HiLL PUBLISHING

Journal of Humanities, Arts and Social Science, 2023, 7(3), 607-611
https://www.hillpublisher.com/journals/jhass/
ISSN Online: 2576-0548
ISSN Print: 2576-0556

An Eye-Tracking Study: Understanding the Impact of Different Formations on People's Visual Attention

Shouxuan Bi

Shanghai Starriver Bilingual School, No. 2588, Jindu Rd, Minhang District, Shanghai, China.

How to cite this paper: Shouxuan Bi. (2023) An Eye-Tracking Study: Understanding the Impact of Different Formations on People's Visual Attention. *Journal of Humanities, Arts and Social Science*, 7(3), 607-611.
DOI: 10.26855/jhass.2023.03.024

Received: March 10, 2023
Accepted: April 8, 2023
Published: May 4, 2023

***Corresponding author:** Shouxuan Bi, Shanghai Starriver Bilingual School, No. 2588, Jindu Rd, Minhang District, Shanghai, China.

Abstract

Formation widely appears in group activities, including taking photos, group dancing, synchronized skating, etc. There are many types of formations, and different formations provide different visual effects. This research focuses on evaluating how different formations affect people's attention. Pictures of mannequins were used as stimuli to avoid bias brought by appearance. Twenty subjects were recruited in total among which eight are females, and twelve are males. The subjects were assigned to two experimental groups, respectively. Group A watched three types of formations consisting of three mannequins. The three formations are "—" shape, "Λ" shape, and "V" shape facing toward the subjects. Group B was also required to watch the same three types of formations, consisting of five mannequins. An eye-tracker was used to record how subjects viewed different types of formation. Eye-tracking parameters were adopted to quantify visual attention, including total fixation duration and fixation count. Comparing the parameters of each dummy could reveal how different formations and the number of group members affect people's visual attention. According to the results, in all three formations, the one in the middle always attracts more attention in terms of fixation duration and fixation count. This applies to both Group A, and Group B. Members in other positions have no significant statistical difference. This finding provides quantitative visual information to the formation, which developed the understanding correspondingly. At the same time, it could facilitate formation design in various areas.

Keywords

Eye-tracking, formation, group activity, dance, gaze, visual attention

1. Introduction

Group dancing has a long history and is an essential activity for human society (Sachs, 1963). In recent years, with the rapid development of the entertainment industry, group dancing has become more and more popular. Since entertainment companies have trained many artists, who usually perform in groups called Girl Groups or Boy Groups. This form is prevalent among the young audience (Zhou et al., 2020). Many researchers have studied this area as it's an essential activity for human society. Some focused on the function of group dancing. For example, Woolhouse found that group dancing could improve person perception (Woolhouse, 2010). Since it helps enhance the memory of others' features. Some others considered that partnered dancing has many benefits, including people's mood, cognitive ability, self-confidence, and physical fitness (Lakes, 2016). Brown also suggests that people should not ignore the entertainment function of group dancing. Moreover, he suggested that group dancing

is the origin of rhythmic entrainment for humans (Brown, 2022). There is also some research discussing group dancing from different perspectives. Tsuchida and his co-workers believed learning formation is as important as choreography in group dancing. They have investigated ways to facilitate dancers learning formation (Tsuchida, 2013; Tsuchida, 2014). Another study also focused on the coordination and synchrony of group dancing. They argued that haptic sensory is the most crucial factor which could improve synchrony (Chauvigné et al., 2019).

The above research reveals that formation is an essential element in group dancing. It is closely related to the quality of a group dance. In previous studies, most researchers discussed group dancing from the angel of dancers, i.e., improving formation quality (Tsuchida, 2013; Tsuchida, 2014; Chauvigné et al., 2019). The present research targets to discuss from the audience's angle, which is different from the previous work. How formation would affect the audience's visual attention will be investigated. At the same time, it considers dancers as individuals and a whole, providing a holistic angle of group dancing. To have a better understanding of the observing process, the eye-tracking technology is adopted. An eye-tracker would be used to record the subjects' gaze data, which could generate quantitative results. This is the very first attempt to combine eye-tracking technology and group dancing formation study. The results could further the understanding of group dancing in terms of how the audience views the performance. It could guide formation design and facilitate arranging dancers' positions. At the same time, the findings could also benefit other activities which require formation, i.e., taking group photos, synchronized skating, and synchronized swimming.

2. Experiment

2.1 Participants

In the study, 20 subjects were randomly recruited at a shopping mall in Shanghai, China, consisting of 8 females and 12 males. Participants were informed they would view a series of photos during the experiment. In addition, they were informed of the potential risks of the study and consented to participate. Participants were randomly assigned into two groups. One group consisted of 5 males and 5 females. The other group consisted of 7 males and 3 females.

