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Exploring the Impact of Visualizing Key Factors in Badminton Tournaments on Audience Experience

Yuan-Chieh Lee[1], Meng-Cong Zheng[2], and Li-Jen Wang[3]

[1]Department of Industrial Design Master Program of Innovation and Design, Taipei Tech, Taipei 10608, Taiwan (R.O.C)
[2]Department of Industrial Design, Taipei Tech, Taipei 10608, Taiwan (R.O.C)
[3]Doctoral Program in Design, College of Design, Taipei Tech, Taipei 10608, Taiwan (R.O.C.)

ABSTRACT

The current statistical data for badminton event broadcasts only present score information for real-time match situations. However, for both broadcasters and audiences, statistical data can aid in understanding the game content and enhance entertainment value. This study explores audience evaluations of badminton event broadcast content and whether visualizing key events can improve audience understanding and enjoyment. This study examines the relationship between broadcast interfaces and re-viewing intention, word of mouth, sport involvement, hedonic and utilitarian attitudes. Surveys were conducted with audiences with varying levels of experience in badminton events to understand changes in their re-viewing intention, word of mouth, sport involvement, hedonic and utilitarian attitudes when watching badminton matches. Results indicate that highly experienced audiences rated their re-viewing intention, word of mouth, sport involvement, hedonic and utilitarian attitudes towards broadcast interfaces significantly higher than low-experience audiences. There were no significant differences between high and low experience audiences in correctly recording score information across different broadcast interfaces. Presenting scores for all games and trajectory information in the broadcast interface can help audiences to anticipate the match's overall direction and improve understanding. Additionally, adding visual trajectory information during replays can enhance their understanding and enjoyment of the game. These findings provide relevant suggestions for visual improvements in sports event broadcasts designed for audiences with different levels of experience, ultimately enhancing the viewing experience.

Keywords: Data visualization, Badminton tournament, Audiences' entertainment, User experience, Sport graphics

INTRODUCTION

The utilization of statistical data reflecting athlete or team performance has been a crucial element in sports broadcasts. Technological advancements adopted in sports broadcast production have transformed the dissemination of information in sports programs. The presentation of statistical data charts on screen, including information about players, teams, scores, and more, has

become integral (Nachman & Bennett, 2011). When engaging with sports event broadcasts, statistical data serves to enhance audience enjoyment and elevate their perception of the objectivity or professionalism of the broadcast content (Hahn, 2023).

The viewing experience of audiences during sports event broadcasts varies depending on their level of interest. Sports enthusiasts, as opposed to non-sports fans, tend to be more immersed and engaged in the viewing experience (Gantz & Wenner, 1995). Moreover, sports enthusiasts with higher interest in sports events demonstrate superior cognitive processing abilities when attending to statistical data presented during broadcasts (Cummins, 2016). Conversely, novice viewers, due to their limited understanding of sports events, struggle to effectively comprehend the content, resulting in a less-than-ideal viewing experience compared to that of avid sports fans (Cummins, 2009).

Typically, sports data is characterized by its vast volume, encompassing multiple dimensions of information, including athlete behavioral patterns, spatial and temporal details, among others. This complexity makes it challenging for users to intuitively perceive the data, as relying solely on numerical presentations may not fully represent the results of data analysis (Du & Yuan, 2021). In the past, this data was predominantly presented in textual tabular forms, leading to difficulties in quick and effective comprehension. Therefore, recent research has increasingly emphasized the visual representation of sports data (Losada et al., 2016). Simultaneously, the visualization of statistical data has become more prevalent in broadcasts, displaying greater diversity in content. This trend enhances audience understanding and entertainment throughout the broadcast, especially for viewers with lower sports experience. The use of visualizations in broadcasting significantly and positively influences their enjoyment, comprehension of meaning, and psychological needs. Although it requires more cognitive effort to process this information, it makes their viewing experience more enjoyable and meaningful (Zheng & Chen, 2022). Moreover, presenting data information with dynamic visual effects during broadcasts not only increases the audience's understanding of the game but also enhances their identification with teams or players. This approach fosters sharing responses and enthusiasm for the game, further elevating the enjoyment of watching sports (Hertzog et al., 2020).

Sports data involves a wide range of information. Du and Yuan (2021) categorize the task of visualizing sports information into three main categories: feature presentation, feature comparison, and feature prediction. Feature presentation involves displaying fundamental information about player behavior and various features. This includes showcasing trajectory information, athlete performances, specific details, and overall event information. Feature comparison focuses on comparing current features and relationships between various types of data, encompassing comparisons of player performances, behavioral event analyses, and event information. Feature prediction involves analyzing data and using existing information to predict various data features. This includes presenting estimations of match outcomes, sports event predictions, and tactical decision-making based on the analyzed data.

