KRAJOWY PLAN ODBUDOWY
Rzeczpospolita Polska
Sfinansowane przez Unię Europejską NextGenerationEU

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Dancing choreography and costumes. Possibilities of applying eye-tracking methods

Based on the project: Podlaskie Allegories
Podlasie dance folklore in jazz musical interpretations

Abstract:

Studying dance issues in relation to the sociology of dance and interest in movement is a very complex and challenging task. Among the qualitative techniques applied to dance, we can distinguish between interview, visual data analysis, observation, and autoethnography. The highlighted research techniques do not exhaust the possibilities that arise in relation to the social aspects of dance. A tool that can be used for a wide variety of dance problems is oculography. Eye tracking is widely used in many areas of life. The benefits of this technology are related to basic information about human vision and the visual system. By applying this modern technology to selected dance forms, choreographers can learn how audiences perceive particular dance figures, which elements they pay more attention to, or which parts they fix their eyes on for longer. Dance, similar to information-marketing research, can be used to optimise stage images.

Furthermore, folk dance, in addition to its many cultural meanings and symbolism, is marked by a large palette of costumes and colours. Therefore, eye tracking may also be used in the study of dance costumes. A total of 35 individuals – viewers of the Podlasie Song and Dance Ensemble performance – took part in the pilot study using eye tracking. Out of this group, 14 participants were shown dancers in folk costumes, while 21 participants watched film sequences of solo parts in confrontation with ensemble dance structures.

In the pilot studies conducted, choreographies and their reception by the viewer were an important issue. Both choreographic structures and emotions were taken into account. The presentation of individual Gridded AOI images involved solo and ensemble parts. Conclusions that emerged in the course of consideration relate to choreography-relevant insights. The dominant one, with regard to the individual film sequences and choreography parts, is the solo pair, which, through emotion and engagement, is more likely to focus the viewer's attention than the precise symmetrical ensemble sequences. However, this was no longer applicable to the prop-based ensemble choreographic structures that dominated the solo pair.

Based on the KPIs of the two Polish folk costumes, parameters were compared within the defined area of AOI1 and AOI2, which allowed analysis in relation to the perception of the dance costume. In the present study, the audience's attention was focused primarily on the dancers' faces.

The subjects' gaze focused on the male and female torsos. The legs and feet attracted attention to a lesser extent. Heat Maps and Focus Maps indicate trends in the perception of dancers in the two selected folk costumes. The observers' gaze was focused on distinctive accessories – in the female dancer, these were beads, shirt ornaments, and cuffs. The attribute of the men's costume was the belt, which, apart from the face, dominated when it comes to attracting the attention of the viewer. The comparisons presented above are from a pilot study and for the purposes of this paper cover a part of the issues. However, inference requires further research and detailed analysis.

Key words: eye tracking, folk dance, visual attention, folk costumes

Introduction

Dance can be considered taking into account functionalism and structuralism. The first view is concerned with analysing what a phenomenon serves, its purpose and origin, while the other one relates to structure. It defines precisely what it consists of (Royce, 2002). We can enjoy dancing by moving to the rhythm of music, and we can also admire the movement of dancers. However, dance becomes an art form when we begin to understand it as a formulated whole (Smith-Autard, 2004).

Dance is an image in motion that allows observers to see thoughtful form and balance. The purpose of choreography is to position the dancers in space. In addition, it is a purposeful, logical justification for the creation of movement (Sofras, 2006). Choreography is a complex process of designing a stage space, while dance in this case becomes an image – a landscape. Composition is a creative process that allows combining individual elements of movement into a compatible whole. The created fragments, through their relationship and synthesis, form an identifiable structure. The ability to look at the body as an artifact, to analyse and understand the cultural meanings in this movement-based, embodied way of knowing the world, is definitely much better today than at any time in the past (Royce, 2002). Studying dance issues in relation to the sociology of dance and interest in movement is a very complex and challenging task. Moreover, the non-verbalised phenomena that deal with corporeality and its social conditions within the framework of traditional sociology, especially quantitative sociology, are very limited. Among the qualitative techniques applied to dance, we can distinguish between interview, visual data analysis, observation, and autoethnography. The highlighted research techniques do not exhaust the possibilities that arise in relation to the social aspects of dance. However, these phenomena are rarely studied using quantitative research techniques although their use is not completely excluded (Byczkowska-Owczarek, 2015).

