

Pre-Task Music's Influence on Flow State and Goal-Shooting Performance in Collegiate Female Futsal Players: A Single-Subject Study

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ABSTRACT

Despite the growing body of research exploring the impact of music on athletic performance, there remains a limited understanding of how pre-task music listening influences both flow state and specific performance outcomes in individual athletes. The study aims to examine the effects of pre-task music listening on flow state and goal-shooting performance among four female futsal players of Universiti Sains Malaysia. In this study, a single-subject design (A-B design) was employed. Participants underwent a Non-Intervention Baseline phase (Phase A) and an Intervention Phase (Phase B). In both phases, each participant performed a goal-shooting task, namely the Massey Futsal Shooting Test (MFST). In Phase A (Weeks 1 to 5), participants did not listen to music before performing the goal-shooting task. In Phase B (Weeks 6 to 10), participants listened to music for ten minutes before performing the goal-shooting task. Participants gave their responses using the Flow State Scale-2, and the researcher recorded the goal-shooting scores. Results for goal-shooting scores and flow state scores were plotted on graphs for each participant using Microsoft Excel. Visual analysis was used to analyse the data. All participants showed an improving trend in goal-shooting scores from Phase A to Phase B, whereby only one participant demonstrated a decrease in flow state score during Phase B. The results offer preliminary evidence that pre-task music listening may facilitate goal-shooting performance, as well as enhancing participants' flow experience. As a practical recommendation, tailoring music selection to individual athletes may provide a useful strategy for enhancing psychological readiness and potentially supporting performance effectiveness across repeated training sessions prior to competition.

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1. INTRODUCTION

The application of music has been extensively used in sports, mainly because of its positive effects in enhancing the sports performance. Many elite athletes acknowledge the use of music as a psychological preparation strategy to regulate arousal, enhance perceived energy, and optimise their readiness for competition. The mechanism pertaining to the ergogenic effects of music during exercise can be explained by the Rejeski's theory of parallel processing (Rejeski, 1985), which describes how music has a capacity to inhibit the fatigue sensation while changing it to a more positive perception (Karageorghis & Priest, 2012). Several previous studies reported that listening to music has significantly enhanced the athletic performances by raising pleasant moods and reduce competition anxiety (Bigliassi et al., 2015; Aloui et al., 2015; Khemila et al., 2021; Gavanda et al., 2021). Elliakim et al. (2012) found that listening to stimulative music increased heart rate and readiness, which is an indicator of increased arousal, acknowledging that making music as part of the pre-performance routine will prepare the body for its upcoming and demanding sport tasks (Loizou & Karageorghis, 2015). Also, psychophysical effects of music, such as reduced perceived exertion at low to moderate intensities have also been found when music is used during exercise (Patania et al., 2020).

Athletes are encouraged to select their music playlists based on their individual preferences that have extra-musical associations, such as meaningful connections with significant people, places, or life events (Karageorghis & Priest, 2012; Bishop et al., 2007). This approach allows the incorporation of personally meaningful and emotionally significant music, which may enhance effort-related decision-making by increasing the enjoyable and personal relevance of the task context (Karageorghis, 2012). Neurophysiological evidence indicates that listening to self-selected music during warm-up enhances arousal and cortical activation, as reflected by increased α and β brain wave activities. These changes suggest that self-selected music may facilitate psychophysiological readiness, thereby preparing individuals for subsequent physically demanding performance (Zhang et al., 2023). For a sports task that involves team performance, such as football or futsal, listening to self-selected music in pre-game was reported to induce positive affective states throughout the game play (McGuckian & Pepping, 2021). Experiencing a positive affective state has been associated with more relaxed and smooth movement patterns in sports (Giraud et al., 2016; Gross, Crane, & Fredrickson, 2012) and may facilitate the automatic execution of well-practised motor skills by reducing the cognitive demands (Vast et al., 2010).

