EXPLORING THE INTERSECTION OF RUNNING AND MUSIC: INSIGHTS INTO USER EXPERIENCE AND INTERFACE DESIGN.

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ABSTRACT | User interfaces for music devices and streaming platforms often neglect the needs of physically active users, who require interfaces optimized for dynamic activities like running. To address this, interfaces must offer intuitive controls, non-intrusive feedback mechanisms, and compatibility with runners' movements. Running, a popular activity for physical and mental well-being, combined with music listening, poses unique challenges and advantages. This study investigates runners' behaviors and interactions with various interfaces, using eye-tracking technology and interviews with 10 participants. The findings highlight the challenges runners face in managing multiple devices while running and emphasize the need for intuitive design.
The research explores the tension between expressive and utilitarian design in user interfaces, especially concerning digital music platforms for runners. It offers insights to enhance user experiences and bridge the gap between technological systems and user needs. By addressing these challenges, the study contributes to a deeper understanding of the intersection between running, music devices, and interface design, guiding future design developments for a more seamless and user-friendly experience.

1. Introduction

Music listening and running are two widely embraced activities that offer distinctive experiences for enthusiasts of both pursuits. Casual running is often pursued for reasons such as weight management, fitness, and meditative purposes (Bood et al., 2013) typically requires no specialized equipment. On the contrary, running with music can disrupt the overall running experience by requiring runners to carry supplementary devices, such as a mobile phone or music player, and a channel like a headphone or earphone, along with an accompanying audio output channel like headphones or earphones. The music control features can pose challenges due to physical movement, external factors, and the extra weight and bulk of the devices (Terry et al., 2012). Despite these challenges, many runners opt to integrate music into their routines to make the experience more seamless and enjoyable (Jebabli et al., 2020).

User interfaces for music devices and streaming platforms often overlook the needs of runners, focusing on static use rather than the demands of dynamic activities like running. Prioritizing usability for runners is crucial, necessitating interfaces that seamlessly integrate with their activity without interruption. This requires intuitive controls, non-intrusive feedback mechanisms (including e.g., auditory tones or vibrations) that confirm user actions without interrupting concentration, and compatibility with runners' movements. Although current mobile music streaming platforms and headphones offer diverse features to enhance the running experience with music, the overall experience can be ambiguous from the runner's perspective. This study focuses on the overall experience and specialized interactions between users and tangible as well as digital interfaces facilitating music for runners.

The researchers claim that by adapting music control interfaces for running activities, it is possible to optimize the user experience and create a safer and more enjoyable environment for runners. Through this study, the researchers aim to bridge the gap between technology and recreational activities, aligning them in a way that enhances rather than hinders the runner's experience. The motivation to explore and innovate in the field of music control interfaces for runners is driven by the belief that advancements in interface design can significantly contribute to optimizing performance, safety, and overall satisfaction during running sessions.

2. Running with Music

Running and music share a unique relationship, as running serves as a physical activity engaging individuals across various age groups and fitness levels. The running experience is multifaceted, encompassing physical sensations, bodily responses, psychological effects, emotional benefits, social aspects, and challenges. Crucial physical changes, such as alterations in heart rate, breathing patterns, and energy expenditure, are essential for meeting the heightened demands placed on the cardiovascular and respiratory systems (Foster et al., 2019). From a psychological perspective, running stands out for its positive effects on mental well-being, with research showing that running can induce a "runner's high" and reduce symptoms of depression and anxiety (Boecker et al., 2008; Dietrich and McDaniel, 2004). Regular running has been associated with enhanced self-esteem, improved cognitive functioning, and reduced symptoms of depression and anxiety (Hassmen et al., 2000; Stults-Kolehmainen and Bartholomew, 2012). Running can also evoke a wide range of emotions, such as joy, accomplishment, and empowerment (Lane and Wilson, 2011). These emotional benefits extend beyond immediate experience, contributing to overall emotional well-being, self-esteem, and body image (Sabiston and McDonough, 2009; Tiggemann and Zaccardo, 2018). Socially, running fosters a sense of belonging and camaraderie among runners, while challenges include the inherent risk of injuries and fatigue (Krabak et al., 2011; Niven et al., 2020).

