Flow of Analogical Thoughts controls Eye Movements in Scene Viewing

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Abstract

Studies on controlling the eye movements are getting popularity for significant reasons of commercial, scientific, and social purposes. To achieve these goals, it is very important, at first, to study the influencing factors that take part in controlling the eye movements. In this study, we experimented a series of eye tracking tests to demonstrate our hypothesis that the movements of human eyes in scene viewing were primarily monitored by the flow of thoughts that were mainly based on analogy. Eye movement data were collected from participants who viewed artistic portraits. The eye tracks from eye tracking system traced sequence of gazes of analogical nature. These experimental phenomena verified the hypothesis that the flow of analogical thoughts controlled eye movements in scene viewing.

Keywords: *Eye movements, Analogical thoughts, Eye gazes, Scene viewing*

1. Introduction and background

Studies on eye movements are getting intensified with novel explorations and findings day-by-day. One of the core studies about eye movements gets concentration on the influential factors that cause such movements of eyes. These works, which are significant for scientific, social, technological, business applications, appeal considerable inspirations among Researchers, Professionals, and Social Practitioners in recent years. So, strong efforts are put in practice to study the influential factors of human eye movements. Undoubtedly, by controlling the influential factors that move human eyes during scene viewing, we may control the eye movements as well.

Human eyes and brain are strongly connected biological entities of every human being. So, the system, consisting of human eyes and brain, eases numerous neurological, perceptual, and cognitive phenomena. In the middle of these activities, there lies an essential and mandatory process; the process of eye movements that helps a human in visual viewing and understanding of surrounding objects. The movements of eyes initiate a series of cognitive functions, including visual attention, perception, analogical thoughts, cognitive reasoning and metacognition [1-5].

Normally, eye movements involve in the verbal and nonverbal communications and assist in providing the desired information among the participants of communication. In addition to these, eye movements actively contribute in the processing of data for information and the visualization of information which are common practices among professionals and individuals, including artists and scientists [5].

In eye movement processes, eyes change their gazes to spot a specific portion of the visible region in viewing because of having tendency to perceive the degree of detail visible in the central direction of gaze. In the movements, they pass through two temporal phases: fixations (the stops or periods of time when point of gaze or significant look is relatively slow) and saccades (the hops between stopping points). Saccades are often information-seeking and directed to specific objects or regions by the requirements of ongoing behavior. This infers the existence of cognitive processes of eye movements in viewing as well [5-9].

Typically, an art is defined as a human way of cognitive activities, which is expected to influence the minds of people who looked at them. Art is productive activity that focuses on the thoughtful modification and embellishment of worldviews. By and large, all known pieces of art are creative and metacognitive as per their roles because they are self-explanatory. The types and styles of art are technology-driven as innovative technologies bring renaissance to the artworks. The most essential part of art is its motive to become conscious about itself and in turn, firing up the cognitive processes in human mind [10-18].

The thought of analogy is significant in cognitive processes and is key mechanism in creativity which is also a part of the subject, like Visual Art. On the whole, there are two prime ideological viewpoints regarding the concept of analogy [11-15][19-23].

One of the groups of experts considers analogy as high-level perception. There is no clear division between perception, including high-level perception, and analogical thought. As a matter of fact, analogy happens not only at the end, but also in the beginning and during the same time as high-level perception. In high-level perception, humans make representations by selecting relevant information from low-level stimuli. As perception is compulsory for analogy, likewise, analogy is also compulsory for high-level perception [19].

However, the other group of experts considers the shared structure mapping theory. According to this consideration, analogy depends on mapping or alignment of the elements of source and target. The mapping takes place not only between objects, but also between relations of objects and between relations of relations. Mapping is basically process of aligning the representational structures of the two cases and projecting inferences. The main focus of such research is on the mapping process by which people understand one state or pattern in terms of another [20-23].

As a conclusive remark about the analogy and analogical thought, it is important to unveil the facts about these concepts. It is considered that though both groups of experts have different aspects about analogy and analogical thoughts, yet it seems that they are different aspects of the same thing, i.e. two perspectives which are identically equal.

Analogical thoughts are progressive and coexisting cognitive functions which are emanated from thoughts of analogy and continue to flow during entire timespan of visual scene viewing. These generated thoughts which are passing through analogically during scene viewing, take part in focal shifts of eyes during active scene viewing.

