Passive Visual Behavior Modifiers and Consumer Psychophysiology Online

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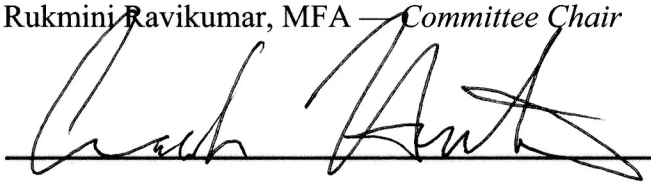

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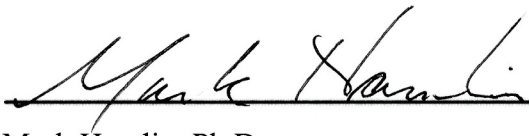

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Abstract

Through an examination of the electroencephalography (EEG) data collected from 27 university students, this study examined the efficacy of three known passive visual behavior modifiers — color, layout, and motion — in an e-commerce environment. These three variables have significant scholarly support in the context of traditional media, but their effect online is still largely unsubstantiated. Using EEG readings taken from regions of interest Fp1 and Fp2, the researcher attempted to measure and compare sustained evoked response upon exposure to six fictitious e-commerce web pages, each exhibiting a different passive visual behavior modifier. It was hypothesized that (H_1) a product in a subtle state of motion, (H_2) a greater proportion of image to text, and (H_3) a color system with a dominant wavelength of approximately 650nm would evoke higher average levels of amplitude (μV) and frequency (Hz) in the ventromedial prefrontal cortex compared to stimuli exhibiting inverse properties: a static product image, a greater proportion of text to image, and a color system with a dominant wavelength of approximately 490nm. The biofeedback measurement was supplemented by a qualitative interview. Participant responses were analyzed for key words, phrases, and trends related to consumer attitude and product preference. While no significant differences were found between the visual stimuli, this study provides insight, limitations, and direction for future psychophysiological research relating to e-commerce.

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Definition of Terms

Absolute Value — "Computes the absolute value of the data. All negative data values are made positive, with no changes to magnitude. This function can be used to rectify data." (Biopac Student Lab PRO Manual, 2010)

Aesthetics — "Giving or designed to give pleasure through beauty; of pleasing appearance." (Abate & Jewell, 2005, p. 25)

Animation — "The process of providing some form of moving video. There are a number of technologies that are used for animation, ranging from simple ones such as GIF animation to much more complex multimedia packages which provide a whole gamut of facilities including sound and video." (Ince, 2009)

Balance — The establishment of "equal or appropriate proportions of elements." (Abate & Jewell, 2005, p. 67)

Beta Rhythm — "Rhythmic brain waves of approximately 13–30Hz, as recorded in an EEG, most often observed when the subject is alert." (Stern, 2001, p. 464)

Biofeedback — "Information concerning the functioning of internal organs, usually obtained through the use of electronic recording equipment." (Stern, 2001, p. 264)

Color — "Color is a sensation produced in the brain in response to the incidence of light on the retina of the eye. The sensation of color is caused by differing qualities of the light emitted by light sources or reflected by objects. It may be defined in terms of the observer, in which case the definition is referred to as perceptual and subjective." (Levkowitz, 1997, p. 6)

Consumer Behavior — "Consumer behavior encompasses individual, group, and organizational decisions and activities affected by intra- and interpersonal variables that are involved in

evaluating, acquiring, using and disposing of products, services, experiences, or ideas, and the impact these processes have on consumers and society." (Sandhusen, 2008, p. 238)

Contrast — "A juxtaposition or comparison showing striking differences." (Abate & Jewell, 2005, p. 206)

Corporate Identity — "Process whereby the design elements of an organization are utilized to maximum effect in order to communicate what it does and how it does it. Corporate identity can embrace products, services, environments, and the means of internal and external communication." (Livingston, A. & Livingston, I., 1992, p. 49)

E-Commerce — "The use of network technology, more specifically Internet technology, to carry out business functions remotely." (Ince, 2009)

Electroencephalography — "A technique for recording over time variations in electrical potentials observed from electrodes on the scalp." (Stern, 2001, p. 266)

Emphasis — "Stress laid on a word or words to indicate special meaning or importance." (Landa, 2006, p. 382)

Fourier Analysis — "A method of breaking down a time series into the sine waves that make it up; a specific version of Fourier analysis often used by psycho-physiologists is the Fast Fourier Transform or FFT." (Stern, 2001, p. 266)

Frequency Domain Techniques — "Techniques for analyzing data represented by different frequencies (or in the frequency domain)." (Stern, 2001, p. 266)

Graphic Design — "Can be thought of as a visual language that is used to convey a message to an audience. A graphic design is a visual representation of an idea that relies on the creation, selection, and organization of visual elements to create an effective communication. A powerful

graphic design can imbue a message with greater meaning through a compelling solution." (Abate & Jewell, 2005, p. 735)

Graphical User Interface (GUI) — "A term used to describe a collection of visual objects such as buttons, windows, text boxes, and menus which make up the interface to a computer program. It is usually abbreviated to GUI." (Ince, 2009)

Hypertext Markup Language (HTML) — "The language used to develop documents which are to be placed on the World Wide Web." (Ince, 2009)

Impedance — "Total resistance to current of an AC circuit; varies with the volume of a conductor and other factors." (Stern, 2001, p. 267)

International 10–20 System — "A system which makes possible standardized placement of EEG electrodes on the scalp." (Stern, 2001, p. 268)

Leading — "The space between lines of type measured from baseline to baseline. Leading is expressed in points and is a term that derives from hot metal printing, when strips of lead were placed between the lines of type to proved sufficient spacing." (Ambrose & Harris, 2006, p. 147)

Line-length — Relates to the length of line of type on a page: "Line length can be measured by the physical length of the line, e.g. by adjusting margins. Some studies refer to this manipulation of physical length as visual angle, which takes into account the physical length and the viewing distance." (Dyson, 2004, p.379)

Navigation — "A set of images and text embedded in a Web page which help users navigate around the Web site in which the page is embedded. Navigation bars are usually found at the top, bottom, or side of a page." (Ince, 2009)

Neurophysiology — "The study of the physiological mechanisms mediating the transduction, coding, and communication of sensory information." (Levkowitz, 1997, p.6)

Paratelic State — "From the Greek *para,* meaning beside […] related to excitement-seeking. This state is characterized as activity-orientation, where the goal of the activity is not important compared to the ongoing activity." (Deng & Toole, 2010, p. 715)

Perception — "The effect of sensory phenomena that are also mediated by higher-level processes, such as memory, attention, and experience." (Levkowitz, 1997, p. 6)

Physical Stimulus — "Measurable properties of the physical world, such as luminance, sound pressure, and wavelength." (Levkowitz, 1997, p. 5)

Point Size — "A type measurement from the ascender line to the descender line of each character." (Ambrose & Harris, 2006, p. 196)

Psychophysics — "The study of the sensations and perceptions that physical energies – such as brightness, loudness, and color – produce." (Levkowitz, 1997, p. 6)

Retail — "The sale of goods to the public in relatively small quantities for use or consumption rather than for resale." (Abate & Jewell, 2005, p. 1445)

Spectral Analysis — "A technique for determining the power of the frequencies present in a physiological record." (Stern, 2001, p. 272)

Symmetry — "A grid or layout in which the recto and verso pages mirror one another." (Ambrose & Harris, 2006, p. 243)

Telic State — "(From the Greek *telos,* meaning goal) […] characterized as goal-oriented in which the ultimate goal of any ongoing activity is perceived as essential for the individual, and the activity itself is peripheral. In the telic state, a high level of arousal is experienced as unpleasant and associated with anxiety." (Deng & Toole, 2010, p. 715)

Time Domain Techniques — "Techniques for analyzing data represented across time (or in the time domain)." (Stern, 2001, p. 273)

Typeface — "A group of characters, numbers, symbols and punctuation which have the same distinct style. A particular design of type." (Ambrose & Harris, 2006, p. 261)

Typography — "Arrangement and specification of type in preparation for printing. Traditionally associated with printing from metal type, now equally applied to typesetting produced by any type composition system." (Livingston, A. & Livingston, I., 1992, p.196)

Website — "A location connected to the Internet that maintains one or more pages on the World Wide Web." (Abate & Jewell, 2005, p. 1903)

Web page — "A document connected to the World Wide Web and viewable by anyone with an Internet connection and a browser." (Abate & Jewell, 2005, p. 1903)

World Wide Web — "A widely used information system on the Internet that provides facilities for documents to be connected to other documents by hypertext links, enabling the user to search for information by moving from one document to another." (Abate & Jewell, 2005, p. 1937)

Introduction

This research attempts to identify the efficacy of passive visual behavior modifiers in an e-commerce environment. Passive visual behavior modifiers, for the purposes of this study, are defined as any visual condition with the potential to affect behavior without the use of written or verbal language. Red wall paint, for example, has been shown to illicit a measurable cognitive reaction. The use of red, therefore, constitutes a passive visual behavior modifier. The researcher tests three variables that could potentially inhibit or encourage purchase probability in e-commerce environments — motion, layout, and color.

Creating the optimal visual conditions for e-commerce is of great priority to online retailers. While traditional media (newspaper, magazine, and television) has enjoyed the benefits of decades of consumer behavior studies, the theory of e-commerce design is still relatively unsubstantiated. This research will attempt to fill a foundational gap in the literature: Is purchasing probability in an e-commerce environment a function of passive visual behavior modifiers?

Since the introduction of the first e-commerce websites in the early 1990s, developers have devoted most of their attention to addressing the most urgent issues first. Consumer confidence was, and still is, the most important factor in the viability of the Internet as a vehicle for commerce. Shoppers are extremely cautious about transferring financial information online, and the science of web development has been largely a pursuit of putting those minds at ease. Usability and accessibility came next. Getting consumers to the point-of-purchase continues to be a major concern of commercial web designers.

Twenty years after the genesis of e-commerce, technology has democratized web design. Today, a small retail business can launch a digital storefront online that has the same perceived level of trust and usability as a giant like Amazon.com. A multitude of software solutions exist allowing even an inexperienced designer to publish a fully functional e-commerce website. So, as the initial technical obstacles to e-commerce diminish and control of the visual presentation of websites becomes more acute, web developers are presented with a strangely foundational question: How should e-commerce websites look? The body of literature has much to say about consumer confidence and usability, but strangely little empirical research exists surrounding visual presentation.

What design characteristics effectively modify consumer behavior online? Will consumers be more likely to purchase something online if certain layout conditions are present? Do some colors motivate purchase intent online more than others? Is a product in motion more likely to be purchased compared to one that is static? These are all questions that this research attempts to answer.

Literature Review

This review of existing research and literature is intended to provide a foundational understanding of aesthetic theory, consumer behavior, and graphic design as they relate to e-commerce. The themes of each section of material are cumulative, each one building upon the last and each essential to understanding the need for the experiment that follows. It includes an overview of the philosophy of aesthetics and the importance of individual taste, the origins and principles of commercial graphic design, and a comprehensive analysis of current theory surrounding e-commerce web environments and the people that use them.

Due to the nature of this research, a great deal of this literature review is devoted to revealing the connection between graphic design and consumer behavior. Graphic design, while sometimes misconstrued as purely decorative and ancillary, is actually a powerful tool in the marketing toolbox. How information is presented to a consumer is often just as important to the consumer as the information itself, whether they are aware of it or not. The hedonic testing variables used in the experiment that follows, while seemingly superficial, have empirically-based precedent for real and measurable behavioral modification.

Aesthetics

The philosophy of aesthetics encompasses a vast field of humanistic enterprises ranging from art to morality, but this study will focus primarily on aesthetics as it applies to a consumerist context, namely the notion of *taste*. While taste is a relatively modern phenomenon, the study of aesthetics and visual composition can be traced back to antiquity. Greek

philosophers made the first inroads into the field of aesthetics, making broad assertions about the characteristics of visual beauty.

Classical aesthetic theory.

Plato claimed that art, both visual and literary, should be judged by its measure of "correctness" (Beardsley, 1966, p. 46). In other words, Plato might say that an object that correctly imitates life has an *aesthetic* quality, though the actual term was not coined until 1735 (Guyer, 2004). Plato also made general observations about composition and its relationship to the measurement of beauty, most famously in his collection of writings titled *Symposium*. Analyzing examples of complex beautiful things, Plato remarked that the objects with the greatest degree of beauty commonly reflected a pattern of balance, precision, and proportion. The human form, classical Greek architecture, even simple geometric figures were found to hold these qualities:

> …the face and figure of Agathon or Alcibiades, the Greek krater or temple? They have unity, regularity, simplicity (whether or not imposed upon complexity) – something like the principle of "the same". […] This is what gives them ideal character […] and either constitutes, or more probably, supports and sustains their beauty. (Beardsley, 1966, p. 43)

While Plato never used the term "symmetry", modern interpretations of his writing and discourse suggest that he, in fact, defined the term before it even had a name. The Greek words *summetros* and *summetria*, used frequently by Plato, translate to 'the same measure' or 'of the

same measure'. Socrates, Plato's mentor and predecessor applied this new term not only to foundational geometry (i.e. the base angles of an isosceles triangle), but also as a reflection of the more practically aesthetic:

> …the plane or solid figures which are formed out of them by turning-lathes and rulers and measures of angles; for these I affirm to be not only relatively beautiful, like other things, but they are eternally and absolutely beautiful. (Lloyd, 2010, p.457)

Socrates' identification of the beauty of a perfectly lathed circle, and the symmetry embodied by it, echoes throughout art history and into modern visual communication. The principles of proportion, symmetry, balance and weight are used by graphic designers every day, and indeed, in this study. If graphic design is a science, these are among the elements that make up its periodic table.

Modern aesthetic theory.

The next major milestones in the study of aesthetics and taste were the edicts of eighteenth-century German philosopher Immanuel Kant. Kant was an objectivist in his approach to aesthetics and taste. *Critique in Judgment*, his illustrious examination of the collective perception of beauty, suggested that aesthetic judgments are not logical. Instead, they exist on some lower, more self-indulgent, level of consciousness. Kant observed that beauty is free from logical interpretation, a concept he termed *free satisfaction*. He believed that this disinterested state of satisfaction was shared universally in regards to objects of high aesthetic quality. This

general consensus, Kant argued, was indicative of some underlying and measurable condition of aesthetic composition. Kant also noted the occasional disparity between *evaluation* and taste (Beardsley, 1966, p. 212). A flower, for example, is considered to be beautiful, but by what measure? A layperson might reference the simple color of the petals or the radial symmetry of the blossom, but a botanist might define the flower's beauty by its cellular complexity and multifaceted evolutionary traits. These two audiences place entirely different values on the same object based on their contrasting backgrounds.

David Hume, another prominent aesthetic philosopher of the same era, sought to define taste more precisely. He investigated beauty empirically, seeking to find a 'standard of taste', and concluded in his manuscript *Treatise* that taste originates from the consensus of a community of experienced critics, or those individuals that had refined their palettes through exposure to a great variety of beautiful things:

> Strong sense, united to delicate sentiment, improved by practice, perfected by comparison, and cleared of all prejudice, can alone entitle critics to this valuable character, and the joint verdict of such, wherever they are to be found, is the true standard of taste and beauty. (Hume, trans. 1978)

Kant and Hume agree that taste is derived from a visceral reaction. An audience subconsciously observes an object, comprehends what that object represents, and makes their judgment based on an underlying feeling of pleasure or displeasure, but Hume persisted in his

pursuit for the finite characteristics of good taste, once proclaiming that a significant part of beauty lies in an object's "convenience and utility" (Kulenkampff, 1990, p. 97).

Hume points to the columns of a building. If constructed with a narrow base and wide top, the columns might be considered ugly due to their precarious appearance. Structure and solidity, therefore, can be considered attributes of beauty, according to Hume (Beardsley, 1966, p. 188). However, even Hume acknowledges the existence of a collective aesthetic dissonance, famously writing "all sentiment is right; because sentiment has a reference to nothing beyond itself" (Kulenkampff, 1990, p. 94).

These, of course, are only a few in a long lineage of aesthetic philosophers, but they are included here to illustrate a point. Graphic design is, in part, applied aesthetic theory, and as these philosophers surmise, the definition of aesthetic quality is problematically nebulous. Immeasurable qualities like beauty, individual taste, and creativity are the reasons why successful graphic design is more than the sum of an empirical equation.

As the literature will reveal, measuring the *effect* of aesthetic quality is commonplace, and it has demonstrated strong commercial significance. However, any *replication* of the testing conditions immediately renders the stimuli ineffective. Copied creativity is no longer creative. A beautiful piece of artwork, if revealed to be a forgery, is somehow less beautiful. Taste, extended beyond the individual, is no longer a reliable forecaster. These artistic interpretations, by definition, have no reproducible characteristics. Consequently, despite countless scientific studies examining observable design properties like symmetry, contrast, and color, the practice

of graphic, design will always be a hybrid enterprise, perpetually adrift between art and science. This is an important acknowledgement to make in any study of graphic design.

Aesthetics and consumer behavior.

Despite its imprecise definition, the effects of aesthetic judgment on consumer behavior are well documented. Researchers recently measured the valuation of financial companies based solely on the aesthetic quality of their annual reports. Testers chose the financial sector because it was assumed that reasoned analysis of data would prevail over the emotional responses typically activated by aesthetics. Participants were given one of two annual reports, each containing the same information but obviously disparate in aesthetic quality. They were then asked to speculate on dependent measures like selling price and market ranking. What researchers found was a strong argument for the value of aesthetics *and* graphic design. Even among finance students, a population whose valuation was presumed to be purely analytical, simple aesthetic quality significantly affected their final appraisals (Townsend & Shu, 2010).

These results were resounded by recent research involving package design and product valuation. Reimann, Zaichkowsky, Neuhaus, Bender, and Weber (2010) used functional magnetic resonance imaging (fMRI) to observe the reward centers of the brain (observed cerebral profusion in the ventromedial prefrontal cortex) as participants were exposed to high and low-aesthetic packaging systems. What they observed confirmed their initial written survey findings: Highly aesthetic packaging, even of an unknown brand, was preferred more often than low-aesthetic packaging. This study suggests that aesthetic quality can be a powerful modifier of consumer behavior, even more so than a time-honored brand.

One 2011 test of online shopping environments sought to identify the valuable aesthetic characteristics for different e-commerce scenarios. Using definitions derived from Schenkman and Jonsson (2000) and Lavie and Tractinsky (2004), researchers tested *aesthetic formality* (order, legibility, symmetry and simplicity) and *aesthetic expressiveness* or *appeal* (creativeness, fascination, originality, and similar hedonic qualities) in websites. Participants exposed to high formality/high appeal websites were more likely to make impulsive purchases and re-visit the site in the future while low formality/low appeal websites led participants to leave the site immediately. Their results also showed some variability between task-oriented (*telic*) and task-free (*paratelic*) participants:

> E-tailors can manipulate web aesthetics to achieve most favorable outcomes. For example, more transaction-based sites with the aim of mitigating customer hesitation and promoting immediate sales should consider an e-tail website that features high aesthetic formality and high aesthetic appeal for task-free online consumers, while an e-tail website featuring high aesthetic formality and low aesthetic appeal may be best to target regular online shoppers with prioritized purchase tasks. Websites which are more directed to relationship-building through repetitive visits and click rates should feature high aesthetic formality and high aesthetic appeal for both task-oriented and task-free online consumers. (Wang, Minor, & Wei, 2011, p. 55)

While these studies provide important indicators of aesthetic theory's commercial utility, again, the professional application of their findings is lacking. Reimann et al. (2010), for example, used aluminum Coca-Cola bottles adorned with colorful vector illustrations versus utilitarian plastic bottles with generic graphics, but failed to adequately *define* the aesthetic characteristics of the stimuli. Without knowing the individual graphic ingredients that make a product (or website) aesthetically pleasing, replication of the research conditions becomes infeasible (and illegal in the case of the Coca-Cola bottle). This research will attempt isolate the finite graphic conditions with that have shown potential to effect on consumer behavior online.

How should designers make aesthetic decisions on the web? How do they know what is appropriate for one audience and ineffective for another? To what degree do principles like applied symmetry and balance affect the success of a marketing effort, and how much is left up to the random nature of individual taste? These are some of the questions that this study will attempt to address in its findings.

Consumer Behavior

While this investigation's focus is on graphic design-related variables and their effects on consumer behavior, it is important to note some of the other factors known to play a role in consumer purchasing habits. Consumer psychology is, of course, a vast realm of study. The following cursory overview of traditional and neuropsychological theory is included to acknowledge that a broad array of influencing factors exist outside of the reach of graphic design and should be considered with equal weight in a retail environment.

Consumer behavior theorists divide a buyer's sphere of influence into four major areas: personal, psychological, cultural, and social. This theory asserts that a web of internal and external factors, including everything from age and gender to socio-economic status and education, governs the decisions consumers make every day (see Figure 1). These four major areas of consumer behavior are further discussed in the next portion of this literature review.

Figure 1. Kotler's Consumer Behavior Model

Cultural	Social	Personal	Psychological
Culture	Reference Groups	Age	Motivation
Subculture	Family	Occupation	Perception
Social Class	Roles & Status	Economic Circumstances	Learning Beliefs & Attitudes
		Lifestyle	
		Personality & Self-concept	

Figure 1. Kotler's traditional model of factors influencing consumer behavior. Adapted from a graph in Kotler, P. (1986). Consumer markets: influences on consumer behavior. *Principles of Marketing.* (p. 163). Englewood Cliffs, NJ: Prentice-Hall.

Demographic influence.

Demographics have a great deal to do with what consumers buy. Taste and need vary significantly depending on the age of an individual, for example. In one survey of perfume brand preference among female consumers over the age of fifteen, participants over the age of 65 consistently showed a preference for older and more established fragrance brands due to the sense of brand loyalty that had developed over a relatively longer period of time compared to younger participants (Lambert-Pandraud & Laurent, 2010).

Gender is another major contributor to purchasing decisions. Men and women have clear differences in preference among many categories of consumables, but the disparities do not stop with taste. Studies consistently show that *how* men and women approach shopping is vastly different. One recent study by Durante, Griskevicius, Hill, Perilloux, and Li (2011) asked a

group of women to purchase items from a retail clothing website throughout their menstrual cycle, and found that subject ovulation cycles would coincide with purchasing "sexier and more revealing clothing, shoes, and fashion accessories." The same study also found that the effect was less apparent in women who were not in the immediate vicinity of a same-sex competitor. The study's conclusions were consistent with the Gangestad, Thornhill, and Garver-Apgar's (2008) ovulatory-shift hypothesis which theorizes women find masculine characteristics more appealing and make efforts to appear more attractive than same-sex rivals during ovulation when the potential evolutionary payoff is highest.

Men also have unique shopping characteristics. Lee, Ibrahim, and Hsueh-Shan (2005) used in-depth interviews and questionnaires to investigate the properties men value most in a brick-and-mortar shopping environment. Their results showed that men, on average, place higher values on utilitarian retail characteristics like customer service, logical floor plans, and sales personnel with good product knowledge as opposed to ancillary features like value-added programs and special events. These gender-specific shopping patterns indicate that gender-biased testing conditions and stimuli would compromise the overall validity of the proposed investigation.

Occupation and *household income* play a role in consumer behavior, as well. The volume and value of product consumption is an obvious function of household income, but research into how different income levels participate in the marketplace reveal several indicators of socioeconomic stratification. For example, recent research into the online buying patterns based

on income showed that men earning more than $30,000 are 15% more likely to use the Internet to make purchases (Hannah & Lybecker, 2010).

Another study from researchers at the University of Utah reveals variations in individual buying patterns based on the distance from the day an employment salary is paid out. Researchers hypothesized that the type of items purchased by participants would depend on where they were in their regular pay cycle, and indeed, the data showed that consumers were more likely to purchase "promotional" items, things like whitening toothpaste and chocolate cake, immediately after a salary was dispensed. Conversely, the same participants tended to buy "preventative" items, such as cavity protection toothpaste and fruit salad, as they neared the end of their pay cycles (Mishra, Mishra, & Nayakankuppam, 2010).

Psychological influence.

Consumers are also guided by individual psychographic characteristics. These endogenous interpretations of experience and perception help consumers build a library of product preferences, and it is extremely important that marketers consider their target's psychographic characteristics during the development of a promotional message. This *psychological influence* is a combination of perception, motivation, beliefs and attitudes.

Perception, or the "activities by which an individual acquires and assigns meaning to stimuli" occurs in three phases: exposure, attention and interpretation (Hawkins, Best, & Coney, 1983). *Exposure* is the initial experience that consumers encounter when presented with a marketing message, be it advertising, branding, or the physical product. Because a person is exposed to innumerable pieces of sensory information throughout the day, marketing theorists

have deduced that exposure is selective. In other words, consumers choose which messages they want to see, hear, smell, taste, or touch:

> The fact that the exposure process is selective rather than random is the underlying basis for effective media strategies. If the process were random, a shotgun approach of trying to place messages randomly in the environment would make sense. Since exposure is not random, the proper approach is to determine which media consumers in the target market are most frequently exposed to and then place the advertising messages in those media (Hawkins, et al., 1983, p. 342).

After exposure has occurred, *attention* is the next step in consumer perception. Attention is the conscious or unconscious interpretation of a message by one of the five senses. Research shows that a number of factors can affect the probability that attention will be given. Contrast, size, color, movement, position, and isolation can all entice the attention of a consumer. These visual concepts are explored in further detail in later sections of this literature review. Research also supports smell, sound, touch and taste as having attention-grabbing capabilities (Hawkins, et al., 1983).

In his book *Brand Sense*, author Martin Lindstrom cites a famous study by Dr. Alan R. Hirsch, director of the Smell and Taste Treatment and Research Foundation in Chicago, in which two groups of subjects were asked to review Nike shoes in two separate rooms. The rooms and shoes were identical, but an independent variable of a faint floral scent was injected into one of

the testing rooms room. Participants preferred the shoes in scented room by a margin of 84% compared to the same shoes displayed in the control room. Sound can also play a key role in consumer attention and brand awareness. During the height of its popularity in the mid-2000's, Nokia's iconic ringtone had a global recognition of 41%. Nearly half of the people on Earth knew the Nokia brand by a simple thirteen-note progression (Lindstrom, 2005).

Interpretation, or "the assignment of meaning to sensation", is the final step in the process of perception. This process has to do with consumer learning patterns and how they assign patterns of sensory input to levels of brand favorability. For example, in a frequently cited *Journal of Marketing* study from 1977, researchers found that potato chips packaged in difficult-to-open polyvinyl bags were rated as crispier and tastier compared to identical chips packaged in wax paper bags. Researchers concluded that the consumer interpretation of a polyvinyl bag as being sturdier and forming a tighter seal resulted in a perception that the potato chips within were fresh and crisp (McDaniel & Baker, 1977).

Motivation, or "the energizing force that activates behavior and provides purpose and direction to that behavior" is identified by consumer psychologists as having a great deal of influence on buyers (Hawkins et al., pp. 346). In fact, one of the first things advertising students learn in college is a foundational principles of consumer motivation: Maslow's Hierarchy of Needs.

In his 1943 paper *The Theory of Human Motivation*, Abraham Maslow outlined a pyramid of basic decision motivators (see Figure 2), which in addition to revolutionizing social psychology, is used today to formulate advertising messages (Kotler, 1986, pp. 179). From the

most basic human needs like breathing, eating, and reproduction to more complex emotional needs like safety, love, and belonging, Maslow's hierarchy encompasses everything it is to be human, and advertisers are essentially in the business of convincing a consumer that part of his or her pyramid is missing.

Figure 2. Maslow's Hierarchy of Needs

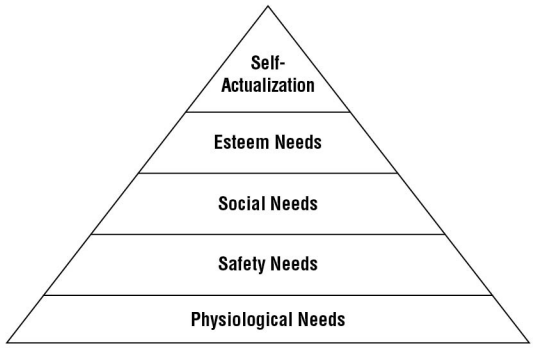

Figure 2. A graphical representation of Maslow's hierarchy of needs. Adapted from a graph in Kotler, P. (1986). Consumer markets: influences on consumer behavior. *Principles of Marketing.* (p. 179). Englewood Cliffs, NJ: Prentice-Hall.

In his book *Buying In,* author Rob Walker (2008) exhibits this concept with the phenomenon of the sport utility vehicle. In the late 1990's and early 2000's, SUV sales soared when the American public was convinced that this was a safer and more durable type of vehicle, despite accident statistics showing the exact opposite.

Figure 3. McGuire's Psychological Motives

INTERNAL NEEDS	EXTERNAL NEEDS
Consistency: The need for internal equilibrium or balance	**Self-Expression:** The need to express self-identity to others.
Causation: The need to determine who or what causes the things that happen to us	**Ego-Defense:**The need to defend or protect our identities or egos.
Categorization: The need to establish categories or mental partitions which provide frames of reference.	**Assertion:** The need to increase self-esteem.
Cues: The need for observalbel cues or symbols which enable us to infer what we feel and know.	**Reinforcement:** The need to act in such a way that others will reward you.
Independence: The need for feeling of self-governance or self-control.	**Affiliation:** The need to develop mutually satisfying relationships with others.
Novelty: The need for variety.	**Modeling:** The need to base behaviors on those of others.

Figure 3. McGuire's list of internal and external psychological motives. Adapted from a chart in Hawkins, D.I., Best, R., & Coney, A. (1983). *Consumer Behavior: Implications for Marketing Strategy.* Plano, TX: Business Publications, Inc. (p. 352)

As an extension of Maslow's theories, McGuire's Psychological Motives suggests that consumer motivation can be further distilled into internal and external motives and needs. Internal motives include the need for consistency, causation, categorization, cues, independence, and novelty. External motives include the need for self-expression, ego-defense, assertion, reinforcement, affiliation, and modeling (see Figure 3). Marketers use McGuire's list to position

a product to fill one or more of these needs (Hawkins et al., 1983). Political campaign ads often use affiliation marketing, for example. Voters, wanting to believe they belong to the most moral or just party, often respond to terminology like ‘family values’ or ‘patriotism’.

Individual *personality* is also a known determinant of purchasing behavior. A 2006 study tested two of the five major personality traits, among them openness to experience and risk-taking propensity, against adoption of shopping online. The research revealed significant correlations between these two specific personality characteristics and likelihood to shop online (Wang, Wang, & Wang, 2006). This research implies that defining a target audience online involves much more than understanding potentially profitable demographic segments. The psychographic characteristics of Internet shoppers are equally important.

These findings were echoed by Larson and Sachau who found that participants who were measured to be more agreeable, conscientious, and extroverted also rated products online more favorably than respondents who scored low on the same measures (2009).

Another analysis of the affect of personality traits in e-commerce environments came from the University of Sonoma in 2007. Researchers analyzed how the popular Myers-Briggs Type Indicators (MBTI), originally developed by famous Swiss psychiatrist Carl Jung, could be used to develop behavior-targeted e-commerce websites. Researchers postulated, for example, that extroverts would react more positively to web environments with direct terminology, pictures of people, and prominent access to secondary communication information like phone numbers, while an introvert might be drawn towards websites that feature more indirect sales appeals, imagery of nature or solitude, and avenues for written communication as a form of

contact (Cunningham, Thach, & Thompson, 2007). Researchers in this case did not conduct empirical research to support their hypotheses, however, and existing literature actually suggests that the MBTI metrics are a weak measure of consumer behavior in a traditional retail setting (Shank & Langmeyer, 1994).

Cultural influence.

In addition to psychological factors, *culture* and *subculture* can carry significant weight in a buyer's decision-making process. A disastrous example of cultural negligence was Pepsi's 1963 campaign that invited consumers to "Come alive with Pepsi." While the advertising was well-received in the United States, the slogan lost some of its meaning in other languages. "Come out of the grave with Pepsi" and "Pepsi brings your ancestors back from the grave" were some of the more unfortunate translations (Mullen & Johnson, 1990, pp. 140).

Social scientists agree that marketing solutions have to be considered within the cultural context of the target. Ethnocentrism tends to misguide many international marketing plans, as has been evidenced by a glut of failed global expansions. Notable catastrophic enterprises include American companies' attempts to sell margarine to Spain and apple pie to Great Britain, both of which failed due to lack of research into epicurean norms of the target populations (Foxall, 1980).

Colors also have very different meanings in different cultures. White, for example, is evocative of purity and innocence in Western cultures whereas the same color is used for mourning rituals in Japan. While the relationship between color and emotion will be further

explored in following sections, it is important to note here that any conclusions drawn from a homogenous group must be presented within its own cultural context (Foxall, 1980).

Social influence.

The final category of traditional consumer behavior theory is *social* influence, which is further divided into three categories of study: reference groups, family, and roles. A *reference group* is a segment of individuals who's "presumed perspectives and values are being used by an individual as the basis for his or her current behavior" (Hawkins et al., 1983, pp. 206). Consumers can either be members of, aspire to be in, or dissociate themselves from different reference groups. For example, a young boy might be a member of his immediate family reference group, aspires to be part of the major league baseball reference group, and dissociates with the punk rock reference group. The typical behaviors of each of these groups influence the boy's consumer behavior (Kotler, 1986, pp. 167).

Marketers actively attempt to reach individuals whose singular opinion is often adopted by the rest of their reference groups. These *opinion leaders* can have significant impact on broad and well-populated reference groups. For example, in his 2002 book *The Tipping Point*, author Malcolm Gladwell notes the explosive resurgence of the Hush Puppies shoe brand in the mid-1990's after a handful of trendsetters started to wear the casual footwear to trendy nightclubs in New York City's East Village. By 1996, the brand had far-surpassed company sales records, prominent American actors were wearing them to the Academy Awards, and Princess Diana had a special collection of her own ("Hushpuppies Timeline").

The *family* is the next significant sphere of influence surrounding the consumer. Kotler (1986) identifies two types of families: *family of orientation* and *family of procreation*. The family of orientation consists of parents, from which an individual usually acquires their initial patterns of religion, politics, and consumerism. The family of procreation consists of an individual's romantic partner and children, if any. The influence of family members has been consistently proven significant. For example, A 2004 study showed a strong similarity in consumer innovativeness within a family. Parents who were inclined to explore new products and brands had children who were likely to do the same (Cotte & Wood, 2004).

Neuropsychology and consumer behavior.

The traditional model of consumer behavior offers valuable insight into purchasing decisions, but by its most elemental definition, consumer behavior is a function of brain chemistry. Research revealing the neural processes behind buying behavior is increasingly more ubiquitous among the behavioral psychology community. In 1996, Italian researchers from the University of Palma discovered an interesting anomaly in the premotor cortex in macaque monkeys. When a monkey was given a stimulus like a nut, that portion of its brain would show electrical activity. This result was expected, but researchers were surprised to find that the same area of the brain lit up when a monkey observed *another* monkey picking up a nut. The actions that triggered these neural responses could not be arbitrary. Walking across the room or sitting in a chair would not result in a measurable reading. Only what were dubbed as 'targeted gestures', or actions involving an object of value, generated a response. The conclusions of this research redefined primate social interaction. In a side-by-side comparison, the neural processes of the

monkey seeing were identical to those of the monkey doing (Gallese et. al, 1996). The parallels with modern advertising are obvious. Replace the nuts with a product, replace the monkeys with consumers, and what results is the foundation of every retail-oriented advertising campaign in the last century.

While the literature involving this mirroring behavior (later attributed to what were called *mirror neurons*) in humans is currently inconclusive (Kilner et al., 2009; Lingnau, Gesierich & Caramazza, 2009), but some evidence suggests that the human brain exhibits similar behavior when exposed to mass media. In *Buyology* (2010), the author notes the similarity of the primate behavior observed in the 1996 Italian research and the human capacity to share emotions with characters in a movie (Shoults, 2011). Humans are programmed to feel empathy based partially on the input they receive from their sense of sight. This essential evolutionary trait is what makes a mother motherly, but it is also endlessly employed as a tool of corporate marketing. Creating desire through imagined emulation is a central principle of modern marketing, and advertisers have become increasingly efficient at it.

Buyology offers the timely example of Abercrombie & Fitch. Everything about Abercrombie & Fitch is designed to trigger the mirror mechanisms in the brain. The attractive models printed on the bags, the inviting fragrance, the beautiful sales-people; Consumers observe these desirable characteristics and subconsciously imagine themselves as part of the attractive and successful ethos. Frequently, as demonstrated by the success of this clothing retailer, this is enough to motivate a purchase (Lindstrom, 2010).

Examples of applied mirror neuron theory already exist online. Unboxing.com is a website entirely devoted to videos of people opening new products. Their tagline "Vicarious thrills from opening new gear" is an overt appeal to live through someone else's experiences. The popularity of online role-playing games is another demonstration of mirroring behavior in action. Multiplayer online games like Second Life and World of Warcraft, which allow players to live as an idealized projection of themselves in a virtual world, represent an $11 billion segment of the video game market (Gamasutra, 2009). Further, a recent report by the Entertainment Software Association (2011) estimated that 19% of United States households pay to play multiplayer online games, and a full twenty out of twenty of the top selling computer games of the year were either role playing, online multiplayer, or first person immersive games.

