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Assessment Of Reliability And Stability Of Various Visual Search Parameters

Michael Don Mizer
Missouri State University, Mizer042@live.missouristate.edu

ASSESSMENT OF RELIABILITY AND STABILITY OF VARIOUS VISUAL SEARCH PARAMETERS

A Masters Thesis

Presented to

The Graduate College of

Missouri State University

In Partial Fulfillment

Of the Requirements for the Degree

Master of Science, Psychology

By

Michael Don Mizer

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ABSTRACT

Research in social science has been on a continuous self-correcting path as scientists find new ways to look at old problems. Recent technology has given us the ability to perform compounded calculations in a fraction of previous times while recording complex measurements with greater degrees of precision. While this is helpful regarding corporeal measures, quantifying cognition is still a difficult task. Recently, many computer-aided eye tracking devices have been developed and used to validate visual search theories. However, few inquiries have been made assessing the reliability and stability of these methods. This study assessed the reliability and stability of visual attention tasks using the Gazepoint eye-tracker. Visual scanning behaviors of 46 participants were recorded to provide evidence of reliability and stability of four measurement outcomes: (1) total number of fixations, (2) latency to first fixation, (3) total time attending, and (4) total number of switches between areas of interest. All visual scanning measures were found to be stable across stimuli and trials with total number of fixations and total fixation time being the most reliable visual scanning measure. These findings can afford better visual theory development and predictions of subsequent development outcomes.

KEYWORDS: reliability, stability, visual scanning, saliency, faces, individual differences,

This abstract is approved as to form and content

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D. Wayne Mitchell, PhD
Chairperson, Advisory Committee
Missouri State University

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Approved:

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D. Wayne Mitchell, PhD

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Erin M. Buchanan, PhD

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Melissa D. Fallone, PhD

_____
Julie Masterson, PhD: Dean, Graduate College

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INTRODUCTION

In the advent of technology, computer aided measurement has become a preferred method of investigation by many scientists in social science research. In the field of cognitive science, it has "provided that much needed assurance that cognitive processes were real; that they could be studied and perhaps understood" (Neisser, 1976). While technology supports the scientific process, researchers in the field of cognition and perception continue to face the challenge of identifying "physiological correlates of cognitive processes…[and] have typically been motivated by two primary goals: (1) to discover the mechanisms underlying these processes and (2) to develop empirical indices that will mark the occurrences of a cognitive event, thereby validating the process" (Cohen & O'Donnell, 1993).

Regarding visual search processes, many models have been proposed; however, while these models may share theoretical overlap of causal agents and relationships, differences among measurements are impossible to discern if we cannot obtain repeatedly the same results by using the same criteria over repeated trials. Researchers have continued to invent unique methods of measuring visual attention and subsequent underlying cognitive processes. Specifically, computer-aided eye tracking devices have been developed (i.e. brands: Gazepoint GP3, Tobii, Pupil Labs, Eye Tribe, etc.) and used to validate visual search theories. For instance, numerous theories have embraced the phenomena that visual attention is directed to the items in the visual field in the order of decreasing saliency irrespective of the task at hand (Theeuwes, 1992; Wykowska & Schubo, 2009). This phenomena relates to research concerning automaticity (Schneider

& Shiffrin, 1977; Shiffrin & Schneider, 1977), pre-attentive processes (Neisser, 1967), pop-out effect (Treisman & Gelade, 1980) , and other similar events that occur without attentional effort. To date these phenomena have not been tested using visual scanning techniques which afford an active (moment to moment) measurement (milliseconds) of visual attention.

Attention

Cognition can be described as the way in "which sensory input is transformed, reduced, elaborated, stored, recovered, and used. It is concerned with these processes even when they operate in the absence of relevant stimulation, as in images and hallucinations" (Neisser, 1967). Attention is the salient feature of cognition; a conscious manifestation of experience. It allows "high-level processing of information in a capacity limited manner" (Kalivas & Petralia, 2012). The study of attention has had an irregular, often seemingly absent, path of existence during the dawning years of psychological theory (Kahneman, 1973; Neisser, 1976). While theories of attention have been sources of debate throughout time, they began to consistently gain credence toward the late 19th and early 20th century. However, with the onset Gestalt psychology and behaviorism, it was the efforts of philosophers/researchers such as William James (1890), Edward Titchener (1908), Wilhelm Wundt (1910), and others who kept the concept of attention from fading completely. Early on, attention was most aptly defined as "the taking possession by the mind, in clear and vivid form, of one out of what seem several simultaneously possible objects or trains of thought. Focalization and concentration, of consciousness are of its essence" (James, 1890). James theorized an analogous

"spotlight" model that likened attention to having a focus, a margin, and a fringe, much like a beam of light with higher-resolution toward the center (focus) and subsequently deteriorating as it moves outward (fringe). What James offered was a framework for a definition that continues to exist today. Half of a century later, Donald Broadbent (1958) introduced a *filter model* of selective attention followed by Charles Eriksen's (Eriksen & James, 1986) *zoom lens model* of attention, both theories further defined and supported James' earlier reasoning. Broadbent's *Filter Theory* (1958, p. 43) further supposed a type of "bottleneck" theory—based on the work of Kenneth Craik and his *single-channel theory* (Craik, 1947)—which allows one bundle of relevant information to pass while rejecting another. The bottleneck theory surmises a problem of attention in that, regardless of conscious effort, an individual can only attend to a limited number of things at any given time (Deutsch & Deutsch, 1963; Kahneman, 1973).

Visual Attention

The human optic nerve is said to be able to transmit 10^7-10^8 bits (1 gigabyte = 134,217,728 bits) of information each second (Itti & Koch, 2001). However, visual attention, like attention in general, is capacity limited, except it is based solely on data collected from visual input. Visual attention is a function of person-centric biological mediators—i.e. anatomical integrity, biochemical makeup, physiological processes, etc. (Campbell & Green, 1965) and external stimulus attributes (size, color, form, etc.).

When an individual visually scans an area of interest (AOI), only a limited amount of information is consciously attended. The rest is either filtered and allocated to the subconscious mind or due to functional design, it is never realized in the first place.

The latter deals with one way a person scans his or her environment; a phenomenon known as saccadic eye movement.

Saccadic Movement. A saccade is a rapid movement of the eye between two fixation points, approximately 30/ms in duration, with each fixation (still period between saccades) lasting on average 30/ ms (Irwin, 1991). Saccadic eye movement allows an individual to take in target information through simultaneous movements of both eyes, however it is not a fluid movement that allows for encoding of all available stimuli. As the eyes shift, higher level images may be processed while lower level images are attenuated, a phenomenon known as *saccadic masking*. As the eyes move from one AOI to another (approximately three times per second), minimal information is processed due to selective blocking by the brain. It is supposed that selective blocking during transient looks allows the brain time to encode visual information from both eyes and interpret what the eyes are essentially "seeing." If continuous information were to be collected from both eyes, which offer two different vantage points, without blocking, the result would literally be a blur of information. This is a concept that can be thought of analogous to a film projector. When a movie is shown at a theatre, film runs between a light source and a lens, subsequently "projecting" it onto a screen. Movie film is a series of still images, each slightly different than the next, continuously displayed giving the effect of simultaneous fluid motion. However, if each frame were to pass the lens without interruption, the output cast onto the screen would be nothing but a blur. To remedy this, a shutter is used. A shutter opens for a fraction of a second, when the full frame appears between the light source and the lens, and closes as the film transitions to the next frame. This happens very quickly, up to 24 times per second, and gives the

illusion of a smooth continuous event. The brain has evolved to take in all incoming stimuli, analyze it, and to either encode or ignore information. When watching a film, the brain ignores the microsecond delays, gathers the information and produces conscious experience.

Transsaccadic Memory. When visually scanning a scene, the brain collects information from saccadic eye shifts, ignores any delays and differences, and in a piecemeal fashion, manifests a stable and continuous conscious experience, a phenomenon called *transsaccadic memory* (Irwin, 1991). While transsaccadic memory can be defined as a process that allows information collected from fixation points to be combined "in such a way that a percept of a stable and continuous world is produced" (Irwin, 1991), it is unclear how the underlying sub-process(es) work. Irwin offers a perspective of how a person perceives a stable environment that may seem counterintuitive. Cognitive processes may not facilitate a detailed memory of successive fixations, but rather the brain may be parsimonious with detailed memory and very little may be remembered from one fixation to the next.

While this is an effective way to encode visual stimuli, it is not without its drawbacks. Rapid shifts between AOI's create *blind spots* in our visual field called *transsaccadic change blindness* (Henderson and Hollingworth, 2003). This creates a temporal problem of experience between real and perceived events since, theoretically speaking, change is constant and our experience is intermittent.

Visual Scanning Theoretical Perspectives.

Over the past few decades, a vast amount of interest has been garnered in the field of visual search research. Numerous theories/paradigms have been proposed to explain visual phenomena to include preattentive processing versus attentional focus, integral versus separable perceptions, global versus local processing, and many others.

Preattentive Processing. Asking what captures attention before attention is captured seems like a paradoxical question. In a way, it is, but more so it depends on how we define *attention*. Earlier attention was described as a conscious manifestation of experience. Visually speaking, it is when we become consciously aware of something within our visual field. But what directs our eyes to different target areas in our environment to facilitate our "awareness?"

