Take Off Your Sports Watch: Designing Identity-based Interface to Reduce the Over-reliance of Physical Activity Monitoring Wearables

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Fig. 1. Overview of APP. (A) The APP is divided into two modes, ordinary mode and (B) vacation mode. Users can select their identity. In the normal mode, the user goes through the steps of setting goals, exercising, evaluating and viewing results. In the vacation mode, the watch does not give the user any prompt except a pattern that changes based on the user's performance in vacation mode.

Personal electronic wearable devices are widely developed for monitoring physical activity and thus promoting well-being. However, a rising number of people who use such wearable monitoring gadgets over-rely on them, resulting in detrimental consequences (e.g., a false sense of security, anxiety emotion of health, and negative mindset of self-integrity). Our research aims to develop a design approach to mitigate over-reliance on wearable monitoring assistants through an identity-driven methodology. We present Watchoff, a sports watch application that helps users identify healthy behaviors by allowing users to renew their recognition through professional or social role-playing. Furthermore, we used GPT-3 to create the unique identity formation process in order to grow self-perception capacity and give a transition phase. We conducted a comprehensive six-week research (three weeks with and three weeks without the smartwatch) and discovered that our app helps over-reliance reduction. We describe the findings and make design suggestions for future over-reliance-reduction-focused designs.

CCS Concepts: • **General and reference** → *Document types*; Surveys and overviews;

Additional Key Words and Phrases: hand tracking, vein visualization, wristband, NIR imaging

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1 INTRODUCTION

The application of well-being-supporting technology holds potential for people facing major public health concerns in our world [72]. Various features are employed to achieve this, with self-tracking being one of the most essential. They can help shape healthy habits by monitoring real-time health data, inspiring individuals to exercise (e.g., heart rate monitors, pedometers, fitness games), adopting healthy diets (e.g., mobile journaling tools for diet tracking, peer support online portals), and promoting relaxation (e.g. mobile relaxation applications, wristwatch-type stress measuring devices). In addition to supporting physical activities, some HCI researchers also claim that these self-monitoring wearables and mobile tracking devices can also improve knowledge and self-awareness, allowing users to be aware of their wellness situation [43].

People may have placed too much reliance on their health wearables, which have a self-monitoring capability. Many individuals believe that data-driven notification of monitoring tools are quick, sleek, and incredibly easy, and they progressively over rely on and overvalue the supporting equipment, forgetting that their use may also have a negative influence [3, 44]. They provide the assistance system too much power. A number of perils are associated with technology, such as distraction, difficulty-emphasizing [49], and the negative impact of over-reliance on self-monitoring wearables includes a false sense of security, anxiety emotion of health, and negative mindset of self-integrity [40]. Some distracting elements cause users to deviate from the exercise itself, and as a result, some users resort to data and gradually lose their intention and passion to engage in physical activity. Instead of recognizing self-improvement and keeping healthy practices, many users of such sports apps fail to develop a permanent habit [74].

Over-reliance may irritate users when they remove the wearable gadgets, which is a sign of self-loss and significantly impedes habit building. In reality, the true habit change is a transformation in identity [10]. When a person's behavior and identity are fully aligned, they may cease altering their conduct to meet their self-identity and instead establish a succession of identity-infused actions. As a result, based on the identity-based motivational model, our study seeks to induce a shift in identity recognition inside the user in order to promote the expansion of awareness, resulting in long-term alteration of people's behavior even after they have left our platform. We present a customized platform that allows users to choose their preferred identities. Users can initially choose either a professional identity (such as doctors, engineers, computer programmers and so on) or a social identity (such as husband, mother, or grandmother). Each identity has been carefully designed with its own graphic figure and unique interactions (Fig. 1 C). As the user trains, their figure progresses across the selected field, vividly illustrated by graphical modifications that demonstrate how effective the training is for the user's career or life. Meanwhile, a language generating tool known as GPT-3 aids in the narrative presentation, allowing people to better grasp how progress occurs. The user can visually see what their agent is achieving in the virtual world and project it onto their real self (Fig. 1 A). By emphasizing the connection between identity and behavior, we expect to intuitively help users understand the benefits of maintaining this behavior and inspire users to engage more in physical activity. A private period will be added to the site to limit users' over-reliance on it. Unlike the standard mode, it urges individuals to exercise independently rather than receiving data input from the devices (Fig. 1 B). More precisely, during this period, users can arrange their own fitness plan, monitor their movements

and evaluate their progress. Due to the engaging experience and environment, it may be easier to translate exercise behavior into reality, thus fostering a long-term habit.

