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An Eye-Tracking Investigation of Attention Allocation during the Observation of Human and Animal Facial Stimuli

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Abstract: *Visual processing plays a pivotal role in the human perception of external information. This study seeks to investigate individuals' perceptual responses by comparing the allocation of visual attention when exposed to both human and animal faces. Employing a within-subject design, 21 participants were recruited randomly to partake in the experiment. They were presented with a series of six visual stimuli, alternating between three human faces and three animal faces, each displayed for a duration of nine seconds. The participants' gaze patterns were recorded using an eye-tracker, facilitating the generation of quantitative data. To conduct subsequent statistical analyses, parameters such as total fixation duration, fixation count, time to first fixation, and first fixation duration were employed. The findings reveal several significant trends. Firstly, when observing both human and animal faces, there is a notable increase in both total fixation duration and fixation count within the eye area compared to other facial elements. Additionally, when examining animal faces, there is a significantly greater total fixation duration and fixation count on the area encompassing the ears, surpassing the attention devoted to the ears in human faces. Lastly, participants spent significantly less time on their first fixation and had shorter initial fixation durations when focusing on the mouths of animals compared to human mouths.*

Keywords: *Face recognition, Animal, Mammal, Human, Eye-tracking, Visual processing*

1. Introduction

The human face serves as a potent stimulus laden with rich social information. It enables individuals not only to discern aspects such as gender, age, identity, and emotional states but also to formulate a wide array of judgments based on facial features (Andrew, 2007; Tomoyo, 2008). Proficiency in face recognition constitutes an indispensable skill in daily life, as the ability to swiftly and accurately identify others holds paramount importance for normal social interactions and environmental adaptation. Evolutionary psychology, since the 1980s, has placed increasing emphasis on cognitive processes uniquely tailored to address crucial survival challenges, with facial recognition being a focal point (Jiao, 2004; Bjorklund & Pellegrini, 2010).

Recognition of animal faces is equally significant for humans, given their coexistence with non-human animals within the natural environment. Certain animals even pose potential threats to human survival, intensifying the importance of recognizing animal faces. Empirical evidence from prior studies has unveiled specialized recognition mechanisms in humans specifically designed for animals, termed the "animals monitoring hypothesis" (New, Cosmides, & Tooby, 2007). Recent advancements in research technology and methodologies have further enhanced our understanding of these mechanisms. Notably, studies have revealed humans' shorter response times to distinctive animal faces, while functional magnetic resonance imaging experiments have identified specific brain regions dedicated to animal processing (Bai, 2011).

Despite the extensive research on the visual processing of human faces, relatively limited attention has been directed toward investigating patterns of animal face recognition (Kanwisher, 2000; Kanwisher & Yovel, 2006; Yin, 1969). Previous inquiries have primarily focused on how humans distinguish among different types of animal faces (Li, 2019) or the presence of attention biases when contrasting animals with other objects (Yang, 2019). Few studies have ventured into the realm of comparative face recognition between humans and animals. Consequently, this study undertakes the task of exploring how individuals observe both animal and human faces, with mammals chosen as the focal category among animals. To enhance the precision and objectivity of the data collected, this investigation introduces eye-tracking technology to monitor participants' gaze trajectories. The quantitative outcomes obtained

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through this methodology aim to provide deeper insights into the nuances of visual processing concerning animal and human faces.

2. Materials and Methods

2.1 Participants

In this experiment, a total of 21 participants (M_{age} = 29.81, SD = 10.32), comprising 11 females and 10 males, were recruited randomly from Shanghai, China. Prior to the commencement of the experiment, participants received detailed information about the experiment's objectives and procedures, and they provided informed consent. As a token of appreciation, participants were offered gifts upon completion of the experiment.

2.2 Stimuli

The stimuli employed in this experiment consisted of six images, comprising three human faces and three mammal faces, denoted as P1, P2, P3, P4, P5, and P6. Among the human faces, P1 and P3 were female, while P5 was male. The three animal faces corresponded to a cheetah (P2), a wolf (P5), and a sheep (P6).