Attentional Capture. At any given time, senses of the human body are monitoring and encoding an insurmountable amount of exogenous data—while concurrently reconciling endogenous feedback, only retaining a fraction of what is potentially available. As theorists often find, dichotomous trends present ; (a) attention is automatic or purposeful (Treisman & Glade, 1980; Treisman & Schmidt, 1982), (b) attention is divided or selective (Kahneman & Treisman, 1984), (c) input is processes consecutively (single-channel theory) or through multiple processes at once. About the latter, multiple processing theories are further broken down; two or more stages processed simultaneously, additivity (Sternberg, 2010), or two signals processed in one stage, parallel processing (Sternberg, 2010; Treisman & Gelade, 1980; Wickens & McCarley, 2008). Once again, these theories call upon the work of James, "[H]ow many

ideas or things can we attend to at once, …the answer is, not easily more than one, unless the processes are very habitual; but then two, or three…" (James, 1890, p. 409).

A popular, and often misunderstood, concept used to explain the lack of encoding of all information suggests that a person filters out irrelevant information and stores only pertinent information (Broadbent, 1958); Neisser states that is a false assumption. He believes, "Perceivers pick up only what they have schemata for, and willy-nilly ignore the rest" (Neisser, 1976). While a willy-nilly ignoring of information may help explain the lack of attending to one's environment, there have been other theories posited that have garnered more empirical support. One such theory is Anne Treisman's selective attention model based on attenuation (1964). In lieu of discarding information altogether, Treisman proposed a weakening of information in which irrelevant input is diminished and does not enter the conscious mind. Unattended items are hierarchically processed and acquire different thresholds depending on personal significance and relevance. Simply speaking, when attending to multiple stimuli, an individual focuses attention on one stimulus, the other stimuli may not completely evade attention, but rather decrease in intensity. Any one of the stimuli can be called to/back to focal attention and processing intensity will increase.

Visual Perception Measurements

A few common measurements used to assess visual perception are evoked potentials, reaction time, and response latency. Computer assisted measurement has allowed our knowledge base to grow exponentially by quantifying that which we cannot see with the naked eye (Evans & Abarbanel, 1999).

Evoked Potentials. Evoked potentials are derived from electrophysiologic recordings of biofeedback resulting from neurofunctions. One such neurofunction is an *action potential*. Action potentials are very rapid (about 1 ms) events where electrical activity in the neuron rises and falls (Evans & Abarbanel, 1999); this activity can be recorded using an electroencephalogram (EEG). Changes in brainwave activity are monitored during stimulus onset and removal by using sensitive laboratory equipment to record electrical activity.

Reaction Time. The time between the presentation of a stimulus and a person's response is known as reaction time (RT). RT is the physical response of the participant cued by a stimulus. In simple RT, there is little cognitive effort and the response is almost automatic. When a complex cognitive task is added, RT increases. The increased time between stimulus onset and response is called response latency (RL). In cognitive psychology, it is known that there are different processes and sub-processes that take place between the presentation of a stimulus and the subsequent response to a stimulus. As such, the processes create a complexity that makes the study of each individual process difficult, if not impossible. A fundamental concept in reaction time studies is the selectivity of effect, i.e. how does each sub-process singularly affect the outcome? To study each sub-process, a researcher must find factors that affect that sub-process while not affecting other sub-processes. Unlike many other measures, RT permits the study of a system when it is functioning well instead of overloading the system on recording its failures. Also, by measuring RT, researchers can make inferences on the temporal organization of unobservable mental processes. Basically, physiological measures can be used to look at immaterial processes (Sternberg, 1969; Sternberg, 2010).

Because cognitive processes cannot be directly observed, we are forced to find alternate ways to look at and subsequently measure a response(s), RT allows this advantage. For example, during visual search tasks we know that there are two different processes taking place, pre-attentive and attentional. During pre-attentive processes, visual stimuli is encoded in parallel and rapidly. Searches are susceptible to distinct differences in luminance, color, orientation, motion direction, form, and velocity. During a target detection task, when a stimulus is introduced, the participant scans the stimulus searching for the target. By manipulating the variables, RT can be increased or decreased (pop-out affect) depending on the complexity and ambiguousness of the visual task. The RT measure can give us insight to underlying processes at work during changes to our environment. Another advantage to RT, it offers a way to study cognitive processes by looking at temporal organization. As mentioned above, many of these processes can be extremely complex and difficult to delineate. Input maybe processed sequentially or at the same time. If multiple factors are processed at the same time, sub-process factors can be manipulated and processes timed and analyzed through mean comparisons. If information is believed to be processed serially, then differences between self-terminating and exhausting processes can be analyzed. Distinct changes in time between stimulus onset and response can be used to make inferences about the overall cognitive processes regardless of how it is processed (Muller & Krummenacher, 2006).

While RT allows for an alternative method of measurement, it is not without its drawbacks. One issue that arises when studying RT of any cognitive process is the trade-off that occurs between speed and accuracy. It stands to reason that preattentive processing is much faster than attentional effort, but when we look at each process

separately they are both influenced by a multitude of factors, some which are shared by both processes (i.e. structural deficits, neurochemical anomalies, etc.). At this point in time, researchers are unable to differentiate temporal cognitive effort from mechanical process time. It is an erroneous assumption to assume that RT data is equally distributed among cognitive effort and physical reaction.

Overall, visual scanning affords a real time physiological correlate that allows us to better monitor latent cognitive processes. All the of these measures can be used in conjunction with visual scanning studies.

Purpose of this Study

Given that visual scanning methods are being utilized more often and used (1) to assess individual and group differences in visual processing and (2) employed to predict subsequent developmental outcome, it is important to establish the reliability and stability of the dependent measures derived from visual scanning data. Like in developing a test that has psychometric properties it is important ascertain the reliability and stability of the test, otherwise diagnosis and predictions would be moot issues. And moreover, the advancement of visual attention theory would be in question with stability and reliability. To date, specific visual attention theories that have not been tested via visual scanning technology, nor has the reliability and stability of derived visual scanning measures. Therefore, a primary purpose of this research was to assess the reliability and stability of visual scanning when viewing a series of animate (adult faces) and inanimate (abstract-object) stimuli.

The reliability of the following derived measures of visual scanning to pre-defined Areas of Interest (AOI) within each of the stimuli: (1) the total number of fixations during stimulus-interval; (2) latency to first fixation; (3) the total time attending; (4) and the number of shifts between stimulus pairs were examined in this study via a series of Pearson correlations (two-trial consistencies) across pairs of facial and object stimuli.

To assess the stability of the visual scanning, the means and standard deviations for the derived measures (e.g., total number of fixations, latency to first fixation, total time attending to target, and number of shifts between stimulus pairs) within participants will be assessed across a series of facial and object stimuli.

Although face stimuli and abstract stimuli have been employed in a variety of studies with infants, children and adults; and the stimulus features attended to have been well documented, no visual scanning norms have been developed. There are standardized sets of visual stimuli (e.g., Brodeur, Dionne-Dostie, Montreuil, & Lepage, 2010); however, the researchers employed a less than optimal method of equating the stimuli; subjective participant personal ratings using Likert-like rating scales were used. It has become evident that stimulus characteristics (e.g., size, contrast, familiarity, novelty, and linguistically based – stimuli that can be named) can impact significantly visual scanning and therefore can produce confounds in the interpretation of individual differences on subsequent recognition memory tasks. Hence, there is need to develop visual stimuli that have been normed in concordance with current visual scanning technology so to (1) better advance our work in recognition memory and attention, and

(2) to develop appropriate diagnostic visual tests that could be used to predict development outcome or detect cognitive anomalies.

Primary Hypotheses

Hypotheses 1 thru 4 relate to assessing the stability of the visual scanning measures of number fixations, latency to first fixation, total fixation time, and the number of visual shifts. Although the null hypothesis is predicted, in tests development theory stability of a given measure(s) is expected.

HYPOTHESIS 1. The mean and standard deviation of the number of fixations across trials should remain consistent with no significant differences.

HYPOTHESIS 2. The mean and standard deviation of the latency to first fixation across trials should remain consistent with no significant differences.

HYPOTHESIS 3. The mean and standard deviation of the total time attending across trials should remain consistent with no significant differences.

HYPOTHESIS 4. The mean and standard deviation of the number of shifts between stimulus pairs across trials should remain consistent with no significant differences.

Hypotheses 5 thru 8 relate to assessing the reliability of the visual scanning measures of number fixations, latency to first fixation, total fixation time, and the number of visual shifts. As in test development theory reliability of a given measure(s) are expected. Within groups two-trial consistencies (reliability) are hypothesized to be significant statistically. Given these are laboratory measures, the normal test-retest reliability of $r = 0.80$ required for standardized tests will not be expected, however significant two-trial consistencies are predicted.

HYPOTHESIS 5. Within groups, significant two-trial consistencies for number of fixations are predicted.

HYPOTHESIS 6. Within groups, significant two-trial consistencies for the latency to first fixation are predicted.

HYPOTHESIS 7. Within groups, significant two-trial consistencies for the total time attending are expected.

HYPOTHESIS 8. Within groups, significant two-trial consistencies for the number of shifts are expected.

METHODS

Sample

Eighty participants were recruited from a pool of Missouri State University's (MSU) students through use of SONA, consisting primarily of students currently enrolled in PSY 121 classes. Participation in a research project is part of the PSY 121 students required course work. Missouri State University's Institutional Review Board (IRB) has reviewed and approved this research project (January 22, 2017; approval #2017-422). Prior to data analysis, a total of thirty-four participants were removed from the study due to equipment malfunction, system lag, task misunderstanding and/or lack of scanning. Multiple participants commented during the debrief that they were unsure if they were supposed to look at the stimulus presentations or remain focused where the "X" appeared and reappeared or that during the trials, they believed their task may have been different than what they were doing.

