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Becoming Your Quantified Self: A Study of the Effects of Personal Avatars in Self-Tracking Sports Apps

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ABSTRACT
Following the Quantified Self (QS) movement, sports apps increasingly adopt self-tracking technologies that offer data-driven insights into personal competencies to enhance self-efficacy. However, sustained engagement with QS technology remains challenging, as interpreting data is complex. One potential solution is to make QS data more meaningful to users. To address this, we present a player card feature within a QS sports app, incorporating a personalized avatar to enhance users' enjoyment, data meaningfulness, and self-efficacy to promote continued use. We evaluate the app through a field experiment in a soccer context to examine the impact of the avatar feature. Results indicate that avatar identification positively affects self-efficacy, data meaningfulness, continued use intention, and enjoyment, though enjoyment did not impact continued use. Our findings suggest that (1) avatar identification can be enhanced through personalization, (2) personalized avatars effectively boost self-efficacy, and (3) sustained engagement may rely more on meaning than on enjoyment alone.

KEYWORDS
Quantified self; avatar; self-efficacy; meaningfulness; gamification

1. Introduction

In recent years, an increasing number of health and sports apps have emerged, designed to promote regular physical exercise and enhance user well-being (Cai & Li, 2023; Schmidt-Kraepelin et al., 2020). Popular apps such as *Strava*, *Fitbit*, *Nike Training Club*, and *adidas Running* allow users to track exercises, monitor heart rate, compete with peers, and visualize progress through interactive dashboards (Schmidt-Kraepelin et al., 2020). These apps often utilize self-tracking technologies that allow users to monitor and record their physical activity, for example via smartphones and wearable devices such as smartwatches and fitness trackers. The rapidly increasing proliferation of these technologies enables individual athletes and sports teams to fine-tune their training programs (Pham et al., 2025; Vesterinen, 2016) in what has been hailed as a paradigm change away from subjective assessment and toward comprehensive and precise data-driven insights (Abeza & Gretchen, 2023). A trend that also aligns with the Quantified Self (QS) movement, in which individuals seek insight and self-knowledge through data gathered from tracking their activities and logging mental performance (Ajana, 2017; Swan, 2013).

Central to this movement is the idea that self-tracking goes beyond mere data collection; the insights into personal data enable individuals to interpret and define a new self-identity, which can be understood as the Quantified Self (Ajana, 2017; Swan, 2013). Thus, QS systems help users to better understand their activities and habits, provide insights, and increase self-control to achieve their personal goals. Research on self-tracking technologies is situated within the field of personal informatics, which explores how individuals collect and engage with personal data. A systematic review by Epstein et al.

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(2020) identifies physical activity as the most extensively studied domain in this field. However, while many systems show promise in supporting behavior change, the review emphasizes that clear guidance on how and when to implement specific design strategies remains limited. Moreover, only about a quarter of personal informatics studies explicitly apply theoretical frameworks in either research or design (Epstein et al., 2020). As a result, there remains a limited understanding of how self-tracking systems can be designed to support psychological outcomes, despite their evident potential to enhance enjoyment, motivation, or self-efficacy (Kinney et al., 2019). These dynamics, central to sustained behavior change, have received limited attention (Mencarini et al., 2019).

Self-efficacy refers to the belief in one's ability to successfully perform certain tasks and skills, such as succeeding in a sport, significantly influencing one's actions and interactions (Bandura, 1977, 1997). It can thus be seen as a critical factor for sports performance and success (Bandura, 1997). Self-efficacy is also a personal key factor that influences the adoption and intention to continue using fitness apps (Chen et al., 2025), and thus their long-term impact on physical activity interventions.

Despite their potential to improve self-efficacy in sports and the persistent use of such applications, QS technologies present significant challenges. Many users find it difficult to interpret and act on the data generated by these applications (Epstein et al., 2020; Hilviu & Rapp, 2015; Rapp et al., 2018). The overwhelming amount of information in QS apps can lead to confusion and frustration, resulting in short-term use of fitness apps, with many users abandoning the apps shortly after initial engagement (Attig & Franke, 2023), undermining the long-term benefits these apps could provide (Schmidt-Kraepelin et al., 2020). This speaks of the importance of data meaningfulness, i.e., having an understanding of what data represents and means to make sense of it (Coşkun & Karahanoğlu, 2023; Ding et al., 2021) and have it contribute to achieving relevant personal goals, which gives data-driven experiences direct personal significance (Ding et al., 2021; Pham et al., 2025).

To address these challenges and promote sustained engagement, many sports apps incorporate gamification (Matallaoui et al., 2017; Schmidt-Kraepelin et al., 2020). Gamification refers to the use of game design elements and principles to increase user engagement and motivation in an activity, system, service, product, or organizational structure (Hamari, 2019) and goes beyond the mere incorporation of the most commonly used features of points, badges, and leaderboards (Hallifax et al., 2023). A growing body of research primarily conducted in recreational and amateur sports contexts, such as among college students and fitness app users, has shown that gamified physical activity can improve self-efficacy (H. M. Kim et al., 2023; Polo-Peña et al., 2021), satisfy needs for competence, autonomy and relatedness (Bitrián et al., 2020), and increase enjoyment of said activities (Matallaoui et al., 2017; Razikin et al., 2017), leading to more exercise (Goh & Razikin, 2015; Johnson et al., 2016). Therefore, gamification shows promising results in settings where the primary aim is not to enhance professional athletic performance, but rather to build consistent exercise habits, increase intrinsic motivation, and maintain a healthy lifestyle.

In games that are designed to encourage people to exercise, called exergames, avatars are emerging as a promising and widely used gamification feature, serving not only as communication and feedback tool but also as motivational support for users (Johnson et al., 2016; Matallaoui et al., 2017). Beyond mere representation, avatars offer users a way to express and extend their identity, creating a bridge between the personal and digital selves (Ducheneaut et al., 2009). While this insight originates from online multiplayer games, in which identity exploration and social interaction are central, it raises the question of whether similar dynamics might also arise in more utilitarian contexts, such as health tracking. A growing body of research supports this possibility, highlighting the importance of how users identify with their avatars, i.e., the extent to which they feel connected to or see themselves in their digital representation, in shaping user experience and behavior (Jahn et al., 2021). For instance, Kao and Harrell (2018) demonstrated that stronger identification with one's avatar can enhance intrinsic motivation, self-efficacy, and engagement in an educational game setting, leading to more time spent in the game and higher quality outcomes. Similarly, in exergaming contexts, avatar identification has been shown to boost enjoyment and influence exercise intention, with enjoyment mediating the relationship between avatar identification and behavioral outcomes (Li & Lwin, 2016). Customization options play a key role, as they increase the likelihood that users will identify with their avatars and feel motivated (Turkay & Kinzer, 2014). These findings underscore the motivational potential of avatars in digital health and fitness settings. However, most prior research focuses on avatars in immersive or entertainment-oriented environments, such as exergames or MMORPGs. Little is known about how avatars function when embedded in utilitarian health-tracking systems, such as QS apps, where the avatar may serve not just as a representation of the user, but also as a novel visualization of their personal data as an alternative to pure numbers (Coşkun & Karahanoğlu, 2023).

Thus, the use of avatars to represent users and their tracked QS data within a QS app has unique potential to increase engagement by humanizing QS data in a personally meaningful way. By visually embodying one's QS data, avatars could provide users with a more relatable and personalized view of their progress and achievements. This personalized visualization that users can identify with could address limitations of conventional QS interfaces, potentially boosting users' self-efficacy, enjoyment, and thus continued engagement.

Despite the promising findings from related domains, our understanding of the use of avatars in QS systems remains limited, particularly with regard to how avatars might induce beneficial psychological effects like enjoyment and self-efficacy. The present study addresses this gap by investigating the following research question:

RQ: How does an avatar within a QS app influence the user's enjoyment, self-efficacy, and continued use intention?

In this paper, we (1) present the design and prototypical implementation of an avatar feature for a QS app in the sports context. We then (2) use the app in a field experiment and examine our research question using a questionnaire.

2. Theoretical background

This section provides an overview of the theoretical foundations relevant to examining the potential impact of avatars in QS applications. We address the key concepts of this study including self-efficacy, meaningfulness, enjoyment, and the avatar itself.

2.1. Self-efficacy

Self-efficacy, a concept rooted in Bandura's social cognitive theory, refers to an individual's belief in their ability to successfully execute a specific task or behavior (Bandura, 1977, 1997). According to self-efficacy theory, individuals are more likely to persist in behaviors when they have a sense of confidence in their ability to perform those behaviors effectively (Bandura, 1998).

This concept plays a crucial role in the realm of sports, as it influences an athlete's cognitive and behavioral responses. Strong beliefs in their own abilities enable individuals to approach and achieve challenging goals, thereby improving performance, while low perceptions of self-efficacy can prevent individuals from overcoming challenging obstacles. Consequently, self-efficacy is a significant predictor of sports performance and motivation in physical exercise (Bandura, 1997; Baretta et al., 2017; Litman et al., 2015).

The extent to which someone experiences self-efficacy is derived from four principal sources identified by Bandura: mastery experiences, vicarious experiences, verbal persuasion, and physiological and affective states (Bandura, 1977, 1997). The most influential sources of self-efficacy are enactive mastery experiences (Bandura, 1997). This refers to an individual's past performance or the attainment of complete mastery in a given task. Success in these tasks builds a robust belief in one's efficacy, while failures can undermine it. This is particularly true in sports, where repeated success enhances athletes' confidence in their skills and competence (Gernigon & Delloye, 2003). Vicarious experiences involve estimating one's own ability based on observing others' performance (Bandura, 1977, 1997). Seeing individuals similar to oneself succeed increases confidence in one's own ability to achieve similar results. Verbal persuasion, although less influential than mastery and vicarious experiences, also affects self-efficacy beliefs (Bandura, 1977). This involves feedback from others, such as encouragement from significant individuals, which reinforces belief in one's capacity to succeed. In sports, coaches, family, friends, and teammates often provide this type of feedback. Lastly, physiological and affective states are the least influential source of self-efficacy (Bandura, 1997). This includes interpreting bodily cues related to a task, such as feelings of fatigue, pain, or excitement. For instance, experiencing fatigue and pain might be interpreted as signs of incompetence, reducing self-efficacy, while feelings of enjoyment and excitement can enhance it.