Despite these challenges, the rewards of running are significant and often outweigh the challenges. Running provides a sense of accomplishment and achievement, contributing to improved fitness, maintenance of a healthy weight, and the overall promotion of physical well-being. Additionally, engaging in running can foster personal growth, heightened self-confidence, and a sense of empowerment (Moore et al., 2020). The running experience encompasses physical, psychological, emotional, and social dimensions, offering a holistic perspective on its impact on individuals. By considering these dimensions, individuals can gain a deeper understanding of the holistic impact running can have on their physical health, mental well-being, and social connections.

Music proves to be a powerful motivational tool, especially in the context of exercise and physical activities. Studies have shown that music has the capacity to elevate affect, reduce perceived exertion, improve energy efficiency, and amplify work output and when chosen for its motivational qualities, music can exert a magnified positive impact on both psychological state and performance (Karageorghis and Priest, 2012). Motivational music is characterized by a fast tempo and strong rhythm, boosting energy levels, and prompting physical activity. It can synchronize with the body's movements, leading to improved performance and endurance (Bood et al., 2013). Listening to motivational music not only stimulates physical activity, but also enhances mood, reduces perceptions of exertion, and brings about changes in arousal. It can also serve as a valuable distraction from pain and fatigue, allowing individuals to overcome challenging moments during exercise (Bood et al., 2013). Music's emotive quality can create a positive affective state even in negative psychological circumstances (Van den Tol and Edwards, 2011). By understanding the motivational qualities of music and selecting appropriate tracks, individuals can harness the power of music to enhance their motivation, performance, and overall exercise experience.

The combination of the two activities 'running-with-music' generates a distinctive synergy that enriches the overall running experience. The rhythmic nature of running aligns well with the rhythmic qualities of music, creating a harmonious and immersive experience. Music, serving as a powerful motivator, provides a steady beat that helps runners to maintain their cadence and pace. It can also uplift spirits, and serve as a distraction from physical discomfort, enabling runners to push through challenging moments with greater resilience.

The incorporation of music into running routines has become increasingly popular, as runners recognize the positive impact it can have on their performance, enjoyment, and overall well-being. The impact of music on running performance has been explored in different contexts. For example, one study found no significant differences in heart rate and perceived exertion with and without music (Cabral et al., 2022). Nevertheless, distinct levels of music information were found to affect running performance, with participants covering a greater distance when there was more music information, particularly in synchronous conditions (Ramji et al., 2016). Auditory-motor synchronization represents a crucial dimension of the intersection between running and music. The beat and tempo of music can synchronize with the body's movements, leading to improved performance and endurance (Bood et al., 2013). Research indicates that synchronizing movement tempo to acoustic stimuli, such as music or metronomes, can positively impact running performance. Music's influence on psychological state during running is profound, shaping mood, arousal levels, and attentional focus. Karageorghis and Priest (2012) emphasize the positive effects of music on psychological state and performance, highlighting its capacity to elevate affect, reduce perceived exertion, and improve energy efficiency. Running with music offers a dynamic and engaging experience that combines the physical benefits of running with the emotional and motivational power of music. Although, some studies present contradictory findings, suggesting that the effects of music on running may vary depending on factors such as exercise intensity and individual preferences, additional research is needed to explore the specific mechanisms underpinning the effects of music on running and understand individual differences in response to music.

3. Research Methodology

The research outlined in this paper seeks to explore ways in which music platforms and their communication/interaction between headphones/earphones can be better designed to enhance the music listening experience of amateur runners while running outdoors. The study explores the user experience with the interfaces that runners use. To closely observe and inquire into runners' experiences, it was deemed essential to conduct in-context fieldwork where participants are observed while running with music devices. Therefore, a fieldwork setup was established, providing a setting where runners actively engage in running with their devices. In addition, the participants wore an eye-tracking device to gather supplementary information on their interactions with the interfaces of music listening devices or app screens. Accordingly, a three staged fieldwork was set up consisting of the following three parts: i) Pre-Running-Interviews; ii) Running Activity on a Track, and iii) Post-Running Interviews. In total, ten participants were secured. Each part of the fieldwork was carried out with each participant individually.

Pre-Running-Interviews, was planned as an interview section in which participants were asked about their running habits, specifically their routines for running with music, the devices they utilize, and platforms they interact with. Additionally, the participants were briefed with more detailed information about the implementation of the study before the commencement of the fieldwork.

