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The processing of evolutionarily relevant stimuli

Angela Marcelle Perta
James Madison University

The Processing of Evolutionarily Relevant Stimuli

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by Angela Marcelle Perta

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Accepted by the faculty of the Department of Psychology, James Madison University, in partial fulfillment of the requirements for the Degree of Bachelor of Arts .

FACULTY COMMITTEE:

____

Project Advisor: Krisztina Jakobsen, Ph.D.
Associate Professor, Psychology

____

Reader: Jeffery, Dyche
Associate Professor, Psychology

____

Reader: Jeffery Andre
Professor, Psychology
HONORS PROGRAM APPROVAL:

____

Barry Falk, Ph.D.,
Director, Honors Program

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The Department of Psychology at James Madison University

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Abstract

Previous research suggests that the human face captures attention more quickly than objects. Based on neurophysiological and behavioral studies, we would expect that the human body would also capture attention efficiently. We used a passive viewing adaptation to the visual search paradigm to examine how quickly whole human body, isolated human face, and isolated human body stimuli capture attention across three array sizes (9, 16, 25 stimuli). Our results suggest that the isolated human face captures attention most efficiently in the two smaller arrays, but no more efficiently than the whole human body and isolated human body in the largest array. Thus, it appears that the isolated human face loses its attention capture properties when compared to other evolutionary relevant stimuli in complex environments.

Introduction

As a daily part of human interaction, people process and respond to the human face and body. The human face is thought to play a significant role in this interaction (Langton, Law, Burton, & Schweinberger, 2008). This theory has sparked an extensive exploration of face perception and processing by evolutionary and developmental psychologists as well as vision scientists. An abundance of literature exists exploring all aspects of face perception, from infants' facial preferences to mechanisms in the brain responsible for facial processing (e.g., Di Giorgio, Turatio, Altoe, & Simion, 2012; Minnebusch & Daum, 2009). Some studies demonstrate that the human face receives specialized processing (e.g., Farah, Wilson, Drain, & Tanaka, 1998; Hershler & Hochstein, 2005), further indicating that the face may play an integral role in communication and social interaction. While many have examined facial processing and perception, few have examined body processing and perception. Thus, the main goal of the present research was to examine human body processing, while also considering the similarities and differences between body and face processing.

Face Perception and Recognition Research

The human face has been the interest of many researchers for decades (Carey, Diamond & Woods,1980; Farah et al., 1998; Palermo & Rhodes, 2007). Researchers have used a variety of methods to look at all aspects of the human face including how emotion and manipulation of the face effect facial processing and attention capture (e.g., Palermo & Rhodes, 2007). Emotions that have been studied include but are not limited to happiness, anger, and fear (Palermo & Rhodes, 2007). Moreover, researchers have studied the effects of manipulating the face by taking away parts of the face (e.g., an eye), inverting the face, and scrambling the face (Palmero

& Rhodes, 2007; Yovel, Pelc, & Lubetzky, 2010). The face has been studied using a variety of methods including functional magnetic resonance imaging (fMRI), event-related potentials (ERPs), eye-tracking, and behavioral measures (Aviezer, Trope, & Todorov, 2012; Di Giorgio, Turatio, Altoe, & Simion, 2012; Palermo & Rhodes, 2007; Sabatinelli et al., 2011). Additionally, researchers have examined face detection and perception among all different populations including adults, infants, and those with mental and developmental disorders (Di Giorgio et al., 2012; Li, Chan, McAlonan & Gong, 2010; Marsh & Blair, 2008). Thus, face perception and recognition is a well-studied field that is continually growing.

Why the Interest?

The applicability of face perception and recognition encourages the continuation of the aforementioned research. The understanding of facial recognition enables the creation of face recognition systems that would be helpful in security and surveillance systems, mug shot searching, and person identification (Tolba, Baz, & Harby, 2006). Additionally, individual differences in facial processing may have application in the clinical setting. Antisocial populations appear to have a deficit in identifying fearful emotions compared to healthy controls (Marsh & Blair, 2008). Schizophrenics also demonstrate difficulty in the perception of emotional facial expression (Li et al, 2009). Moreover, combat exposure appears to effect perception of facial expressions in that combat participants more accurately identify threatening face than non-threatening faces compared to controls (Anaki, Brezniak, & Shalom, 2012). Thus, differing perceptions of the human face among special populations might provide the clinician and authorities (e.g., military authorities) with new insights (Anaki, Brezniak, & Shalom, 2012). Finally, because faces are considered to be of great biological and social importance (Hershler, Golan, Bentin & Hochstein, 2010; Palermo & Rhodes, 2007) results from face perception studies test the validity of these theories and can help determine if humans have an innate bias for socially relevant stimuli (Crouzet, Kirchner, & Thorpe, 2010).