Flow state can be defined as a psychological state when people are totally involved in an activity without being influenced by external benefits (Jackson & Csikszentmihalyi, 1999). When in flow, people may accomplish the tasks for personal satisfaction. Although it involves high difficulty and no rewards, gaining the experience will make people to get into flow state. In sports, flow state is aspired by many athletes (Jackson, 1992), which can be experienced at any level of sport participations (Csikszentmihalyi, 1990; Stein, et al., 1995). Flow state is connected not just to superior performance but also to automaticity, confidence, and the ease with which movements particular to a sport may be performed (Harris et al., 2017). Music listening has been shown to activate the mesolimbic reward system through dopaminergic mechanisms associated with reward anticipation and emotional pleasure (Salimpoor et al., 2011). Such activation may enhance motivation, enjoyment, emotional regulation, and attention which are psychological states closely related to the development of flow during performance. Terry et al., (2020) suggested synchronisation and preference with music, and the intensity of physical activity may influence how music is perceived to evoke positive emotions that can increase a flow experience among exercise participants. Moreover, Philippe et al. (2022) discovered that self-selected music enhances an individuals' focus on body feelings and emotions associated with flow, which could be considered a way of listening to one's body and capturing feelings. Using a single-subject, multiple baseline research design, Pain, Harwood, and Anderson (2011) revealed that listening to simulative music among soccer players before the game set the 'in the zone' state that enhanced optimal arousal, motivation, and focus on the players.

Futsal is an indoor and fast-moving sport that requires an intense focus for players to complete short kicks, dribble ball through small spaces, and kick a powerful and accurate shooting. In futsal, where performance involves repeated short bursts of high-intensity activity, appropriate pre-event activation and mental arousal may be important for preparing athletes to perform explosive and skill-based actions effectively (Laukka & Quick, 2013). To deliver a quick

and accurate decision in performing futsal skills, players must be able to selectively focus on pertinent information while tuning out distractions (Robazza et al., 2016). It has been reported that applying pre-task music listening improved power output during rowing activities (Pusey et al., 2023), netball shooting performance (Pates et al., 2003) repeated sprint performance in soccer players (Tounsi et al., 2019), and physical performance of swimmers (Aburto-Corona, et al., 2022). Moreover, the inclusion of female futsal players in the present study is considered important because responses to sport-related interventions may not be similar across male and female athletes. For example, female handball athletes reported lower perceived exertion and greater motivation when listening to self-selected music, whereas these effects were not evident among male athletes (Barreto-Silva et al., 2021). This finding is relevant to the present study because music used before futsal performance may influence athletes' motivational and psychological states, which could subsequently affect their readiness to perform sport-specific skills such as goal shooting.

Although the beneficial effects of music on sport performance have received considerable attention, existing research has mostly focused on continuous endurance activities, such as running and cycling (Karageorghis & Priest, 2012; Terry et al., 2020). Comparatively, less attention has been given to the strategy of using music in skill-based intermittent and outdoor team sports, including among female futsal athletes, where successful performance involves integration among technical execution, perceptual decision-making, and psychological states associated with flow experience. The present study addresses this gap by examining the influence of individually selected music on futsal shooting performance by adopting an individualised examination of performance and psychological state, rather than group level assessment. Because shooting performance in futsal can be assessed objectively and repeatedly over time using a specific test, single-subject designs through visual analysis provides detailed examination of performance changes within individuals across repeated conditions, particularly when investigating behavioural interventions such as music exposure (Kazdin, 2019). Visual analysis of the scores across the baseline and intervention phases enables researchers to examine changes in level, trend, and stability (Ledford & Gast, 2018), thereby determining whether improvements in individual athletes are immediate, gradual, or maintained over time.

2. METHODS

Study Design

The present study employed an A-B single subject design (multiple baseline and multiple intervention sessions). The design was applied to seek the changes in four individual participants among futsal players who were involved in five weeks of a non-intervention baseline phase (Phase A) and five weeks of an Intervention phase (Phase B). During Phase A, participants did not listen to music before executing the goal shooting task. During Phase B, participants listened to a music playlist five minutes before executing the goal shooting task. Unlike group experimental designs that typically require larger sample sizes to achieve sufficient statistical power, single-subject designs can involve relatively few participants because each participant serves as the primary unit of analysis, with repeated assessments conducted across the baseline and intervention phases (Smith, 2012). Therefore, the sample size of four participants was considered appropriate for the exploratory, participant-level purpose of the present A-B design.

Participants

Participants were recruited from the Universiti Sains Malaysia (USM) Health Campus women's futsal team based on several inclusion criteria: (a) experience competing at the competitive level, (b) playing in attacking positions, and (c) being free from current physical injuries and medical illnesses. Four players, comprising two Pivots and two Wingers, aged between 20 to 23 years old met the criteria. They reported having four to five years of playing experience and represented university at national level competitions, such as National Futsal League Championship and Intervarsity Futsal Championship. Participants participated in regular futsal training along with other team members four days a week from 1730 to 1900 on the university's futsal court. None of the participants had previous experience with standardized futsal performance assessment conducted in this study.

