our general medium for having a world," (Merleau-Ponty, 1945).

In the second manuscript, we employ a more ecological approach that accounts for the embodied nature of conscious experience. We explore first-person phenomenal experiences and how they come to be shared. Moreover, we place the study of phenomenal consciousness smack dab in our contemporary world, where abundant digital technology and screens play a fundamental role in our daily conscious experience.

What happens when individual conscious experiences align to form embodied ways-of-being? The following manuscript delves into extreme cases of inter-group phenomenal conscious experiences, investigating the juncture of consciousness, phenomenology, embodiment, and sociality.

Reference

Merleau-Ponty, M. (1945). Phénoménologie de la perception.

Internet Sociality: An Epidemiology of Cultural Experience in a Wired World

Moriah Stendel [1,2], Maxwell Ramstead [1,3], & Samuel Veissière [1,2, 4]

[1] Department of Psychiatry, McGill University
[2] The Lady Davis Institute, Jewish General Hospital
[3] Department of Philosophy, McGill University
[4] Department of Anthropology, McGill University

Corresponding author:

Samuel Veissière, Ph.D.
Division of Social and Transcultural Psychiatry, McGill University
samuel.veissiere@mcgill.ca

1. Introduction: an evo-devo epidemiological approach to the study of (internet) sociality

1.1. The puzzle of sociality and "society"

Human sociality refers to our species' unique ability to form joint goals, engage in joint action, and develop shared ways of doing things (Tomasello, 2009). In more phenomenological terms, it also refers to our ability to *feel* similar things. In anthropology, sociality is characterized by culturally-specific ways of "inhabiting one's body" (Mauss, 1973; Bourdieu, 1977). It is precisely because we can identify stable differences between groups on all these levels, differences which can be attributed to social learning and not merely to biological hardwiring, that we can speak of "culture" per se (Tomasello, 2009; Veissière, 2016). "Culture" here is understood as fundamental fact about the general ecological niche for human forms of life; "cultural differences," in turn, point to observable behavioural differences between groups of the same species that arise through largely implicit forms of social learning (Veissière, 2016).

In phylogeny (the evolutionary timeline of a species), human sociality is theorized as having arisen through cognitive adaptations for perspective-taking and shared intentionality—that is, the ability to be attuned to the "invisible" intentions, thoughts, feelings, and needs of others (Hrdy, 2011; Tomasello & Rakoczy, 2003). How cultural forms of life are "passed on," "rediscovered," improved upon, iterated, reiterated, and occasionally abandoned in ontogeny (the developmental timeline in the life of an organism—and each generation, in terms of a culture) without much explicit instruction is still open for debate (see Sperber, 1996; Ingold, 2001; Henrich, 2016; Ramstead, Veissière, & Kirmayer, 2016 for different positions).

The study of large-scale sociality (in both phylogeny and ontogeny) presents further theoretical and methodological challenges. As most human groups began to transition into large societies and large scale civilizations twelve thousand years ago, they started to form integrated communities that became increasingly abstract and "imagined". Such a shift was not without its effects on human cognition and lived experience. Nowadays, most humans implicitly acquire culturally-specific tastes, values, implicit biases, and ways of doing and desiring things with only limited opportunities for face-to-face interaction and imitation with the vast network of peers that constitute their societies.

The evolutionary anthropologist Robin Dunbar (1992) famously argued that, for the most part, humans cannot maintain stable relationships with more than 150 of their conspecifics. What is called "Dunbar's number" is now generally accepted as a cognitive limit on human memory, reflected in the size of our neo-cortex (Hill & Dunbar, 2003) (see Wellman, 2012; Gonçalves et al., 2011 for a discussion of Dunbar's Number in online communities). For Dunbar, all human relations beyond 150 people become increasingly abstract; social cohesion beyond this number will require intense forms of "social grooming" and specific social pressures.

Following anthropologist Keith Hart (2003), we can define "society" as "the totality of social relationships linking a large group of people together". Like Hart, we are compelled to acknowledge the difficulty faced by researchers who hope to describe what these networks of relations actually entail for human cognition and forms of life. "Society", writes Hart, "is mysterious to us because we have lived in it and it now dwells inside us at a level that is not ordinarily visible from the perspective of everyday life" (Hart, 2004).

1.2. Evo-devo Anthropology and Cultural Epidemiology

Like our colleagues in Evolutionary Developmental Biology (Evo-Devo in the lingo), our approach to Evolutionary Anthropology seeks to infer phylogenetically adapted traits in the species *Homo sapiens* by studying the developmental course of cultural forms of life and their acquisition by new members. As we argue in this paper, studying online communities provides us with rich material for this task. In studying the emergence and stabilization of new cultures and shared ways of being, we hope to highlight invariant mechanisms in the workings of societies on the one hand, and work toward a better description of the invariant cognitive, affective, and behavioural underpinnings of human sociality in general, on the other.

Over the past two decades, cognitive anthropologist and archeologists working in the field of Cultural Epidemiology have made significant advances in their understanding of these mechanisms (Sperber, 1996; Richerson & Boyd, 1998; Whitehouse, 2001; Boyer, 2001; Wengrow, 2013; Henrich, 2016).

The task of Cultural Epidemiology as envisioned and pioneered by Sperber (1996) is to identity invariant ecological and cognitive factors for the transmission of cultural information. The study of these factors typically focuses on information and learning mechanisms of high learnability, high memorability, and their feed-forward potential for transmission. When an idea, value, trend, or practice becomes widely shared in one or more groups and durable across generations, we can speak of its epidemiological success.

Anthropologists and psychologists have identified a set of cognitive biases that facilitate epidemiological success in cultural transmission: the salience of counter-intuitive ideas that violate core knowledge categories (Boyer, 2011), in-group and out-group biases (Kurzban & Neuberg, 2005), prestige and scarcity biases (Henrich, 2016) and frequency/conformist biases (Boyd & Richerson, 1998) (see Veissière, Ramstead, and Kirmayer, forthcoming, for a new synthesis of these biases, and a description of these cognitive factors as *attentional* biases).

1.3. Hyper-Natural monitoring: Society is like the Internet (not the other way around)

In a series of papers on internet-mediated sociality, Veissière (2015, 2016) has pointed out that the 'invisibility' of Internet communities, in which people who do not interact with one another in the flesh or engage in direct face-to-face-imitation can nonetheless co-negotiate systems of embodied meaning, providing a compelling example of the workings of societies. In Veissière's sense, the point is not so much that the Internet is like society, but rather that that societies themselves are like the Internet.

We propose that studying the ontogeny of Internet culture gives us a further window into ordinary mechanisms of human social cognition. In a companion paper, Ramstead, Veissière and Kirmayer (2016) have described symbolically-enriched human worlds as organized landscapes of "cultural affordances" grounded in mutual, recursively nested expectations, especially expectations about standards of behavior ("What would Mommy want me to do here?"; "How much can I improvise, given what others expect of me?"). On this view, humans learn to see the world through the perspective of other people, and intuitively imagine context-relevant agents to guide them in most of their everyday actions. In other words, from context to context and moment to moment, we outsource a large part of our thinking, feeling, and decision-making to sometimes explicit, most often implicit scenarios of the "what would so-and-so think, feel, or expect me to do" variety.

This reassuring feeling of being watched and guided by imaginary others has been hypothesized to play an important role in the evolution of cooperation, morality, large-scale social life, and organized religion—in this view, often called the Supernatural Monitoring Hypothesis, we fashioned our Gods and Spirits to better flesh out the imaginary agents that guide our ordinary cognition, consciousness, and action (Atran & Norarenzayan, 2004; Gervais & Norenzayan, 2012) When this 'other-minds' mental system become hyper-excited and goes in overdrive due to the action of a variety of genetic and environmental factors, in turn, we experience delusions—about other people (Gold & Gold, 2015).