Narrowing the Focus: Examining the Human Face and Attention Capture

Visual Search Paradigm. The visual search paradigm (Treisman & Gelade, 1980), is one paradigm that has been utilized by researchers to study facial processing (e.g., Hershler & Hochstein, 2005). In the visual search paradigm, a salient target is placed among numerous distractor items in an array and reaction time to find the target is measured (Treisman & Souther, 1985). Typically, participants demonstrate two different search patterns. If the target is indeed salient in comparison to the distractors, it is said to "pop-out." Treisman and Souther (1985) define pop-out as reaction time to locate the target being independent of number of distractors present; in this case, participants use a parallel search to find the target, indicating that the target quickly captures their attention among the distractors. Conversely, if the target is not salient or does not "pop-out," participants exhibit a serial search pattern which is defined as a linear increase in search time as the number of distractors (or array size) increases. In order to assess search efficiency, slopes are calculated using reaction times as the dependent variable. Treisman and Souther (1985) propose that slopes characterized by an increase in reaction time around 5- 6 m/s per item or distractor constitute a parallel search rather than a serial search, which is characterized by an increase in reaction time of more than 20 m/s per item. Serial search is also thought to require focused attention, whereas parallel search is defined by automatic attention capture.

Wolfe (1998) argues that when interpreting results, researchers should consider slopes on a continuum rather than as a dichotomy between serial and parallel search. This proposal is based on a meta-analysis that examined results from 1 million visual search task trials (Wolfe, 1998). Studies included in the meta-analysis were based on convenience; however, all experiments shared the traditional characteristics of a visual search paradigm: participants were instructed to locate a certain target item as quickly and as accurately as possible, the target was present on only 50% of trials, and the display was presented only until the participants responded (Wolfe, 1998). Based on the results, Wolfe concludes that the interpretation of the results from visual search paradigm experiments present a false dichotomy between serial and parallel search. He argues that the rules of thumb used to describe parallel and serial search patterns are arbitrary. Moreover, he contends that when analyzing results, researchers should compare the relative steepness of the slopes to describe search efficiency. Thus, Wolfe theorizes that significant differences in slope steepness can provide insight into how participants allocate their visual attention, even if the slopes do not fall within the thresholds of the visual search paradigm dichotomy. Accordingly, when interpreting the results of the visual search paradigm, relative search efficiency between slopes should be assessed.

Are Faces Special? Some researchers have sought to simply determine if faces are special, meaning that they capture attention more quickly than other stimuli (Hershler & Hochstein, 2005; Simpson, Jakobsen & Mertins, under review). In order to measure attention capture, Hershler and Hochstein (2005) employed the visual search paradigm by placing faces among objects. The results of five experiments revealed that participants' detection of the human face among a variety of objects was independent of array size, indicating greater search efficiency for faces. VanRullen (2006), however, criticized the work of Hershler and Hochstein (2005), along with other face perception research that employs the visual search paradigm, by proposing that faces only pop-out when they are visually dissimilar from the distractor objects. The results from his own experiments, demonstrated that participants' search times were just as efficient when searching for an object among faces as they were when searching for a face among objects; therefore, VanRullen contends that the visual search paradigm is flawed (VanRullen, 2006). Accordingly, VanRullen theorizes that faces pop-out in the visual search paradigm because of low-level processing of the stimuli rather than high-level processing. Low-level processing of stimuli is defined as participants relying on rudimentary features such as color contrast to identify the target, whereas high-level processing indicates specialized processing independent of rudimentary features.

Hershler and Hochstein (2006) note that VanRullen (2006) failed to find a pop-out effect for a specific object (a car) among heterogeneous objects (household items, plants, food, etc.) but found that a face pops out among the heterogeneous objects. Accordingly, Hersher and Hochstein (2006) contend that the use of a heterogeneous background (a variety of objects) does not dramatically differ from the target (face) by "any obvious identical basic feature" (p.3). Thus, Hershler and Hochstein challenge VanRullen to identify a low-level feature hidden within their heterogeneous background responsible for the potential low-level processing behind facial attention capture in the visual search paradigm. Additionally, Hershler and Hochstein argue that the use of a homogeneous background, such as an object among faces, prompts the participant to identify the target through low-level features (e.g., color contrast), whereas the use of heterogeneous background prevents low-level processing.

More recent surmounting facial processing evidence further discredits the claims of VanRullen (2006; Hershler, Golan, Bentin & Hochstein, 2010; Langton et al., 2008). Findings from a recent study employing a visual search paradigm suggest that faces are special in that they capture attention more quickly than other stimuli, when accounting for low-level processing of the face by using target controls that share similar features of the human face (e.g., dog and clock faces; Hershler, Golan, Bentin & Hochstein, 2010). Faces and control targets were placed at different eccentricities in visual search arrays. Researchers found greater search efficiency for human faces compared to control targets (dog and clock faces; Hershler et al., 2010). This evidence further indicates that faces are processed in a specialized manner. Langton, Law, Burton and Schweinberger (2008) also utilized the visual search task to assess attention capture of faces. The results from two experiments demonstrated that faces elicit differential processing from other objects even when participants were not asked to search for the face (Langton et al., 2008). Participants demonstrated an increase in reaction time when searching for an object in an array that contained a human face as a distractor object versus searching for an object in an array that did not contain a face as a distractor. The search for face targets, however, was not subject to interference by other animal distractors (Langton et al, 2008), reaffirming the hypothesis that faces receive specialized processing.