Information visualization in team sports requires clarification of both the target audience and the displayed content, categorizing the audience into athletes, spectators, and referees (Page & Moere, 2006). The data required for displaying content includes score table data summarizing sports event statistics, tracking data concerning actions and trajectories during the event, and metadata related to the sport and participants (Perin et al., 2018). Different types of information visualization are employed in sports broadcasting, tailored to the specific event (Page & Moere, 2006), with graphical methods such as scatter plots, radar charts, parallel coordinate plots, and heatmaps being commonly utilized in visualizing sports data (Du & Yuan, 2021).

Badminton event broadcasts typically utilize fixed-angle camera shots to record players' movements and the shuttlecock's trajectory (Chen et al., 2023). Scoreboards are also employed to convey match information during badminton broadcasts, including team names, scores, and other relevant details (Newth, 2023). In badminton, a racquet sport, players earn points by hitting the shuttlecock over the net into the opponent's court, with each successful landing earning one point, and the first team to reach 21 points winning the match (Percy, 2009). The angle and force of a badminton player's shot significantly affect the shuttlecock's flight trajectory, underscoring the importance of controlling it effectively for tactical planning (Chen et al., 2009). Tactical strategies in racket sports identify key events leading to victory (Chen et al., 2022). In table tennis matches, a tactical strategy is composed of the attributes of three consecutive shots. (Wu et al., 2018). Similar patterns exist in badminton, where tactical play guides players to victory through well-coordinated shot combinations (Chen et al., 2023).

According to the website of Badminton Master (2016), different types of shots can be executed in a badminton match, including clear, lob, drop shot, smash, tumbling net shot, net kill, net lift, and drive. In singles badminton matches, players typically return to the center of court after executing a shot to prepare for their opponent's return, and this movement is considered a fundamental technique in badminton (Tanaka et al., 2022). Additionally, since players often retreat to the midcourt to defend after hitting a shot, aiming to reach the opponent's next shot with the shortest distance possible, the midcourt is generally considered the opponent's comfort zone (Chen et al., 2023), and players should aim to avoid landing shots in this area.

This research endeavors to enhance the comprehension of badminton event broadcasts, especially for audiences with limited badminton experience, by incorporating visualized content. The aim is to address challenges arising from insufficient information provided during broadcasts, making it difficult for less-experienced viewers to comprehend the events. By measuring the understanding and enjoyment of broadcast statistical information among audiences with varying levels of experience, this study aims to identify the optimal presentation format for badminton broadcast interfaces. Considering the potential impact of sports broadcast content on the understanding, re-viewing intention, word of mouth, sport involvement, hedonic and utilitarian attitudes of viewers with different experience levels, this study proposes the following hypotheses and research questions:

1. Presenting score and trajectory information in the broadcast interface enhance the audience's comprehension of the content.
2. Visualized trajectory information can increase the audience's re-viewing intention, word of mouth, sport involvement, hedonic and utilitarian attitudes towards the badminton match.

MATERIALS AND METHODS

This research experiment focused on investigating and experimenting with the broadcast interfaces of the top three international badminton tournaments. Participants were categorized based on their experience and involvement in badminton events. The objective of the experiment was to understand the audience's perceptions and evaluations of the existing broadcast interfaces. The experiment involved 30 participants who watched the same match but with different information presented through various broadcast interfaces. Subsequently, they provided feedback on their perceptions of the information using scales measuring re-viewing intention, word of mouth, sport involvement, hedonic and utilitarian attitudes.

Survey of Badminton Event Broadcast Interfaces

The Badminton World Federation (BWF) serves as the premier governing body for the sport of badminton worldwide, organizing seven major international badminton tournaments. Among these, badminton events at the Summer Olympic Games are broadcast and licensed by the Olympic Channel, while the remaining events are broadcast and licensed by the BWF TV. The BWF also collaborates with continental federations, with badminton tournaments organized by these five continental federations being simultaneously broadcast on their respective network channels. This study investigated the broadcast channels of these organizations during international badminton events from 2020 to 2023. In a randomly selected sample of 7 matches, the broadcast interface information is observed to present scoring board information for approximately 90% of the time during each match, with the remaining 10% dedicated to displaying replay footage and player statistics.