Internet communities and social media, as we will argue, also provide an opportunity for meeting the human need to be connected, but also the need to watch and monitor others, and better still, for the need to be seen, heard from, thought about, monitored, judged, and appraised by others. We might call this the *Hyper-Natural Monitoring Hypothesis*.

1.4. Cyber-mediation: The mediation of the experience of human embodiment through the Internet

In this paper, we extend the ecological-enactive framework (Bruineberg & Rietveld 2014; Ramstead, Veissière, & Kirmayer, 2016) to the ecological niche of cyberspace. We argue that the Internet can be understood as a space of interaction (an eco-niche) that supports dynamic feedback loops between the lived experience of humans separated in space, but connected through the medium of the Internet.

These feedback mechanisms enable the conception, dissemination, and sustainment of embodied ontologies. Online communities and social media platforms serve as hubs for the constitution of shared ways of being, allowing for the emergence of online cultures that function much like subcultures 'in real life', albeit subcultures that spread virally with faster feed-forward potential.

Our hope is to provide a closer look at online communities, with the goal of addressing how inter-phenomenal states, that is, shared ways of experiencing, arise in groups that only interact in cyberspace and never face to face. More specifically, this paper will use the ecological-enactive framework, extended by the theory of cultural affordances (Ramstead, Veissière, & Kirmayer, 2016), to examine the formation of online communities and how these communities mediate embodied experiences through the Internet.

First, we situate the Internet in the ecological-enactivist approach. We employ the notion of cyberspace, and consider the Internet as an emergent ecological niche within which virtual communities form. We mobilize the framework for the study of cultural affordances that we have developed elsewhere for this task. Human agents experience things in the world as possibilities for action and perception (what are called 'affordances' in ecological psychology), rather than as action-neutral things divorced from concerns and embodied expectations of the agent (Gibson 1986; Chemero, 2009; Bruineberg & Rietveld, 2014).

Second, we argue that the communities of cyberspace, too, can constitute distinct cultures, with their own characteristic forms of shared attention, expectations, and experience, with communities forming through collectively mediated expectations. We suggest that these communities, like those in real life, are formed and remain cohesively bound through shared rituals, which in being enacted secure powerful group bonds by aligning agent expectations. As the Internet becomes increasingly entangled with mind, body, and life, there is a natural expansion of subcultures into cyberspace, and these virtual cultures depend on similar formative mechanisms as those in real life.

After examining the formation of online communities, we turn to the diverse mechanisms by which online communities transmit and share ways of being in this world. In particular, we discuss the elements of digital technology that enable the spread of shared, embodied ontologies. These are acquired through distinct forms of joint-attention, embodiment, and absorption that mediate shared cyber-ontologies. To further unpack these concepts, we examine theories of everyday, ordinary hypnosis (Kirsch & Lynn, 1997; Kirsch, 1999) and emotional contagion, relying on Veissière's (2016) concepts of hypnotic sociality and *inter-phenomenality*—the shared phenomenal, "what it feels like" aspects of lived experience, for communities that acquire similar ways of feeling and narrating their selves through immersive participation in the cyberspace. We argue that the Internet functions to amplify our tendency towards hypnotic sociality, or, in other words, that cyberspace can be regarded as an 'absorption matrix' that leverages the human tendency to surrender attention under particular circumstances.

The final section of this paper comprises a typology of thriving online communities. Here, we transpose our theoretical perspective to the practical realm through an ethnographic typology of virtual communities. We illustrate how the aforementioned processes interact to mediate distinct shared embodied experiences.

2. The internet and the ecological-enactivist approach

Before any directed discussion, it is imperative to distinguish between the Internet and cyberspace. Elsewhere, these terms may be synonymous, but here we differentiate between a tangible, physical Internet and a notional cyberspace. There is massive physical infrastructure that comprises the Internet. Billions of hardware components connect to form a network of networks in a complex, highly engineered fashion (Willinger et al, 2002). While the ownership of this infrastructure is distributed, the platitude of a democratic, neutral, Internet ignores its implicit power dynamics. The tech world is somewhat of an oligarchy, with its big players (Google, Twitter, facebook, etc.) acting as gatekeepers of information. This contributes to issues of transparency, surveillance, and privacy (Mansell, 2016; Tsatsou, 2014). Speed, accessibility, and censorship vary across the globe, with a recent UN survey estimating that only about half the world's population even uses the Internet at all. While these topics are beyond the scope of this paper, it is important to acknowledge the power dynamics embedded in the technical architecture of the Internet.

What emerges from the Internet's physical mechanism and protocol is the notion of cyberspace, an embodied space or affordance landscape (Rietveld & Kiverstein, 2014; Bruineberg & Rietveld, 2014). Cyberspace can be understood through the lens of more ecological approaches as a highly dynamic ecosystem. Minds do not only *make* the Internet, but also *make up* the Internet as cyberspace. Biological models and theories might be apt for the study of the fluxing, dynamical nature of digital spaces and the interconnected loops of this open-state system.

2.1. Ecological systems, niches, and affordances

An ecosystem is typically defined as a physical system comprising of a biological community of organisms that stand in relations of dense interaction with one another and with their physical environment. The Internet might be modeled as a biologically diverse ecosystem, where the cyberspace, constituted by various websites, message boards, and other platforms, is analogous to the physical environment of a natural ecological system. The highly interconnected nature of ecosystems blurs the boundaries between consumer/producer and organism/environment. Ecosystems are integrated, singular, systems.

Such a picture of the Internet fits well with 'enactive' views of biological systems. On such views, the organism and the environment effectively produce one another in a process of mutual constitution and natural drift (Varela, Thompson, & Rosch, 1991; Thompson, 2007). Cyberspace is equally a space of co-construction where users simultaneously produce content and consume it; the Internet constitutes the user in part by providing platforms whereby content can be accessed, and is constituted by the users and their own provision of content. In other words, there is no ontological gulf or separation between the users and the space they inhabit. Online spaces are not 'outside' the user, but instead, users enact online spaces through a variety of actions: producing content, choosing a path of links, using search engines to generate relevant information, etc. Unlike a terrestrial ecosystem, delimited in space and time as they are, the architecture of cyberspace is comprised of bits (danah boyd, 2010), a fundamental difference that enables certain possibilities. While the resources of planet Earth are bordering depletion, the Internet as a virtual cyberspace is scalable and has proven able to accommodate massive growth (Karakas, 2009). This scalability has fostered a shift from the earlier, more passive web, based primarily on viewing of pre-existing content, to the establishment of the web as we know it today, a highly interactive and collaborative platform running mostly on user-generated content. This platform, Web 2.0 or World 2.0 (Karakas, 2009; Tim O'Reilly, 2007) signals a move from a static surface picture to a dynamic ecosystem.

In previous work, we have extended the ecological-enactive account of affordances and the organism-niche relation to the kinds of affordances that make up the human niche. Following work in this tradition (Chemero, 2003, 2009; Rietveld and Kiverstein, 2014; Bruineberg & Rietveld, 2014) we define an 'affordance' as a relation between an aspect of the material environment of an organism and an ability that is available in the form of life of that organism. Here, the notion of 'form of life' is adapted from the later work of Wittgenstein (1953). A form of life, in this sense, is to be understood as a set of relatively robust behavioral patterns, which is characteristic of a group or population. We define the 'niche' or (equivalently) the 'landscape of affordances' as the set of affordances (possibilities for action and perception) available to a given population in the physical environment to which the organisms are coupled in mutually constitutive interactions. We suggest that the affordances most relevant to human cultural ensembles are acquired through immersive participation in patterned cultural practices, notably by mobilizing the attentional processes of the participating agent (Roepstorff et al., 2010; Ramstead, Veissière, & Kirmayer, 2016). The co-enaction of such regimes of attention endows all those who participate with similar sets of shared expectations.