Passive viewing. Facial processing has also been studied using a modified visual search paradigm. Developmental researchers have adopted the visual search paradigm as a passive task when using infant and adult participants (Adler & Orprecio, 2006; Gliga, Elsabbagh, Adravizou, & Johnson, 2009; Di Giorgio, Turati, Altoe, & Simion, 2012). Through the use of an eye-tracker, researchers have been able to study face attention capture in infants, while still using the visual search paradigm. Accordingly, infants are presented with an array of images and researchers use first look and reaction time in order to identify the objects that capture the infant's attention. This passive viewing paradigm has been employed using simplistic stimuli such as a + among L's (Adler & Orprecio, 2006) as well as more complex stimuli such as faces among objects (Gliga et al.,2009). Consistent with adult findings, faces seem to capture infant's attention more efficiently than objects (Gliga et al., 2009). In a study using 6-month-old infants, Gliga et al. (2009) found that infants' first look was more likely to be at the human face more than any other object in the array. Additionally, when visual frequencies were manipulated faces failed to attract infants' first looks, suggesting that some structural information (a component of high-level processing) plays a role in attention capture (Gliga et al., 2009). Adults have also been tested using this modified paradigm in order to compare results between age groups (Adler & Jazmine, 2006; Di Giorgio et al., 2012). A study utilizing this paradigm found that faces captured the attention of both infants and adults preferentially compared to other objects (Di Giorgio et al., 2012).

Other Paradigms

Other researchers have measured saccadic eye movement when investigating face attention capture (Crouzet, Kirchner, & Thrope, 2010; Morand et al., 2010). Crouzet, Kirchner and Thrope (2010) found that participants demonstrated faster saccades toward human faces compared to animals or vehicles. Morand et al. (2010) further explored saccadic eye movements for faces through an anti-saccadic paradigm that required participants to orient attention in the opposite direction from the target stimuli: the face or the object (a car). When accounting for low-level visual properties between the face and the car images by equating the spatial frequency, contrast, and luminance, participants still made more errors when orienting away from the face than away from the car, suggesting that the processing of faces is involuntary and automatic (Monrad et al., 2010). Accordingly, saccadic eye movement studies also demonstrate automatic, specialized, and maybe even involuntary, processing of the human face.

The inversion effect is another behavioral measure used in the study of face perception (Farah et al., 1998; Yovel, Pelc, & Lubetsky, 2010). The inversion effect is defined by impaired processing for inverted stimuli, including faces (Minnebusch & Daum, 2009; Yovel, Pelc, & Lubetsky, 2010). Many studies have found this effect for faces but not for other objects or stimuli, which serves as additional evidence for special facial processing (Farah et al., 1998; Minnebusch & Daum, 2009; Yovel, Pelc, & Lubetsky, 2010).

The Expertise Hypothesis

Researchers have sought to explain why human faces might be processed in a specialized manner, leading to the formation of the expertise hypothesis (Diamond & Carey, 1986). The expertise hypothesis suggests that we process faces differently from other stimuli because of frequent exposure and that they are important for everyday interaction (Minnebusch & Daum, 2009). Experiments have confirmed the expertise hypothesis not only for faces, but for other objects (Diamond & Carey, 1986; Gauthier & Tarr, 1997). Diamond and Carey (1986) conducted a study demonstrating in which they found that faces were more easily remembered and identified in a recognition task than objects, suggesting that humans are face “experts.” The researchers also demonstrated specialized processing of dog faces in an experiment in which dog experts participated in a recognition task of dogs (Diamond & Carey, 1986); dog experts identified dog faces significantly more accurately in a forced choice recognition series than controls (novices). Additionally, both human and dog faces were subject to the inversion effect among dog experts. Thus, these results suggest that continued exposure can lead to specialized processing.

Brain Mechanisms and Biological underpinnings behind Facial Processing

Identifiable face processing mechanisms in the brain help to elucidate discrepancies surrounding whether faces are “special.” Numerous fMRI studies have attempted to identify face processing mechanisms in the brain. One fMRI study revealed higher activation in the ventral occipital region, or what some have termed the occipital face area (OFA), when participants viewed faces compared to tools (Peelen & Downing, 2005). Results from other fMRI and EEG studies support the existence of the OFA (Minnebusch & Daum, 2009). In addition to the OFA, the fusiform face area of the fusiform gyrus of the temporal lobe shows continual activation when viewing the human face (Minnebusch & Daum, 2009). A recent study also suggests that the left and right fusiform gyrus process different aspects of the human face, with the left hemisphere identifying the semblance of a face and the right hemisphere making categorical of face/non-face judgments (Meng, Cherian, Singal, & Sinha, 2013).

Moreover, the neuropsychological disorder prosopagnosia provides additional evidence for specialized face processing brain regions. Prosopagnosia is a rare disorder defined by the inability to recognize and identify human faces, including the patient’s own face (Moro et al., 2012). While patient’s ability to recognize faces is impaired, intellectual and cognitive abilities, however, remain intact (Moro et al., 2012). The damaged brain areas seen in this disorder usually encompass the occipital face area and the fusiform face area (Moro et al., 2012). This evidence further suggests that specialized brain mechanisms exist for processing the human face.

The Investigation of Body Perception and Processing

Behavioral Evidence

While many have examined if the face is special (Hersher & Hochstein 2005; Hershler et al., 2010; Morand et al., 2010; Simpson et al., under review), few have examined if the body also receives specialized processing. Fletcher-Watson, Findlay, Leekam, and Benson (2008) examined whole body detection using a paradigm in which participants are presented with two types of randomly paired scenes: person-present and person-absent. Participants demonstrated strong biases in attending to a scene containing the person compared to a scene where the person was absent. Eye movement data revealed the participants spent the majority of the time looking at the person with no instruction to do so, suggesting that the human body and face receive preferential attention (Fletcher-Watson et al., 2008). Fletcher-Watson et al. (2008) assert that these findings are not confounded by low-level visual factors as the persons presented in the scenes were composed of a variety of small areas of differing in color contrast.