These images were selected based on specific criteria. First and foremost, all images were required to feature clear facial attributes, including eyes, ears, nose, and mouth, without any obstructions or distractions. Secondly, all subjects in the images were depicted facing directly forward, avoiding any side, bottom, or top views. Lastly, for the human faces, a balance between genders was maintained to ensure result accuracy and objectivity. As part of a pre-processing step, all six stimuli were edited to have a uniform white background and maintain the same facial-to-image ratio, with the entire face taking up the majority of each image, omitting any parts below the neck.

2.3 Design and Procedure

The experiment followed a within-subject design. There were six stimuli, consisting of human faces (P1, P3, and P5) and animal faces (P2, P4, and P6). Participants viewed the images in the sequence of P1 to P6, with human and animal faces alternating. This presentation order remained consistent for all participants.

Participants provided informed consent and agreed to complete the experiment. Demographic information such as gender and age was also collected to enable a comprehensive and objective analysis of the results. Participants were seated in front of a screen equipped with an eye-tracker (Tobii 4C) positioned at the bottom. Both the eye-tracker and the screen were connected to a laptop with Tobii Pro Lab software installed. Prior to the formal experiment, each participant underwent a nine-point calibration process to ensure the accuracy of eye movement data. Subsequently, on-screen instructions were displayed: participants were instructed to maintain their gaze on the screen without making excessive head or body movements. They were informed that six images would automatically appear on the screen in a specific order, with each image displayed for 9 seconds. Following these instructions, the experiment commenced, and the images were presented.

Areas of interest (AOIs) within each image were divided into four sections: Eyes, Eears, Nose, and Mouth. The eye-tracking parameters recorded during the experiment for analyzing participants' visual behavior included total fixation duration (TFD), fixation count (FC), time to first fixation (TFF), and first fixation duration (FFD).

2.4 Data Analysis

For each AOI area, the data for the three human faces were aggregated, forming the "human" category. Similarly, the data for the three animal faces were combined, representing the "animal" category. To compare and contrast participants' visual behavior towards human faces (P1, P3, P5) and animal faces (P2, P4, P6), between-group t-tests were conducted for each AOI area. These areas included Human Faces vs. Animal Faces, Human Eyes vs. Animal Eyes, Human Ears vs. Animal Ears, Human Nose vs. Animal Nose, and Human Mouth vs. Animal Mouth. The TFD and FC analyses aimed to investigate participants' overall attention and visual focus on each image, while the TFF and FFD analyses were designed to explore participants' initial attention towards human and animal faces.

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Furthermore, single-factor ANOVA tests were performed to compare differences in facial areas within either human faces (Eyes vs. Nose vs. Ears vs. Mouth) or animal faces (Eyes vs. Nose vs. Ears vs. Mouth).

3. Results

3.1 Data Analysis of TFD

As presented in Table 1, the T-test indicates that there is no significant difference between human eyes (Mean = 7.58, SD = 4.16) and animal eyes (Mean = 6.47, SD = 4.17; t = 0.87, $p > 0.05$). The T-test results for TFD demonstrate a significant difference for ears between humans (Mean = 0.30, SD = 0.46) and animals (Mean = 0.99, SD = 1.42; t = 2.15, $p < 0.05$). Analysis of TFD through T-test also reveals a significant difference for the nose between humans (Mean = 4.42, SD = 4.19) and animals (Mean = 1.51, SD = 1.55; t = 2.99, $p < 0.05$). Additionally, T-test results for TFD show a significant difference for the mouth between humans (Mean = 1.46, SD = 1.31) and animals (Mean = 0.42, SD = 0.63; t = 3.27, $p < 0.05$).