Arguably, the creation of a digital ecosystem opens a new set of ecological sub-niches. The scalability of Web 2.0 allows for seemingly limitless expansion, and thus, the Internet affords the creation of new spaces for human interaction. These new niches enable the emergence of new affordances and in turn, allow for new, embodied ways of being – or, inter-phenomenal experiences. To reiterate, *Inter-phenomenality* is the "the sensory, ‘what it feels like’ aspects of intersubjectively mediated lived experience for humans who come to develop similar ways of feeling and narrativizing themselves” (Veissière, 2016), as members of online communities do. When entering these online communities, users engage with the affordance landscape of cyberspace. They immerse themselves in a digital culture, participating through a variety of perceptions and actions like posting, clicking, liking, reading, or listening. In these behaviours, embodied sensations are described, prescribed, performed, conformed, amplified, suppressed, learned, and forgotten.

2.2. The formation of Internet cultures: Imagined communities and technological revolutions

The term ‘Internet culture’ is often used parochially to describe message boards, cat memes, gifs, and silly videos. In truth, cyberspace is extensively heterogeneous and comprised of innumerable distinct subcultures. While different online platforms contain similar features and functions, each is a unique environment in constant flux (Bucher & Helmond, 2017). These virtual spaces have paved room for online communities to form around almost any imaginable interest or idea (Kirmayer et al., 2013). With an ease once unfathomable, now, with a few quick mouse clicks millions of people can connect over mutual hobbies, experiences, and problems. In this section, we attempt to explain the formation of online communities and justify the notion that they constitute distinct, virtual cultures.

As we have argued above, there is nothing paradigmatically different between a large-scale society bounded by international borders (or diasporically spread across multiple nation states) and an Internet community. Both are in a sense “virtual,” in that their large, anonymous makeup prevent face-to-face interaction between members; both, however, enable the large-scale spread of embodied ideas that shape their members identities and expectations. Both have it in common, following Anderson (1983), that they are largely *imagined communities*. The concept of imagined communities was originally introduced to explain the spread of nationalism in the early modern period despite the relative paucity of personal relationships between all members. For Anderson, the nation is a social and cognitive construct that exists in the imaginations of its inhabitants, fueled notably by the advent of print-culture (Anderson, 1983). More recent archaeological accounts of the spread of certain forms of art, culture, and iconography (notably of “monster” images) following the invention of clay seals in the fourth millennium BC have also been described as the first print revolution (Wengrow, 2013).

Whether the advent of digital media, like the invention of writing, and then print culture, has brought forth a paradigmatic shift in social organization and a new “cognitive revolution” is still an open question (but see Veissière, 2016a; 2016b; Serres, 2014; Harari, 2015 for a discussion).

Online communities conform to nation-like structures with specific vernacular, rules, and expectations. Members have accounts and usernames, holding a digital ‘nationality’ of sorts. Etiquette and communication vary from one site to the next. However, most importantly, few users will ever meet ‘IRL’ (in real life)—in cyberspace, nearly all communities are imagined ones. While real-life nations are bound in geography and time, these boundaries are fragmented in cyberspace. The unique affordances of cyberspace—like replicability, persistence, and searchability (danah boyd, 2010)—allow for communities to exist in temporally and spatially extended ways that would not be feasible in physical environments. This spatio-temporal fragmentation means that the unity of a community rests on the collective imagination and shared expectations of the Internet users that constitute it.

From a collectively imagined ‘we’ emerges collective intentionality, that is, shared ways of being in the world and engaging with one another (Searle, 2001; Tuamelo, 2007; Tomasello et al., 2005). Most accounts of shared or collective intentionality center on concrete interactions between individuals, where separate minds act in unison. Zahavi & Satne (2015) remind us that there are many ways that shared intentionality can take shape, and in certain instances, shared intentionality might arise from an indivisible plural subject. In such cases, the group itself holds intentions rather than the assembled minds of individuals (Tollefson, 2006). Communities of cyberspace have personalities, actions, and intentions of their own that surface from the collective.

Here we should recall the distinction between individuals that are *collected* versus *collective*, second-personal and face-to-face versus third-personal and anonymized.

Tomasello (2014) operationalizes this split by distinguishing *joint intentionality* from *collective intentionality*. The former refers to a triadic situation whereby two individuals 'triangulate' a shared object of attention; joint intentionality entails the sharing of one intention with a particular other. The latter refers to a shared intention with a generalized other (Tomasello, 2014). Because it transcends the bounds of the concrete intersubjective exchange here and now, collective forms of intentionality allow for the formation of a shared system of knowledge, conventions, beliefs, and institutions that seem "ready-made" for those entering it (Zahavi & Satne, 2015). They are also later appearing in human phylogeny and ontogeny (Tomasello, 2014; Henrich, 2016).

In cyberspace, both forms of Tomasello's intentionality are operative. Two coders may engage in joint intentionality as they collaborate on a script in the open-source website, GitHub. Alternatively, full-fledged online communities emerge from a collective imagination and form collective intentionality—they become an inter-phenomenal 'we' who experiences and believes collectively. In fact, in the online sphere, the boundaries of space and time are less concrete, and therefore the group bond relies more heavily on collective imagination and intentions.

2.3. Ritualistic bonding in cyberspace

Fundamental to a community is the metaphorical 'glue' that makes it cohere. What allows a community to form and stay together? One explanation may lie in the fundamental human craving for shared experiences and a structured worldview. This need can be satiated through cultural groups such as families, religious groups, or other communities that disseminate systemic knowledge that might respond to such needs. However, if the structured world order we inherit fails us, we may search for a new pre-existing order that seems more rational, or at least able to account for those failings (Veissière & Gibbs-Bravo 2016, Whitehouse, 2001). This sheds light on diverse phenomena such as cults, music festivals, artistic sub-cultures, born-again Christians, ex-Mormons, and of course, Internet communities, which are a natural extension of this phenomena into the digital sphere. Online communities share systems of beliefs, expectations, and attention. And akin to cults, many online communities are bound by rites of passage (Veissière & Gibbs-Bravo, 2016) — one must assert their belonging in a community, be it virtual or not.

Rites of passage are perplexing. They are evolutionarily expensive – challenging, uncomfortable, dangerous, or all three. Yet despite this, they are present in nearly all cultures, religions, and communities (Xygalatas et al., 2013). To interpret this paradox, Xygalatas et al. (2013) theorize that extreme rituals must act as a social technology and serve to strengthen group cohesion and cooperation. In the lab, we see bond formation after intense shared experiences (Fischer & Xygalatas, 2014, Xygalatas et al. 2013). Even walking on a suspension bridge creates stronger feelings of attraction to a conspecific (coined misattribution of arousal, see Dutton and Aron, 1974). Any near-universal phenomenon usually exists for a good reason, and bond-formation is a powerful component of social cohesion.

Harvey Whitehouse's seminal work on modes of religiosity (2001; 2004), which Veissière discusses in terms of 'modes of ritual action' (Veissière, 2016; Veissière & Gibbs-Bravo, 2016) provides important concepts to appreciate the role of different types of rituals to facilitate the spread and maintenance of different forms of sociality. The rarely performed, highly arousing rites of passages that Whitehouse calls 'imagistic' rituals (e.g., traditional rites of boyhood or girlhood) tend to build episodic memory, create strong social bonds in small groups, and confer a sense of choice, agency, and privilege on those who partake in the experience. Doctrinal rituals, conversely, are characterized by frequently repeated actions and low arousal, and typically build semantic memory, which in turn facilitates the large-scale spread of anonymous communities. Veissière and Gibbs-Bravo have argued that entering a new subculture or cultural sub-niche usually entails imagistic rites of passages that facilitate bonding to a new group. Subcultural identities, in turn, tend to be reinforced and maintained through frequently repeated doctrinal rituals, usually entailing new restrictions (e.g. dietary) and group-specific ways of doing things (e.g. specific ways of preparing foods, etc.).