Bindemann, Scheepers, Ferguson, and Burton (2010) extended the findings of Fletcher-Watson et al. (2008) in a study that required participants to observe isolated natural scenes that contained differing body stimuli (whole body, isolated body, isolated human face). The researchers found that the fastest attention capture occurred when the whole human body was present in the scene versus when just the face was present. Participants detected the isolated human body and face with similar efficiency. Accordingly, the researchers assert that this finding suggests that the differing size of the stimuli does not confound the overall findings because size was not related in a linear manner (Bindeman et al., 2010). Thus, the results indicate that the body may also capture attention more quickly than other environmental stimuli, and that the human face and body equally promote person detection in naturalistic scenes (Bindeman et al., 2010).

The inversion effect has been studied in body processing as well. Yovel, Pelc, & Lubetzky (2010) tested whether inverted bodies also lead to slower processing. The researchers found an inversion effect for bodies with heads (without facial features) but not for headless bodies. Additionally, the removal of another body part (e.g., arm or leg) did not abolish the inversion effect. The abolishment of the body inversion effect through the removal of the head suggests that the body might be processed differently from the face and that the head mediates specialized processing for the body (Yovel, Pelc & Lubetsky, 2010).

Neuropsychological Evidence

Neuropsychological evidence and the identification of parallel brain mechanisms for the human body suggest that the human body might receive similar specialized processing that the face receives. In fMRI studies, an area in the extrastriate cortex of the occipital lobe shows greater activation during the perception of human bodies and parts when compared to the activation for objects and faces (Minnebusch & Daum, 2009).   Researchers have termed this area the extrastriate body area (EBA), localized in the postero-inferior temporal cortex paralleling the occipital face area (Minnebusch & Daum, 2009; Moro et al., 2012). Moreover, an area in the posterior fusiform gyrus has also been identified for specialized body processing (Minnebusch & Daum, 2009; Moro et al., 2012). This area has been termed the fusiform body area (FBA), analogous to the fusiform face area (FFA; Minnebusch & Daum, 2009; Moro et al., 2012). In a recent neuropsychological study, patient FM demonstrated deficits in perception of the body and face after ischemic stroke following a cardiological surgical procedure (Moro et al., 2012). FM's cerebral damage encompassed the left EBA and right FBA as well as the left and right FFA and the right FBA, further suggesting specialized brain mechanisms for both the face and body (Moro et al., 2012).

Extending the Research

The present study sought to extend on the aforementioned research by adopting Treisman and Souther's (1985) visual search paradigm as a passive viewing task. While the passive viewing modification proved useful in previous studies for comparing adult and infant attention capture (Adler & Orprecio 2006; Di Giorgio et al., 2012), the present study also found this paradigm applicable. The researchers considered this paradigm to be a better indicator of attention capture for socially relevant stimuli because the participant was able to freely examine the pictures, whereas in an active task the participant has an expectation of the target. Additionally, distractors were heterogeneous in accordance with the Hershler and Hochstein study (2005; 2006) and Simpson et al. (under review). Reaction time was measured through the use of an eye-tracker to determine if one target (whole human body, isolated human body, and isolated human face) captures the attention of participants more quickly than others. The neutrality of the targets was taken into consideration to account for emotionality as a confounding variable. Also, participants were asked to report Reserve Officers' Training Corps affiliation to account for potential differences in experience (i.e., target training) that could serve as a mediating factor in target category identification. In light of the previously mentioned research, we predicted that the whole human body would be most efficient (i.e., the quickest) in capturing participants' attention and that the face would capture attention more quickly than isolated bodies.

Method

Participants

A total of 36 participants were recruited from a large southern university. Of the 36 participants 23 were female and 13.8 % were of minority descent (Asian and Afghan). One participant was excluded from the data set due to calibration failures. All participants reported normal or corrected-to-normal vision. One participant was enrolled in the ROTC program. Participants were compensated with course credit for their participation.

Apparatus

Tobii eye tracker. A Tobii T120 eye tracker was used to measure participants' reaction time to locate the target. The Tobii eye tracker is equipped with a remote 43 cm monitor and has a sampling rate of 120 Hertz that allows for integrated eye tracking. The participants sat 60 cm from the eye tracker. Tobii Studio software (Tobii, Technology, Sweden) was used in data collection and analysis. Participants' time to first fixation to the area of interest (AOI) was measured. Fixation was defined as fixating for a minimum of 100 ms within a 50 pixel radius.

Measures

Health and demographics form. The Health and Demographics form was used to gather data on the participants' age, sex, vision problems, and if the participant is a member of the Reserve Officers' Training Corps (ROTC) at JMU.

Stimuli. The stimuli consisted of three different targets—the whole human body, the isolated human body, and the isolated human face. The *whole human body* was defined as the presence of the human head/face, neck, torso, and extremities, whereas the *isolated human body* was the presence of the human torso and extremities excluding the head and neck. The *isolated* *human face* was defined as the presence of the human face alone. All stimuli were presented in an upright position facing forward. Stimuli were selected for diversity in terms of age, gender, and race. All stimuli, both targets and distractors, were the same size (2.86° x 2.86°).