During artistic portrait observation, we move our eyes rapidly in irregular manner to change focus from one fixation to another fixation. This process, saccade, is one of the most common behavior of eyes. Pattern is obtained only during the periods of relative gaze constancy, known as fixations. The process of directing the eyes to view picture in real time is known as gazing of eyes [3-9][11-15][24-26].

The main motive of this study in artistic scene viewing is to demonstrate the analogical thoughts as core decisive and controlling factors on which our eye movements depend profoundly and to visualize the sequential traces of eye gazes due to eye movements during the eye movements.

2. Eye tracking system

In eye tracking system, the system illuminates infrared light for tracking the eye movements. The camera, connected to the system, captures the location of viewer's eyes in terms of fixation during experimentation time. As the viewer moves his/her eyes to look a new location of the scene, the camera records new fixation also. This process of recording continues subsequently. The system generates eye movement tracks and heat maps using the captured data which is utilized for further analysis.

The schematic diagram of eye tracking system and basic processes involved during eye tracking experimentation is represented in Figure 1.

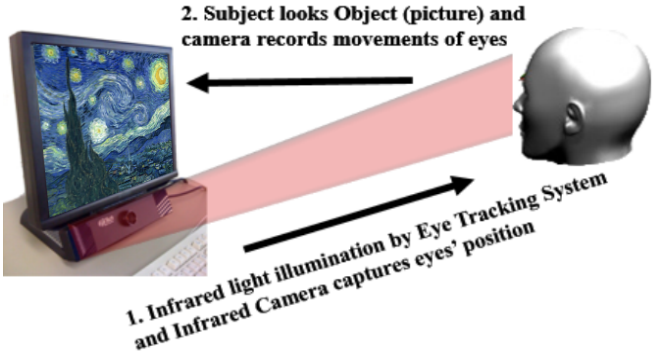

Figure 1. Eye tracking system with operational processes.

The traces of eye movements are taken in diverse layouts as per analyst's suitability. Among them, there are two most common formats are Heat Map and Sequenced Gazing with circle of concentration. In Heat Map, the track of eye is recorded as illumination and intensity of infrared light rays. This is based on Energy Therapy Technique (ETT). In Sequenced Gazing, the eye tracks are entered as numbered circles with their areas indicating the time duration of eye's gazing in those areas respectively [3][4].

In our experiments, we study the sequenced gazing of viewer's eye movements, which is generated by the system, during scene viewing. These are the dynamic shifts of eye gaze in scene viewing.

3. Present study

We investigate the gazing of eye movements from cognitive perspective, including the flow of analogical thoughts, during scene viewing and analyze the patterns of sequenced gazing to visualize the information. Here, visualization of sequenced gazing patterns to extract information for interpretation are essential steps of this study.

Initially, eye movements, in terms of sequenced gaze, are collected from participants who view full-color scenes while engaging in a visual search task in which they are freely viewing different fields of each scene. Finally, we compare and analyze the sequenced gazing against the artistic scene. The interpretation is carried out with the help of cognitive and analogical processes in current research.

The study on eye movements during scene viewing consists of a number of steps to be performed. These steps are represented as shown in the adjacent flow chart diagram (figure 2). This is a comparative study of two items; one item is artistic portrait and other item is the eye movement tracks of the same portrait, which is generated from eye tracking system.