In the case of online communities, however, the extreme practices that characterize imagistic bonding rituals can often be experienced beforehand, and become rationalized post-hoc as justifying one's belonging to a new group in which people are expected to undergo similar experiences. As social networks migrate to the Internet, imagistic and doctrinal modes of ritual action are preserved, allowing members to form secure bonds and attribute meaning to their experience.

Like non-virtual communities, but perhaps to a greater extent, online communities tend to form group identities around shared suffering or salient emotional experiences. Online support groups are one instance where members form strong bonds over shared suffering. Users bond over loneliness, trauma, fear, and rejection. However, even seemingly happy digital communities have rites of passage. Health-nuts, meditators, and lucid dreamers pleasantly convene in cyberspace, but they also bond over challenging rituals like juice cleanses, laborious dream journals, or vows of celibacy. In striving for esoteric, challenging, and highly embodied experiences, members of these communities cohere to a shared identity while also warranting their membership (Veissière & Gibbs-Bravo, 2016). They deserve to belong and their suffering is a demonstration of their devotion. Groups are woven together through the enactment of intense rites of passage that serve as social technologies—they enable mutual understanding, but also bestow the right to join a community, a culture.

3. The mechanisms of cyber-mediation

3.1 Joint-attention, second-order learning, and the ontology of screens

Our world contains a near limitless amount of information; infinitely more than any single human could encode or parse. One could attempt to navigate this endless sea of knowledge on one's own, but this would be inefficient. In addition to learning first-order information (primary knowledge), humans develop second-order statistical learning: or, learning from whom to learn (Henrich, 2016). Elsewhere we have suggested that human beings implicitly and automatically evaluate salient attentional cues in order to select sources of information and label them as relevant (Veissière, Ramstead, Lifshitz, & Kirmayer, 2017). Human beings thereby surrender their epistemic authority to the source that most secures their credence.

This deference to epistemic authority is evident in infanthood, emerging at 9-12 months old, when infants begin to understand human beings as intentional agents

(Tomasello, 2014). At this age, infants can secure explicit and implicit joint-attentional cues to guide their own awareness, exhibiting preferential looking patterns to locations where others orient their attention (Tomasello, 2014; Heinrich, 2016; Sterelny, 2012). In these triadic interactions, infants know to attend to adults, follow their gaze upon an object, and imitate their actions on the object of shared attention, and in doing so, they can begin to immersively participate in, and thereby acquire, culture (Tomasello, 2014; Ramstead, Veissière, & Kirmayer, 2016)

Though acquired early in ontogeny, this pattern of deference in human development persists throughout the human lifespan—we learn from others at all ages, and use cues to guide our further acquirement of knowledge well into adulthood. Now that most of human knowledge is available on the Internet, knowing from where and from whom to learn is of massive importance; indeed, second-order learning may be one of the most useful skills to have in the 21st century. As we navigate the Internet, we secure cues and learn heuristics that guide us through immense amounts of data. Our epistemic 'antennae' survey cyberspace for contextual cues that indicate reliability: perhaps it is easier to submit oneself to a .org web address than a flashy site with explicit pop-up ads, although the readiness of surrender would depend on the information one seeks. Second-order cues are constantly revived, with 'likes', 'views' and 'comments' as indices of collective attention.

Due to the rise of Web 2.0. and its seamless integration into daily life, screens have become a prevalent target of joint attention. In the era of digital natives, we are learning to pay attention to screens at very young ages. Of course, the stimulation of color, light, and movement captures the attention of a young child. In a vignette of modern life, a frantic parent—in desperate need of peace and quiet—plops their fussy child in front of a television or tablet. However, the complex relationship between attention and screens goes beyond any intrinsically stimulating properties. More importantly, joint-attention mediates second-order learning from screens. There are many scenarios where a screen is the object of joint attention: videogames, movie theatres, televised sports, chat windows, or massively multiplayer online role-playing games (MMORPGs). We frequently engage in scripted narratives, suspending disbelief to what we see on the screen. This second-order learning is dependent on the social cues that guide our intentions, in this case, surrendering to the screen in an automatized fashion. A lifetime of learning to attend to the screen imbues it with epistemic power that becomes easy to submit oneself to.

On the Internet, joint-attention and second-order learning facilitate an epistemic preference for digital information. In doing so, these mechanisms allow the individual to join in on collective intentions, entering a shared system of knowledge, conventions, and ways-of-being.

3.2 Mind, body, and Internet

Once a novelty, the Internet is now seamlessly integrated with both life and mind, and increasingly so, as a generation of digital-natives enter adulthood. Digital technology has a unique relationship with human attention, as discussed above, but also with the human body. The integration of our sensory systems and our digital ecologies is evident in the design of technological devices, which is highly interwoven with the human perceptual system (as evidenced by the emergent science of ergonomics). Tapping a touchscreen device is a feat of multisensory integration, our typing rhythm congruent with the visual, sonic, and haptic stimuli of the interface. Despite claims that the digital age fosters disembodiment, clearly, the navigation of technology is fundamentally embodied. Internet culture is not disembodied; it is differently embodied.

Conceptions of cognition as extended (Clark & Chalmers, 1998) or extensive (Hutto, Kirchhoff, & Myin, 2014) become increasingly relevant in a digital context. In the case of the Internet, the human brain is actively coupled with an external entity, arguably forming a distinct, integrative system beyond the individual human body. However, this line of argument pertains most clearly to the myriad relationships between an agent and an artifact. The Internet is a collective artifact, and as such, the lines between organism and environment are blurred even further. When one interacts in the digital sphere, the coupling is not limited to human and computer, but rather encompasses multiple agents and artifacts, including the agency of the collective, or collective intentionality. In the Internet era, extensive mind-body processes mesh with the digital landscape, each constituting one another. This conception of the embodied co-construction of user and interface is supported in empirical studies that reveal the potential of cyber-mediated social contagion (Kramer et al., 2014; Ferrara & Yang, 2015; Mueller & Abrutyn, 2015).

In non-digital social networks, the spread of affect is a validated effect, and has long-lasting impacts (Fowler & Christakis, 2008, Kramer et al., 2014). Face-to-face emotional contagion is often explained by spontaneous mimicking of facial expressions and neural mirror systems (Colombetti, 2012, Fuchs & de Jaegher, 2009). These internalist theories do not focus on the interaction, but rather view this social process as an inner, simulative process of the brain where the body is merely an instrument for transmission (Fuchs & de Jaegher, 2009). How can an imitative theory of social cognition explain a cyber-mediated spread of affect, where visual, haptic, and auditory contact is limited?

Fuchs & De Jaegher (2009) propose an alternative theory to explain interactions, that can explain intersubjective experiences in real life and online. Their conception of enactive intersubjectivity is explored through two routes: dynamical coupling and mutual incorporation. The former refers to an embodied, looping coordination of action and meaning between two agents. Social understanding arises through this coupled action, which itself takes on an agency of its own.

This framework for enactive intersubjectivity is typically used to explore living systems, but it is equally applicable to digital systems. For instance, the theory may account for the telesomatic transfer of moods that occurs through *virtual* social networks. In a massive (n=689,003) experiment, Kramer et al. (2014) manipulated the content of Facebook user's Newsfeed, titrating the posts to tend toward either positive or negative expressions. The result of this manipulation was emotional contagion that corresponded with the valence of the content: if negative content was reduced, users produced more positive posts and vice versa. This study exhibits the power of the Internet to modulate highly embodied experiences, such as emotions, and reveals the enactive, and extensive manner in which users inhabit online social spaces.

