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Evolution

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Term Project Proposal: Evolution of the Eye as Communicator

In my term project I would like to answer key questions concerning the evolution of human behavior in conjunction with the evolution of socio-cultural norms, and how certain behaviors may have formed as adaptations to help us survive not just in changing environments but in new social dynamics that involve interpersonal relations. I will be focusing on the eyes and their evolution as traits of important social significance, particularly as it relates to the concept of “the gaze” and communication. I will also explore how the biological evolution of the human eye may also have played a role in the adaptation of certain social behaviors involving the eyes. The ultimate product of my research and explorations will be a work of art that articulates how the unique physiology of the human eye shapes our daily social interactions, with the eye being depicted literally and aspects of the gaze being conveyed through the use of colors, textures, and materials.

Through my research, I have learned how the eye has evolved in its cultural function as well as in its physiology. In human culture, the eye and its gaze has come to have great effects on human behavior, as exemplified through Ernest-Jones, Nettle, and Baetsman’s study on the effects eye-images have on the behaviors of university students in a cafeteria. The researchers devised an experiment in which posters encouraging cafeteria goers to throw away their trash were paired with either an image of human eyes or of flowers; the goal of the experiment was to determine whether or not the posters with eyes had any effect on people’s behavior in cleaning up after themselves. Ernest-Jones, Nettle, and Baetsman found that “Eye images are likely to evoke the feeling of being watched” and as a result “displaying posters featuring eye images caused people to be more likely to remove litter from their tables in a self-clearing cafeteria” (Ernest-Jones, et al.). The researchers go on to state that cooperation in response to the images of eyes was born from “the psychological mechanisms controlling decisions about whether to behave cooperatively are specifically responsive to cues which usually indicate social scrutiny” (Ernest-Jones, et al.). Similarly, a New York Times article by Michael Tomasello discusses the “cooperative eye hypothesis”, which postulates that the human eye evolved as it did with the whites visible-called the sclera-in order for humans to successfully survive in groups through “the coordinating of visual attention” (Tomasello). Tomasello states that the evolution of the human emphasis on eye contact may have formed the “foundation for the evolution of human language” and the formation of human communities that survive through cooperation and coordination of activities and behaviors. Kobayashi and Hashiya agree with the idea perpetuated

by the cooperative eye hypothesis, stating that “the human eyes most likely evolved as an adaptation to cooperative social interaction”(Kobayashi, et al.).

Comparisons between the social function of the eyes in humans and in primates in conjunction has helped to illuminate key similarities and differences in the evolutionary function of various forms of eye gaze. Researchers such as Emery note how both humans and primates utilize the eyes as social signals, and that this function could be born from an awareness of mind that developed in humans and primates, stating that, “The use of eye gaze as a social signal by human and non-human primates may have become necessary due to morphological, environmental and habitat changes throughout primate evolution. This shift to visual processing, and gaze especially, as an important means for signaling, may be related to the development of mental state attribution (theory of mind) in humans (and possibly the great apes)” (Emery). With the group oriented nature of both humans and primates, the utilization of the eyes as a form of communication is markedly “less ambiguous than auditory and olfactory signals”, and over time the eyes became a tool in which to convey emotional states to others of the group. These similarities in primate and human social eye usage implies a similar evolutionary history unique to humans and primates, for other vertebrates, whether due to “limitations in the facial anatomy” or inability to interpret visual social signals due to their complexity, do not display behaviors of communication as expressed through the eyes. While sharing a similar evolutionary history, the human eye appears to have evolved one step further, allowing for different methods and implications of eye based communications This became crucial to the development of humans as social beings as the group size and structure of human societies began to expand; humans live in the largest sized groups of any primates, and thus there came to be an “increasing requirement for signaling functions of gaze” that resulted in the loss of sclera pigmentation. The formation of the human eye in which the sclera is unpigmented is an attribute unique to humans, an anatomical factor that makes it easy to follow the gaze of those around us. As Tomasello notes, “The whites of our eyes are several times larger than those of other primates, which makes it much easier to see where the eyes, as opposed to the head, are pointed” (Tomasello). In studies done between humans and primates, this aspect of the eye’s formation shows a divergence in evolution based on two opposing adaptations: either gaze camouflaging or gaze signaling. Kobayashi and Koshima, through their research on this topic crafted the hypothesis that “coloration of the human eye is adapted to enhance the gaze signal while eye coloration of other primates is adapted to camouflage the gaze direction against other individuals and/or predators” and that in “comparing the divergent functions of camouflaging and signaling, the gaze-signaling function has overcome the camouflaging function in humans”(Kobayashi, et al.). The morphology of our eyes as such allows them to hold great socio-cultural influence and significance, as for humans the function of our eyes becomes more than just “looking” or “seeing” and is instead a method of communicating; as Kobayashi states, the eyes not only “look, but are looked at” as they “provide signals to other individuals.” So crucial is the white