The emotional valence of the isolated human face stimuli was previously assessed for neutrality in prior study (Simpson et al., under review). Whole human body and isolated human body stimuli were rated for emotional valence on a Likert scale (1 completely neutral, 7 very emotional). Previous research indicates that the face has a moderating effect on how the body is rated in that the presence of the face effects the emotionality rating of the body (Aviezer, Trope, & Todorov, 2012; Willis, Palmero, & Bruke, 2011). Therefore, the whole human body stimuli were rated as a single unit (with both face and body present) instead of in two parts (isolated face, isolated human body). Whole human body and isolated human body stimuli rated above 3.5 on the scale were excluded. Target stimuli were presented in an array among objects differing in number of distractors present (8, 15, or 24 distractors).

Procedure

Upon arrival to the lab, the experimenter explained the experiment in detail to the participant**.** Interested participants signed a consent form. Participants were then positioned directly in front of a Tobii eye-tracker. The experimenter calibrated the eyes of the participant by asking the participant to track an object to five different points on the screen. After successful calibration, participants were instructed to follow the directions on the screen: "You will be viewing a series of pictures on each slide. Please look at every slide of pictures. Please press the space bar when you are ready to begin." In accordance with previous studies, all arrays were randomly presented for five seconds (e.g., Simpson et al., under review). There were 72 trials total: eight trials per array size (9, 16, 25) per condition (whole human body, isolated human body, isolated human face). Upon completing the experiment, participants completed a health and demographics questionnaire.

Results

A 3x3 (Array Size [9,16,25] x Target Category [whole human body, isolated human body, isolated human face]) analysis of variance (ANOVA) on reaction time of attention capture revealed a main effect of target category ($F(2, 34)=12.754$, $p<.001$, $\eta_p^2 = .31$), a main effect of array size ($F(2,34)=17.451$, $p<.001$, $\eta_p^2 = .37$), and an interaction between array size and target category ($F(4,34)=5.122$, $p=.031$, , $\eta_p^2 = .15$). A post hoc test of target revealed significant differences between the human face target and full human body ($p<.001$) and isolated human body ($p<.001$) but no significant difference between full human body and isolated human body ($p=.490$). A post hoc test of array size revealed significant differences between all three array sizes ($p<.05$). Three follow-up ANOVAs were conducted to assess the interaction.

A one-way ANOVA revealed significant differences in reaction time across target categories in the 9 array size condition ($F(2,34)=12.450$,$p<.001$, $\eta_p^2 = .27$). Pairwise comparisons revealed that the isolated human face (*M*=1209, *SD*=658) captured attention more quickly than the whole human body targets (*M*=1708, *SD*=601), $p<.001$, and the isolated human body targets (*M*=1677, *SD*=683), $p=.001$. No significant difference was found between whole human body (*M*=1708, *SD*=601) and isolated human body targets (*M*=1677, *SD*=683), $p=.811$.

A one-way ANOVA also revealed significant differences in reaction time across target categories in the 16 array size condition ($F(2,34)= 16.747$, $p<.001$, $\eta_p^2 = .35$). A pairwise comparison revealed that the isolated human face (*M*=1326, *SD*= 606) captured attention more quickly than the whole human body (*M*=1957, *SD*=636), $p<.001$, and the isolated human body (*M*=2018, *SD*=634) $p<.001$. There was no significant difference between the isolated human body (*M*=2018, *SD*=634) and the whole human body (*M*=1957, *SD*=636) $p=.690$. A third ANOVA demonstrated no significant differences across the target category reaction times within the 25 array condition (*F*(2,34)=.977, *p*=.382).

An examination of the slopes revealed the steepest slope for the isolated human face (*M*=57, *SD*=59), followed by the whole human body (*M*=31, *SD*=61), and the shallowest slope for the isolated human body (*M*=13, *SD*= 60; See Figure 1).

Discussion

It was predicted that the whole human body would capture attention the quickest due to the aggregation of the specialized processing enjoyed by both the face and the human body. This prediction was based on prior behavioral and neuropsychological studies that suggest that the face and body receive specialized processing and have specialized brain processing pathways (Bindeman et al., 2010; Fletcher-Watson et al., 2008; Minnebusch & Daum, 2009). A comparison of slope regressions indicated that the isolated human body had the shallowest slope indicating, followed by the whole human body, and then the isolated human face. According to Wolfe (1998) shallow slopes indicates great processing efficiency. Additionally, it was predicted that the human face would be processed more quickly than the isolated human body as it provides more social information than the isolated human body. The results revealed the isolated human body was processed more quickly than the isolated human face. When assessing the pairwise comparisons, however, the isolated human face captured attention significantly more quickly than the whole and isolated human body within the 9 and 16 array size conditions.

Within the 25 array size condition, however, the human face loses this advantage. Our findings suggest that as the number of distractors increases or the environment becomes more complex, the face loses its advantage when compared to other evolutionarily salient stimuli: the whole and isolated human body. It is important to note, however, that this result reflects that the human face only loses its advantage when compared to other human body stimuli. Thus, it does not necessarily lose its general attention capture advantage over non-evolutionarily relevant stimuli (e.g., clock faces or animal faces), a phenomenon demonstrated in previous studies (e.g., Hershler et al., 2010; Simpson et al., under review).