Eye tracking – possibilities for use in dance research

Eye tracking is widely used in many areas of life, such as medicine, psychology, industrial engineering, marketing, advertising, computer industry, education, etc. (Duchowski, 2002, Mele, et. al. 2012). It is also used extensively by the marketing industry. This applies to the effectiveness of the transmission of advertising content, or the content and construction of websites.

The technology associated with recording and measuring changes in the position of the eyeballs is becoming particularly useful in psychological research, including educational research (Andrzejewska, et al. 2016, Stolinska, et al. 2017). The broad applications of eye tracking are definitely developmental in nature and provide a platform for more and more new considerations. A number of cutting-edge studies have emerged and continue to be a space for exploration.

Eye movement research is not limited to medical, educational, or marketing problems only. The decision-making process has also been a source of interest for researchers (Orquin, 2013). Therefore, it has a very wide range of applications, while research problems continue to develop.

By applying this modern technology to selected dance forms, choreographers can learn how audiences perceive particular dance figures, which elements they pay more attention to, or which parts they fix their eyes on for longer. Dance, similar to information-marketing research, can be used to optimise stage images.

In dance, the process of creating involves telling a story using movement. It also involves designing a stage space and manifesting dancers' emotions through movement combined with music. Composition allows combining individual elements of movement into a compatible whole. The created fragments, through their relationship with music and synthesis, form an identifiable structure. Dance is a three-dimensional image created from movement and its combinations.

Choreographers' and dancers' skills and tools are based on technique, figures, dynamics, symmetry, space, etc. The formative stimulus of dance movement is largely music, which influences the emotional-content character of the movement. It is music that organises the dynamics and the flow of time, and may also determine the spatial, temporal, and dynamic structure. Music and dance are interwoven and form a coherent structure. Based on such formulated assumptions, music interacts with sound; dance, on the other hand, should be captivating thanks to its beauty of gesture, as well as movement (King, 2012).

Appreciating human movement can be a powerful aesthetic experience. In the 21st century, choreography teachers need to go beyond the emphasis on traditional craftsmanship and support creativity through various innovative means. The methods developed so far, as well as opening up to modernity and understanding the reactions and thought processes of the modern viewer, will allow the creation of much more sublime designs. The novelty of contemporary composition is the formation of committed choreographers whose movement design and space organisation will go beyond the usual methods. This requires a complex process based on the foundations of dance composition – thorough and properly organised (Morgenroth, 2006). The process of creating choreography can also be supported by an eye-tracker. Studies by Orgs, et al. 2013, Röder, et al. 2016, Weege, et al. 2012, Woolhaous, et al. 2014, prove the proper role and support of the research process in this novel way. Furthermore, folk dance, in addition to its many cultural meanings and symbolism, is marked by a large palette of costumes and colours. Therefore, eye tracking may also be used in the study of dance costumes.

Research using eye tracking in the field of the broadly defined sociology of dance can address separate problems or support the research process. Focusing the viewer's attention on the perception of dance is not a new phenomenon. The use of eye tracking in relation to the body and movement, and its various aspects, has concerned many considerations and problems so far (Woolhaous, et al. 2014, Ponmanadiyil, et al. 2018).

For this study, we have developed two hypotheses to investigate how the audience will respond to a dance performance and its impact on folkloric costumes. Firstly, using eye-tracking technology, we anticipate that the "Nowy Sącz" costume, which is the most popular, will attract more attention than the "Podlasie" costume. Secondly, we expect that solo choreography will result in longer gaze dwell times and more fixations compared to group sequences, even when props are used, whether they are symmetrical or asymmetrical.

Materials and methods

The study used appropriate, technically prepared images with adequate resolution and colour, as well as the spatial distribution of individual elements. Both static images and video footage were used, in which (due to the dynamic content and complex nature) image sequencing and readings of eye movement indicators were performed for individual frames relevant to the research assumptions. The duration of each study did not exceed 5 minutes.

A total of 35 individuals – viewers of the Podlasie Song and Dance Ensemble performance – took part in the pilot study using eye tracking. Out of this group, 14 participants were shown dancers in folk costumes, while 21 participants watched film sequences of solo parts in confrontation with ensemble dance structures.