Based on expert interviews, in-lab design workshops, and field implementations, our report describes our design approach with an emphasis on improving wearable devices and their accompanying sports apps, and gaining a complete understanding of the user experience. A dual-channel design with appealing visuals and text may create a more realistic atmosphere and thoroughly engage users, while multi-identity functionalities stimulate and drive behavior change. Furthermore, the use of GPT-3 as a storytelling approach has been shown to be extremely successful in raising people's self-awareness, and the vacation mode with a self-assessment mechanism has also been shown to be quite helpful in minimizing over-reliance and aiding authority re-establishment. Based on these findings, we make recommendations for the future development of wearable devices and applications, such as using more produced AI agents to raise people's identity awareness and using trans-disciplinary design to assist users in gaining self-consciousness while interacting with computers. ← **XAC**: are these statements based on study findings? now they read like claims made by ourselves

Our main contributions include:

- We proposed an identity-based method for reducing over-reliance on physical activity monitoring wearables, which included proposing salient identity-based motivation theories as well as ways for converting those concepts into tangible design goals.
- We designed and implemented a functional, interactive Watchoff interface that implements identity-driven habit-forming by encoding manually and passively tracked activity data into smartwatch interfaces.
- We summarized some findings from online, in-lab, and on-field studies that characterize how people understand and engage with identity-based formats, including a better understanding of the impact such interfaces can have in everyday life.

2 RELATED WORK

In this section, we introduced some existing works related to our topics, namely, techniques for health behvaior changing, identity-based motivation and habit, and the over-reliance of the monitoring tools.

2.1 Techniques for Health Behavior Changing

Since habit formation is a gradual process and involves constant repetition [52], many techniques are designed to help users reach that goal. Habit change can be divided into two phases, initiation of a new behavior and continuous contextual repetition [20]. The initiation of behavior generally comes from the people's desire for fulfillment and a vision of the future [35]. There are three ways to get people to engage in new behaviors: 1) Arouse people's curiosity, e.g., combine playing outside with code programming and let children experiment with their own code [54], 2) Explain to people the benefits of this behavior, e.g., Teach people the benefits of daily flossing [26], 3) Give people a sense of control, e.g., children can program the rules for their own game [54]. In exercise realm, brands like Jawbone, FitBit and Nike had widely adopted devices with sophisticated features targeting at the initiation of new behavior. In spite of the generation of new behaviors, the maintenance of new behaviors is also an essential consideration of wellness applications. The typical example of these devices is the health-tracker, which is also the most common health techniques. It allows users to report daily activities and feelings through a mobile application / web [30], thereby increasing awareness of repeating the exercising behavior[28].

In recent years, Wearable devices equipped with abundant sensors are prevailing in the growing market, research community's interest had been sparked about their ability to encourage self-reflection and positive behavior change. Even in this early stage, studies on activity-tracking technologies (e.g. pedometers) have proved effective in improving the physical activity of individuals [11, 42, 47]. In addition to studying these technologies from the perspective of health and wellness [33, 45, 62], HCI researchers are also studying their potential to enhance self-knowledge (personal informatics) [40, 41], improve memory [25], and reducing the environmental impact [18]. Quantified self-movement has also received attention in the research literature, as they represent early adopters of these behavioral tracking technologies. [9, 40, 68, 77] But when it comes to the field of customized daily health-monitoring, its reliability is still to be questioned. Some companies have also developed interactive features providing behavior-changing interventions or habit-forming guidance in their product as an extension of health monitoring. [37, 84]