Running Activity on a Track, constituted a fieldwork procedure involving 10-15 minutes of running activity around Middle East Technical University's outdoor running track, incorporating the use of a wearable eye tracker. The participants carried their headphones/earphones and technological devices to enable music listening while running. The participants were given commands regarding music control during the running activity, and the sequences of performing commands were recorded through an eye-tracking device. The primary objective of this activity was to gain insights into participants' experiences with physical and digital interface components, aiming to uncover any challenges that participants encountered in relation to these interface elements.

Participants were given a period to wear eye-tracking glasses, wear their own headphones that they brought, and keep their smartphones connected to digital music listening platforms. When the participants were ready, the running activity commenced. Participants began running around the track, with each round covering approximately 410 meters. Throughout their run, eight banners, each featuring a distinct music playback commands (i.e., start the playlist; turn the volume down; turn the volume up; change the song; pause the song; resume the song; change the playlist; and finish the playlist) were strategically lifted up by the researcher in varied orders and at different locations on the running track to prevent participants from forming expectations based on a regular order. The commands were reinforced with both corresponding icons and written text. The eight commands were chosen by estimating the music playback controls that are likely to be interacted with the most during a run. Since more complex music playback controls, such as liking/disliking a song, preparing a playlist, following lyrics, are less likely to be used while running, the study only focused on the eight commands.

Figure 1 provides a diagrammatic representation of how the commands were displayed on the track, with each participant receiving a different command combination. Upon the completion of all eight commands (approx. four rounds around the running track), the running activity concluded. Participants were given a short break to rest and remove the equipment they used. Subsequently, they were escorted to the post-running-interviews, marking the final part of the fieldwork.

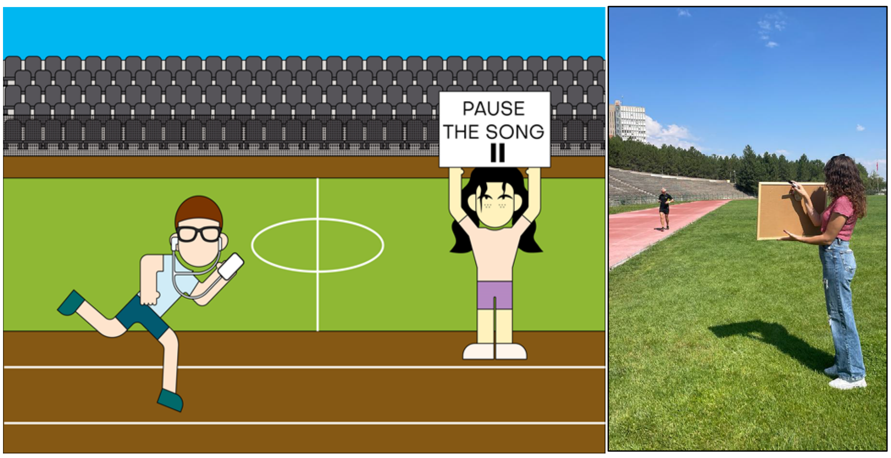

Figure 1. A representation of how the researcher instructed the participants on music playback commands was through a banner displayed on the track.

Post-Running Interviews, were conducted immediately after the running activity with the aim of gathering feedback on both the activity itself and the commands provided to participants. Participants were specifically inquired about the advantages and challenges that they experienced with the devices and interfaces to carry out the commands while running. Their recommendations for the design of product and digital interfaces were also sought. Additionally, participants shared their thoughts on the experience with the wearable eye tracker.

4. Results

The semi-structured interviews conducted before and after the running activity provided insights into the runners' experiences and expectations regarding their music listening routines and the interfaces they interacted with while running. Additionally, the running activity provided a measurable means of capturing the steps in the runners' experience of performing music playback commands and their corresponding execution times with the help of eye-tracking technology.

During the pre-running Interviews, participants disclosed details about their music listening routines and habits while running, highlighting the characteristics of the devices and interfaces they used. In the post-running Interviews, they evaluated the challenges encountered in performing the music playback commands during the field activity and elaborated on the underlying reasons.

The difficulty ratings of the music playback commands conveyed in the post-running Interviews were arranged in tabular format, and their respective percentage analyses were indicated. The fieldwork results and analysis are presented together with the design insights about the current digital and tangible interface interactions in the context of running and the discussion of the role of eye-tracking technology in capturing runners' experiences.