The video material included four 30-sec. sequences created with the use of Final Cut Pro X software. For research purposes, the videos were shown to the audience in two blocks simultaneously (the films were presented on the same screen with 50:50 image splitting). The first block included the solo choreography as well as the symmetric choreography of the group of dancers with props. The other block included the solo choreography as well as the asymmetric choreography of the group of dancers without props.

For the rest of the study, SMI BeGazeTM software was used to present the results in visual and numerical forms, with a filtering function, inclusion of group, and randomised data.

Results

Dance is a multidimensional socio-cultural phenomenon consisting of many components, which include movement, narrative or semi-narrative scenes, music, costumes, lighting, stage design, etc. (Jola, et al. 2012). The eye-tracking method can be used in a wide variety of dance research problems and has great potential. The technology provides an exciting platform for studying scenes and dancers' behaviour, emotions, structural phenomena, or the costumes and props used.

In order to pre-adapt attempts to use an eye-tracker in dance research, Heat Map, Focus Map, as well as selected areas of the so-called Areas Of Interest (AOI) were analysed.

Figures 1-12

Heat maps (Fig. 1-2, 7-8) show the aggregate results of attention focus for a given group of respondents. They make it possible to determine which elements of the viewed image attracted the most attention, and which ones the respondents skipped. The degree of attention focus of survey participants concerning dance costumes and choreography is represented by colours. The red colour shows the greatest interest in a given item, yellow shows less interest, and green shows negligible visual focus. In addition, the saturation of the colours shows the level of intensity.

Focus maps (Fig. 3-4, Fig. 9-10) highlight which elements of the viewed image the respondents noticed, and photographs represent graphically inverted proportions. In the presentation of the above results, the so-called Gridded AOI was additionally proposed (Fig. 5-6, Fig. 11-12).

In the present study, the audience's attention was focused primarily on the dancers' faces. The subjects' gaze focused on the male and female torsos. The legs and feet attracted attention to a lesser extent. Heat Maps and Focus Maps indicate trends in the perception of dancers in the two selected folk costumes. In the case of the "Lachy Sądeckie" costume, the observers' gaze was focused on distinctive accessories – in the female dancer, these were beads, shirt ornaments, and cuffs. The attribute of the men's costume was the belt, which, apart from the face, dominated when it comes to attracting the attention of the viewer.

Graphic images as well as Gridded AOI (Fig. 5-6) of a man and a woman indicate that the gaze of observers was distributed differently in the juxtaposition of folk costumes of two different regions. In the case of the ”Podlasie” costume, the viewers were predominantly focused on the female. The focus of attention was on the areas of the torso: the woman's face (2258.3 ms) as well as the area around the shirt ornaments and beads (1427.9 ms). The “Podlasie” cap (hood), characteristic of the “Podlasie” folk costume, covered an average of 681.1 ms, while the feet and lower part of the skirt covered 813.2 ms. In the case of a man, the average facial fixation time included 1742.1 ms for the upper part (eyes and hair), 845.6 ms for “perebora” (the Podlasie shirt’s ornaments) and 714.4 ms for "krajka", the belt characteristic of Podlasie. The remaining areas were far less looked at by Gridded AOI viewers (Fig. 6.). A different distribution was presented by the average fixation time of the “Nowy Sącz” costume (Fig.5.). The proportions between the average fixation on a woman and a man as well as body areas were not so clear. As for a woman, the face dominated with 1914.4 ms and the upper torso with 1087.7 ms. The distribution of average focus during the male observation was quite even – 1293.4 ms face, 1127.8 ms upper torso, 1396.7 ms lower torso, and 793.4 ms male leather belt. The “Sącz” costume also marked a difference in favour of the male in headgear where the hat slightly dominated over the hand-embroidered headscarf (Fig.5).

Regarding the variations of the costume, an additional task in observing the viewer's attention was the juxtaposition of only one female dancer in two different costumes (Fig. 7-12). More attention was focused on the ”Sącz” costume. It was an interesting observation to note the viewer's predominant fixation on the face of the woman in the ”Sącz” costume compared to the “Podlasie” costume. In Fig. 11, the torso and face in the “Sącz” costume predominated (1935.2 ms – face; 1419.9 ms – upper torso, and 1465.3 ms – lower torso). The observations for the same areas in the “Podlasie” costume were as follows: 1352.2 ms, 1181.1 ms, and 1164.2 ms. After switching sides, a greater difference became apparent in the face of the same woman in the “Sącz” costume – 2298.5 ms to 1622.1 ms in the “Podlasie” costume. Thus, the outfit may differentiate the viewer's perception, but in this case, it requires further analysis and statistical studies.