These statistics demonstrate a strong propensity to identify with virtual representations in games, but it is easy to imagine how this principle could be removed from the entertainment context and applied to a retail setting. Could dynamic or moving product images on a website help activate this mirroring behavior? Some online retailers are already trying. Zappos.com, for example, features movies of nearly every one of its products in action (either worn or demonstrated by a model) in addition to conventional product images.

The mirror neuron is not the only promising biomedical marketing device. Researchers are increasingly using fMRI technology to observe the brain as it is exposed to various marketing messages. Many of the findings add credence to what is already considered marketing dogma: Repeat exposure yields message retention, messages that appeal to basic needs trigger higher response, celebrity endorsements produce positive emotional responses, and brand allegiance can

override taste preferences (Fugate, 2007). While these conclusions are not groundbreaking, the implications of this type of measurement for marketing are far-reaching. The ability to observe the consumer mind in real time as it is exposed to design stimuli offers a new level of validity to the body of evidence surrounding visual communications and consumer behavior.

An example of such a study was recently conducted by University of California researchers who used electroencephalography (herein referred to as EEG) to correlate measured electrical activity in the brain upon exposure to different types of advertising messages: logical persuasion vs. non-rational influence. Logical messages featured tables of facts about the product and straightforward product specifications while non-rationally driven ads were characterized by sexual overtones and abstract imagery. They found that print ads that used logical persuasion elicited higher levels of electrical current than the non-rational ads in portions of the brain responsible for learning and memory (Cook, Warren, Pajot, Schairer, & Leuchter, 2011).

The idea of using medical biofeedback equipment for marketing purposes, as one might expect, has garnered considerable criticism. Some observers equate these types of measurements to “reading tea leaves”, suggesting that the degree of information gained from an fMRI is, as of yet, imprecise. Neuroscientists also question the ethics of using such a technology for commercial gain, while still others have reservations about the legitimacy of psychological conclusions drawn from a test designed to diagnose disease (Fugate, 2007). Despite these criticisms, the use of biofeedback devices like EEG and fMRI will continue to expand as more and more consumer behavior-related conclusions are derived from the data they produce.

Another emerging theory neuropsychology as it applies to marketing is the existence of memory imprints known as *somatic markers*. Damasio, Tranel, and Damasio (1991) proposed that the human decision-making process is subject to individual experience. Throughout the course of a human life, positive and negative experiences are stored in the ventromedial prefrontal cortex (see Figure 4).

Figure 4. The Ventromedial Prefrontal Cortex

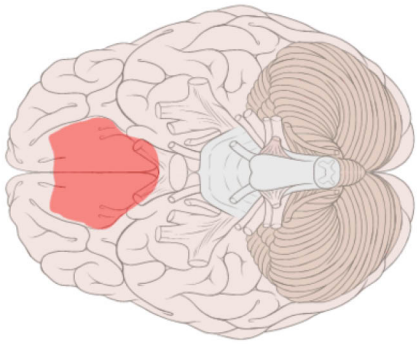

Figure 4. An illustration of the ventromedial prefrontal cortex, shown to be an area of the brain where somatic markers are stored and aesthetic judgments are made. Illustration by Patrick J. Lynch © 2008. Used with permission.

According to Damasio et al. (1991), this library of somatic markers helps the brain make decisions without having to relearn all of the factors involved. This type of tacit knowledge is the basis of brand loyalty. Lifelong Ford F-150 owners buy the same model of truck over and over again because they can reasonably expect the newer model to last as long as its predecessor.

Antoine Bechera, a colleague of Damasio, expounded upon the link between decision-making processes and somatic markers. Activations in the prefrontal cortex were observed in patients who had experienced brain trauma in this region. Bechera found that participants who had experienced significant damage to this part of the brain also exhibited poor decision-making in tasks involving emotional judgments (2004).

While the work of Bechera and Damasio primarily surrounds non-commercial applications of somatic marker theory, the direct relationship between the ventromedial prefrontal cortex and consumer behavior has been documented, as well. Koenigs and Tranel

(2008) recently tested the so-called Pepsi-paradox, a phenomenon by which consumers will prefer the taste of Pepsi to Coca-Cola in a blind taste test, but when brand names are revealed, consumers consistently prefer Coca-Cola. They found that participants who had suffered trauma to the ventromedial prefrontal cortex were not susceptible to the predicted influence of Coca-Cola's brand. They had no brand allegiances, and picked whichever cola tasted best regardless of what brand was or was not on the label. These participants had lost their library of learned experiences, and simply made their consumer-decisions based upon immediate sensory input.

Traditional and neurological consumer behavior doctrine reveals that the consumer mind is unarguably malleable. While it is preferable to believe that all purchasing decisions are rational choices based on thoughtful analysis, the literature suggests the exact opposite. Consumer purchasing patterns are frequently a result of low-order cognitive processes — automatic or routine reactions to stimuli — and it is exactly this type of response that this study is investigating. Can color, layout, or motion be as effective as hormones, mirror neurons, somatic markers, and East Village trendsetters? As the next sections reveal, each of the proposed stimuli are promising candidates for consumer behavior modification on the web.

Color

This collection of existing research is intended to help define one of this study's proposed testing conditions: color. It offers a foundational understanding of color theory, science, meaning, and marketing applications. It also presents the existing literature surrounding color as it exists online.

Color history.

While the origins of color theory can be traced back to classical antiquity, this study will begin its analysis with Isaac Newton's *Opticks*, a collection of scientific observations considered by most to be the genesis of modern color theory. Newton's experiments investigated the behavior of light and how it passed through different mediums such as water and glass. One of Newton's principle findings was the concept of refraction, by which light is bent and divided into the seven wavelengths of the *physical spectrum*: red, orange, yellow, green, blue, indigo, and violet (Holtzschue, 2011, pp. 134-137).

Figure 5. The Linear Visual Spectrum

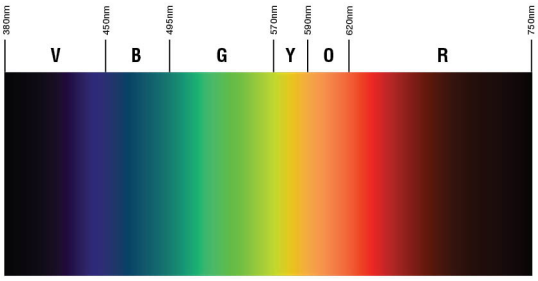

Figure 5. A representation of the linear visual spectrum, measured in nanometers. Isaac Newton was the first to propose that this spectrum composed visual light.

Figure 6. Newton's Continuous Color Wheel

Figure 6. Newton's color wheel, the first of its kind, showing the continuous nature of the visible spectrum. This image originally appeared in Newton's *Opticks*, published in 1704. It is used here under the terms of public domain.

By directing the refracted light of a prism array into yet another prism, Newton was able to recombine them into white light. Newton famously deduced that color is a function of light and vice versa (see Figure 5). Although it is now known that the spectrum of light is linear, Newton also introduced the concept of the continuous color wheel (see Figure 6) which has been

reused and adapted to create the ubiquitous radial color charts used in most modern art classrooms (Holtzschue, 2011, pp. 134-137).

Newton's theories were intensely debated in the century following the release of *Opticks*. One of the more vocal critics came from Johann Wolfgang von Goethe, who took issue with the utility of Newton's theory, saying:

> (Newton's theory of colour) does not help us to perceive more vividly the world around us […] even if we found a basic phenomenon, even then, the problem remains that we would not want to accept it as such […] Things which belong together according to our senses often lose their connections once we look into their causes. (Goethe as quoted in Holtzschue, 2011, p. 137)

Essentially, Goethe meant that while Newton's theory might indeed be valid, it loses all usefulness when taken out of the realm of theory. An artist could not use light to paint canvas any more than a musician could use sound to write a symphony. Therefore, Goethe's contributions to color theory were decidedly more practical. He introduced the concepts of color *polarity* (contrast or opposition) and *gradation* (color intervals) (see

Figure 7. Goethe's Concepts in Color

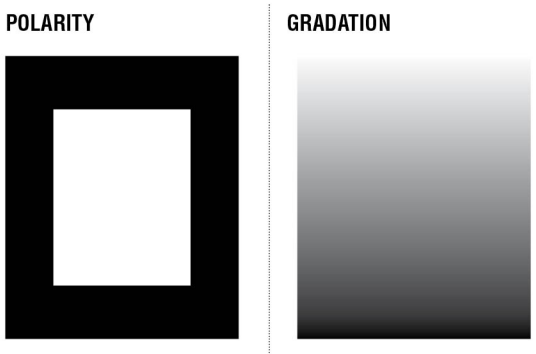

Figure 7. Johann Wolfgang von Goethe introduced two critical concepts in color theory: color polarity (contrast or opposition) and gradation (color intervals). (Holtzschue, 2011, pp. 136-138)

Figure 7). Goethe is also credited with the invention of the modern *artist's spectrum*: red, orange, yellow, green, blue, and violet. Note the omission of Newton's indigo, which according to Goethe, was an unnecessary distinction and not useful to the typical artist's color palette. Goethe derived his emblematic color wheel from an earlier discovery by French printmaker Jacques Christophe Leblon that identified the primary pigments of red, yellow and blue (Holtzschue, 2011, pp. 136-138).

The next major leap in color study came with the founding of the Bauhaus group in 1919. Six color theorists — Feininger, Klee, Kandisnsky, Itten, Albers and Schlemmer — were tasked with resolving color's remaining theoretical questions. Their contributions, specifically those of Johannes Itten, were largely based on color as a *complementary* system of opposites. Each color has complementary partners on the other side of the spectrum. These harmonious groups are known as *color chords*. He described this relationship with color wheels overset with geometric shapes (see Figure 8). Itten's principles formed the mathematical foundations of color harmony, on which modern color algorithms are built (Holtzschue, 2011, pp. 141-142). A popular example of this type of algorithm is Adobe's Kuler platform (http://kuler.adobe.com/).

Figure 8. Johannes Itten's Color Chords

Figure 8. Johannes Itten argues each color has complementary partners on the other side of the spectrum. He describes this relationship with color wheels overset with geometric shapes, illustrated here. (Holtzschue, 2011, pp. 141-142)

Arthur Schopenhauer furthered Itten's ideas by suggesting that color harmony was also a function of color luminosity, or reflective capability (see Figure 9). He assigned numerical values to each of the visual spectrum's colors, giving yellow the highest reflective potential and violet the lowest. Color harmony, Schopenhauer suggested, could only be achieved when the luminescent values of complementary colors (spectrum opposites) were in balance (Holtzschue, 2011, pp. 144).

Figure 9. Schopenhauer's Analogous Colors

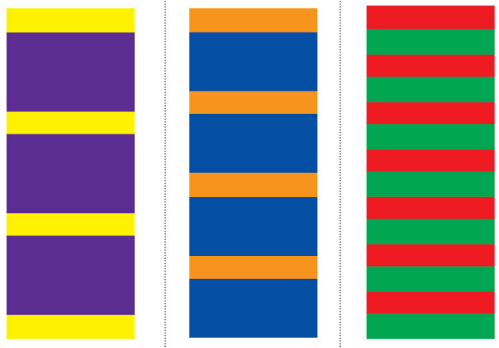

Figure 9. Arthur Schopenhauer theorized colors could only be in balance when their luminosity was taken into account. Since yellow is highly reflective, it must be displayed in smaller relative proportions when paired with purple. Adapted from (Holtzschue, 2011, p. 144)

Color science.

Modern investigations of color perception are largely focused on optical anatomy and how the human brains perceives information that it receives from the eyes. Before examining how the photoreceptive cells in the eye receive and transmit color, it is necessary to have a basic familiarity with terms commonly used to describe it (Holtzschue, 2011, pp. 230-243):

- Achromatic — "Having no discernible hue or color."
- Brilliance — "The combined qualities of high light-reflectance and strong hue, typically found in saturated colors and strong tints."
- Gamut — "The full range of colors available in software and seen as the light display of a color monitor."

- Hue — "The of the color: red, orange, yellow, green, blue, or violet. Synonymous with chroma and color."
- Iridescence — "An attribute of surfaces on which the hue changes as the observer's angle of view changes."
- Luminosity — "Used to describe the light-reflecting quality of color. Luminous colors reflect light."
- Saturation — "The measure of a color's intensity. A fully saturated color contains one or two of the primary colors but never the third. Saturated colors are undiluted by black, white, or gray. Synonyms are pure color, full color, or maximum chroma."
- Shade — "A pure color made darker, or with black added."
- Temperature — "In lighting, the measurable temperature in degrees Kelvin of any given light source. In color theory and description, the relative warmth (red-yellow-orange cast) or coolness (blue or green cast) of a color."
- Tint — "A color plus pure light, or made lighter."
- Value — "Relative light and dark, with or without the presence of hue. High-value samples are light; low-value samples are dark."

The manner by which the brain interprets visual information is complex and individualized, but there are some guiding principles that help designers create compositions that are easy to interpret and impactful. First is the concept of *lateral inhibition*, or the brain's natural tendency to distinguish edges. When an image with light and dark contrast reaches the eye, the

cells receiving the light part of the image inhibit their cell neighbors' ability to detect light (Holtzschue, 2011, pp. 52). This effectively helps the brain see contrast in low light scenarios, but is also responsible for the *legibility* of type — the displayed appearance of individual typographic characters in any given environment (clearly discernable characters are said to be legible). High contrast between type and its background helps the brain distinguish characters on a page (see Figure 10).

Figure 10. Lateral Inhibition

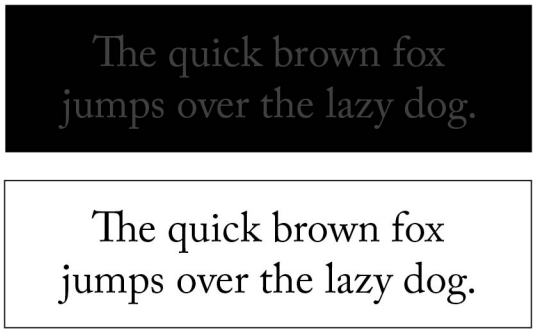

Figure 10. When an image with light/dark contrast reaches the eye, the receptor cells receiving the lightest portion in a visual field suppress the cells around them, allowing the brain to define the edges. As contrast increases, so does processing fluency.

Figure 11. Figure-Ground Perception

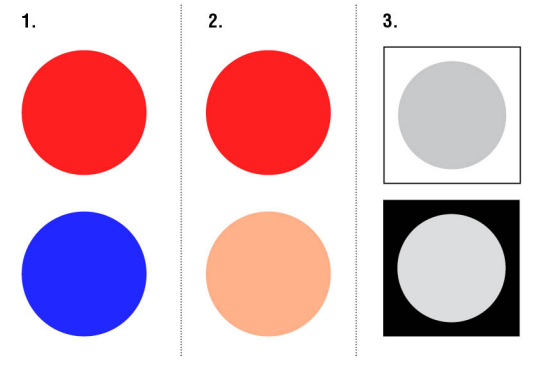

Figure 11. 1. Warm colors are given visual priority over cool colors, 2. saturated colors take priority over less saturated color, and 3. high-contrast images take priority over objects that share similar values. Adapted from a figure in (Holtzschue, 2011, p 117).

Figure-ground perception is another physiological effect relevant to this research. This principle helps the brain give visual priority to objects in the field of view. When an image enters the retina, the brain partitions dark from light areas, distinguishes edges, and then makes a logical interpretation as to what is the object of focus.

The brain uses simple cues to help make that distinction (Holtzschue, 2011, pp. 116): Warm colors are given visual priority over cool colors, saturated colors are given visual priority over grayer hues, and high contrast objects are given visual priority over objects that share similar values (see Figure 11). In combination with proportion, size and balance, graphic

designers use figure-ground perception to distribute visual weight on a page. These principles, used correctly, can create the illusion of emphasis, an essential part of directing an audience's eyes across a printed or digital page.

Simultaneous contrast, another involuntary color response, is the natural tendency for the eye to seek visual equilibrium. In other words, the human eye will naturally implant complementary colors into a visual stimulus. For example, if a warm red color is presented next to an achromatic gray, the gray will adopt a complementary greenish hue so the eye can be at rest (Holtzschue, 2011, pp. 99). This physiological preference for color balance is directly responsible for our interpretation of color harmony.

While the brain does recognize complementary colors as harmonious (common examples include red/green, orange/blue, and yellow/purple), the term color harmony is used much more loosely in practice. Essentially, any combination of colors can be deemed harmonious, but color theorists have established *some* guiding principles. For example, uniform intervals between colors in a palette can create 'harmony', whether those intervals exist between hues, saturations or values. Similarly, color systems exhibit 'harmony' when the level of saturation remains generally constant. *Analogous* colors, or colors adjacent to each other on the spectrum, are also used harmoniously in graphic design. (Holtzschue, 2011, pp. 151-160).

The most important distinction that a *web* designer must make when considering color is the difference between *direct light* and *reflected light*. In a normal human eye, microscopic cones and rods receive and transmit visual stimuli to the brain. Color is the brain's interpretation of

light emanating from or *reflecting* off of a surface. Magazines represent reflected color. The colors seen on a printed page are the brain's interpretation of the light bouncing off the pigment.

In web design, color is produced with *direct light*, sometimes referred to as backlit color (Holtzschue, 2011, pp. 2-4). Backlit color, such as the kind produced by an LCD display, is capable of producing a gamut of colors that exist far beyond the capabilities of print reproduction. Currently, the most popular models for on-screen color are RGB (red, green, blue — individually expressed on an additive scale of 0 – 255, where 0 represents the complete absence of light) and HSB (hue, saturation, brightness — where hue is expressed by a radial coordinate 0-359°, and saturation and brightness are percentages).

Color psychology.

Color is also characterized by its ability to affect human emotion. In 1966, researchers from the University of Canterbury used galvanic skin response (GSR), a method by which electrical impulses are recorded via sensors placed on the surface of the skin, to measure physiological reactions to red versus green. They hypothesized that hues with longer wavelengths (red and yellow) would elicit higher states of arousal than colors with short wavelengths (blue and purple). Their findings indicated that red induced arousal at a significantly higher rate than blue (Wilson, 1966).

Some data, however, suggests that these long wavelength hues are capable of impairing problem solving abilities. In a recent 2007 study, researchers administered a series of anagrams to participants, asking them to solve the riddles within a five-minute time frame. Prior to starting the test, experimenters asked participants to verify that a series of identification numbers had

been written in the top margin, which were written in red, green or black marker. Their results showed that participants exposed to red identification numbers were much less successful at solving their anagrams than participants with green or black numbers. The authors hypothesized that this effect could be attributed to a motivational avoidance response, by which visual cues can discourage and distract base simply on their association with danger (Elliot, Maier, Moller, Friedman, & Meinhardt, 2007).

While red and yellow have been shown to cause anxiety and avoidance behavior, their analogous complements blue and green, are known to be pleasurable and soothing. Valdez and Mehrabian found in a survey of undergraduate students at the University of California that blue, blue-green, and green were rated as the most pleasant in comparison with green-yellow, yellow, and yellow-red (1994).

Color may also have an effect on interpersonal human relationships. Damhorst and Reed (1986) found a correlation between the color value of clothing worn by women job applicants and their perceived levels of professionalism. In a survey of 204 businessmen and women, applicants wearing darker clothing were rated as more professional, qualified, and powerful than women who wore lighter clothing.

Color in advertising.

Color has also been proven to have significant effect on consumer interpretations of advertising. In a study of color use in magazine advertising, researchers found that ads with higher levels of saturation and value yielded responses of excitement and relaxation, which translated further into feelings of advertising favorability (Gorn, Chattopadhyay, Tracey, & Dahl,

1997). This research was compounded by a later study that showed advertising with a dominant red hue and high saturation increased levels of pleasure, arousal, and attitude towards the ad (Lichtlé, 2007).

In the Lichtlé study, researchers used optimal stimulation level (OSL) as a moderating variable. This concept was defined by Berlyne (1960) as an individual's "optimal level of stimulation or ideal arousal to which all individual behavior strives and which an individual will attempt to maintain or reestablish". Nelson, Pelech and Foster (1984) later linked OSL to color theory, discovering that high stimulation *seekers* prefer red while low stimulation seekers prefer blue.

In a 2001 *Journal of Advertising* investigation, researchers tested the effect of color in Yellow Pages advertising. Their results showed that perception of quality and credibility were given to those ads that used colorful graphics and photography compared to plain black and white advertising, so long as the participant did not have significant product expertise already (Lohse & Rosen, 2001).

The exclusion of experienced product users in the case of the Lohse and Rosen experiment raises an interesting question about color and photography on e-commerce websites. It could be proposed that the abundance of product information on the Internet democratizes product expertise. Someone who knew nothing about cell phones, for example, could easily become well versed in current trends and technologies through direct (company websites) or third party (blogs, forums, etc.) channels. It is logical to assume that implicit indicators of quality (like graphics and color) will not have a significant impact on consumer behavior on the Internet

as those behavioral cues will be supplanted by immediately available, reliable, and explicit product knowledge.

Color online.

While the importance of color has been well established in the case of traditional media — television, radio, newspapers, and magazines — equivalent research in the digital arena is relatively sparse. A study in 2010 tested user preference and trust of two retail websites, one with a blue color scheme and one with green (chosen because of their proximity on the color spectrum). Their conclusions showed the participants strongly preferred the blue website, but their data pertaining to trust was less conclusive (absolute difference of .05 on a one to seven scale). These conclusions offer some general direction for e-commerce color palettes, but the utility of those palettes is still unclear (Lee & Rao, 2010).

Another study from Taiwan concluded that a website with warm colors and fast music elicits high states of arousal among Taiwanese undergraduate students. No assertions are made about arousals relationship to purchase intent, only that it is possible to excite or depress using color and music. These findings add further support that colors with long wavelengths (>570nm; yellow, orange, and red) lend to website's ability to excite purchase behavior. These results are significant, and also raise an important point. In their discussion, researchers note that red is perceived positively within most Asian cultures, but the same is not necessarily true in Western cultures (Wu, Cheng, & Yen, 2008).

Indeed, colors carry a wide assortment of cultural meanings and stigmas. Green is highly respected in Muslim cultures because the prophet Mohammed is said to have worn a green

turban (“Culture and color”, 1997). It might be reasonable to deduce that a green retail website would perform well with Islamic societies, but perhaps not. The use of a religiously evocative color in a commercial setting could be perceived as offensive. Similarly, black scooters are very fashionable in Japan, but the same color and model do not sell in India due to that population’s strong association of black with death.

The list goes on: Pink is synonymous with good luck in China, white is symbolic of heroism and moral integrity in the West, and red still evokes memories of communism in Russia (1997). If anything can be assumed from these wide disparities in color interpretation, it is this: Color’s effect is partly a function of audience, and therefore must be applied prudently in a global medium like the Internet. A website that endeavors to hold a position in the global marketplace must consider targeted design strategies based in part on stratified cultural color meanings.

If what is known about color in e-commerce environments is inconclusive, ignores cultural context, or is too subjective, it might be proposed that the most reliable color on the web is no color at all. The measured use of *white space* has been consistently associated with quality, prestige, trust, and leadership. In a comparative study between high and low white space area in print advertising, brands in ads with liberal whitespace were rated as exhibiting high quality, high value and trustworthiness (Pracejus, Olsen, & O'Guinn, 2006).

This study affirms the conclusions made in a similar investigation where perceived expensiveness and likelihood to purchase was measured based on variable white space in

supermarket ads. Again, the products advertised with a percentage of white space were described as having higher value and increased participants' likelihood to buy (Jacobs & Poillon, 1992).

In summary, color is a necessary component of the online shopping experience and should be considered by designers and corporations alike. This study will only measure color in its environmental capacity, removed from the product itself. Red hues in advertising have elicited feelings of arousal and pleasure in some studies related to traditional media, but can the same effect be replicated on the Internet? Warm colors have been shown to stimulate shoppers in Taiwan, but will the same hold true for Western cultures? The majority of research falls on the side of high frequency colors as having the greatest potential to modify consumer behavior. Therefore, this study will test the efficacy of red as a function of consumer behavior modification in an e-commerce environment.

Layout

The arrangement of type and imagery on a page is a central responsibility of the designer. There are scores of different layout strategies, ranging from strict single column grids to the most abstract and spontaneous arrangements one can imagine. Every strategy is useful for a unique set of content requirements. This compilation of literature will demonstrate how some of these layout approaches have been shown to increase or decrease brand and product favorability.

Layout history.

The principles of page layout (printed or digital) are rooted in millennia of literature design beginning with Egyptian hieroglyphics over four thousand years ago. This overview of

layout history, however, will focus on how text and imagery have been combined since Johann Gensfleisch Gutenberg's invention of movable type in 1450. Although the Chinese had been using wood block characters since A.D. 500, Gutenberg's printing press is widely considered the genesis of mass media. Improving upon China's hand-carved wooden stamps, Guttenberg devised a system by which every character in the Roman alphabet was represented by steel glyphs that could be lined up to form whole pages of text (Meggs, 2006, pp. 68-75).

This technology made printed literature accessible and affordable which, in addition to its immeasurable sociopolitical ramifications, spawned a revolution in the study of typography. No longer was the design a book restricted to the hand skills of the manuscript artist. The arrangement of type on a page had become an exercise of methodical engineering. A revolution in the establishment of type foundries, publishing houses, and literary enterprises followed Gutenberg's invention, heralding a new age in the dissemination of the written word (Meggs, 2006, pp. 68-75).

Printing technology and typographic layout technique expanded and evolved across the Western world over the next three centuries until the next pivotal figure in layout design emerged at the beginning of the Industrial Revolution. William Morris (1834-1896) is known for his pioneering role in Europe's Arts and Crafts Movement, which was the artistic community's response to the declining quality of the collective visual narrative at the time. Since the invention of mechanized printing, page design had been an imprecise amalgamation of words on paper. Expediency and profit were given precedent over design and aesthetics. Morris and his English colleagues were the first to reject that precision and beauty were inevitable casualties of mass

production. They emphasized *legibility* — the ease at which a reader can scan through a block of text — through unity, consistency, and order in design (Meggs, 2006, pp. 167-169).

One of Morris' closest collaborators, Emery Walker, is often credited as the first master of modern grid technique. "The ornament, whatever it is, picture or pattern-work, should form part of the page, and should be part of the whole scheme of the book," Walker once said. He equated page design to architecture: All the elements of a page must be meticulously planned to produce a unified final product. Margins, line-height, letter spacing, column width, typeface, and page markers were, for the first time, given the same level of scrutiny as the literary content these elements delivered (Meggs, 2006, pp. 167-179).

Layout design progressed through the Industrial Revolution and the first half of the twentieth century with major contributions made by designers in the Netherlands and Germany until the 1950s, when page grid and design came to a resounding crescendo with the introduction of *The International Typographic Style*. This new Swiss epoch of page design was primarily defined by mathematical precision — each part on a page having a quantifiable relationship to the next. The preceding design styles of the late nineteenth and early twentieth century were often shrouded in hyperbole (as exemplified by Bolshevik propaganda) or metaphor (as was the case in both nouveau and deco movements), but the designers of the Swiss era dissentingly embraced plainly objective and clear presentations of information, creating a clear separation between art and design. San serif typefaces, left justified text, explicit photography, linear and harmonious divisions of space, modularity, unity, and utility were the rules of Swiss design law (Meggs, 2006, pp. 357-361).

Led by visionaries like Ernst Keller, Théo Ballmer, and Max Bill, this rapid evolution in the design industry was an appropriate reaction to the globalization of the world's nations, economies and enterprises following the Second World War. By using precise underlying grid structures and finely tuned shapes and letterforms, the new Swiss style communicated messages broadly and plainly using the universal disposition of applied mathematics (Meggs, 2006, pp. 363-370).

As designers eventually learned, however, the rigidity of the Swiss style was both its greatest strength and greatest limitation. While Swiss technique and principle remains a large influencer of modern design, designers of the latter part of the twentieth century eventually reacquainted themselves with abstraction and metaphor, shedding the confines of Swiss structuralism and blurring the lines between art and design once again (Meggs, 2006, pp. 363-370).

Creativity in design.

The shift back towards nonlinear and conceptual design is a natural consequence of media saturation and market segmentation. It is appropriate at this point to explain the significance of creativity in graphic design. Although the premise of this research is to identify design variables that demonstrate a measurable propensity for consumer behavior modification, and while innumerable studies exist affirming the neuropsychological significance of a range of design characteristics, the indefinite element of creativity in design cannot be ignored. In a series of recent studies from St. Louis University, researchers found that creativity in advertising

effectively increased unaided brand recall (Till & Baack, 2005) message recognition (Baack, Wilson, & Till, 2008).

These are just the most recent in a long line of investigations into market penetration as a function of creativity. In a study by Ang and Low, participants reported positive attitudes and greater purchase intent in ads that exhibited novelty, relevance and emotion so long as the message of the ad was optimistic (2000). In another study, investigators used eye tracking and brand memory tasks to measure the effectiveness of what independent assessors determined to be original advertising. Participants routinely paid more attention and were better able to recall brands in ads deemed ‘original’ versus ‘familiar’ (Pieters, Warlop, & Wedel, 2002).

Creativity in graphic design is a challenging variable, however. The novelty of any given design solution is determined largely by individual perception. What one person deems highly creative may be seen as mundane and obvious by the next. Conversely, a design seen as highly creative by one person might be too complex for another to understand, negating the message of the piece entirely. This unpredictable variability, combined with the irreproducible nature of creativity, makes testing and application problematic.

Layout in traditional media.

Traditionally, when a graphic designer begins a project, he or she will inventory requisite text and artwork, assess the amount of space given or needed, and then develop a grid that accommodates all of the necessary content.

Dividing content on a page manifests in an infinite number of ways ranging from a simple single column text block to the spontaneous and chaotic layering of elements on a page. Each grid strategy is suited for a different type of content, and each attempts to present content with clarity, space economy, and continuity. For example, when portions of unrelated information need to be presented together (calendars, voting ballots, catalogues, etc.) a modular approach is warranted (see Figure 12).

Figure 12. Modular Grid Design

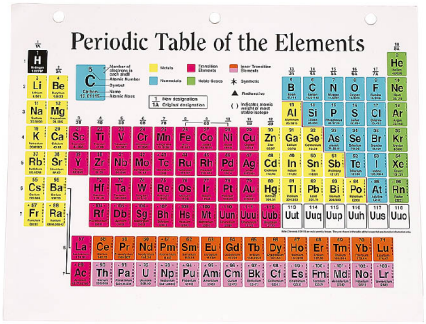

Figure 12. The modular grid, represented here by the periodic table, was a defining characteristic of the International Typographic Style, popular during the 1950s and 60s. It allows for maximum flexibility and organization of complex information.

Contrastingly, a body of text that requires lengthy and continuous reading (books, journals, magazine articles) might necessitate a simple single column grid (see Figure 13). A functional layout will allow for maximum legibility and thematic content division. The audience, ideally,

Figure 13. The Single Column Grid

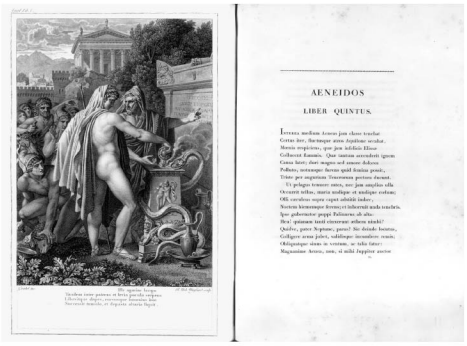

Figure 13. The single column grid, ideal for presentations of long and continuous text is exemplified here by a page from Pierre Didot's *Bucolica, Georgica, et Aeneis*, originally printed in 1798 (as cited in Meggs, 2006, p. 129).

should know how to visually navigate through a page, understand where to find different types of information, and be able to interpret the hierarchy of text with relative fluency (Samara, 2002).

Consumer behavior modification through layout design is a primary concern of the advertising industry. In 2007, researchers from the University of Maryland used eye-tracking technology to find the optimal sizes for branding, text, price, and image in print advertising. Their findings showed that increasing the size of branding and price encourages longer focus time thus increasing retention and positive attitudes towards a product (Pieters, Wedel & Zhang, 2007). Additionally, it has been established that modern consumers regard advertising with a larger proportion of image to text as a more positive reflection of a product (McQuarrie & Phillips, 2008). These findings suggest that an emphasis on engaging imagery, clear pricing, and prominent branding would lend to a successful e-commerce environment.

While it has been mentioned before in the context of color, the judicious use of negative or white space in a page layout plays a crucial role in reading comprehension and information processing (see Figure 14). Jan Tschichold, a famous Swiss typographer of the Modernist era, once equated white space to "the lungs of a good design" (Ambrose & Harris, 2007). Popularized in the 1950s and 60s in New York by Paul Rand and

Figure 14. Negative Space

Figure 14. This ad, created in 1960 by the Doyle Dane Bernbach agency, is an irreproachable example of applied white space in a commercial context. Emphasis and implied meaning are created by the *absense* of graphic elements (as cited in Meggs, 2006, p. 390).

the creative team at Doyle Dane Bernbach agency (Meggs, 2006, pp. 389-391), the application of generous spacing between design elements can both draw attention and imply meaning.

Citing the Pracejus et al. (2006) study again, respondents consistently reported that products in advertising with an abundance of white space as "higher in quality, prestige, trust, leadership and lower in risk." Moreover, even though the brand in the advertising stimuli was fictitious, a measure taken to protect against any chance of pre-existing brand loyalty, participants reported that it appeared to be a large company with significant market share.

Ease of information processing is also a significant variable of layout efficacy. Two concepts are identified as playing key roles here. The first is known as *spatial contiguity principle* and states "the effectiveness of multimedia instruction increases when words and pictures are presented contiguously in time or space" (Moreno & Mayer, 1999). In other words, people are better able to follow a pattern of organization when related content is placed in closer proximity versus further away. This principle has been demonstrated in recent eye tracking studies that proved message continuity and comprehension was a function of organized and intuitive content arrangements (Holsanova, Holmberg, & Holmqvist, 2009).

Signaling principle, the second of the two information processing theories relevant to layout, says "people learn more deeply from a multimedia message when cues are added that highlight the organization of the essential material" (Mayer, 2005, p. 183). This, of course, is a central principle of content hierarchy in graphic design. Design practitioners use emphasis and contrast to assign visual order to elements on a page. Holsanova et al. (2009) showed that

participants benefited from signaling principle in reading comprehension, text and illustration integration and semantic processing.

These concepts owe their effectiveness to the mind's inclination to take the path of least resistance, a principle further evidenced by recent findings concerning *prototypicality* and beauty. Human interpretation of visual stimuli is characterized by its attraction to information that is most easily interpreted, decided by visual averaging of information (Reber, Schwarz, & Winkielman, 2004). If there is no incentive to dedicate processing resources to the interpretation of a visually complex stimulus, the brain will ignore it. Conversely, a familiar and intuitive presentation of content, Reber argues, will make that content easier for the brain to interpret. This study also notably reviewed some of the seminal principles of objectivist aesthetic theory: figure-ground contrast, repetition, and symmetry. All of these stimuli have been shown to ease processing fluency. Prototypicality is a central premise of online page layout. Internet users have come to expect to find information in certain regions of a website. For example, it is typical for a company's logo to appear somewhere at the top of a web page. These visual devices, as will be revealed in the e-commerce portion of this literature review, play a key role in consumer confidence.

A division in theory — traditional versus new media.

So far, spatial relationships on the Internet have generally followed the conventional rules set forth by print media. For example, journalism websites frequently use the modular grid of their printed counterparts and shopping websites resemble the familiar modular catalogue pioneered by the Sears mailings of the late nineteenth century (see Figure 15). But, are these print-derived theories reliable methods of web design, or are they simply hasty carryovers from centuries of traditional media dogma?

Figure 15. Websites Using Print Layouts

Figure 15. Here, The New York Times' website is presented next to it's print edition. Notice the similarity in column and grid systems. The modular layout of the website are clearly derived from the traditional rules used by its printed predecessor.

Every medium, from newspaper to radio to television, has had to define its own marketing principles and strengths, and the Internet, it seems, is no exception. For example, University of Israel investigators recently studied the reading performance of 11th graders in congruent versus incongruent reading situations, which they respectively defined as "…text, which was designed to be read from paper, is read online, and vice versa." They found that text designed for print but read on-screen had a strong negative effect on reading performance. In their conclusions, researchers stressed the need for medium-specific type and layout design. This research is one in a number of studies that exemplify the disparity between effective design rules in print versus digital environments (Eshet-Alkalai & Geri, 2010).

Another study analyzing equivalently designed advertising in print versus online environments revealed Internet advertising actually outperforms print in the cases of low-involvement products and light Internet users. This study measured consumer perceptions of brand favorability after being exposed to either online banner or traditional print advertising. It also found that online ads were more effective at communicating implicit meaning than their print counterparts (Dahlén, Murray, & Nordenstam, 2004).

Additionally, optimal line-lengths for legibility are markedly different on a screen compared to print. Conventional knowledge suggests that the most advantageous line-length for comprehension and reading rate in a printed medium is somewhere around 70 characters per line (Spencer, 1968). Recent tests have revealed, however, that reading patterns on screen are less consistent. One test of online reading puts optimal comprehension and speed conditions in the range of 55 characters per line (Dyson & Haselgrove, 2001). Another earlier study from the same researcher found that longer lines, approximately 100 characters per line, were read with greater efficiency than shorter lines (Dyson & Kipping, 1998).