4.1 Difficulty Ratings of the Music Playback Commands

As mentioned before, during the running activity, participants were asked to perform the music control commands as soon as they encountered them. After they completed the running activity participants asked to rate how easy or difficult it was for them to execute the music playback commands given to them on a 5-point Likert scale [Very easy (1), Easy (2), Moderate (3), Difficult (4), Very difficult (5)] (see Figure 2). In addition, the participants were given multiple-choice questions to find out which commands were challenging and simple to follow.

In the Post-running Interviews, it became clear that the participants had trouble separating related commands into individual evaluations. Therefore, in this section, commands requiring opposite actions were decided to be paired (e.g., 'Volume Up/Volume Down') for easier analyses in contrast to the analysis in the earlier sections where the commands and reaction times to them were analyzed separately (e.g., 'Volume Up' and 'Volume Down').

Music Playback Commands	Participant no.	P_01	P_02	P_03	P_04	P_05	P_06	P_07	P_08	P_09	P_10	Aver.
	Change the Playlist	4	3	4	3	3	5	4	3	3	4	**3.6**
	Change the Song	3	2	4	3	2	2	3	2	1	1	**2.3**
	Pause / Resume the Song	1	1	3	3	1	3	3	1	1	1	**1.8**
	Start / Finish the Playlist	1	3	1	1	3	2	3	1	1	1	**1.7**
	Volume Up / Down	1	5	1	1	1	1	1	1	1	2	**1.5**

Figure 2. Rank order averages of Likert scale scores for music playback commands based on evaluations from 10 participants.

The distribution of responses for music playback commands is as follows (unmentioned scales indicate that none of the participants responded accordingly).

- *Change the Playlist*. 'Moderate' (5/10), 'Difficult' (4/10), 'Very difficult (1/10)'.
- *Change the Song*. Very easy' (2/10), 'Easy' (4/10), 'Moderate' (3/10), 'Difficult' (1/10).
- *Pause/Resume the Song*. 'Very easy' (6/10), 'Moderate' (4/10).
- *Start/Finish the Playlist.* 'Very easy' (6/10), 'Easy' (1/10), 'Moderate' (3/10).
- *Volume Up/Down*. 'Very easy' (8/10), 'Easy' (1/10), 'Very difficult' (1/10).

Participants were asked to identify the easiest and most challenging and commands. The majority of the participants (8/10) found 'Volume Up / Volume Down' the easiest, likely because of the convenience of tangible volume control buttons. They preferred using these physical buttons over navigating digital music platforms on screens, finding them more user-friendly.

In contrast, most participants (9/10) described the command 'Change the Playlist' as the most difficult due to the need for multiple interactions across screens. They mentioned that they could manage commands through their headphones except for 'Change the Playlist'. The participants' statements regarding the easiest and most difficult commands align with the results of the ANOVA analysis of execution times.

4.2 Analysis of the Command Execution Times based on Eye Tracking Data

This section concentrates on the analysis of the execution times of music playback commands, with a specific emphasis on data obtained from eye-tracking. The collected eye-tracking data involved measuring and ranking the time participants took to perform the commands. This ranking aimed to assess the perceived difficulty of the commands obtained from the interviews. At the same time, various screenshots were captured from the eye-tracking recordings. These screenshots facilitated a visual analysis of the participants' commands execution and the duration taken to perform them.

A one-way ANOVA (Analysis of Variance) test was used to determine whether there was a statistically significant difference between the execution times for the commands (discrete groups of data) and, if so, between which pairs of commands. In the test, 'p-value' is commonly defined as '0.05', such that < 0.05 corresponds to the presence of a statistically significant difference between at least one of the test pairs. The ANOVA was run with eight groups, corresponding to the eight music-playing commands, with data from the ten participants in each group (Figure 3). A Tukey's HSD post hoc test was used to identify which (if any) of the pairs from the ANOVA contained significant differences. An online statistics page (Statistics Kingdom, 2023) was used to calculate ANOVA and Tukey's HSD Test.

One Way ANOVA test, using F distribution df (7,72) (right-tailed) detected significant differences between some groups. The post hoc Tukey HSD test revealed the pairs of groups had significant differences. The results of the Tukey HSD test are shown in Figure 4, revealing (in bold text) the following pairs to have statistically significant differences: x1-x2, x1-x3, x1-x4, x1-x5, x1-x7, x1-x8, x2-x6, x3-x6, x4-x6, x5-x6, x6-x7, x6-x8.