Particularly, features claiming to assist with exercise habit-forming won the biggest market. [7, 8, 27, 71] Rabbi et al introduces a smartphone app, MyBehavior,which is characterized by providing deeply customized health feedback using state-of-art behavioral monitoring supported by an algorithm extracted from recommendation systems. [64]. Contextual guidance is another popular solution, such as having a glass of water during each of your break [26], which essentially uses "if-then" mechanism to raise implementation intentions [63]. Some others utilize adaptive interventions which are brought just-in-time [36]. Several experiments have been conducted to prove that concept including Smyth et al.'s study of just-in-time stress management intervention which intends to figure out whether it is useful [73]. In terms of physical activity, a significant correlation between activity and incorruptibility is revealed [24, 46, 55, 69]. Okoshi et al. discovers that intervals between two different activities, like the short period you decide to stop yoga and do jogging, are suitable moments when notifications can pop up [55]. Mehrotra et al. as well discovers that some activities (e.g., biking) are less appropriate than others (e.g., walking) [46]. Many contemporary technology are employed during the researching process to guarantee accuracy and effectiveness. For example deep learning models are utilized to customize positive maintenance motives and guarantee a intended result, e.g. during the intervention. Behavioral model of medication adherence are also included [6], or turn to an explainable artificial intelligence (XAI) system to assist users form habits [39].

Additionally, theories of health behavior change have contributed significantly to the prosperity of self-monitoring and self-management technologies. Examples are countless. The Social Cognitive Theory has pointed out a wearable health monitor can facilitate interpersonal interactions via fostering observational learning [2]. It also works well in individual models, taking the Theory of Planned Behavior as an instance, it has been practically proved that health trackers can both succeed or fail to the extent that they enable or inhibit an individual's perceived behavioral control [23]. Goal Setting Theory successfully predicts that a specific, appropriately targeted goal is more likely to be attainable than not [76]. In the field of individual and interpersonal connection,it disappointed researchers that theories of health behavior modification only offer little guidance to health-monitoring development,thus they have to reck their wits how technologies can best utilize theory [67]. Some researchers including HCI researchers choose to tackle with this issue through empirical study, giving Munson & Consolvo's research on goal-setting for physical activity as a successful example[50]. Others have appealed that technologists and health researchers work closer together [2].

2.2 Identity-based Motivation and Habit

Identity-based motivation theory (IBM) is a social psychological theory of human motivation and goal pursuit, which explains when and in what situations, people's identities or self-concepts will motivate and act towards their goals. IBM predicts that the motivating power of our identities depends on which identities come to mind and what they

mean at any given moment (termed “dynamic construction”), whether or not those identities feel like they fit with the current situation (termed “action-readiness”), and how experienced difficulties are interpreted (termed “interpretation of difficulty”).

Real behavior change is a change of identity. Someone may start a habit out of motivation, but the only reason you will stick with it is that it has become part of their identity. People do not always take action to promote health, instead they adopt in unhealthy habits and reporting health fatalism. One important mechanism underlying these patterns involves identity-based motivation [56]. Identity involves self-identity and social identity.

Self-identity can be thought of as an individual’s mental representation of who they are, including those aspects of the self that make a person unique or social, beliefs, motivations, recurring thoughts, emotions and self-perceptions [57, 83]. It is a fundamental human drive to understand who a person is, what they believe and what they do [65]. Your current behavior is simply a reflection of your current identity, and you are simply acting as a reflection of the kind of person you already believe yourself to be (whether consciously or unconsciously) [10]. When your behavior and your identity are fully aligned, you no longer seek to change your behavior, because strong motivations rooted in self-identity can trigger repeated and consistent actions that can then become habits [10, 22, 81, 83]. The more we repeat a behavior, the more we reinforce the identity associated with that behavior. Identity-based habits are known to be one of the most effective techniques for creating lasting habits because they require no effort, and you do them automatically as they’re part of your identity and personality [10, 21, 22].