Measures

Brunel's Music Rating Inventory-3 (BMRI-3; Karageorghis & Terry, 2011) was utilized to identify playlists that would have a motivating effect on athletes while they were performing. The BMRI-3 consists of six items, indicating how much participants agree that each component of music motivates them during the activity. For example, "The rhythm of this music would motivate me during exercise", which refers to the rhythmic components of the music. Participants rated each item on a 7-point Likert scale anchored by 1 (strongly disagree) and 7 (strongly agree). The mean Cronbach alpha coefficient of BMRI-3 was .89. The overall BMRI-3 score was calculated by summing the responses across all six items, with higher scores indicating greater perceived motivational qualities of the music.

The Flow State Scale-2 (FSS-2; Jackson & Eklund, 2002) in English version was used to assess flow state. The questionnaire consists of 36 items that provides a quantitative measure of the nine dimensions of flow state rated on 5-point Likert scales. The FSS-2 determines the extent to which individuals experience flow during a sport or physical activity. In this study, the global flow state was determined by summing up the scores from all nine flow dimensions. The internal consistency reliability (Cronbach's alpha) reported for the nine FSS-2 scales range from 0.72 to 0.91.

The Massey Futsal Shooting Test (MFST) was employed to assess goal-shooting performance. During the test, participants were required to perform three shooting attempts, with a 60-second passive recovery period between consecutive attempts. MFST involves performing a ball shooting in a designated zone, that is rectangle in shape, sized 20 meters $\times$ 8.5 meters. The nearest line of the shooting area is 8 meters from the goal line. Four cones were placed to mark each corner of the shooting zone. Two wooden boxes were placed on each side of the shooting zone as a rebound board. Each box was placed at a 30-degree angle as shown in Figure 1. To perform the MFST, first, the participants stood by facing the goal, at the distance of approximately 11 meters from the ball. Then, participants kicked the ball towards the wooden boxes either to the right side or left side. There is no accuracy concerning to which direction the ball should go, as long as the ball travels within the shooting zone. Finally, participants kicked and shot the rebounded ball towards the goal. For each attempt, the score was given according to the section of the goal through which the ball entered. If the ball did not enter the goal, a score of 0 was given. Goal shooting performance was subsequently evaluated using the cumulative score obtained across the three attempts.

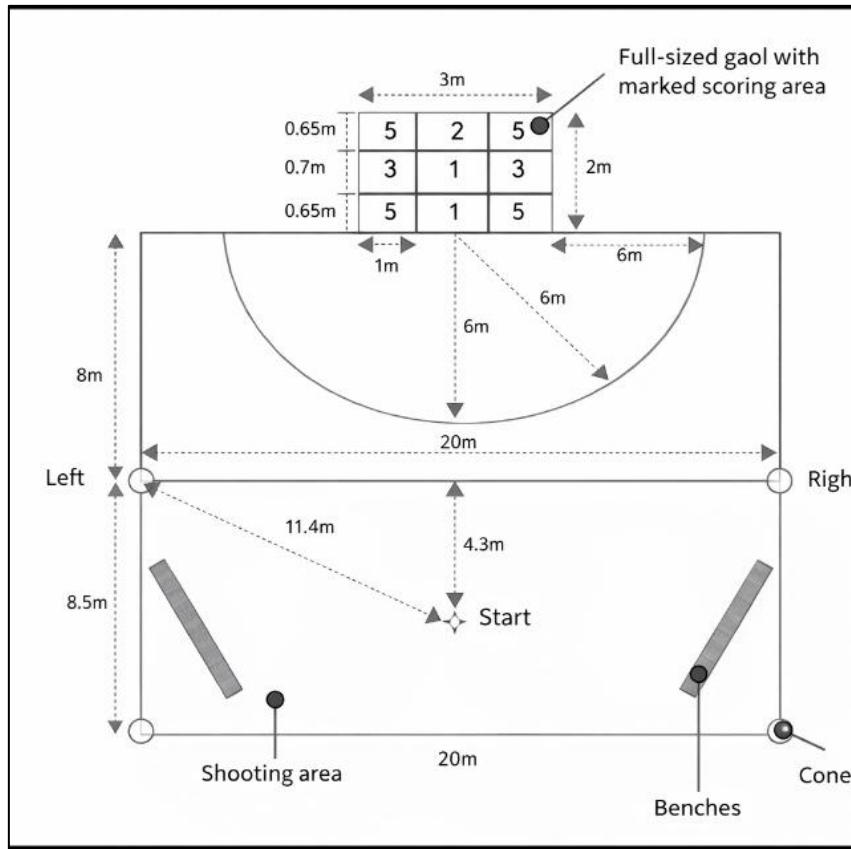


Figure 1: Schematic representation of Massey Futsal Shooting Test layout (adapted from Naser & Ali, 2016)

Study Procedure

After obtaining an ethical clearance from the USM Research Ethics Committee (JEPER), researcher met with USMKK female futsal team for the participants' recruitment process. During an initial meeting, four key players were identified following consultation with the coach and team athletes. Participants volunteered to participate in the study and provided written informed consent after receiving a brief explanation from the researcher. At the end of the session, each participant was asked to prepare a list of 10 songs that they would like to listen to before performing their futsal tasks. The participants were also invited to attend a music selection session at the Exercise and Sports Science Laboratory.