Sample Size	Time Interval to Execute the Command (in seconds)							
	x6	x1	x5	x7	x8	x2	x3	x4
Participant no.	Change the Playlist	Start the Playlist	Change the Song	Pause the Song	Resume the Song	End the Playlist	Volume Up	Volume Down
P_01	10.2	18.1	5.8	6.5	2.1	3.7	2.2	2
P_02	15.8	16.4	2.3	2.3	2	2.1	3.2	3.1
P_03	12.3	17	2.3	2.1	3.5	2.3	2.4	2.2
P_04	15.2	8.7	5.1	2.1	2.3	2.3	1.4	1.4
P_05	18.5	5.1	8	6	5.2	2.7	1.7	1.3
P_06	10.1	6.5	3.2	2.2	2.5	2.3	2.8	1.4
P_07	8.3	10	3.5	3.5	2.2	2.4	1.8	1.7
P_08	9.5	5.3	5.3	4.1	2.1	3.1	1.4	2.2
P_09	13.5	12.3	3.1	3.2	2.3	2	2.2	2.5
P_10	15.8	8.2	3	2.1	3	2.5	2.3	1.8
Aver.	**12.92**	**10.76**	**4.16**	**3.41**	**2.72**	**2.54**	**2.14**	**1.96**

Figure 3. ANOVA and Tukey's HSD calculations (in ranked average order) with eight groups of music playback commands (in x) by ten sample sizes (in P).

Group	x2	x3	x4	x5	x6	x7	x8
x1	**8.22**	**8.62**	**8.8**	**6.6**	2.16	**7.35**	**8.04**
x2	0	0.4	0.58	1.62	**10.38**	0.87	0.18
x3	0.4	0	0.18	2.02	**10.78**	1.27	0.58
x4	0.58	**0.18**	0	2.2	**10.96**	1.45	0.76
x5	1.62	2.02	2.2	0	**8.76**	0.75	1.44
x6	**10.38**	**10.78**	**10.96**	**8.76**	0	**9.51**	**10.2**
x7	0.87	1.27	1.45	0.75	**9.51**	0	0.69

Figure 4. Summary of Tukey's HSD Test / Tukey-Kramer Test Results.

Both commands “Start the Playlist” (x1) and “Change the Playlist” (x6) took a significantly slower time to execute then all the other commands, except that no significant difference was found between “Start the Playlist” (x1) and “Change the Playlist” (x6). Apart from these results, none of the other commands had execution times that were significantly slower or faster. For example, the two commands with the shortest execution interval – “Volume Down” (x4) and “Volume Up” (x3)– were not significantly shorter than the other commands. With the help of the fieldwork, both the actions and the statements of the participants showed that the difficult levels of the music controls can be ranked and compared. In the running activity, thanks to the eye-tracking technology, participants' actions were recorded and the time intervals to manage music controls were detected. Also, the post-running-interviews obtained the statements of the participants about the music controls that they executed. For runners who prefer to listen to music while running, the difficulty or ease of music controls can vary depending on their preferences and the interfaces provided by their chosen devices and platforms. However, some general observations were made.

The play/pause button is typically the simplest and most intuitive control for runners. A large, easy-to-press button allows for quick management of music playback without much thought or effort.

Selecting a song and controlling the music can be challenging. Runners find it difficult if the interface is complex or if they have to navigate through multiple screens or menus to find and play their desired music. If a runner wants to search for a specific song, artist, or album while on the move, this can be quite challenging. Typing or voice recognition for searching might not be as accurate or quick as desired. On the other hand, an interface that allows for quick and intuitive music selection and control, such as a simple swipe or tap gesture, can make it easier for runners to manage their music while on the move. Interfaces that offer fine-tuned navigation, such as rewinding or fast-forwarding within a song, can be challenging to use while running. These controls often demand precise touch gestures or screen interactions that are not conducive to a smooth run.

Volume controls are often straightforward, especially when physical buttons or touch-sensitive surfaces are well-designed. Runners can easily adjust the volume to suit their preferences or situational needs. However, there were different scenarios when analyzing the volume control commands. As Figure 5a illustrates, one participant decided to control the volume from the digital interface of the digital music streaming platform while the other participants (e.g., see Figure 5b) were controlling volume through the tangible buttons of the smartphones. These two scenarios revealed the fact that digital interface interaction took more time than the tangible buttons with the help of eye tracking recordings.