The failure of the whole human body stimuli to capture attention efficiently contradicts the previous findings of other behavioral studies exploring attention capture and the human body (e.g., Bindeman et al., 2010). Bindeman et al. (2010) found that scenes containing the whole human body captured participants' attention the quickest versus scenes with just the human face or body. Thus, the lack of advantage in capturing attention demonstrated by the whole human body in the current study challenges Bindeman et al. (2010) findings. This may be a result of the difference in behavioral paradigms between the Bindeman et al. (2010) study and the current study. Bindeman et al. (2010) used natural scenes for their environment, where the present study used arrays of distractor objects. Therefore, the 25 array size was arguably more complex than the natural scenes in the Bindemann Paradigm, which may have it more difficult for the participants to identify the whole human body the quickest. Although the Bindeman et al (2010) paradigm is more representative of the everyday environment, if there is something "special", however, about the whole human body compared to other stimuli than the results of the current study should have concurred with the findings of Bindeman et al (2010).

Moreover, the findings of Yovel et al. (2010) demonstrated that the presence of the head mediates the specialized processing of the human body. This was seen in the abolishment of the body inversion effect through the removal of the head. Thus, it would be least expected that the isolated human body would have the shallowest slope, suggesting fastest attention capture overall. Finally, specialized brain areas have been identified for both face and body processing (Minnebusch & Daum, 2009). Subsequently, one would predict fastest processing of the whole human body stimuli due to the aggregated processing of these specialized brain areas. Continual attention to certain parts of the body (e.g., attention to the human face during social interaction) may act as a negating factor of this aggregation.

The fact that the isolated human face captured attention the quickest within the 9 and 16 array sizes is, however, consistent with prior research suggesting faces are “special” (Hershler & Hochstein, 2005; Hershler et al., 2010; Langton et al., 2008;Simpson, Jakobsen, & Mertins, under review). Both Hersheler and Hochstein (2005) and Simpson, Jakobsen, and Mertins (under review) demonstrated quick attention capture of the human face when placed in arrays of objects. Additionally, Hersheler et al. (2010) and Langton et al. (2008) demonstrated automatic attention capture of the human face using differing behavioral methods and paradigms. The isolated human face in the present study, however, loses its advantage of quickest attention capture within the 25 array size. This resulted in the isolated human body have the shallowest slope, as reaction times for the isolated human body were more consistent across array size category compared to the isolated human face.

The loss of advantage seen within the 25 array for the isolated human face could be a result of a number of factors. The face demonstrated a clear advantage over the isolated and whole body stimuli within the 9 and 16 array sizes. Yet, this advantage is lost when the environment becomes more complex. Thus, it could simply be that the human face loses this advantage within a complex environment when compared to other human body stimuli. Moreover, it could also be a result of participants’ expectations. Due to the lack of specific instruction, some participants employed a serial search as they thought that it was essential to identify a pattern or a recurring object by looking at each picture. This factor may have been especially influential in the 25-array size as participants had 24 distractors to concentrate on and analyze for a pattern—distracting them from the human face. Thus, some participants' concern for identifying a pattern may have negated the attention capture effect of the isolated human face as they were no longer just casually glancing at the pictures but intensely analyzing the array.

In order to assess these potential mediating factors one of two adjustments could be made to the current paradigm. First, comparison target trials that include one homogenous factor that resembles the feature of the human face (such as a dog or clock face used in the Hershler et al., 2010 study) could be added to the paradigm. This would allow the researcher to assess if the human face loses its general advantage of attention capture or if it only loses its advantage to other body stimuli within the 25-array set. Moreover, a two-target paradigm used in the Langton et al. (2008) study could also be employed. In this paradigm, participants would be instructed to find a target (e.g., car) within each array. Each array would also contain a human stimuli distractor (whole human body, isolated human body, and isolated human face) or no human distractor. The reaction time to find the target within the each array would then be compared across distractor groups. It would be expected that the arrays containing human stimuli distractors would increase reaction time to find the target because the human stimuli, especially the face, would be expected to automatically capture attention, distracting participants from the target. Thus, this would eliminate any participant expectations because of instruction ambiguity.

Finally, an active task paradigm could be adopted to assess the differences between human stimuli. In this paradigm, participants would be asked to search for each target type (whole human body, isolated human body, and isolated human face). Therefore, an active task would eliminate the potentially confounding effect of participants' expectations, while still directly comparing the attention capture of across the whole human body, isolated human body, and isolated human face.

The lack of a comparison target and participant expectation effects serve as limitations of the current study. Adjustments to the aforementioned paradigm would help to address these limitations in future studies. Additionally, attention capture of human stimuli could be examined across special populations using the current or adjusted paradigms. For instance, one could examine attention capture of the human body across civilians, combat soldiers, combat soldiers suffering from post-traumatic stress disorder, and non-combat soldiers in order to assess if military training and experience serves as a moderating factor in attending to different aspects of the human body. This would be useful, as very few studies have examined military populations and their attention to the human body (Anaki, Brezniak, & Shalom, 2012). These findings could be potentially applicable in training and clinical military settings. Moreover, other studies could assess attention capture between children of normal development and children suffering from Autism Spectrum Disorders. Differences in attention capture between these two groups could provide insight into how those suffering from Autism attend to the human body and more generally—people.