During the music selection process, participants used an audio player to listen to the music playlists that they had prepared beforehand for 60 seconds for each song. To guide the music selection process, the BMRI-3 questionnaire was given to each participant, in which they rated each song immediately after they have finished listening to a particular song. The researcher chose five songs with the highest BMRI-3 scores and shortened each song's duration to 60 seconds. Then, the music playlist containing five songs was transferred to each participant's mobile phone.

Phase A was conducted first for five weeks, followed by Phase B for another five weeks. In both phases, participants performed a goal shooting test (MFST) that was conducted once a week, between 1700 to 1900 h, following the procedure as described in the Measures section. Also, participants gave their responses on the FSS-2, immediately after they have completed the goal shooting task. Phase B began after participants had completed five weekly test sessions in Phase A. During Phase B, 10 minutes prior to performing the MFST, each participant listened to their selected music playlist using earphones connected to a mobile phone. The music volume was standardized at 70% of the device's maximum output to ensure consistent listening conditions across participants. Following the music exposure, participants completed the MFST and subsequently responded to the FSS-2 questionnaire.

Data Analysis

Flow state and goal-shooting performance scores collected during Phases A and B were plotted using Microsoft Excel. The data were analyzed using visual analysis, as illustrated in Figure 2. As part of the visual analysis, a celeration line was constructed to characterize the data over time and estimate the direction and rate of change (Barlow & Hersen, 1984). The construction of the celeration line in each phase involved several steps. First, the total number of data points within each phase was counted. Second, the data points in each phase were divided into two equal halves by inserting a vertical line (red line). Third, the mean score for each half of the baseline phase was calculated and plotted on the graph. Fourth, the two mean values were connected with a straight line (maroon line). Finally, this line was extended into the intervention phase to form the celeration line (dashed line).

The result was reported by observing the ascending or descending trend of data points based on the mean line plots (blue line) made from the data obtained in Week 1 to Week 5 (Phase A) and Week 6 to Week 10 (Phase B). Also, the level was observed by looking at the data point in the first week of Phase B, to determine the change that occurs as soon as the intervention is initiated. In addition, the mean scores between Phases A and B were compared, and the distribution of data points was examined to determine whether they fell above or below the celeration line.

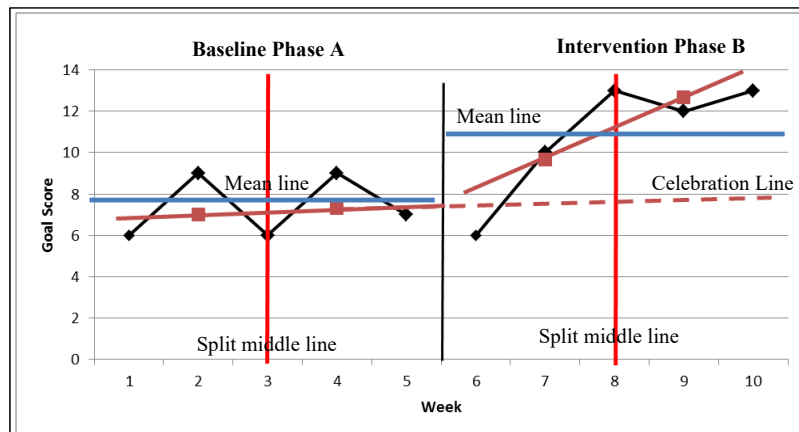


Figure 2: A sample of visual analysis

3. RESULT AND DISCUSSION

3.1 Result

Scores for the goal shooting performance and flow state were reported in each week for Phase A and Phase B. The results were plotted on graphs for each individual participant that was named anonymously as Player 1, Player 2, Player 3, and Player 4.

Player 1

As shown in Figure 3, Player 1's goal shooting performance exhibited a decreasing trend from Week 1 to Week 5, particularly after Week 2 in Phase A. In Phase B, goal shooting performance shows an increasing trend from Week 6 to Week 10. The change in level at the start of the intervention was small. The mean shooting performance score was higher in Phase B (12.6) compared to Phase A (8.0). All data points in the Phase B were above the celeration line.