Stimulus

According to the world ranking system outlined in the 2022 World Badminton Federation (BWF) Statutes, this study identifies the top three broadcast channels for events of various levels as BWF TV, Olympic Channel, and Badminton Asia. This study utilizes the After Effects image processing software to simulate the broadcast interfaces used by these three channels, overlaying them in a simulated badminton match. The simulated badminton match video presents a complete segment of the game, including common match situations, starting from the second half of the third game of a single match. The content includes player serves, back-and-forth rallies, scoring, exchange of service, match point, winning point, etc., with a total video duration of 4 minutes. The simulated broadcast interface incorporates statistical data on player information, serving rights, and the scores of both sides. To minimize the impact of auditory factors on the viewing experience

of the broadcast content (Cummins et al., 2019), simulated badminton match videos do not feature broadcast commentary or noise from live audiences (Billings et al., 2010).

Procedure

The experiment will involve randomly sampling 30 participants with varying levels of experience, distributing them equally among one of three experimental samples. The duration of each experiment is approximately 30 minutes. After watching the simulated broadcast videos, participants are asked to rate their re-viewing intention, word of mouth, sport involvement, hedonic and utilitarian attitudes scale based on a seven-point Likert scale. Following the completion of the questionnaire, a semi-structured interview will be conducted to further assess participants' evaluations of the broadcast content. This interview aims to gather more in-depth insights into participants' perceptions and opinions regarding the simulated broadcast experiences.

Table 1. Experimental sample.

Sample A	Sample B	Sample C
Badminton Asia	BWF TV	Olympic Channel
		

Evaluation Measures

Re-Viewing Intention

Re-viewing intention scale used in this study consists of three items, adapted from Lee et al. (2016). Their research investigated the impact of sports commentators on viewers' willingness to watch sports broadcasts again.

Word of Mouth

The word of mouth scale, adapted from Goebert and Greenhalgh (2020), was employed to gauge sports enthusiasts' perspectives on sports marketers adopting augmented reality. The scale comprises three items and has been validated for reliability in Sartore-Baldwin and Walker's (2011) study.

Sport Involvement

The sport involvement scale, developed by Shank and Beasley (1998), comprises eight items to measure the relationship between sports participation and sports-related behaviors. Th study found that cognitive and emotional dimensions were associated with watching sports broadcasts, reading sports-related articles, and participating in sports events.

Hedonic and Utilitarian Attitudes

The hedonic and utilitarian attitudes scale, developed by Voss et al. (2003), includes ten items to measure consumers' hedonic and utilitarian attitudes toward a product. The scale uses semantically differentiated items to assess consumers' hedonic and utilitarian attitudes towards product categories and different brands within those categories. Six studies were conducted to validate the unidimensionality, reliability, and effectiveness of the hedonic and utilitarian attitudes scale.

Participants

This study collected responses through online dissemination of questionnaires regarding personal information and experiences with badminton events. A total of 325 valid responses were obtained. 30 participants from the top 27% and bottom 27% of the participation experience of badminton were selected and invited to participate in the experiment. The sport spectator involvement scale, designed by Bahk (2000), was used to measure participants' engagement in badminton matches. This scale examines participants' emotional fluctuations, time spent reading, listening to, watching, and discussing sports-related information, to assess emotional, cognitive, and behavioral aspects of watching sports events. Participants used the sport spectator involvement scale and rated it on a seven-point Likert scale. The top 27% and bottom 27% were separated based on score ranking, forming high and low experience groups. The low-experience group had an average score below 3.57, while the high-experience group had an average score above 5.00.

RESULTS

High Experience Audience Provide Higher Rating for Broadcast Interfaces

At this stage, the experimental data are analyzed. Specifically, an independent samples t-test is employed to analyze the response conditions of willingness to re-watch, word-of-mouth, sports engagement, enjoyment and utilitarian attitudes scales towards the broadcast interface between two groups with high and low participation experiences. According to the results of the independent samples t-test, there are statistically significant differences in re-viewing intention ($t = -2.736$, $p = 0.011$), word of mouth ($t = -3.129$, $p = 0.004$), sport involvement ($t = -3.616$, $p = 0.002$), as well as hedonic and utilitarian attitudes ($t = -3.491$, $p = 0.002$) towards watching badminton broadcast between individuals with high and low participation experiences. Participants with high participation experiences scored significantly higher than those with low participation experiences in re-viewing intention (MD = 1.24), word of mouth (MD = 1.24), sport involvement (MD = 0.93), and hedonic and utilitarian attitudes (MD = 1.09) towards badminton broadcast interface.