According to the results of a single-factor ANOVA, when observing human faces, the TFD value for human eyes (Mean = 7.58, SD = 4.16, F = 52.13, $p < 0.05$) is significantly higher than the other facial areas (ears: Mean = 0.30, SD = 0.46; nose: Mean = 4.42, SD = 4.19; mouth: Mean = 1.46, SD = 1.31).

Similarly, based on the results of a single-factor ANOVA, when observing animal faces, the TFD value for animal eyes (Mean = 6.47, SD = 4.17, F = 55.15, $p < 0.05$) is significantly higher than the other facial areas (ears: Mean = 0.99, SD = 1.42; nose: Mean = 1.51, SD = 1.55; mouth: Mean = 0.42, SD = 0.63).

3.2 Data Analysis of FC

As presented in Table 2, T-test results for FC indicate no significant difference for eyes between humans (Mean = 28.48, SD = 16.43) and animals (Mean = 26.62, SD = 17.04; t = 0.36, $p > 0.05$). T-test results for FC show a significant difference between human ears (Mean = 1.38, SD = 1.91) and animal ears (Mean = 4.38, SD = 5.43; t = 2.39, $p < 0.05$). Analysis of FC through T-test also reveals a significant difference for the nose between humans (Mean = 15.57, SD = 7.67) and animals (Mean = 5.38, SD = 3.84; t = 5.45, $p < 0.05$). Furthermore, there is a significant difference for the mouth between humans (Mean = 6.14, SD = 5.23) and animals (Mean = 1.57, SD = 2.09; t = 3.72, $p < 0.05$) based on the results of T-test for FC.

According to the results of a single-factor ANOVA, when observing human faces, the FC value for human eyes (Mean = 28.48, SD = 16.43, F = 70.90, $p < 0.05$) is significantly higher than for other facial areas (ears: Mean = 1.38, SD = 1.91; nose: Mean = 15.57, SD = 7.67; mouth: Mean = 6.14, SD = 5.23).

Similarly, based on the results of a single-factor ANOVA, when observing animal faces, the FC value for animal eyes (Mean = 26.62, SD = 17.04, F = 67.20, $p < 0.05$) is significantly higher than for other facial areas (ears: Mean = 4.38, SD = 5.43; nose: Mean = 5.38, SD = 3.84; mouth: Mean = 1.57, SD = 2.09).

3.3 Data Analysis of TFF

As shown in Table 3, T-test results for TFF indicate no significant difference for eyes between humans (Mean = 8.51, SD = 5.39) and animals (Mean = 6.35, SD = 5.35; t = 1.30, $p > 0.05$). T-test results for TFF also reveal no significant difference for ears between humans (Mean = 3.84, SD = 5.18) and animals (Mean = 5.90, SD = 6.76; t = 1.11, $p > 0.05$). There is no significant difference for the nose between humans (Mean = 3.60, SD = 3.65) and animals (Mean = 4.27, SD = 3.87; t = 0.58, $p > 0.05$) according to the results of T-test for TFF. However, T-test results indicate a significant difference for the mouth between humans (Mean = 6.77, SD = 4.01) and animals (Mean = 3.36, SD = 4.30; t = 2.66, $p < 0.05$).

3.4 Data Analysis of FFD

As presented in Table 4, T-test results for FFD indicate no significant difference for eyes between humans (Mean = 1.40, SD = 0.63) and animals (Mean = 1.28, SD = 0.77; t = 0.55, $p > 0.05$). Similarly, T-test results for FFD show no significant difference for ears between humans (Mean = 0.17, SD = 0.28) and animals (Mean = 0.34, SD = 0.41; t = -1.69, $p > 0.05$). Moreover, based on the T-test results, there is

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no significant difference for the nose between humans (Mean = 0.73, SD = 0.82) and animals (Mean = 0.51, SD = 0.41; t = 1.12, $p > 0.05$). However, T-test results imply a significant difference for the mouth between humans (Mean = 0.51, SD = 0.40) and animals (Mean = 0.25, SD = 0.36; t = 2.22, $p < 0.05$).