2.2. Meaningfulness

User experience (UX) design often focuses on hedonic aspects of use, such as momentary pleasure. However, this approach can neglect the broader, deeper aspects of user satisfaction and well-being (Mekler & Hornbæk, 2016). In contrast to hedonism, eudaimonia emphasizes the long-term impact of UX design, asking how a product can continue to provide value and support the user's well-being over time, rather than just providing short-term satisfaction. Thus, designing for eudaimonia means designing for personal meaning-making, where the product not only serves functional purposes but also enriches the user's life in a significant and lasting way (Hassenzahl et al., 2013; Mekler & Hornbæk, 2016).

In QS systems, designing for meaningfulness refers to the extent to which users can interpret their tracked data in ways to make sense of it, so as to support their personal goals, values, and sense of identity (Coşkun & Karahanoğlu, 2023; Ding et al., 2021). However, especially in the case of QS applications, it is often observed that displayed statistics are difficult to interpret and therefore difficult for users to relate to Bentvelzen et al. (2022). This lack of comprehensibility makes the data less meaningful to users because they cannot fully understand or engage with it. Meaningfulness emerges when users see a clear connection between their tracked behaviors and desired outcomes, such as improved performance. Therefore, intuitive data representations are important (Hilviu & Rapp, 2015; Rapp et al., 2018) because understanding is needed to attain personally significant goals (Ding et al., 2021; Huta & Ryan, 2010). This can be supported by personalized data representations, narrative feedback, or goal-based visualizations (Coşkun & Karahanoğlu, 2023; Hilviu & Rapp, 2015; Rapp et al., 2018).

2.3. Enjoyment

While eudaimonic principles emphasize long-term well-being and meaningful user experiences, hedonic aspects, such as enjoyment, pleasure, and immediate satisfaction, remain crucial components of UX design. This is particularly evident in the design of gamified systems, which should provide users with hedonically satisfying experiences to make activities more engaging (Hamari et al., 2014). Designing for hedonism "implies the design of products that become direct sources of pleasure by creating or mediating pleasurable experiences rooted in human values and evidently pleasurable activities" (Desmet & Hassenzahl, 2012, p. 12). The perceived enjoyment of use—how much one finds the act of using a system enjoyable for its own sake, disregarding any expected outcomes or performance-related implications—is an often used indicator for the hedonic success of a system (Davis et al., 1992).

In the context of QS systems, enjoyment refers to the pleasure users derive not only from the physical activity itself, but also from interacting with the system (Li & Lwin, 2016; Matallaoui et al., 2017). This type of enjoyment can be fostered through gamification by integrating engaging elements such as avatars, progress feedback, achievement badges, and social interaction–features designed to make the tracking experience more engaging and intrinsically rewarding (Matallaoui et al., 2017; Morschheuser et al., 2014; Polo-Peña et al., 2021).

2.4. Avatars and identification

Avatars act as proxies in the virtual world, serving as a digital representation of the user. Typically, avatars have human-like characteristics that simulate the nature of real humans and human-like interactions (Nowak & Rauh, 2005; Zhu & Yi, 2024). They can extend individuals' identities, allowing users to express various facets of themselves (Ducheneaut et al., 2009), especially when the avatar reflects idealized or aspirational aspects of their identity (Loewen et al., 2020). At the same time, the identification with an avatar involves a temporary shift in a user's self-concept as they adopt the perceived traits of their avatar (Kang & Kim, 2020; Klimmt et al., 2009). This identification can manifest as users

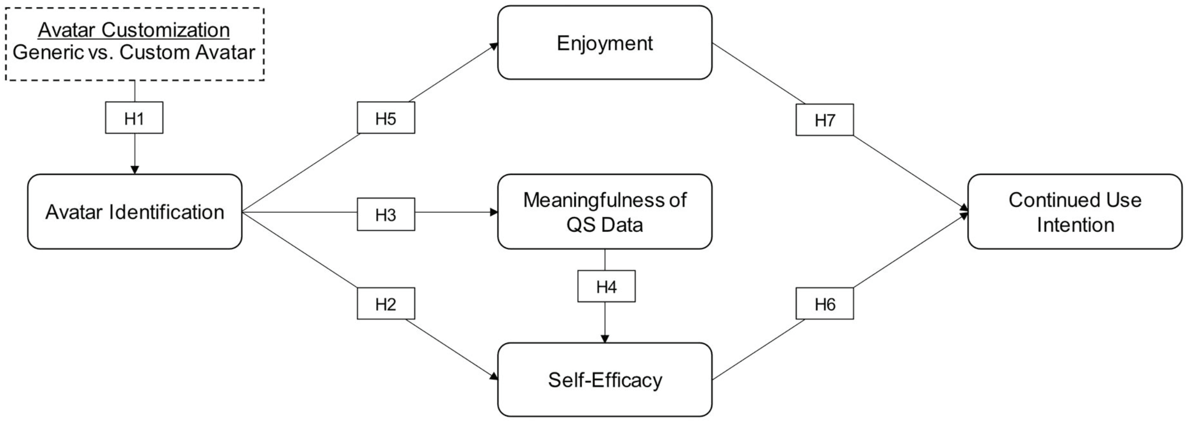

Figure 1. Research model.

perceiving their avatars as extensions or parts of themselves (C. Kim et al., 2012), fostering an emotional connection between the user and the avatar (Ducheneaut et al., 2009).

According to Van Looy (2015), there are two primary forms of avatar identification that capture how users cognitively and emotionally relate to their avatars: similarity identification and wishful identification. Similarity identification arises when users recognize shared characteristics with their avatars, such as appearance or personality traits. Wishful identification occurs when users aspire to be or act like their avatars. Although they do not necessarily occur together, the two types are not mutually exclusive. Some models also include embodied presence as a third dimension of avatar identification (Van Looy et al., 2012), referring to a subjective sense of physically inhabiting the avatar's body. This dimension captures a more experiential aspect of identification, often evoked in immersive environments, and complements the cognitive and emotional aspects.

Previous research indicates that avatar identification in games and gamified systems can enhance the user experience and enjoyment (Jahn et al., 2021; Kao & Harrell, 2018; Trepte & Reinecke, 2010), and can even influence real-world behavior—a phenomenon known as the Proteus effect (Yee & Bailenson, 2007). According to this effect, users internalize and adopt the expected characteristics of their avatars during virtual interactions based on its visual appearance. For example, embodying avatars with different visual characteristics, such as changes in footwear, can lead to distinct movement patterns in walking tasks, indicating a behavioral impact of avatar appearance (Oberdörfer et al., 2024a, 2024b). In addition to these behavioral effects, recent research also highlights cognitive impacts, such as improvements in psychological well-being and resilience when users embody new virtual identities in stressful situations, such as a pandemic (Paul et al., 2022). In the fitness context, this effect has even been shown to enhance physical performance, with users performing better when embodying avatars with athletic appearances compared to those with less sporty representations, as demonstrated in various exergame settings (Kocur et al., 2020; Navarro et al., 2022; Peña et al., 2016; Peña & Kim, 2014; Szolin et al., 2023).

3. Research model

Our proposed research model to answer our research question is illustrated in Figure 1 to provide a visual overview. In this section, we trace the relationships between the variables of interest, anchoring each of the research model's connections in the literature and formulating the study's hypotheses.

3.1. Avatars, customization, and identification

Avatar customization allows users to create personalized avatars, which significantly increases the users' identification with the avatar compared to using generic, non-personalized avatars, an effect associated with the Proteus effect (Ratan et al., 2020). Customization has been shown to increase feelings of body ownership, presence, and dominance, thereby strengthening the connection between the users and their avatars (Waltemate et al., 2018). Personalized avatars enhance identification and affect users' psychophysiological responses and self-reported identification with the avatar (Rheu et al., 2022). In contrast, limited customization options or generic avatars often result in lower levels of identification and weaker connections with the digital representation (Bailey et al., 2009; Kang & Kim, 2020). This lack of personalization can diminish users' arousal, presence, and overall engagement within the virtual environment (Bailey et al., 2009). The similarity achieved through customization plays a crucial role in forming bonds between users and their avatars, promoting deeper identification (Teng, 2019). Enhanced identification resulting from avatar-user similarity leads to greater enjoyment and engagement in digital experiences (Jahn et al., 2021; Trepte & Reinecke, 2010).

Overall, evidence supports that users with customized avatars experience higher identification with their avatars compared to those with generic avatars. Personalizing avatars influences user behavior and conformity, fostering stronger bonds and leading to increased identification and engagement in various virtual environments. Therefore, we formulate the hypothesis:

H1: Users with a personalized avatar have a higher level of identification with their avatar than users with a generic avatar.

3.2. Avatars, quantified self, and self-efficacy

Avatars have been increasingly recognized for their potential to enhance self-efficacy across various domains. Research has shown that utilizing avatars can positively impact self-efficacy (Birnstiel et al., 2025). In the context of online gaming, where avatars are prevalent for visualizing the players and their interactions with the virtual world, identification with one's avatar drives self-efficacy and the intention to persist in using the virtual environment (C. Kim et al., 2012). This concept extends to areas such as obesity and weight-loss initiatives, where avatars have been used to enhance self-efficacy through digital gaming interventions. For instance, Behm-Morawitz et al. (2016) conducted a study demonstrating the effectiveness of embodying an avatar in a virtual world to engage in physical exercise for weight loss. The study revealed a notable increase in exercise and nutrition self-efficacy among overweight adults who perceived the avatar as an extension of themselves. Additionally, Johnston et al. (2012) found that participants who observed their avatars participating in health-promoting activities in a virtual world experienced significant health behavior changes and heightened self-efficacy. Furthermore, Horne et al. (2022) highlighted that seeing an evolved, future self depicted in the avatar reinforced self-efficacy and motivation for behavioral change. In summary, these studies suggest that avatars can be a powerful tool to enhance self-efficacy, drive behavioral change, and improve psychological outcomes.

Beyond avatars, Quantified Self (QS) technology, which involves individuals monitoring and tracking various aspects of their lives, can significantly improve self-efficacy. By using QS technology, individuals enhance their self-awareness and self-knowledge by systematically collecting and analyzing personal data (Hilviu & Rapp, 2015). Tracking information related to health, fitness, or other life areas provides valuable insights, boosting individuals' confidence and belief in their capabilities. This, in turn, can lead to improved self-efficacy. However, users often find it challenging to relate to their QS data, underscoring the necessity of intuitive data representation to foster user engagement and identification (Coşkun & Karahanoğlu, 2023; Hilviu & Rapp, 2015; Rapp et al., 2018).