Data were further screened for assumptions and outliers. Mean replacement was used within participant trials for scores that deviated from the participant trend. In Latency to First Response columns, mean replacement was used within participant trials (n = 20) if first response was greater than or equal to 1000/ms in two or less trials. In Total Number of Switches Between AOI's, mean replacement was used on participant data (n = 2) if total number of switches deviated more than 75% of the within participant trend. The final sample size was n = 46 participants.

Materials

Subtest. A Wechsler Adult Intelligence Scale-Revised—WAIS-R (1981) picture arrangement subtest was administered to each participant. The subtest was used to validate the normality of participants regarding attention to detail and to assess the concurrent relationship between this subscale and the derived visual scanning measures.

Stimuli. Three sets of visual stimuli (faces, abstract-object, and manipulation check) were created. Each set of the first two sets consisted of three stimuli. The face stimuli (Lundqvist, Flykt, & Öhman, 1998) differed in emotion; neutral, happy, and anger. For the abstract-object, three stimuli were created with differing levels of complexity (saliency map); low, medium, and high. For the manipulation check, two new stimuli were used; a novel face pair and an abstract-object image.

Apparatus. The stimulus images were displayed on a 60 cm color monitor. Eye tracking was recorded using GazePoint GP3 Eye Tracker sensor and data collected using GazePoint Analysis and Control software.

Procedure

The design of the study was a 2 (Stimulus: Face vs. Object) X 2 (Gender: Male vs. Female) X 2 (Presentation Order: Forward vs. Reverse) X 9 (Trials) factorial design with a repeated measure on the last factor. Each stimulus set was followed by a manipulation check (Trial 10) to assess whether participants were exerting cognitive effort when scanning. Data from the manipulation check (Trial 10) was used to validate the link between visual scanning and cognitive performance.

Participants were assigned randomly to one of four groups: [1] Face Stimulus Forward Order (FSFO); [2] Face Stimulus Reverse Order (FSRO); [3] Object Stimulus Forward Order (OSFO); and [4] Object Stimulus Reverse Order (OSRO). Within each stimulus set, the lateral position (left and right) were counterbalanced, and between groups, the presentation order (forward and reverse) were counterbalanced. Therefore, each participant was presented 9 stimulus pairs. Each stimulus pair was displayed for 5 seconds with a 3 second inter-stimulus interval (ISI) between stimulus presentations. Each participant viewed 3 stimuli (Face: *Angry, Happy, Neutral* or Saliency: *High, Low, Medium*) in a series of stimulus pairs. For the Face Group (FSFO and FSRO), the pairs were randomly ordered: *Angry-Angry, Happy-Happy, Neutral-Neutral, Angry-Neutral, Neutral-Angry, Happy-Neutral, Neutral-Happy, Angry-Happy, and Happy-Angry*. For the Object Group (OSFO and OSRO), the pairs were ordered randomly: *High-High, Low-Low, Medium-Medium, High-Low, Low-High, Low-Medium, Medium-Low, High-Medium, and Medium-High*. The participant sat approximately 60-70 cm in front of the Eye Tracker monitor. Once the participant's eyes were detected by the Eye Tracker, a 5-point calibration routine was conducted to ensure their eye gaze mapped correctly on to the stimuli. Via the GazePoint software, numerous visual scanning measures were calculated (e.g., number of total fixations, latency to first fixation of target areas, total fixation duration of AOI's, and number of shifts between AOI's).

Following each stimulus set, a recognition memory problem was presented as a manipulation check to assess the degree of effort each participant engaged in during visual scan task. A novel stimulus (face or object) was presented for 5 seconds with a 20

second ISI, following which, the participant was asked to recall image features that were present (a recall memory assessment).

Pretest Process. Upon arrival, participants were greeted and escorted to a designated assessment room. They were sat at a table and asked to please read and sign the informed consent form and fill out the demographics sheet. They were asked if they have any questions regarding the forms. Next, participants were given summaries of the tasks, stated as follows:

> "There will be two tasks. The first task will be a WAIS-R picture arrangement subtest; it is simply a working and spatial memory assessment. Secondly, we will perform a visual assessment. The computer is equipped to perform an analysis of your visual field. We will briefly calibrate the system to your eyes and then display a series of photos. The entire process should take no longer than 20-25 minutes."

Phase 1. The researcher began the WAIS-R Picture Arrangement task per the WAIS-R Manual (1981). Scores were recorded.

Phase 2. After the WAIR-R subtest was completed, participants were moved to a workstation setup with the GazePoint program. The participant was instructed to sit squarely in front of the monitor and to rest his/her chin comfortably on the stabilization bar in front of him/her. The system was calibrated to each participant after the following statement was read to him/her,

> "You will see a white dot with a red center enter the screen from the upper left hand corner of the monitor and it will quickly move to the center. It will slowly shrink before moving to the upper right hand corner. Do your best to focus on the center of the dot at all times without looking at the area surrounding the dot or its perimeter. Try to keep your head in a fixed position and only follow the dot with your eyes. This ensures the most accurate calibration. The dot will make its way around the screen to five locations (the researcher will motion with his/her hands the calibration path)."

Once calibration was complete, the researcher began the primary visual task. Before clicking "Record," the task was explained. "You will see the word 'Start' followed by an 'X' in the center of the screen. While the 'X' is present, please focus your attention to the center of it. When the 'X' disappears, you are free to view anywhere on the screen. When the 'X' reappears, please focus on the center of it once again. Are you ready to begin?"

Once the final stimulus was presented, the participant was asked to recall details of the previous image while his/her responses were recorded.

Debriefing

As soon as each participant completed all assessments, he or she was debriefed and allowed to ask questions. Participants were informed upon exiting that results would be provided to participants upon request once the study was complete.

RESULTS

Preliminary Analyses

All participants passed the manipulation check and were considered attentive throughout the stimuli presentations. The data was screened for outliers and assumptions (normality, linearity, and homogeneity) and found to be satisfactory. As stated previously, to assess the normality of the sample a WAIS Picture Arrangement Subtest was administered. The sample data and WAIS scores were found to be within normal ranges (sample WAIS $M = 9.13$, $SD = 2.74$; WAIS norm $M = 10$, $SD = 3$)

Primary Analyses

Data was first analyzed for order effects to assess whether stimulus presentation order affected the outcome and gender effects to assess any gender differences. A 2 (Group: Forward vs. Reverse) X 2 (Gender: Female vs. Male) X 9 (Trials) mixed factorial ANOVA was conducted ($N = 46$) for each of the four DV's. A correction of the p-value was used ($p = 0.0125$). The results (Table 1) of *Total Number of Fixations* did not yield any significant order effects, $F(1,38) = 0.001$, $p = .96$, $\eta p^2 = 0.000$ or gender differences, $F(1,38) = 0.63$, $p = .43$, $\eta p^2 = 0.006$. The results of *Latency to First Response* did not yield any significant order effects, $F(1,38) = 0.001$, $p = .71$, $\eta p^2 = 0.001$ or gender differences, $F(1, 38) = 0.003$, $p = .95$, $\eta p^2 = 0.000$. The results of *Total Time Attending* did not yield any significant order effects, $F(1,38) = 0.19$, $p = 0.66$, $\eta p^2 = 0.003$ or gender differences, $F(1,38) = 1.48$, $p = 0.23$, $\eta p^2 = 0.02$. The results of *Total Number of Shifts Between AOI's* did not yield any significant order effects, $F(1,38) = 0.55$, $p =$

.46, ηp^2 = .005 or gender differences, $F(1,38) = 0.01$, $p = 0.91$, $\eta p^2 = 0.000$. For all subsequent analyses comparing means, gender and test order was collapsed within Groups, hence the primary statistical analyses approach was a 2 (Group: Face vs. Object) X 9 (Trials) mixed ANOVA with a repeated measure on the last factor.

After groups were collapsed, stability was assessed through used of a series of 2 X 9 ANOVAs calculating means and standard deviations using two one-sided tests (TOST) of equivalence (Lakens, 2016); reliability was assessed looking at two-trial correlations. Two-trial consistencies were analyzed several ways: (1) Face and Object groups combined with correlations ran in sequential order (Trial 1/Trial 2, Trial 2/Trial 3, etc.); (2) Face and Object groups combined with correlations ran with respective matched pair trials (Happy Angry/Angry Happy; High Low/Low High); (3) Face and Object groups separate with correlations ran in sequential order; (4) Face and Object groups combined with correlations ran with respective matched pairs. Note: in the second group, Happy was combined with High Saliency, Neutral was combined with Medium Saliency, and Angry was combined with Low Saliency. These iterations provided for multifarious organized comparisons of the correlations and in the following sections the stability and reliability analyses of each of the derived scanning measures will be discussed in turn.

Means and standard deviations were analyzed for measurement reliability through use of TOST. A test of equivalence was used to assess whether the groups means differ "too much" for setting up two one-sided *t*-tests. If significant, the means will be less than the upper limit and greater than the lower limit. Finally, two-trial consistency (Pearson's Correlation) was used to determine the reliability of various visual scanning measures over trials. Given the magnitude of two-trial consistency correlations only the range and

magnitude will be presented and discussed, however, all two-trial consistency and summary statistics are tabled in the appendices.