Audience Evaluations of the Experimental Sample A, B and C

The responses of participants to re-viewing intention, word of mouth, sport involvement, and hedonistic and utilitarian attitudes scales towards three experimental samples (A, B, and C) were analysed by one-way ANOVA. There were no significant differences observed in participants' responses to the three experimental samples in re-viewing intention ($P = 0.750$), word of mouth ($P = 0.602$), sport involvement ($P = 0.966$), and hedonistic and utilitarian attitudes ($P = 0.789$). However, in post hoc multiple comparisons, differences were observed in participants' ratings of re-viewing intention for different experimental samples, with the order being A ($M = 5.767$), C ($M = 5.367$), B ($M = 5.333$). For word of mouth ratings, participants rated sample B ($M = 5.433$) higher than A ($M = 5.233$) and C ($M = 4.867$). Regarding sport involvement, participants rated sample B ($M = 5.663$) higher than A ($M = 5.575$) and equal to C ($M = 5.575$). Additionally, for hedonistic and utilitarian attitudes, participants rated sample C ($M = 5.110$) higher than A ($M = 5.080$) and B ($M = 4.820$).

Audience Assessments in the Semi-Structured Interviews

All the participants were invited to provide feedback and suggestions at the end of the experimental questionnaire. In the semi-structured interviews, participants provided evaluations for experimental samples A, B, and C. For samples A and B, each of them has over 40% of participants expressed a preference, and highlighted the simplicity and clarity of the interface. sample A was commended for its clear presentation of the service icon, player names, and scores for each game. sample B was appreciated for presenting player names, scores for each game, and highlight the score of the game won by the player. In contrast, 50% of participants indicated a disliking for sample C. They noted that sample C did not provide information on scores for each game. 50% of participants accurately recorded scoreboard information, including winning player, final score, and game points. There are no significant differences between high and low-experience participants or different broadcast interfaces. 80% of participants indicated that presenting scores for all games on the broadcast interface helped anticipate the match's overall direction, while 60% of participants preferred using the colour to highlight winning game points in the scoreboard for clearer identification of the ongoing game score. Furthermore, 93% of the participants indicated that they do not particularly pay attention to boring and repetitive exchange of strokes between players during a match, but they do have a better memory of the exciting plays that involve changing the pace of strokes and key winning strokes. Additionally, participants pay attention to the players' positioning, the direction of the strokes, and players' emotions while watching the broadcast. Among these participants, 67% believe that trajectory information improved understanding the game. Moreover, 76% of participants suggested adding visual trajectory information to enhance understanding and enjoyment of the game, with 53% recommending providing this information during replays, as offering it during the game might disrupt the viewing experience.

CONCLUSION

This study aims to investigate the impact of visualizing key factors in badminton events on audience experience, particularly focusing on the relationship between broadcast interfaces and audience evaluation. The results indicate significant differences in responses between audiences with high and low participation experiences, consistent with previous research findings (Gantz & Wenner, 1995). Compared to less experienced viewers, those with more experience consistently provided higher ratings for the broadcast interface in terms of re-viewing intention, word of mouth, sport involvement, hedonic and utilitarian attitudes. The analysis further examined three experimental samples (A, B, and C) representing different broadcast interfaces and provided additional insights through semi-structured interviews. Participants expressed a preference for interfaces that are simple, clear, and prominently display important information (such as player names and game scores), with trajectory information being considered beneficial. During the broadcast, viewers pay attention to the players' movements and the direction of the strokes, particularly the exciting plays such as stroke of key factors. This trajectory information helps to enhance their understanding of the match while watching. Currently, replays of badminton events only showcase exciting moments from different camera angles without providing further trajectory information, prompting most participants to suggest its inclusion during replays. The provision of trajectory information has traditionally been applied in professional sports data analysis, aiding athletes and coaches in enhancing training effectiveness and making informed decisions during competitions, thereby improving their performance (Janetzko et al., 2014). These include sports like tennis, table tennis, and badminton, where visualizing trajectory information is crucial for statistical analysis. Ye et al. (2021) presented badminton stroke trajectory data in a 3D visualization format, accompanied by ring charts and grid charts to illustrate shot path usage and success rates, understanding the relationship between shot outcomes and the techniques used in the previous shot. Chen et al. (2023) depicted the relationship between badminton players' pre-shot positions and their movement positions through heatmaps and histograms, enabling coaches to compare the distribution of player shot positions in past matches. Overall, this study reveals that presenting game scores in sports event broadcasts and referencing past studies to visualize trajectory information suitable for viewers can enhance audience understanding and enjoyment. This study provides valuable suggestions for optimizing broadcast interfaces for audiences with different levels of experience, ultimately enhancing the overall viewing experience of badminton event broadcasts.

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