Another mechanism that may account for the cyber-mediation of bodily experiences is *somatic amplification* – the selective focus on bodily sensations. Absorption may render individuals more likely to somatically amplify (Kirmayer et al., 1994), and engaging in cyberspace is a highly absorptive experience. Digital media is stimulating and rewarding, we surrender our attention to screens, and individuals with a propensity for cognitive absorption are more likely to use the Internet in the first place (Bozoglan et al., 2014). These factors may further account for the role online communities can play in the modulation of embodiment.

4. An anthropological survey of cyber-mediated bodily experiences

In a moment we will delve into a non-comprehensive survey of thriving online communities. Our typology spans from the wonderfully weird to the possibly dangerous, and while the peculiarity may pique interests, we do not intend for this to be a cyber-sideshow. Rather, we are interested in how studying these communities can help us further understand the relationship between humans, personhood, embodiment, and technology.

4.1. Cyberchondria

WebMD is a popular online source of health information, featuring news articles, videos, and proxy diagnoses. The website conveys relays several epistemic cues that reinforce its trustworthiness. For instance, the clean design is plastered with images of doctors, and the website title includes ‘MD’, insinuating credentials. This generalized lab coat effect (Milgrim, 1963) increases the likelihood of epistemic surrender. A notorious feature of the website is the symptom checker, a tool that uses algorithms to calculate possible diagnoses given the inputted symptoms. To use this feature, an individual scans through a proxy body in the interface while also scanning their own, checking off the boxes that correspond with their symptoms. The design of this tool affords the highly embodied experience of a body scan framed in the semantics of pathology. In tandem with the absorptive nature of Internet use, the symptom checker could render one susceptible to potentially harmful or dangerous somatic amplification.

Cyberchondria is a distinct condition of the digital era, characterized by excessive and repetitive online searches for information about health-related information. Although there is valid medical information available online, studies suggest that searching behaviours can be harmful. Some findings indicate that this activity often leads to increased health anxiety (Starcevic & Aboujaoude, 2015; Aiken & Kirwan, 2012). Additionally, through affect contagion and somatic amplification, exposure to symptomatology may actually induce a shift in bodily sensations.

4.2. Empty Nose Syndrome

Empty nose syndrome (ENS) is somewhat of a medical mystery. Weeks to years after a nasal surgery, often to the turbinates but not always, a minute percentage of patients experience debilitating symptoms including sensations of suffocation, pain, nasal dryness, sleep problems, anxiety, and depression (Saafan et al, 2016; Lemogne et al., 2015). The intensity of these symptoms has driven many to suicide, one patient even stabbing their otolaryngologist to death. Despite the severity of ENS, its etiology remains enigmatic to doctors – a consistent anatomical cause has yet to be identified and there are no validated diagnostic tests. Moreover, there appears to be a significant level of comorbidity between ENS and psychiatric conditions, suggesting that there may be a psychosomatic component to the distress (Payne, 2009). The distinct demographic niche within which the syndrome tends to occur, in turn, may imply that ENS is a culture-bound syndrome (Oliphint, 2016).

Many ENS sufferers turn to the Internet to seek answers and comfort, and in doing so they enter an affordance landscape that may shape their phenomenological experience of the syndrome itself. ENS has a huge online presence with prolific blogs, forums, and articles devoted to discussing the syndrome. The online communities that shape around ENS make the condition a possible example of a cyber-mediated ontology. Despite being connected virtually, sufferers can form intense bonds over their shared rite of passage into the ENS online community – namely, an elective surgery gone wrong. The intensity of surgery along with the subsequent symptomatology connects users, allowing them to form shared ways of framing their experiences. Through ritualistic bonding, ENS sufferers collectively describe distress, often in a desperate, catastrophizing manner. This is compounded by the medium of cyberspace itself, which affords high absorption and thus puts users at risk of selective somatic amplification. Given the capacity of social contagion via cyberspace, ENS forums may be doing more harm than good.

In exploring these psychosocial factors, we are in no way discounting the extreme phenomenological suffering of those with ENS. However, re-framing the condition may actually improve the course of treatment. Lemogne et al. (2015) describe a case study of a 37-year-old male ENS patient with extreme functional impairment; the patient had withdrawn from all social activities to isolate himself in his bedroom with an air humidifier. Following a normal physical examination, a psychiatrist diagnosed him with a typically presenting somatic symptom disorder (SSD) – a condition characterized by excessive thoughts and catastrophizing about somatic symptoms that may or may not be associated with an organic etiology (Lemogne et al, 2015). Following standard treatment for SSD, which includes cognitive therapy that targets core dysfunctional beliefs and avoidance behavior, the patient reported substantial functional improvement. This case study suggests that a comprehensive understanding of ENS may be imperative to successful treatment.

4.3. Erowid experience vaults

Erowid is a non-profit, educational resource with information about drugs, plants, and altered states of consciousness, with an overall mission of harm-reduction. Their website hosts an experience vault with over 23,000 user-submitted reports of personal psychoactive experiences that range from illuminating to frightening.

The placebo effect has proven to be very robust when it is used in the medical contexts involving pharmaceuticals, and can actually cause changes in pathophysiology (Raz et al.; 2008; Medoff & Colloca, 2015; Garry & Assefi, 2003; Parker et al., 2011). Of course, drugs have a chemical effect on the brain, regardless of mindset, however these findings on the placebo effect inform us that our response to psychoactives is influenced by expectations, context, and sociality. This compounds with the generalized lab coat effect (Milgram, 1963) of pharmaceuticals, or the shared societal expectations that drugs change us in a biological, physical, or sensory way. An Erowid review holds the power to transform an individual's expectation of their experience, and subsequently, the experience itself.

What makes Erowid an effective mediator of this effect? Firstly, Erowid displays epistemic power through their .org web address and the sheer mass of information they possess. Their focus on harm-reduction and education imparts them as more trustworthy – they are trying to help with honesty and facts, rather than propaganda. Every experience published was selected, reviewed, and edited, earning it a second-order epistemic stamp of approval. Finally, the intensity of psychoactive experiences strengthens the bond between users, promoting in-group identity and social contagion.

4.4. Online meditation

Meditation is increasingly popular in Western life and science, with a particularly expansive digital presence, through apps, websites, and online communities. Now, reddit hosts a large subforum (a.k.a. subreddit) called r/Meditation, with hundreds of thousands of members, who convene to discuss their meditative experience, their motivations for practice, and their practice stories. Bound together by the embodied ritual of mediation, the group shares bodily experiences that are reinforced by group sociality. Additionally, the constant exposure to positive benefits of practice may contribute to a spread of affect and the amplification of certain bodily sensations.

Additional groups of interest are the Zen Buddhism communities of SecondLife. SecondLife is an immersive, digital world in which millions of people participate. While interaction on r/Meditation is mostly mediated narratively and linguistically, the affordance landscape of SecondLife is richer, allowing for gestural and verbal communication, as well as a more complex representation of self through an online avatar. The inhabitants of SecondLife are called *residents*, and Grieve (2010) operationalizes this term as the cybersocial entity comprising of both the user in real life and the avatar's online presence. Residents of the Zen Buddhist community come together in cyberspace to engage in talks, silent meditations, and other activities. Their physical bodies are geographically separate, but their avatars are present with one another, engaging in *virtual embodiment*, Grieve's (2010) term for immersed, embodied, performances that occur in cyberspace. When these groups unite to sit a silent meditation together, they engage in an embodied and challenging ritual that reinforces the group cohesion and fosters collective intentionality.