These studies clearly demonstrate the need for continuing online layout research. In addition to the obvious disparities between traditional and new media, research is further complicated by the constantly changing technical specifications of computer monitors. Aspect ratios, pixel resolutions, and graphics cards have drastically changed since the introduction of the personal computer. Conclusions drawn from a test on a cathode ray tube (CRT) monitor in the late 1990s might be significantly different from the same test on a new liquid crystal display

(LCD) conducted today. Optimal layout conditions will certainly continue to evolve as technology progresses.

Layout online.

Existing research surrounding website layout strategy can shed some light on general user preferences. One recent joint venture by the eye-tracking specialists at the Poynter Institute and researchers at the University of Denver analyzed subject eye movements with screen-mounted cameras to determine an average visual order in which web pages were viewed. Their data revealed that website users typically start at the top left portion of the page and move from left to right down the page in a Z-shape, similar to reading a book in Western cultures. Additionally, researchers found that if elements typically found in one portion of a page were moved to an unexpected position, those elements would attract added user attention (Castelluccio, 2004).

The Reber et al. (2004) prototypically and processing fluency study, mentioned previously, has been recently echoed by researchers who measured participant task completion times and aesthetic assessment of nine existing online book retailers. Their research shows content organization, visual organization, navigation system, color, and typography are important factors in regards to user preference, with content organization being the most significant determinant in participant preference between the nine sites. These findings, while significant, do not measure final purchase decision, only preference as measured by a ten point Likert scale. Additionally, investigators suggest that further research is needed to specifically define each of the design variables used in the study (Lee & Koubek, 2010).

Another 2010 investigation studied the effect of web page layout against different patterns of online shopping behavior. Researchers developed twelve online gift store homepages that ranged from low complexity/low order to high complexity/high order. Complexity was a function of the number of links, graphics and text on a page. Order was determined by the level alignment and loyalty to a grid, adherence to typical browsing patterns (Z-shaped), and use of partitioning mechanisms. Further, participants were preconditioned to approach the test in telic (objective-oriented browsing) or paratelic (passive/non-goal-oriented browsing) states. Their results showed that organized websites were judged to be more pleasant by participants in the telic condition, while participants in the paratelic condition preferred highly complex websites. Researchers suggest implications for e-commerce targeting. A stock trading website would reasonably expect its users to be in a telic state, making an emphasis on order in its layout a prudent strategy. On the other hand, users of an online apparel store might prefer a visually complex layout with greater opportunities for browsing and discovery (Deng & Poole, 2010). These finding are consistent with the data presented by the aforementioned study by Wang et al. (2011).

The literature also divulges some information about the use of different styles of type on the web. Font choice is, of course, a primary concern of online layout as each typeface carries its own legibility and style characteristics. A 2008 eye-tracking study offers a precise look into the challenges of displaying type on a computer screen. Researchers measured the on-screen readability of four typefaces: Times New Roman, Arial, Georgia, and Verdana. Verdana was concluded to be the best of the four, resulting in faster reading speeds and fewer instances of

regression, or reading a portion of text twice (Josephson, 2008). While this study offers valuable insight, recently developed technologies have given web designers a much broader range of available fonts from which to choose. The ever-expanding library of available screen fonts necessitates further digital typeface research.

A summary of the above layout literature suggests that adherence to objectivist aesthetic principles, an emphasis on imagery over text, and obedience to prototypical online layout patterns would lend to greater purchase probability online. It has also become clear that the *objectives* of online shoppers will weigh on their response to various visual stimuli, as well. Introducing the telic or paratelic purchasing state as a pretest condition will yield more consistent results. The proposed comparative investigation, purchase probability as a function of text to image ratio online, appears to be necessary, as no such data exists

Motion Graphics

This portion of the literature will review the potential use of motion graphics as a consumer behavior modifier on the Internet. Animation has existed since the first celluloid movies in the late nineteenth, but the commercial benefits of motion have only recently been investigated. The introduction of After Effects in 1993 and Macromedia Flash in 1996 have made animating a abundant form of commercial art. These two pieces of software are still commonly used today to create the third stimulus in the proposed investigation: *motion graphics*.

Motion graphics are short pieces of animation that make up only a small part of a larger visual narrative. They exist as a form of embellishment; a method of adding dynamic features to

what otherwise might only be static. Some popular examples of motion graphics today are movie studio logo animations, animated GIF images, dynamic buttons or menus online, interactive mobile-platform learning tools, and television graphics.

Motion graphics psychology.

The educational benefits of animation have been confirmed, discounted, and otherwise studied at length, mostly in studies relating to medical training (Kim, Yoon, Whang, Tversky, & Morrison, 2007; Large & Beheshti, 1996; O'Day, 2010; Ruiz, Cook, & Levinson, 2009). The conclusions drawn from these studies are conflicting, but another education-focused review by Mayer and Moreno (2002) does offer some psychological concepts relating to animation and cognitive processing.

The first finding by Mayer and Moreno is what they call *multimedia principle* which states "students learn more deeply from animation and narration than narration alone." Subjects in the experiment used to develop this principle were asked to demonstrate an understanding of basic mechanical components. One group of students was given only a narrative explanation and the other was aided by narration and animation. Participants whose explanations were accompanied by animation tested significantly better in demonstrated learning (2002).

The second of Mayer and Moreno's concepts, *spatial contiguity*, has already been mentioned in this review in the context of layout: learning fluency increases when an animation is presented closer to its accompanying text compared to further away. Mayer hypothesizes that the cognitive capacity needed to connect the two related elements slows comprehension (2002).

Next, *coherence principle* states that extraneous text, audio and video in an animated learning environment can have negative repercussions on retention. Cognitive capacity, it is suggested by Mayer, is finite. Unneeded information tends to slow processing ability (Mayer & Moreno, 2002).

Finally, *modality principle* proposes that a combination of animation and narration is better for learning compared to animation and on-screen text. Again, this is related to cognitive fluency. The learner's visual information processing capacity can become overloaded when text and animation are displayed together (Mayer & Moreno, 2002). Obviously, it is impractical to replace all text on the Internet with audio, but these finding are consistent with other studies presented in this review suggesting imagery should be given precedent over type in an online sales environment.

Motion graphics online.

Mayer's learning concepts are foundational to the available research regarding motion graphics in e-commerce environments. A recent study by Yee-Lin, Kuan, Kai-Lung, & Na found a relationship between the use of motion graphics and strong brand recall and perceived value. Investigators created e-commerce environments designed to sell electronic equipment, one using moving images and one using static images. Their results suggest that products displayed with animation lead to higher consumer involvement and the perception of quality and utility (2009).

A 2009 study of interactivity in e-commerce environments reveals much about the benefits of dynamic imagery to the online consumer. Researchers developed e-commerce interfaces using 2D, low interaction 3D, and high interaction 3D approaches. The 3D low

interaction approach allowed participants to view all angles of a product in a separate window. The 3D high interaction interface allowed participants to view every angle and interact with its functional parts. For example, users were able to open and close a laptop, press buttons, eject and close a CD drive, and view additional product information by clicking on different areas of the product. The 3D product representations outpaced the 2D interface in measured level of visual detail and feeling of product competence (Ozok & Komlodi, 2009).

Ozok and Komlodi (2009) revealed the higher-order cognitive utility of interactive three-dimensional graphics on the web, proving that participants do indeed find value in dynamic and moveable representations of products. Displaying moveable parts and available features in an interactive space is an adept strategy for familiarizing online consumers with complex products like electronics and cars, but what about simpler products like a peach or an article of clothing? Representing a piece of fruit in a 3D interactive space seems superfluous, but perhaps a touch of motion could elicit a positive response on a much lower cognitive level.

Can a product in a subtle state of motion act as a purchase motivator? Some might see it as a needless parlor trick, but consider this example: A woman wants to find a dress to wear to a wedding. She browses through several websites, scanning over countless static images of dresses in different styles and colors until she comes across one thumbnail that is different. The model is stationary, the background is static, but the dress itself moves slightly as if there were a breeze in the room. The motion is almost imperceptible, but is just enough to make assumptions about the physical characteristics of this product. The way the fabric moves around the figure of the model, the cut of the hem as it flows around the legs, the color of the skirt as it moves in and out of

shadow; Seeing a product come to life, even if ever so slightly, could have significant potential as a consumer motivator.

The graphics interchange format (GIF).

A moving product image could be easily achieved with a familiar web-specific technology: the animated GIF. Animated GIFs were first supported by Netscape 2.0 in the early 1990s and were initially used as a novelty item on web pages. The ubiquitous flashing "Under Construction" signs, background sparkles, and dancing babies were a staple of popular web design throughout the 1990s but eventually fell into disfavor as technologies improved and web designers began approaching site design more seriously. More advanced formats (FLV, MOV, HTML5, etc.) have all but replaced animated GIFs on the web today.

The format does still exist, however, and it has retained all of the benefits that made it popular during the Internet's infancy. GIF images are cheap to produce and have relatively small file sizes. They are still supported by all browsers, making it one of the few universally compatible image formats available to web developers. The capabilities of the animated GIF have also greatly improved since its introduction. Unlike their predecessors, GIFs today support a wide color spectrum, loop seamlessly, and have time controls that allow them to display fluid real-time motion. Some of the more impressive examples of this format can be found at (http://cinemagraphs.com).

A study by Jiang and Benbasat (2007) lends credence to this strategy of motion as a behavioral modification cue. Researchers in this case studied the effect of 'vividness' or media richness in e-commerce environments. Researchers chose audio, video, and motion graphics as

variables exhibiting vividness and tested them against 3D interactive graphic user interfaces — similar to those of the later Ozok and Komlodi study. Interestingly, Jiang and Benbasat found that testing environments employing simple audio and motion were more than *twice* as effective in measures of consumer product understanding, replication of real world shopping experience, and overall shopping enjoyment.

The studies detailed in this section suggest motion graphics could add significant hedonic qualities to an e-commerce website. While there seems to be some argument about the extent of animation's utility on the web, the consensus remains that *some* utility certainly exists. This study will attempt to refine and extend the use of this technology on the web by making it less invasive, less distracting, and more aesthetically pleasing.

E-Commerce

The Internet became commercially available in 1991, and by 1994, Amazon was fully operational and you could order a pizza from Pizza Hut using a desktop computer. Since then, e-commerce has grown exponentially. According to a comparative report by The U.S. Census Bureau, e-commerce accounted for nearly four times the percentage of sales in the third quarter of 2010 than those of the same quarter a decade earlier (2010). According to eMarketer, a leader in online marketing statistics, 174 million shoppers over the age of 14 will research products online in 2011, and a full 83% of that population will go on to make a purchase online. E-commerce will constitute a $188 billion industry in 2011, and that figure is expected to increase

by another billion dollars by 2015. By next year, nine of ten US citizens will be shopping online (Grau, 2011).

This rapid adoption of the Internet as a vehicle for commerce can be attributed to the privacy afforded by shopping from a personal computer, access to hard-to-find items, online price competition, and the convenience of home delivery. Limiting factors include information overload, content confusion, and insufficient product detail, but the most routinely reported reasons for choosing not to shop on the Internet are related to trust. 75% of Internet users prefer not to give out credit card numbers or personal information online (Horrigan, 2008).

Consumer confidence.

Corbitt, Thanasankit & Yi (2003) definitively established that the perception of trustworthiness and quality in a website will drive sales. The same study also found that as a user's technical expertise increases, the likelihood that they will participate in an online transaction would also increase.

Some of the first conclusions about the factors that instill trust in e-commerce environments were made by qualitative surveys. Fang and Salvendy (2003) conducted personal interviews with fifty e-commerce users in order to determine what design factors were most important to customers at the time. Participants emphasized the need for a prominent brand name, ease of navigation, and detailed pictures of products. The responses Fang and Salvendy collected also foreshadowed what many empirically studies have proven since: Trust is the single most important qualifier for final purchase decisions online.

Song and Zahedi (2005) tested the importance of a variety of graphic and informational categories, finding that the items on an e-commerce website which were considered to be most essential were those related to service and promotion. Price comparisons, discounts, product recommendations, security and privacy information, warrantees, and contact information were all rated as important features of a retail website, corroborating the findings of previous studies.

Reber et al. (2004) suggests that these judgments of truth, like beauty, might be a function of processing fluency. The authors suggest figure-ground contrast, repetition, symmetry, and prototypically are all modifying variables of credibility. This conclusion was derived from data showing relationships between these design characteristics and processing fluency, adding credence to this study's research objective.

Reber also analyzed the perceived truth of statements in high contrast versus low contrast settings. Their findings showed that the same statement displayed in various levels of figure-ground contrast was assigned comparative levels of perceived truth. The words presented in high contrast were deemed significantly more trust-worthy than the same words printed in low contrast. Again, researchers attributed this effect to processing fluency: Objects that are easy for the brain to process are intrinsically recognized as familiar, leading the mind to believe that the object and its contents can be trusted (Reber & Schwarz, 1999).

Impulse control.

The impulsive method by which people tend to shop online offers some justification for increased emphasis on passive visual behavior modifiers. Some studies suggest that a significant

portion of e-commerce is compulsively driven and hedonically motivated, based upon visual stimulus (Kim & Eastin, 2011; Li, Kuo, & Russel, 1999).

Hawkins Stern wrote one of the first in-depth examinations of impulse buying behavior. In his *Journal of Marketing* article, he outlines four types of impulse buying that are still being used today. *Pure impulse* is characterized by purchases that defy a shopper's normal buying behavior. These purchases are usually a result of some kind of environmental condition, and thus, are most relevant to this particular study. *Reminder impulse* occurs when a shopper encounters an item and, upon seeing it, is reminded of their need for it. Advertising capitalizes on the reminder impulse mechanism by creating latent need for a product that is subsequently recalled once the exposed shopper encounters the product in the real world (Stern, 1962).

Suggested impulse occurs at the point of sale when a shopper is persuaded by active sales statements or perceived product quality. In contrast to pure impulse, a suggested impulse purchase might be completely rational. Finally, *planned impulse buying* occurs when a shopper enters a retail environment with the objective of buying a few specific items, but also concedes that they will make some unplanned purchases, as well (Stern, 1962).

Online shoppers working on pure impulse behavior are characterized by non-specific buying intentions, abbreviated page-views, and erratic page scanning (Kim & Eastin, 2011; Moe & Fader, 2001). These traits parallel the paratelic shopping condition, and indicate browser-oriented shoppers should be targeted in this experiment.

Rook and Gardener (1993) established that shoppers in a state of arousal or pleasure, two hedonic motivators consistently shown to be a function of passive design characteristics, are also

prone to impulse buying. In their experiment, researchers asked 155 respondents to identify what moods trigger impulsive behavior. They found that when a shopper was experiencing pleasure or were in some way aroused, they were more likely to purchase something impulsively. These findings were consistent with previous studies that observed a positive mood typically increased the likelihood of taking action with a known positive outcome (Isen & Simmonds, 1978).

Impulse buying has also been shown to be a function of general website quality. In a recent study of young adult online shoppers, researchers developed e-commerce interfaces that exhibited both high quality and low quality designs characterized by the security cues, functional convenience, and visual appeal. They found firm evidence suggesting websites that were high in perceived quality were much more likely to generate impulsive behavior (Wells, Parboteeah, & Valacich, 2011). These studies add credibility to the general theory that website design does play a role in how consumers shop online, but there is still little evidence as to what specific design cues can trigger positive attitude, feelings of pleasure, and impulsive behavior online.

Usability.

In their analysis of human-computer interaction (HCI), Nah and Davis (2002) define *usability* as "the ability to find one's way around the Web, to locate desired information, to know what to do next, and, very importantly, to do so with minimal effort. Central to this idea of usability are the important concepts of ease of navigation and search." Usability, while not specifically being observed in this study as a modifier of consumer behavior, is very important online shoppers. The findings of this section dictate some of the shared design characteristics of the web page stimuli used in the experimental design of this research.

The concept of usability was explored by Constantinides (2004) who, based on the existing literature of the time, identified several antecedents of a usable website: *Ordering/payment processes*, *site speed*, *findability*, *site navigation/information architecture*, and *convenience. Ordering* online has been shown to be a considerable contributor to customer frustration. Online consumers need to be constantly reassured with feedback mechanisms like payment confirmations and data security cues. Any interruption in the ordering process caused by improper *syntax*, or the functional code of the website, will often lead a consumer to abandon the ordering process all together. *Site speed* is another important factor in usability. Online shoppers are accustomed to fast load times and will quickly navigate away from a page if it is loading too slowly (Constantinides, 2004).

Findability involves a website's searchable content (Constantinides, 2004). Search engines identify the content of web pages using complex data indexing algorithms called *spiders*. A website's position in a search engine's query results is determined in part by the manner in which searchable text is presented on a page. Different web browsers have different methods of determining search priority, but generally, *spiders* assume that the most important information occurs towards the top of the code, which means placing important terms in the top-level navigation or in the metadata will increase a site's chances of returning higher in a given search query. Search priority is also a function of the number of links to a page. Pages that are linked to by several external sources are likely to be given precedence in a search return.

Site navigation and information architecture are also significant to elements of usability. Web users expect to be able to easily navigate around a site, whether their intentions are

objective-oriented (telic) or browsing-oriented (paratelic). Logical *site architecture*, sometimes referred to as *taxonomy*, is a fundamental part of intuitive site navigation. As most sites are collections of many separate but linked files, a site's architecture is usually decided upon in the early planning stages of web development. *Site navigation* is typically represented by a system of buttons, menus, and search bars that direct a user around a site. The logical, readable, and accessible design of a site's navigation is essential to its overall usability (Constantinides, 2004).

Research has shown that aside from its functional utility, usability also has a larger effect on user satisfaction and trust in e-commerce environments. In a recent survey using an online bookstore as the independent variable, participants were asked to complete a questionnaire rating usability, satisfaction, and perceived honesty. Results showed a strong correlation between rated usability and perceived honesty, which as the literature has established, is an essential component to a consumer's willingness to purchase online (Casalo, Flavian, & Guinaliu, 2010).

Usability, some research suggests, is also a function of product modularity online. Research has shown consumers respond favorably to product modularity and customization (Lai, Lin, Yeh, & Wei, 2006), and the e-commerce environment is a perfect venue for displaying a variety of color choices in a product. However, it is important to consider the manner by which those options are presented. In a comparative study of common e-commerce color option presentations (product thumbnails versus color options) participants were tested on search times, error rates, and preference. Data showed that smaller numbers of possible color combinations resulted in shorter search times and lower error rates, but also that users tested significantly

better in environments categorized by their number of color combinations (Wu, Chen, Lee, & Chen, 2010).

Technical considerations.

There are a number of potential uncontrollable modifiers in any online environment. If the proposed variables were tested in some kind of online survey, acknowledgements would need to be made regarding the variability of screen displays. Computer monitors vary significantly in quality, size, resolution, screen temperature, brightness, color capacity, and environmental surroundings. A saturated red on a new high-definition LCD display might display as a muddy orange on an old CRT monitor. Additionally, two identical displays might project colors completely differently based on their respective calibrations and environmental lighting conditions.

Connection speed is also a concern. While bandwidth is generally high on academic campuses, home connections can be much slower and far less reliable. The possibility of incomplete surveys as a result of slow load times is a significant threat to external validity if efficient content loading is not assured.

Browser and platform compatibility, sometimes referred to as *interoperability*, while a significant consideration for the modern web designer, should not be of significant concern in a study of this type. None of the proposed testing conditions would require advanced syntax, fonts are easily tested for universal compatibility, and all testing layouts will be created using World Wide Web Consortium (W3) compliant techniques to guarantee cross-browser consistency. However, because of the precise hedonic qualities of the stimuli being proposed, tight regulation

of the testing conditions is important. These interceding technological variables suggest a controlled laboratory setting would be most appropriate for this study.

Conclusions

This literature review has demonstrated that an investigation into the proposed independent variables — motion, layout, and color — is both viable and necessary to the advancement of the body of knowledge surrounding e-commerce environments. All three conditions have been shown, with varying degree and under varying circumstances, to have significant effect on consumer behavior. It has also been revealed that the brain uses its combined learned behavior to make purchase decisions, and not all of those decisions involve rational decision-making. Hedonically motivated purchase decisions are frequently impulsive and triggered without the involvement of the conscious mind.

While much has been concluded about the effect of the independent variables offline, little evidence exists regarding their psychophysiological implications in an e-commerce environment. Prudent use of these visual cues had both psychological and physiological effects, ranging from perceived feelings of trust, satisfaction, and brand favorability, to observed activations in regions of the brain known to control aesthetic judgments, decision making, and working memory.

Suitable candidates will be between the ages of 18 and 49, a standard age range used by Pew Research for online metrics (Horrigan, 2008). Ideal candidates will be computer literate, have the capacity to purchase online and have made online purchases before. It will also be

important to create a testing environment that is both hedonistically targeted and otherwise well designed, as governed by the aforementioned literature. Impulse behavior and positive consumer attitudes are clear functions of website design quality. Furthermore, each participant should be primed for a task-free (paratelic) shopping experience, as the literature has shown that browser-oriented shoppers are most receptive to the type of passive visual behavior modifiers being observed.

A gender-neutral product category will also be advantageous, as products typically suited for one sex or another might fail to command the attention of the opposite gender. If a gender specific category of product is chosen, it will be necessary to direct the design of the website to suit that particular demographic. A female in the paratelic condition could be exposed to a web page featuring an article of clothing on a hypothetical women's apparel website, for example.

While a measure of consistency could be attained if this test were to be administered online, the visual nature of the testing variables suggests the need for a more controllable testing environment. A computer lab with no windows, equivalently calibrated monitors, achromatic wall paint, and neutral lighting would be ideal. Additionally all tests should occur during the same general time of day and within a relatively narrow date range.

Examples of potential instruments are widely varied in the existing literature. The proposed dependent variable, purchase probability, while feasibly testable using a quantitative survey, would be vulnerable to several external threats to validity. This study tests the unconscious decision-making process. These neural events occur well before any rational

thinking takes place and form an emotional footing on which subsequent conscious choices are made (Libet, Gleason, Wright, & Pearl, 1983).

Additionally, a survey requires the participant to think about their response, which is contrary to the theme of this research. This study assumes a more deterministic theory of consumer behavior. Newton said, “To every action there is always opposed an equal reaction.” Equally, as consumer neuroscience theory dictates, every stimulus has a measurable response. A more appropriate instrument, considering the hedonic nature of the independent variables, would be a study of biofeedback. Observing physiological processes in real-time allows researchers to observe the biology of perception removed from conscious and subjective reasoning. This lets researchers identify biases and trends of which the participants themselves may not be aware.

Viable physiological measures include visual attention recorded by eye-tracking equipment, electrical activity in the brain measured by EEG, and hemodynamic response measured by fMRI. Each of these measures has precedent in the literature, and each could reveal valuable insights relating to product attitudes, visual attention, arousal, and regional brain activity in the consumer mind upon exposure to the testing variables.

Eye-tracking software has been used to measure attention and make conclusion about message retention and positive product attitudes online (Pieters et al., 2007). An increased amount of attention given to the products within the testing web pages might have been correlated with survey responses to make conclusions about positive consumer attitudes. However, it has been decided that because this study was seeking to identify *environmental*

characteristics as modifiers of consumer behavior, the observation should not be specific to the product itself. Rather, a general reaction to the web page stimulus as a whole is desired.

Additionally, Ohme, Matukin, and Pacula-Lesniak (2011) argue, in their recent meta-analysis of biometric measures of advertising online, that while eye-tracking can reveal attention to specific objects within a web page, it is incorrect to assume that acquired attention translates into positive response. Their own observations suggest that elements that garner the most visual attention on web pages frequently have a neutral or even negative reaction. They also noted that while some theories suggest that eye pupil dilation can be linked to positive emotional response, there are many variables that can change the size of the pupil, including changes in lighting condition, cognitive workload, and the angle in which the subject is viewing the stimulus. Therefore, a measurement of eye movement has been eliminated, as it would probably not yield reliable results in this case.

Functional Magnetic Resonance Imaging (fMRI), while sometimes used for studies of this type, is both cost-prohibitive and has a relatively slow time resolution, meaning the stimulus exposure would have to occur over an undesirably long amount of time. Additionally, the environment in which an fMRI test is conducted is not reflective of a real-world online shopping experience, which poses a potential threat to external validity.

After exploring the feasibility of the aforementioned instruments, EEG has been selected as the most suitable testing instrument for a variety of reasons. As a relatively non-invasive method of measuring psychophysiology, EEG represents the most practical and replicable process by which reliable data can be gathered. EEG allows for the targeting of specific regions

of the brain and can provide instant readings at hundreds of samples per second. Its portability also allows the researcher to conduct experiments in a highly controlled environment that reasonably replicates a scenario in which the participants would be shopping online. Though it comes with complications of its own, EEG represents the best option for predicting purchase probability.

Considering the above scholarly precedent, the researcher has developed the following experimental hypotheses:

Hypotheses

H_1 — Observed electrical activity in the ventromedial prefrontal cortex will be higher upon exposure to an e-commerce web page characterized by a product that is in a subtle state of motion versus an e-commerce web page characterized by a static product image.

H_0 — Observed electrical activity in the ventromedial prefrontal cortex will not change significantly upon exposure to an e-commerce web page characterized by a product is in a subtle state of motion versus an e-commerce web page characterized by a static product image.

H_2 —Observed electrical activity in the ventromedial prefrontal cortex will be higher upon exposure to an e-commerce web page characterized by a high image to type ratio versus an e-commerce environment characterized by a low image to type ratio.

H_0 — Observed electrical activity in the ventromedial prefrontal cortex will not change significantly upon exposure to an e-commerce web page characterized by a high image to type ratio versus an e-commerce environment characterized by a low image to type ratio.

H_3 — Observed electrical activity in the ventromedial prefrontal cortex will be higher upon exposure to an e-commerce web page characterized by a dominant color wavelength of 650nm versus an e-commerce web page characterized by dominant color wavelengths of 490nm.

H_0 — Observed electrical activity in the ventromedial prefrontal cortex will not change significantly upon exposure to an e-commerce web page characterized by a dominant color wavelength of 650nm versus an e-commerce web page characterized by dominant color wavelengths of 490nm.

Method

Introduction

The following experimental design attempts to identify the efficacy of motion, layout, and color as consumer behavior modifiers in an e-commerce environment. A fictitious online electronics store was developed through which the experimental variables could be delivered. EEG data emitted from a specific *region of interest*, the ventromedial prefrontal cortex (herein referred to as VMPFC), was analyzed using both sustained endogenous evoked response and FFT spectral analyses. Then, the average frequency and power measured during each stimulus was compared against a baseline measurement and another website designed to exhibit the inverse condition (i.e. an animated product image vs. a static product image). In addition to an analysis of compared mean differences, the data was also correlated with individual responses given in a pre-test survey and post-test questionnaire (see Appendix A).

Participants

Twenty-seven (N=27) college students ranging from 18 to 26 years of age ($\bar{X}$ = 19.48) were recruited from the University of Central Oklahoma Research Participation System. Each participant was awarded course

Figure 16. Average Hours Spent Online

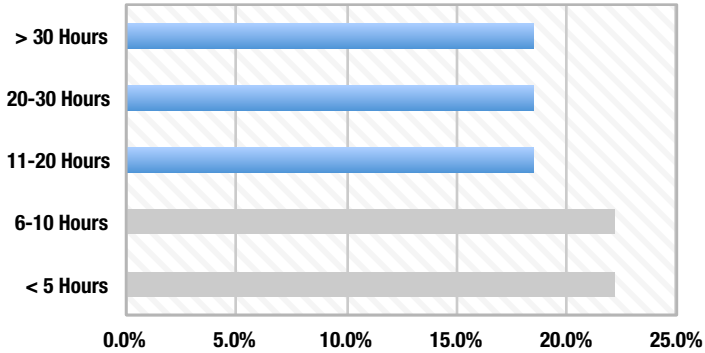

Figure 16. The average amount of hours spent online per week by members of the experimental sample population.

credit for participating in the research experiment. Ten males and 17 females participated. A sample size of 20–40 participants was predicted to yield a measurable effect size at a significance level of 5% (α=.05). As the null hypotheses do not specify a target frequency or amplitude value on which an effect size could be calculated, sample size was based upon previous EEG studies of this theme and scope (Cook et al., 2011; Kappenman & Luck, 2010; Smith, Cacioppo, Larsen, & Chartrand, 2003; Handy, Smilek, Geiger, Liu, & Schooler, 2010).

Figure 17. Average Amount of Shopping Done Online

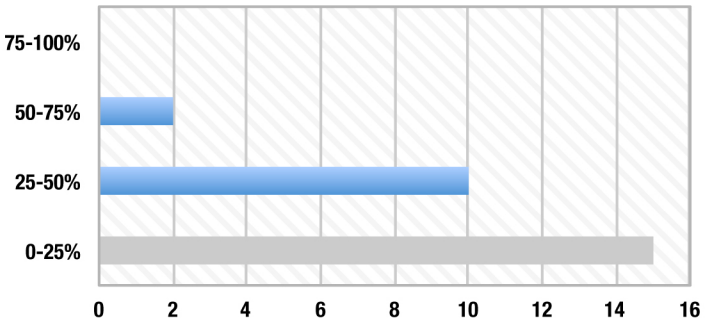

Figure 17. Average percentage of shopping conducted online reported by frequency of response.

All participants in this study were young adults between 18 and 26 with some college education, truthfully reflecting the heaviest segment of online shoppers (Horrigan, 2008). These assumptions were confirmed by the data gathered in the pre-test survey, which in addition to demographic information, gathered information about Internet usage and online shopping patterns. A majority of the participants (55.5%) reported being online at least eleven hours per week. Nearly one-fifth of the participants spend over thirty

Figure 18. Primary Intention While in an Online Store

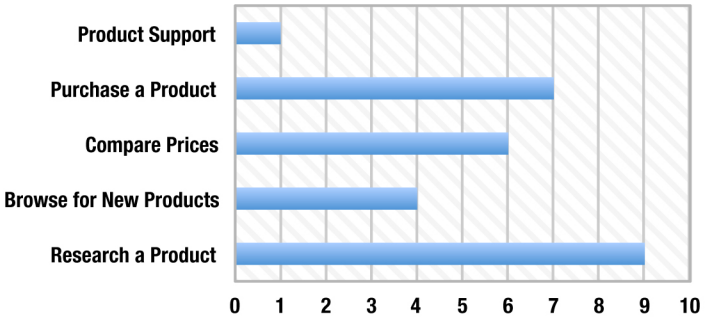

Figure 18. Primary intentions when visiting an online store reported by frequency of response (*N*=27).

hours per week online (Figure 16). The sample also reflected a predictably high percentage of overall shopping conducted online with 44.4% of the sample reporting that they shop online for at least 25% of all of their purchases. Over 7% of the sample reported at least half of their expenditures were made online (Figure 17). Most respondents (33.3%) stated that their primary intention when visiting online stores was to research a product. The next two most popular responses were to purchase a product (25.9%) or compare prices (22.2%) (Figure 18).

A partial medical history was also included in the pre-test survey in order to identify a number of physiologically-related exclusion criteria, including a history of bipolar disorder, schizophrenia, Alzheimer's disease, seizures, alcohol or drug abuse, head trauma, stroke, or brain injury, all of which can modify brain wave frequency (Cook et al., 2011). It was also necessary to ask if the participant was color blind, a condition that would invalidate color-related stimulus exposures. No participants were excluded from the data set due to preexisting medical conditions or color-blindness.

Procedure

Testing environment.

Testing occurred at the University of Central Oklahoma's Department of Psychology between the hours of 9 a.m. and 3 p.m during the month of February 2012. Because the stimulus was exclusively visual, it was of paramount importance to consider and control all extraneous visual stimuli. Two adjacent private counseling rooms were requisitioned for the experiment. The rooms were chosen for their relative visual neutrality, meaning their existing wall color was

a relatively neutral hue and value and shadow dispersant fluorescent ceiling fixtures provided the room lighting (Figure 19). Participants were tested one at a time over the course of four weeks.

Figure 19. Testing Room

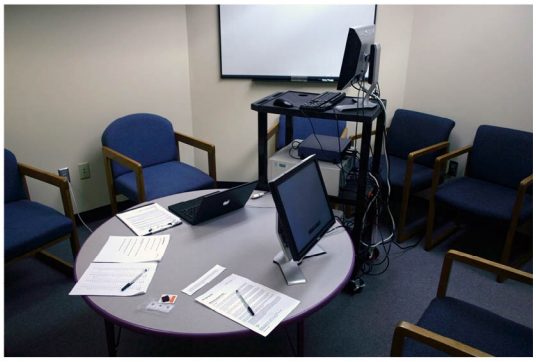

Figure 19. Testing rooms were prepared thirty minutes prior to each subject's arrival. The stimulus screen was positioned at a viewing distance of approximately 24"–36". The researcher stood opposite of the subject so that EMG artifacts could be observed and logged.

The visual stimuli were displayed on a single Dell HD flat panel monitor (Model #1707FPt) at a resolution of 1280 X 1024 using the factory default color, contrast, and brightness settings (Figure 20). While monitors with higher resolutions and superior color gamut capabilities exist, the Dell monitor was chosen for its ubiquity. The Internet is still viewed primarily on mid-range PC monitors of this type, using the Microsoft Windows operating system (W3Schools, 2012). Participants were positioned at a viewing distance and angle of approximately 30 inches and 25°. The researcher stood opposite of the participants during the procedure so that muscle-related electromyogram (EMG) artifacts could be observed and recorded for later removal.

Figure 20. Stimulus Display Monitor

Figure 20. A Dell Flat Panel HD Monitor (Model #1707FPt) was chosen as the stimulus delivery device. Each subject viewed the stimuli on the same monitor, set to factory default, to ensure an exposure of consistent luminosity and color temperature across the entire sample.

Visual stimuli.

Neural activity was observed during exposure to six web pages, each designed to exhibit one of the six testing variables. The stimuli were delivered in a non-interactive .m4v movie that was time-synchronized to the EEG data acquisition. It was necessary to display the stimuli in this manner to minimize muscle activity while the EEG was recording data. If the participants were allowed to browse through a website using a mouse, for example, the movements of the hand around the desk surface would register on the EEG readout, compromising the validity of the experiment.

The first twenty seconds of the movie was a static gray screen of neutral hue and value. This was included to for two reasons: First, to provide a baseline measurement of activity, and second to allow the participant to grow accustomed to the testing conditions before the experimental variables began appearing. After the first 20 seconds, each web page appeared at 20-second intervals separated by five seconds of gray screen. The timeline of exposure was scheduled so that the subjects were allowed sufficient time to review the contents of the page, but not so long as to be outside of the realm of the average time typically spent on e-commerce web pages (Figure 21). The EEG data acquisition and movie were timed to last exactly 170 seconds, which allowed for later alignment and correlation of the visual stimuli and EEG *epochs* (a unit used to describe a section of time within an EEG readout).

Figure 21. Timeline of Stimuli

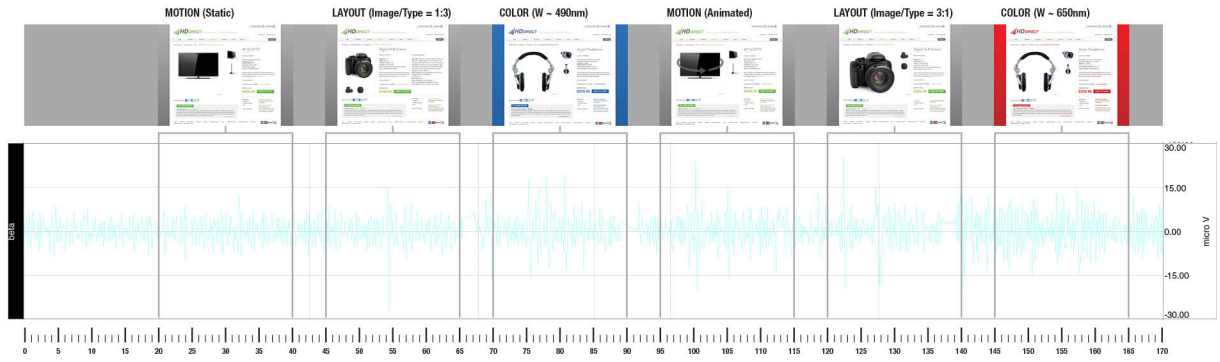

Figure 21. This chart shows the sequential timeline of stimulus events over the course of the entire exposure. The slideshow and EEG data capture were run concurrently and lasted exactly 170 seconds, which allowed the researcher to match visual stimuli to their corresponding EEG epoch.

The stimuli were ordered in a linear block design: (B) > (M1) > (L1) > (C1) > (M2) > (L2) > (C2). The web page coding system can be seen in Table 1. A five second gray screen between each stimulus allowed participants to blink or readjust as needed, minimizing the occurrence of EMG artifact contamination.

Table 1

Stimulus Coding System

Code	Stimulus Name	Description of Stimulus
(B)	*Baseline*	Blank gray screen
(M1)	*Motion (Static)*	Main product image is static.
(L1)	*Layout (Image < Type)*	Product area is 1/3 image and 2/3 type.
(C1)	*Color (W ~ 490nm)*	Web page features a dominant color wavelength of ~ 490nm.
(M2)	*Motion (Animated)*	Main product image is animated.
(L2)	*Layout (Image > Type)*	Product area is 2/3 image and 1/3 type.
(C2)	*Color (W ~ 650nm)*	Web page features a dominant color wavelength of ~ 650nm.

Note. The color palette used in web pages in which color was not specifically being observed (B, M1, L1, M2, L2) was a combination of non-chromatic gray and a neutral green hue with a dominant wavelength of 570nm.