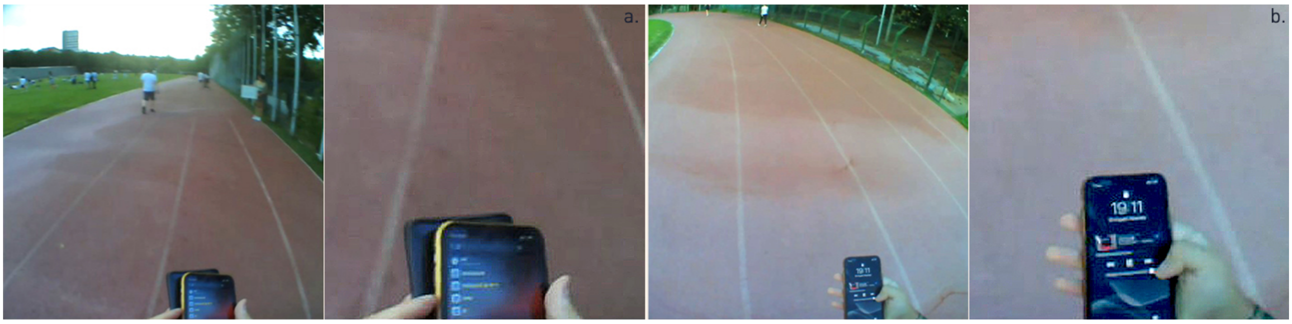

Figure 5. Screenshots from eye-tracking recordings while a participant: a. controlling the volume from the music platform interface; b. turning the volume down from the smartphone interface.

Creating or editing playlists on the move, like running, can be intricate. The reality is that our preferences and moods may change dynamically during the run, making on-the-move adjustments essential. This challenges the notion that this task is better suited for pre-run setup or post-run sessions when the runner can allocate more time and focus. Instead, we argue for the necessity of better-designed interfaces that cater specifically to the dynamic needs of runners, allowing them to seamlessly modify playlists as they go.

Modifying a playlist, such as rearranging songs or adding new ones, can be cumbersome if the interface lacks user-friendly drag-and-drop features. Accordingly, changing the playlist while running emerged as the most difficult command for the participants. Interacting with multiple icons and screens to change the playlist results in participants spending an extended period in this orientation. Another contributing factor to a runner's difficulty in altering their playlist is often the pre-existence of a single, pre-prepared playlist before the run. Consequently, they may have found themselves spending additional time searching for an alternative playlist to switch to as soon as they receive the command.

In summary, the most user-friendly music controls for runners are typically those that demand minimal effort, such as play/pause and volume adjustments. On the other hand, controls involving precise navigation, searching, or playlist management can pose more challenges during a run, necessitating extra attention and potentially distracting from the overall experience. Runners commonly appreciate devices and platforms that strike a balance between functionality and ease of use while on the go.

4.3 Design Suggestions

Based on the research findings, a range of insights, both general and feature-specific, can be proposed for the design of digital and physical interfaces for devices and the music streaming platforms tailored for runners. The design insights from this research have broad applications across disciplines encompassing design, development, health, sports, and design research, benefiting both researchers and practitioners.

The primary outcome of this research was the ranking of the difficulty levels associated with commands executed by runners while running with music. Data collected from the participants' verbalized and numerical evaluations from the field study revealed that changing the playlist ranked as the most challenging command, whereas volume up/down commands were the easiest to execute. In addition to this, design suggestions were offered for both tangible and digital interfaces, aiming to enhance the experience of listening to music while running. These suggestions are based on the insights gained through participant interviews and the eye-tracking recordings during the fieldwork. The design development suggestions can be organized under the following headings.

Intuitive Physical Controls
Elevating the running experience with music involves thinking carefully about how digital and physical interfaces work together in terms of user engagement and overall satisfaction. Central to this enhancement is the incorporation of intuitive physical controls. These controls should feature sizable, tactile buttons strategically positioned to facilitate common functionalities such as play/pause, volume adjustment, and track skipping. The tactile nature of these controls is designed to afford users the ability to manipulate music playback without diverting attention from their running focus.

Voice Commands
Complementing physical controls, the integration of voice command functionality introduces a hands-free dimension to music playback, track selection, and playlist management. The robustness of voice recognition, particularly in acoustically challenging outdoor settings, becomes a critical consideration. Concurrently, the incorporation of gesture controls on touchscreens aligns with contemporary interaction trends. These gestures, designed to be both intuitive and responsive, can be further customized to accommodate individual user preferences.