Total Number of Fixations

A small significant effect was found (Table 2) in *Total Number of Fixations* between face and object groups, $F(1,44) = 12.59$, $p < .001$, $\eta p^2 = 0.1$. *Post hoc* analysis revealed participants in the face group had a larger average number of fixations (M = 12.02, SD = 2.11) compared to participants in the object group (M = 10.49, SD = 2.57). The finding is not surprising when considering the human face is comprised of multiple AOI's (i.e. eyes, nose, mouth) compared to the object stimulus (saliency map) which consisted of one AOI (target) among a field of homogenous distractors. Over trials, a non-significant effect for the number of fixations was found with no differences between trials, $F(8, 352) = 1.37$, $p = 0.21$, $\eta p^2 = 0.02$. To test just how small the difference between trial means were, TOST equivalence was used. A small effect size (d = 0.20) was selected for lower and upper bounds indicating any effect larger than d = 0.20 was considered "not small" and non-significant at the set alpha level (α = 0.05). All trial permutations were found to be non-significant for the Null Hypothesis Significance Test (NHST) and TOST While there was a non-significant effect and the null-hypothesis was retained, there was still too large of difference between means (within stated parameters) to find significant equivalence.

Face/Object. Correlations among trials of combined face and object groups (Table 3) showed a primarily[1] significant medium to large effect ($r \sim 0.38$). Correlations

[1] Effects sizes were averaged over eight permutations of trial pairs with the term "primarily" used to indicated the majority were either significant or non-significant.

among matched pair trials (Table 4) showed a significant averaged large effect for all permutations ($r \sim 0.46$)

Faces. Correlations among face trials (Trial 1-2, Trial 2-3, Trial 3-4, etc.) returned mixed reliability results (Table 9); an average correlation of nine repeated trials yielded a primarily non-significant small-medium effect sizes ($r \sim 0.24$). Correlations among face matched pair trials (Table 19-22) showed primarily non-significant averaged medium effects ($r \sim 0.27$).

Objects. Correlations among object trials (Table 15) returned mixed reliability results; an average correlation of nine repeated trials showed a primarily non-significant medium to large effect ($r \sim 0.39$). Correlations among object matched pair trials (Table 8) yielded a significant averaged large effect ($r \sim 0.56$).

Latency to First Fixation

A non-significant effect was found in the analysis of *Latency to First Fixation* between face and object groups, $F(1,44) = 0.28$, p = .60, $\eta^2 = 0.002$. Over trials, a non-significant effect for the number of fixations was found, $F(8, 352) = 0.99$, $p = 0.44$, $\eta^2 = 0.01$. Once again, to test how small the difference between trial means were, the TOST equivalence was used. A small effect size ($d = 0.20$) was selected for lower and upper bounds indicating any effect larger than $d = 0.20$ was considered "not small" and non-significant at the set alpha level ($\alpha = 0.05$). All trial permutations were found to be non-significant for NHST and TOST. While there is a non-significant effect and the null-hypothesis is retained, there is still too large of difference between means (within stated parameters) to find significant equivalence.

Face/Object. Correlations among trials of combined face and object groups (Table 3) showed an equal split between significant and non-significant trial pairs with an average medium effect ($r \sim 0.29$). Correlations among matched pair trials (Table 8) showed a significant averaged medium effect for angry, happy, neutral pair variations ($r \sim 0.32$), but returned a non-significant averaged small effect for control pair variations ($r \sim 0.10$).

Faces. Correlations among face trials returned mixed reliability results (Table 12); an average correlation of nine repeated trials showed an equal split between non-significant and significant results with a medium to large effect ($r \sim 0.37$). Correlations among face matched pair trials (Table 20) yielded a primarily non-significant averaged medium effect ($r \sim 0.27$).

Objects. Correlations among object trials returned mixed reliability results (Table 16); an average correlation of nine repeated trials showed a primarily non-significant medium effect ($r \sim 0.28$). Correlations among object matched pair trials (Table 24) yielded a primarily non-significant averaged small to medium effect ($r \sim 0.21$).

Total Time Attending

A non-significant effect was found in the analysis of *Total Time Attending* between face and object groups, $F(1,44) = 0.04$, $p = 0.84$, $\eta p^2 < 0.001$. Over trials, a significant effect for the total time was found, $F(8, 352) = 2.92$, $p < 0.0125$, $\eta p^2 = 0.03$. Post hoc analysis revealed Trial 5 ($M = 3704.70$, $SD = 317.32$) and Trial 6 ($M = 3867.48$, $SD = 287.44$) were significantly different with participants having less variation in time spent viewing and viewing Trial 6 longer, than compared to Trial 5). The significant

effect was the only one out of 36 permutations and the researcher determined the result is not meaningful and likely an artifact of the analysis. The differences were tested using TOST equivalence. A small effect size ($d = 0.20$) was selected for lower and upper bounds indicating any effect larger than $d = 0.20$ was considered "not small" and non-significant at the set alpha level ($\alpha = 0.05$). All trial permutations were found to be non-significant for NHST and TOST. While there is a non-significant effect and the null-hypothesis is retained, there is still too large of difference between means (within stated parameters) to find significant equivalence.

Face/Object. Correlations among trials of combined face and object groups (Table 5) showed a primarily significant effect for trial pairs with an average large effect ($r \sim 0.46$). Average correlations among matched pair trials (Table 9) showed a significant large effect for all pair variations ($r \sim 0.47$).

Faces. Correlations among face trials returned significant reliability results (Table 13); an average correlation of nine repeated trials showed significant results with a medium to large effect ($r \sim 0.44$). Correlations among face matched pair trials (Table 21) showed a significant averaged large for angry, happy, neutral pair variations ($r \sim 0.56$), but returned a primarily non-significant averaged large effect for control pair variations ($r \sim 0.10$).

Objects. Correlations among object trials returned mixed reliability results (Table 17); an average correlation of nine repeated trials showed a primarily significant large effect ($r \sim 0.53$). Correlations among object matched pair trials (Table 25) yielded a primarily non-significant averaged medium to large effect ($r \sim 0.44$).

Total Number of Shifts Between AOI's

A non-significant effect was found in the analysis of *Total Number of Shifts Between AOI's* among face and object groups, $F(1,44) = 0.11$, $p = 0.74$, $\eta p^2 < 0.001$. Over trials, a non-significant effect for the number of fixations was found, $F(8, 352) = 3.64$, $p < 0.0125$, $\eta p^2 = 0.05$. Post hoc analysis revealed Trial 6 ($M = 4.00$, $SD = 1.14$) and Trial 8 ($M = 5.00$, $SD = 1.63$) were significantly different with participants having less total number of switches and a smaller within group variance for Trial 6. Again, the significant effect was the only one out of 36 permutations and the researcher determined the result is not meaningful and likely an artifact of the analysis. The differences were tested using TOST equivalence. A small effect size ($d = 0.20$) was selected for lower and upper bounds indicating any effect larger than $d = 0.20$ was considered "not small" and non-significant at the set alpha level ($\alpha = 0.05$). All trial permutations were found to be non-significant for NHST and TOST. While there is a non-significant effect and the null-hypothesis is retained, there is still too large of difference between means (within stated parameters) to find significant equivalence.

Face/Object. Correlations among trials of combined face and object groups (Table 6) yielded mixed results equally split between non-significant and significant effects for trial pairs with an averaged medium effect size ($r \sim 0.32$). Correlations among matched pair trials (Table 10) yielded mixed results equally split between non-significant and significant effects with an averaged medium effect size ($r \sim 0.34$).

Faces. Correlations among face trials (Trial 1-2, Trial 2-3, Trial 3-4, etc.) were primarily significant (Table 14); an average correlation of nine repeated trials yielded a

primarily significant medium effect ($r \sim 0.3$). Correlations among face matched pair trials (Table 22) showed a primarily non-significant averaged large effect ($r \sim 0.35$).

Objects. Correlations among object trials yielded mixed reliability results (Table 18); correlations of nine repeated trials returned an equal split between non-significant and significant effects with an averaged large effect size ($r \sim 0.37$). Correlations among matched pair trials (Table 26) yielded mixed results equally split between non-significant and significant effects with an averaged medium to large effect size ($r \sim 0.44$).

DISCUSSION

Total Number of Fixations

A main effect was found between face and object groups indicating participants in the face group had a larger number of fixations as compared to the object group. The finding is not surprising when considering the human face is comprised of multiple AOI's (i.e. eyes, nose, mouth) compared to the object stimulus (saliency map) which consisted of one AOI (target) among a field of homogenous distractors. In terms of stability over trials, no significant difference was found between groups; the mean number of fixations from one trial to the next did not vary significantly. However, after analyzing how similar the groups are using a small effect, a non-significant effect was found. Groups still had too large of a difference between means to be practically equivalent. Further research should be conducted to determine outcome modulation and why groups are not significantly different, but are not significantly the same. In terms of reliability, the average number of group fixations between trial pairs was found to have a medium to large effect, but only significant in half of the analyses. Previous research would suggest that reliability of the total number of fixations is expected to higher than other indices. A participant's task understanding, search method, encoding speed, etc. should not vary greatly between trials. Any variation is likely due to novelty effects of the stimuli or environmental distractions.

Latency to First Fixation

A non-significant effect was found between face and object groups; there were no apparent differences between groups in how long it took participants to record their first fixation once the stimulus presented. This finding is not surprising in that both stimulus sets consisted of a pair of stimuli that appeared in the same location over trials; each having salient features that garner attention. Future research may want to look at differences between groups and latency to first fixation regarding salient AOI's. In terms of stability over trials, no significant difference was found between groups; the mean number of fixations from one trial to the next did not vary significantly. After analyzing how similar the groups are using a small effect, a non-significant effect was found. Groups still had too large of a difference between means to be practically equivalent. Further research should be conducted to determine outcome modulation and why groups are not significantly different, but are not significantly the same. In terms of reliability, the average number of group fixations between trial pairs was found to have a small to medium effect, but only significant in less than half of the analyses.