Electronics were chosen as a gender-neutral category of product that is frequently purchased online. All brand names were removed from the product images to minimize the effect of any pre-test exposure or potential bias caused by brand loyalty, and prices represented fair market value for the type of products shown. Product information was modeled after equally valued merchandise sold by electronics retailers such as Sony and Nikon. Similarly, the electronics retailer, *HD Direct*, was also fabricated. Again, this negated the existence of any pre-existing brand allegiances within the sample population.

The pages' shared design elements were governed by best practices collected during the literature, the intent being to create six e-commerce environments that participants could reasonably imagine themselves visiting in real life. The *HD Direct* e-commerce store feels familiar because its overarching design elements were chosen to reflect the known quantities of web design (Figure 22). Logical navigation, prominent contact information, z-shaped reading patterns, large prices, customer reviews, consumer confidence devices such as money-back guarantees, generous white space, readable san serif typography, and general aesthetics were all taken into consideration during the development stage of the stimuli (Casalo et al., 2010; Corbitt et al, 2003; Deng & Poole, 2010; Holsanova et al., 2009; Josephson, 2008; Mayer, 2005; Pracejus et al., 2006; Reber et al, 2004;

Figure 22. Stimulus Web Page Template

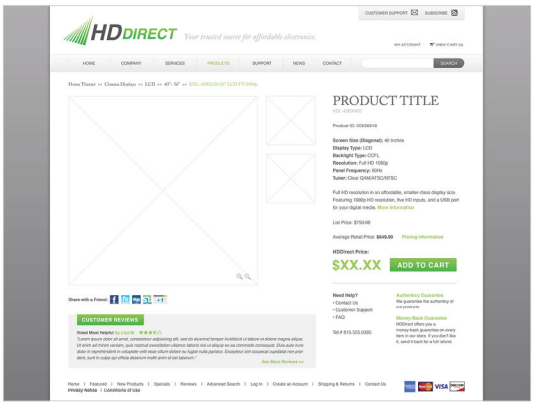

Figure 22. The foundational design on which all experimental web pages were based upon.

Reimann et al., 2010; Sogn & Zahedi, 2005). These are the qualities that the literature and design community have established are necessary for a healthy online shopping experience.

Additionally, using the conclusions drawn from the Wang, et al. study, the template's architecture was intended to exhibit high aesthetic formality and appeal, a type of environment that was shown to encourage purchasing behavior and increase the likelihood that participants would revisit the store. Strict grids were established during the development of the template, creating an overall sense of order and prototypically. Figure-ground contrast between typography and background was emphasized to encourage legibility, and a simple hierarchy of information (product image, product title, product price, and product information) was established to create a simple and easy-to-interpret user interface (2011).

The conditions of the experimental stimuli were individually applied to this template to create the six web page stimuli (see Appendix B). Each variable that was predicted to have an effect was preceded by inverse stimulus that was not. For example, C1's blue accent color was not predicted to have an effect while C2's red accent color *was* predicted to have an effect. This design was intended to draw out some measurable difference between the three pairs of otherwise identical web pages.

Figure 23. Stimulus M1 — Motion (Static)

Figure 23. This stimulus was not animated. The accent color was chosen for its central location in the visible color spectrum.

Figure 24. Stimulus M2 — Motion (Animated)

Figure 24. This stimulus featured a product in motion. The television rotated slowly through the duration of the exposure.

The motion stimuli, exhibited by M1 (Figure 23) and M2 (Figure 24) were developed to test the efficacy of a product in motion as a modifier of consumer behavior. Research has shown that an interactive product image can help consumers quickly learn about the product by interacting with its parts (Ozok & Komlodi, 2009). The use of motion graphics has also been successfully linked to strong brand recall and perceived value (Yee-Lin et al., 2009). During the M1 exposure, the television shown remains static throughout its duration. Contrastingly, in M2, the television rotated slightly, giving the participant a side profile view. The additional visual information of the slimness of the television was predicted to illicit higher state of electrical activity in the regions of interest.

Figure 25. Stimulus L1— Layout (Text>Image)

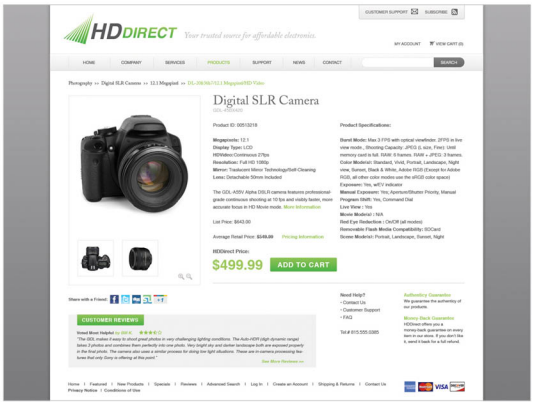

Figure 25. This stimulus tested the subject's reaction to a product area is composed of 1/3 image and 2/3 text.

Figure 26. Stimulus L2 — Layout (Image>Text)

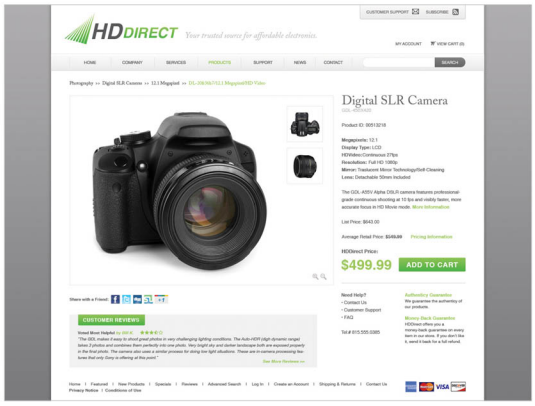

Figure 26. This stimulus tested the subject's reaction to a product area is composed of 2/3 image and 1/3 text.

The layout stimuli, exhibited by L1 (Figure 25) and L2 (Figure 26), were based upon the findings of McQuarrie and Price who found that consumers prefer images to text. In their study, the researchers found that consumers view promotional messages as "pictures to be viewed and not as documents to be read" (2008). Consumers are increasingly visual in their evaluation of products in a retail setting. To test the efficacy of this finding online, the main content area of the template was divided into three columns. In L1, text occupied two of the columns in the product area, and the product image only occupied one-third of the product area. In L2, the opposite strategy was exhibited. Text was placed in only one of the three columns, allowing product imagery to occupy two-thirds of the product area.

Figure 27. Stimulus C1 — Color (W ~ 490nm)

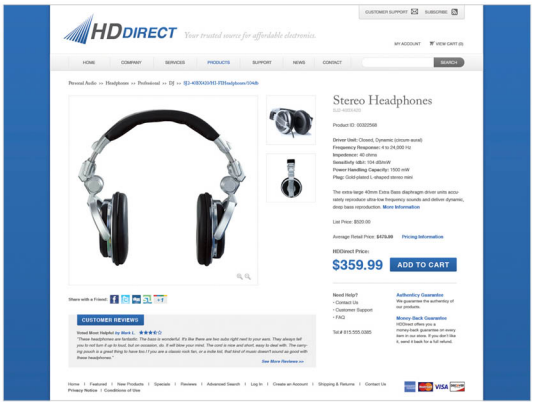

Figure 27. This stimulus featured an accent color with a dominant color wavelength of approximately 490 nanometers.

Figure 28. Stimulus C2 — Color (W ~ 650nm)

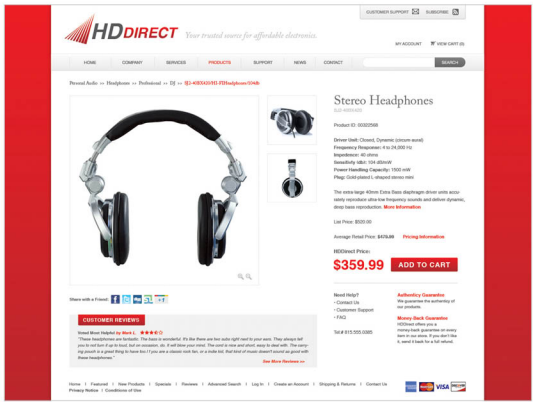

Figure 28. This stimulus featured an accent color with a dominant color wavelength of approximately 650 nanometers.

The color stimuli, exhibited by C1 (Figure 27) and C2 (Figure 28), were defined by dominant colors 80 nanometers above and below a central point in the visual spectrum, a yellowish-green with a dominant wavelength of 570nm. This color, incidentally, was the accent color used for M1, M2, L1 and L2, as its relative chromatic neutrality in the spectrum and made its probable effect minimal. Blue (W ~ 490nm) is perceived as more soothing (Vladez & Mehrabian, 1994), but a majority of the literature falls on the side of red (W ~ 650nm) as a positive consumer behavior modifier (Gorn et al., 1997; Lichtlé, 2007; Wilson, 1966; Wu et al., 2008). Higher frequency colors like red have produced feelings of arousal, pleasure, and positive attitudes in a retail setting. The accent colors of C1 and C2 were chosen from opposite ends of the spectrum so that any effect would be easily identified. C1 and C2's color value and saturation were not being tested, but those quantities were also considered in the development of these stimuli. A readable value (relative lightness) was chosen for operative design elements such as

the price and logo, and a high saturation was applied consistently to both red and blue conditions so that both colors would appear vibrant on screen.

Experimental procedure.

Electroencephalography involves the observation of the amplitude and frequency patterns originating from the cerebral cortex. In this case, the researcher observed beta waves (13–30Hz, typically exhibited by relatively low amplitudes of 5–10μV) originating from the approximate location of the VMPFC. The beta frequency is associated with visual engagement and mental processing and is usually seen in subjects who are awake and alert. In terms of physiology, rhythmic activity in the beta frequency is considered an indicator of cerebral perfusion (Cook, O'Hara, Uijtdehaage, Mandelkern, & Leuchter, 1998; Neidermeyer, E. 1999; Pflanzer, Uyehara, McMullen, 2011; Rangaswamy et al., 2004). Increased activity in the VMPFC in response to a visual stimulus was measured by both elevated beta band frequencies and increased volume of amplitude over time (Cacioppo, Tassinary, & Berntson, 2000; Handy et al., 2010).

EEG data is collected by applying positive and negative electrodes to the surface of the skin, thereby creating an electrical circuit through which an observable signal can travel. Some EEG psychophysiology studies also use a web of electrodes placed uniformly around the head, a procedure known as a dense electrode array, to isolate the origin of specific behaviors within the brain. This study, however, used only two active electrodes, placed near the center of the forehead in order to measure the output of the VMPFC, a region of the brain the literature has shown to control numerous factors relating to consumer behavior, including aesthetic judgment

(Reimann et al., 2010), working memory (Damasio et al., 1991), decision-making (Bechara, 2004), and perceived value (Koenigs & Tranel, 2008).

Prior to arriving at the research facility, participants were told that they would be taking part in a study of consumer behavior and were instructed to avoid fasting, drinking an excessive amount of caffeine, or taking sedatives. All of these activities can potentially alter biofeedback output. Additionally, participants were asked to avoid using hair products such as gels or hair spray on the day of the test, as these materials interfere with electrode conductivity.

During the experiment, the researcher followed a detailed step-by-step checklist to minimize the possibility of procedural irregularities (see Appendix C). After obtaining informed consent, administrating the pre-test survey, and confirming the participants' eligibility to take part in the research, the subject was asked to sit in a chair in front of the monitor on which the stimuli would be delivered. The primary investigator would then give a brief overview of the equipment and begin affixing the physiological testing instruments to the participant. This experiment used the Biopac MP35 physiological data acquisition unit (Biopac Systems, Inc., Goleta, CA) with silver-silver chloride skin-adhering electrodes. The electrodes were connected to the MP35 with a shielded cable assembly featuring pinch leads and color-coded positive, negative, and ground wires.

Before adhering the electrodes to the participant's skin, the primary investigator prepared the region of interest by removing any dead skin cells with a light scrubbing with an abrasive pad followed by an alcohol swab. Electrodes were then placed according to a standardized cranial mapping diagram known as the International 10-20 system. To observe activity in VMPMC, two

positive (also known as *active*) electrodes (+) were placed specifically on Fp1 and Fp2, about an inch above the inner crest of each eyebrow (Figure 29). The reference electrodes (–) were positioned on the mastoid process structure behind each ear, and grounding electrodes were adhered to each earlobe in accordance with a standard method by which the difference in amplitude between the active and reference electrodes is calculated. The result of that equation is the relative frequency and power originating from the region of interest. A small amount of electrically conductive gel placed on the back of each electrode ensured conductivity between the epidural surface and the silver-chloride contact (Kappenman & Luck, 2010).

Figure 29. International 10-20 System

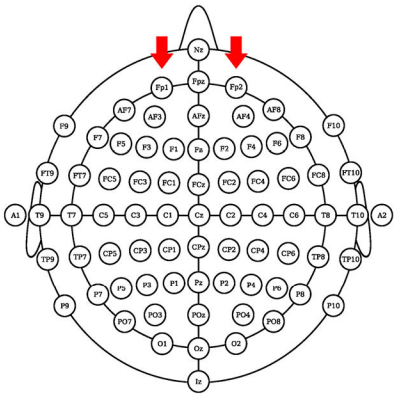

Figure 29. This diagram shows the position where electrodes were placed on the forehead according to the International 10-20 system. Illustration by Marius 't Hart. Adapted with permission.

It should be noted that the VMPFC is actually anatomically positioned behind the orbitofrontal cortex. Fp1 and Fp2 represented the closest possible International 10-20 locations to the VMPFC structure. Ideally a subcutaneous electrode probe would be used to measure activity originating specifically from the VMPFC area. Obviously, inserting an electrode probe into the brain is not possible unless the subject has been anesthetized. For this reason, most psychophysiological investigations involving visual stimuli and the VMPFC are conducted with fMRI, a non-invasive method of observing deep-brain structures in action. However, as mentioned before, cost and environmental constraints prevented an fMRI analysis at this time.

After connecting the participant to the Biopac hardware, impedance levels were checked to ensure a healthy and relatively noise-free signal. While it is generally accepted that ideal impedance levels should be below 5kΩ, the level of impedance achieved for this study averaged around 30kΩ. This was due to incomplete removal of the outer epidermal layers prior to electrode adhesion, a realization that was regrettably made only after all data had been collected. The extra impedance lowered average amplitude levels and increased signal noise, but because the same procedure was used on all participants, data homogeneity was maintained. Despite the less-than-ideal impedance levels, the researcher maintains reliable data was successfully obtained from the sample.

After the electrodes are in place, the investigator asked the participant to close their eyes and breathe normally for approximately 30 seconds. This allowed time for the gel to dry and gave the participant the opportunity to acclimate to the testing conditions. After 30 seconds had been passed, each participant was asked to read a short hypothetical scenario that primed him or her for a browser-oriented (paratelic) shopping experience. The statement read as follows:

> "You are shopping for a friend's birthday present online. You have plenty of money in the bank and want to get something really nice. You know they like electronics, so you are browsing around for something they might like. You will be shown a number of web pages. Look around the pages as if you were browsing normally. At the end of the test, you'll be asked which, if any product, you would purchase. Do not feel obligated to purchase anything."

The objective of the paratelic priming scenario was to put the subject in a state of task-free browsing, a state-of-mind during which hedonic motivators such as the ones in the stimuli have been shown to be most effective (Li et al., 1999; Wang et al., 2011). Additionally, consumers primed for a browser-oriented shopping experience are more likely to buy on impulse (Kim & Eastin, 2011; Moe & Fader, 2001).

Before EEG data recording began, each participant was asked to avoid blinking their eyes, talking, or making any big movements. Each of these actions can cause undesirable data artifacts. They were also told the approximate length of the video and that there would be periodic intervals of gray screen during which it would be acceptable to blink or move (Figure 30).

Figure 30. Recording the EEG

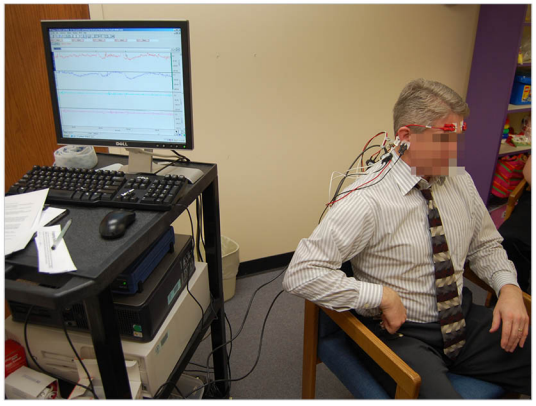

Figure 30. Here, a test-subject waits for the test to begin while connected to the Biopac MP35 physiological data acquisition unit.

At this point, the investigator started the movie and began acquiring EEG data. EEG amplitude and frequency was recorded for 170 seconds at 200 samples per second, a rate of acquisition determined by multiplying the frequency range of interest (13–30Hz). The sample rate (also known as *time resolution*) can be equated to pixel resolution on a screen; a minimum density is required to achieve a quality image but any excess will not make any discernable difference. A generally accepted equation for determining an appropriate sample rate is twice the highest frequency being observed (Biopac Student Lab

PRO Manual, 2010; Stern, Ray, & Quigley, 2001, p. 90). The Biopac software that controls sample rate has a default value of 200 samples per second. Though this was more resolution than was necessary, I left the setting at its default to reduce the risk of an incidental deviation from the procedure. As mentioned before, the web page stimuli were arranged in a block design preceded by 20 seconds of blank gray screen. During the exam, the researcher observed the participant as he or she watched the stimulus monitor, logging any eye blinks, muscle activity, or extraneous interceding variables such as unexpected loud noises. These artifacts were later manually removed from the data set. In addition to physical artifact removal, a limiting filter was applied to the entire beta waveform, normalizing any spikes in activity to no more than 15μV, as any powers above that threshold were assumed to be anomalous (Pflanzer et al., 2011).

A brief questionnaire was administered before the participant was excused to determine which web pages and products, if any, the participant found most appealing (see Appendix D for transcripts). The questionnaire was designed to allow for as much commentary and insight from the subjects as possible. It also included questions regarding trust and consumer confidence in order to determine if the fictitious online store was perceived as being trustworthy, an important antecedent of purchasing probability (Corbitt et al., 2003).

In addition to identifying patterns of preference, the qualitative questionnaire represented an opportunity for participants to reveal factors not previously considered by the researcher, which could be considered in future studies. Participants were asked to write in their responses as opposed to answering orally, giving them time to fully consider the questions. The following questions were asked after the web page stimuli had been administered:

1. Did you find some pages more attractive than others? If so, which?

2. Were some pages easier to read than others? If so, which?

3. Were some products more enticing than others? If so, which?

4. When you shop online, do you prefer websites to look a certain way (e.g., simple, detailed, colorful, plain, static, animated)?

5. Do you often worry about giving out your personal financial information when you shop online?

6. Would you trust your financial information with the websites you saw today?

7. Would you purchase a product from the websites you saw today?

Analyses

Three approaches were used in the analysis of the data set: (1) A comparative analysis of average sustained evoked response over time; (2) a Fast Fourier Transform (FFT) spectral analysis of individual frequency power over time; and (3) an analysis of key words, phrases, and trends taken from the qualitative survey responses.

Figure 31. Absolute Value

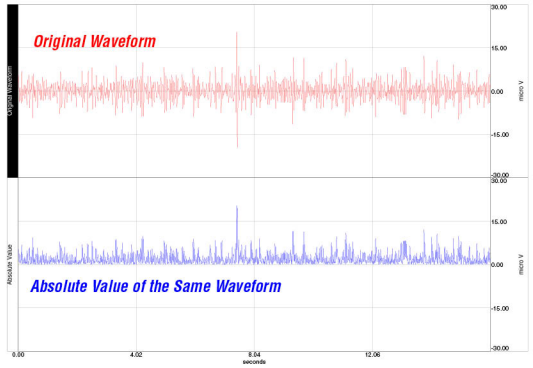

Figure 31. A before-and-after comparison showing how a normal oscillating waveform is converted into equivalent positive values.

(1) The first step in calculating average sustained evoked response over time in the EEG data set (see Appendix E & F for individual EEG readouts and analyses) was to assess the *absolute value* within the beta band of each of the seven epochs (B, M1, L1, C1, M2, L2, C2) for each participant. Biopac's BSL Pro 3.7 (Biopac Systems, Inc., Goleta, CA) software was used to transform a regular waveform, which contains an oscillating wave morphology of negative and positive amplitude, to a waveform in which all values had been made positive without changes to the total overall magnitude (Figure 31) (Rangaswamy et al., 2004). Then, the mean amplitudes for each epoch were calculated, imported into SPSS (SPSS, Inc., Chicago, IL), and compared with the same calculations taken from both the baseline and the inverse pair (M1 vs. M2, L1 vs. L2, and C1 vs. C2) using a paired-samples *t* test.

(2) The second analysis involved finding the principal frequency (Hz) observed within each epoch. This was accomplished by applying a Fast Fourier Transform (FFT) spectral analysis to the waveform. The FFT analysis is best described as a linear diagram of how much of each frequency is represented within a given amount of time (Figure 32). In other words, it converts a *time-domain* waveform (X-axis=Seconds) to a *frequency-domain* waveform (X-axis=Hz). Again, the BSL Pro 3.7 software was used to generate these measurements. A Hanning window was used to minimize waveform

Figure 32. FFT Spectral Analysis

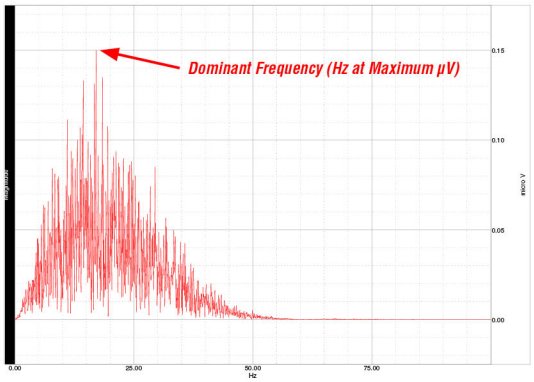

Figure 32. An example of a FFT spectral analysis. Notice the bell-curve. The dominant frequency is represented by the highest point.

incoherence. From the spectral analysis of each epoch, the dominant frequency (Hz value at maximum spectral amplitude) within the beta band (13-30Hz) was isolated and recorded in SPSS. These values were correlated with the same measurements taken from the baseline and inverse stimuli using paired-samples *t* tests (Stern et al., 2001, p. 230-233).

(3) The third analysis involved the identification of patterns in answers given during the qualitative interview. This involved two parts: First, individual preferences for specific stimuli were identified and aggregated, giving the researcher a general understanding of what the sample population thought about the products and web pages to which they had just been exposed. Second, individual EEG feedback was correlated with the sample mean when a particular condition was positively mentioned. For example, if a participant responded, "I liked how the TV rotated", that individual's mean frequency and amplitude would be compared to the rest of the sample's mean response during that epoch. This allowed the researchers to identify any possible individualized effect.

The methodology of this research was intended to observe the effect of passive visual behavior modifiers in an environment that was as close to a real world shopping scenario as possible. Because of the sensitivity of the physiological instrument, it was of primary importance to make the participants feel as comfortable with the conditions of the experiment as possible. Again, the investigator wanted each participant to feel as if they were really browsing online for a birthday present for their friend. This was accomplished through realistic e-commerce environments and a non-invasive biofeedback measure. The results, however, would reveal that

the concessions made in the name of believability and comfort may have compromised the overall observable effect.

Results

An analysis of paired difference in means did not reveal significant effect in amplitude or frequency, confirming the null hypotheses. Data from both continuous variables were compared using a paired-samples *t* test. Additionally, demographic subgroups were tested against the continuous variables with a one-way analysis of variance.

Average Amplitude (μV)

The comparison of average amplitudes between the baseline and web page stimuli did not yield significant results at a confidence level of 95% ($p = .05$). There was no discernable difference between average baseline amplitude versus average amplitude upon exposure to the web pages in the ventromedial prefrontal cortex (VMPFC) region of interest (Table 2).

Table 2

Baseline Stimulus Mean Amplitude (μV) vs. Web Page Stimuli Mean Amplitude (μV)

Code	Mean μV	Mean *d* with (B)	*t*	Sig. (2-tailed)*
(B)	2.6743950	n/a		
(M1)	2.7041649	-.029769926	-.646	.524
(L1)	2.7009730	-.026578000	-.380	.707
(C1)	2.7369519	-.062556889	-1.388	.177
(M2)	2.7096550	-.035260000	-.639	.529
(L2)	2.6520233	.022371741	.381	.706
(C2)	2.6542207	.020174296	.322	.750

Note. (B) = Baseline; (M1) = Motion, Static; (L1) = Layout, Image < Type; (C1) = Color, W~490nm; (M2) = Motion, Animated; (L2) Layout, Image > Type; (C2) = Color, W~650nm. *$p = .05$.

Statistical significance was also not achieved in the same analysis of inverse stimuli (M1, L1, C1) versus experimental stimuli (M2, L2, C2). It was predicted that the experimental stimuli would yield higher evoked response, but no significant effect was found in a comparison of mean differences (Table 3).

Table 3

Inverse Stimuli Mean Amplitude (μV) vs. Experimental Stimuli Mean Amplitude (μV)

Code	Mean μV	Mean *d*	*t*	Sig. (2-tailed)*
(M1)	2.7041649	-.005490074	-.139	.890
(M2)	2.7096550			
(L1)	2.7009730	.048949741	.832	.413
(L2)	2.6520233			
(C1)	2.7369519	.082731185	1.694	.102
(C2)	2.6542207			

Note. (M1) = Motion, Static; (L1) = Layout, Image < Type; (C1) = Color, W~490nm; (M2) = Motion, Animated; (L2) Layout, Image > Type; (C2) = Color, W~650nm. **p = .05.*

After failing to find significance in measures of amplitude, I tested a known quantity in EEG readings to ensure that the data had not been compromised. Of the fourteen separate measurements of amplitude and frequency conducted in this experiment, the female subgroup scored higher in twelve (Table 4). This finding was consistent with existing literature that states females routinely exhibit higher average frontal lobe activity in measures of cerebral perfusion and EEG feedback (Christakou, Halari, Smith, Ifkovits, Brammer, & Rubia, 2009; Pflanzer et al.,

2011). This trend indicated that the data set had maintained validity, at least in terms of its relationship to gender.

Table 4

Gender vs. Stimuli μV & Hz Means

Stimulus	BμV	BHz	M1μV	M1Hz	L1μV	L1Hz	C1μV	C1Hz
Male	2.37042420	17.0117189	2.48902440	17.2802734*	2.46083120	15.6884767	2.43707800	18.0908204
Female	2.85320135*	17.7001954*	2.83071818*	17.0266544	2.84223288*	16.8571922*	2.91334829*	17.9744945*

Stimulus	M2μV	M2Hz	L2μV	L2Hz	C2μV	C2Hz
Male	2.46270120	16.66045630	2.43781270	16.333008	2.44097050	18.1975799*
Female	2.85492194*	18.45128682*	2.77802947*	17.793543*	2.77966200*	17.9615694

Note. (B) = Baseline; (M1) = Motion, Static; (L1) = Layout, Image < Type; (C1) = Color, W~490nm; (M2) = Motion, Animated; (L2) Layout, Image > Type; (C2) = Color, W~650nm. *= Higher Activity

FFT Spectral Analysis

In an examination of compared differences in frequency (Hz), no statistically significant divergences were found (Table 5). In the first comparison of the baseline measurement versus the web page stimuli, the dominant mean frequency in all epochs ranged from 16–18Hz, values situated at the low end of the beta band (13–30Hz).

Table 5

Baseline Stimulus Mean Frequency (Hz) vs. Web Page Stimuli Mean Frequency (Hz)

Code	Mean Hz	Mean *d* with (B)	*t*	Sig. (2-tailed)*
(B)	17.445204	n/a		
(M1)	17.120587	.324616778	.475	.639
(L1)	16.424335	1.020869481	1.896	.069
(C1)	18.017578	-.572374074	-.823	.418
(M2)	17.787905	-.342701037	-.435	.667
(L2)	17.252604	.192599963	.294	.771
(C2)	18.048981	-.603776556	-.808	.426

Note. (B) = Baseline; (M1) = Motion, Static; (L1) = Layout, Image < Type; (C1) = Color, W~490nm; (M2) = Motion, Animated; (L2) Layout, Image > Type; (C2) = Color, W~650nm. **p = .05.*

In the analysis of compared differences in average frequency during the inverse stimuli (M1, L1, C1) versus experimental stimuli (M2, L2, C2), it was hypothesized that observed activity in the region of interest would be higher in the latter set of experimental conditions. While the average frequencies in M2, L2, and C2 were all higher than their inverse pairs, statistical significance was not achieved (Table 6).

Table 6

Inverse Stimuli Mean Frequency (Hz) vs. Experimental Stimuli Mean Frequency (Hz)

Code	Mean Hz	Mean *d*	*t*	Sig. (2-tailed)*
(M1)	17.120587	-.667317815	-.666	.511
(M2)	17.787905			
(L1)	16.424335	-.828269519	-1.397	.174
(L2)	17.252604			
(C1)	18.017578	-.031402481	-.065	.949
(C2)	18.048981			

Note. (M1) = Motion, Static; (L1) = Layout, Image < Type; (C1) = Color, W~490nm; (M2) = Motion, Animated; (L2) Layout, Image > Type; (C2) = Color, W~650nm. *$p = .05$.

Qualitative Interview

Operative words and phrases were identified in the qualitative interview responses, which revealed some explicit trends in measures of preference and product attitudes. Additionally, responses indicated that consumer confidence issues were of primary importance to the sample, and a majority of participants would trust the fictitious website, *HD Direct*, with their personal financial information. Further, a strong majority reported that they would buy one of the products they had been shown from the website.

In the first question, participants were asked to identify which pages they found the most attractive. The most common responses, as seen in Table 7, were related to the flat screen TV (N=13). Nine of those who preferred pages with the TV specifically mentioned the animation. For example, one participant wrote, “I like how the TV rotated so you could see the entire merchandise.” The second most common responses came from subjects who indicated no

preference or thought all the pages looked about the same (*N*=6), and those who specifically preferred the red stimulus those (*N*=6). However, one respondent expressed their distaste for the red e-commerce environment saying, "*The pages with a lot of red seemed less attractive."*

Table 7

Web Page Stimuli Preferences

	M1 & M2	**M2**	**C2**	***No Difference***
N	13	9	6	6
% of Total	48.15%	33.33%	22.22%	22.22%

Note. (M1) = Motion, Static; (L1) = Layout, Image < Type; (C1) = Color, W~490nm; (M2) = Motion, Animated; (L2) Layout, Image > Type; (C2) = Color, W~650nm.

The next question asked participants to divulge which, if any pages were easier to read than others. This question was included to reveal preferences for the amount of type on the pages. Most participants saw no difference in readability between the pages (*N*=18). Four participants indicated that they preferred pages that had an emphasis on imagery vs. type. One participant answered, "*Typically, the pages with less words or not intense color (such as green) were easier to read.*" Another replied, "*Yes. The ones with minimal information. The camera.*" Interestingly, another subject said, "*I was too busy looking at pictures to do much reading.*"

In the next question, it was asked if some of the products were more enticing than others. This question was asked to determine if one product was widely preferred over another, a potential threat to validity. The TV and camera were mentioned most frequently, referenced 16 and 12 times, respectively. The headphones only garnered one response. Because the headphones

were the least expensive of the items shown, this could indicate an interceding variable of perceived value.

Though it was not its intention, this question also revealed some insightful preference-related responses. Again, the animated television was the stimuli with the most specific mentions here:

- "*Yes, the second TV because the picture was mobile, and the second camera because the picture was up close and detailed.*"
- "*The TV, especially when it turned from the side to the front.*"
- "*The second screen of the camera, for sure.*"

The question about product preference also revealed an unforeseen consideration. Two participants specifically mentioned that they liked the camera pages because the consumer review on the page said nothing negative about the product. One subject said, "*The camera was very enticing because it received good reviews while the other two products had glitches or faults.*" Another responded, "*The camera. The user review had nothing negative in it.*"

The next question gauged subject preference for e-commerce website design, generally, as they experience it in their own experiences online. Twelve subjects (N=12) responded that they prefer user interfaces to be simple. Equally, 12 participants (N=12) indicated that they prefer a lot of detail when shopping online. Usability was another common theme (N=4). One participant wrote, "*I think websites should be used to first inform the customer, providing*

accurate details about the product. If it is too overwhelming, the customer will have a hard time navigating the site." Another said, "*I like them to be simple, clearly organized, but with detailed pictures of the product.*" That sentiment was echoed by another participant who wrote, "*The simpler a website is, the more likely I am to use it. If I want more information, there must be a way to find all the details.*" Additionally, eight subjects (*N*=8) noted that they preferred colorful websites to plain.

The next three questions dealt with consumer confidence. When asked if they often worry about giving out personal financial information online, a strong majority of respondents said 'yes' (*N*=20, 74.07%). The subjects were almost split about their confidence in *HD Direct*, with 15 (*N*=15, 55.56%) reporting that yes, they would trust their financial information with the website they were just shown, and 12 (*N*=12, 44.44%) subjects saying no or they would need to research the company before making a decision. However, when asked if he or she would purchase a product from *HD Direct*, over 70% (*N*=19) responded positively. One subject in that group said, "*I would feel confident trusting this site because it had sentences off to the side explaining its financial process, and the site looked legitimate*." Several subjects who responded that they would not trust *HD Direct* indicated that they typically research a company before making a purchase online.

After the review of operative words had concluded, the investigator returned to the first question, which asked specifically, "*Did you find some pages more attractive than others? If so, which?*" In this part of the analysis, average frequency and amplitude of those participants who had explicitly mentioned one of the experimental stimuli (M2, L2, or C2) was compared to the

sample average (Tables 8 & 9). This case study model was intended to detect any correlation between individual conscious decision-making and EEG activity.

Table 8

Comparison of Individual's Who Specifically Preferred M2 (Animated Product) vs. Sample Averages

Participant #	**2**	**4**	**5**	**7**	**11**	**13**	**19**	**23**	**26**
Participant μV	2.408708	2.418708	2.784327	2.983070	2.307490	2.825287	2.658259	3.921309	2.896611
Sample $\bar{x}$ μV	2.709655	2.709655	2.709655	2.709655	2.709655	2.709655	2.709655	2.709655	2.709655
Participant Hz	20.117188	16.064453	17.138672	21.582031	29.736328	13.671875	14.062500	13.134766	15.234375
Sample $\bar{x}$ Hz	17.787905	17.787905	17.787905	17.787905	17.787905	17.787905	17.787905	17.787905	17.787905

Table 9

Comparison of Individual's Who Specifically Preferred C2 (W ~ 650nm) vs. Sample Averages

Participant #	**3**	**6**	**13**	**14**	**18**	**24**
Participant μV	2.713933	2.467663	2.686490	3.497125	4.920499	2.009628
Sample $\bar{x}$ μV	2.6542207	2.6542207	2.6542207	2.6542207	2.6542207	2.6542207
Participant Hz	16.894531	20.068359	20.019531	24.096680	21.337891	16.699219
Sample $\bar{x}$ Hz	18.048981	18.048981	18.048981	18.048981	18.048981	18.048981

While no significant patterns were found in this comparison, it does demonstrate the common difficulty with EEG experiments: Amplitudes and frequency fluctuate between individuals based on a variety of external factors, not including the visual stimulus, each of which could hinder or promote the evoked response to the visual stimulus. One person may report an explicit interest in a very specific condition, but because of the individual circumstances of their physiological exam, no elevation in evoked response is observed. Drinking a big cup of coffee prior to an exam may result in a false positive. Conversely, a lack of rest the night before a test could significantly lower overall neural output. Additionally, individual epidural resistance can interfere with an electroencephalogram. If a participant perspires during the exam, for example, the electrodes adhered to the skin may not maintain consistent contact, resulting in an unreliable reading (Cook, et al., 2011; Pflanzer, Uyehara, McMullen, 2011; Stern et al., 2001).

As mentioned before, incomplete removal of the outer layer of skin at the point of electrode contact can also obscure an EEG recording. Electrical activity from the brain has to travel from the cortex through several layers of subcutaneous tissue to reach the surface of the skin, including about seven millimeters of solid bone. Electrodes need ideal conditions to see through those layers and detect electrical activity from the brain. Dead skin cells that have built up on the cranial surface significantly dampen an EEG signal, as was the case in this experiment.

Discussion

Implications

Passive visual behavior modifiers showed no significant effect on consumer psychophysiology online, confirming all three null hypotheses. However, that does not mean no effect exists. It most likely indicates that the circumstances of this experiment prevented that effect from revealing itself. Half a century of perception and consumer behavior research, as demonstrated by the literature review, has supported the hypothesis that the informed use of color, layout, and motion in retail environments changes the way consumers think about brands and products. Few researchers would argue that hedonic motivators like these are not, to some degree, a part of the marketing equation.

Design is an industry that sells itself largely on the premise that astutely applied graphic principles can exponentially increase the market appeal of a product. This theory is supported not only by the established literature, but also the free marketplace at large. AT&T spent almost three billion dollars on advertising last year because they knew they would profit from every dollar spent on television ads, magazine spreads, and websites (Bashin, 2011). Design is an essential governor of consumer behavior, and color, layout, and motion are essential components of design. If the sum of a designed composition's parts can affect consumer behavior, it stands to reason that the distinct parts of that composition carry some individual effect themselves. The effect is undoubtedly there. It is just a matter of crafting a method that allows for their observation.