Thus, integrating an avatar to represent a user's QS data can foster a deeper connection with their self-monitoring efforts, further enhancing self-efficacy. The QS data embodies the quantitative aspect of the self, while the avatar provides a digital, human-like representation. Merging these two forms of self-representation can create a more profound emotional connection with the QS data, making it more relatable and impactful for the user.

For instance, when users engage with QS applications, they typically encounter a compilation of data showcasing their competencies and achievements, such as progress in physical activity, improved metrics, or adherence to personal goals. This data reflects their past accomplishments, also known as their mastery experience. However, this information is often presented in the form of graphs and numbers, which many users find difficult to relate to and struggle to see themselves in Rapp et al. (2018). An avatar can bridge this gap by serving as a relatable and tangible embodiment of users' achievements, going beyond the raw QS data. For instance, instead of merely seeing numerical weight improvements, users could view an avatar that visually represents their progress and thus improving their self-efficacy in losing weight (Horne et al., 2022). Strong identification with an avatar symbolizing their mastery experience could enhance users' self-efficacy by fostering a greater sense of connection to their own success and boosting their confidence in their skills. Users who identify more strongly with their avatar are likely to perceive a higher mastery experience because they see their accomplishments through the lens of their avatar, which acts as a proxy of their achievements.

On the other hand, the achievements of an avatar can also be understood as vicarious experiences, where seeing an avatar as an individual similar to oneself succeed can boost confidence in one's own abilities (Birnstiel et al., 2025). This concept was explored by Fox and Bailenson (2009), who studied the effects of virtual self-modeling. In their study, participants were assigned self-avatars that mirrored weight loss or gain based on their real-life physical activity on a treadmill. Participants who observed favorable changes in their avatars exhibited an increase in real-life exercise compared to those in other conditions. Notably, avatar identification emerged as a crucial factor. Participants who saw their own facial features on the avatar showed a higher intent to sustain their exercise routines than those who viewed someone else's face. This suggests that avatar identification significantly influences the impact of vicarious experiences on self-efficacy.

In summary, whether avatars are viewed as representations of mastery experiences or vicarious experiences, they can significantly increase perceptions of self-efficacy when used to represent QS data. However, this effect is dependent on the user's identification with the avatar. Based on this understanding, we propose the following hypothesis:

H2: Avatar identification is positively related to perceived avatar impact on self-efficacy.

3.3. Avatars and meaningfulness

Coşkun and Karahanoğlu (2023) and Rapp et al. (2018) identified the need for a more personalized form of QS data presentation that promotes identification with the data. Presenting data using an avatar could enhance users' identification with their QS data and provide a clearer and more emotionally engaging connection to the information. This method could help users understand their metrics more easily and help them build a stronger emotional connection to their data, thereby deriving more meaning from it. In addition, as players identify with their avatar, they may feel a higher motivation to exert cognitive effort to engage with the data, which is now linked to an element that they feel a part of themselves. The cognitive processing capacity increased in this manner is known as generative processing (Mayer, 2019). In this way, users who identify with their avatar are more likely to make sense of the data, i.e., to find it meaningful. Therefore, we propose the following hypothesis:

H3: Avatar identification is positively related to the meaningfulness of QS data.

Furthermore, if users perceive their data as personally meaningful, it is likely to strengthen their belief in their own abilities. Consequently, the meaningfulness of QS data is expected to have a mediating effect on the positive relationship between avatar identification and self-efficacy, which we state the following hypothesis:

H4: Meaningfulness of QS data is positively related to self-efficacy.

3.4. Avatars and enjoyment

An avatar, particularly in online gaming, can be a significant source of enjoyment, especially when a user identifies strongly with it (Birk et al., 2016; Trepte & Reinecke, 2010). Integrating an avatar into a QS data presentation can create a sense of closeness between users and their data, increasing user identification and satisfaction. Therefore, an avatar can make the data presentation more engaging and enjoyable, thus serving as a source of enjoyment by itself. Thus we propose:

H5: Avatar identification is positively related to perceived enjoyment of the avatar.

3.5. The interplay of self-efficacy and enjoyment and continued use intention

In the fields of online gaming, web-based information systems and mobile fitness apps, previous research has already demonstrated a positive relationship between self-efficacy and the intention to continue using a product (Chen et al., 2025; C. Kim et al., 2012; Yi & Hwang, 2003). Thus, an increased level of self-efficacy should also promote an individual's intention to continue using QS applications by fostering a greater sense of confidence, belief in one's abilities, and commitment to achieving one's goals (Bandura, 1977, 1997). The use of a QS application that displays the user's progress through an avatar can reinforce the user's belief in their ability to control and positively influence their performance outcomes. The successes achieved and visualized in such an app could strengthen their self-efficacy beliefs, creating a positive feedback loop that further motivates continued use. Therefore, we propose the following hypothesis:

H6: Perceived self-efficacy is positively related to continued use intention.

The pleasure of using a product can also encourage continued use. When users find an application enjoyable and fun, they are more likely to return, which fosters loyalty and regular engagement. This positive relationship between enjoyment and users' intention to continue using an application has been demonstrated in several studies (Hamari & Koivisto, 2015; Rodrigues et al., 2016; Van Der, 2004). Since we expect that the use of an avatar within a QS app will make the data presentation more engaging and enjoyable, and thus serve as a source of enjoyment in itself, we also expect, in line with previous research, that this induced enjoyment will positively influence the user's intention to continue using the app. This leads to the following hypothesis:

H7: Perceived enjoyment is positively related to continued use intention.

4. System design

To examine the formulated hypotheses, we used and extended a commercial product called TEAM FX by adidas (2024). This QS product, specifically designed for soccer players, served as the QS system for this study.

4.1. Quantified-self system

The used QS system is designed for soccer players to gain valuable insight into their performance while playing and training. This system comprises a wearable sensor and a corresponding smartphone app, presenting the tracked metrics through various visualizations. The sensor is equipped with a gyro sensor, an accelerometer, and a compact processor that employs machine learning to identify soccer-specific movements. Data captured by the sensor is wirelessly transmitted via Bluetooth to the corresponding QS app. The sensor is designed to be inserted into the designated pocket within the insole of the user's dominant foot as illustrated in Figure 2; for the non-dominant foot, an insole with a symmetry plastic tag suffices.

The first time the product is used, the sensor connects to the mobile app via Bluetooth, after which the user creates an account and enters the information relevant to the sensor for tracking performance, such as age, gender, height, weight, and dominant foot. The app then provides comprehensive guidance on inserting the sensor into the insoles. While playing or training, the sensor captures and stores soccer-specific movements. After the soccer session, the user synchronizes the tag with the QS app via Bluetooth to transfer the data. The sensor has the capability to measure five key metrics: ball speed (the velocity at which the player kicks the ball), kick count (the total number of ball kicks), running speed (the speed at which the player runs or sprints), distance traveled (comprising all forms of movement, including walking, running, and sprinting), and explosiveness (number of intense speed changes within a short time span). The app's dashboard, depicted in Figure 2, provides users a comprehensive overview of their athletic performance. Additionally, the app features a statistics section, shown in Figure 2, that allows users to delve deeper into the numerical details of their data, displaying graphs and statistics on performance metrics for

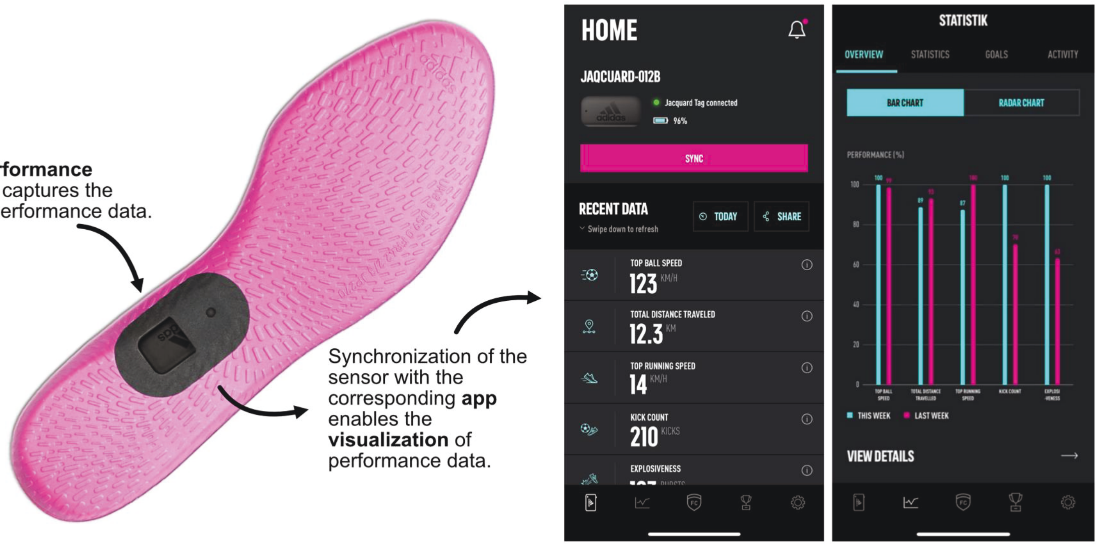

Figure 2. The QS system used in the study, showing the application of the sensor (left) alongside the QS app interface, including the dashboard and the statistics tab (right).

the current and previous weeks. This section also contains a comprehensive activity history and a graphical representation of the progression of individual metrics over time.

4.2. Player card feature

The QS app presents QS data in numerical and graph-based formats. In order to create a stronger sense of identification with the data and enable users to extract more meaningful insights from it, we designed and prototyped a player card feature featuring an avatar for this study as a beta version of the app, thus providing an easily interpretable visualization of personal data, which is in particularly valuable for novice users, as suggested by Rapp and Cena (2016).

Our player card feature is based on the design of traditional trading card games, which are popular card games where players can build their own deck of cards by selecting cards from a large pool to play according to the rules of the specific game (Hodge et al., 2019). One of the earliest games in this genre was *Magic: The Gathering*, designed by Richard Garfield in 1993. Other successful games in this genre include Nintendo's *Pokémon* and Konami's *Yu-Gi-Oh!*. The cards usually feature an illustration of a game character and its name, along with text and/or statistics describing its abilities, strengths, and weaknesses. In general, the goal of a trading card match is to strategically play highly skilled cards that will reduce the opponent's life points to zero before the opponent is able to do so.