2.2 Stimuli

Instead of photos of real people, photos of wooden mannequins were chosen as stimuli in this study. This is to avoid bias brought by the subjects' preference for appearance. Participants were asked to watch a series of photos of wooden mannequins. The series of photos are divided into two groups: Group A and Group B. The formation of Group A consisted of three mannequins, which were A1, A2, and A3, from left to right, respectively. Group B consisted of five mannequins, B1, B2, B3, B4, and B5, respectively, from left to right. Each group had three types of formation, respectively, labeled as FI, FII, and FIII. The formation of FI was a "—" shape, which was a straight line. In Group A, A2 stood in the middle of the line. In Group B, B3 stood in the middle. The formation of FII was a "Λ" shape whose vertex was far from the audience. In Group A, A2 was at the vertex, and in Group B, B3 was at the vertex. The formation of FIII was a "V" shape, whose vertex was close to the audience. In the two groups, A2 and B3 were at the vertex, respectively. In all groups, the mannequins were standing straight and facing the audience.

2.3 Experimental Design

The study used a between-subject design. Subjects were divided into two groups. Each subject was assigned to either Group A or Group B randomly. They were asked to view pictures from Group A or Group B accordingly, as described above. The subjects were asked to read and sign the consent form. Afterward, the subjects sat down in front of a screen, which was connected to a laptop and an eye tracker (Tobii 4C). Following a successful calibration procedure and experimental instruction slide, the subjects watch photos of either Group A or Group B. Each photo was displayed one by one, and the sequence was fixed. The duration of each photo was six seconds. The task took approximately five minutes to complete. All subjects were given small gifts after the experiment.

There were totally ten area of interest (AOIs). In Group A, mannequins from left to right were considered A1, A2, and A3. The whole photo, including all mannequins, is considered as A. In Group B, mannequins from left to right were considered as B1, B2, B3, B4, and B5. The whole photo, including all mannequins, was considered as B.

2.4 Data Analysis

To evaluate the subjects' attention distribution to mannequins in each formation, eye-tracking parameters, including fixation duration (FD) and fixation count (FC), were used for statistical analyses, respectively. In Group A, within-group ANOVA tests were carried out among (A1/A), (A2/A), and (A3/A) of FI; (A1/A), (A2/A), and (A3/A) of FII; (A1/A), (A2/A), and (A3/A) of FIII. In Group B, within-group ANOVA tests were carried out among (B1/B), (B2/B), (B3/B), (B4/B), and (B5/B) of FI; (B1/B), (B2/B), (B3/B), (B4/B), and (B5/B) of FII; (B1/B), (B2/B), (B3/B), (B4/B), and (B5/B) of FIII. Between-group ANOVA tests were also conducted for FD and FC, respectively, including (A1/A) among FI, FII, and FIII; (A2/A) among FI, FII, and FIII. (A3/A) among FI, FII, and FIII. The statistical analyses were also conducted on B1, B2, B3, B4, and B5 in Group B among FI, FII, and FIII. The ratio of individual mannequins over all mannequins revealed how subjects allocated their visual attention to each individual when observing different types of formations.

3. Result

ANOVA tests of Group A were conducted as described above. For FI, the FD ratio of A2 (M=0.66, SD=0.14) is significantly (P<0.05) greater than A1 (M=0.14, SD=0.14) and A3 (M=0.14, SD=0.10); and the FC ratio of A2 (M=0.61, SD=0.14) is significantly (P<0.05) A1 (M=0.16, SD=0.15) and A3 (M=0.16, SD=0.11). For FII, the FD ratio of A2 (M=0.52, SD=0.21) is significantly (P<0.05) greater than A1 (M=0.15, SD=0.11) and A3 (M=0.14, SD=0.13); and the FC ratio of A2 (M=0.57, SD=0.16) is significantly (P<0.05) greater than A1 (M=0.16, SD=0.14) and A3 (M=0.12, SD=0.11). For FIII, the FD ratio of A2 (M=0.62, SD=0.21) is significantly (P<0.05) greater than A1 (M=0.12, SD=0.13) and A3 (M=0.15, SD=0.12); and the FC ratio of A2 (M=0.57, SD=0.16) is significantly (P<0.05) greater than A1 (M=0.17, SD=0.17) and A3 (M=0.15, SD=0.11). For the FD ratio of A1 among FI, FII, and FIII, there is no significant difference (P>0.05). For the FD ratio of A2 among FI, FII, and FIII, there is no significant difference (P>0.05). For the FD ratio of A3 among FI, FII, and FIII, there is no significant difference (p>0.05). For A3 among FI, FII, and FIII, there is no significant difference (P>0.05). The between-group ANOVA analysis of FC also doesn't show a significant difference among all groups (p>0/05).