The process by which the content of social identities influences beliefs about the goals and strategies of the group [58]. Social identity theories describe how individuals come to define themselves through the social groups to which they belong, arguing that these social identities are essential parts of self-concept [1, 59].

2.3 The Over-reliance of Monitoring Tool

As wearable monitoring devices become more popular, over half of people in some developed countries track their body data for various purposes.[29] People do this mainly because they believe that qualitative monitoring plays a vital role in self-improvement. Many people who used this idea see monitoring tool as a much more reliable way to track their own behavior than self-evaluation.[29] They hope that analyzing and guiding the accurate data provided by the sensors will make it easier for them to do self-improving, especially, forming a healthy exercising habits. [29]. However, the research stated that so far they have "found limited support for techniques grounded in habit formation theory” and “highlighted the risk of dependency and reduced autonomy" [66]. Indeed, there are many compelling points against the overuse of monitoring tools. A study looking at more than a hundred habit-formation apps found that "Self-monitoring doesn’t support habit-formation, and it doesn’t help to embed the new behavior into a daily routine". [34, 75] Another team that reviewed dozens of research and practice concludes, "Self-monitoring-driven changes are only effective if the monitoring behavior is maintained and once the tracking and monitoring stops the behavior can revert to pre-intervention levels". [31] All of this leads to a clear conclusion: monitoring tools did not work well for self-improvement, only caused over-reliance, users are unable to keep the changes they gained after leaving the monitoring device. [53]

Since our goal is to reduce users’ over-reliance on wearable devices and apps, an essential part of our work is to develop a brand-new habit-forming app that will not cause over-reliance, enabling users to abandon those qualitative apps and develop running habit on our reliance-free device. Designing such a platform is a subtle task. Efforts should be implemented to avoid features that cause reliance [75] and eliminating the inevitable reliance caused during habit-forming. Our research with more than 100 respondents mainly shows that no running distance or rankings or other

statistical data should be displayed on the screen, preventing users from fully immersing themselves in running and disturbs the form of habit. Instead, a visible representation of running data is intended to provide a clearer understanding and avoid distractions on the purpose of running. Additionally, the app should allow users to independently estimate their running conditions instead of telling them directly, allowing for a restoration of users' sense of control over physical-activities.

3 FORMATIVE STUDY

Prior to design, we conducted formative investigation to 1) figure the motivations and needs of self-tracking device users; 2) identify the concrete expression and the disadvantages of an excessive reliance on monitoring tools for the formation of healthy habits; 3) identify the challenges that users face in the over-reliance on the monitoring tools; and 4) illuminate design opportunities that address these challenges.

3.1 Method

We recruited 20 participants (11 female, 9 male) via social media. Their ages ranged from 19 to 27 years old (Mage = 22.13 years, SDage = 2.33 years). Most of the participants have long-term experience in using the smartwatch for exercising and self-report that the smartwatch affects their exercising performance (e.g., speed, time, frequency). In addition, three specialists from local institutions with extensive research expertise in human-computer interaction and habit-forming advice were invited. We invite them to respond to customer input from an anti-over-reliance standpoint.

We used a paired-survey approach, with end-users and specialists being referred to separately. When a user answers a question or expresses an opinion based on their experience, experts are encouraged to comment or ask more in-depth questions. We invited all the participants to our lab and conducted a semi-structured interview. The interview began with general questions that placed few limits on users 'responses to their perception of exercise and experience (e.g., users' habit and attitude towards exercise) with sports watches. Next, we introduced them to the definition of over-reliance and let them self-evaluate their over-reliance degree. We also interviewed them about the specific manifestations, the corresponding reason for over-reliance, and the challenges of leaving the smartwatch. Thematic analysis was used to summarize and organize the collected interviews. Two researchers encoded the data and met to achieve an agreement before separately encoding all the data. Following that, we conducted many sessions to synthesize the findings on the various issues.