So, what was the value of this study, if not for its data? The researcher would argue that this study provides an exploratory foundation for future studies of similar theme. Psychophysiological measures of online consumer behavior are exceptionally rare due to the inherent constraints of the equipment involved. Simply, it is hard to realistically replicate an online shopping scenario when your subjects are attached to complicated medical machinery. This research, more than anything, succinctly exhibits the complications inherent to biofeedback measures of marketing. New technologies, however, are being developed that are more appropriate for an EEG study that does not necessarily fit in to the conventional clinical framework. One example, the Emotiv Epoc® (Figure 33), uses a 14 channel wireless headset to collect EEG data. Not only does it record evoked response with the same precision as clinical systems, the Epoc hardware also has a built in stabilization gyroscope that lets the subject move while the test is being conducted. This research sets a theoretical framework for future studies of this type, and technologies like the Epoc®, as they develop, will make studies of similar objective easier to conduct and will result in better, cleaner data gathered in a more realistic environment.

Figure 33. The Emotiv Epoc®

Figure 33. The Emotiv Epoch® is an example of an EEG system designed to be flexible enough to use outside of a clinical setting.

Limitations

Several factors placed limitations on the validity of the data. First and foremost, impedance levels were undesirably high. High resistance between the electrode and the skin significantly lowered the observable level of activity and resulted in an undesirable level of signal noise. This was a procedural error that would be easily corrected in future studies of similar design. As mentioned before, however, the investigator would not go as far as to say that high impedance was the sole reason for a lack of significant findings. While no correlations between the visual stimuli were found, higher levels of amplitude and frequency among the females in the sample indicated that valid data was recorded. Moreover, recent research examining the effect of impedance on data quality showed that even in instances of high impedance, the frequencies that are disturbed are very low on the frequency spectrum, well below the 13–30Hz window of interest in this study (Kappenman & Luck, 2010).

Other intervening variables were more likely to blame for the lack of significant effect. While every effort was made to ensure that subjects genuinely engaged in the stimuli, it could have been the case that some subjects simply were not paying attention. Subjects were receiving course credit for their participation, but attendance was all that was required. Little incentive existed for subjects to truly survey the stimuli. Participant #5, whose neural output remained almost constant throughout the entire 170-second exposure period, supports the possibility that some participants cognitively detached from the task at hand.

Additionally, because the investigator stayed in the room to record EMG artifacts during the EEG recording, participants may have been concentrating on what he was doing instead of focusing on the stimuli. Rook and Fisher (1995) found that subjects are less likely to engage in impulsive behavior when they are being watched, a possible explanation for the unexceptional level of observed activity.

Individual product preferences may have also contaminated the results. As one participant said in their exit interview, "*Personally, I am interested in cameras, so the sites with the cameras caught my attention.*" Another subject expressed his bias for the stimuli featuring televisions because, at the time of the test, he was looking for one to buy. Due to the commercial nature of the testing stimuli, it was necessary to feature some type of product. It was thought that electronics would represent a gender-neutral category of product that almost everyone has bought at some time in his or her life, but pre-existing product preferences are unavoidable, it seems.

The paratelic priming scenario designed to give the participant a browser-oriented and impulsive predisposition may have also created a unintentional cooling effect on any activity being generated by they experimental variables. In a recent study from Queen's University, researchers established a positive correlation between increased electrical activity in the medial prefrontal cortex and impulse control, meaning higher levels of amplitude in the region of interest indicate impulse behavior is being *suppressed* (Hayton, Lovett-Barron, Dumont, & Olmstead, 2010). Because the design of this experiment encouraged impulsive behavior, it could be deduced that this neuropsychological reaction had a mediating effect on any potential activity

being created as a result of aesthetic judgment, working memory, decision-making, or perceived value.

There is also an inherent and unavoidable problem with a study of this type: It tries to observe the effect of something that is buried underneath a multitude of more obvious and apparent consumer behavior modifiers, each one representing a threat to the internal validity of the data. The nature of the experimental variable and the way it must be presented creates a circular invalidation: It is difficult to confirm that passive visual behavior modifiers have a definitive effect without placing them within a larger visual narrative, but the non-experimental graphic elements that co-exist with those variables also have effects of their own. An individual's reaction to those interceding variables disguises the effect of what the investigator is trying to observe.

For example, the Red Bull logo (Figure 34) has a primary color of red, and we know that red has been linked to positive brand attitudes. However, if we observed higher levels of activity in the frontal cortex with this logo compared to a gray version, we could not claim that effect was due to the sole influence of the red. This logo also contains a bold san serif typeface and strong masculine symbolism, which might skew data towards the male subgroup within the sample. As we learned in the literature review, consumer

Figure 34. Red Bull Logo

Figure 34. The Red Bull logo exemplifies the circular invalidation of conclusions drawn from a single composition exhibiting multiple design characteristics.

behavior is guided by any number of pre-existing biases and experiences. Conclusions drawn from an aggregate pool of biofeedback measurements must take into account these individual disparities in perception as they relate to graphic design.

Suggestions for Further Research

This study, while failing to produce a significant correlation between passive visual behavior modifiers and consumer psychophysiology online, did reveal the need for a continuation for this type of research in the future. The body of literature pertaining to graphic design online is still very young, and the questions posed by this study still need to be answered. There is great potential for further exploration of this topic, but researchers should approach with diligence. As demonstrated by the course of this study, conditions need to be tightly controlled to ensure valid results.

Future studies of this type should note the pivotal importance of impedance control and artifact reduction. If possible, it is suggested that a physiological instrument which has been specifically designed for neuromarketing applications be used. Additionally, it may be beneficial to record video of the procedure so EMG artifacts can be precisely identified and removed afterwards. If using the Biopac system, it is recommended that researchers record EMG and EEG data concurrently. The accompanying software has the capability to automatically remove known EMG artifacts from the EEG waveform if synchronous data exists.

It might also be useful to drastically simplify the parameters of this study before trying to replicate its experimental design. Comparing perception of a blank red screen versus a blank blue

screen may provide direction for further studies to build upon. By establishing an average effect generated by these variables, it may be easier to extrapolate their significance in scenarios where the visual stimulus is more complex.

While this study sought only to compare the experimental variable against its inverse condition and the baseline, future studies of similar design might consider developing 18 different web pages exhibiting each possible combination of the stimuli. This approach would yield significantly more statistical analyses options, including a comprehensive analysis of variance (ANOVA).

It is always desirable to test a larger sample. Distributing data over a larger population could mitigate some of the pre-existing biases that become very important when a data set is small. Testing over a larger sample will also allow researchers to break the sample into its demographic subgroups, increasing the possibility of finding significance among a particular segment of the population. Specifically, it would be interesting to examine the effect of passive visual behavior modifiers in an e-commerce environment in participants significantly older than the sample tested in this study.

Different approaches to the EEG measurement might prove more successful. For example, some neuropsychologists are observing human emotion and motivation using high-density electrode arrays to measure approach and avoidance tendencies. In what is known as the frontal asymmetry paradigm, researchers have found that behavior is controlled by either the innate attraction to scenarios that have a possible desirable outcome (approach tendency) or the innate retreat from scenarios that have possible aversive outcomes (avoidance tendency). It is

now know that the left hemisphere of the brain controls approach tendencies and the right hemisphere controls avoidance tendencies. Researchers are already testing hemispheric brain activity upon exposure to a variety of visual stimuli, including interactive advertising (Ohme et al., 2011). Such an experimental strategy could provide valuable data regarding the general effectiveness of pages exhibiting passive visual behavior modifiers.

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Appendix A — Informed Consent, Survey & Questionnaire

Informed Consent Form

Research Title: Website Design & Consumer Behavior

Dear Participant,

First of all, thank you for your participation in this study. This research involves an analysis of commercial website design and its effect on consumer behavior. The entire process will take approximately one hour. You will begin by filling out a brief questionnaire that will collect basic information about you including age, gender, medical history, and Internet usage.

This study involves minimal risk to you, the participant, but there is always a small degree of inherent risk when disclosing personal information. The following measures have been taken to protect your privacy. At the top of the questionnaire, you will notice a number. This is a randomly generated identification number used to protect your identity. At no time will any of the data collected during this research be connected with your real name. Additionally, all physical data will be kept in a secure and locked location in the investigator's office. All digital data will be stored on a password protected computer on the University of Central Oklahoma's Edmond campus.

As mentioned before, this questionnaire includes questions about your medical history. It will ask you to disclose any history of bipolar disorder, schizophrenia, Alzheimer's disease, seizures, alcohol or drug abuse, head trauma, stroke, brain injury, or color blindness. If you have any of these conditions, you cannot take part in this research. The investigator will excuse you from testing without penalty.

After you have completed the questionnaire, you will be asked to view a number of web pages while connected to a piece of equipment that measures your brain activity. The process of attaching the equipment to your scalp involves a light cleaning of the contact area and placement of small tin electrodes on the skin. The application of these adhesive electrodes is painless and will leave no impression or marks on the skin. To clarify, these electrodes only measure electricity on your scalp. They do not transmit electricity and present no danger of electrical shock.

After you have been fitted with the equipment, you will be asked to read a short statement and view several web pages while the investigator measures your brain activity. This will take no more than ten minutes. After you complete the test, you will be asked to complete a brief questionnaire. Again, you will not be asked to give your name, and all data will be reported anonymously.

This research is entirely voluntary, and you have the right to withdraw at any time without penalty. You also have the right to refuse to answer any of the questions on the written surveys. While this research provides no direct benefit to you, the data acquired from your participation in this research will provide valuable insight into website design.

Affirmation by Research Subject *(Please read the following statement and sign below.)*
I hereby voluntarily agree to participate in the above listed research project and further understand the above listed explanations and descriptions of the research project. I also understand that there is no penalty for refusal to participate, and that I am free to withdraw my consent and participation in this project at any time without penalty. I acknowledge that I am at least 18 years old. I have read and fully understand this Informed Consent Form. I sign it freely and voluntarily. I acknowledge that a copy of this Informed Consent Form has been given to me to keep.

Name: _____
Signature: _____
Date: _____

Adam Gault • Primary Investigator • agault@uco.edu • (405) 308-2092
Rukmini Ravikumar, MFA • Faculty Sponsor • rravikumar@uco.edu • (405) 974-5210
UCO Institutional Review Board • (405) 974-5479 • irb@uco.edu

IRB Approval #: 12006

Pre-Test Survey

Subject ID#_____

1. What is your age?

2. What is your gender?
☐ Male
☐ Female

3. How many hours per week do you spend online?
☐ Less than 5 hours
☐ 6-10 hours
☐ 11-20 hours
☐ 20-30 hours
☐ Over 30 hours

4. What percentage of your shopping do you do online?
☐ 0-25%
☐ 25-50%
☐ 50-75%
☐ 75%-100%

5. When you visit an online store, what is most often your primary intention? Select one.
☐ Research a product
☐ Browse for new products
☐ Compare prices
☐ Purchase a product
☐ Product support

6. Do you have a history of any of the following medical conditions? Select all that apply.
☐ Bipolar Disorder
☐ Schizophrenia
☐ Alzheimer's Disease
☐ Seizures
☐ Alcohol or Drug Abuse
☐ Severe Head Trauma
☐ Stroke
☐ Brain Injury
☐ None of the Above

7. Are you partially or totally color blind?
☐ Yes
☐ No

8. What hand do you write with?
☐ Right
☐ Left

Exit Interview

Subject ID#_____

1. Did you find some pages more attractive than others? If so, which?

2. Were some pages easier to read than others? If so, which?

3. Were some products more enticing than others? If so, which?

4. When you shop online, do you prefer websites to look a certain way (e.g., simple, detailed, colorful, plain, static, animated)?

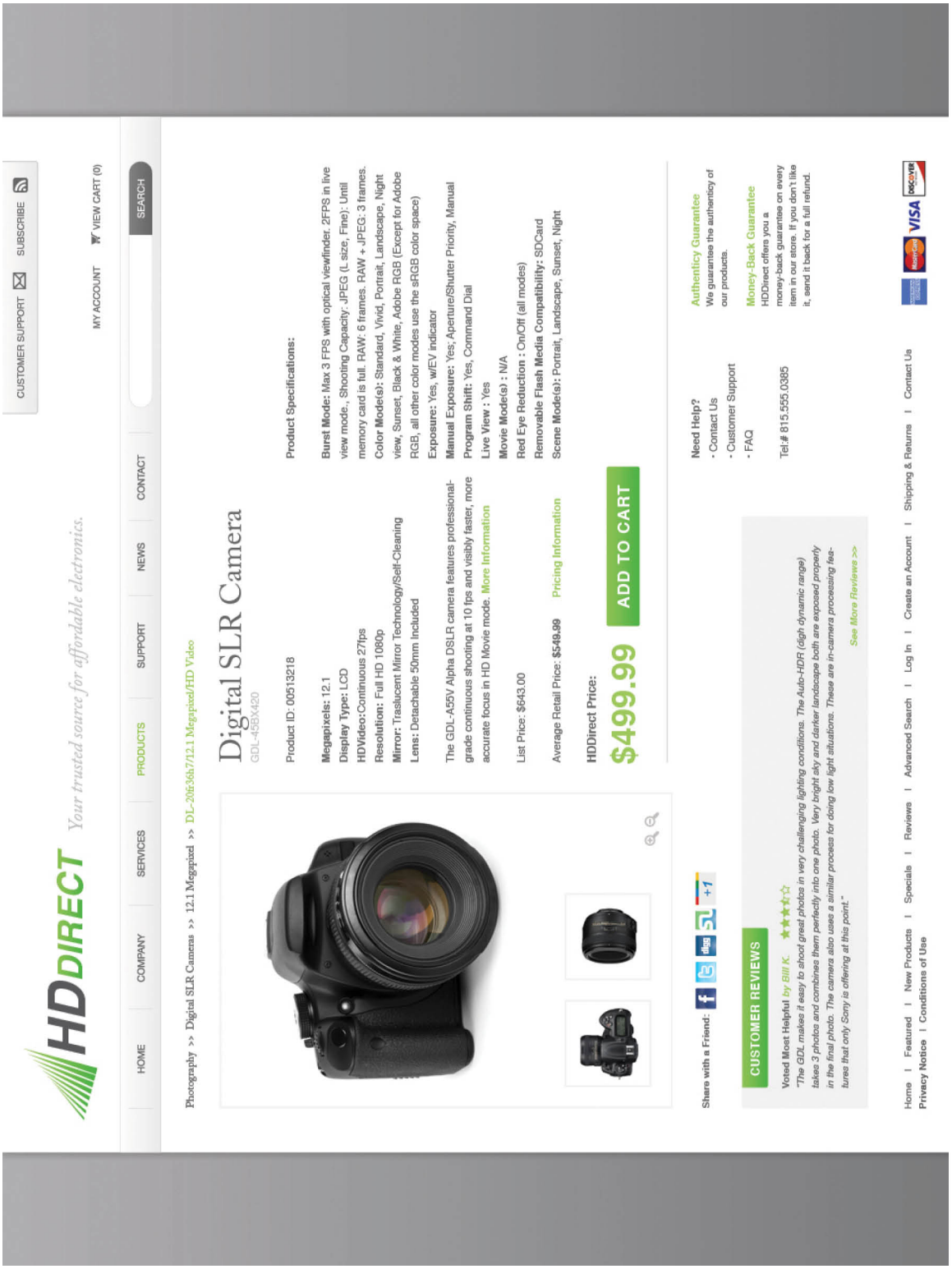
5. Do you often worry about giving out your personal financial information when you shop online?

6. Would you trust your financial information with the websites you saw today?

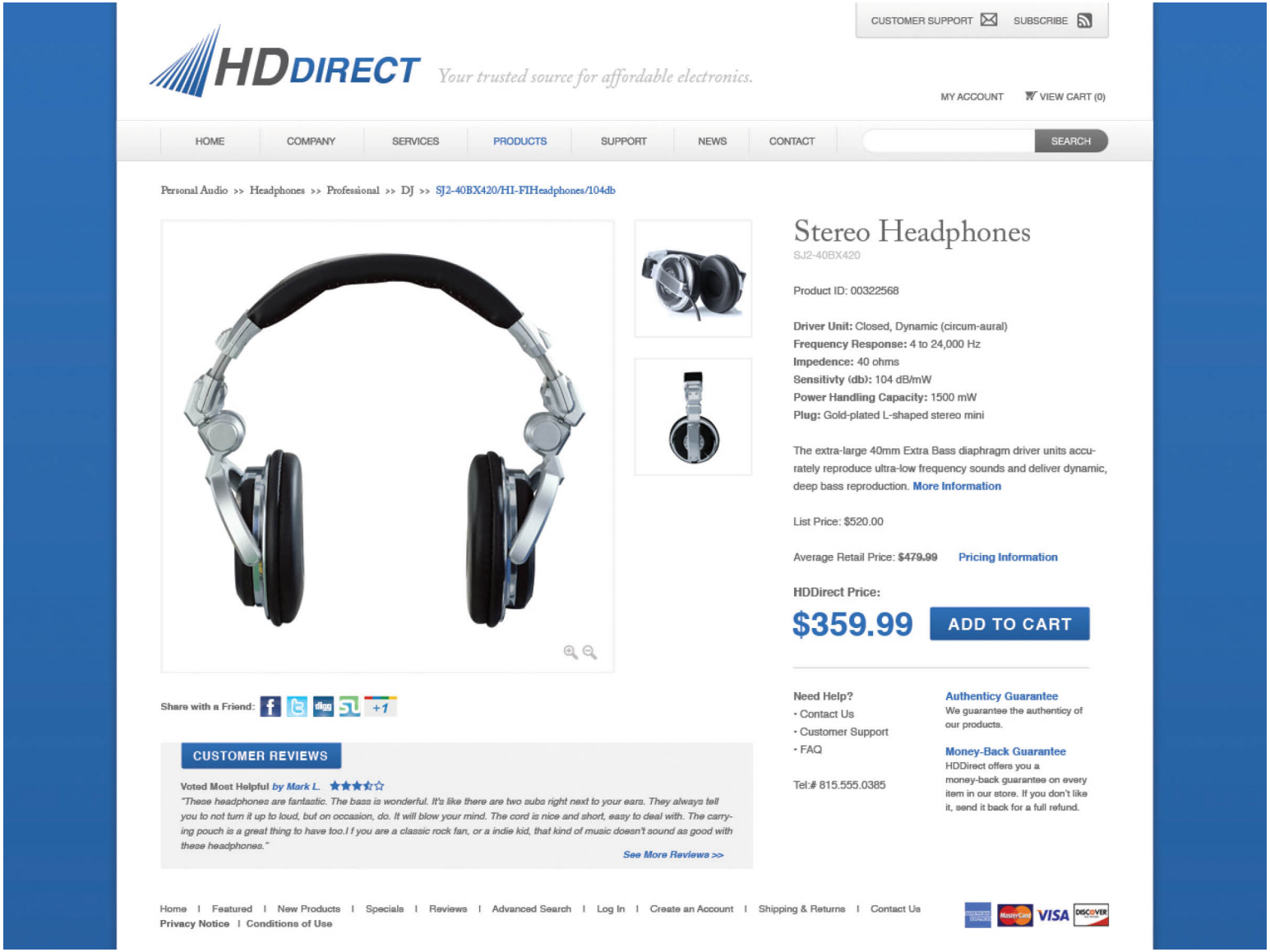
7. Would you purchase a product from the websites you saw today?

Appendix B — Web Page Stimuli

Stimulus Code (M1) — Main product image is static.

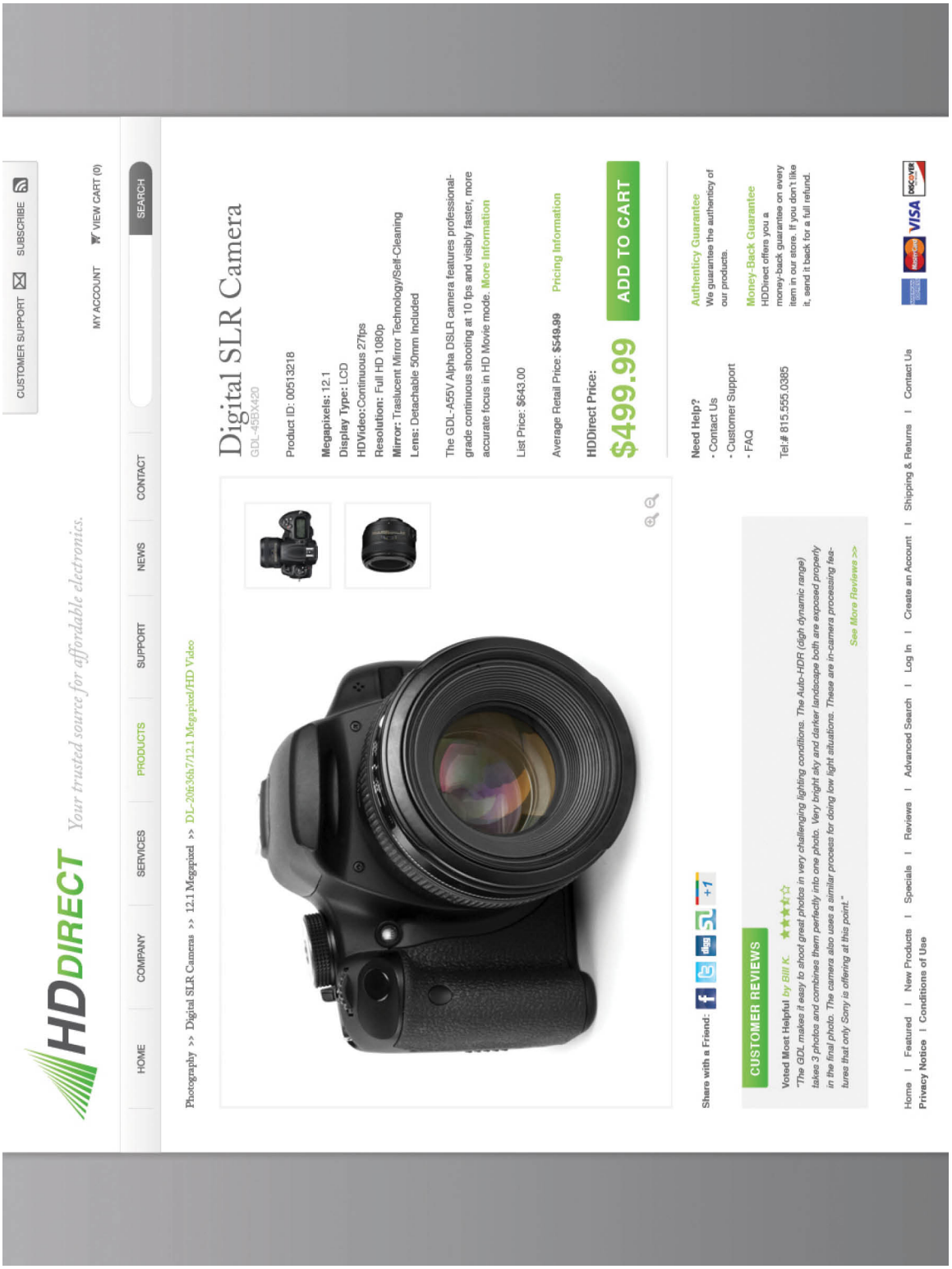


Stimulus Code (L1) — Product area is 1/3 image and 2/3 type.

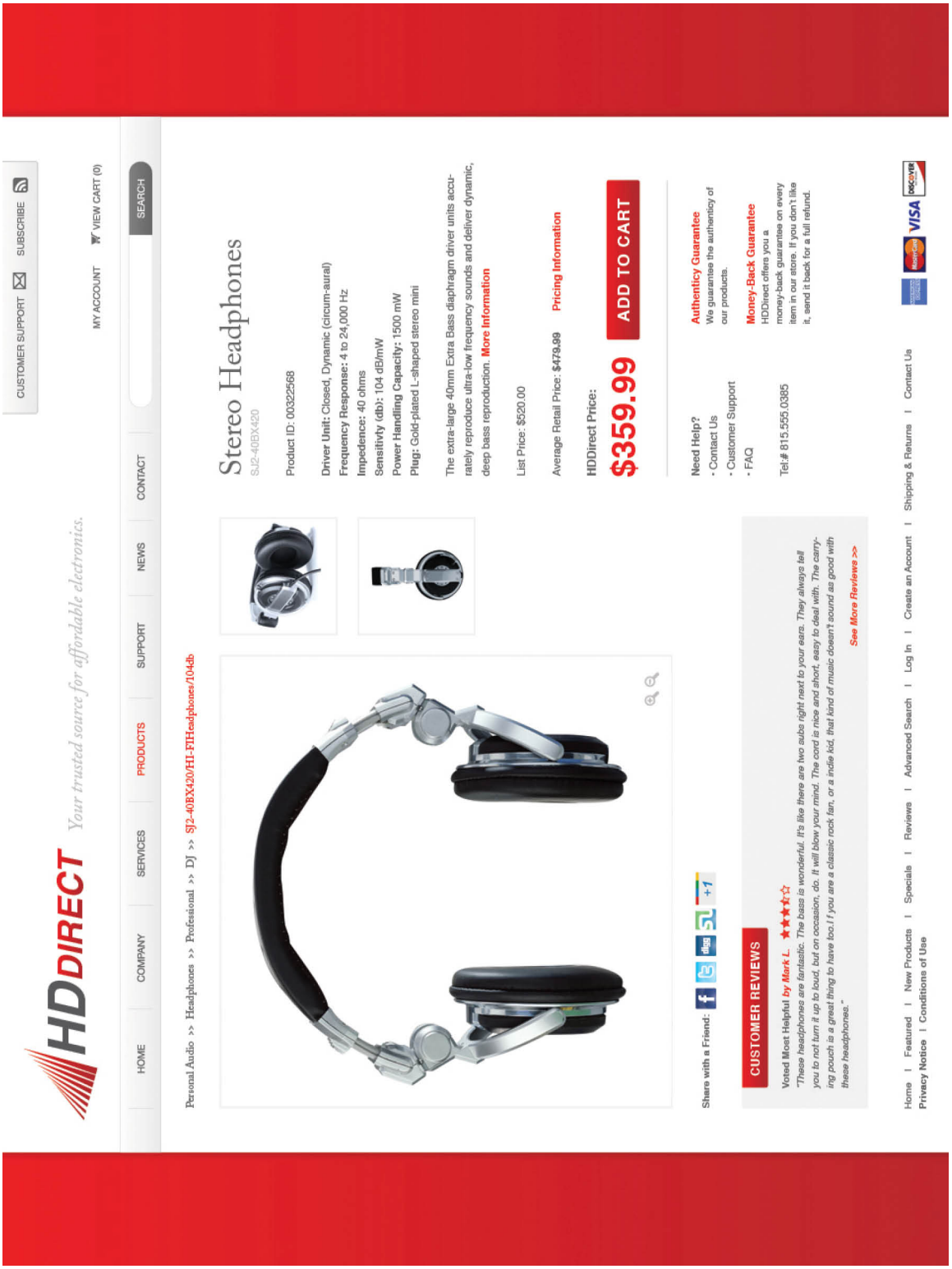


Stimulus Code (C1) — Web page features a dominant color wavelength of ~ 490nm.

Stimulus Code (M2) — Main product image is animated.



Stimulus Code (L2) — Product area is 2/3 image and 1/3 type.



Stimulus Code (C2) — Web page features a dominant color wavelength of ~ 650nm.

Appendix C — EEG Procedure Checklist

EEG Procedure

BEFORE THE TEST:

1. Instruct students to sign up for an available time slot using the Sona System which can be accessed at http://uco.sona-systems.com. The study name is *Consumer Behavior & Website Design.*

2. Instruct participants to avoid fasting, consuming excessive amounts of caffeine, or taking sedatives on the day of your test. Also, avoid applying hair product such as gel or hairspray before the test.

TESTING:

1. Welcome — *"Thank you for coming today. The test we're about to do is a study of website design and how people shop online. We'll start by filling out some paperwork, and then I'll have you view several web pages while connected to this computer. These little sensors collect information that gives me a glimpse into your thought processes. They have a bit of sticky adhesive on the back, just like a Band-Aid, and they'll be attached to a few different locations on your scalp. Before I put them on, I'll prep the area a mild abrasion pad and an alcohol swab. Two will go on your forehead, another two go behind your ears, and the last two will be attached to your earlobe. After we have the sensors in place, I'll use this flexible band to gently press the sensors against your skin. Then, I'll have you look at some web pages for a couple of minutes. After we're done with that, I'll ask you to write down what you thought and felt about the web pages. If you have a cell phone, please turn it off. The whole process won't take any more than an hour."*

2. Informed Consent Form — *"Please read and sign this."*

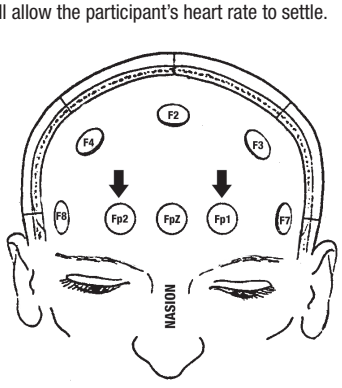
3. Pretest Questionnaire — *"Please fill this out."* Check participant eligibility. Assign participant ID#. In the event that a participant is not eligible, read the following statement: *"Thank you for your participation in this research. It appears that you are not a viable candidate for further testing. Your attendance today will still qualify you for course credit. You are free to go"*

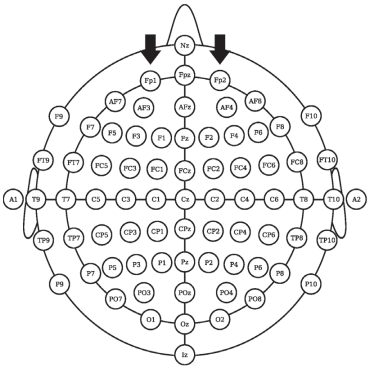
4. Administer Priming Scenario

5. Turn on the Computer.

6. Plug Electrode Leads (SS2L) into CH1 and CH2.

7. Apply Electrodes to Participant — Lightly scrub the skin of areas Fp1 and Fp2 (areas that control impulse, attention, and working memory). Wipe area with alcohol scrub. Apply **ACTIVE** electrodes to Fp1 and Fp2. Apply REFERENCE electrodes to mastoid structures behind each ear. Apply **GROUND** electrodes to each earlobe. Attach clips at the end of each lead wire to corresponding color. Neatly arrange wires, draping them behind the earlobes and down the back of the neck. Snuggly wrap the participant's head with flexible band, ensuring electrodes are pressed firmly against the skin. Ask the participant to close their eyes and relax. Dim the room lights if possible. This time will allow the participant's heart rate to settle.





8. Turn on BIOPAC

9. Open Software BSL Pro 3.7

10. Select File > New — Save a new document with a file named according to the participant ID#.

11. Select MP35 > Setup Channels — Select *Electroencephalogram (EEG), .5 - 35 Hz* from Presets drop down menu. Make sure all checkboxes next to the CH1 and CH2 are selected. You are looking for a change in amplitude in the beta brain wave. In the Calculations Channels box, select EEG beta (13-30Hz). Filters out all frequencies except the beta band.

12. Select MP35 > Setup Acquisition — Ensure top drop-down menus say *Record* and *Append* using *PC Memory*. Set sample rate of 200 samples/second. Set *Acquisition Length* to 170 seconds.

13. Electrode Checker — One at a time, insert each lead into the Electrode Checker on the front panel of the BIOPAC. *Select MP35 > Electrode Checker.* Red channel impedance should be below 5 kΩ. If it is higher, apply additional conductive gel using a blunt needle syringe. After impedance has been minimized, replace each lead into their original channel inputs.

14. Queue Video — Open video. Enter Full Screen mode.

15. Start Recording — Press *Start* in the lower right hand corner of the screen. Data will start recording. You should see waveforms start to track across the screen. If waveforms are unrecognizable, select *Display > Autoscale Waveforms*. After twenty seconds of recording with the participants eyes closed, ask the participant to open their eyes. You should see the aggregate waveform jump on both channels upon exposure to visual stimuli. If clipping occurs, reduce the gain by selecting *MP35 > Set up Channel > View/ Change Parameters*. Conversely, if waveform is weak, increase gain using the same menu. Ask the participant to close their eyes again for another twenty seconds. Waveforms should decrease again as visual stimuli has ceased.

> *"We're ready to start. Keep your eyes closed for now, but when I ask you to open them, you'll see a gray box in the screen in front of you. That will stay up there for about twenty seconds before you start seeing webpages. Each webpage will be on the screen for about twenty seconds. During that time, I want you to relax and observe. Pretend like you're at home in your computer chair browsing for stuff online.* ***If you can, avoid blinking, speaking or making any big movements while the video is showing.*** *Keep your facial muscles relaxed, and just focus on the screen. The whole test is less than five minutes long. If you feel uncomfortable at any time, just let me know, OK?"*

16. Start the Exam — Ask the participant to open their eyes, play the video, and ***set a marker*** (F9). Select *Display > Auto Scale Waveforms* in BSL Pro 3.7 window. ***Then, set markers at the appearance of each webpage*** and on eye blinks, muscle movements, or other undesired artifacts.

17. Stop the Video — When the last webpage fades out, press Stop in the lower left corner, and close the video window. Save the recorded data.

18. Remove the Electrodes — Remove the compression wrap. Detach each clip, leaving the ground electrodes for last. Gently remove each electrode, taking care not to pull skin or hair. Offer the participant a wet wipe to remove any residual gel.

19. Exit Interview — Ask the participant to complete the exit interview questionnaire.

20. Debrief — Debrief the participant. Explain the experimental variables, and thank the participant for their time.

21. Back Up Files — Save all data to a flash drive.

22. Clean Up — Gently coil the lead chord, and put it back in the supply chest. Replace any supplies that have been pulled out. Power down the equipment.

Appendix D — Exit Interview Transcripts

Did you find some pages more attractive than others? If so, which?

1. Yes. TV.
2. Yes. I preferred the TV ad. The animation peaked my interest.
3. Yes, the green TV page and the last headphone page with red writing.
4. Animation. Gives greater look. Looks cooler.
5. The one with the graphics. The site where the television was moving. The others were just moving.
6. Liked red better than green.
7. The page with the TV that rotated, so the viewer could see the TV at different angles.
8. No, they all had the same general layout.
9. No, they were the same page. Only the color changed.
10. Yes. Flat screen and camera.
11. Yes, when the TV was moving.
12. The pages with a lot of red seemed less attractive
13. Yes, I personally liked the one with the TV rotating. I also liked the headphone page with the red side panels.
14. Red was pretty to look at.
15. No.
16. None more so than the next.
17. Yes. I found the headphones image more attractive, just because it caught my attention more.
18. The page that displays the camera within the red background.
19. They all seemed about the same. I like how the TV rotated so you could see the entire merchandise.
20. No. Considering all of the pages were from the same website the colors and layout looked the same to me.
21. Not really. They all looked similar.

22. TV.
23. The TV page. The image swiveled making the product more appealing.
24. When the price for the headphones was in red.
25. Yes, the lime green pages.
26. Yes, the rotating TV was more interesting, along with the larger camera.
27. I found the first three more attractive than the second three.

Were some pages easier to read than others? If so, which?

1. TV
2. The quieter pages were easier on the eyes.
3. I thought they were all the same.
4. All were about the same.
5. Yes. The ones with minimal information. The camera.
6. No
7. All pages were pretty easy to read.
8. The pages were about the same. The camera page was easier to read.
9. No. All about the same, just different layouts.
10. Yes. Flat screen.
11. The ones that had less words and bigger fonts.
12. Typically, the pages with less words or not intense color (such as green) were easier to read.
13. No. I was too busy looking at pictures to do much reading.
14. No
15. No
16. All were equally easy to read and understand.
17. They were equal as far as reading them, it was just a matter of keeping my attention.
18. The first page with the LCD TV.

19. The pages with less information was easier to read, however, lack of information was irritating.
20. They were all about the same.
21. No
22. Digital camera.
23. The blue type was the easiest to read. I didn't like the green.
24. No
25. The green ones.
26. Not necessarily easier to read, but more inviting to read – provide more information
27. No

Were some products more enticing than others? If so, which?

1. TV
2. I am looking for a new TV so I liked them.
3. I thought the TV was the most enticing of the three products.
4. The TV
5. Yes. Personally I am interested in cameras, so the sites with the cameras caught my attention.
6. Yes. The TV
7. The TV appealed to me
8. The camera was very enticing because it received good reviews while the other two products had glitches or faults.
9. Yes, the second TV because the picture was mobile, and the second camera because the picture was up close and detailed
10. Yes, flat screen and camera
11. Yes, the TV and the camera
12. The TV, especially when it turned from the side to the front.
13. Yes the TV

14. Yes. Camera
15. Yes, I found the camera more enticing.
16. The TV more so than the camera and headphones
17. The were somewhat equal.
18. The first LCD TV
19. I like the cameras but I have enough technology at my house.
20. I found the camera and headphones more enticing than the TV.
21. Yes. The Digital SLR camera
22. TV
23. The camera. The user review had nothing negative in it.
24. The plasma TV
25. Yes. The moving flat screen TV.
26. The second screen of the camera for sure
27. The cameras were more enticing than the other items.

When you shop online, do you prefer websites to look a certain way (e.g., simple, detailed, colorful, plain, static, animated)?

1. Detailed
2. Detailed and easy colors.
3. I like them to be detailed but easy to use.
4. Usability. Real services
5. Yes. I like simple to-the-point information. I also look for sites that have reviews on the product.
6. Simple and informational
7. I prefer websites that have color but are still simple enough to navigate.
8. I like detailed with color.