Defining areas of interest allowed us to generate results in the form of key performance indicators (KPI) such as entry time, dwell time, hit ratio, revisits, average fixation, first fixation and fixation count, and to compare audience behavior in relation to selected folk costumes of the areas marked.

Based on the KPIs of the two Polish folk costumes, parameters were compared within the defined area of AOI1 and AOI2, which allowed analysis in relation to the perception of the dance costume.

Tab. 1.

Dwell time figures (ms) indicate a predominance of fixation in the case of a woman in the Podlasie costume (51% of the time compared to 38% for a man). A significantly different situation occurred with regard to the ”Sącz” costume, where the advantage was marked in the viewer's focus on the man's costume (43% compared to 37% for a woman) (Tab. 1).

An additional way of using the eye-tracker in the pilot study was the film analysis of choreographic structures divided into ensemble sequences (symmetrical and asymmetrical) and solo patterns. Analyses were also conducted based on the props used in the dance.

Fig. 13-14

Symmetrical choreography drew much more attention than asymmetrical schemes. The viewer's attention was drawn to the props used, which dominated in the presented film excerpt. Based on the KPI of symmetrical group choreography combined with solo choreography, the parameters within the defined area from the selected frame of the film AOI 1 and AOI 2 were compared, which allowed a thorough analysis of the area and the viewer's focus on different parts of the scene. Dominant in relation to the individual film sequences and parts of the choreography is the solo couple (only regarding the symmetrical group choreography without the prop used), which, through emotion and involvement, definitely draws the viewer's attention more than the precise group sequences (Tab. 2).

In this comparison, the viewer's attention shifts in favour of the group choreographic structure with the use of a prop (Tab. 3)

Tables 2-3

The lists provided combine parameters related to the participants' gaze fixation depending on the choreographic schemes (symmetrical and asymmetrical) and the props used. At this stage of the

study, the perception of choreographic structures and costumes used can be determined. Eye movements in such tasks provide detailed quantitative information about momentary attention, implicit knowledge, and expectations of a specialised field such as dance. The comparisons presented above are from a pilot study and for the purposes of this paper cover a part of the issues. However, inference requires further research and detailed analysis.

Discussion

Sociological research on dance can be broadly applicable and simultaneously encompass complex problems. Dance sociology as a sub-discipline is a relatively new field that uses theoretical concepts as well as research methods from other scientific fields and disciplines. Thus, sociology of the body, culture, anthropology, ethnography or cultural studies constitute part of such research (Byczkowska-Owczarek, 2015).

Against the background of the studies available in the literature, the observations received and presented in this paper are confirmed (Heat, Focus Maps).

Dance costumes, despite their variety and colours, drew less attention in comparison to the faces of the dancers. This was noted for both men and women. This fact corresponds with a study (Woolhaous, et al. 2014) aimed at focusing the gaze on different areas of the dancers' bodies (head, torso, legs, and feet). In this case, significantly longer fixation time concerned the head, which once again proved to be the main "communication portal." As the results indicate, it is this area that is most concerned with emotion, intention, affect, and empathy.

In the pilot studies conducted, choreographies and their reception by the viewer were an important issue. Both choreographic structures and emotions were taken into account. The presentation of individual Gridded AOI images involved solo and ensemble parts. Conclusions that emerged in the course of consideration relate to choreography-relevant insights. The dominant one, with regard to the individual film sequences and choreography parts, is the solo pair, which, through emotion and engagement, is more likely to focus the viewer's attention than the precise symmetrical ensemble sequences. However, this was no longer applicable to the prop-based ensemble choreographic structures that dominated the solo pair. Fixations were bigger in the case of symmetrical choreographies compared to the asymmetrical ones – a fact also confirmed by the study of Orgs, et al. (2013), Tang Poy, et al. (2020).