As shown in Figure 4, Player 1's flow state exhibited a decreasing trend from Week 1 to Week 5 in Phase A. Similarly, during the intervention in Phase B, there was a decreasing trend from Week 6 to Week 10. Although there was a positive change in level when the intervention started, the flow state scores dropped until Week 9. The mean score in Phase B was slightly lower (128) compared to the mean score in Phase A (129.8). Majority of the data points in Phase B were above the celeration line.

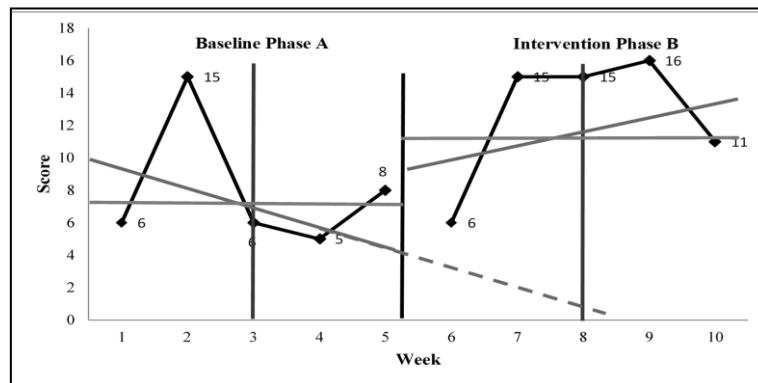


Figure 3: Visual analysis of goal shooting performance of Player 1

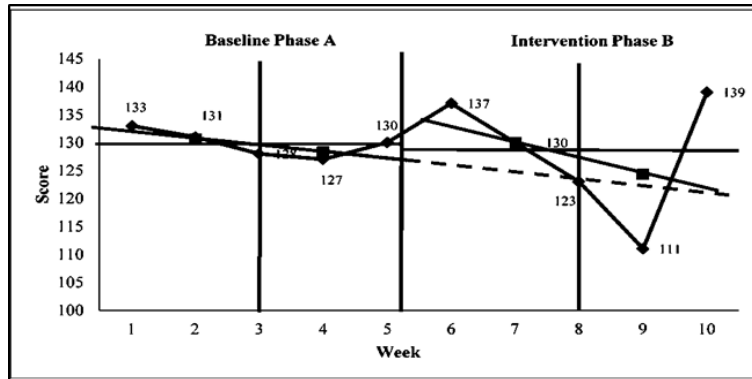


Figure 4: Visual analysis of flow state of Player 1

Player 2

As shown in Figure 5, Player 2's goal shooting performance in Phase A exhibited an ascending pattern from Week 1 to Week 5. The performance increased from Week 1 to Week 3, then decreased in Week 4, and increased again in Week 5. In Phase B, there was also an ascending pattern from Week 6 to Week 10, although performance dropped in Weeks 7 and 10. The mean score for goal shooting performance was higher in Phase B (9.8) compared to Phase A (7.8). Most data points in Phase B were above the celeration line.

As shown in Figure 6, Player 2's flow state in Phase A exhibited an ascending pattern from Week 1 to Week 5, though there were small fluctuations in the scores during Week 2 and Week 4. In Phase B, there was an ascending and stable pattern from Week 6 to Week 10, with a small decrement in Week 7. The mean flow state score was higher in Phase B (171.2) compared to Phase A (158.6). All data points in Phase B were below the celeration line.