More recently, digital card games such as *Hearthstone*, released by Blizzard Entertainment in 2014, have taken a similar game concept and made it popular in digital form. However, the concept of player cards is not limited to analog and digital forms of card games but has also become popular in other forms of digital games, most notably in virtual soccer games such as EA Sports' *FIFA* (Electronic Arts Inc., 2023). In this game, each player is represented by a specialized shield known as a *player item*, which displays an image of the player and the player's distinctive in-game ratings and attributes, such as speed and defense.

Inspired by this popular concept, we designed a player card for the used QS app that illustrates a user's own athletic performance in an engaging and relatable way. We adapted the concept and added the player's name and position, an avatar, avatar stats, a level indicator, and rewards in the form of animations to our version of a player card as depicted in Figure 3. The first time the user accesses this feature within the QS app, the individual player card will be created and personalized.

4.2.1. Avatar

Our player card features a 3D avatar instead of a static illustration or image, as is commonly used in classic player card concepts. In order to investigate our research question and thus compare different levels of

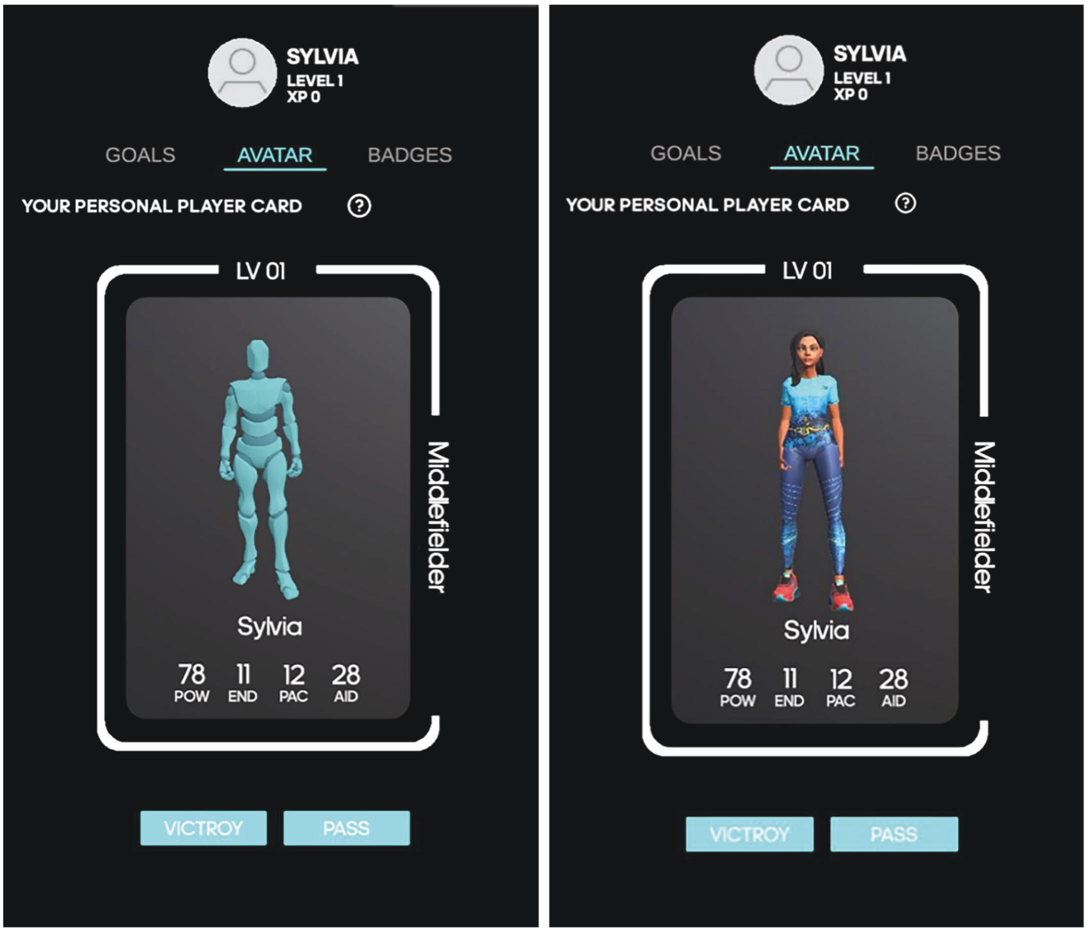

Figure 3. Two versions of the player card feature implemented in the QS app. The left screenshot includes a generic avatar, while the right one features a personalized avatar.

identification with the avatar, two versions of the feature were developed, one with a generic avatar and the other with a personalized avatar, as shown in Figure 3. To create and personalize the player card, users first select their current soccer position from a drop-down menu, after which the avatar is created. The soccer position will later be displayed in the frame of the player card as shown in Figure 3.

In the *generic avatar version*, the avatar automatically appears on the player card immediately after the user selects their soccer position and completes the creation process. The generic avatar resembles a blue robot, which was chosen because of its dissimilarity to a human and the lack of a recognizable human face. This was expected to minimize the likelihood of user identification with this character.

In the *personalized avatar version*, users create their personalized avatar after selecting their soccer position in order to trigger strong identification with the avatar. For this reason, we have included an online avatar creator powered by Ready Player Me (Ready Player Me Inc, 2024). In particular, this specific avatar creator allows users to generate an avatar based on a photo, ensuring a high similarity between the avatar and the user to achieve a stronger identification with the character, as shown by previous research (H. K. Kim & Kim, 2016; Trepte & Reinecke, 2010). Moreover, the chosen avatar creator affords numerous personalization options, encompassing skin tone, eye color, clothing, and more, enabling users to personalize their avatars, as shown in Figure 4. Upon completing the avatar personalization process, the player card is subsequently generated and displayed in the player card section of the QS app. The entire personalization process takes just a few clicks and can typically be completed within minutes.

4.2.2. Avatar statistics

Since a player card usually describes a character's skills, we decided to display soccer-related performance statistics on the player card that summarize the avatar's skill set based on the user's performance.

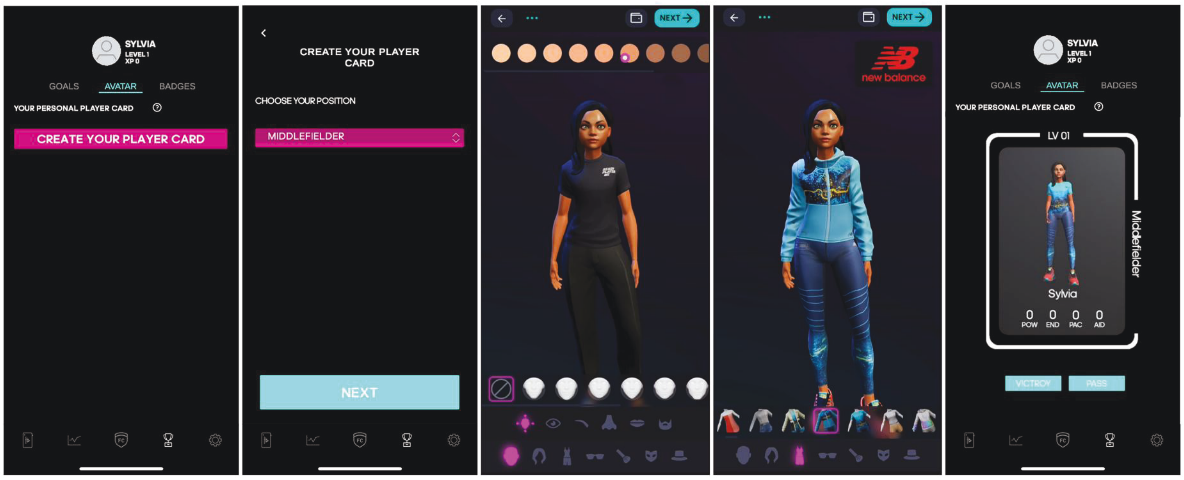

Figure 4. The avatar personalization process using the integrated avatar creator powered by Ready Player Me Inc (2024).

The displayed statistics are related to the avatar, aiming to strengthen the emotional connection between the avatar and the player by connecting the avatar with the player's performance. The avatar statistics are designed to mirror the user's competencies and skills in a readily interpretable and relatable manner to facilitate self-reflection (Coşkun & Karahanoğlu, 2023; Rapp & Tirabeni, 2020). It is anticipated that users' perception of mastery experience, so encompassing perceived past success and competence (Bandura, 1977, 1997), can be positively influenced if they feel a stronger connection to their data and previous achievements.

Metrics in other fitness apps often consolidate data into more comprehensible scales, such as Garmin's Body Battery (Bentvelzen et al., 2022). This example combines various health data into a single, consolidated, easy-to-understand metric showing the user's energy level on a scale from 0 (completely out of energy) to 100 (completely fit) without requiring the user to interpret complex health data such as quality of sleep, physical activity, stress levels, etc. In our case, we wanted to present a concise and easy-to-understand summary of an avatar's skills and therefore decided to also create relevant, consolidated metrics based on the performance data measured by the QS sensor with scores ranging from 0 to 99, whereby 0 represents the lowest and 99 is the highest performance score. The complexity associated with raw metrics is mitigated, and users are provided with an accessible summary of their overall performance without the need to interpret complex graphs and numbers.

The new avatar statistics consist of four metrics: power, pace, endurance, and aid. Each metric is derived from distinct performance metrics measured by the sensor. The user's current data for each performance metric (e.g., the number of kicks the user took on a given day) is compared to a maximum reference value (e.g., the maximum number of kicks that can be taken on one day). The maximum reference values were derived from the app's database, including data from professional soccer teams that had previously used the product. The reference values were set to be high but still achievable by an amateur soccer player.

The avatar statistics generally hold the highest score ever achieved by the user on any given day and will not decrease, providing a positive reinforcement approach. A pop-up will appear if a user improves at least one of the scores, as shown in Figure 5. The avatar will applaud or give a thumbs up, celebrating the achievement and encouraging the user to continue their efforts. The pop-up avatar congratulating the player is designed to positively impact the user's perceived social persuasion, defined as encouragement from significant others, and reinforce the player's belief in their ability to succeed (Bandura, 1977, 1997).