For Group B, in FI the FD ratio of B3 (M=0.34, SD=0.22) is significantly (P<0.05) greater than B1 (M=0.06, SD=0.10), B2 (M=0.15, SD=0.14), B4 (M=0.32, SD=0.15), and B5 (M=0.06, SD=0.07); and the FC ratio of B3 (M=0.35, SD=0.19) is significantly (P<0.05) greater than B1 (M=0.05, SD=0.08), B2 (M=0.16, SD=0.12), B4 (M=0.29, SD=0.11), and B5 (M=0.07, SD=0.08). In FII, the FD ratio of B3 (M=0.40, SD=0.27) is significantly (P<0.05) greater than B1 (M=0.01, SD=0.03), B2 (M=0.04, SD=0.05), B4 (M=0.11, SD=0.10), and B5 (M=0.12, SD=0.20); and the FC ratio of B3 (M=0.37, SD=0.24) is significantly (P<0.05) greater than B1 (M=0.02, SD=0.03), B2 (M=0.07 SD=0.07), B4 (M=0.13, SD=0.10), and B5 (M=0.03, SD=0.05). In FIII, the FD ratio of B3 (M=0.58, SD=0.28) is significantly (P<0.05) greater than B1 (M=0.03, SD=0.05), B2 (M=0.08, SD=0.10), B4 (M=0.08, SD=0.08), and B5 (M=0.04, SD=0.05); and the FC ratio of B3 (M=0.56, SD=0.24) is significantly (P<0.05) greater than B1 (M=0.04, SD=0.05), B2 (M=0.09 SD=0.10), B4 (M=0.10, SD=0.11), and B5 (M=0.03, SD=0.05). Between-group analyses for the FD and FC ratio of B1 among FI, FII, and FIII has no significant difference (p>0.05). This also applies to B2, B3, and B5 statistical analyses among all formations. However, the FD ratio of B4 in FI (M=0.32, SD=0.15) is significant (p<0.05) greater than B4 in FII (M=0.11, SD=0.1) and FIII (M=0.08, SD=0.08). The FC ratio of B4 in FI (M=0.29, SD=0.11) is also significantly (p<0.05) greater than FII (M=0.13, SD=0.1) and FIII (M=0.1, SD=0.11).

All results are consolidated in Table 1 and Table 2.

4. Discussion

This study is the very first attempt to leverage eye-tracking to investigate group formation. It investigated if different types of formation would affect the audience's attention distribution. The experiment used photos of mannequins as stimuli. Three types of formation were investigated, the "—" shape, the "Λ" shape, and the "V" shape. All mannequins in the photos were standing and facing the subjects. Each formation had two groups. Group A consisted of three mannequins, and Group B consisted of five. The subjects were assigned to Group A or B randomly and viewed photos of the three types of formation. An eye-tracker was used to record the subjects' gazing behaviors. According to the results, for all three formation types, the one in the middle always got significantly more fixation duration and fixation count data. This indicates that regardless of the type of formation, the one in the middle always attracts more attention. The number of group members also does not affect the conclusion. Moreover, people

pay a similar level of attention to other group members. There is no significant statistical difference among other mannequins. One exception is the fourth individual of the "—" shape formation in Group B. B4 got a higher fixation duration and fixation count value than the others. The potential reason is discussed below.

Table 1. The FD and FC ratio of Group A

	FD Ratio			FC Ratio		
	FI	FII	FIII	FI	FII	FIII
A1	0.14(±0.14)	0.15(±0.11)	0.12(±0.13)	0.16(±0.15)	0.16(±0.14)	0.17(±0.17)
A2	0.66(±0.14)	0.52(±0.21)	0.62(±0.21)	0.61(±0.14)	0.57(±0.16)	0.57(±0.16)
A3	0.14(±0.10)	0.14(±0.13)	0.15(±0.12)	0.16(±0.11)	0.12(±0.11)	0.15(±0.11)

Table 2. The FD and FC Ratio of Group B

	FD Ratio			FC Ratio		
	FI	FII	FII	FI	FII	FIII
B1	0.06(±0.10)	0.01(±0.03)	0.03(±0.05)	0.05(±0.08)	0.02(±0.03)	0.04(±0.05)
B2	0.15(±0.14)	0.04(±0.05)	0.08(±0.10)	0.16(±0.12)	0.07(±0.07)	0.09(±0.10)
B3	0.34(±0.22)	0.40(±0.27)	0.58(±0.28)	0.35(±0.19)	0.37(±0.24)	0.56(±0.24)
B4	0.32(±0.15)	0.11(±0.10)	0.08(±0.08)	0.29(±0.11)	0.13(±0.10)	0.10(±0.11)
B5	0.06(±0.07)	0.12(±0.20)	0.04(±0.05)	0.07(±0.08)	0.03(±0.05)	0.03(±0.05)