User-Friendly App Interfaces
In the digital domain, the development of user-friendly app interfaces emerges as a crucial priority. Mobile and smartwatch apps should be carefully designed to facilitate seamless navigation with minimal user input. This involves the provision of large touch targets for key controls and gestures, contributing to an interface characterized by both efficiency and user-friendly design.

Personalization
Playlist management plays a vital role in enhancing the user experience. A streamlined process for creating, editing, and organizing playlists is essential for user convenience, particularly before a run. Moreover, the implementation of automated playlist suggestions, tailored to a runner's preferences and past listening habits during workouts, enhances personalization to a greater extent.

Adaptive Interfaces
The notion of adaptability extends beyond interface design to the performance of the interface itself. Adaptive interfaces, responsive to a runner's pace and movement dynamics, help reduce unintended inputs during high-speed runs. This adaptability is further underscored by customization options, allowing users the ability to adjust interface sensitivity in accordance with individual preferences.

Integration with Health Data
Integration with health and fitness data amplifies the holistic nature of the music–running relationship. By integrating metrics, such as heart rate and GPS information, the design can facilitate the generation of

tempo-synced playlists aligned with the runner's pace. Furthermore, the incorporation of voice feedback on performance metrics, such as distance covered or calories burned, can augment the informational aspect of the running experience.

Social Features
Within the social realm, features enabling interaction and collaboration among users are integral. Incorporating social sharing mechanisms within music applications fosters a sense of community, allowing runners to share achievements and musical tastes. Additionally, tools for discovering new music through social interactions, such as playlist recommendations from peers, contribute to a collaborative and enriching environment.

Feedback Mechanism
Last but not least, a robust feedback mechanism is one of the most important experience improvement strategies. Providing real-time feedback upon reaching specific running milestones, whether they are distance goals or personal records, is crucial for sustaining user motivation. The customization of feedback to be motivational and encouraging fosters a mutually beneficial and positive relationship between the runner and the musical accompaniment, culminating in an enriched running experience.

5. Conclusions

The primary conclusion of this study, derived from semi-structured interviews and eye-tracking data from the fieldwork, is the identification of the most challenging aspects of runners' interactions with both tangible and digital interfaces of their music-listening devices. Changing the playlist was observed as the most time-consuming interaction, which was justified by the fact that there were multiple steps to complete in order to perform this interaction, all performed through the smartphone and digital music listening platform interfaces of. Conversely, the easiest interaction for the participants was increasing/decreasing the volume, largely performed using tangible buttons on their smartphones, explaining its quicker and more straightforward execution. Within the scope of this study on amateur runner experiences, it was discerned that users tend to navigate tangible interfaces faster and more easily than digital ones. Additionally, it was inferred that individuals engaging in outdoor mobile exercises prefer minimal interaction with devices when controlling music.

In addition, design suggestions were informed by the valuable insights shared by the participants during interviews and the eye-tracking recordings. These suggestions aimed to address variations in the digital music listening platforms used by the participants. Rather than suggesting changes or elimination of elements within a specific interface, suggestions were made to improve the interactions between different interfaces considering the overall experience. The primary approach for these design suggestions involved exploring options for multi-sensory interactions. Runners should not only interact through touch and visual feedback, but also through audible and haptic means. Another design suggestion emphasizes user-friendly interfaces for digital music listening platforms, specifically tailored to enhance running experience. This signifies a shift from isolated interface improvements to a holistic approach that considers the entire running experience. Lastly, the integration of social sharing mechanisms into the digital music streaming platforms is proposed to enrich the music listening experience for runners, aligning with the overall design approach.

Incorporating responsive design into music player interfaces for runners can allow adjustments based on activity level, preferences, and environmental conditions. For example, during running, the interface can prioritize essential controls while minimizing distractions for improved usability. It can adapt to user behavior and can dynamically adjust itself to environmental factors like lighting and noise levels, enhancing improved visibility and usability in different conditions. This flexibility, tailored to each runner's needs and context, contributes to a smooth and enjoyable experience. Our research findings have highlighted the intricate relationship between running and music, emphasizing the need for carefully tailored interaction features in devices and music platforms for runners. Effortless access to music controls not only enhances the overall running experience but also reflects a user-centric design approach, ensuring that the joy of running with music remains undisturbed by cumbersome interfaces. By addressing the specific requirements of active users, music playing devices and streaming platforms can provide a seamless and enjoyable experience not only for runners but also for individuals engaged in other physical activities.

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