Total Time Attending

A non-significant effect was found between face and object groups; there were no apparent differences between groups in how long participants fixated on the viewing area once the stimulus presented. This finding is not surprising in that saccadic movement, blink rate, and focus should primarily be a function of individual differences with each participant behaving the same over trial periods over a short time frame. Future research may want to look at differences between groups and changes individual behavior over

time. In terms of stability over trials, no significant difference was found between trial pairs (only 1 of 36 found significant). After analyzing how similar the groups are using a small effect, a non-significant effect was found. Groups still had too large of a difference between means to be practically equivalent. Further research should be conducted to determine outcome modulation and why groups are not significantly different, but are not significantly the same. In terms of reliability, total time attending was found to be the most reliable. When looking at trial pairs, the average time attending was found to have a primarily significant medium to large effect. This measure should return the highest reliability which suggests that each participant is cognitively engaged and visually attending approximately the same amount of time per each five-second presentation.

Total Number of Shifts

A non-significant effect was found between face and object groups; there were no apparent differences between groups in how many times participants shifted from one AOI to another once the stimulus presented. This finding is a little surprising in that, like the total number of fixations, face stimuli has more detail to consider between stimulus pairs while object stimuli only has one target area of interest. This could be a function of the ambiguous task. Participants, knowing it was a psychological study, may have been come up with their own search paradigms that they used to help determine the purpose of the study. In other words, scanning patterns may have had less to do with the stimulus sets and more to do with mental tasks arising from not knowing what they should be looking at. Future research may want to look at differences between groups with detailed task descriptions compared to ambiguous task descriptions. In terms of stability over

trials, no significant difference was found between trial pairs (only 1 of 36 found significant). After analyzing how similar the groups are using a small effect, a non-significant effect was found. Groups still had too large of a difference between means to be practically equivalent. Further research should be conducted to determine outcome modulation and why groups are not significantly different, but are not significantly the same. In terms of reliability, the average number of switches between stimulus pairs was found to be split equally between non-significant and significant with a medium to large effect over trials.

Two-Trial Consistency Combinations

Reliability data should be carefully interpreted with consideration given to changing rank order between trial pairs. Novelty of one trial over another may influence outcomes and change the rank order due to a function of individual differences; i.e. a happy face may garner one person's attention longer in a trial as compared to another emotion.

Limitations

The ambiguous nature of the task should be reconsidered in future studies. During the debrief, multiple participants suggested they changed their scanning behavior during one or more trials due to uncertainty of task requirements. Participants were not given a goal, but they assumed that there was a goal they should be trying to achieve; i.e. "Should I have kept my focus on the spot where the "X" was?", "Was I looking for differences between the pictures?", "After the first couple of pictures, they looked like

the same things." A second limitation to the study is an *afterimage effect*. Two participants commented after the study that when the "X" disappeared, they could still see it in their field of vision. This effect was undoubtedly intensified due to the white "X" on a black background.

Conclusion

The primary purpose of this study was to assess the reliability and stability of visual scanning when viewing a series of animate (adult faces) and inanimate (abstract-object) stimuli. While no significant differences were found between test measurements, there were no significant equivalencies between groups either. A measure of the total number of fixations and the total time attending during visual scanning tasks appear to be the most reliable measures. Because of this, future studies may utilize the reliability of these measures to be more confident about the consistency of their task measures and variable influences. Future research should also explore factors contributing to group differences and limited equivalency. Overall, an average medium correlation was found between trial pairs, but with mixed results of statistical significance. With a larger sample size, statistical significance would likely be achieved in further studies. Likewise, as technology improves and we learn more about visual attention, more reliable results will likely be obtained.

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APPENDICIES

Appendix A. Consent Form.

Missouri State University Consent of Participation
Infant Perception and Learning Laboratory

This study is part of the Missouri State University Psychology Graduate Program designed to give us more information and to fulfill a thesis requirement for Michael Mizer. The following information is provided so that you can decide whether you wish to participate in this study. If you agree to participate, we will administer an intelligence subtest and observe your visual responses to a series of slides of human faces and abstract shapes. One of the members of the research lab should have explained the purposes and procedures of the study to you, and will answer any questions you might have. Please be assured that if you agree to participate, you are free to withdraw from the study even after you have signed this consent form. If you wish to withdraw, simply stop any on-going task and tell the research staff you wish not to continue. Should you decide to terminate the research session; all data pertaining to you that have been collected will be destroyed.

Since it is our policy to protect the confidentiality of all our participants, your name will not be included in any data analyses, subsequent publication or presentations related to this research study. All raw data collected during this study will be identified only by code-number to insure confidentiality of the information collected.

If questions arise after you have left the research laboratory, feel free to give D. Wayne Mitchell, Ph.D. a call at 417-836-6941 or at waynemitchell@missouristate.edu.We do not anticipate any risk to you as a result of participating in this study, but it is unlikely that this study will provide you with any direct benefits. Your participation will, however, make an important contribution to our scientific knowledge, and we very much appreciate your cooperation.

In addition, we would appreciate your filling out the attached demographic sheet so we can document the characteristics of our participants. Any of the questions you feel uncomfortable about answering, please feel free to leave blank. As with the raw data collected, this information will be entered into our computer system and only identified by code-number to insure confidentiality.

I have read the above description of the study and I agree to participate.

Participant's Name (please print):_____

Participant's Signature: _____

Witness's Signature: _____

Date: ____/____/_____

Appendix B. Demographics Information Form.

Participant's Name: _____

1. Date of Birth _____

2. Gender _____

3. Major _____

4. Do you wear any prescription eye wear? Yes _____ No _____

If yes, Glasses? _____ Contacts _____

5. Are you aware of any other vision problems you may have? Yes _____ No _____

If yes, please explain _____

_____

_____

Appendix C. WAIS Participant Response Form.

	Item	Time (sec)	Letters (L to R)	Points
1.	House			
2.	Flirt			
3.	Romeo			
4.	Louie			
5.	Enter			
6.	Escape			
7.	Hill			
8.	Fish			
9.	Robber			
10.	Taxi			

Face Manipulation Check

What differences did you see?

- Smiley face
- Vampire teeth
- Red eyes
- Missing nostril
- Missing eyebrows

Object Manipulation Check

How many blue squares did you see? _____

What color was the roof? _____

What color was the circle? _____

LIST OF TABLES

Table 1. Presentation Effects of Order and Gender Analysis: 2 (Forward/Backward) X 2 (Female/Male) X 2 (Face/Object) X 9 (Trials).

Group	*DV*	*df*	F	ηp^2	*p*	Significant
FWD/BWD	FIX	1,38	0.002	<.001	.96	N
FEM/MALE	FIX	1,38	0.630	.006	.43	N
FWD/BWD	RL	1,38	0.140	.010	.62	N
FEM/MALE	RL	1,38	0.003	.010	.53	N
FWD/BWD	TIME	1,38	0.190	.002	.66	N
FEM/MALE	TIME	1,38	1.480	.020	.23	N
FWD/BWD	SWITCH	1,38	0.010	<.001	.91	N
FEM/MALE	SWITCH	1,38	0.550	.005	.46	N

Table 2. Primary Analysis: 2 (Face/Object) X 9 (Trials).

Group	*DV*	*df*	F	η^2	*p*	Significant
FACE/OBJ	FIX	1,44	12.590	.100	.013	Y
TRIAL	FIX	8,352	1.370	.020	.020	N
FACE/OBJ	RL	1,38	0.280	.002	.002	N
TRIAL	RL	8,352	0.990	.010	.010	N
FACE/OBJ	TIME	1,38	0.040	.000	.000	N
TRIAL	TIME	8,352	2.920	.030	.030	N
FACE/OBJ	SWITCH	1,38	0.110	.000	.000	Y
TRIAL	SWITCH	8,352	3.640	.050	.050	N

Table 3. Two-Trial Consistencies for Face and Object with Total Number of Fixations of Trials 1-9.

Trial	Trial	*r*	*p*	Effect	Significant
1	2	.40	<.010	M-L	YES
2	3	.51	<.001	L	YES
3	4	.37	<.050	M	YES
4	5	.49	<.001	L	YES
5	6	.28	.060	M	NO
6	7	.34	<.050	M	YES
7	8	.37	<.050	M	YES
8	9	.29	.050	M	NO

Table 4. Two-Trial Consistencies for Face and Object with Latency to First Fixation of Trials 1-9.

Trial	Trial	*r*	*p*	Effect	Significant
1	2	.40	.570	S	NO
2	3	.51	<.050	M	YES
3	4	.37	.080	M	NO
4	5	.49	<.050	M	YES
5	6	.28	<.001	L	YES
6	7	.34	.250	S-M	NO
7	8	.37	.420	S	NO
8	9	.29	<.001	L	YES

Table 5. Two-Trial Consistencies for Face and Object with Total Fixation Time of Trials 1-9.

Trial	Trial	*r*	*p*	Effect	Significant
1	2	.48	<.050	L	N
2	3	.50	<.010	L	Y
3	4	.32	.120	M	N
4	5	.42	<.050	M-L	Y
5	6	.46	<.050	L	Y
6	7	.57	<.010	L	N
7	8	.64	<.001	L	N
8	9	.31	.120	M	Y

Table 6. Two-Trial Consistencies for Face and Object with Total Number of Shifts Between AOI's of Trials 1-9.

Trial	Trial	*r*	*p*	Effect	Significant
1	2	.37	.060	M-L	N
2	3	.51	<.010	L	Y
3	4	.58	<.010	L	Y
4	5	.26	.200	S-M	N
5	6	.16	.430	S-M	N
6	7	.08	.710	S	N
7	8	.11	.590	S	N
8	9	.48	<.050	L	Y

Table 7. Two-Trial Consistencies for Face and Object Matched Pairs with Total Number of Fixations of Trials 1-9.