While the findings in the current study were unexpected, these findings still help to elucidate the curiosity surrounding attention capture of the human body. Although the current study prompted more questions than it answered, it does not serve to discredit the value of the research at hand. Answering the prompted questions and conducting future studies using the suggested paradigms will help to explain human body processing. The wonder surrounding attention capture can only be explained through the continual process of answering questions prompted by former studies. Finally, it is important to realize the significant applicable value of the current research. As previously mentioned, the understanding of face and body processing among typically developing individuals can help highlight the difference in face and body processing across clinical populations. Understanding this difference could be applicable across different types of occupational training and clinical diagnosis and treatment. Therefore, it is essential to continue to explore and explain the ambiguity surrounding human face and body processing.

Appendix

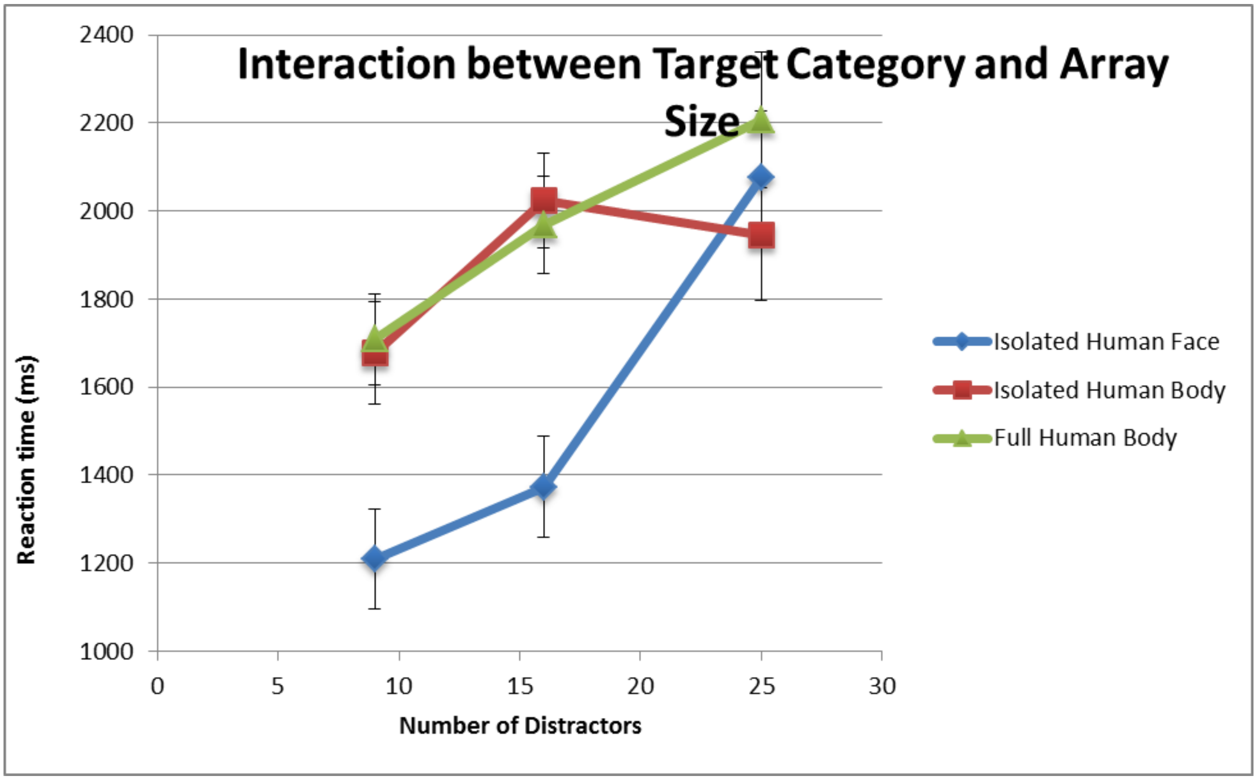

Figure 3. Represents the interaction between array size and target category.

References

Adler, S.A. & Orprecio, J (2006). The eyes have it: Visual pop-out infants and adults. *Developmental Science, 9*(2), 189-206.

Anaki, D., Brezniak, T. & Shalom, L. (2012). Faces in the face of death: Effects of exposure to life-threatening events and mortality salience on facial expression recognition in combat and noncombat military veterans. *Emotion, 1*(4), 860-867. doi: 10.1037/a0029415

Aviezer, H., Trope, Y. & Todorov A. (2012). Holistic person processing: faces with bodies tell the whole story. *Journal of Personality Social Psychology, 103* (1).. doi: 10.1037/a0027411. Epub 2012 Feb 20.

Bindemann, M., Scheepers, C., Freguson, H.J., & Burton, A. M. (2010). Face, body, and center of gravity mediate person detection in natural scenes. *Journal of Experimental Psychology, 36* (6), 1477-1485. doi : 10.1037/a0019057

Crouzet, S. M., Kirchner, Thrope, S.J. (2010). Fast saccades toward faces: face detection in just 100 ms. *Journal of Vision, 10*(4), 1-17. doi: 10.1167/10.4.16

Diamond, R. & Carey, S. (1986). Why faces are and are not special: An effect of expertise. *Journal of Experimental Psychology, 115* (2). 107-117.