The meaning and calculation of the four metrics can be reviewed within the app by clicking on the info icon, providing users with a comprehensive overview to prevent misinterpretations (Coşkun & Karahanoğlu, 2023). How the metrics are calculated is also explained in the following.

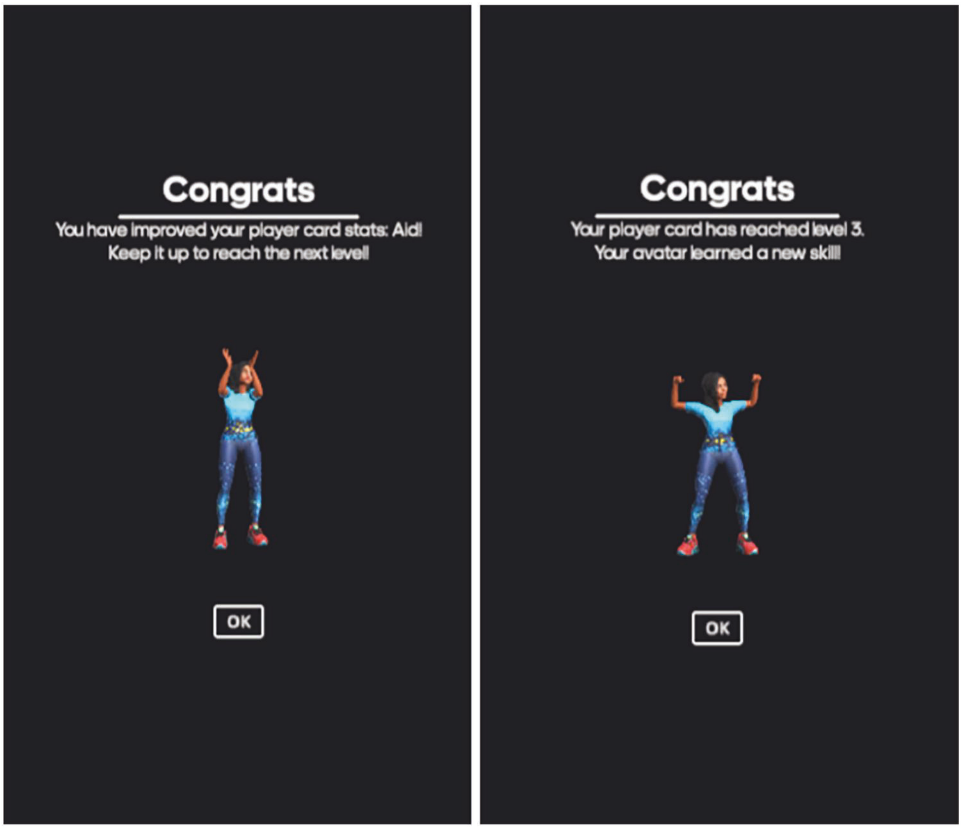

Figure 5. Avatar feedback on improved avatar statistics and next level.

Power: Increasing the ball speed can increase the chances of scoring a goal, making ball speed a crucial success factor (Rađa et al. 2019). Because high ball speeds require a lot of physical power, we created the ball speed-based metric power (POW), representing a soccer player's ability to exert maximum power during kicks. This is calculated using the following formula in which $BallSpeed_{Player}$ represents the user's maximum ball speed in a day, and $BallSpeed_{\mathrm{MAX}}$ refers to a constant of the maximum possible ball speed as a reference value, set to 100 km/h:

$$POW = \frac{BallSpeed_{Player}}{BallSpeed_{MAX}} \cdot 100$$

Endurance: Professional soccer players typically cover distances of 9 to 14 km during a match (Sarmento et al., 2014; Stølen et al. 2005). To be able to move these distances, endurance (END) is an essential skill for soccer players. The majority of the distance is usually covered at a low level of exertion and thus at a lower speed, while a small but essential amount involves high-intensity sprints (Dolci et al., 2020). Thus, the formula for endurance includes calculations for both running speed and running distance. In the following formula representing endurance, $RunningSpeed_{Player}$ represents the user's fastest running speed in a day, while $RunningSpeed_{\mathrm{MAX}}$ refers to a constant for the maximum running speed, which is set to 36 km/h. $RunningDistance_{Player}$ represents the user's total distance traveled in a day, while $RunningDistance_{\mathrm{MAX}}$ refers to a constant for the maximum distance, which is set to 12 km:

$$END = \left(\frac{RunningSpeed_{Player}}{RunningSpeed_{MAX}} \cdot 0.4 + \frac{RunningDistance_{Player}}{RunningDistance_{MAX}} \cdot 0.6\right) \cdot 100$$

Pace: High pace (PAC) represents a player's ability to dynamically change speed and reach top running velocities. This skill is key in soccer, where quick bursts of speed, such as when shooting for a goal or outrunning an opponent, are common (Sweeting et al., 2017). As a result, pace becomes a critical determinant of success in the sport. In our formula, the pace calculation is based on the user's running speed, similar to our endurance calculation. In addition, $Explosiveness_{Player}$ is taken into account, which is the user's number of rapid speed increases in a day. The constant for its maximum value $Explosiveness_{\mathrm{MAX}}$ is set to 36 bursts.

$$PAC = \left(\frac{RunningSpeed_{Player}}{RunningSpeed_{MAX}} \cdot 0.5 + \frac{Explosiveness_{Player}}{Explosiveness_{MAX}} \cdot 0.5 \right) \cdot 100$$

Aid: A high percentage of possession time is an indication that a team is successfully organizing its offensive strategy (Wang et al., 2022). Not only does the team have greater control of the game, they also have more opportunities for offensive attacks. When an individual maintains substantial ball contact, it suggests active participation within the team's gameplay, often receiving passes and actively contributing to the team's strategic buildup, facilitating attacks, and ultimately increasing the team's chances of winning. Hence, the aid (AID) metric, based on the frequency of kicks during matches or training sessions, represents a player's overall engagement and aid to the team's triumphs. Thus, aid is calculated as follows, where $KicksCount_{Player}$ is the total number of kicks the user has in a day, and $KicksCount_{\mathrm{MAX}}$ is a constant of the maximum number of kicks in a day, set to 1000:

$$AID = \frac{KicksCount_{Player}}{KicksCount_{MAX}} \cdot 100$$

4.2.3. Level, goals and rewards

Our player card feature, which consists primarily of an avatar and stats, is enhanced with additional gamification elements, including experience points (XP), levels, goals, and rewards, to further enhance users' understanding of their achievements and motivate improvement.

The app offers the option to create various *goals*, allowing the user to select a key performance metric measured by the sensor in which the user wants to improve, set a time frame for achieving the goal, and specify the intensity level, e.g., 100 ball kicks. Once a goal is created, users can track their progress through the goal overview, which displays all ongoing goals and their respective progress. By completing a goal, users earn *XP*. Choosing a higher intensity level corresponds to an increase in XP earned. By earning XP, players can increase their *level*, which is displayed at the top of the player card. Each level increase triggers a popup, as shown in Figure 5, with their avatar congratulating and acknowledging their achievement. In addition, reaching a higher level will unlock a *reward* in the form of a new animation for the avatar. At the first level, two animations are enabled by default. The animations can be played by clicking the buttons below the player card.

Integrating levels, goals, and rewards within the player card is grounded in self-efficacy theory. The level is a straightforward metric of personal success, determined not by external reference values, like the avatar statistics, but by the player's individual objectives. Aligning with self-efficacy theory (Bandura, 1977, 1997), individuals with higher self-efficacy set more ambitious goals, consequently elevating their actual performance. The goal-setting functionality in the app supports this mechanism by allowing players to visualize their objectives and successes, thus encouraging them to strive for higher goals and enhance their performance. Seeing the avatar leveling up is supposed to increase the players' confidence that they, too, have the capacity to become better and strive for higher achievements, thus functioning as a form of vicarious experience. The avatar's congratulatory response and the reward received upon reaching a higher level aim to enhance the players' perception of social persuasion, offering positive feedback, praise, and honor through the avatar.

5. Research methodology

To examine the effects and relationships of using an avatar in QS apps on enjoyment, self-efficacy, and continued use intention, we conducted a between-subject field experiment in the context of soccer. To manipulate the level of identification with the in-app avatar, the experiment featured two experimental conditions, in which the app either displayed a *generic avatar* in the player card or a *personalized avatar*.

5.1. Participants

We recruited amateur soccer players from three local German amateur soccer clubs, including two women's teams competing in the district league (Bezirksliga) and a men's team in the district class league (Kreisklasse), as well as recreational soccer players who played in a local company-internal hobby soccer league. In total, 93 participants signed up for the experiment, which was conducted as a highly realistic field experiment embedded in the participants' everyday soccer practice settings.

Entire teams were randomly assigned to one of the two conditions to minimize the influence of potential interactions and experience sharing between participants using different versions of the app and avatars. However, due to the nature of the field setting, we faced practical constraints that affected participant retention and group distribution. Specifically, we had to exclude 40 participants from the final analysis because they did not meet the minimum engagement requirement of completing at least four soccer sessions using the app during the study period. This threshold was set to ensure sufficient exposure to the intervention. Reasons for low engagement included technical issues, injuries, illness, travel, or other personal commitments that limited participation, unavoidable in this realistic sport setting. As a result, the final sample included data from the resulting 53 participants who met the engagement requirement and provided questionnaire responses. Within this pool of data, one participant omitted to answer the demographic questions. Among the 53 participants included, 20 were in the generic avatar condition, while the remaining 33 were in the personal avatar condition.

The gender distribution included 23 female participants (12 in the generic avatar condition and 11 in the personal avatar condition), 29 male participants (eight in the generic avatar condition and 21 in the personal avatar condition), and one who did not specify their gender. The age distribution showcased mean ages of 28.9 years ($SD = 9.46$) for the generic avatar condition, 28.1 years ($SD = 6.36$) for the personal avatar condition, and an overall mean age of 28.4 years ($SD = 7.62$). Age ranged from 17 to 45 years across the entire participant pool.

The participants typically use health and fitness apps on a weekly basis, with a median usage of 4 times per week ($M = 3.83, SD = 1.80$). Among them, eight participants reported never using such apps, while ten participants indicated using them daily or multiple times a day. Regarding wearable fitness trackers, such as fitness watches or smartwatches, the usage is more varied among participants. Twenty participants reported never using wearables, whereas 17 participants use them daily or even multiple times a day ($Mdn = 4, M = 3.54, SD = 2.35$).