3.2 Findings and System Requirements

3.2.1 Users exercise based on professional identity. Physical activities are regarded as an additional secondary task for most of our participants, who often turn to physical activity for its potential career benefits. According to our survey, physical activity is typically used to retain ultimate strength, increase endurance, or relax, with the ultimate objective of these activities being job progress. However, none of the participants appreciate or enjoy the physical exercise itself. People's motivation to exercise is often determined by their professional identity and associated needs. For instance, on "why do they run", P3 said, "I am a photographer, I need to do exercises to equip enough physical strength to withstand hours of outdoor photography". And P5 said, "I have a degree in literature and I often have good ideas while I'm running". According to an expert (E1), some people's exercise habit perfectly complements their initial work identity, making them more inclined to prioritize exercise, whilst others may only sometimes exercise for utilitarian reasons. Another expert (E3) stated that when identity and behavior are perfectly aligned, people shall gain coherence, otherwise they might look for a way to deal with cognitive dissonance. From this, we can conclude that

behavioral changes are mainly due to identity changes, which indicate that healthy behaviors are better sustained with an exercise-friendly identity.

3.2.2 Users exercise based on social identity. Some of the participants claimed that they sometimes exercise at the request of others. One participant said: "My mother often calls me and tells me to exercise more because she is afraid that I will not be healthy after sitting for too long". Another participant lists a different circumstance: "It sounds vain, but I exercise to rank higher in a social circle". From these answers we can deduce that sport is sometimes intended to maintain social relationships, to acquire social value to consolidate social identities. According to our specialists, social identity refers to the attributes that others or society bestow on individuals. Such an identity is a person's social sign, indicating his or her involvement with a social group. Examples of social identities are parents, students, Catholics, etc. Having these identities means that they have certain obligations towards others, for example, parents have the responsibility to bring up healthy children. And it is the students' job to study hard and progress in all aspects. Because social identity functions in the same manner as professional identity, it is critical to link social identity with exercise in order to create a consistent exercising habit.

3.2.3 Users lack a sense of control and authority. 16 out of 20 participants said that they failed to evaluate their exercise condition when they left the healthcare wearable devices, which is the typical symptom of over-reliance. Over-reliance deprives users' perception of their own exercise, as six participants reported that the quantitative feedback somehow interfered to their beliefs or weakened their willpower. In particular, both P8 and P6 from the user group expressed concern: "I can't assess my exercising condition. For me, running 400 meters under the supervision of a sports watch is more convincing than running around the playground by myself, even though I can feel my heart racing, I won't stop until I reach the set mileage". Our experts explained this as a false sense of security. Constant quantitative reporting convinces people and provides them with a false sense of security, whether their practice is effective or not. Over time, such over-reliance can deprive users' control over their own healthy activity. This can be confirmed by the statements of our participants, who said they found it difficult to judge whether they were doing the same amount of exercise if they forgot to wear their sports watch.

3.2.4 Lack of an adaption leaving period. Many participants mentioned that leaving something suddenly makes them feel uncomfortable and insecure, which makes them more dependent. This discomfort emerges mostly in actions such as subconsciously turning to tracker devices in the case of wearable fitness equipment. P4 confessed: "Once I decided to take off my sports watch and enjoy the pure joy of sports, but every time I realized that I was not wearing my watch, anxiety hit me".Other participants stated that even when the workout is over, they will continue to wear their smartphones or use their apps. Experts classify it as a behavioral inertia, or an outward manifestation of self-identity. The process of reducing this dissonance is long-term, needing a period of adjustment to get used to not acting like before. "It's like a reversion of habit-forming", commented Expert 2.