9. I think websites should be used to first inform the customer, providing accurate details about the product. If it is too overwhelming, the customer will have a hard time navigating the site. I like websites to have a continual theme throughout.
10. Yes. Colorful and detailed
11. I like them to be colorful but not overdoing it.
12. The simpler a website is, the more likely I am to use it. If I want more information, there must be a way to find all the details.
13. Animated and simple
14. No
15. Yes, I prefer them simple and detailed.
16. Simple is always best. Too much going on can be distracting.
17. Yes, because color gets my attention especially during certain seasons, but a majority of the time I purchase online I know exactly what I'm getting.
18. I prefer the website includes detailed information about the products.
19. I like detailed and colorful websites.
20. I prefer color and a simple layout to navigate the site easily with no trouble.
21. Simple with just enough information about the product.
22. Detailed
23. I like them to be simple, clearly organized, but with detailed pictures of the product.
24. I prefer them more simple and for the price to include shipping.
25. Not really
26. Simple is always nice when shopping online; makes the process easier and sometimes less stressful
27. I prefer websites to be detailed so you know what you are buying, but plain so it is not distracting.

Do you often worry about giving out your personal financial information when you shop online?

1. Yes
2. Yes
3. Not really
4. Not usually
5. Yes. I do not like to.
6. Yes
7. Yes
8. Yes
9. Sometimes it just depends on the credibility of the site and if I have used it before with good results. There is always the fear of identity theft.
10. Yes
11. No, I usually trust websites
12. Very often, generally skeptical if it isn't a famous company or pay service.
13. Yes, very much.
14. Sometimes
15. Sometimes
16. Not when I shop.
17. Yes, that's why I don't do it often and when I do it's with companies I've done it with before.
18. No
19. Yes, I do worry because some sites may not be secure.
20. Yes
21. Yes
22. Yes
23. Yes. I always do a little background check if they don't use Pay Pal.
24. Yes

25. Yes
26. I probably should, but not very much, no.
27. No

Would you trust your financial information with the websites you saw today?

1. No
2. I would research the website.
3. Yes
4. Yes
5. Yes. It seemed like the sites were legitimate.
6. Would need more information on the company and if it was a secure site, i.e. https or http.
7. Yes
8. No
9. No, because I have never used or heard anything about it. I would rather pay more somewhere I trusted to ensure I received a quality product/shopping experience.
10. No, because I've never heard of or seen them before.
11. Probably
12. Most likely from what I could tell
13. I would have to take a better look at the security measures from the website.
14. Yes
15. Yes
16. Not without doing more research into the company selling the items.
17. Probably not. It just looked too good to be true.
18. No
19. Possibly, but I would want to look at the website info first.
20. I would feel confident trusting this site because it had sentences off to the side explaining its financial process, and the site looked legitimate.

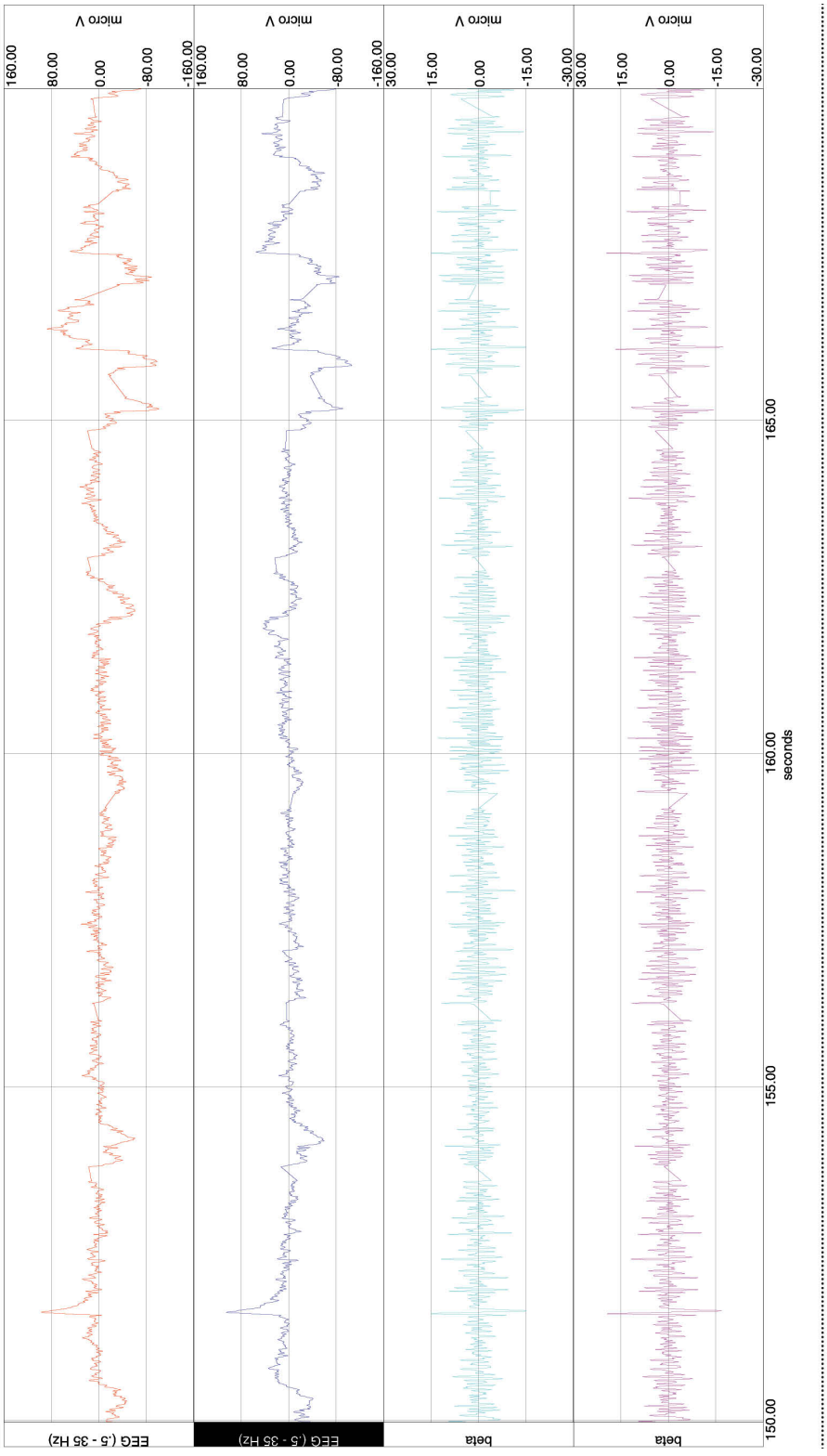
21. Maybe
22. No
23. Probably
24. Yes
25. Yes
26. Yes
27. Yes

Would you purchase a product from the websites you saw today?

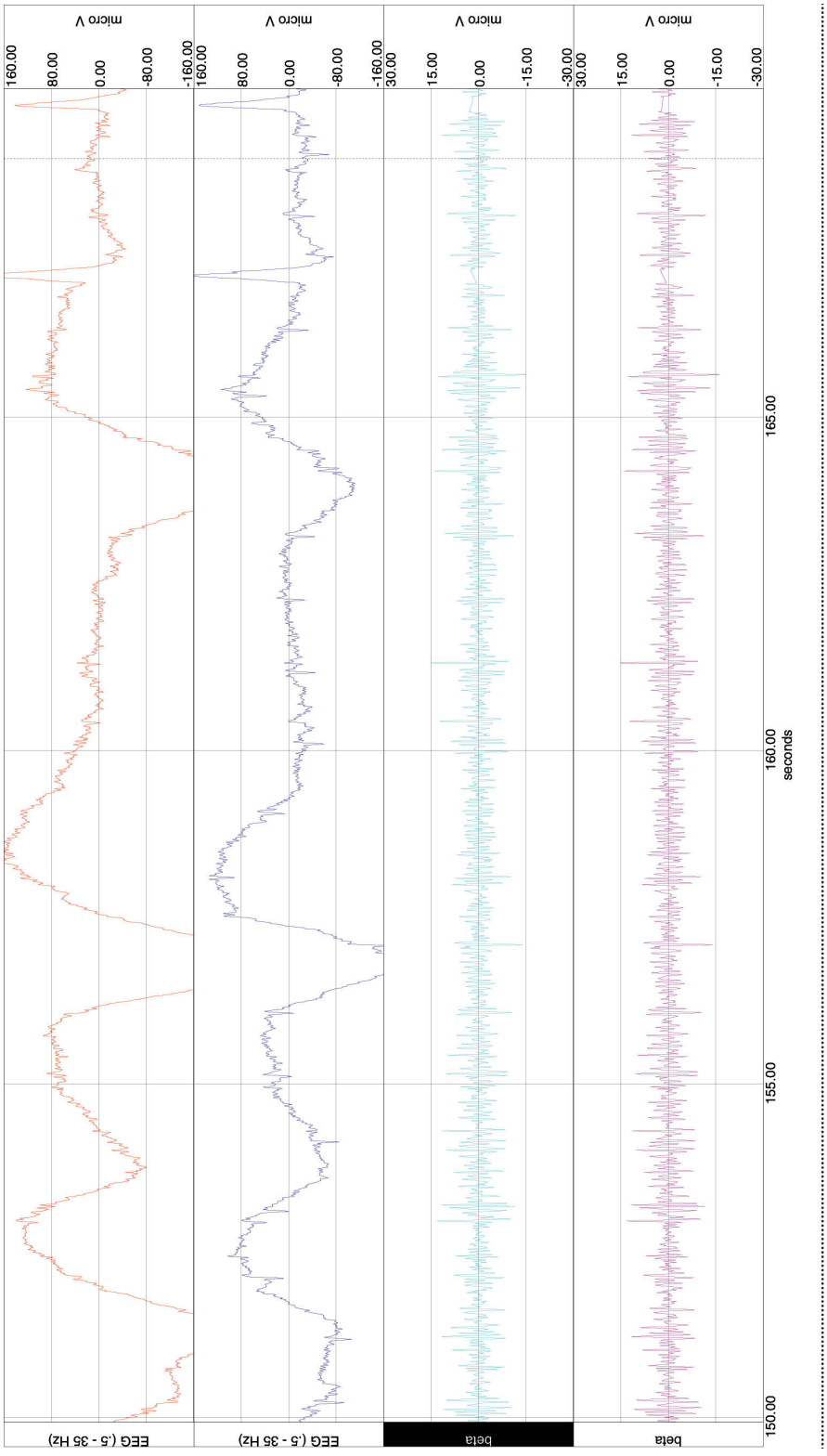
1. No
2. After research, possibly.
3. Yes
4. Yes
5. No
6. Yes
7. Yes
8. No
9. No, I prefer to buy electronics from in-store to ensure they arrive safely to their destination.
10. Yes
11. If I needed a product from there, yes.
12. Yes
13. Perhaps the TV
14. Probably
15. If I had the finances, possibly.
16. After looking into it more to make sure it's a safe purchase, possibly the TV.
17. Probably not
18. No

19. No. I’m a broke college student. I do not have that kind of money.
20. The Camera
21. Maybe
22. No
23. After price comparing, if they were the lowest, including shipping and handling, yes.
24. Yes
25. Yes
26. Probably, yes.
27. Yes