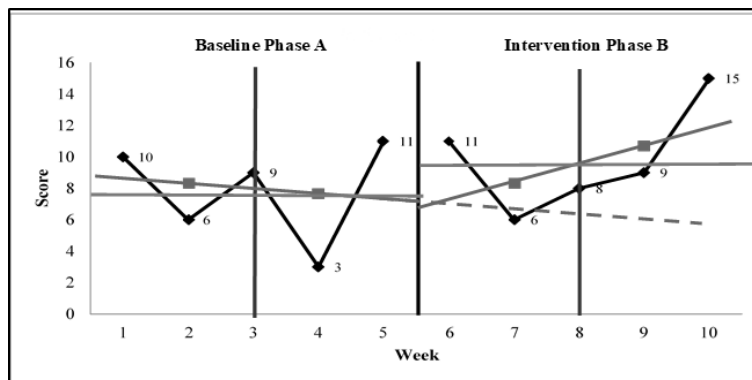


Figure 5: Visual analysis of goal shooting performance of Player 2

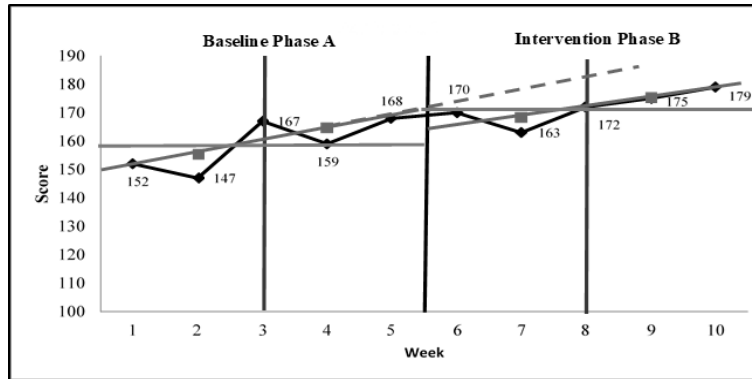


Figure 6: Visual analysis of flow state of Player 2

Player 3

As shown in Figure 7, Player 3's goal shooting performance in Phase A exhibited an ascending pattern from Week 1 to Week 5, but there was a dramatic drop in the data point for Week 4. In Phase B, there was an ascending pattern from Week 6 to Week 10, though there was a dramatic drop in Week 10. The mean score for goal shooting performance was higher in Phase B (10.6) compared to Phase A (6.2). Two out of five data points were above the celeration line in Phase B.

As shown in Figure 8, Player 3's flow state in Phase A exhibited a descending pattern from Week 1 to Week 5. In Phase B, there was an ascending pattern from Week 6 to Week 10, although there was a slight drop in the data point for Week 10. The mean flow state score was higher in Phase B (133.2) compared to Phase A (113.6). All data points were above the celeration line in Phase B.

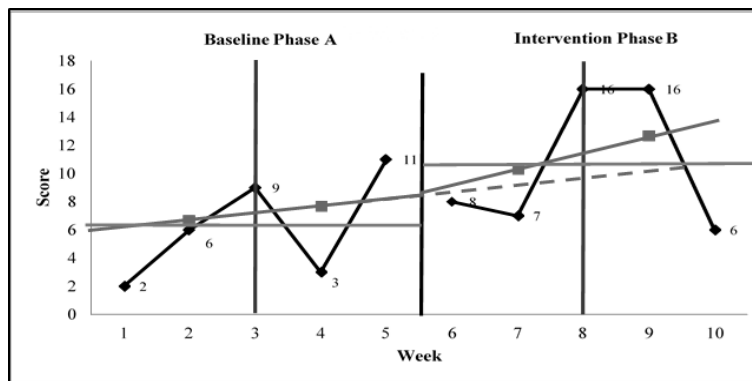


Figure 7: Visual analysis of goal shooting performance of Player 3

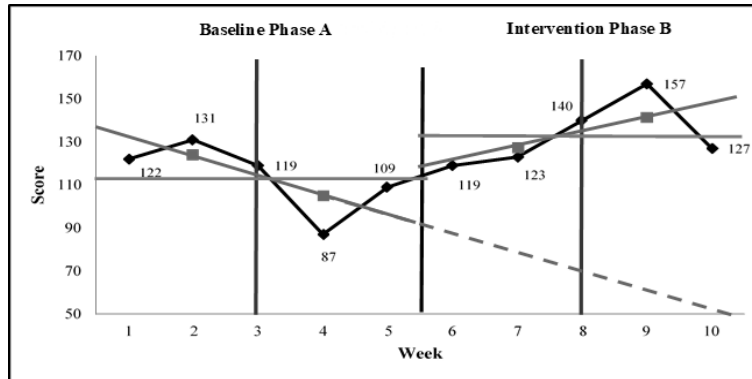


Figure 8: Visual analysis of flow state of Player 3

Player 4

As shown in Figure 9, Player 4's goal shooting performance in Phase A exhibited an ascending pattern from Week 1 to Week 5, although the data points fluctuated. In Phase B, there was an ascending pattern from Week 6 to Week 10, though the data points fluctuated. The mean score for goal shooting performance was higher in Phase B (13.6) compared to Phase A (8.0). Three out of five data points were above the celeration line.

As shown in Figure 10, Player 4's flow state score in Phase A exhibited an ascending pattern from Week 1 to Week 4. In Phase B, there was an ascending pattern from Week 6 to Week 10, although there was a slight drop in the data point for Week 7. The mean flow state score was higher in Phase B (144.4) compared to Phase A (123.2). All data points in Phase B were below the celeration line.