4.5. Otherkin

Otherkins ontologically define themselves as partially or entirely non-human along a spectrum (O' Callaghan, 2015). The subculture arose online in the mid 1990s and cyberspace has continued to be the primary arena for discussion, communication, and interaction, although there are gatherings in 'real life' (Laycock, 2012). While the label is nebulous and encompasses a broad range of experiences, there is consensus among Otherkin that their inter-phenomenal experience is highly embodied. Otherkin describe unusual bodily characteristics, like minor deformities, phantom limb/wing/tail sensations, or subtle physical powers (Laycock 2012; O'Callaghan, 2015). The process of discovering one's Otherkin identity is called *awakening* and for many, this manifests itself in a somatic manner. The physical process of *awakening* is a rite of passage that all members of the community go through, a second puberty that secures group cohesion. The oppositional 'other', entitled 'non-kin', 'mundanes', or 'muggles', magnify the group bond and create an in-group boundary to maintain (Laycock, 2012).

As the Otherkin title represents an extensive variety of experience, it would be impossible to paint a comprehensive picture. The community negotiates identity in a diverse manner, narrating through myth, the occult, spirituality, reincarnation, and more.

4.6. r/NoFap

r/NoFap is a subreddit community of around 200,000 primarily male users that abstain from masturbation. The reasons for abstinence vary from one member to the next, from promoting health, improving appearance, or gaining confidence. Many of the users engage in the community and its rituals to overcome a pornography addiction. The community has an eclectic epistemology drawing from a variety of sources, like Alcoholics Anonymous, behavourism, Daoism, neuroscience, and humoural theory.

NoFap is strikingly similar to AA as they share an abstinence-based model, count the length of 'sobriety' (AA with sobriety coins, noFap with labels beside a username), and both are highly supportive communities that share the goal of beating addiction. Here, addiction is conceptualized in a behaviourist framework, where a stimulus and behaviour are linked through paired repetition. For many young boys, their first exposure to sexuality is via Internet pornography and thus they learn to associate the behaviour of masturbation with hyper-stimulating pornography. To decouple this paired association, the community abstains from masturbation. We can consider this through *humourism*, a theory prevalent across many times and geographies, whereby the human body consists of basic substances that cause dysfunction if out of balance (Lindemann, 2010). Through abstinence, the retaining of a vital human substance can cause physiological changes. The idea of the benefits of abstinence is present Daoism, too, and may be found in Chinese folk ontologies more generally. A central concept in Daoist thought is *jing*, the energetic substance of the human body (Wile, 1992). There is a ritualistic emphasis on limiting ejaculation, as *jing* is lost in the process. Members of noFap engage with Daoist knowledge, and there are online Daoist communities with a focus on abstinence, like theDaoBums.com. The nofap subreddit also rests many of their arguments with neuroscience, which seems to have a strong epistemic power in a contemporary, western context (for further discussion, see Ali, Lifshitz, & Raz, 2014). There is extensive discussion of rewiring neural pathways, increased testosterone, and addiction centers of the brain.

In participating as a member of the NoFap community, users engage in an affordance landscape that guides their perception and actions, and thus, they encounter and enact radical shifts in their embodied phenomenology. Users report the embodied benefits of their practice, claiming quite profound changes like the breeze feeling better, increased dexterity, a more masculine appearance, quicker wit, thicker facial hair, richer colour perception, synesthetic experiences, new talents, and regaining the ability to feel the whole spectrum of human emotion. We do not aim to discount the validity of these claims, nor disregard the physiological effects of celibacy. However, we would like to explore additional mechanisms that may contribute to, or amplify these bodily changes.

The NoFap community engages in ritualistic bonding through their shared abstinence, which unites them in an embodied manner and grounds their bodily experiences. On reddit, there exist highly tangible and measurable indices of social approval in the form of comments and upvotes, which create intergroup pressure but also promote a hivemind mentality by rendering the most popular posts the most visible. Constant exposure to the benefits of the practice amplifies certain somatic sensations in turn reinforcing their actions and strengthening the group bond. The ritual context bestows authority to the group's system of knowledge and expectations, creating a context where physiological sensations are emphasized or muted.

4.7. Tulpamancy

Tulpamancy is the practice of conjuring sentient imaginary companions (tulpas) through 'thoughtform' meditative practice (Veissière, 2016). There is controversy surrounding the origin of tulpamancy; it is often traced back to traditional Tibetan meditation techniques. The practice in its current form, however, proliferated online in 2012 after surfacing in a discussion on lucid dreaming in a 4chan forum monitored by so-called Bronies – or adult male fans of the *My Little Pony* TV show. At present, tens of thousands of individuals form online communities of tulpamancers on the subreddit r/Tulpas and the forum Tulpa.info.

The practice of tulpamancy is esoteric and challenging, marked by a set of shared rituals. The most important of these rituals may be 'forcing', whereby one mentally conjures, then interacts with their tulpa in order to develop and sustain them. 'Forcing' is a challenging, exciting, and elusive process – the perfect ingredients for ritualistic bonding. As members of the community work towards this hard-to-reach common goal, they become a closer-knit group. Tulpa communities may also be bonded through shared 'real-life' experiences, as many report struggling with mental health problems and extreme loneliness (Isler, 2016). From these shared experiences emerges a unified culture with prescribed ontologies, taboos, and a unique lexicon of terminology.

As a bonded group, tulpamancers are able to share interphenomenal embodied ways-of-being. The act of tulpamancy is sensory at the core, wherein hosting human or non-human tulpas in a single body involves auditory, tactile, visual, olfactory, and (more controversially, sexual) sensations. These shared sensory experiences may arise from a heightened state of absorption that Tulpamancers have a proclivity for (or have cultivated) as evidenced by high scores on the Tellegen Absorption scale (Veissière, 2016). The absorptive affordance of cyberspace may further encourage these experiences. By harnessing jointly mediated absorption in a virtual context that that invites, expects, frames the experience of conjuring tulpas, members of the community can develop similar ways-of-being. Tulpamancy is a wonderful example of a cyber-mediated ontology. For Veissière, the practice points to the cultural neurophenomenal feedback loops that underpin narrative dimensions of personhood at large.

4.8. Xenomelia

Xenomelia, literally 'foreign limb', is a condition where an individual does not recognize one or more healthy limbs as their own, and thus, possesses a strong desire for paralysis or amputation (McGeoch et al., 2011; see supplement A for a review of naming conventions). Neurological findings may indicate that such a disturbance in body schema originates in the brain (Brugger et al., 2013, McGeoch et al., 2011), however a purely neuroscientific approach has its limits. For instance, there are instances where an individual's foreign limb switches to the opposite side of the body, or desires more amputations over time (Brugger et al., 2013). Alternatively, years of hostility directed toward a limb may cause neuroplastic changes to the cortex (Brugger et al., 2013).

Regardless of origin, the Internet plays a role in the incidence and manifestation of xenomelia (Davis, 2011; Charland, 2004). Our body is in constant negotiation with its cultural backdrop that structures the matrix of normality. We co-construct our body image with the body image of others. As a stigmatized group, people with Xenomelia often turn to the Internet as a safe haven to share their experiences and strife. In Davis' phenomenological account of transabled.org members (2011), she explores the complex co-construction of identity that occurs in cyberspace. The identity of Xenomelia simultaneously shapes and is shaped by digital content in the form of narratives, experiences, and questions, which stabilize the identity as a category available for consumption (Davis, 2011). Connecting over shared suffering also acts as a social technology that strengthens the bond of the group as well as their identity. In these online communities, language is a powerful mediator of intersubjective representations, and may be a mechanism that amplifies somatic symptoms.