4 DESIGN WORKSHOP

We outline Watchoff's primary characteristics based on the design potential found in the formative study: identity formation help. aimed at making users aware of the way in which their professional and social identities are correlated with physical activity. Then, with 10 participants, we began the design workshop to learn more about the concrete idesign of Watchoff's interface during usage, and how to assist users establish a real-life identity after leaving our

Watchoff rather than merely understanding the virtual identity on the interface. In specifically, we would want to investigate the following three design questions in this workshop:

- Q1: How to design resonant visual images to evoke users' immersion in the chosen occupational identity or social identity and inspire them to exercise?
- Q2: How to correlate identity and exercise in the design process so that users can be activated to exercise spontaneously?
- Q3: How to arouse users' consciousness about identities and exercise to develop endogenous desires and form an exercise habit?
- Q4: What kind of design can release users from dependence on the wearables and keep exercising after leaving the watch?

4.1 Procedure

We recruited ten participants (age: 17-34; 6 female, 4 male) by placing an announcement on our institution's online community website. All participants had more than three years of design experience for app design or figure design.

We presented our formative results to the participants first, and then requested them to develop the expressive UI and interaction workflow of the APP based on the APP's key feature — identity shaping. After everyone has completed their work, we encouraged all participants to discuss all the work and encourage them to give their ideas freely. Finally, we asked participants to further refine their work accordingly, incorporating valuable suggestions and insights from others.

4.1.1 Brainstormed Low-fi Prototype. Considering some works might share the same design concept, five works (Fig. 2) are selected by all participants during the workshop. For aesthetic reasons, we adapted or redrew the concept drawings from the users' sketches without changing the original intention of the participants.

The work of P3 (Fig. 2 A) created two virtual characters that prompt the user to exercise through the "friend" character. The role of the user is a runner, and the "friend" is the character selected by the user. During the practice, the virtual friends will invite the user to exercise and share their own running routes and experiences. The longer the user uses the APP, the less frequently the role of friends will appear, until the user eventually develops a running habit. The designer said this is called "emotionalize companionship" and can help users to keep exercising without feeling lonely.

The work of P5 (Fig. 2 B) represented several different stages of life with different objects. The test tube represents the beginning of life. It must be tested constantly. The bucket represents the burden of having a family and a career; Rockets represent individual contributions to human society; The candle represents when people age and gradually fade away.This incorporates the designer's personal outlook on life into the work, which can resonate with and inspire consumers who share the same ideals.

The work of P6 (Fig. 2 D) used text to give users feedback. After entering the app, users are allowed to choose their favorite activity by writing a diary. After each exercise, users will be given written feedback. Over time, these words will form a story and users will experience the benefits of the exercise through a narrative method as the app recording their exercise data.

The work of P7 (Fig. 2 E) Users are given the identification of athletes since athletes must be able to properly assess their own physical state, therefore users must continually improve their capacity to assess the amount and quality of exercise. Users must assess their calorie consumption, duration, and so on after each workout in her design before

they can see the real exercise data. The athlete's athletic ability will be increased based on the accuracy of the user's evaluation and the quality of the workout.

The work of P10 (see Fig. 2 C) and P8 (see Fig. 2 F) use similar storytelling methods. The work from P10 is rich in imagination, related to the fantasies of birds and pilots, and relates the narrative of a bird saving a kid in a hot air balloon. The child grows up to befriend the bird and eventually becomes a pilot. The user can keep the story going by sticking to the practice. P8's work is more realistic and tells how the older sister raised the younger brother after the younger brother was born. Through constant exercise, the user can make the younger brother learn to walk with the help of the elder sister, and correct the habit of not eating well, etc. This allows people to sympathize and be drawn to others who have had similar experiences.

4.2 Design Strategies

To resonate, our design should integrate self-identity, which is established via constant experience and is rather stable once formed [70]. As a result, it is difficult to develop or transplant a completely new identity. Thus, the greatest task is to modify people' cognition and refresh their identities through design.

As the workshop revives, we would like to include users' voices and ideas into the design process, leveraging their extensive experience with smartwatches and apps to help us design functions to achieve our goal and solve problems. Therefore, we have worked out some findings below.