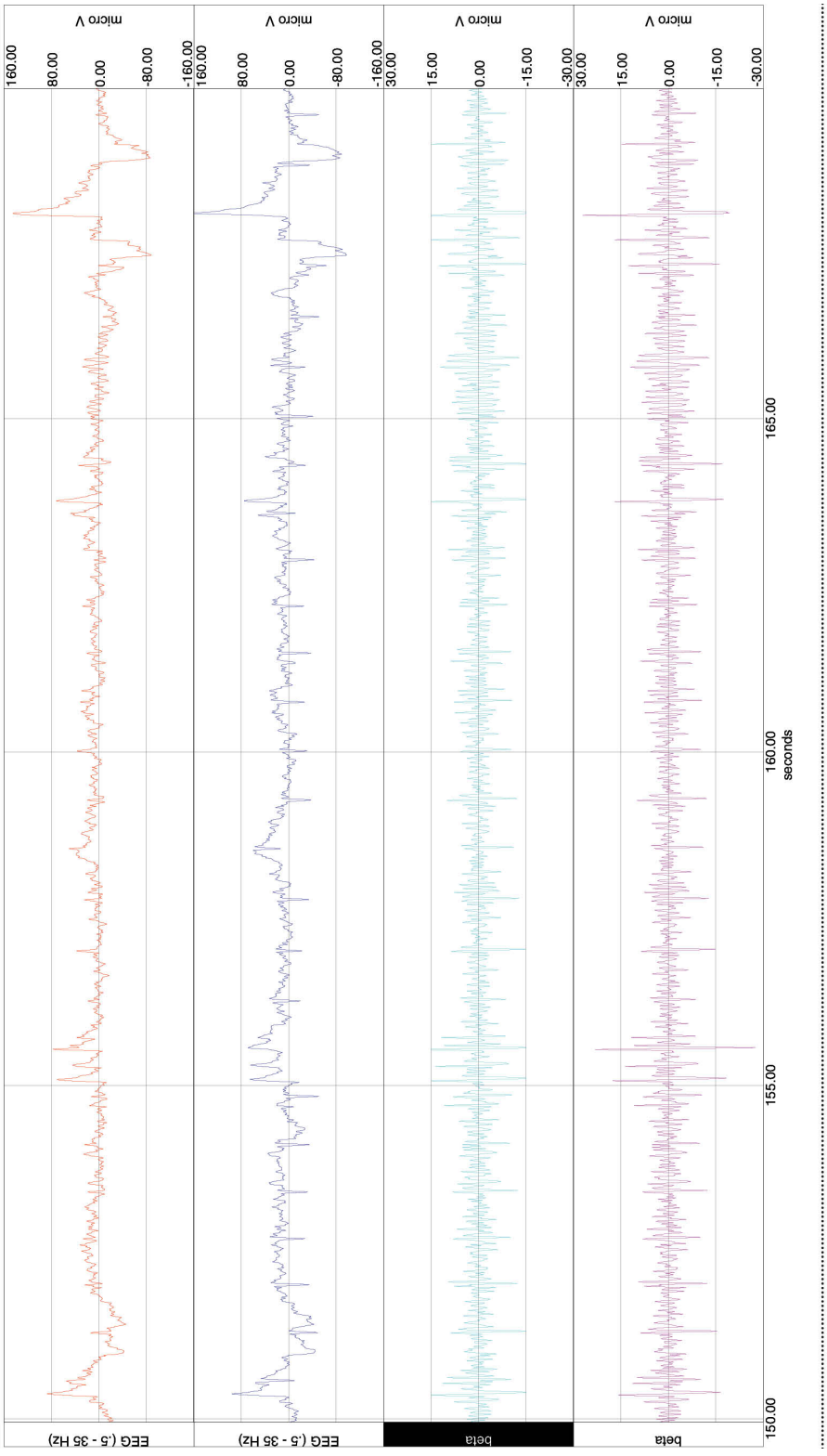
Appendix E – Raw EEG Readouts



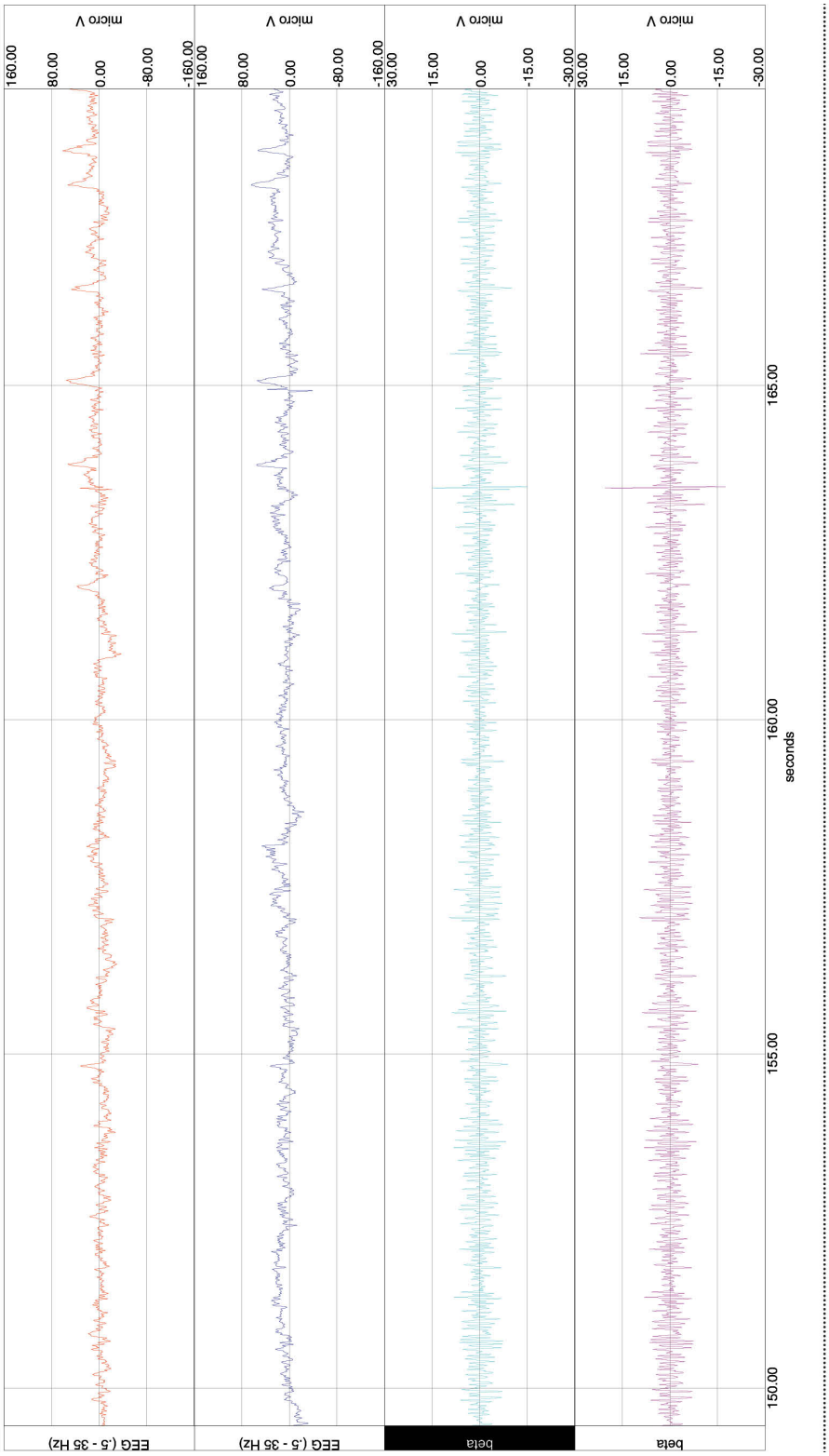
Participant #1 Raw EEG Readout



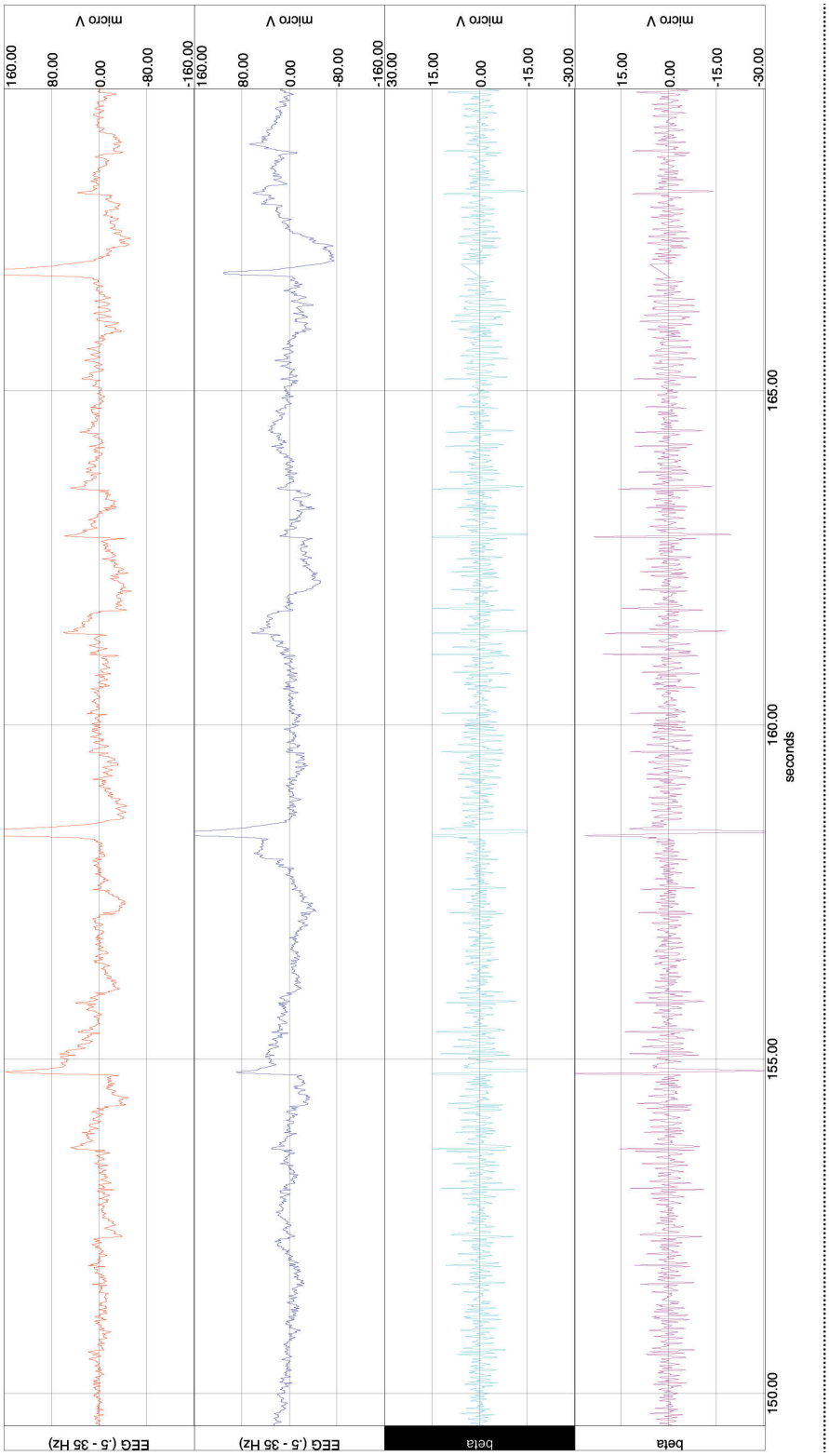
Participant #2 Raw EEG Readout



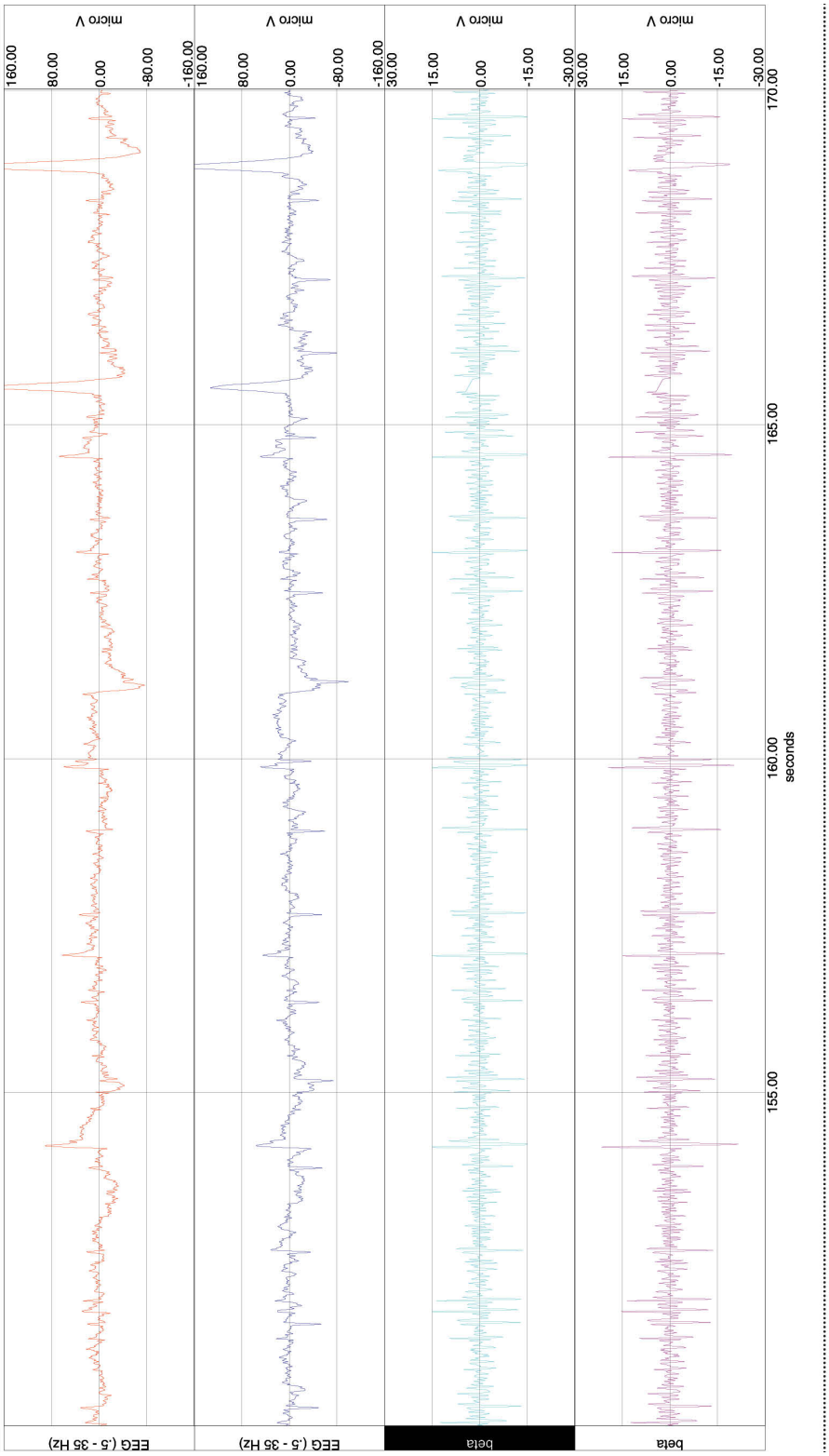
Participant #3 Raw EEG Readout



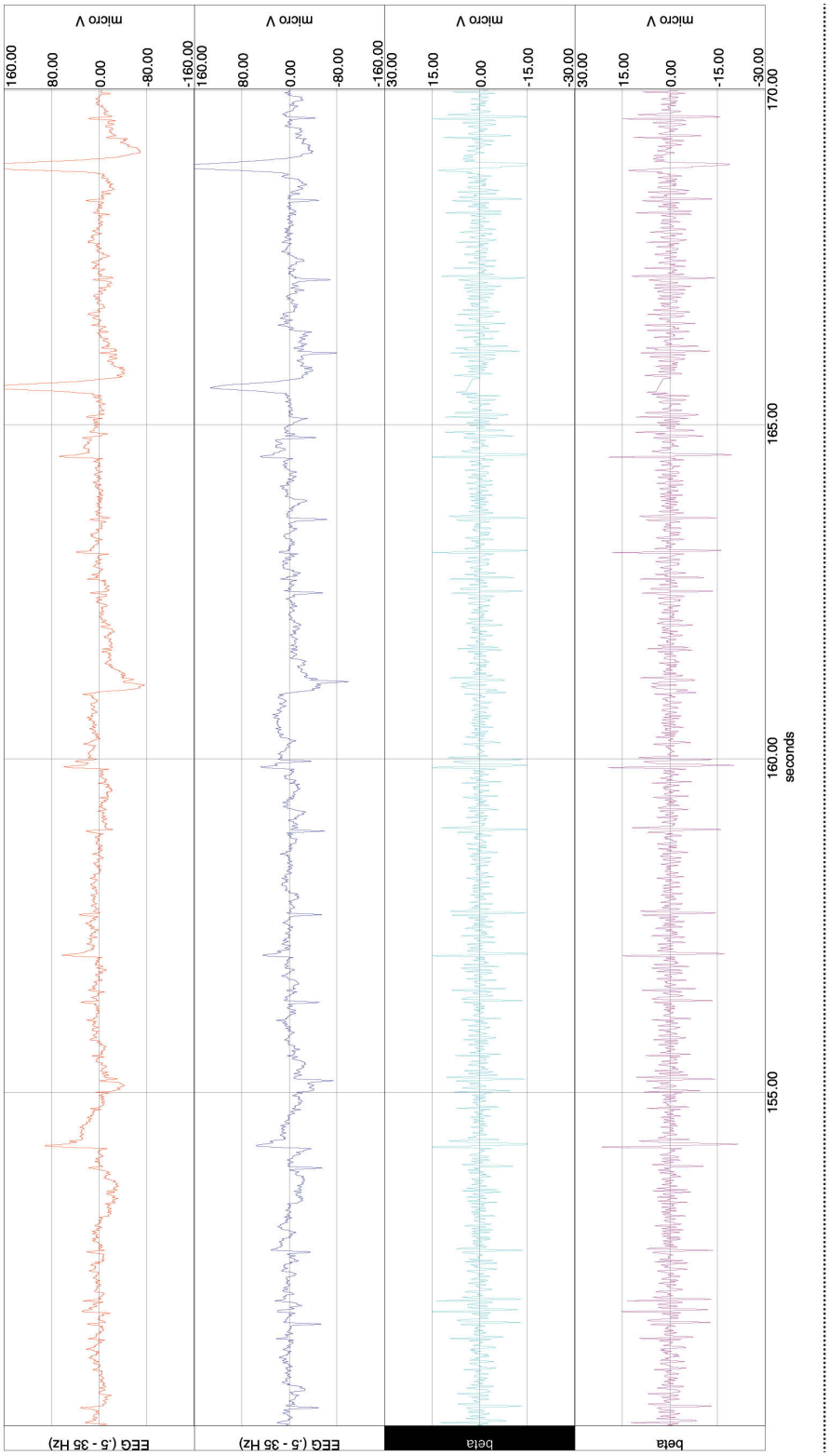
Participant #4 Raw EEG Readout



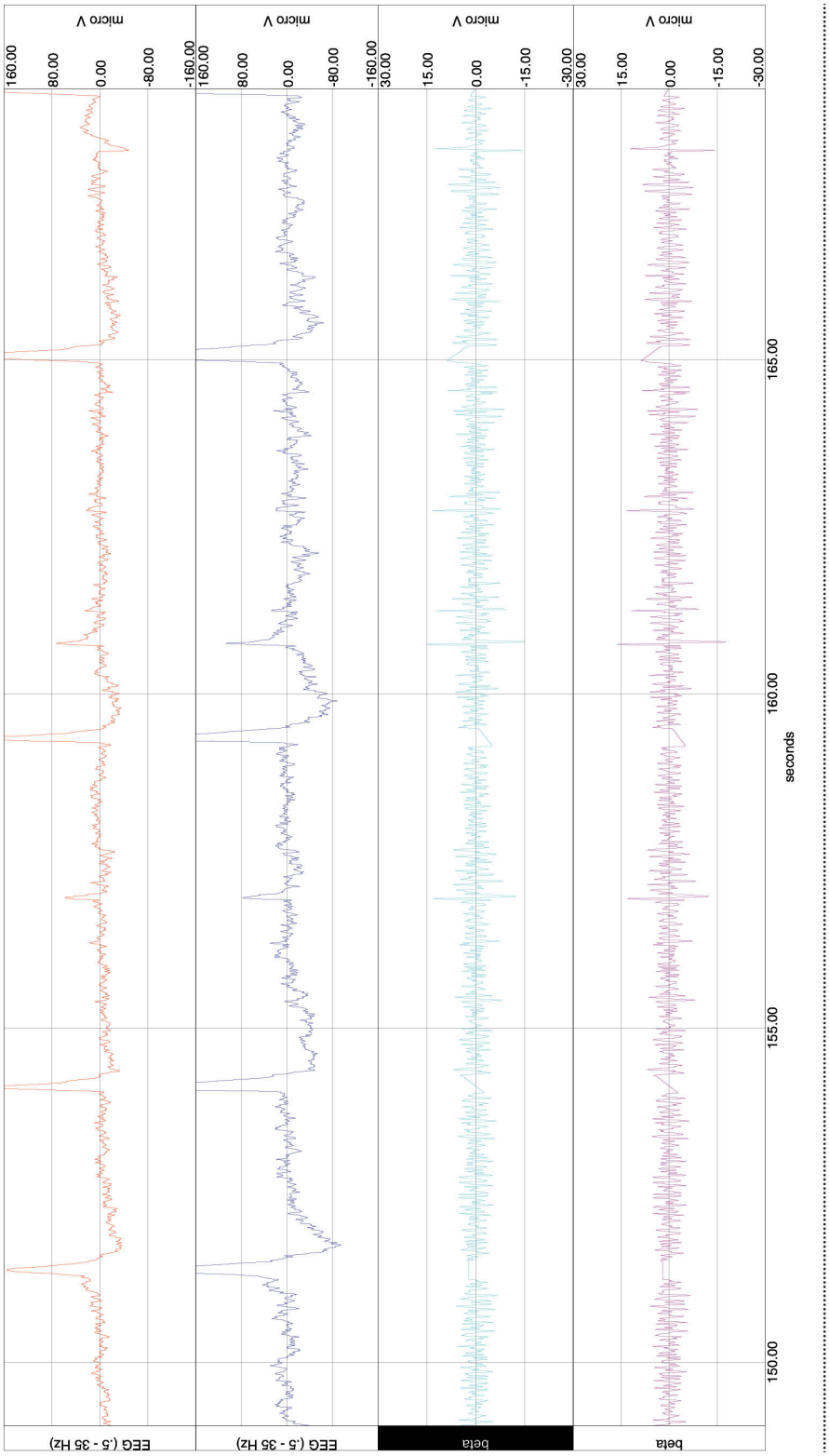
Participant #5 Raw EEG Readout



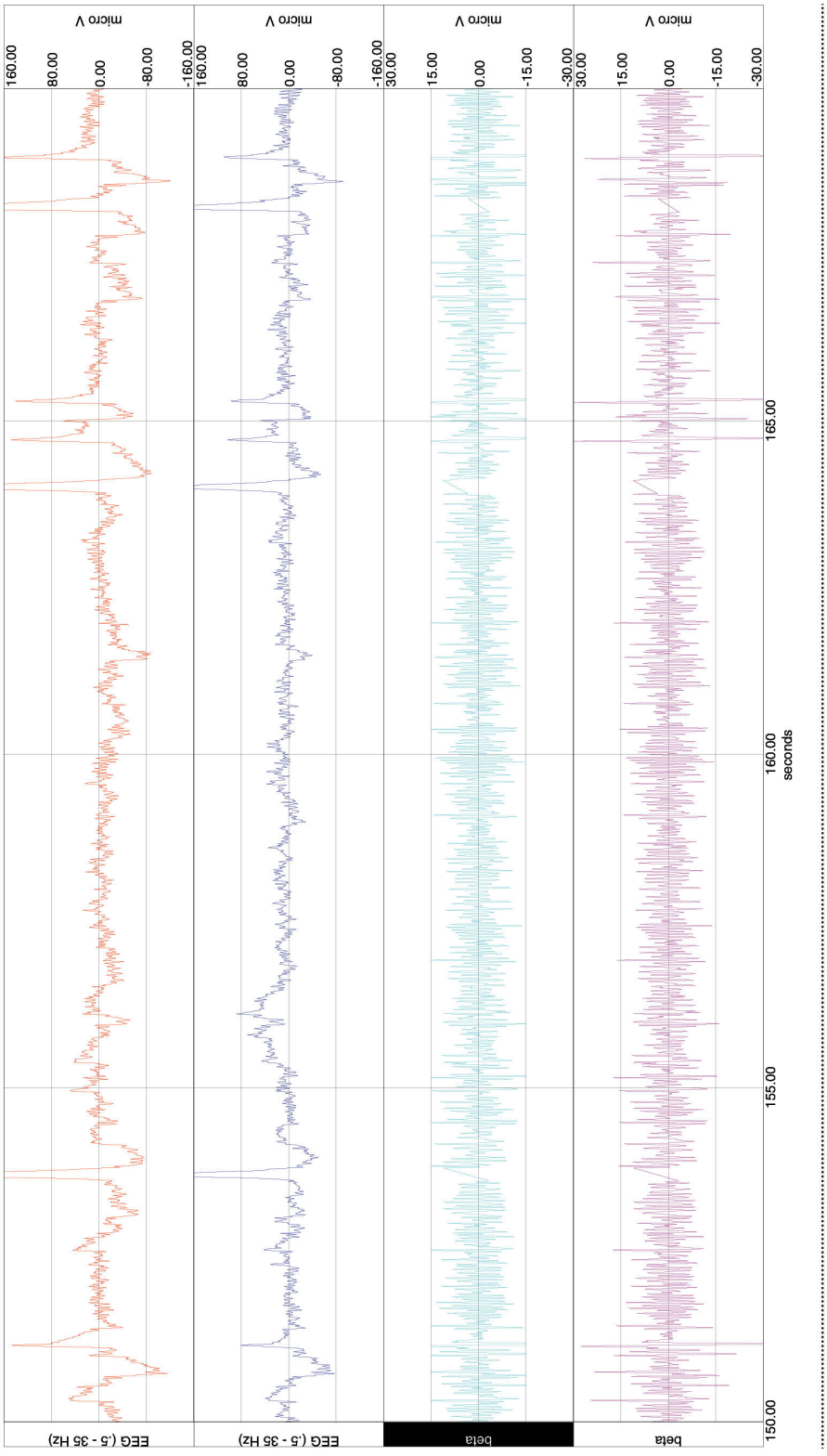
Participant #6 Raw EEG Readout



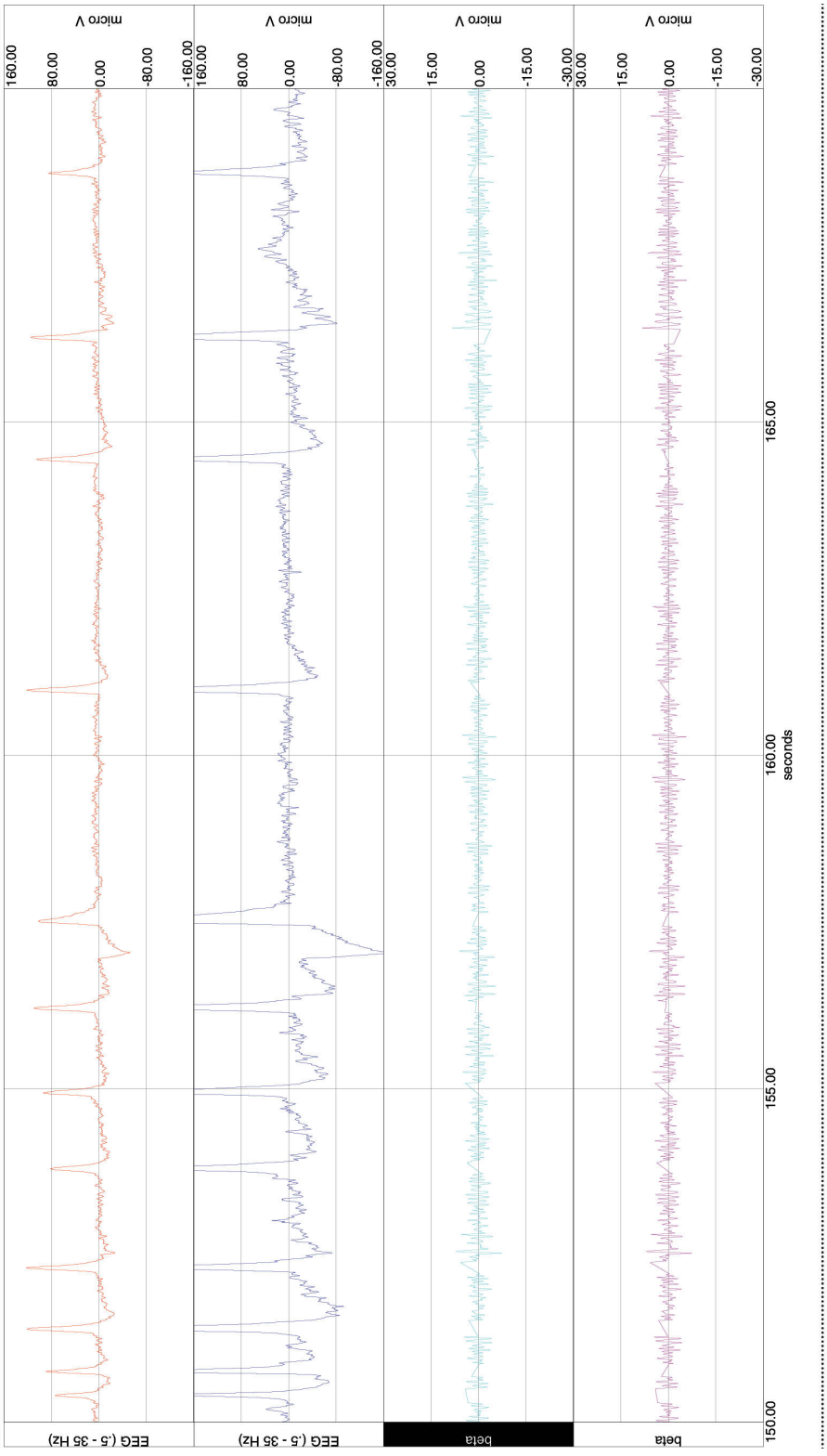
Participant #7 Raw EEG Readout



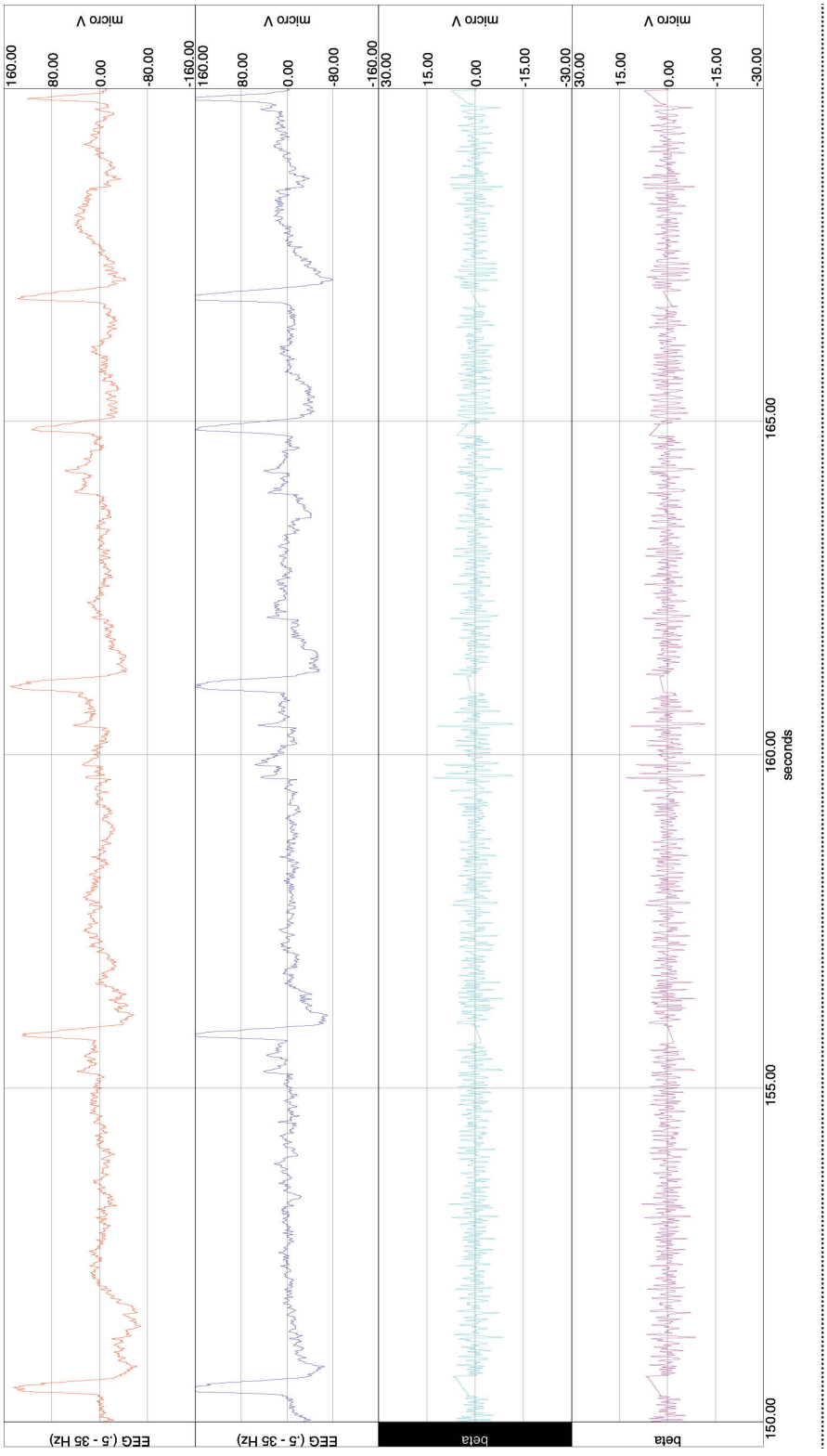
Participant #8 Raw EEG Readout



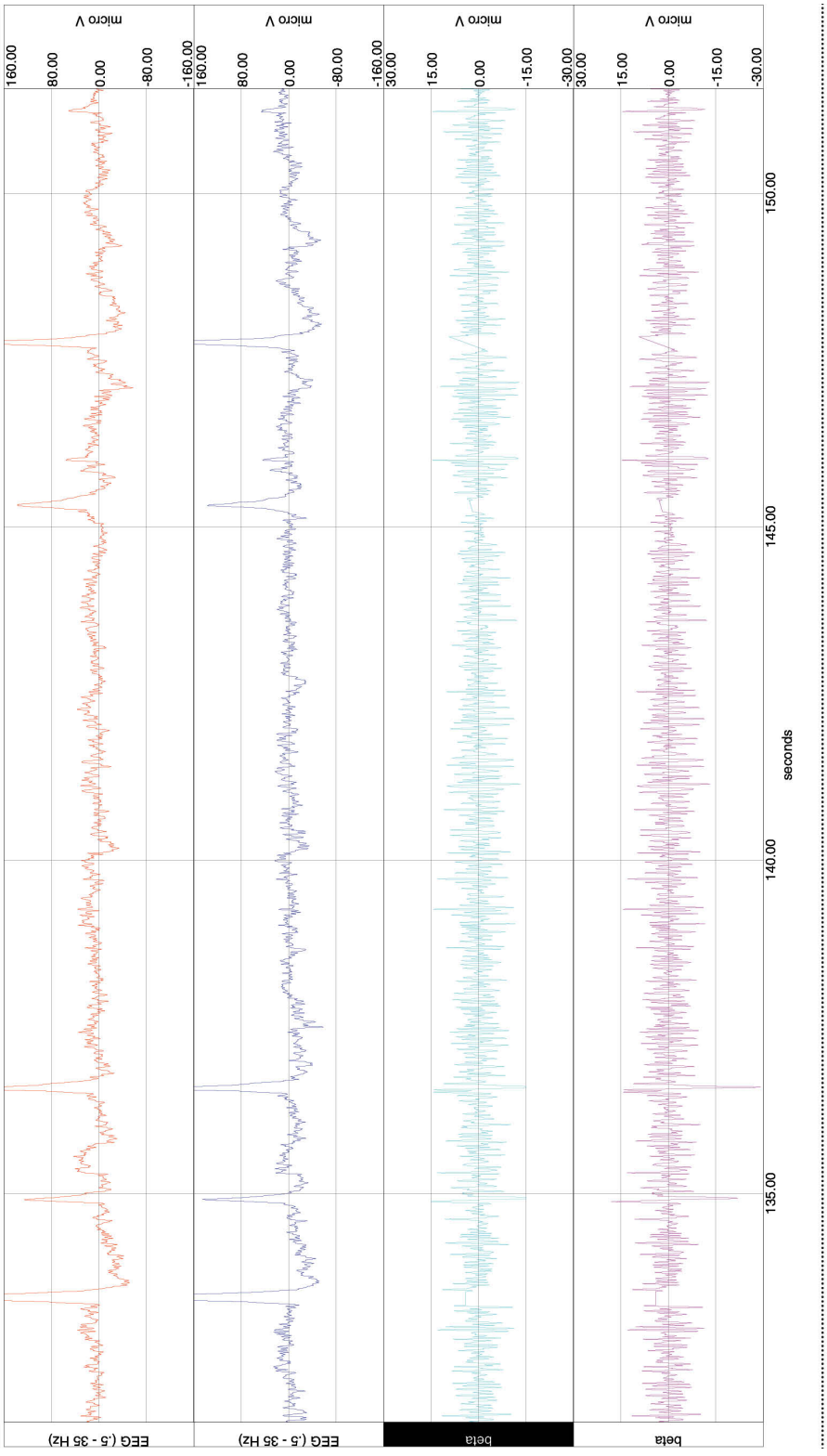
Participant #9 Raw EEG Readout



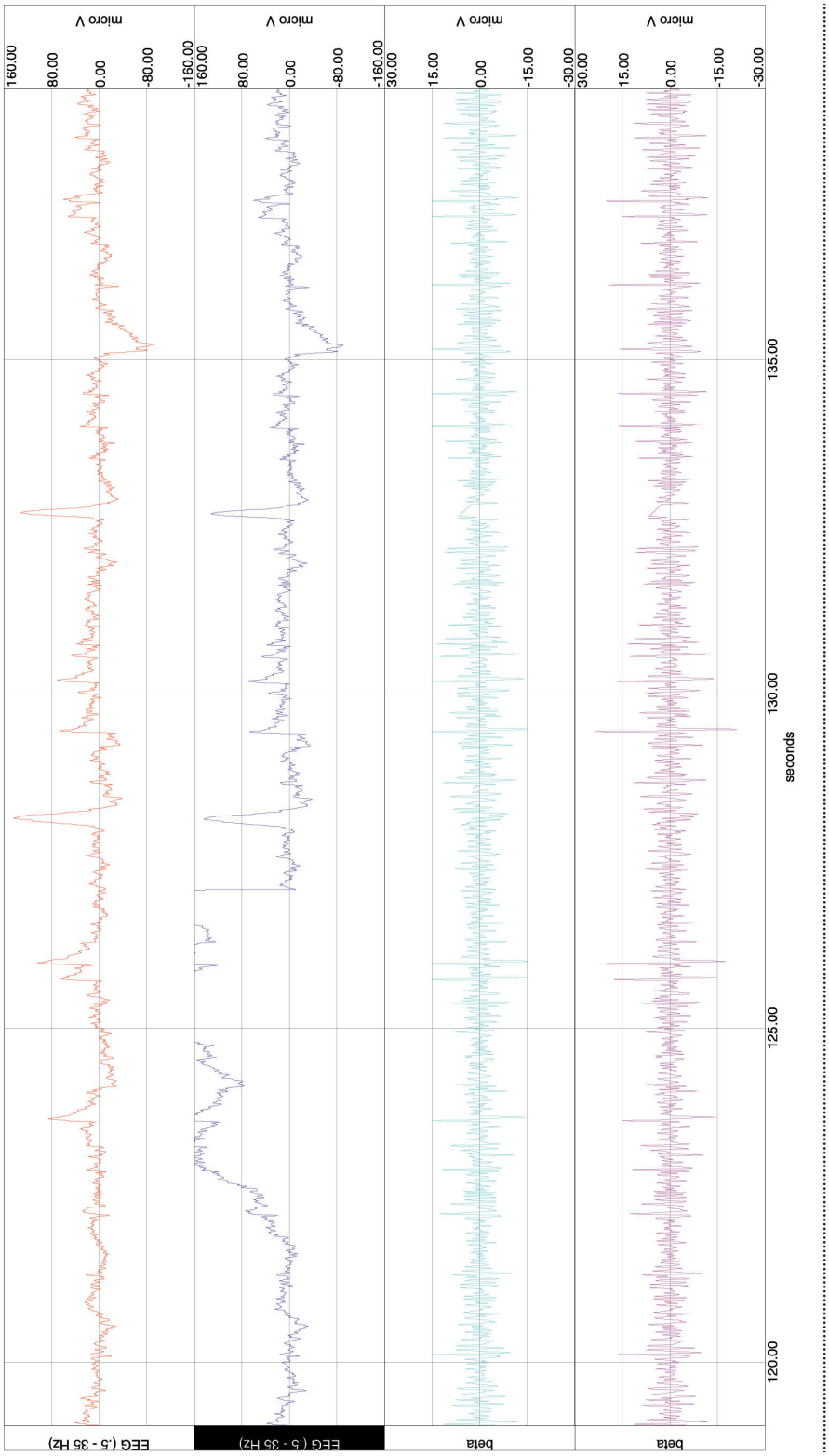
Participant #10 Raw EEG Readout



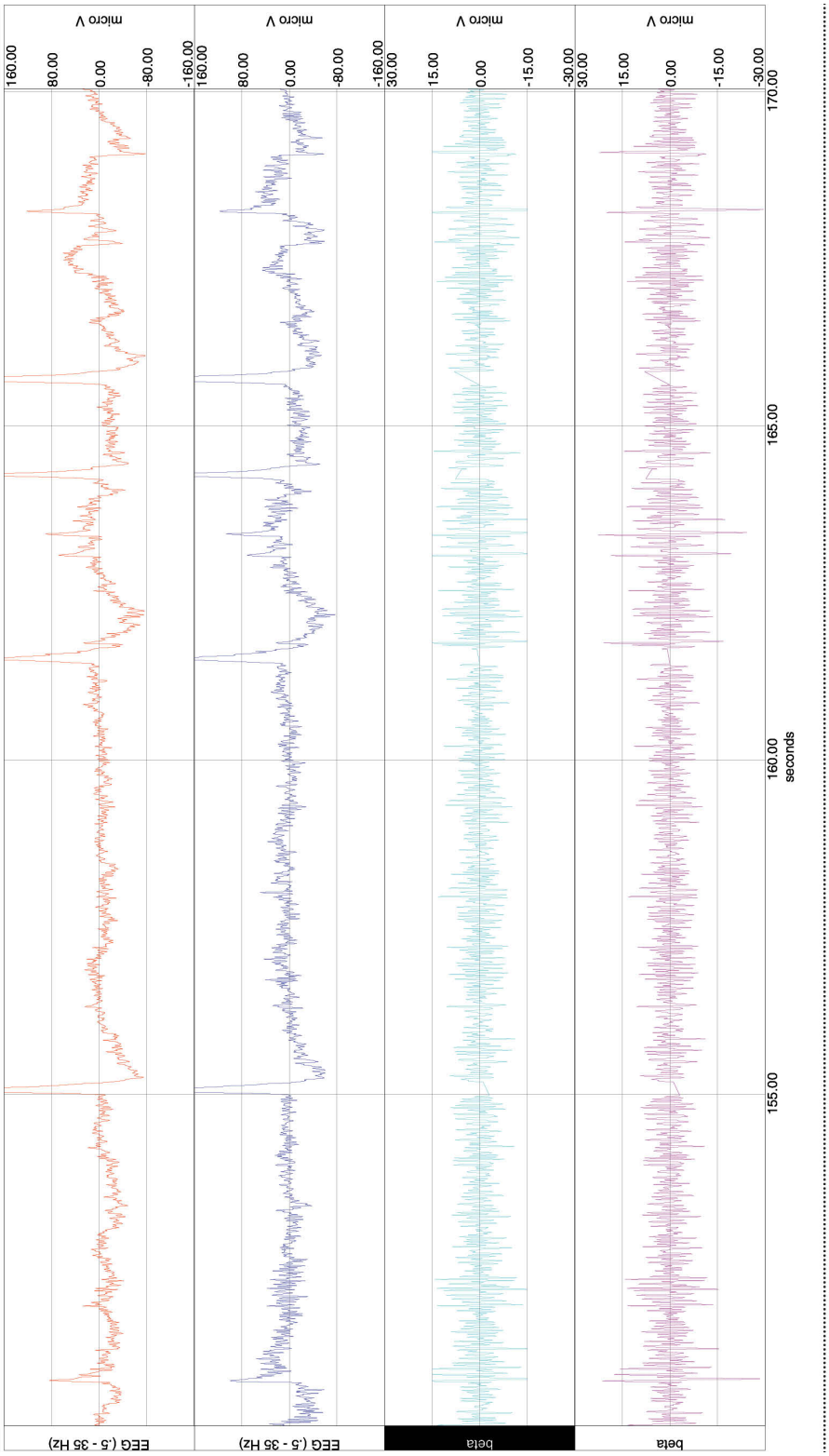
Participant #11 Raw EEG Readout



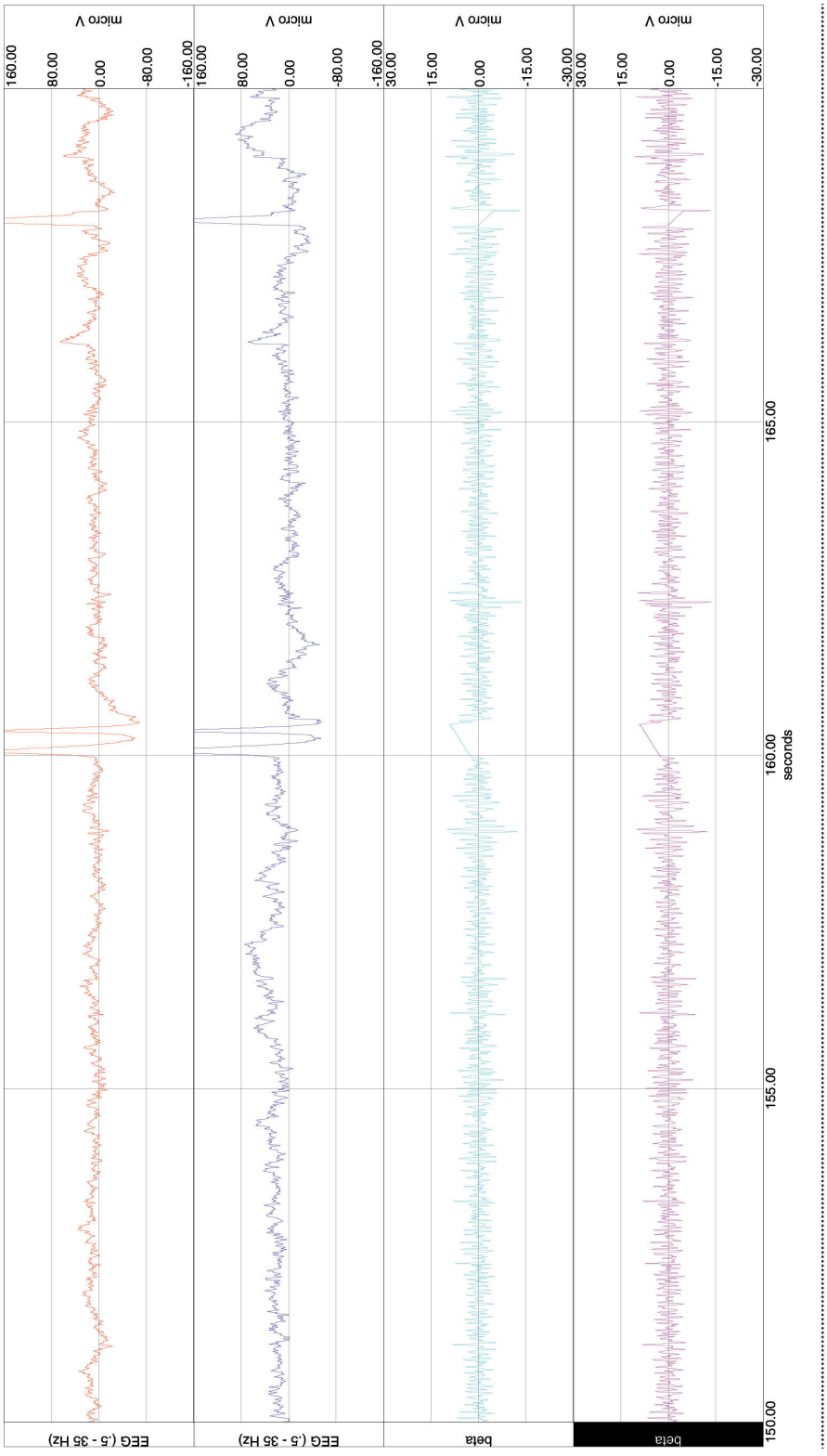
Participant #12 Raw EEG Readout



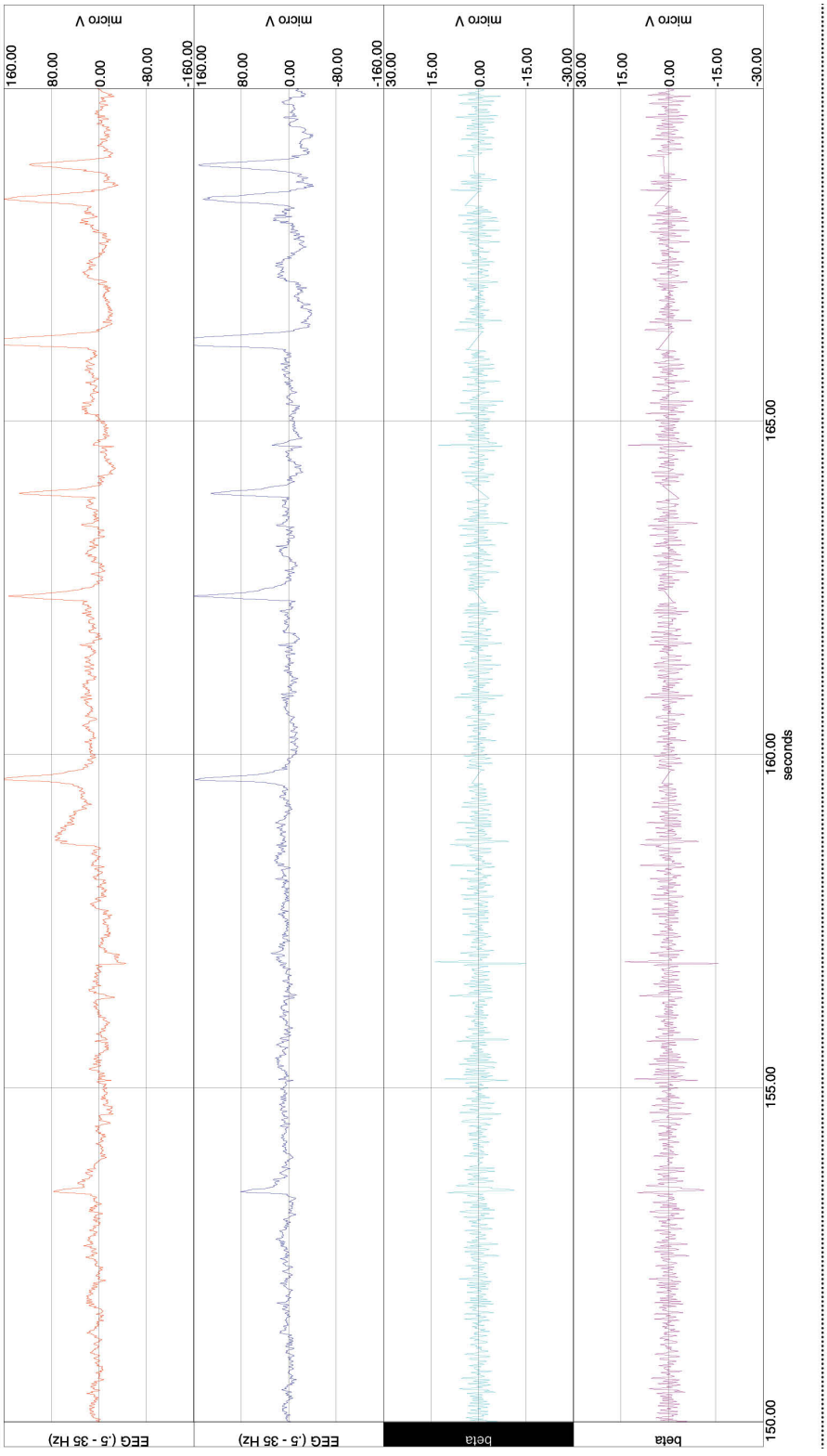
Participant #13 Raw EEG Readout



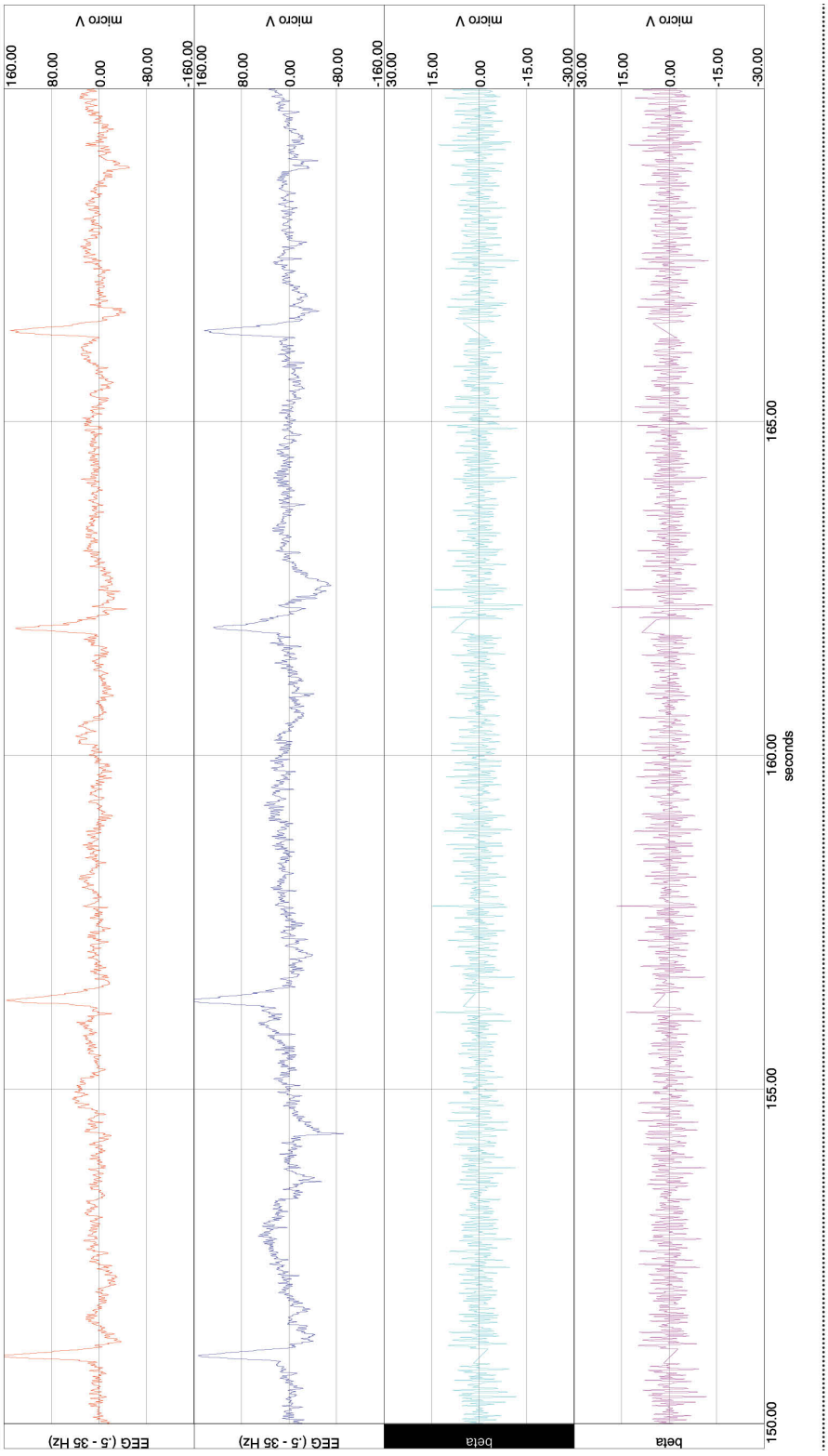
Participant #14 Raw EEG Readout



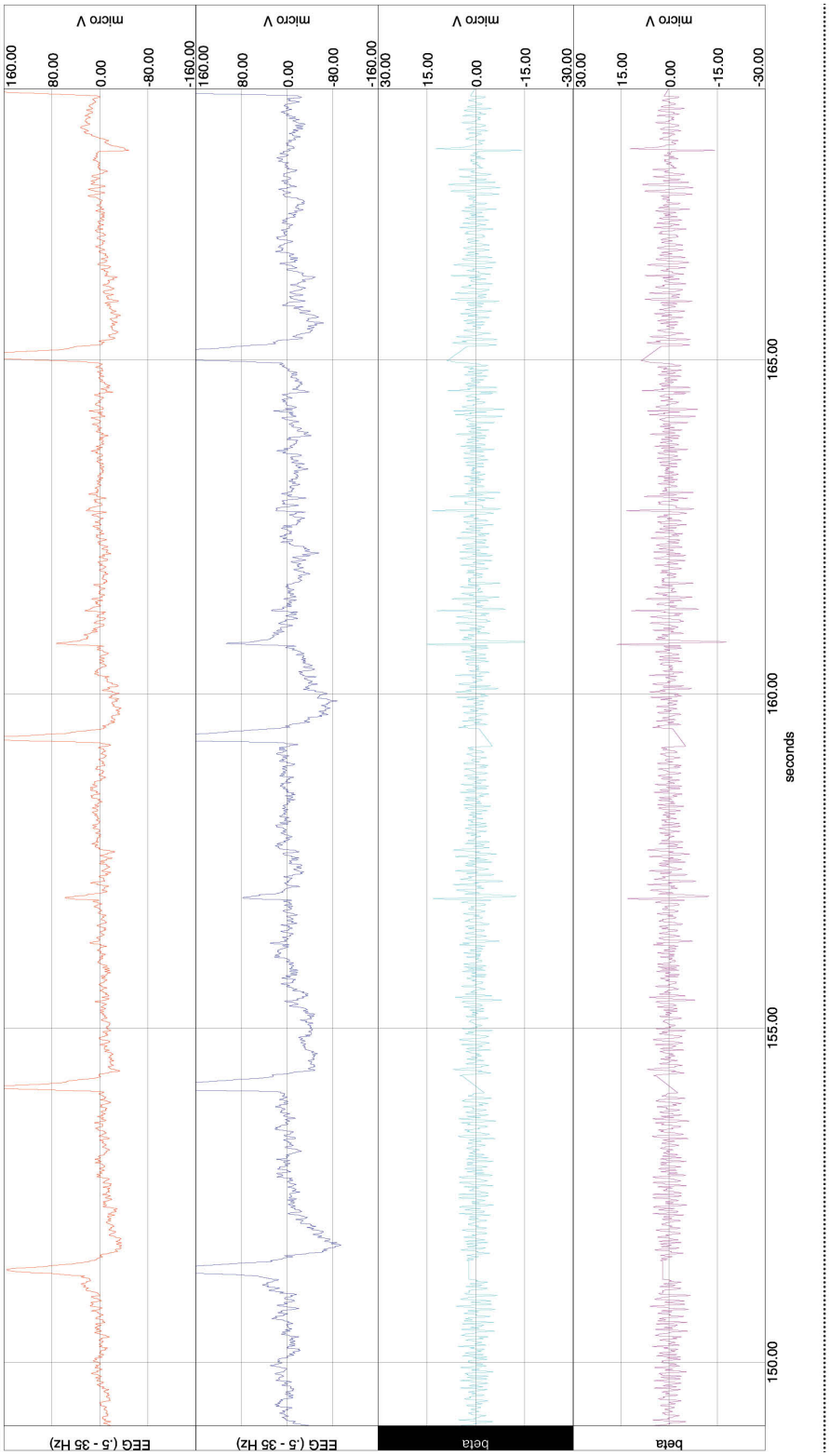
Participant #15 Raw EEG Readout



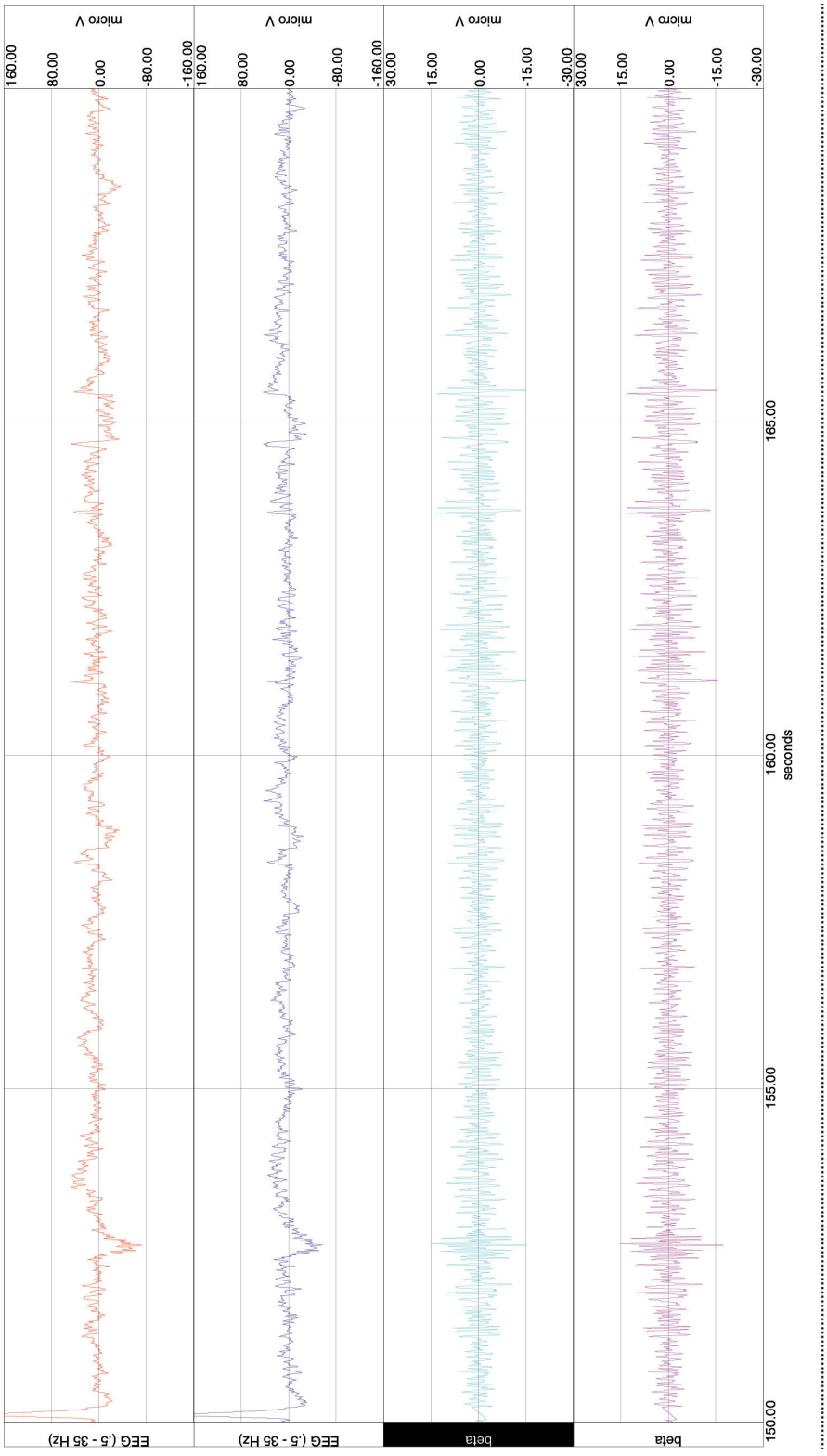
Participant #16 Raw EEG Readout



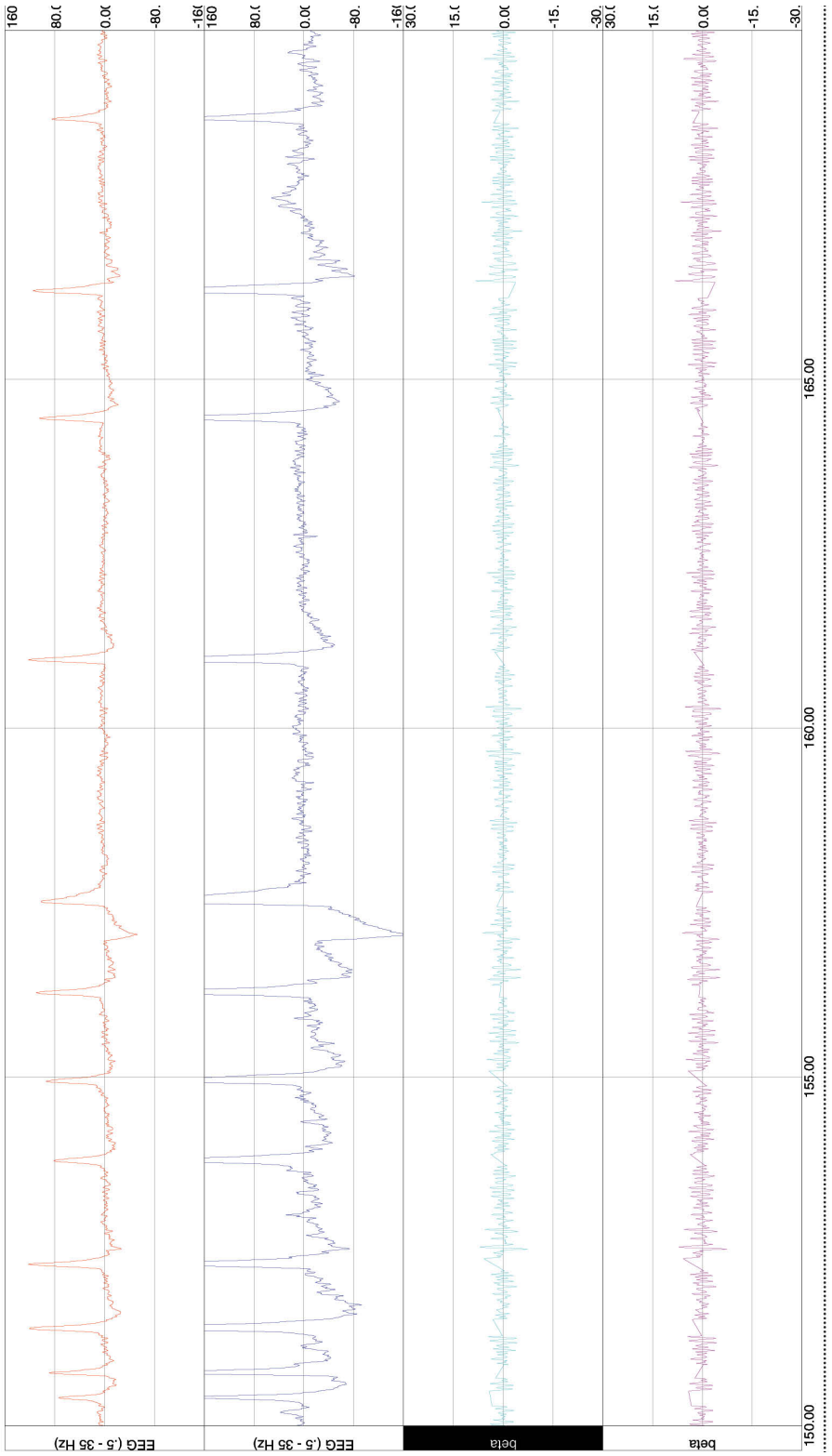
Participant #17 Raw EEG Readout



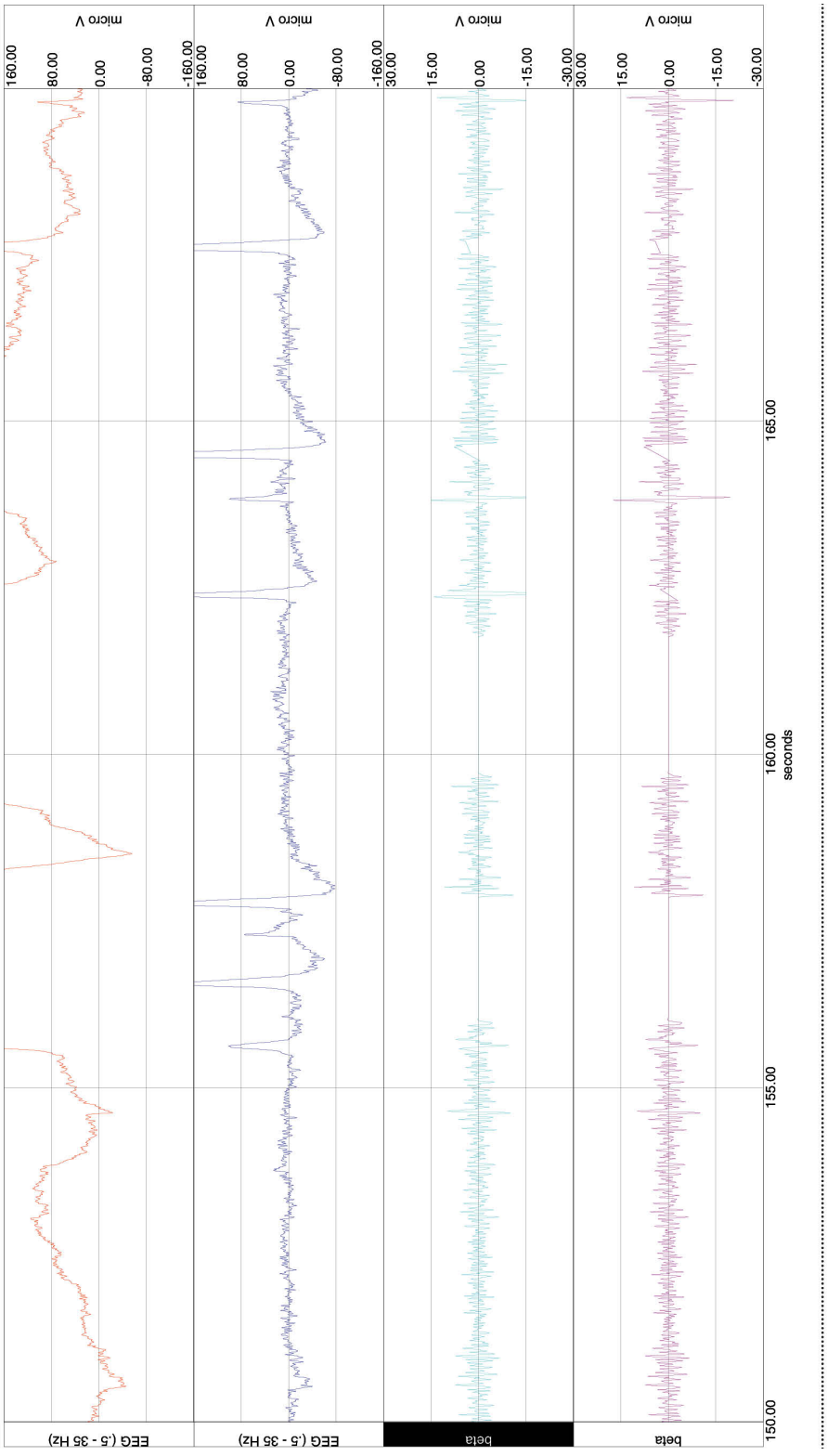
Participant #18 Raw EEG Readout



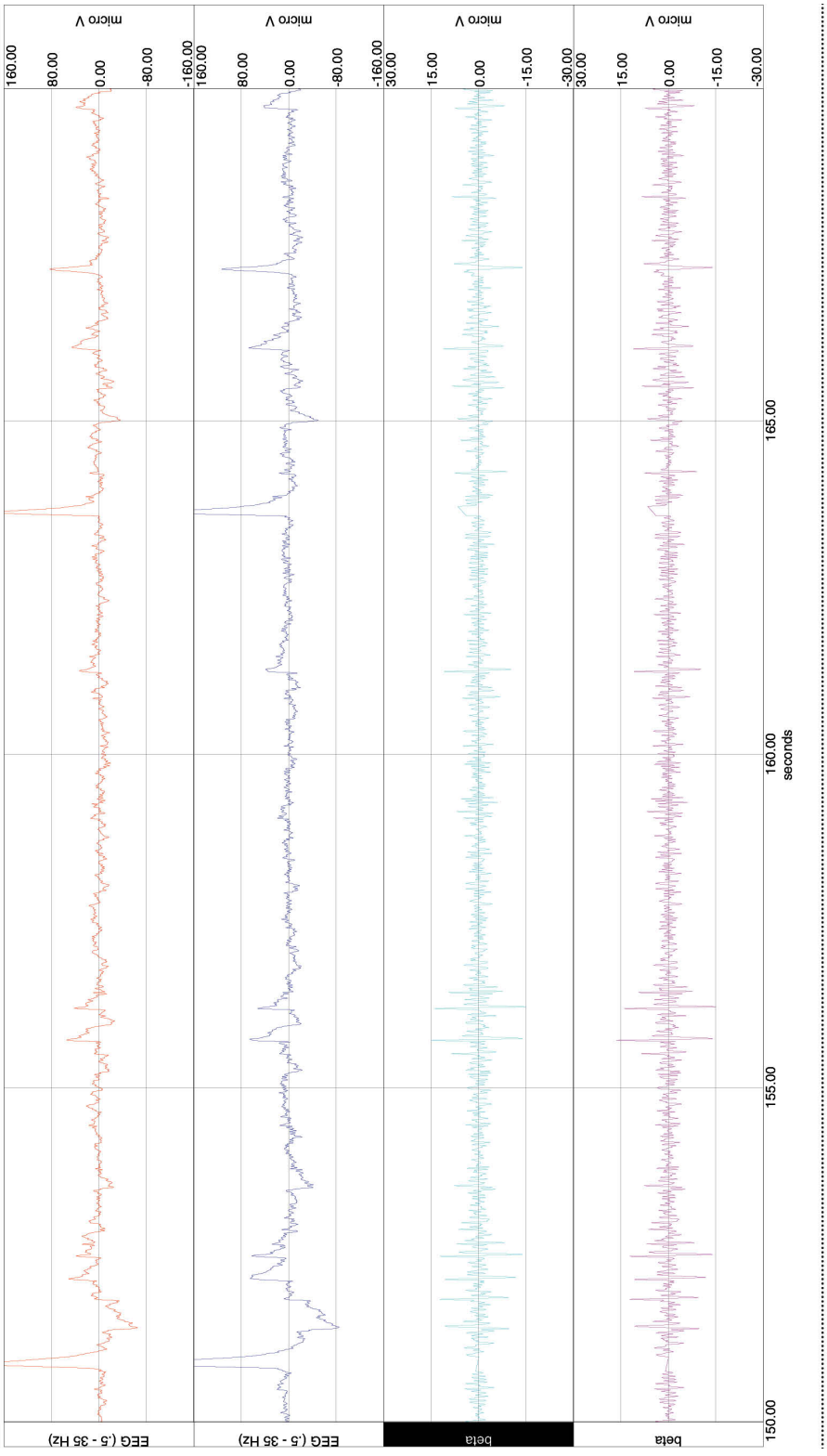
Participant #19 Raw EEG Readout



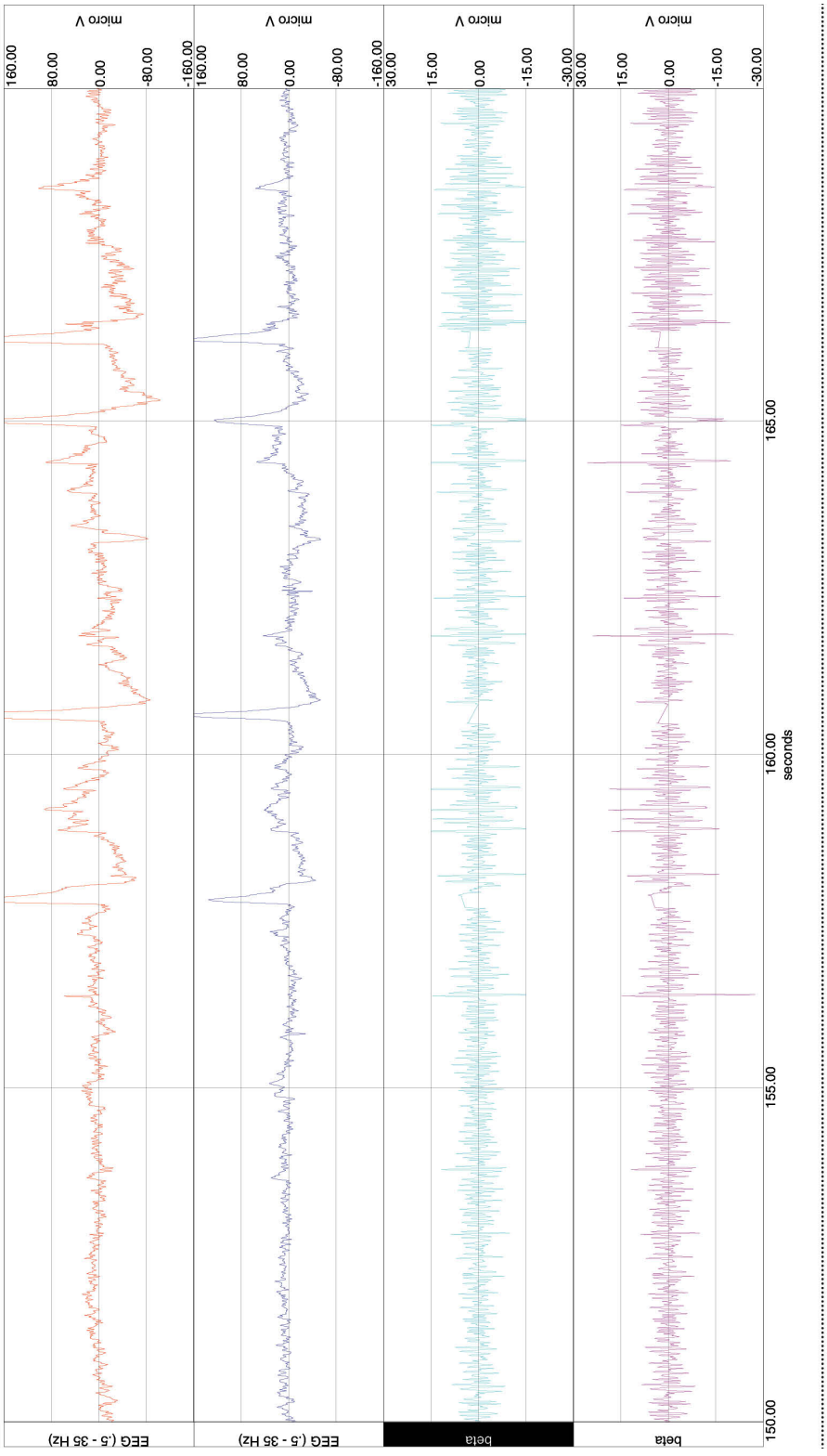
Participant #20 Raw EEG Readout



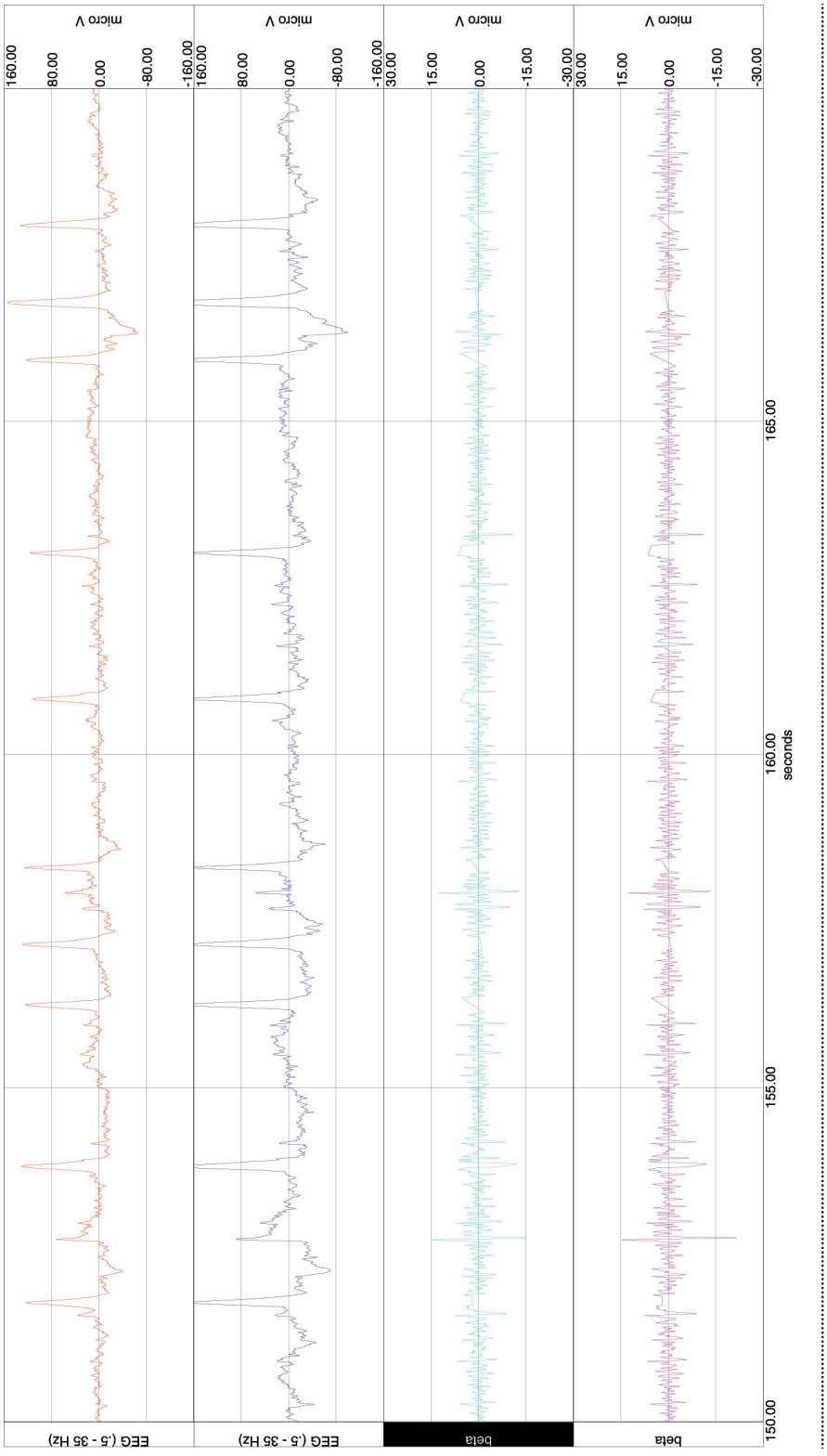
Participant #21 Raw EEG Readout



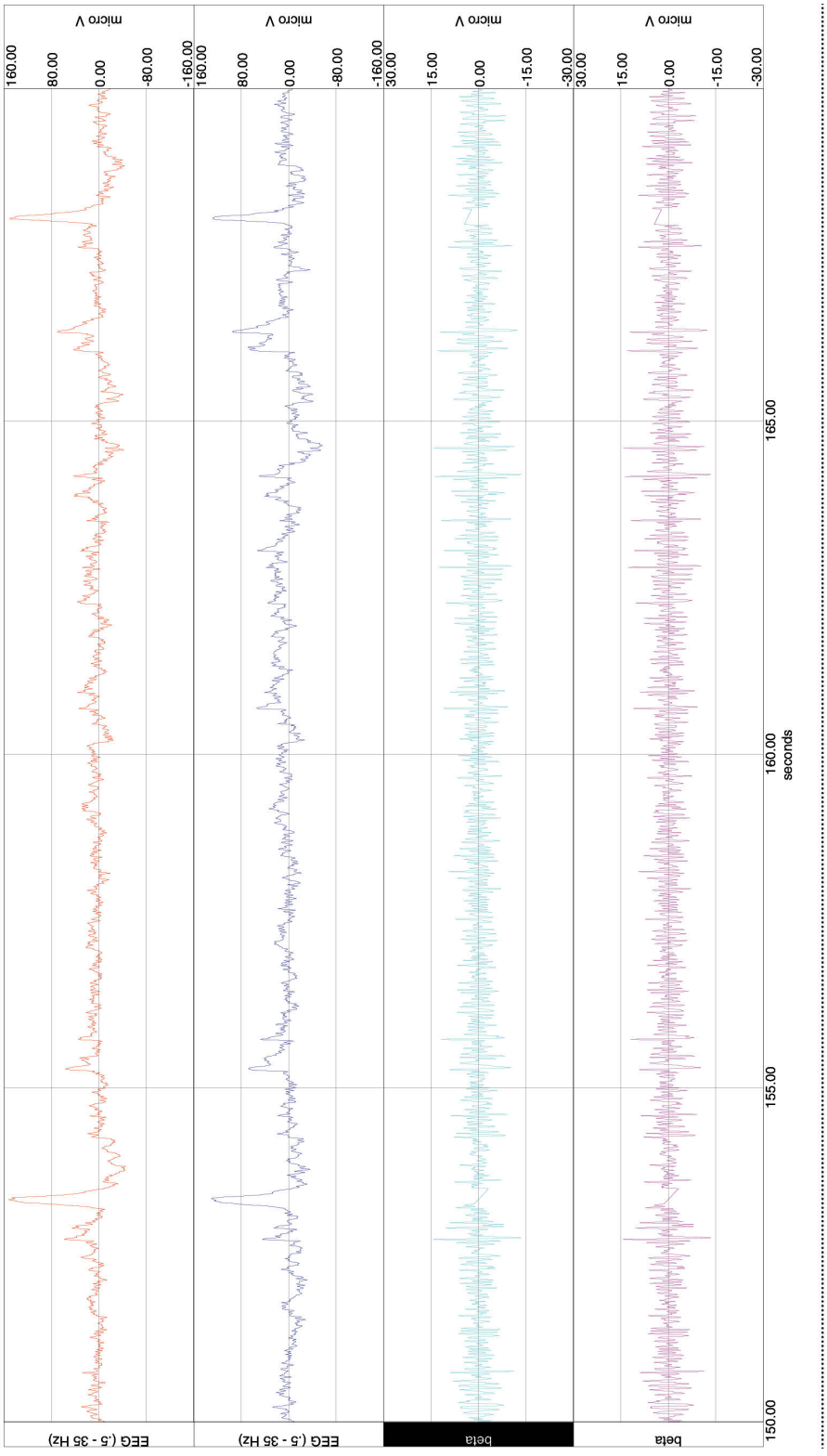
Participant #22 Raw EEG Readout



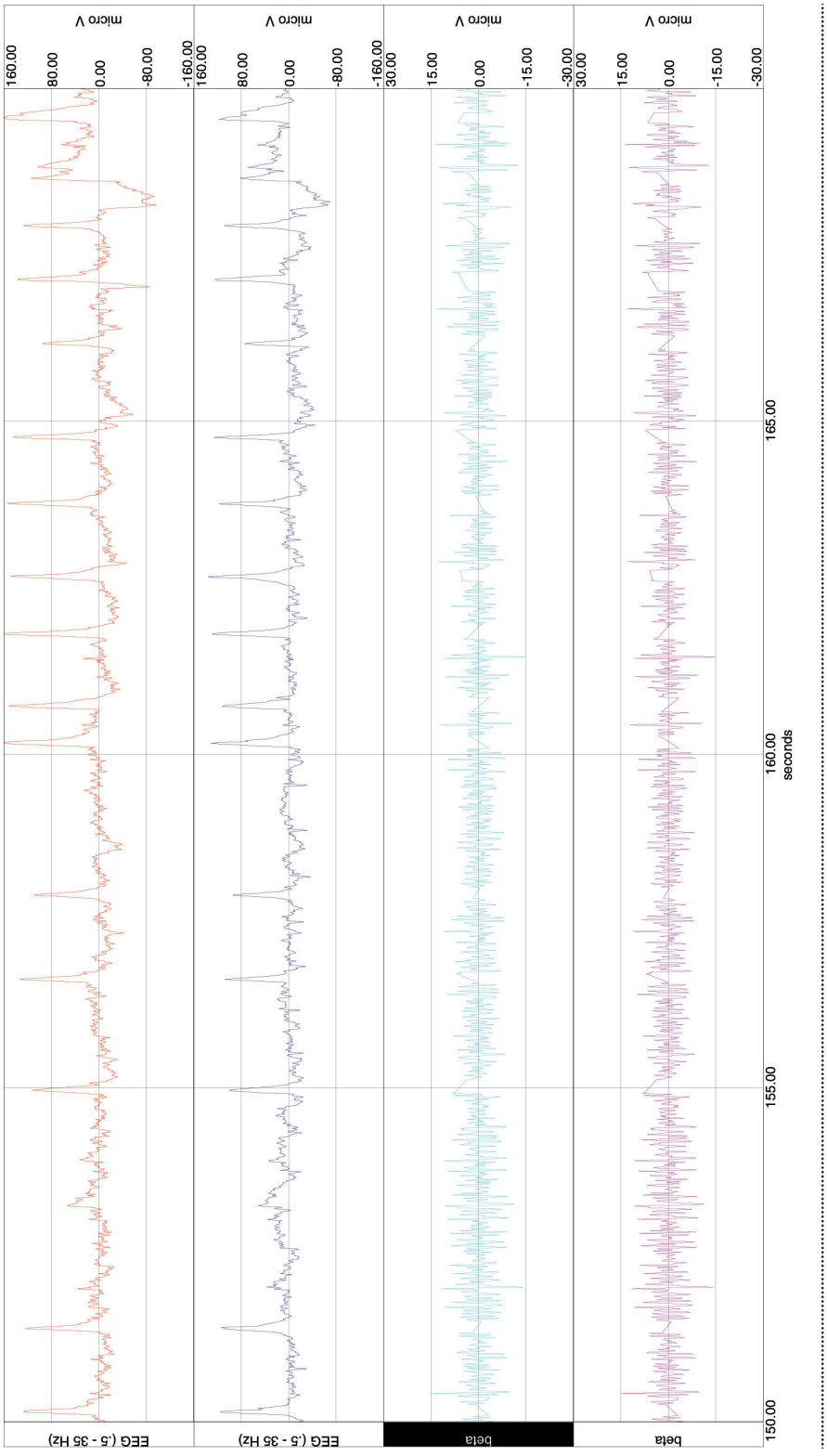
Participant #23 Raw EEG Readout



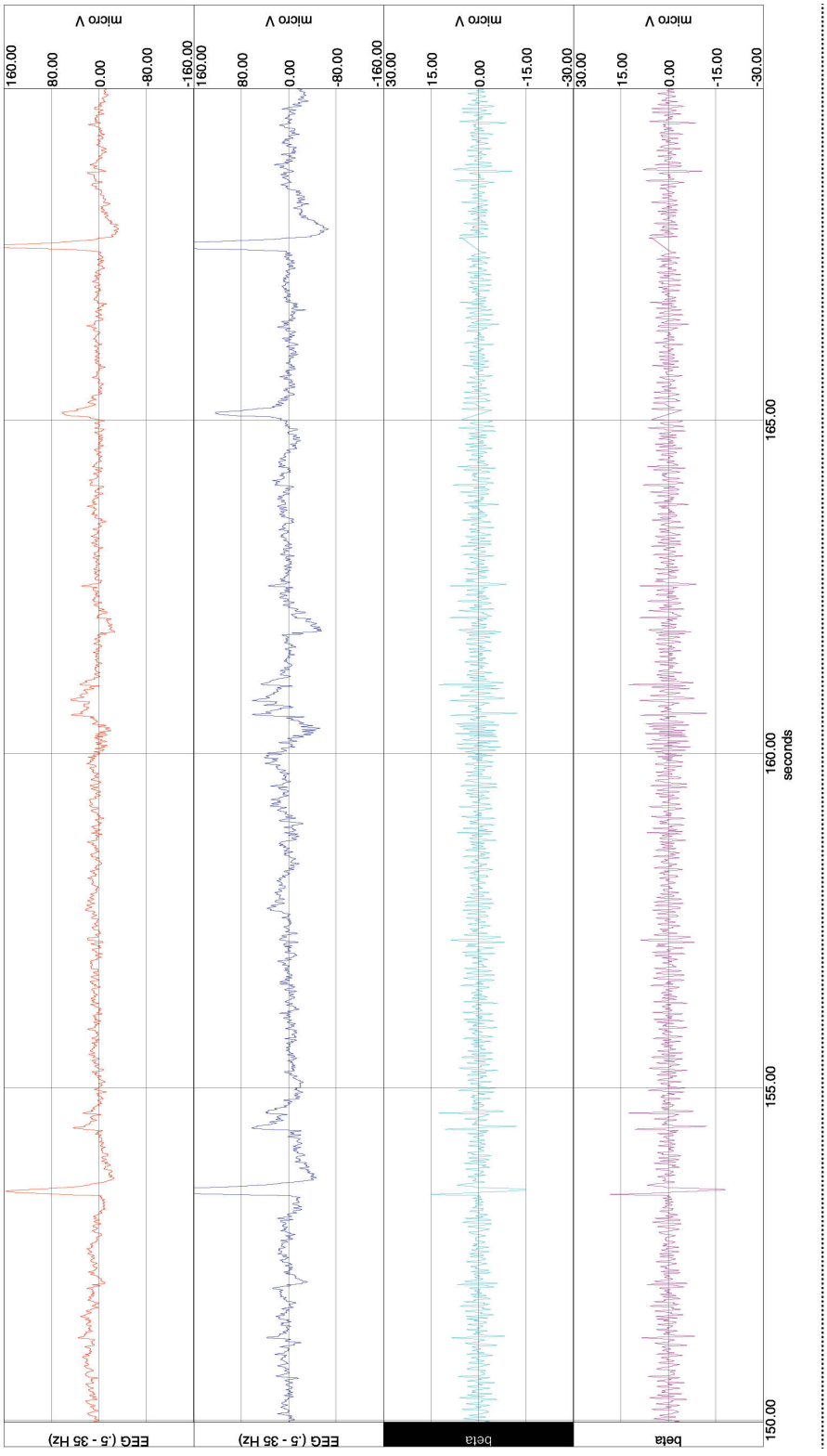
Participant #24 Raw EEG Readout



Participant #25 Raw EEG Readout



Participant #26 Raw EEG Readout



Participant #27 Raw EEG Readout

Appendix F – Individual EEG Epoch Data

	BuVMEAN	BMaxHz
1	3.193579	19.384766
2	2.067054	18.945313
3	3.121982	13.085938
4	2.140262	19.726563
5	2.427597	17.382813
6	2.179957	16.943359
7	2.471028	17.285156
8	1.909025	13.037109
9	4.354627	20.458984
10	1.710037	16.992188
11	2.510003	16.845703
12	2.950858	17.285156
13	2.877405	15.283203
14	3.606980	13.183594
15	2.209663	18.701172
16	2.266113	16.259766
17	3.019006	21.728516
18	5.356745	22.314453
19	2.743515	15.087891
20	2.395145	20.898438
21	2.132578	13.525391
22	2.106655	16.650391
23	3.678975	22.827148
24	2.083211	15.722656
25	2.416332	16.503906
26	2.371818	18.994141
27	1.908515	15.966797

	M1uVMEAN	M1MaxHz
1	2.949139	15.722656
2	2.555754	15.380859
3	3.196121	13.525391
4	2.226634	14.599609
5	2.452737	18.408203
6	2.327167	16.845703
7	2.800201	20.361328
8	2.083160	16.601563
9	4.343232	21.630859
10	1.548016	20.849609
11	2.445026	14.306641
12	3.053575	19.921875
13	2.791806	17.285156
14	3.573076	15.917969
15	2.233967	14.111328
16	2.300854	17.578125
17	3.194806	15.039063
18	4.543578	15.380859
19	2.775558	13.427734
20	2.457109	16.894531
21	2.079242	18.359375
22	1.926414	14.208984