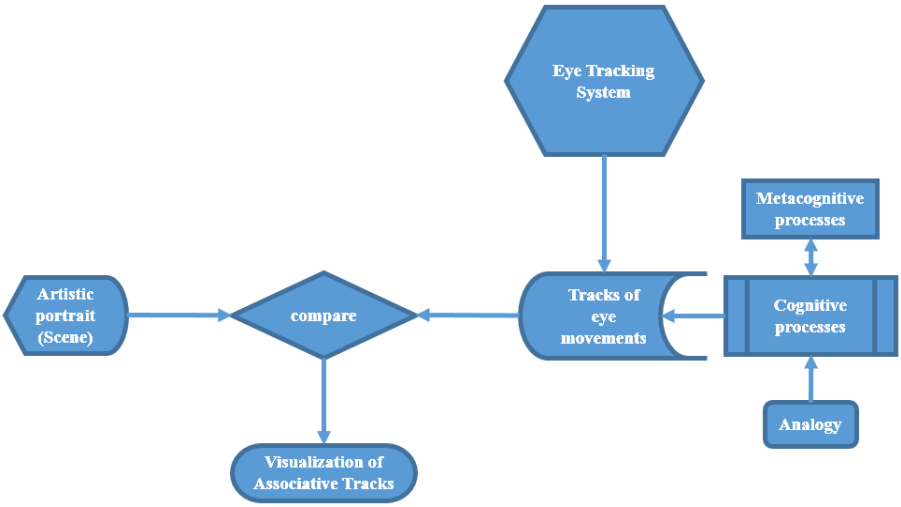

Figure 2. Flow chart of research study.

It begins with recording of eye movement tracks for a Subject; a viewer on eye tracking system for an Object; artistic portrait. The generated eye movement tracks of the same artistic portrait is comparable to the original artistic portrait. This comparative analysis infers visualization and interpretation of the outcome. So, these two items gets compared side by side.

During comparison stage, we utilize cognitive process, and metacognitive process, in addition to analogical thoughts that are happening consistently, to understand the crucial correlation that creates resultant maps. By analyzing, we come up with concluding remarks about the dependency of eye movements on the analogical thoughts that controls the phenomena of dynamic shifts of eye gazes.

4. Method

We selected 52 participants from a number of fields randomly, aging from 22 years to 32 years. These Subjects, the participants were assigned to view 3 randomly selected famous artistic portraits as shown below in figure 3.

The artistic portraits were “Starry Night; a famous portrait by Van Gogh during exile time”, “Last Supper of Jesus with his companions by Leonardo Da Vinci”, “Artistic Expressions by unknown”.

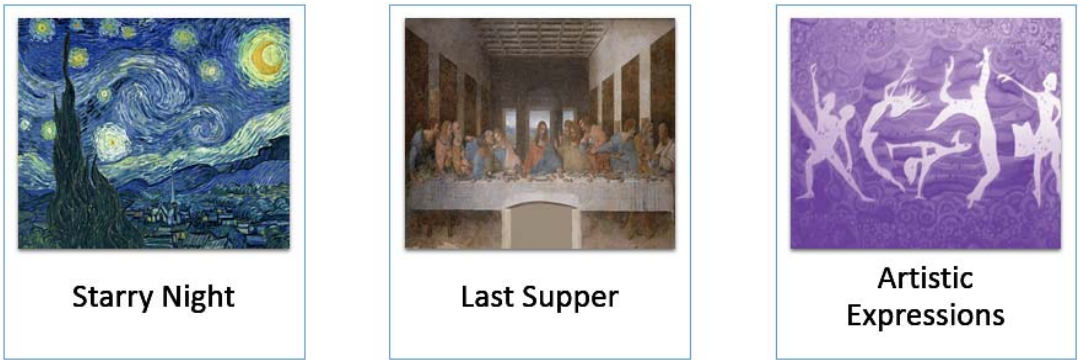

Figure 3. Selected Artistic Portraits for research study

Their eye movements were closely monitored as they viewed 32 bits full-color artistic scenes. The Objects, the scenes were displayed on a computer monitor. The scenes were shown at a resolution of 1280 × 1024 pixels and subtended 15 deg. horizontally by 10 deg. vertically at a viewing distance of 75 cm. Eye position was sampled from an Eye Tech Digital Systems TM3 16 mm Eye Tracker, and eye tracking data was parsed into sequenced gazing with circles of concentration.

The Subjects’ heads were held steady in advance prior to experimentation. Prior to the first trial, Subjects completed a procedure to calibrate the output of the eye tracker against spatial positions on the display screen. This procedure was repeated regularly throughout the experiment to maintain high level of accuracy. Subjects were initiated to view the scenes freely.

The scenes were presented to the Subjects for maximum duration of 60 seconds. During this time span, the Subjects viewed the scenes with their normal eyes and focused attention on the Object, the portrait.

Here, we analyzed all 3 portraits respectively with the intention to elaborate our findings in the most common and generalized perspective.

5.1. Analysis 1: Study of Starry Night artistic portrait

Figure 4. Artistic portrait and eye movement track of the same artistic portrait

In the above artistic portrait of figure 4, the left side portrait is the original portrait. The right side portrait is the eye movement track by eye tracking system during the scene viewing by the Subject.