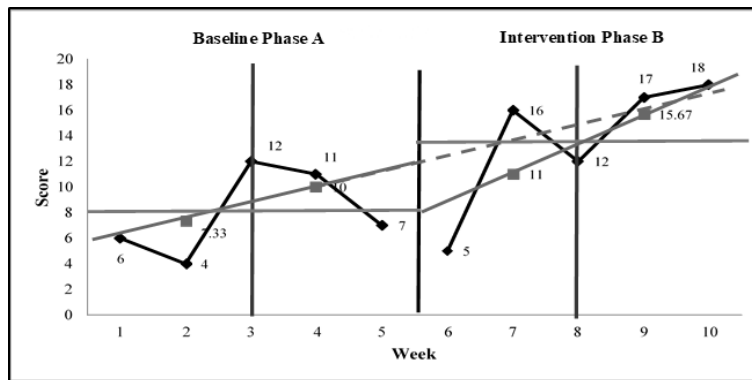


Figure 9: Visual analysis of goal shooting performance of Player 4

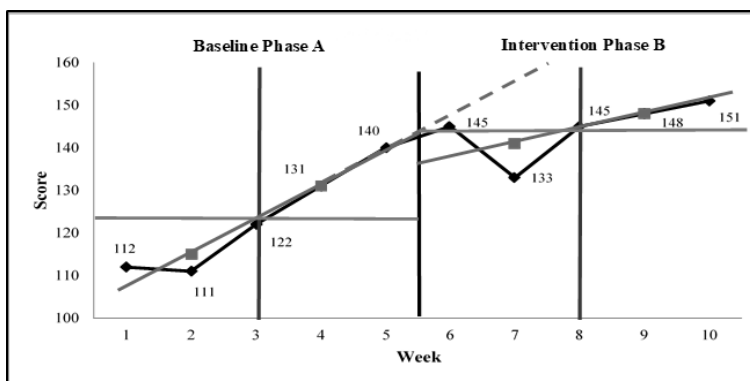


Figure 10: Visual analysis of flow state of Player 4

3.2 Discussion

Analysing one's own performance using single subject design in sports can help an athlete assess and enhance their tactical and performance abilities. In addition to the team approach, team sport participants need to participate in individual consultations to comprehend the physical and psychological needs unique to their positions and tasks on the field. In contrast to conventional group designs, which can obscure individual variations by averaging responses, single subject design enables practitioners and researchers to examine the distinct paths taken by individual athletes.

Based on the results of the present study, different distributions of data points and trends were observed across participants, suggesting that each of them responded individually to the music intervention for their flow state and shooting performance. As can be seen in the figures, all participants showed an ascending pattern in goal shooting scores, with the average scores during Phase B generally falling above the mean line, following exposure to music prior to the shooting task. These findings indicate that music may have contributed to improvements in goal-shooting performance, although alternative explanations should also be considered. It is possible that the music selected by the participants provided an additional advantage because it reflected their personal preferences and the meanings they associated with the music. However, it should be noted that as the selected music playlists did not standardise the BPM and included both upbeat and slow-tempo music, it is unlikely that tempo itself was the primary factor influencing performance in the present study. Instead, the observed effects may have been more closely related to the motivational and psychological significance of the self-selected music. Ballmann (2021) suggested that fast or slow music provides benefits to sports performance, if it is perceived to be stimulating and motivating to listeners. Moreover, the task performed by participants in the present study differs from activities involving repetitive movements, such as cycling or running, where tempo plays an important role in enhancing an individual's performance. Therefore, in sports, the emphasis on mental preparation makes the psychological impact of pre-task music more significant than the tempo itself, suggesting that its influence on performance may not be the same in every situation.

The improvement pattern in goal shooting scores across participants can be attributed to several reasons related to the self-selected music intervention used in this study. Listening to music could help participants to increase their concentration when scoring goals. Music has been reported to restrict an individual's attention, thus distracting attention from irrelevant thoughts during sport performance and lowering RPE (Shih, 2012; Dyrland & Wininger, 2008). This situation is important in futsal games when participants must perform an accurate pass and kick the ball towards the goal. In addition, rather than directly improving technical ability of futsal shooting, listening to music could help participants to achieve optimal arousal, which may influence their mental readiness to perform the shooting task (Terry & Karageorghis, 2006). According to Bishop, Karageorghis and Loizou (2007), music that alters emotional and physiological arousal can be used prior to competition or training to regulate arousal and thus calm anxious feelings. Despite these explanations, the consistent improvement in shooting performance observed across all four participants following the introduction of the music intervention provides preliminary support for the potential influence of music on shooting performance. However, because practice effects and ongoing training were not experimentally controlled, the relative contribution of music to these improvements cannot be determined with certainty. Furthermore, the A-B

single-subject design did not include a withdrawal or control phase, which limits the ability to establish a causal relationship between the music intervention and the observed improvements in shooting performance.