Trial	Trial	*r*	*p*	Effect	Significant
4	6	.40	<.010	M-L	Y
2	3	.39	<.010	M-L	Y
7	9	.33	<.050	M	Y
1	5	.46	<.010	L	Y
5	8	.51	<.001	L	Y
1	8	.67	<.001	L	Y

Table 8. Two-Trial Consistencies for Face and Object Matched Pairs with Latency to First Fixation of Trials 1-9.

Trial	Trial	*r*	*p*	Effect	Significant
4	6	.37	<.050	M-L	Y
2	3	.30	<.050	M	Y
7	9	.30	<.050	M	Y
1	5	.10	.500	S	N
5	8	.29	.050	M	N
1	8	.00	.990	None	N

Table 9. Two-Trial Consistencies for Face and Object Matched Pairs with Total Fixation Time of Trials 1-9.

Trial	Trial	*r*	*p*	Effect	Significant
4	6	.67	<.001	L	Y
2	3	.46	<.010	L	Y
7	9	.50	<.001	L	Y
1	5	.33	<.050	M	Y
5	8	.33	<.050	M	Y
1	8	.53	<.001	L	Y

Table 10. Two-Trial Consistencies for Face and Object Matched Pairs with Total Number of Shifts Between AOI's of Trials 1-9.

Trial	Trial	*r*	*p*	Effect	Significant
4	6	.34	<.050	M	Y
2	3	.47	<.001	L	Y
7	9	.28	.060	M	N
1	5	.21	.150	L	N
5	8	.52	<.001	L	Y
1	8	.19	.200	L	N

Table 11. Two-Trial Consistencies for Faces with Total Number of Fixations of Trials 1-9.

Trial	Stimulus	Trial	Stimulus	*r*	*p*	Effect	Significant
1	ANG-ANG	2	NEU-HAP	.04	.830	None	N
2	NEU-HAP	3	HAP-NEU	.25	.210	M	N
3	HAP-NEU	4	ANG-HAP	.18	.370	S-M	N
4	ANG-HAP	5	NEU-NEU	.32	.120	M	N
5	NEU-NEU	6	HAP-HAP	.20	.320	S-M	N
6	HAP-ANG	7	ANG-ANG	.10	.640	S	N
7	ANG-NEU	8	HAP-HAP	.56	<.050	L	Y
8	HAP-HAP	9	NEU-NEU	.29	.150	M	N

Table 12. Two-Trial Consistencies for Faces with Latency to First Fixation of Trials 1-9.

Trial	Stimulus	Trial	Stimulus	*r*	*p*	Effect	Significant
1	ANG-ANG	2	NEU-HAP	.03	.880	None	N
2	NEU-HAP	3	HAP-NEU	.42	<.050	M-L	Y
3	HAP-NEU	4	ANG-HAP	.34	.090	M	N
4	ANG-HAP	5	NEU-NEU	.46	<.020	L	Y
5	NEU-NEU	6	HAP-HAP	.69	<.001	L	Y
6	HAP-ANG	7	ANG-ANG	.23	.260	S-M	N
7	ANG-NEU	8	HAP-HAP	.24	.240	S-M	N
8	HAP-HAP	9	NEU-NEU	.56	<.010	L	Y

Table 13. Two-Trial Consistencies for Faces with Total Fixation Time of Trials 1-9.

Trial	Stimulus	Trial	Stimulus	*r*	*p*	Effect	Significant
1	ANG-ANG	2	NEU-HAP	.38	<.010	M-L	Y
2	NEU-HAP	3	HAP-NEU	.46	<.010	L	Y
3	HAP-NEU	4	ANG-HAP	.32	<.050	M	Y
4	ANG-HAP	5	NEU-NEU	.41	<.010	M-L	Y
5	NEU-NEU	6	HAP-HAP	.46	<.010	L	Y
6	HAP-ANG	7	ANG-ANG	.57	<.001	L	Y
7	ANG-NEU	8	HAP-HAP	.55	<.001	L	Y
8	HAP-HAP	9	NEU-NEU	.38	<.010	M-L	Y

Table 14. Two-Trial Consistencies for Faces with Total Number of Shifts Between AOI's of Trials 1-9.

Trial	Stimulus	Trial	Stimulus	*r*	*p*	Effect	Significant
1	ANG-ANG	2	NEU-HAP	.40	<.010	M-L	Y
2	NEU-HAP	3	HAP-NEU	.47	<.010	L	Y
3	HAP-NEU	4	ANG-HAP	.44	<.010	M-L	Y
4	ANG-HAP	5	NEU-NEU	.18	.230	S-M	N
5	NEU-NEU	6	HAP-HAP	.29	<.050	M	Y
6	HAP-ANG	7	ANG-ANG	.24	.110	S-M	N
7	ANG-NEU	8	HAP-HAP	.34	<.050	M	Y
8	HAP-HAP	9	NEU-NEU	.32	<.050	M	Y

Table 15. Two-Trial Consistencies for Objects with Total Number of Fixations of Trials 1-9.

Trial	Stimulus	Trial	Stimulus	*r*	*p*	Effect	Significant
1	LOW-LOW	2	MED-HGH	.56	<.050	L	Y
2	MED-HGH	3	HGH-MED	.65	<.010	L	Y
3	HGH-MED	4	LOW-HGH	.21	.370	S-M	N
4	LOW-HGH	5	MED-MED	.60	<.010	L	Y
5	MED-MED	6	HGH-LOW	.17	.490	S-M	N
6	HGH-LOW	7	HGH-LOW	.40	.080	M-L	N
7	LOW-MED	8	LOW-MED	.21	.380	S-M	N
8	HGH-HGH	9	HGH-HGH	.31	.180	M	N

Table 16. Two-Trial Consistencies for Objects with Latency to First Fixation of Trials 1-9.

Trial	Stimulus	Trial	Stimulus	*r*	*p*	Effect	Significant
1	LOW-LOW	2	MED-HGH	.32	.170	M	N
2	MED-HGH	3	HGH-MED	.09	.700	S	N
3	HGH-MED	4	LOW-HGH	.17	.480	S-M	N
4	LOW-HGH	5	MED-MED	.15	.540	S	N
5	MED-MED	6	HGH-LOW	.24	.310	S-M	N
6	HGH-LOW	7	HGH-LOW	.09	.690	S	N
7	LOW-MED	8	LOW-MED	.01	.970	None	N
8	HGH-HGH	9	HGH-HGH	.52	<.050	L	Y

Table 17. Two-Trial Consistencies for Objects with Total Fixation Time of Trials 1-9.

Trial	Stimulus	Trial	Stimulus	*r*	*p*	Effect	Significant
1	LOW-LOW	2	MED-HGH	.32	.190	M	N
2	MED-HGH	3	HGH-MED	.44	.050	M-L	N
3	HGH-MED	4	LOW-HGH	.39	.090	L	N
4	LOW-HGH	5	MED-MED	.47	<.050	L	Y
5	MED-MED	6	HGH-LOW	.52	<.050	L	Y
6	HGH-LOW	7	HGH-LOW	.55	<.050	L	Y
7	LOW-MED	8	LOW-MED	.33	<.150	M	N
8	HGH-HGH	9	HGH-HGH	.09	.700	S	N

Table 18. Two-Trial Consistencies for Objects with Total Number of Shifts Between AOI's of Trials 1-9.

Trial	Stimulus	Trial	Stimulus	*r*	*p*	Effect	Significant
1	LOW-LOW	2	MED-HGH	.42	.060	M-L	N
2	MED-HGH	3	HGH-MED	.47	<.050	L	Y
3	HGH-MED	4	LOW-HGH	.21	.370	S-M	N
4	LOW-HGH	5	MED-MED	.08	.720	S	N
5	MED-MED	6	HGH-LOW	.45	<.050	L	Y
6	HGH-LOW	7	HGH-LOW	.50	<.050	L	Y
7	LOW-MED	8	LOW-MED	.58	<.010	L	Y
8	HGH-HGH	9	HGH-HGH	.26	.260	M	N

Table 19. Two-Trial Consistencies for Face Matched Pairs with Total Number of Fixations of Trials 1-9.

Trial	Stimulus	Trial	Stimulus	*r*	*p*	Effect	Significant
4	ANG-HAP	6	HAP-ANG	.17	.390	S-M	N
2	NEU-ANG	3	HAP-NEU	.25	.210	M	N
7	ANG-NEU	9	NEU-ANG	.48	<.050	L	Y
1	ANG-ANG	5	NEU-NEU	.27	.190	M	N
5	NEU-NEU	8	HAP-HAP	.23	.250	S-M	N
1	ANG-ANG	8	HAP-HAP	.20	.330	S-M	N

Table 20. Two-Trial Consistencies for Face Matched Pairs with Latency to First Fixation of Trials 1-9.

Trial	Stimulus	Trial	Stimulus	*r*	*p*	Effect	Significant
4	ANG-HAP	6	HAP-ANG	.51	<.010	L	Y
2	NEU-ANG	3	HAP-NEU	.42	<.050	M-L	Y
7	ANG-NEU	9	NEU-ANG	.13	.530	S	N
1	ANG-ANG	5	NEU-NEU	.22	.280	S-M	N
5	NEU-NEU	8	HAP-HAP	.24	.230	S-M	N
1	ANG-ANG	8	HAP-HAP	.11	.590	S	N

Table 21. Two-Trial Consistencies for Face Matched Pairs with Total Fixation Time of Trials 1-9.