As the Subjects started to move the eyes, the visual attentions of the Subjects caused them to gaze their eyes across the region of star; the whirled round shape. Next, due to initiation of cognitive and metacognitive processes, the Subjects fell into the state of perception. Further, they moved their eyes to the similar left-side region which was another star. This shift of visual attention was due to stimulated flow of thoughts which got initiated by cognition. The flow of thoughts which were completely based on analogy, might be visualized in the eye movements as well. In this case, the existing flow of analogical thought compelled eye gazes to propagate further and directed the focus of eyes to move along in the same direction of analogical thought transmission. So, the eye movements were closely operated and controlled by the flow of analogical thoughts that existed consistently and concurrently during the entire span of time of scene viewing.

With these controlling analogical flow of thoughts, the eyes of Subjects moved subsequently to other similar regions of the portrait, which was obvious from the eye movement links of the portrait. Therefore, the floating thoughts of analogical perspectives which were mainly happening in between the established cognitive process of visual attention, regulated the eye movements during scene viewing.

Further, later interview of Subjects confirmed the influential factor of analogical thoughts that led them to track their eyes as directed. In the beginning, they were gazing at the whirled round star and later got interest in similar region consisting of whirled round star that was adjacent to the current portion of portrait. The process of such viewing continued further and ended after allocated timespan. So, these interests due to analogy in adjacent regions of the scenery, led human eyes to move towards a directed path based on floating analogical thoughts.

5.2. Analysis 2: Study of Last Supper artistic portrait

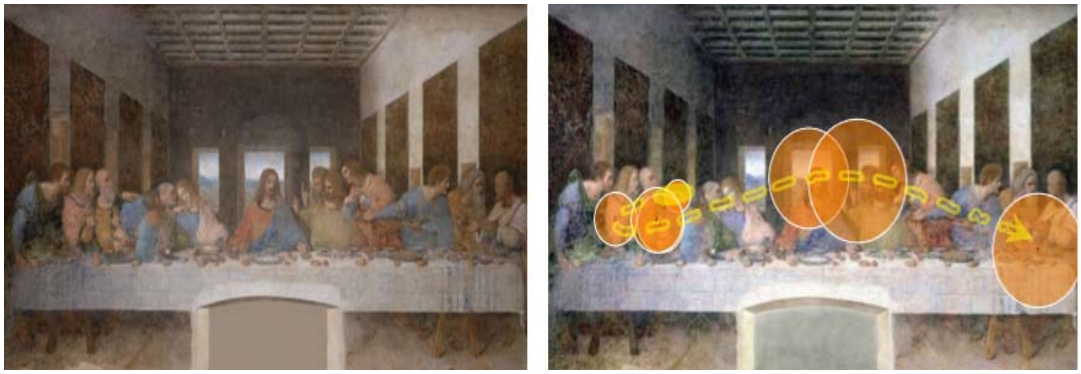

Figure 5. Last Supper artistic portrait and eye movement track of the same portrait

In this artistic portrait of figure 5 of the Last Supper, Jesus, sitting in the center, was having dinner with his companions at a common table. Suddenly, he spoke, “One of you will betray me”. Thereafter, the scene reflected beautifully the reactions of the all the 11 companions and Jesus himself.

In the beginning, the Subjects looked over left-side region of the portrait and their visual attentions were largely concentrated over numerous gestures; mostly by hands, eyes, and facial expressions which were directed flow of motion to express the emotions and feelings of the companions. These gestures and expressions compelled Subjects towards visual perception and in turn, evolutionary idea of analogy within participating cognitive processes. Consequently, due to the motivation of analogy, they moved their gazes at the central part of the portrait where they found again similar gestures for Jesus and other companions. Finally, they moved at the right-side of the portrait with these influential idea of analogy based on gestures and expressions.

So, these happenings of phenomenal sequences concluded that the flow of analogical thinking directed and guided the Subjects’ eyes towards the same direction as the direction of the flow. Further,

these observations led towards another remark that eye movements were totally controlled by the prominent factor, i.e. Subjects' analogical thoughts during this scene viewing.

In successive interview, the concerned Subjects revealed that they were strongly influenced by the gestures and facial expressions during scene viewing. Mostly, they were interested to understand the communicative gestures and the analogy behind these gestures and expressions. Therefore, this confirmed again the influential factor of analogical thoughts that controlled the movements of Subjects' eyes.