5. Conclusion

In this paper, we sketched out a cultural ecological epidemiology and phenomenology of Internet sociality. We argued that online communities, though seemingly novel and often 'strange', give us a window into invariant mechanisms of shared intentionality, distributed attention, and embodied joint expectations through which all human experiences arise. We have argued that if a paradigmatic shift in ways of being social beings can be detected through this increased digitalization of cultural epidemiology, it may simply be on a level of *speed* and *scale* of distribution. As the drastic examples of "new" internet-mediated forms of embodiment described above show, new levels of affective *intensity* (in pain and pleasure, wellness and distress) may also be emerging.

For the rest, as the old stories goes, there is nothing new under the sun.

References

Aiken, M., & Kirwan, G. (2012). Prognoses for diagnoses: medical search online and "cyberchondria". *BMC Proceedings*. 6,(S4), 30.

Ali, S. S., Lifshitz, M., & Raz, A. (2014). Empirical neuroenchantment: from reading minds to thinking critically. *Frontiers in human neuroscience*, *8*.

Anderson, B. (1983). Imagined communities: Reflections on the origin and spread of nationalism. London, UK: Verso.

Atran, S., & Norenzayan, A. (2004). Religion's evolutionary landscape: Counterintuition, commitment, compassion, communion. *Behavioral and brain sciences*, *27*(06), 713-730.

Bourdieu, P. (1977). *Outline of a Theory of Practice*. Cambridge university press.

boyd, danah (2010). Social Network Sites as Networked Publics: Affordances, Dynamics, and Implications. In Papacharissi, Z. (Ed.), *Networked Self: Identity, Community, and Culture on Social Network Sites*, 39-58. Routledge.

Boyer, P. (2001). *Religion explained: the evolutionary origins of religious thought*. New York: Basic Books.

Boyer, P. (2011). Intuitive expectations and the detection of mental disorder: A cognitive background to folk-psychiatries. *Philosophical Psychology*, *24*(1), 95-118.

Bozoglan, B., Demirer, V., & Sahin, I. (2014). Problematic Internet use: Functions of use, cognitive absorption, and depression. *Computers in Human Behavior*, *37*, 117-123.

Bruineberg, J. & Rietveld, E. (2014). Self-organization, free energy minimization, and optimal grip on a field of affordances. *Frontiers in human neuroscience, 8*, 599. doi:10.3389/fnhum.2014.00599.

Brugger, P., Lenggenhager, B., & Giummarra, M. J. (2013). Xenomelia: a social neuroscience view of altered bodily self-consciousness. *Frontiers in psychology*, *4*, 204.

Bucher, T. & Helmond, A. (2017). The Affordances of Social Media Platforms. In Burgess, J,

Poell, T. & Marwick A. (Ed.) *The SAGE Handbook of Social Media*, London and New York: Sage Publications Ltd.

Chemero, A. (2009). *Radical embodied cognitive science*. Cambridge, MA: MIT Press.

Chemero, A. (2003). An outline of a theory of affordances. *Ecological psychology, 15*, 181-195.

Clark, A., & Chalmers, D. (1998). The extended mind. *Analysis Oxford*, 58(1), 7–19.

Colombetti, G. (2012). Psychopathology and the enactive mind. Oxford University Press.

Dunbar, R. I. (1992). Neocortex size as a constraint on group size in primates. *Journal of human evolution*, *22*(6), 469-493.

Dutton, D. G., & Aron, A. P. (1974). Some evidence for heightened sexual attraction under conditions of high anxiety. *Journal of personality and social psychology*, *30*(4), 510.

Ferrara, E., & Yang, Z. (2015). Measuring emotional contagion in social media. *PloS one*, *10*(11), e0142390.

Fischer, R., & Xygalatas, D. (2014). Extreme rituals as social technologies. *Journal of Cognition and Culture*, *14*(5), 345-355.

Fowler, J. H., & Christakis, N. A. (2008). Dynamic spread of happiness in a large social network: longitudinal analysis over 20 years in the Framingham Heart Study. *Bmj*, *337*, a2338.

Fuchs, T., & De Jaegher, H. (2009). Enactive intersubjectivity: Participatory sense-making and mutual incorporation. *Phenomenology and the cognitive sciences, 8*(4), 465-486.

Assefi, S. L., & Garry, M. (2003). Absolut® Memory Distortions Alcohol Placebos Influence the Misinformation Effect. *Psychological Science*, *14*(1), 77-80.

Gibson, J. J. (1986). *The ecological approach to visual perception*. Hillsdale, NJ: Erlbaum.

Gold, J., & Gold, I. (2015). *Suspicious minds: How culture shapes madness*. Simon and Schuster.

Gonçalves, B., Perra, N., & Vespignani, A. (2011). Modeling users' activity on twitter networks: Validation of Dunbar's number. *PloS one*, *6*(8), e22656.

Grieve, G. (2010). Virtually Embodying the Field: Silent Online Buddhist Meditation, Immersion, and the Cardean Ethnographic Method. *Online-Heidelberg Journal of Religions on the Internet*, *4*(1).

Harari, Yuval N. (2015). *Sapiens: a brief history of humankind*.

Hrdy, S. B. (2011). *Mothers and others: the evolution of mutual understanding*. Harvard University Press.

Hart, K. (2003). *Studying world society as a vocation*. Goldsmiths College, University of London.

Hart, K. (2004). Notes towards an anthropology of the internet. *Horizontes Antropológicos*, *10*(21), 15-40.

Hill, R. A., & Dunbar, R. I. (2003). Social network size in humans. *Human nature*, *14*(1), 53-72.

Henrich, J. (2016). *The Secret of Our Success: How culture is driving human evolution, domesticating our species, and making us smarter*. Princeton University Press.

Hutto, D. D., Kirchhoff, M. D. & Myin, E. (2014). Extensive enactivism: Why keep it all in?. *Frontiers in human neuroscience, 8*, 706. doi: 10.3389/fnhum.2014.00706.

Ingold, T. (2001). From the transmission of representations to the education of attention. In H. Whitehouse (Ed.), *The debated mind: Evolutionary psychology versus ethnography*. 113-153 Oxford: Berg Publishers.

Isler, J. J. (2016). Tulpamancy: Transcending the Assumption of Singularity in the Human Mind. 3th Annual Graduate Conference in Comparative Literature: The Extra-Human University of Texas at Austin

Gervais, W. M., & Norenzayan, A. (2012). Like a camera in the sky? Thinking about God increases public self-awareness and socially desirable responding. *Journal of experimental social psychology*, *48*(1), 298-302.

Karakas, Fahri (2009). Welcome to World 2.0: the new digital ecosystem. Journal of Business Strategy, 30(4) pp. 23–30.

Kirmayer, L. J., Robbins, J. M., & Paris, J. (1994). Somatoform disorders: Personality and the social matrix of somatic distress. *Journal of abnormal psychology*, *103*(1), 125.

Kirmayer, L. J., Raikhel, E., & Rahimi, S. (2013). Cultures of the Internet: Identity, community and mental health.

Kirsch, I., & Lynn, S. J. (1997). Hypnotic involuntariness and the automaticity of everyday life. *American Journal of Clinical Hypnosis*, *40*(1), 329-348.

Kirsch , I. (1999). "Hypnosis and Placebos: Response Expectancy as a Mediator of Suggestion Effects" (pdf). *Anales de Psicología*. 15 (1): 99–110.

Kramer, A. D., Guillory, J. E., & Hancock, J. T. (2014). Experimental evidence of massive-scale emotional contagion through social networks. *Proceedings of the National Academy of Sciences*, *111*(24), 8788-8790.

Kurzban R., Neuberg S. (2005). Managing ingroup and outgroup relationships. In Buss D.M., (Ed.). Handbook of Evolutionary Psychology (pp. 653–675). Hoboken, NJ: Wiley.