5.2. Procedure

A series of experiment kickoff meetings marked the start of the study. During the kickoff meetings, participants were informed about the research project's objectives and the central focus on investigating the usage of avatars within QS apps. Participants were provided comprehensive guidance on how to utilize the sensor and app and were introduced to the performance metrics that can be tracked. Additionally, key features of the app, crucial for the study, were highlighted, such as the player card, including the avatar and avatar statistics, and goals that could be accomplished to enhance the player card's level. Based on the assigned condition, participants were given access to the respective version of the app to download to their personal devices. Moreover, every participant received a test account to maintain anonymity and confidentiality. Notably, participants were unaware of the existence of different conditions at this stage to maintain experimental blinding, which we disclosed at the end of the experiment. Following the provision of informed consent, the necessary sensors and insoles were distributed, and participants were assisted in setting up the app and pairing their sensors with the app.

Subsequently, participants had the opportunity to engage in independent training sessions within their soccer teams using sensor and app. The training period spanned two to eight weeks, depending on the frequency of training sessions, with a minimum requirement of engaging in at least four soccer sessions during the experiment. The duration provided a sufficient timeframe for participants to enhance their avatar statistics, advance to higher levels, and unlock new animations for their avatars. Consequently, participants were given the opportunity to establish an emotional connection with their avatars and their training performance metrics. After completing the training phase, participants were asked to complete a 15-minute online questionnaire.

5.3. Measures

During the app usage period, participants' interactions with the player card feature were tracked within the app to monitor the number of interactions with the feature. After participants demonstrated active engagement with the app, and specifically with the implemented player card feature, they were asked to complete a questionnaire.

5.3.1. App engagement

To monitor user engagement with the player card feature within the mobile application, event tracking was utilized. We recorded user interactions each time the application was opened and when the player card section was viewed. Relevant data points, including user ID, date, and time, were logged and securely transmitted to a dedicated server. Analyzing the event log afterwards allowed us to quantify the frequency of player card usage across distinct days. Thereby we could verify that users did not just use the app for mere performance tracking but actively engaged with the player card feature during the study.

5.3.2. Questionnaire

To explore the research hypotheses and user experience, we designed a questionnaire based on various established measurement instruments from previously published sources, adapting them to our context by referring to the specific app used and situating the items within the domain of soccer, where necessary. A comprehensive outline of the questionnaire is provided in Table A1 in Appendix A.

The first set of questions focuses on the avatar presented within the player card feature and consists of the four constructs of avatar identification, perceived self-efficacy, perceived enjoyment and meaningfulness of QS data. Participants' identification with their avatar is assessed using a five-item scale developed by Jahn et al. (2021) and adapted from Van Der Land et al. (2015). Perceived self-efficacy is measured on a three-item scale adapted from Polo-Peña et al. (2021), perceived enjoyment on a four-item scale adapted from Hamari and Koivisto (2015), and meaningfulness of QS data on a six-item scale adapted from May et al. (2004). For each of these items, participants provide responses on a Likert scale ranging from 1 (strongly disagree) to 7 (strongly agree). High scores represent strong perceptions of avatar identification, self-efficacy, enjoyment, and meaningfulness, respectively. The order of these items is randomized to reduce order bias.

The second set of measures assesses users' intentions to continue using the app, employing a three-item scale derived from Venkatesh et al. (2003). Again, items are measured on a Likert scale ranging from 1 (strongly disagree) to 7 (strongly agree), with high scores indicating a strong intention to continue using the app.

Third, the questionnaire gathers insights into the players' experiences with the app, using two qualitative questions, which are described in more detail in Section 5.3.3.

Lastly, demographic information about the participants is collected, including their age, gender, and soccer position. Additionally, the usual frequency of use of fitness apps and wearable fitness trackers, such as smartwatches, is assessed using a scale adapted from Venkatesh et al. (2012), measured on a scale from 1 (never) to 7 (several times a day).

5.3.3. Qualitative user experiences

To complement the quantitative data and gain deeper insights into participants' experiences with the app during the field experiment, two open-ended questions were included in the questionnaire: *What frustrated you about the use of TeamFX?* and *What did you like about your experience with TeamFX?*

The use of broad, open-ended questions was intentional. Given the real-world nature of the field setting, where participants interacted with the app autonomously, a wide range of unanticipated issues and experiences was expected. Broad prompts gave participants the flexibility to reflect on any aspect of their experience, including technical issues, usability, motivation, or design. Although the questions were general, the functionality described in Section 4.2 was central to the investigation. Therefore, responses were primarily analyzed for feedback related to these features, providing deeper insight into participant engagement while preserving the exploratory value of the broader approach.

5.4. Validity and reliability

We tested our research model shown in Figure 1 with the above-described questionnaire using a component-based Partial Least Squares Structural Equation Modeling (PLS-SEM) using SmartPLS 4 (Ringle et al., 2022). PLS-SEM was chosen as a structural equation modeling (SEM) method because of its ability to handle complex causal models with multiple dependent variables (Lowry & Gaskin, 2014), ensuring a rigorous examination of the hypothesized relationships within the study framework.

We assessed convergent validity by analyzing Cronbach's α, average variance extracted (AVE), and composite reliability (CR) as documented in Table 1. All convergent validity metrics have been met and are well above the established thresholds, as each construct's α is > 0.7, each construct's AVE is > 0.5, and each construct's CR is > 0.7 (Fornell & Larcker, 1981). In addition, we examined convergent validity by confirming that the loading of each item on its corresponding construct exceeds the threshold of 0.7, as documented in Table A2 in Appendix A (Hair et al., 2022). We examined discriminant validity by comparing the square root of each construct's AVE to all the correlations between it and other constructs, where all of the square roots of the AVEs should be greater than the correlations between the corresponding construct and any other construct (Fornell & Larcker, 1981). Table 1 indicates that this criterion is met.

The minimum sample size was estimated using the commonly applied 10-times rule of thumb, which recommends that the sample size should be at least 10 times the maximum number of structural paths directed at any latent construct in the model (Hair et al., 2022). In this study, the most complex endogenous construct, Continued Use Intention, is predicted by three constructs, indicating a minimum required sample size of 30 participants. Furthermore, we performed an estimation of the statistical power achieved with our final sample size in PLS-SEM using the gamma-exponential method with WarpPLS (Kock, 2023; Kock & Hadaya, 2018). With 53 participants and a significance level of $\alpha = .05$ a power of 0.76 is achieved, which is close to the standard 0.8 in empirical research (Kock & Hadaya, 2018).

6. Results

We assess the impact of the player card feature by first examining participant engagement with the app to ensure sufficient interaction with the relevant features. Following this, we test H1 using an independent samples t-test. The remaining hypotheses are analyzed using SEM.

6.1. App engagement analysis

Analyzing the event logs with the user interaction data revealed a mostly active engagement with the player card feature among the 53 final participants throughout the study. Figure 6 shows for each week of the study how many users had at least one interaction with the player card feature within that week, revealing a consistent usage pattern among participants. It is important to note that start dates and training frequency varied. Also, players who trained several times a week used the sensor for a shorter period of time than participants who played soccer more infrequently, which explains the decreasing trend in the graph. The majority engaged with their player card on 3–6 different days over the course of the study, underscoring the active integration of the feature into their soccer activities.

6.2. Avatar identification

We computed an independent-sample t-test to assess whether avatar identification was higher when a personalized avatar was present than when a generic avatar was present on the player card within the app. We tested the assumptions for computing the test, revealing that all assumptions were met. In particular,

Table 1. Validity and reliability metrics, including Cronbach's α, average variance extracted (AVE), composite reliability (CR), and the Fornell-Larcker criterion.

Construct	Cronbach's α	AVE	CR	AI	SE	PE	MQ	CU
AI	0.959	0.860	0.968	**0.927**				
SE	0.931	0.878	0.956	0.818	**0.937**			
PE	0.934	0.835	0.953	0.781	0.767	**0.914**		
MQ	0.929	0.740	0.944	0.753	0.742	0.667	**0.860**	
CU	0.990	0.980	0.993	0.470	0.491	0.327	0.505	**0.990**

Note. The Fornell-Larcker criterion is printed in bold.

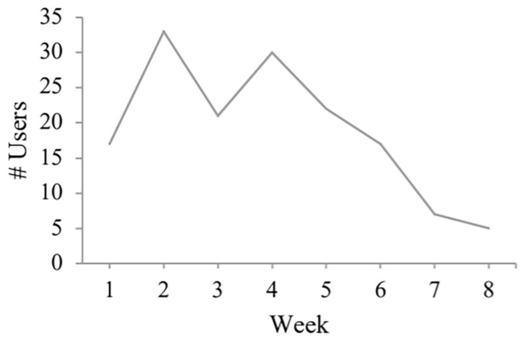

Figure 6. Weekly number of users with at least one player card interaction during that week.

Table 2. Descriptive statistics.

Construct	Condition	*M*	*SD*
Avatar Identification	Total	3.46	1.652
	Generic	2.58	1.186
	Personalized	4.00	1.679
Perceived Avatar Impact on Self-Efficacy	Total	3.72	1.632
	Generic	3.30	1.372
	Personalized	3.97	1.743
Perceived Enjoyment	Total	4.74	1.350
	Generic	4.44	1.376
	Personalized	4.92	1.321
Meaningfulness of QS Data	Total	4.14	1.262
	Generic	3.90	1.299
	Personalized	4.29	1.235
Continued Use Intention	Total	4.94	1.567
	Generic	4.48	1.915
	Personalized	5.22	1.266

we identified no significant outliers in our data, the normality assumption was met according to a Shapiro-Wilk test with $p = .326$, and a Levene's test confirmed the absence of violation of the assumption of homogeneity of variances with $p = .082$. We computed the t-test with a directional hypothesis and an α-level of 0.05. The results reveal a significantly higher identification in the personalized avatar condition ($M = 4.00, SD = 1.68$) than in the generic avatar condition ($M = 2.58, SD = 1.19$), ($t(51) = -3.31, p < 0.001, d = 0.94$).

6.3. Analysis of the structural equation model

For a detailed analysis of the research model, SEM was applied. Table 2 provides an overview of the descriptive results, while Figure 7 and Table 3 document the results of the SEM.