sclera to the evolution of human social interaction that Kobayashi states, “A small change in scleral coloration might thus have played a critical role in the evolution of human communication, by promoting functions of the gaze...that would have enabled remote communication via gaze and efficient cooperation or joint activities with other group members”(Kobayashi, et al.).

The central scientific idea that I will work to convey through my creative work is how the formation of the human eye with the unpigmented sclera evolved in order to enhance the eye’s ability to communicate; the communications I will focus on will be those involving cooperation amongst large groups of humans, as it is hypothesized that this was the original factor that caused the evolution of an exposed sclera to be an adaptation in humans. In the work the social function and physiology of the human eye will be juxtaposed with that of the primate eye, as it has been shown that primates use their eyes for communication as well, but their eyes are formed as such that their scleras are pigmented, camouflaging the direction of their gaze. My first project concept will utilize Gregory’s 1929 book, *Our Face from Fish to Man* as an aesthetic reference, for the book contains a number of ink diagrams of the human eye that showcase how I may approach representations of the eye in my work, mainly with the appearance of anatomical studies. The aspects of my topic that focus on the concept of the gaze and eye communication will be represented more abstractly by materials such as yarn that will connect the human eyes, which in theory would create a web of various colored strings that are meant to emphasize eye contact. The strings end in the appearance of two humans facing each other while looking directly into each other’s eyes. This will be the central image of the work; however, depicted smaller somewhere in the work will be a diagram of the physiological evolution of the human eye showcasing the development of the non pigmented sclera that leads compositionally into the focal image. This particular aspect of the work is meant to refer back to the key question concerning the differences between cultural and biological evolution; the strings of eye gaze progressing through the work are indicative of the adaptive quality of “gaze signaling” through time as an important survival mechanism for humans as a social species. The second concept I have in mind involves a series of small paintings that depict large group of humans working in a hunter-gatherer society utilizing their eyes as tools of intent as they cooperate during collaborative tasks; suffused into the various compositions may be primates in their respective habitats with an emphasis on their averted the gazes. The gazes of both the primates and the humans will be articulated through embroidered string with the humans gazing directly at one another while the primates are practicing gaze avoidance. This concept would emphasize how the human eye evolved to its present state as an adaptation for surviving in group communities that require collaborative acts in order for survival; the presence of the primate community will show the divergent social functions of the primate and human eyes. I may also include elements of the environment that may pose a threat to the respective communities, such as the presence of

predators, and depict how each species uses the eyes to handle the peril in order to successfully survive.

Scientific Ideas

Representation of Idea in Project

<p>The unpigmented sclera in humans versus the pigmented sclera of closely related primates suggests that humans use their eyes for forms of expression and communication, while primates require the sclera to be pigmented in order to disguise their gaze from predators.</p>	<p>This might be displayed in the work through diagrams that compare the physiological differences between the two formations of the eye. This also may be shown through depictions of interactions of each species within their respective groups, with an illustrative focus on the eyes..</p>
<p>Humans and primates are the main species that utilize eye gaze to transmit information in the form of expression, emotion, or mental state.</p>	<p>This will be displayed through only depicting primates and humans in the work.</p>
<p>The large group sizes that humans live and interact with daily may have caused the evolution of the unpigmented sclera as a mechanism of conveying overt signals about environmental and social factors through the gaze to others.</p>	<p>This may be displayed through the illustrations showing humans in the beginnings of interacting with each other in group communities, with emphasis on eyes and eye gaze in the works; the humans would be in situations that would require them to utilize the gaze in order to convey important messages concerning issues of survival.</p>
<p>The structure of the human eye evolved as an adaptation to the increased need for cooperation and interaction amongst other human beings.</p>	<p>This may be shown through the use of diagrams; while they may appear decorative, they will showcase the human eyes morphology more carefully, conveying how the aspects of the eye, mainly the sclera, were formed to make eye movement and direction explicit to those that were to follow the gaze.</p>
<p>Recognizing each other's gaze directions is an important cognitive basis for communication in humans as this ability helps us to interact with others and with our environments.</p>	<p>This may be shown through the depiction of environmental risks to successful survival and a demonstration of how the eye evolved successfully as an adaptation that would help to escape peril.</p>