4.2.1 DS1: Evoke empathy with common experiences. We shall pay attention to build bond between the exercise and the real experience of the user. Two participants who majored in design mentioned that sometimes a straight design is more impressive than a gorgeous and dreamy design, because it can directly evoke memories in one's life. In the workshop, some participants selected dreamlike scenes. For example, P4 chose to use birds as a metaphor for a pilot's dream. Some participants chose a more realistic scenario, such as directly employing a human representative. But when we gave people the design to review, we found that people prefer to put themselves in the relatively real image of the character. For example, when seeing a picture of a chubby brother, a participant who has a younger brother immediately said, "It's really tiring to carry my brother up the stairs, and he must ask me to carry him". So when we design the professional and social identities, we tend to use more straightforward images and articulation that allows people to relate to their own real-world experiences.

4.2.2 DS2: Trigger intuitive motivation with customized identity diary. Our design can be better if we provide customized design for each participant and make the figure and story self-renewable so that users will maintain interest in its novelty. The schema of a particular identity is complicated and multidimensional, requiring customization and dynamic design. Participants were concerned that visual monochrome would reduce the novelty of the user experience and make users stop paying attention to the picture. Some participants suggested that it might be possible to add "journal-style" entries to make feedback more variable. Some participants also mentioned that if only a few types of options are provided, users may not be able to choose their preferred career, and such apps will have little incentive for them. Participants suggested that providing a customized option might be useful in broadening the reach of the tool. This is how we came up with the idea of applying custom and adaptive narratives in our app, so that the settings will not be too rigid and could bring users a more realistic experience.

4.2.3 DS3: Divide occupational identity and social identity and link them with exercise. We will divide identities into professional identities and social identities based on their different attributes. Professional identities are inextricably

linked to their lives or aspirations, tying fitness to their most ardent desire. When utilizing the app, the well-designed image and adaptive text sequence can subliminally link the identity and professional motivation of users so that there are no deviations about their identity and behavior. All this leads to the awareness of the importance of running in real life and the benefits it brings to every corner of our life. We also provide social identities, naturalizing the connection between social identity and exercise. For example, we will relate a narrative to parents about how engaging in physical activities on a regular basis may help parents better guide and accompany their children, forming an organic family bond. At the beginning of our workflow, users will either choose a professional identity or a social identity to follow them throughout the experiment. In any case, people can learn about the benefits of exercise for their lives and eventually establish an instinctive habit of exercising, reducing their need on this process.

4.2.4 DS4: Goal-setting and Self-assessment mechanism to guide users involve cognition. To assist users regain control of their own physical activities, they are asked to set a goal at the beginning of each exercise and, at the end, to self-assess their current exercise intensity before seeing the truth value. This process enables users to see the gap between their goal, estimated value, and the actual value. The sequence of such exercises educate the user on the perception of their level of exercise, and they should gradually regain the feeling of mastering his own physical activity.

4.2.5 DS5: The vacation mode of identity formation. A vacation mode is suggested to be essential in reducing over-reliance. During the workshop, a participant suddenly remarked on their identity as a mother, "Who can work and take care of the baby all the time? It must be unbearable". And one participant said, "Sometimes it's important not to force yourself to do something and to give yourself a window period. The empty window gives a sense of freedom, so you can stop thinking that a task is a task and start enjoying your own thing". Almost all participants believe that constant intervention is not a good idea and that each identity should be given a vacation so that users may try to focus on and feel themselves rather than virtual identity representations. One participants' work (see Fig. 2.a) inspired our ideas. His design places particular emphasis on the process of habit formation. The longer the app was used, the less often the friends in the app encountered the virtual image of the user. As a result, users will get less and less incentive from the app, so they will gradually have to get used to the habit of relying on their inner power to continue exercising, or rather, exercising independently. His point provides the initial idea for our vacation mechanism. From this case, we believed that an intermittent adjustment period could be a good way to get users to abandon almost everything, including the app. In order to divide the total usage time of the application into three phases, we need to develop a strategy of gradually reducing the frequency of use of our application in order to provide users with an adjustment period. Users should experience a smooth decrease in daily app usage until reliance on wearable devices is completely eliminated.