5.3. Analysis 3: Study of Artistic Expressions artistic portrait

Figure 6. Artistic Expressions portrait and eye movement track of the same portrait

In the eye tracking experimentation for Artistic Expression of figure 6, the Subjects were gazing their eyes at the left-side of the portrait in the beginning. The visual attention and the state of perception cognitively refocused Subjects' eyes towards the central portions of the scenery where an expression of happiness and joy were booming among living creatures. Due to the initiation of the cognitive processes which played a vital role during the entire scene viewing phenomena, the evolution of Subjects' analogical thoughts took place and started to impact the happenings of eye movements. Subsequently, the transmission of such emotional feelings were exaggerated as per the basis of analogy observed among these different adjacent portions of the scenery. Finally, the focus of eye gazes ended to the right-side of the portrait.

So, these sequential activities led towards the observable confirmation that the existence of analogical thoughts that flowed in between the processes of scene viewing, guided and controlled the movements of eyes. These eye movements were clearly followed along the direction of the flow of analogical thoughts.

Later interview of the Subjects concluded that they were interested in identifying the theme of emotions among these living creatures. The similarity among these gestures and emotions shown by these Objects' elements; living creatures led them to recognize the feelings of happiness and joy among these living creatures.

6. Discussion

In this research work, we choose some of the finest pieces of art intentionally. The artistic sceneries embrace in their manifestation with the foremost purpose of artistic artworks in the shape of human cognition mechanism in viewing these artistic sceneries [5][6][8-18]. These creative pieces of art reflect inherent human interaction to perceive knowledge and interpretation of realistic world in human mind. These emotional views are rather too complicated to understand from visual analytics and analytical reasoning. Consequently, these cognitive perspectives, i.e. thoughts of analogy and flow of analogical thoughts are discovered by eye movements in scene viewing.

Coexisting flow of analogical thoughts during scene viewing is significant step for appropriate retrieval of task-relevant visual information which are essential for visualization of final maps [11-15]. In this study, we observe that the generated eye movement tracks of sequenced gazes are strongly

following the same path as the flow of analogical thoughts. These are major evidences to verify our objective, i.e. the eye movements get manipulated operation under the guidance of analogical thoughts broadcast. As a result, without taking into account the influential factor; analogical thought propagation, it is impossible to link the entire scenario of human cognition in the sequential eye gazing of eye movement tracks.

The visualization of streaming analogical thoughts in terms of followed eye movement tracks is a tactical and decisive part of whole activities. The visualization of controlled eye movement tracks, in terms of analogical thoughts, is unarguably innovative perspective of each and every analyst who examine them for definite intents. This, in turn, causes a number of analogical thoughts in scene viewing by various perspectives of analysts. Though the existence of analogical thoughts is available in the literature [19-23], yet its presence and clarification varies drastically. In this regard, the visualization of relevant eye movement tracks reinforce again the existence of dominating analogical factor; the controller of entire phenomena in between the inherent cognitive and metacognitive processes during scene viewing.

In addition to these arguments, the experimental evidence of analogous traversal path generated by eye tracks as the flow of analogical thoughts during active scene viewing holds our hypothesis for which we conducted a series of experimentations. The hypothesis that flow of analogical thoughts controls eye movements in scene viewing, is persuasive and pioneering breakthrough related to eye movements study.

The applicability of current findings might be inherited in a number of domains; Cognitive studies, Medical research, Human factors, and specially, Commercial usability. One of the core areas where the findings might be thoroughly feasible, can be the behavioral studies of the consumers for improvement and sophistication of commercial sensors. These findings might become the guidelines for controlling and developing novel perspectives of human-generated impacts on sensory devices. Tracking of eye gazes is the decisive factor in remodeling and designing of the smart and human centric systems.

7. Conclusion

We conclude that the analogical thoughts which are flowing within the visual fields of artistic portraits during scene viewing, controls and directs the movements of human eyes during visual scene viewing. The guided shifts in eye gaze depend on the flow of analogical thoughts during scene viewing. These flowing analogical thoughts, in terms of cognitive consequences, control humans' eye movements, in terms of the eye tracks during scene viewing.

8. References

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