To assess the model's explanatory power, the coefficient of determination (R^2) is used. The model demonstrates significant explanatory power in several areas: it explains 70.6% of the variance in participants' perceived avatar impact on self-efficacy, 61.0% of the variance in participants' enjoyment, and 56.7% of the variance in the perceived meaningfulness of the QS data. Additionally, the model accounts for 24.8% of the variance in participants' continued use intention.

The results of the SEM reveal several significant relationships. There is a significant direct relationship between avatar identification and avatar impact on self-efficacy ($\beta = 0.598, p < .001, f^2 = 0.526$),

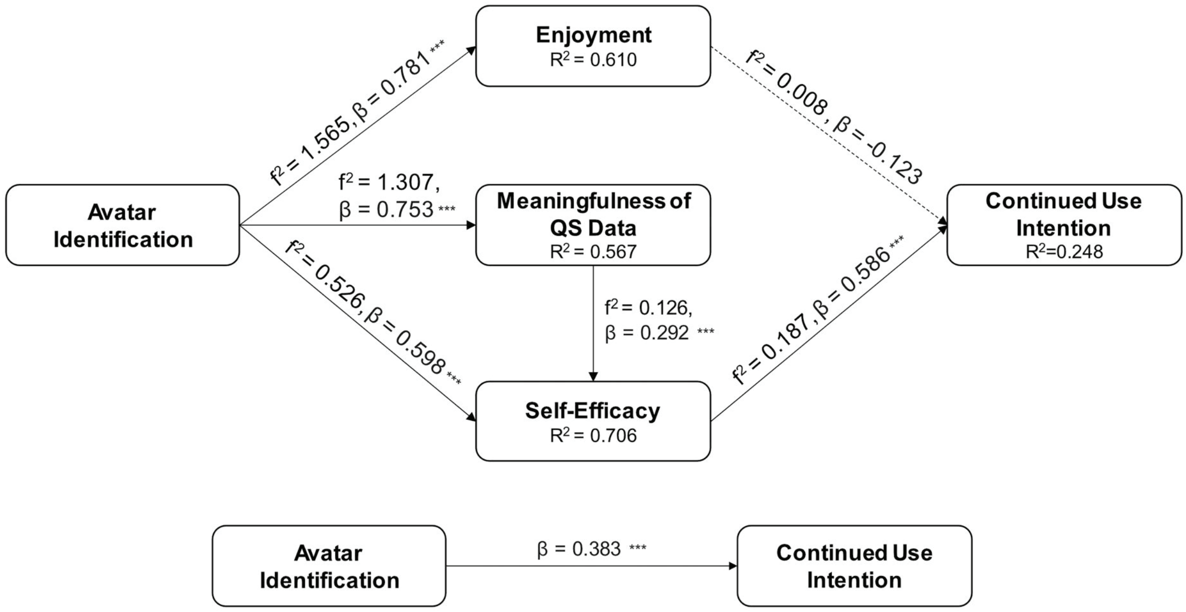

Figure 7. Results of the SEM, with significance levels indicated as follows: $*: p < .05$, $**: p < .01$, $***: p < .001$.

Table 3. Results of path coefficients with β representing the standard regression coefficient and CI representing the confidence interval.

Independent variable	Dependent variable	β	95% CI		*p*
Avatar Identification	Impact on Self-Efficacy	0.598	0.320	0.797	0.000
	Meaningfulness of QS Data	0.753	0.571	0.883	0.000
	Perceived Enjoyment	0.781	0.690	0.858	0.000
	Continued Use Intention	0.383	0.194	0.563	0.000
Meaningfulness of QS Data	Perceived Self-Efficacy	0.292	0.086	0.538	0.009
Perceived Enjoyment	Continued Use Intention	−0.123	−0.523	0.269	0.546
Impact on Self-Efficacy	Continued Use Intention	0.586	0.325	0.905	0.000

indicating a large effect based on the thresholds of $f^2 > 0.02$ (small), > 0.15 (medium), and > 0.35 (large), thus **supporting H2**. Additionally, avatar identification has a positive and highly significant relationship with the meaningfulness of QS data ($\beta = 0.753, p < .001, f^2 = 1.307$) also indicating a large effect and **supporting H3**. A positive and significant relationship between the meaningfulness of QS data and avatar impact on self-efficacy is observed ($\beta = 0.292, p = .009, f^2 = 0.126$), indicating a small effect and **supporting H4**. The relationship between avatar identification and enjoyment is significantly positive with a large effect size ($\beta = 0.781, p < .001, f^2 = 1.565$), **supporting H5**. However, the relationship between enjoyment and continued use intention is non-significant ($\beta = -0.123, p = .546$, $f^2 = 0.008$), indicating no significant effect and thus **not supporting H7**. On the other hand, avatar impact on self-efficacy shows a positive and significant relationship with continued use intention ($\beta = 0.586, p < .01, f^2 = 0.187$), indicating a medium effect size and **supporting H6**.

Regarding the partial effects modeled, the following specific indirect effects were noted. The meaningfulness of QS data served as a mediator in the relationship between avatar identification and self-efficacy impact ($\beta = 0.220, p = .021$). Additionally, self-efficacy avatar impact significantly mediated the relationship between avatar identification and continued use intention ($\beta = 0.350, p = .004$).

In examining the direct relationships within the full model, a positive and significant relationship was observed between avatar identification and continued use intention ($\beta = 0.383, p < .001$).

6.4. Qualitative results

The qualitative analysis of the responses to the open-ended questions provides a nuanced understanding of the participants' experience during the experiment, complementing the quantitative data with valuable insights. An inductive thematic analysis was conducted following Braun and Clarke's guidelines (Braun & Clarke, 2006), identifying recurring themes across responses.

Negative experiences with the full commercial product, into which the player card and avatar features were integrated, centered around three primary themes: hardware and connectivity issues related to the sensor, shortcomings in core app functionalities (e.g., slow loading times, login problems, and interface design), and limitations of the player card feature. As the purpose of this study was to evaluate the player card component specifically, the following analysis focuses exclusively on user feedback concerning the player card experience. For instance, participants criticized the lack of connection between the avatar's skills and soccer (*"Skills can have more features linked to soccer."*), expressing a desire for unlockable skills relevant to the sport rather than generic skills like backflips that did not align with their athletic goals (*"Avatar should really learn soccer skill and not back-flip etc."*). Those using the generic avatar reported wanting more personalization options (*"I couldn't customize."*), while those with personalized avatars suggested a broader selection of soccer-specific outfits, as the available clothing was limited to casual clothes and lacked soccer-specific items such as shoes or jerseys. In addition, participants were dissatisfied with the inability to change the appearance of the avatar after its initial creation (*"Once the avatar is created, it cannot be edited."*) and expressed a need for more flexibility to dynamically adapt their avatar over time.

Similar to the negative feedback, the positive responses clustered around three key themes: core app functionalities (e.g., performance tracking and a leaderboard feature), visualization of progress, and the integrated player card components (including the avatar and goal-setting features). As with the negative feedback, the following analysis focuses solely on aspects related to the player card and, therefore, excludes comments on core app functionality. For instance, the positive feedback underscored the enjoyment and sense of meaning participants found in accessing and analyzing their soccer statistics and recognizing their progress (*"Seeing my stats was fun.," "Improve them while playing is a lot of fun.," "You can see your progress."*). This could potentially contribute to their sense of self-efficacy. They particularly appreciated features such as the player card and avatar design (*"See all values at a glance."*), which enhanced engagement with the platform: *"The avatar is also a cool idea for watching my own stats, just like in a video game."* The goal-setting functionalities were also a relevant contributor to participants' enjoyment and potentially to their self-efficacy, empowering participants to set and track their objectives effectively (*"Setting goals [was] also really nice."*). Moreover, the ability to compare their performance with others emerged as a significant source of enjoyment and meaning for participants (*"The one thing I like a lot is the player card (stats), to compare them with others."*), highlighting the social dimension of the experience.

7. Discussion

In this study, we investigate whether a personal avatar within a Quantified-Self app can make personal data more meaningful and personally relevant to users, thereby increasing their intention to use such apps and thus to collect data. Therefore, we (1) present the design of a player card feature for an existing QS sports app that aims to create a more meaningful representation of the user's self-tracking data. Inspired by the concept of trading cards, which have even found their way into popular sports games such as *FIFA*, our player card feature incorporates an avatar to give the user a digital identity within the app and support the user's self-efficacy. We then (2) conducted a field experiment following a between-subjects design in which the avatar on the player card was either customizable or generic, according to the participant's condition, to examine its effects on enjoyment, self-efficacy, and continued use intention. The results of our study have a number of implications, both theoretical and practical, which are discussed in detail below.

7.1. Theoretical implications

Participants using the personalized avatar in the player card feature had the option to personalize their avatar, which likely encouraged users to create avatars that resemble themselves, fostering a sense of similarity identification (Van Looy, 2015). Simultaneously, the customization process may have strengthened the bond between the user and the avatar (Kang & Kim, 2020), potentially creating a sense of bodily ownership over the avatar (Waltemate et al., 2018). This effect likely contributed to our finding that a personalized avatar on the player card resulted in a higher level of identification than a generic avatar (H1). Thus, we demonstrated in our study that the identification with an in-app avatar can be strengthened through personalization options.

The improved identification with the user's personalized visual representation, in turn, significantly increased the avatar's impact on the user's self-efficacy regarding their skills (H2), with this effect partially mediated by the meaningfulness of the data (H3 and H4). Our findings suggest that the personalization of the avatar contributed to data meaningfulness by presenting it in a more engaging and relatable form (Coşkun & Karahanoğlu, 2023). While QS apps inherently have the potential to enhance self-efficacy through the visualization of performance data, users often find it difficult to interpret these numerical and statistical representations (Epstein et al., 2020; Rapp et al., 2018). The personalized avatar helped address the issue of abstract or impersonal data presentation by providing a more engaging and intuitive representation of progress, one that could be easily interpreted at a glance, as indicated by the qualitative feedback. Further, participants described enjoyment in watching their avatar evolve over time, suggesting that the visualization contributed to a more motivating and meaningful experience. In our study, this was achieved by displaying the animated, progressively improving personalized avatar alongside performance statistics on a virtual player card, thus representing data in a manner that felt more personal and relevant to users. This implies that a personalized avatar in a QS context can function as an emotional bridge to complex data, enhancing users' sense of relevance and engagement with the data. Consequently, personalized avatars not only increase the meaningfulness of QS statistics but also contribute to improved self-efficacy by making performance data more accessible for users, thus overcoming the shortcomings of classical QS designs (Epstein et al., 2020; Rapp et al., 2018). Therefore, personalized avatars represent a novel and effective design strategy for enhancing self-efficacy within QS applications.