Three participants (Player 2, Player 3, Player 4) reported higher mean flow states during Phase B compared to Phase A. This suggests that participants were able to align their skills with the demands of the task, which is a key aspect of achieving a flow state. During the test, participants were encouraged to attain high scores on each attempt. It is important to note that all participants in this study had prior playing experience and had been involved in skills development for several years through their regular training. Listening to music may have helped participants effectively utilize their skills to achieve the goals of the shooting task. The result agrees with the findings of Baghurst et al., (2014), which showed that listening to different genres of music improved golf putting performance in golfers. Moreover, Pusey et al., (2023) stated that listening to music can help alleviate negative thoughts, such as fear of failure, doubt, and pressure on competition days. Therefore, the improvement in flow state occurred as music enhanced participants' evaluations of their abilities and increased their enjoyment of task performance.

Only Player 1 showed lower flow state scores in Phase B than in Phase A, despite improvements in her shooting scores during Phase B. This indicates that changes in flow were not always consistent with changes in performance, suggesting that performance may not necessarily correspond directly with the experience of flow (Stavrou et al., 2007). Improvements in shooting performance might arise from factors such as training and the players' ability to cope with game situations. Based on the responses given by Participant 1 in the flow state questionnaire, she scored low on the dimensions of unambiguous feedback and concentration on the task at hand. These two dimensions are important for players in making correct decisions, especially when performing tasks that require precision and focus. It could be noticed that Participant 1 could not concentrate on shooting the ball because she felt distracted by the presence of people during the test.

Several limitations should be considered when interpreting these findings. First, the A-B single-subject design has limited the ability to establish a causal relationship between music and improvements in performance. Second, participants continued their regular futsal training throughout the study, making it difficult to separate the effects of the intervention from natural skill development. Third, in terms of the test setting, because it was conducted in an open space, it might have been difficult to control external distractors such as the presence of outsiders and the weather, which potentially influencing participants' concentration and flow experiences. Fourth, it is possible that repeated exposure to the MFST may have resulted in practice or familiarity effects that contributed to improved shooting performance over time. Finally, the small sample of four players limits transferability of the findings, although this is consistent with the purpose of single-subject research, which emphasises individual patterns rather than population generalisation.

Future studies should employ stronger experimental controls, such as A-B-A-B or multiple-baseline single-subject designs, to better distinguish intervention effects from practice or maturation effects. In addition, including psychophysiological measures, such as heart rate variability, perceived arousal, and ratings of perceived exertion together with qualitative interviews may also provide a more comprehensive understanding of how pre-task music influences both psychological states and sport performance of the futsal athletes.

4. CONCLUSION

In conclusion, the present study highlights the value of using single subject design to analyse individual performance in sports, particularly in the context of music intervention for enhancing flow state and goal shooting performance among female futsal players. The findings demonstrate that listening to self-selected music before a shooting task can lead to significant improvements in performance, as evidenced by increased goal shooting scores across individual participants. Moreover, while individual responses to the music varied, the overall trend suggests that self-selected music can effectively enhance concentration and motivation, potentially contributing to a more enjoyable and rewarding athletic experience. The results further emphasize the complexity of flow state, revealing that high performance does not always correlate with optimal flow, as illustrated by one participant's decreased flow scores despite improved shooting accuracy. This points out the necessity of developing individual training programs that would utilize a combined physical and mental approach to performance improvement.

5. ACKNOWLEDGEMENTS

Authors would like to acknowledge commitments given by the participants in this study.

6. CONFLICT OF INTEREST STATEMENT

The authors declare no conflict of interest.

7. AUTHORS' CONTRIBUTION

Amirah Syafiqah Rosli (ASR) and **Nurul Azuar Hamzah (NAH)** designed the study; ASR collected the data; ASR and NAH analysed the data; NAH draft the manuscript; ASR and NAH revised the draft of the manuscript; ASR and NAH agree with the final version of the manuscript.

8. DECLARATION OF GENERATIVE AI IN THE WRITING PROCESS

During the preparation and revision of this manuscript, generative artificial intelligence (AI) tools may have been used to support language refinement, grammar checking, and improvement of structural clarity.

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