Table 1: TFD (s) Analysis of Human and Animal Faces

	Eyes	Ears	Nose	Mouth
Human	7. 58	0. 30	4. 42	1. 46
Animal	6. 47	0. 99	1. 51	0. 42

Table 2: FC Analysis of Human and Animal Faces

	Eyes	Ears	Nose	Mouth
Human	28. 48	1. 38	15. 57	6. 14
Animal	26. 62	4. 38	5. 38	1. 57

Table 3: TFF (s) Analysis of Human and Animal Faces

	Eyes	Ears	Nose	Mouth
Human	8. 51	3. 84	3. 60	6. 77
Animal	6. 35	5. 90	4. 27	3. 36

Table 4: FFD (s) Analysis of Human and Animal Faces

	Eyes	Ears	Nose	Mouth
Human	1. 40	0. 17	0. 73	0. 51
Animal	1. 28	0. 35	0. 51	0. 25

4. Discussion

The objective of this study was to investigate how people observe human and animal faces. Human stimuli consisted of two female faces and one male face, while animal stimuli included a sheep, a wolf, and a cheetah. The analysis of total fixation duration (TFD) and fixation count (FC) through single-factor ANOVA revealed that participants dedicated the longest time and the highest number of fixations to the eyes, whether it was a human or an animal face. The T-test results indicated that participants looked at human eyes, mouth, and nose more frequently and for longer durations than at animal faces. However, when observing the ear region, animal ears attracted more attention than human ears. Additionally, the data analysis on time to first fixation (TFF) and first fixation duration (FFD) indicated that the initial fixation duration and the time taken to first fixation on the mouth and nose of animals were significantly shorter than those for human faces.

The ANOVA results for TFD and FC suggest that people tend to focus more on the eyes than other facial areas when viewing both human and animal faces. This preference for eyes may be attributed to the rich emotional cues conveyed through eye contact, which is an inherent human instinct observed from infancy (Batki et al., 2000). Consequently, whether it is a human or animal face, individuals tend to pay more attention to the eyes.

The T-test results for TFD and FC indicate that participants fixate significantly more on human faces than animal faces in areas such as eyes, nose, and mouth, suggesting that individuals tend to pay more attention to features related to themselves. However, the T-test for the ear area shows that participants fixate longer and more frequently on animal ears compared to human ears. This suggests that people are naturally drawn to the novelty of animal ears, which deviate from the typical human facial features. The relatively shorter fixation duration and lower fixation count on the nose and mouth of animals compared to human faces may be attributed to fear. Individuals may spend less time gazing at animal noses and mouths due to a fear of animals. Similarly, the T-test results for TFF and FFD indicate a significant difference only in the mouth area when observing human and animal faces, with participants fixating less on animal mouths. This can be explained by the vigilance-avoidance hypothesis proposed by Karin Mogg (2004), where individuals unconsciously pay attention to potential threats but quickly divert their attention to avoid negative emotions such as anxiety and fear. In the case of animal faces, the mouth area may evoke thoughts of being bitten, leading to a rapid shift in attention away from it.

However, it is important to acknowledge certain limitations of the experiment. The sample size was relatively small, which may limit the generalizability of the results. Future studies could include a larger and more diverse sample to improve the representativeness of the findings. Additionally, this study

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exclusively used mammalian animals as stimuli. Future research could explore reactions to a broader range of animal types, as different animals may elicit varying responses from participants.

5. Conclusion

This study aimed to compare how people view human and animal faces. Participants alternately viewed images of three human faces and three animal faces. The findings indicate that, when observing both human and animal faces, participants fixated on the eyes area for significantly longer durations and more frequently than on other facial areas. Furthermore, when observing animal faces, the fixation duration and count for the ears area significantly exceeded those for human ears. Conversely, the time taken to make the first fixation and the duration of the first fixation on animals' mouths were significantly shorter than when observing human mouths.

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