In examining the effects of the proposed design on users' intention to continue using the app, our study found that the avatar's impact on self-efficacy positively influenced continued use intentions (H6), aligning with findings from previous research (Chen et al., 2025; C. Kim et al., 2012; Yi & Hwang, 2003). The inclusion of the personal avatar on a player card displaying users' progress reinforced their belief in their abilities, with the visualized achievements fostering a positive feedback loop that further motivated continuous app use and, thus, data tracking. In contrast, hedonic aspects such as enjoyment of the app did not significantly affect continued use intentions (H7), even though enjoyment was positively associated with users' identification with their avatar (H5). In gamification literature, hedonic effects are often considered as mediators of behavioral outcomes and value creation (Huotari & Hamari, 2017). Although our study supports that the gamified design, specifically the personalized avatar displayed on the player card, positively impacted enjoyment (as supported by both quantitative and qualitative results) and contributed to continued use intentions via self-efficacy, we did not find enjoyment itself to significantly influence continued use, contradicting the typical mediation. This finding suggests that while users may find interacting with their personal avatar enjoyable, hedonic aspects alone are less influential in sustaining long-term engagement in the data-centric QS context. Rather, it is the deeper, more meaningful connections rooted in personal relevance and self-efficacy that drive sustained engagement (Coşkun & Karahanoğlu, 2023; Hassenzahl et al., 2013; Mekler & Hornbæk, 2016). This underscores the importance of incorporating eudaimonic elements into QS app design to enhance continuous user engagement. Our findings reveal that eudaimonic elements, often overlooked in gamification literature, can significantly impact the continued use of gamified designs, suggesting that sustainable engagement in QS applications may depend more on fostering personal relevance and meaning than on hedonic enjoyment alone.

7.2. Practical implications

These findings are of practical value, particularly for the design and development of QS apps and similar platforms aimed at improving personal skills or behaviors, where a stronger sense of self-efficacy can motivate persistance. Firstly, incorporating personalized avatars that reflect users' personal data and that can be customized to resemble them can enhance user engagement and identification with personal data. This is particularly evident in the qualitative feedback, in which users explicitly expressed appreciation for the player card and avatar features, explaining that they enjoyed interacting with them and valued seeing their progress at a glance. These findings confirm the success of simplified and personalized data visualization in the form of using avatars, as proposed by Rapp and Cena (2016) and Coşkun and Karahanoğlu (2023). However, we observed that identification with the personalized avatars tested resulted in moderate avatar identification, with a mean of 4.00 on a 7-point Likert scale, indicating room for improvement. In the qualitative feedback, participants in our study specifically mentioned that the available outfits were not tailored to the soccer context of the study, as there were no soccer-specific outfit options. Additionally, the unlockable skills were seen as too generic, with participants expressing a preference for skills relevant to soccer. This user feedback underscores the importance of context-aware design, suggesting that a range of customization options, alongside context-specific rewards (e.g., soccer-related skills), is essential for users to feel fully represented and suited to the app's intended purpose.

Moreover, the enhanced understanding and meaningfulness of data through personalized avatars can make information more accessible and relevant, potentially leading to improved outcomes. It is crucial that avatars not only resemble the users but also present their data and achievements in ways that highlight personal progress in a relatable and engaging manner, such as through animations or statistics, as implemented in our player card feature.

Yet users identified more strongly with their personalized avatars than with generic avatars, likely due to the customization process involved during initial setup (Bailey et al., 2009; Kang & Kim, 2020). The qualitative feedback indicated that participants in the generic condition even missed the option to customize and wished they had it. However, unlike avatars in video games, which users actively control throughout the game (Rheu et al., 2022), interaction with avatars in our study was limited. Here, the avatars were rather static, with movement limited to basic animations triggered by button clicks. In addition, users interacted with the avatars only briefly during the intervention period. Despite these limitations, our results show that even minimal interaction, limited to initial customization and occasional animation as in our context, is sufficient to foster a sense of connection with one's in-app avatar.

Finally, these insights could be applied beyond the fitness and sports context, extending to other fields such as education, health, and professional development, where enhancing the meaningfulness of data could support users' sense of self-efficacy and encourage sustained engagement.

7.3. Limitations and future work

While our study offers valuable insights, there are opportunities for further exploration. First, we focused on a specific solution for soccer, which allowed us to generate relevant findings for this well-defined context. However, this context is just one of many where such solutions could be applied. We encourage future research to build on our work by examining the effectiveness of similar solutions across a variety of settings, such as different sports, educational environments, or professional workplaces. This would help to determine whether the positive effects observed in our study extend to other domains, thereby enhancing the generalizability of our findings. In the context in which this study was conducted, some participants may have known each other despite being in different teams, so they may have had some degree of information about different conditions even though we randomized entire teams to avoid contamination. While this is difficult to avoid in contexts such as small hobby leagues, future studies should be attentive to this possibility. In addition, we recommend future studies involving larger samples to increase statistical power.

For this study we designed an avatar that aimed to bolster self-efficacy by incorporating features aligned with various antecedents, including mastery experience and vicarious experience. The observed effects of the avatar on self-efficacy may result from viewing accomplishments through the lens of the personal avatar, which serves as a proxy for the users' achievements and with which they identify and connect with, thereby promoting a sense of mastery which could be associated with the Proteus effect (Yee & Bailenson, 2007). An alternative explanation is that users may perceive their avatar not as a representation of their achievements, but rather as an individual similar to themselves, thereby promoting vicarious experiences, consistent with the theory of Fox and Bailenson (2009) and investigation of Birnstiel et al. (2025). However, while we assessed the overall impact of the avatar design on self-efficacy in our study, we did not specifically measure the individual antecedents of the observed effects. Future studies could delve deeper into exploring what antecedents of self-efficacy, such as mastery or vicarious experience, contribute more significantly to the observed outcomes. This would provide a more nuanced understanding of the relationship between specific elements of avatar design and their impact on self-efficacy, offering valuable insights for optimizing avatar-based interventions in the future. Furthermore, this study asked participants about their perception of the avatar's impact on self-efficacy, whereas future studies can ask for self-efficacy without involving the avatar in the question.

Finally, avatars themselves can be operationalized through different features and represent QS data in various ways. Here, progress resulted in new avatar animations, but other options include, e.g., physical and appearance changes to the avatar. Future studies incorporating different design elements would further elucidate the role of avatars, and features therein, in supporting self-efficacy.

Author contributions

CRediT: **Sandra Birnstiel**: Conceptualization, Investigation, Software, Validation, Visualization, Writing – original draft; **Sylvia Reiss**: Conceptualization, Formal analysis, Investigation, Methodology, Software, Visualization, Writing – original draft; **Daniel Fernández Galeote**: Writing – original draft, Validation; **Burkhard Duemler**: Writing – review & editing, Resources, Software; **Benedikt Morschheuser**: Conceptualization, Supervision, Writing – review & editing.

Disclosure statement

Generative AI (OpenAI ChatGPT) was used occasionally for language refinement. All intellectual contributions, interpretations, and analyses are entirely our own.

Ethical approval

This study was approved by the institutional review board of the German Association for Experimental Economic Research (No. LfjtMD2P) and conducted in accordance with national and institutional guidelines, as well as the Declaration of Helsinki. All participants provided informed consent and were informed of the study's purpose prior to participation. Participation was voluntary, and confidentiality was maintained in accordance with EU data protection regulations (EU Regulation 2016/679). A full debriefing, including details about avatar differences, was provided at the conclusion of the study.

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Appendix A

Table A1. Questionnaire constructs, items and sources.

Construct	Item		Source
Avatar Identification (AI)	AI1	I have the impression that the avatar is a part of myself.	Jahn et al. (2021), Van Der Land et al. (2015)
	AI2	I identify with my avatar.	
	AI3	I feel connected to my avatar.	
	AI4	My avatar is related to my personal identity.	
	AI5	My avatar's appearance is related to my personal identity.	
Perceived Self-Efficacy (SE)	SE1	My avatar empowers me to feel more confident in my capacity to play soccer.	Polo-Peña et al. (2021)
	SE2	My avatar empowers me to feel self-assured in terms of my capabilities in soccer.	
	SE3	My avatar empowers me to master the necessary skills to play soccer.	
Perceived Enjoyment (PE)	PE1	Seeing my avatar in the TEAM FX App is enjoyable.	Hamari and Koivisto (2015)
	PE2	Seeing my avatar in the TEAM FX App is pleasant.	
	PE3	Seeing my avatar in the TEAM FX App is exciting.	
	PE4	Seeing my avatar in the TEAM FX App is interesting.	
Meaningfulness of QS Data (MQ)	MQ1	My avatar stats in the TEAM FX App are very important to me.	May et al. (2004)
	MQ2	My avatar stats in the TEAM FX App are personally meaningful to me.	
	MQ3	My avatar stats in the TEAM FX App are worthwhile.	
	MQ4	My avatar stats in the TEAM FX App are significant to me.	
	MQ5	My avatar stats in the TEAM FX App are meaningful to me.	
	MQ6	My avatar stats in the TEAM FX App are valuable.	
Continued Use Intention (CU)	CU1	I intend to use the TEAM FX App in the future.	Venkatesh et al. (2003)
	CU2	I predict I would use the TEAM FX App in the future.	
	CU3	I plan to use the TEAM FX App in the future.	

Table A2. Factor loadings of all items on their corresponding construct.

Construct	Item	Factor loading
Avatar Identification	AI1	0.878
	AI2	0.960
	AI3	0.944
	AI4	0.953
	AI5	0.897
Perceived Self-Efficacy	SE1	0.951
	SE2	0.944
	SE3	0.916
Perceived Enjoyment	PE1	0.922
	PE2	0.873
	PE3	0.933
	PE4	0.927
Meaningfulness of QS Data	MQ1	0.863
	MQ2	0.995
	MQ3	0.724
	MQ4	0.901
	MQ5	0.874
	MQ6	0.891
Continued Use Intention	CU1	0.993
	CU2	0.988
	CU3	0.988