Laycock, J. P. (2012). "We Are Spirits of Another Sort": Ontological Rebellion and Religious Dimensions of the Otherkin Community. *Nova Religio: The Journal of Alternative and Emergent Religions,* 15(3), 65-90.

Lemogne, C., Consoli, S. M., Limosin, F., & Bonfils, P. (2015). Treating empty nose syndrome as a somatic symptom disorder. *General hospital psychiatry*, *37*(3), 273-e9.

Lindemann, Mary (2010). *Medicine and Society in Early Modern Europe*. University Printing House.

Mansell, R. (2016). Power, hierarchy and the internet: why the internet empowers and disempowers. *Global Studies Journal*, *9*(2), 19-25.

Mauss, M. (1973). Techniques of the body. *Economy and society*, *2*(1), 70-88.

Medoff, Z. M., & Colloca, L. (2015). Placebo analgesia: understanding the mechanisms. *Pain Management*, *5*(2), 89–96. http://doi.org/10.2217/pmt.15.3

McGeoch, P. D., Brang, D., Song, T., Lee, R. R., Huang, M., & Ramachandran, V. S. (2011). Xenomelia: a new right parietal lobe syndrome. *Journal of Neurology, Neurosurgery & Psychiatry*, *82*(12), 1314-1319.

Milgram, S. (1963). Behavioral Study of Obedience. *The Journal of abnormal and social psychology*, *67*(4), 371.

Mueller, A. S., & Abrutyn, S. (2015). Suicidal disclosures among friends: using social network data to understand suicide contagion. *Journal of health and social behavior*, *56*(1), 131-148.

O'Callaghan, S. (2015). Navigating the 'other'world: cyberspace, popular culture and the realm of the Otherkin. *Culture and Religion*, *16*(3), 253-268.

O'Reilly, Tim. (2007). What Is Web 2.0: Design Patterns and Business Models for the Next Generation of Software. *International Journal of Digital Economics*. 65. 17-37.

Oliphint, J. (2016). Is Empty Nose Syndrome Real? And If Not, Why Are People Killing Themselves Over It? Retrieved August 28, 2016, from https://www.buzzfeed.com/joeloliphint/is-empty-nose-syndrome-real-and-if-not-why-are-people-killin?utm_term=.ekLkL2Rlx5#.niOMPXOg4x

Parker, S., Garry, M., Einstein, G. O., & McDaniel, M. A. (2011). A sham drug improves a demanding prospective memory task. *Memory*, *19*(6), 606-612.

Payne, S. C. (2009). Empty nose syndrome: what are we really talking about?. *Otolaryngologic Clinics of North America*, *42*(2), 331-337.

Ramstead, M. J., Veissière, S. P., & Kirmayer, L. J. (2016). Cultural affordances: scaffolding local worlds through shared intentionality and regimes of attention. *Frontiers in Psychology*, *7*.

Raz, A., Raikhel, E., & Anbar, R. D. (2008). Placebos in Medicine: Knowledge, Beliefs, and Patterns of Use. *McGill Journal of Medicine : MJM*, *11*(2), 206–211.

Richerson, P. J., & Boyd, R. (1998). The evolution of human ultrasociality. *Indoctrinability, ideology, and warfare: Evolutionary perspectives*, 71-95.

Rietveld, E. & Kiverstein, J. (2014). A rich landscape of affordances. *Ecological psychology*, 26(4), 325-352.

Roepstorff, A., Niewohner, J. and Beck, S. (2010). Enculturating brains through patterned practices. *Neural networks, 23*, 1051-1059.

Saafan, M. E., Hegazy, H. M., and Albirnawym O. A. (2016). Empty Nose Syndrome: Etiopathogensis and Management. *The Egyptian Journal of Otolaryngology*. 32:119-129.

Searle, John R. *The construction of social reality*. New York: Free Press, 2001.

Serres, M. (2014). Thumbelina: the culture and technology of millennials.

Sperber, D. (1996). *Explaining Culture: A naturalistic approach*. Oxford: Blackwell Publishers.

Starcevic, V. and Aboujaoude, E. (2015), Cyberchondria, cyberbullying, cybersuicide, cybersex: “new” psychopathologies for the 21st century?. *World Psychiatry*, 14: 97–100.

Sterelny, K. (2012). *The evolved apprentice: How evolution made humans unique*. Cambridge, Mass: The MIT Press.

Thompson, E. (2007). Mind in life: Biology, phenomenology, and the sciences of mind. Cambridge, MA: Harvard University Press.

Tollefsen, D. P. (2006). From extended mind to collective mind. *Cognitive systems research*, *7*(2), 140-150.

Tomasello, M. (2014). A natural history of human thinking. Harvard University Press. Chicago

Tomasello, M. (2009). *Why we cooperate*. MIT press.

Tomasello, M. (2008). *Origins of Human Communication*. MIT Press.

Tomasello, M., Carpenter, M., Call, J., Behne, T., & Moll, H. (2005). Understanding and sharing intentions: The origins of cultural cognition. *Behavioral and brain sciences*, *28*(05), 675-691.

Tomasello, M., & Rakoczy, H. (2003). What makes human cognition unique? From individual to shared to collective intentionality. *Mind & Language*, *18*(2), 121-147.

Tsatsou, P. (2011), "Digital divides revisited: what is new about divides and their research?", *Media, Culture and Society*, 33(2), 317-331.

Tuomela, R. (2007). *The philosophy of sociality: The shared point of view*. Oxford: Oxford University Press.

Varela, F. J., Thompson, E., & Rosch, E. (1991). *The embodied mind: Cognitive science and human experience*. Cambridge, MA: MIT Press.

Veissière, S. (2016). Varieties of Tulpa experiences: the hypnotic nature of human sociality, personhood, and interphenomenality. *Hypnosis and meditation: Towards an integrative science of conscious planes*, 55-76.

Veissière, S., & Gibbs-Bravo, L. (2016). Language, Ritual, and Placebo Sociality in a Community of Extreme Eaters. *Food Cults: How Fads, Dogma, and Doctrine Influence Diet*, 63.

Wellman, B. (2012). Is Dunbar's number up?. *British Journal of Psychology*, *103*(2), 174-176.

Wengrow, D. (2013). *The Origins of Monsters: Image and cognition in the first age of mechanical reproduction*. Princeton University Press.

Whitehouse, H. (2004). *Modes of religiosity: A cognitive theory of religious transmission*. Rowman Altamira.

Whitehouse, H. (2001). Transmissive frequency, ritual, and exegesis. *Journal of Cognition and Culture*, *1*(2), 167-181.

Wile, D. (1992). *Art of the bedchamber: The Chinese sexual yoga classics including women's solo meditation texts*. SUNY Press.

Willinger, W., Govindan, R., Jamin, S., Paxson, V., & Shenker, S. (2002). Scaling phenomena in the Internet: Critically examining criticality. *Proceedings of the National Academy of Sciences*, *99*(suppl 1), 2573-2580.

Wittgenstein, L. (1953). *Philosophical investigations*. Oxford: Blackwell.

World Internet Users Statistics and 2017 World Population Stats. (n.d.). Retrieved January 1, 2017, from http://www.internetworldstats.com/stats.htm

Xygalatas, D., Mitkidis, P., Fischer, R., Reddish, P., Skewes, J., Geertz, A.W., Roepstorff, A. and Bulbulia, J., (2013). Extreme rituals promote prosociality. *Psychological science*.

Zahavi, D. & Satne, G. (2015). Varieties of shared intentionality: Tomasello and classical phenomenology. In J. A. Bell, A. Cutrofello & P. M. Livingston (Eds), *Beyond the analytic-continental divide: Pluralist philosophy in the twenty-first century* (pp. 305-325). New York and London: Routledge.