In the authors' opinion, aesthetic preferences depend on body posture, apparent continuity of movement and choreographic structure. However, the viewers preferred symmetrical schemes to asymmetrical sequences. Apparent biological movement and aesthetic effects may depend on three levels of movement representation: body posture, movement transitions and choreographic structure. However, to a large extent, dance and its aesthetics will be influenced by the physical attractiveness of the dancers. This one is and can be read from studies conducted on the basis of eye tracking (Röder, et al. 2016). Attractive female dancers significantly drew more male viewers' attention than unattractive dancers. Highly attractive female dancers received more visual attention than less attractive female dancers, while men's visual attention correlated positively with their ratings of attractiveness, femininity, and harmony of dance movement (Röder, et al. 2016). Another example is also harmonious, precise, and beautiful movement. Beauty captured in the mind of the beholder and the role of dance movement can be important for partner selection. A good dancer and his movements become more attractive. A study by Weege, et al. (2012) indicates that women were looking at "good" dancers significantly longer and more often than "bad" dancers. In addition, visual attention was positively correlated with perceived attractiveness and masculinity, although the latter relationship did not reach statistical significance in the authors' study. Conclusions indicate that women focus more visual attention on "good" male dancers than "bad" dancers. In addition, "good" male dancers are rated as more attractive.

Dance, in which the main medium is movement, deliberately and systematically programmed, additionally presents emotions, which we read from movements, gestures, and facial expressions. All the content that the viewer perceives appears in music and choreography. Therefore, eye-trackers can serve as tools for assessing the emotional state of dancers. For such purposes, Dyck, et al. (2013) searched for emotional content encoded in human dance movement. Based on silent videos depicting depersonalised avatars of dancers in motion, viewers were shown two videos side by side – one in a sad mood and one in a happy mood. Based on the results of the study, it was found that viewers were able to identify the emotional state of the dancers with a high degree of accuracy. However, these emotions were much better identified in women than in men. Similarly, as in the costume studies presented in the case of this paper, the gaze of observers focused on the upper torso in the chest area of the avatars (Dyck, et al. 2013).

Music is an integral part of the dance. Eye-tracker is primarily used for visual research. However, it cannot be limited in any way. This is demonstrated by Fink, et al. (2019) in the research regarding the use of the device to study music perception. Eye movement, pupil dilation and blinking activity can give us a lot of clues about musical processing. There are many references and possibilities that relate to the eye tracking of music performers, or the perception of musical stimuli correlated with eye movement. Yet another example in relation to music in contact with dance is the study by Woolhaous, et al. (2014). It was shown that dance movement that was synchronised with music focused the viewer's attention for longer. Thus, music-dance synchronisation results in longer visual control time. Additionally, music and tempo, as indicated by another study by Woolhaous, et al. (2016), influence group cohesion and social bonding in dancers, which largely demonstrates the unlimited possibilities of research using the eye-tracking device.

Conclusion

Eye-tracking technology provides an exciting platform for studying visual behaviour in relation to the art of dance. Related systems offer researchers the opportunity to study and understand perceptual-cognitive processes in various manifestations and levels. In the field of dance sociology in the broadest sense, also the methodology and the art of choreography, the possibilities with eye tracking are very broad and complex. They can provide researchers with a lot of information.

The perception of choreography and dance structures is always subjective, and the solutions applied are difficult to assess. The use of eye tracking makes it possible to determine whether there exist any rules that an artist can follow, or if the structures used in choreographies can attract a viewer’s attention more depending on the perspective of the stage/a spectator, costumes, energy, movement type, etc.

When it comes to the video material presented in the study, the hypotheses proposed by artists are confirmed. The dominant one, with regard to the individual film sequences and choreography parts, is the solo pair, which, through emotion and engagement, is more likely to focus the viewer's attention than the precise symmetrical ensemble sequences. However, this was no longer applicable to the prop-based ensemble choreographic structures that dominated the solo pair.

Due to time-related limitations, only some choreographic structures were used. The results obtained indicate that further research is needed to investigate the issues under study.

In general, there is a scarcity of data on the subject, and similar solutions have been rarely used. However, they can contribute to better understanding of the composition- and stage-related rules. Moreover, they can constitute a much more objective tool which, if applied appropriately, may help to assess methods and forms used by choreographers.

Acknowledgements

* "Allegories Podlaskie - Podlasie dance folklore in jazz musical interpretations using eyetracker". - financed by the National Institute of Music and Dance under the agreement no. 376/KPO. GRANTY/NIMiT/2024 of 25/10/2024.

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Sfinansowane przez Unię Europejską NextGenerationEU