23	4.085100	22.119141
24	2.148931	16.650391
25	2.576697	22.070313
26	2.578097	22.021484
27	1.766456	13.037109

	L1uVMEAN	L1MaxHz
1	2.819244	16.113281
2	2.436210	19.384766
3	2.982421	17.138672
4	2.427472	15.039063
5	2.327407	13.671875
6	2.225025	14.111328
7	2.653952	16.601563
8	1.985815	15.185547
9	4.652291	23.828125
10	1.636849	15.429688
11	2.255464	14.794922
12	3.214991	16.162109
13	2.745146	13.085938
14	3.600791	17.529297
15	3.436682	13.232422
16	2.108363	17.041016
17	3.264039	17.724609
18	4.421906	24.121094
19	2.660164	14.648438
20	2.414282	20.410156
21	2.136213	15.820313
22	1.791798	15.185547
23	3.513647	19.091797
24	2.067871	13.525391
25	2.617073	16.259766
26	2.737088	13.037109
27	1.794067	15.283203

	C1uVMEAN	C1MaxHz
1	3.018040	16.015625
2	2.223150	18.994141
3	3.026978	17.089844
4	2.338432	22.998047
5	2.373938	17.187500
6	2.276066	14.648438
7	2.900817	21.337891
8	2.044256	17.724609
9	5.076658	24.658203
10	1.678973	15.087891
11	2.160694	15.136719
12	3.043542	17.333984
13	2.890925	16.748047
14	3.668475	23.144531
15	2.346495	15.087891
16	2.182302	17.773438
17	3.456154	18.505859
18	5.289161	23.583984
19	2.901306	16.259766
20	2.369448	15.625000
21	2.090708	14.306641
22	1.855503	19.824219
23	3.440973	20.800781
24	2.059128	15.722656
25	2.625253	22.802734
26	2.740426	13.720703
27	1.819900	14.355469

	M2uVMEAN	M2MaxHz
1	2.626453	16.748047
2	2.408476	20.117188
3	2.896083	14.843750
4	2.418708	16.064453
5	2.784327	17.138672
6	2.395749	17.138672
7	2.983070	21.582031
8	2.095856	16.064453
9	4.716210	24.414063
10	1.553577	16.357422
11	2.307490	29.736328
12	3.181659	19.677734
13	2.825287	13.671875
14	3.445372	13.330078
15	2.421003	16.308594
16	2.079899	18.603516
17	2.988689	16.796875
18	4.886645	24.707031
19	2.658259	14.062500
20	2.363114	26.708984
21	2.052689	15.429688
22	1.745455	14.990234
23	3.921309	13.134766
24	1.945454	14.843750
25	2.658918	15.087891
26	2.896611	15.234375
27	1.904323	17.480469

	L2uVMEAN	L2MaxHz
1	2.852855	13.330078
2	2.484326	15.039063
3	3.025299	14.013672
4	2.268194	18.408203
5	2.692894	16.503906
6	2.326014	13.037109
7	3.126272	21.142578
8	1.938057	14.453125
9	4.169898	21.191406
10	1.536719	23.291016
11	2.202075	15.283203
12	3.135185	16.162109
13	2.805784	16.748047
14	3.457647	17.041016
15	2.323201	16.552734
16	2.042594	18.359375
17	3.148501	14.355469
18	4.829089	28.076172
19	2.757113	16.455078
20	2.059529	19.287109
21	2.238107	16.552734
22	1.625034	18.652344
23	3.150223	17.480469
24	1.875194	17.480469
25	2.750161	14.160156
26	2.846126	18.017578
27	1.938537	14.746094

	C2uVMEAN	C2MaxHz
1	2.681508	16.552734
2	2.475198	18.066406
3	2.713933	16.894531
4	2.255849	18.457031
5	2.740095	16.113281
6	2.467663	20.068359
7	3.100832	22.998047
8	2.124454	17.382813
9	4.374234	23.974609
10	1.459514	16.113281
11	2.184800	14.501953
12	3.210022	19.238281
13	2.686490	20.019531
14	3.497125	24.096680
15	2.302495	18.896484
16	2.012888	17.626953
17	3.020278	15.185547
18	4.920499	21.337891
19	2.880941	13.378906
20	2.306100	13.964844
21	1.762059	15.039063
22	1.747972	14.208984
23	3.084103	21.582031
24	2.009628	16.699219
25	2.675323	22.686250
26	2.841229	18.029785
27	2.128727	14.208984