Annotated Bibliography

Emery, N.j. “The Eyes Have It: the Neuroethology, Function and Evolution of Social Gaze.” *Neuroscience & Biobehavioral Reviews*, vol. 24, no. 6, 2000, pp. 581–604., doi:10.1016/s0149-7634(00)00025-7.

Emery’s review discusses “the evolutionary role of social gaze in vertebrates”, working with the hypothesis that the role of the eyes and the gaze has evolved to become particularly important for humans and primates as opposed to other organisms. Emery contributes this change to “morphological changes to the face and eyes” that can be observed in the evolutionary progression of humans and primates; Emery also notes that environmental and habitat changes could have contributed to an evolved emphasis on the importance of the abilities of the eye and what it signifies in the social settings of humans and primates. Emery notes that emphasis on the eyes/the gaze would serve an adaptive purpose in species that hunt or are hunted, and the ability to perceive whether another organism is looking towards or away from them is a trait that has come to be adopted by a variety of species. Humans and primates, however, are considered the main species that use the gaze to transmit information in the form of expression, emotion, or mental state.

Ernest-Jones, Max, et al. “Effects of Eye Images on Everyday Cooperative Behavior: a Field Experiment.” *Evolution and Human Behavior*, vol. 32, no. 3, 2011, pp. 172–178., doi:10.1016/j.evolhumbehav.2010.10.006.

The study conducted by Ernest-Jones, Nettle, and Baetsman involves the effects images of human eyes have on social behaviors, concentrating on issues of cooperation. The authors devised an experiment in which posters encouraging cafeteria goers to throw away their trash were paired with either an image of human eyes or of flowers; the goal of the experiment was to determine whether or not the posters with eyes had any effect on people’s behavior in cleaning up after themselves. At the conclusion of the experiment researchers found “a halving of the odds of littering in the presence of posters featuring eyes, as compared to posters featuring flowers”; the authors attributed this to a sense of “social scrutiny” that the human mind associates with images of the human eye, leading them to ascertain that “the proximity of eye images can have substantial effects on cooperative behaviour in real world settings”.

Gregory, William K. *Our Face from Fish to Man*. G.P. Putnam's Sons, 1929.

While antiquated, Gregory’s book articulates preliminary notions of how the human eye evolved based on early hypotheses formulated by scientists. Gregory stresses the importance of light reception as a main factor that contributed to the evolution of eyes in both invertebrates and vertebrates that bring the majority of organisms to share in the possession of eyes; he cites the views of L. Plate, a contemporary, that state that “the

paired eyes of vertebrates originated as directional organs, guiding the animal toward the light and that later by acquiring a lens they became true visual organs” (Gregory 178). Gregory describes in detail the construction of the eyes of cephalopods and other invertebrates as a segway into the discussion as to the evolution of the vertebrate eye, ascertaining the beginnings of the findings in science that showcase that the vertebrate eye and invertebrate eye evolved separately from each other. Gregory goes on, with the supplementation of ink diagrams and drawings, to illustrate the evolutionary progression of the human eye, drawing comparisons between the eyes of sharks and apes. Gregory concludes his section on the eye by reiterating the human eyes’ evolutionary trajectory. Gregory’s book, while not a source of empirical scientific data, serves as a form of historical context for the ways in which science through time has worked to understand the evolutionary formation of the eye, while also showing examples of the synthesis between artistic capitulations of the eye and science’s work to understand the eyes’ mechanics.