Farah, M.J., Wilson, K.D., Drain, M., Tanaka, J.N. (1998). What is “special” about face perception?. *Psychological Review, 105* (3), 482-498.

Fletcher-Watson, S., Findlay, J.M., Leekam, S.R., & Benson, V. (2008). Rapid detection of person information in a naturalistic scene. *Perception, 37,* 571-583. doi: 10.1068/p5705

Gauthier, I. & Tarr, M.J. (1997). Becoming a “Greeble” expert: Exploring mechanism for face recognition. *Vision Research, 37*(12). 1673-82.

Di Giorgio, E.D., Turati, C., Altoe G. & Simion, F. (2012). Face detection in complex visual displays: An eye-tracking study with 3-and 6-month-old infants and adults. *Journal of Experimental Child Psychology,* 113, 66-77. doi: 10.1016/j.jecp.2012.04.012

Gliga, T. & Dehaene-Lambertz, G. (2005). Structural encoding of body and face in human infants and adults. *Journal of Cognitive Neuroscience, 17*(8), 1328-1340.

Gliga,T., Elsabbagh, M., Andravizou, A., & Johnson, M. (2009). Faces attract infants; attention in complex displays. *Infancy, 14* (5). 550-562. doi: 10.1080/15250000903144199

Hershler, O. & Hochstein, S. (2005). At first sight: A high-level pop out effect for faces. *Vision Research, 45*, 1707-1724. doi: 10.1016/j.visres.2004.12.021

Hershler, O., Golan, T, Bentin, S & Hochstein, S. (2010). The wide window of face detection. *Journal of Vision, 10*(10), 1-14. doi: 10.1167/10.10.21

Langton, S.R.H., Law, A.S., Burton, A.M. & Schweinberger, S.R. (2008). Attention capture by faces. *Cognition, 107*, 330-342. doi:10.1016/j.cognition.2007.07.012

Li, H., Chan, R.C.K., McAlonan, G.M. & Gong, Q. (2010). Facial emotion processing in schizophrenia: A meta-analysis of functional neuroimaging data. *Schizophrenia Bulletin, 36* (5), 1029-1039. doi: 10.1093/schbul/sbn 190

Marsh, A.A. & Blair, R.J.R (2008). Deficits in facial affect recognition among antisocial populations: A meta- analysis. *Neuroscience and Behavioral Reviews, 32,* 454-465. doi: 10.1016.j.neubiorev.2007.08.003

Meng, Cherian, Singal, & Sinha (2013). Lateralization of Face Processing in the Human Brain. *Proceedings of Royal Society B: Biological Sciences, 1735*, 2052-2061. doi: 10.1098/rspb.2011.

Minnebusch, D.A., & Daum, I. (2009). Neuropsychological mechanisms of visual face and body perception. *Neuroscience and Behavioral Reviews, 33,* 1133-1144. doi: 10.1016/j.neubiorev.2009. 05.008.

Morand, S.M., Grosbras, M.H., Caldara, R., Harvey, M. (2010). Looking away from faces: influence of high-level visual processes on saccade programming. *Journal of Vision, 10*(3), 1-10. doi: 10.1167/10.3.16

Moro, V., Pernigo, S., Avesani, R., Bulgarelli, C., Ugresi, C., Candidi, M., & Aglioti, S.M. (2012). Visual Body recognition in prospoagnosic patient. *Neuropsychologia, 50,* 104-117. doi: 10.1016/j.neuropsychologia.2011.11004

Palermo, R & Rhodes, G. (2007). Are you always on my mind? A review of how face perception and attention interact. *Neuropsychologia 45*, 75-92. doi: 10.1016/j.neuropsychologia, 2006.04.025

Peelen, M.V., & Downing, P. E., (2005). Selectivity for the human body in the fusiform gyrus. *Neurophysiologia, 93,* 603-608. doi: 10.1152/jn.00513.2004

Sabatinelli, D., Fortune, E.E. Qingyang, L. Siddiqui, A., Krafft, C., Oliver, W.T., Beck, S. & Jeffries, J. (2011). Emotional perception: Meta-analyses of face and natural scene processing. *Neuroimage, 54,* 2524-2533.doi: 10.1016/j.neuroimage.2010.10.011

Simpson, E.A., Jakobsen, K.V., Mertins, H. L. (under review). How broad is attention capture for faces*? Pop out effect occurs for human faces, but may not occur for nonhuman animal faces.* Manuscript submitted for publication.

Tolba, A.S. & El-Harby, A.A. (2006). Face recognition: A literature review. *International Journal of Signal Processing, 2* (2), 88-103.

Treisman, A. & Souther, J. (1985). Search Asymmetry: A diagnostic for preattentive processing of separable features. *Journal of Experimental Psychology: General, 114* (3), 285-310.

VanRullen, R. (2006). On second glance: Still no high-level pop-out effect for faces. *Vision Research, 46,* 3017-3027. doi: 10.1016/j.visres. 2005.07.009

Wolfe (1998). What can 1 million trials tell us about visual search? *Psychological Science, 9* (1), 33-39.doi: 10.1.1.148.6975

Yovel, G., Pelc, T. & Lubetzky I. (2010). It's all in your head: Why is the body inversion effect abolished for headless bodies? *Journal of Experimental Psychology, 36*(3). 759-767. doi: 10.1037/a0017451