Trial	Stimulus	Trial	Stimulus	*r*	*p*	Effect	Significant
4	ANG-HAP	6	HAP-ANG	.68	<.001	L	Y
2	NEU-ANG	3	HAP-NEU	.50	<.010	L	Y
7	ANG-NEU	9	NEU-ANG	.51	<.010	L	Y
1	ANG-ANG	5	NEU-NEU	.37	.060	M-L	N
5	NEU-NEU	8	HAP-HAP	.32	.110	M	N
1	ANG-ANG	8	HAP-HAP	.70	<.001	L	Y

Table 22. Two-Trial Consistencies for Face Matched Pairs with Total Number of Shifts Between AOI's of Trials 1-9.

Trial	Stimulus	Trial	Stimulus	*r*	*p*	Effect	Significant
4	ANG-HAP	6	HAP-ANG	.31	.120	M	N
2	NEU-ANG	3	HAP-NEU	.51	<.010	L	Y
7	ANG-NEU	9	NEU-ANG	.23	.260	S-M	N
1	ANG-ANG	5	NEU-NEU	.08	.710	S	N
5	NEU-NEU	8	HAP-HAP	.44	<.050	M-L	Y
1	ANG-ANG	8	HAP-HAP	.11	.580	S	N

Table 23. Two-Trial Consistencies for Face Matched Pairs with Total Number of Fixations of Trials 1-9.

Trial	Stimulus	Trial	Stimulus	*r*	*p*	Effect	Significant
4	LOW-HGH	6	HGH-LOW	.46	<.050	L	Y
2	MED-HGH	3	HGH-MED	.65	<.010	L	Y
7	LOW-MED	9	MED-LOW	.80	<.001	L	Y
1	LOW-LOW	5	MED-MED	.45	<.050	L	Y
5	MED-MED	8	HGH-HGH	.54	<.050	L	Y
1	LOW-LOW	8	HGH-HGH	.45	<.050	L	Y

Table 24. Two-Trial Consistencies for Face Matched Pairs with Latency to First Fixation of Trials 1-9.

Trial	Stimulus	Trial	Stimulus	*r*	*p*	Effect	Significant
4	LOW-HGH	6	HGH-LOW	.18	.460	S-M	N
2	MED-HGH	3	HGH-MED	.09	.700	S	N
7	LOW-MED	9	MED-LOW	.58	<.010	L	Y
1	LOW-LOW	5	MED-MED	.01	.950	None	N
5	MED-MED	8	HGH-HGH	.35	.130	M-L	N
1	LOW-LOW	8	HGH-HGH	.07	.760	S	N

Table 25. Two-Trial Consistencies for Face Matched Pairs with Total Fixation Time of Trials 1-9.

Trial	Stimulus	Trial	Stimulus	*r*	*p*	Effect	Significant
4	LOW-HGH	6	HGH-LOW	.67	<.010	L	Y
2	MED-HGH	3	HGH-MED	.44	.050	M-L	N
7	LOW-MED	9	MED-LOW	.49	<.050	L	Y
1	LOW-LOW	5	MED-MED	.40	.080	M-L	N
5	MED-MED	8	HGH-HGH	.32	.170	M	N
1	LOW-LOW	8	HGH-HGH	.29	.210	M	N

Table 26. Two-Trial Consistencies for Face Matched Pairs with Total Number of Shifts Between AOI's of Trials 1-9.

Trial	Stimulus	Trial	Stimulus	*r*	*p*	Effect	Significant
4	LOW-HGH	6	HGH-LOW	.35	.130	M-L	N
2	MED-HGH	3	HGH-MED	.47	<.050	L	Y
7	LOW-MED	9	MED-LOW	.36	.120	M-L	N
1	LOW-LOW	5	MED-MED	.54	<.050	L	Y
5	MED-MED	8	HGH-HGH	.66	<.010	L	Y
1	LOW-LOW	8	HGH-HGH	.28	.220	M	N