Goldsmith, Timothy H. “Optimization, Constraint, and History in the Evolution of Eyes.” *The Quarterly Review of Biology*, vol. 65, no. 3, 1990, pp. 281–322. *JSTOR*, www.jstor.org/stable/2832368.

Goldsmith’s article works to examine the eye and its mechanisms “in order to explore the relative roles of adaptation and historical and developmental constraints”. Goldsmith explores the various evolutionary lineages that are revealed through the multiplication of the evolution of the eye, comparing and contrasting how rods, cones, and opsins have evolved for vertebrates. The review analyzes how traits such as color vision, nocturnal vision, and the actual construction of various components of the eye evolved as adaptations, while also locating where homologies in the evolution of the eye may exist between species. In his findings Goldsmith states that “homologies exist between opsins from three major phyla”, highlighting similarities in eye anatomy and genetics that has been retained throughout evolution; however Goldsmith also notes that “opsins from different photoreceptors in the same animal will frequently have distinct and ancient evolutionary histories”, a factor that illuminates how the complexity of the eye’s evolutionary narrative.

Kobayashi, Hiromi, and Kazuhide Hashiya. “The Gaze That Grooms: Contribution of Social Factors to the Evolution of Primate Eye Morphology.” *Evolution and Human Behavior*, vol. 32, no. 3, 2011, pp. 157–165., doi:10.1016/j.evolhumbehav.2010.08.003.

In this article Kobayashi and Hashiya discuss how the eye may have formed as an adaptive trait in order for primates, including humans, to best survive in large social groups. The authors, conducting studies with 30 different types of primates including humans, analyzed data for correlations between “eye morphology, social factors and

other factors such as habitat type and body mass” that would serve as drives for the evolutionary emphasis of the gaze as a component of social survival. Results of the studies show correlations between habitat and the size of social group in the use of eye gaze as a social function amongst primates and that the actual structure of the eye allows for these behaviors to be adapted. Kobayashi and Hashiya also note the differences between the primate eye and the human eye, particularly the exposed white sclera of the human eye versus the camouflaged sclera of the primate eye and how these biological attributes lend themselves to varying evolutions of the gaze.

Kobayashi, Hiromi, and Shiro Kohshima. “Unique Morphology of the Human Eye and Its Adaptive Meaning: Comparative Studies on External Morphology of the Primate Eye.” *Journal of Human Evolution*, vol. 40, no. 5, 2001, pp. 419–435., doi:10.1006/jhev.2001.0468.

Using comparative analysis Kobayashi and Kohshima work to “clarify the morphological uniqueness of the human eye and to obtain cues to understanding its adaptive significance”; Kobayashi and Kohshima went about exploring this through analyzing eye shape, sclera color, facial coloration around the eye, and habitat and body size of 88 primate species and humans. These results were used to determine the validity of the hypothesis that “only coloration of the human eye is adapted to enhance the gaze signal while eye coloration of other primates is adapted to camouflage the gaze direction against other individuals and/or predators”. The results of Kobayashi and Kohshima’s work were in support of this hypothesis, while also finding that the human eye may have evolved into its particular shape and form in order to “extend the visual field by eyeball movement, especially in the horizontal direction”, and that while it is an adaptation for other primates to have their gaze concealed by a pigmented sclera, in human evolution the need for “gaze camouflage” declined as humans became more social, leading to gaze-enhancement becoming a greater adaptation.

Tomasello, Michael. “For Human Eyes Only.” *The New York Times*, The New York Times, 13 Jan. 2007, www.nytimes.com/2007/01/13/opinion/13tomasello.html.

Tomasello’s article discusses the theories of the evolution of cooperation in human society using the distinct appearance of the human eye, particularly the visible sclera. The visibility of the sclera makes it possible for humans to “see where the eyes, as opposed to the head, are pointing”, a factor that Tomasello states is advantageous in social habitats such as those of humans, in which cooperation within large groups is key to survival. Tomasello highlights studies done with human infants and apes, in which infants would follow eye movement while apes responded when the whole head was moved as opposed to just the eyes. Using the foundations of the cooperative eye hypothesis, Tomasello considers whether the use of the gaze in human beings as a form of communicative may

have evolved before the advent of language in order for groups of our ancestors to coordinate themselves while hunting or gathering food.