This study brought more insights for formation studies from a different angle, which could help photographers, choreographers, as well as stage designers, create a better arrangement that would capture the audience's attention on specific elements. For example, by using the findings from this experiment, photographers and stage designers could place the essential person in the center. On the other hand, all members could rotate to the central position so that everyone receives equal attention. A previous study also reached a similar conclusion. A study on ships reveals that the ship at the central position is more significant to other targets, regardless of the color, size, and shape. The position is the decisive factor (Sang et al., 2014). In human visual information processing, salient objects are always prioritized for processing, and other non-salient objects are even ignored or discarded. This processing strategy enables humans to allocate computational resources selectively. Hence the processing efficiency is significantly improved (Lai, 2014). Since objects in central positions are significantly different from their surroundings, the human visual system tends to recognize them as salient objects. That means more attention will be allocated since the bottom-up control strategy is a fast, low-level cognitive process based on the input image (Sang et al., 2014). This explains why individuals in central positions always attract more attention. In Group B, the fourth individual in the "—" shape formation also got more attention. The sentences of the instruction slide ended at a similar position to the fourth mannequin. Hence, the subjects' initial gazing point overlaps with the fourth mannequin. Based on the analysis, six out of ten participants put their first fixation point on B4, which supports the explanation.

There are some limitations and improvements. In future studies, the design of instruction slides could be improved since it may affect subjects' initial gaze points. Alternatively, an interfering slide could be displayed before the stimuli, i.e., a blank slide. This study used a white background. In real-case scenarios, there are various kinds of backgrounds. The background would also influence the human visual processing process (Jacoby, A., 1992). Further studies could explore the impact of backgrounds. Moreover, findings could facilitate the stage or background design. Last but not least, this research investigated three types of formation. There are still many different types. Future research could focus on other types of formation.

References

Brown, S. (2022). Group dancing as the evolutionary origin of rhythmic entrainment in humans. New Ideas in Psychology, 64 (4). https://doi.org/10.1016/j.newideapsych.2021.100902.

Chauvigné, L.A., Walton, A., Richardson, M.J., & Brown, S. (2019). Multi-person and multisensory ysynchronization

during group dancing. Human movement science, 63, 199-208. https://doi.org/10.1016/j.humov.2018.12.005.

Gallagher, A. C., & Chen, T. (2009). Understanding images of groups of people. 2009 IEEE Conference on Computer Vision and Pattern Recognition. https://doi.org/10.1109/cvpr.2009.5206828.

Jacoby, A. (1992). Epilepsy and the quality of everyday life. Social Science &Amp; Medicine, 34(6), 657-666. https://doi.org/10.1016/0277-9536(92)90193-t.

Lakes, K. D., Marvin, S., Rowley, J., Nicolas, M. S., Arastoo, S., Viray, L., Orozco, A., & Jurnak, F. (2016). Dancer perceptions of the cognitive, social, emotional, and physical benefits of modern styles of partnered dancing. Complementary Therapies in Medicine, 26, 117-122. https://doi.org/10.1016/j.ctim.2016.03.007.

Li, W.Y., Wang, P., Qiao, H. (2014). A Survey of Visual Attention Based Methods for Object Tracking. ACTA AUTOMATICA SINICA, 2014, 40(4): 561-576. https://doi: 10.3724/SP.J.1004.2014.00561.

Sachs, C. (1963). World History of the Dance (The Norton Library) (1st ed.). W. W. Norton & Company.

Sang, N., Li, Z.L., & Zhang, T. X. (2004). Applications of human visual attention mechanisms in object detection. Infrared and Laser Engineering, 33(1), 38-42.

Tsuchida, S., Terada, T., & Tsukamoto, M. (2013). Proceedings of the 4th Augmented Human International Conference On - AH '13. https://doi.org/10.1145/2459236.2459266.

Tsuchida, S., Terada, T., & Tsukamoto, M. (2014). A system for practicing formations in dance performance using a two-axis movable electric curtain track. Proceedings of the 5th Augmented Human International Conference. https://doi.org/10.1145/2582051.2582106.

Woolhouse, M. & Dan, T. (2010). Group dancing leads to increased person-perception. Proceedings of the 11th International Conference on Music Perception and Cognition (ICMPC11).

Zhou, T., Liu Z., Chen, Y.T., Chuan, T.F., & Li, L.C., (2020). Talent Show: The Difference between Boy Group and Girl Group. Inside and Outside (high school version), 7.