LIST OF FIGURES

Group Mean Differences

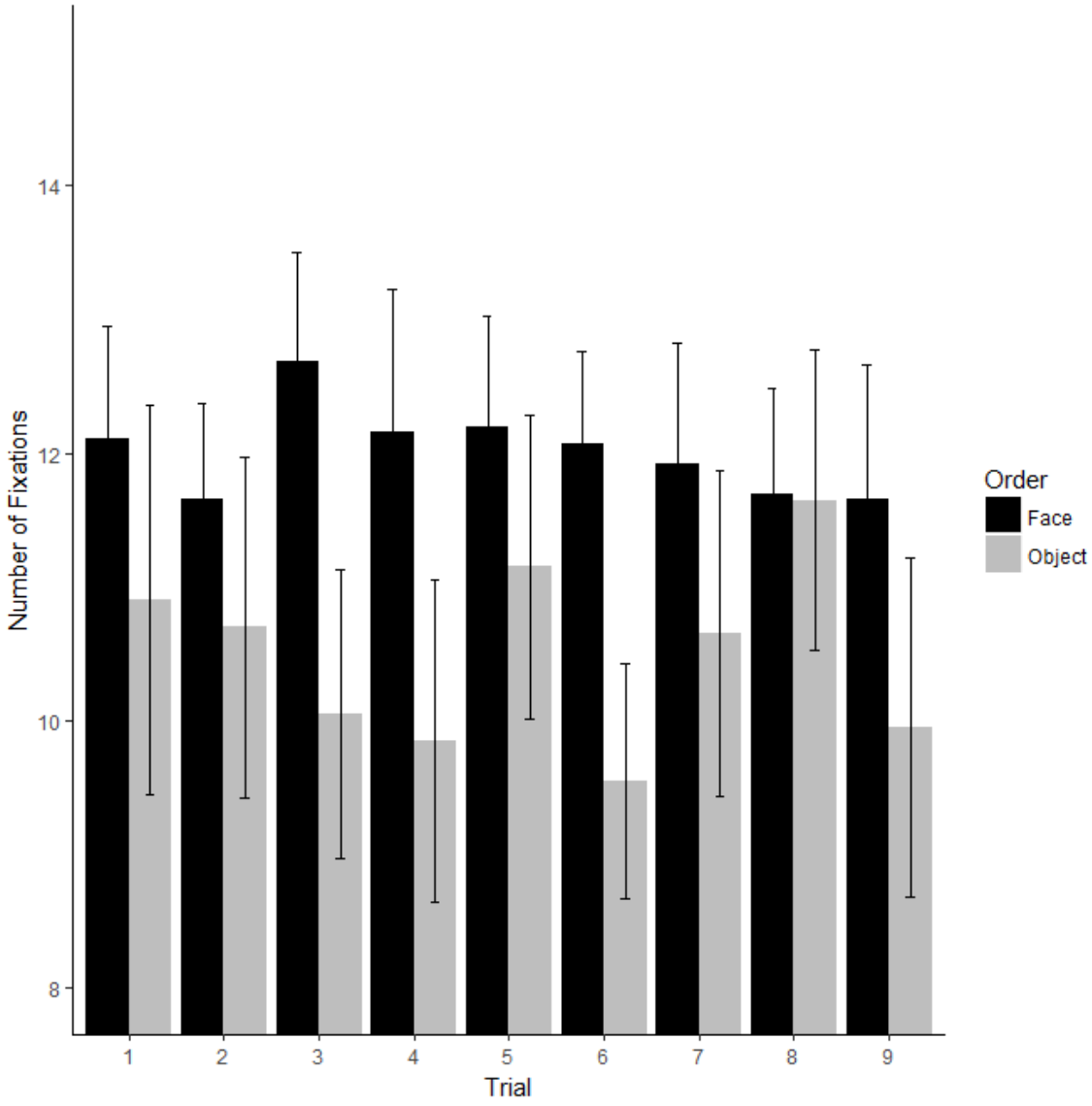

Figure 1. Group Differences: Total Number of Fixations

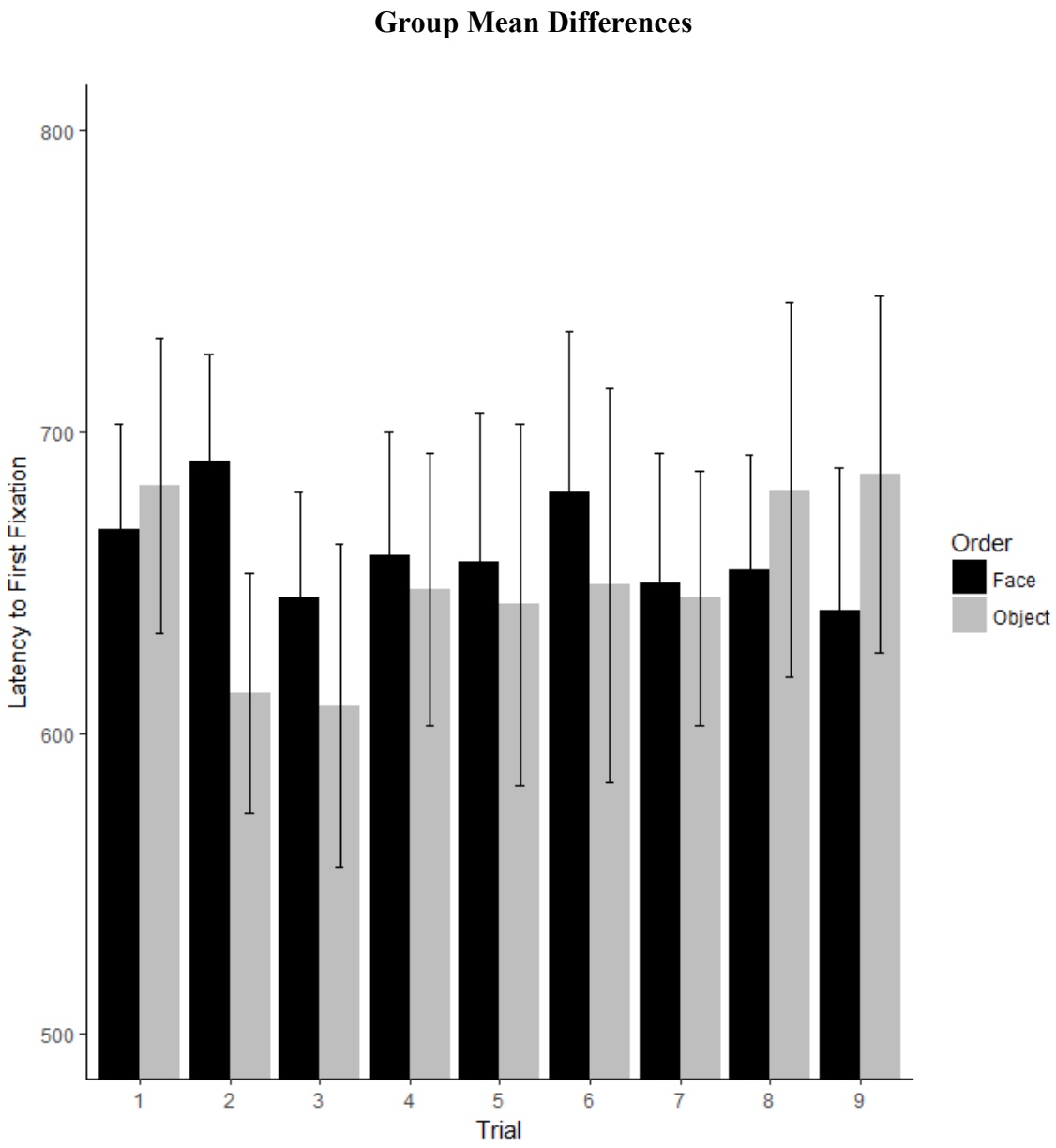

Figure 2. Latency to First Fixation

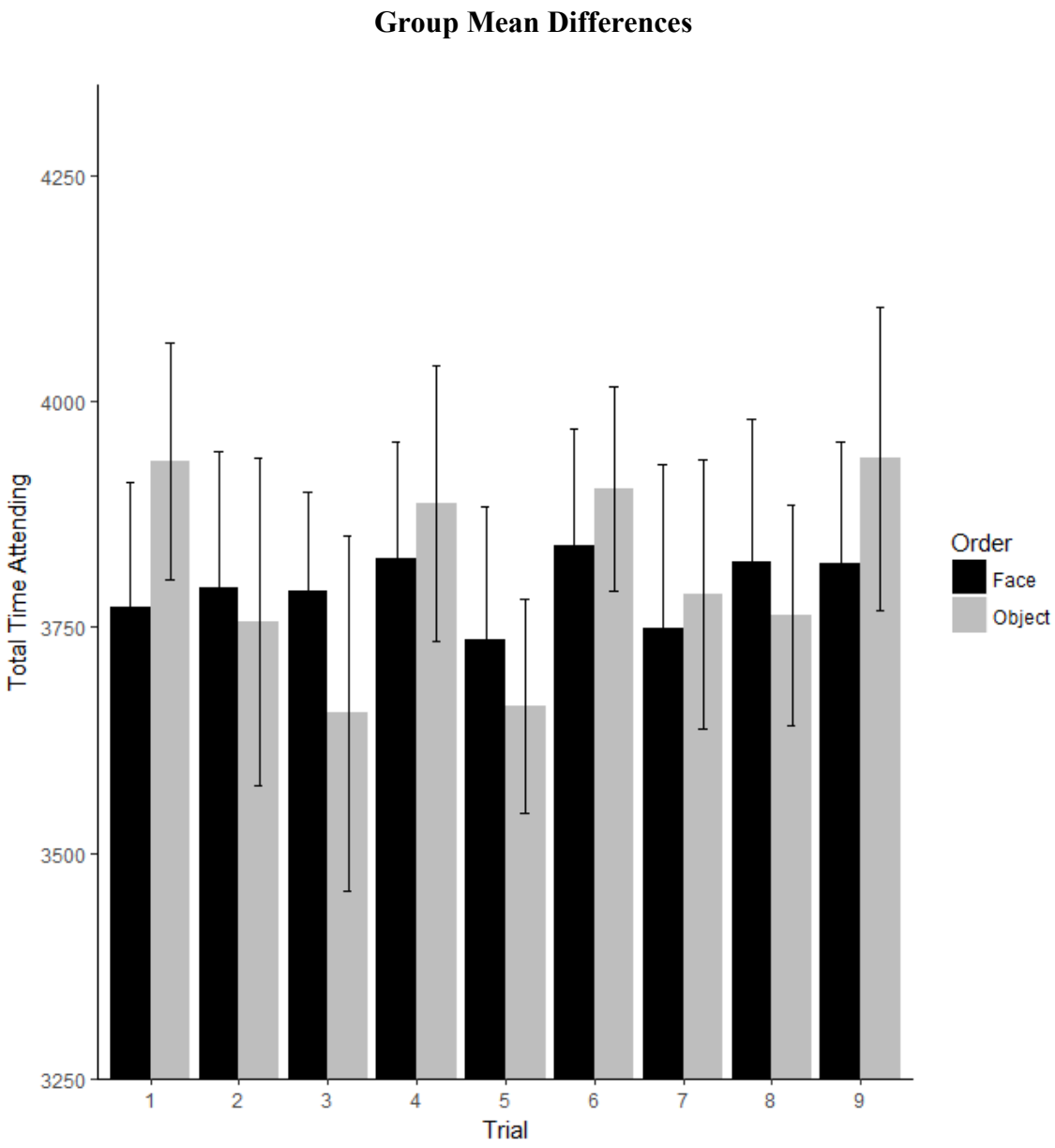

Figure 3. Total Fixation Time.

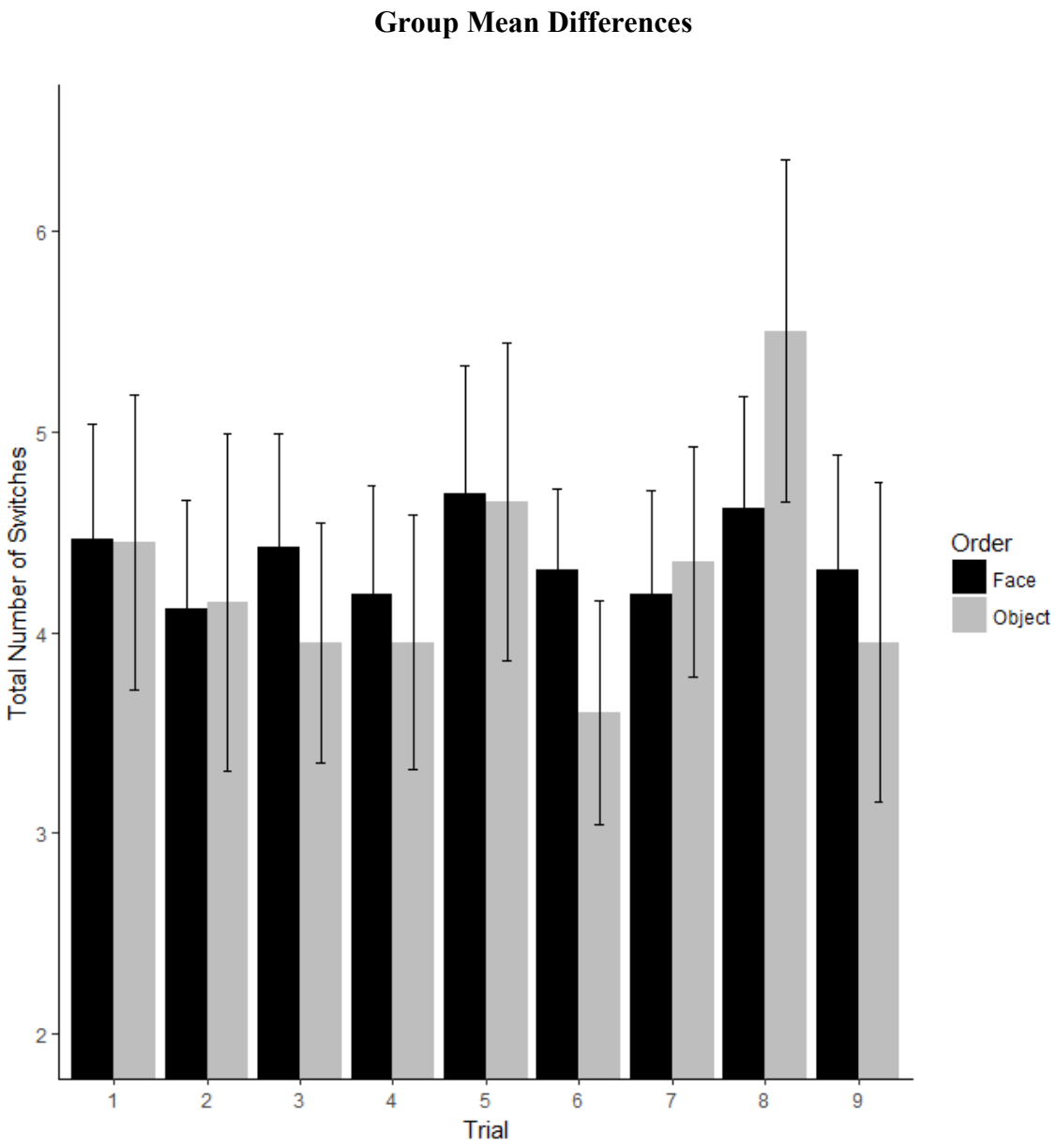

Figure 4. Total Number of Shifts.