5 WATCHOFF

5.1 System Overview

Our system is implemented in an app installed on an android smartwatch, which is coded with JavaScript. The app helps the user form habits through identity shaping, using a customized graphic interface to show how much the user has progressed without specific data displayed, revealing the strong connection between exercising and their real life. We use various sensors on the watch to get all necessary, real-time data, which can be output via '.log' files when the watch is connected to the computer or the Internet. With the accelerator sensor providing speed and pace data, the heart rate sensor providing real-time heart rate data, and the GPS telling us the exercising distance and route, among

Fig. 2. Some of the work that inspired us in the design workshop. (A) Build social bond and provide socialized feedback. (B) Provide figure-based feedback. (C)(F) Show progress based on a visualized story. As the user exercises, the story progresses with figure changes accordingly. (D) Provide feedback through AI-generated story. First the user texts in his dream identity, then after every exercise, AI will generate a written story themed on his pursuing his dream and save it in storage. The more he exercises, the story is better developed. (E) Provide an opportunity for self-evaluation. Ask the user to self-evaluate his exercising intensity before revealing the truth.

other things, we are able to obtain all the first-hand, qualitative data for analysis and lead to an accurate responsible conclusion.

Our app consists of two main processes: normal mode and vacation mode (DS5, see Fig. 5). In the normal mode, users continuously use the app, which aims to shape their own identity. In vacation mode, the app runs in the background to record users' running situations without app direction, with the goal of helping users shift their focus away from their virtual personas and back to themselves, with the expectation that the user progressively becomes independent of the running app. These two modes appear alternately. Vacation mode will gradually lengthen over time. This feature is designed to provide users with an adjustment period, and gradually help users to develop the habit of running independently. In this section, we introduce these two modes of our Watchoff App and its implementation.

5.2 Dual-channel Presentation

To evoke user empathy and enhance user immersion, we adopted two channels, well-designed images and customized text sequence for better output. These two channels operated across two modes. They are all detailed and intuitive so that users can resonate with the virtual character quickly and get deeply involved into the procedure of habit-forming (DS2). The images and texts are also complementary and interpretive, altogether assist users understanding what they are doing (DS1), what they have done and why their exercising behavior can lead to certain results.

5.2.1 Images. Figure-based feedback plays a vital role in triggering instinctive motivation. Series of images are carefully designed in normal mode to induce users to behave according to certain identity and renew their cognition of their previous self-identity (DS3). Each sequence of images starts with an initial state of the virtual character, and users can empower their chosen characters in various aspects via exercising (DS2). The more users exercise, the stronger the character and the more merits that can be formed; the more users exercise, the better the physical strength and the more time that can be spared to accompany children (DS1). The images not only allow users to be more vicariously involved, but also represent their outcomes in a graphic and descriptive approach.

Apart from these illustrative graphics, some more quantitative and calm images function in vacation mode (DS5). These graphics mainly facilitate the users self-assessment in a transitional period in the hope of alleviating over-reliance (DS4).

5.2.2 Texts. To satisfy every participants' identity choice, we decide to introduce AI-generated text in addition to figures and texts that we prepared previously. Along with the image series, the GPT-3 technology is utilized to intelligently generate the storyline, to make the identity more vivid and enable users to relate more deeply to the consequences of their actions (DS2). For example, when a user chooses doctor as his or her professional identity, the narratives can be: "You are a doctor. Today, you ran three kilometers, your strength improved, you were able to concentrate better during surgery, and you improved success rate of the procedure".

Furthermore, if the user loves the extra occupational or social identities that we haven't defined in detail, the AI might automatically produce unique stories based on the user's make-up characters (DS2).

5.3 Identity Image Choosing

The app's key feature, selecting a dream identity (see Fig. 4 A), tries to shape the user's identity. The identities in our app encompass both work and social interactions (DS3). When users initially visit our app, they are presented with an identity-options screen from which to select. Users who are already doing their chosen career or in the relationship they wish to be in can pick that identity directly. Users who do not yet have their desired career or social identity can

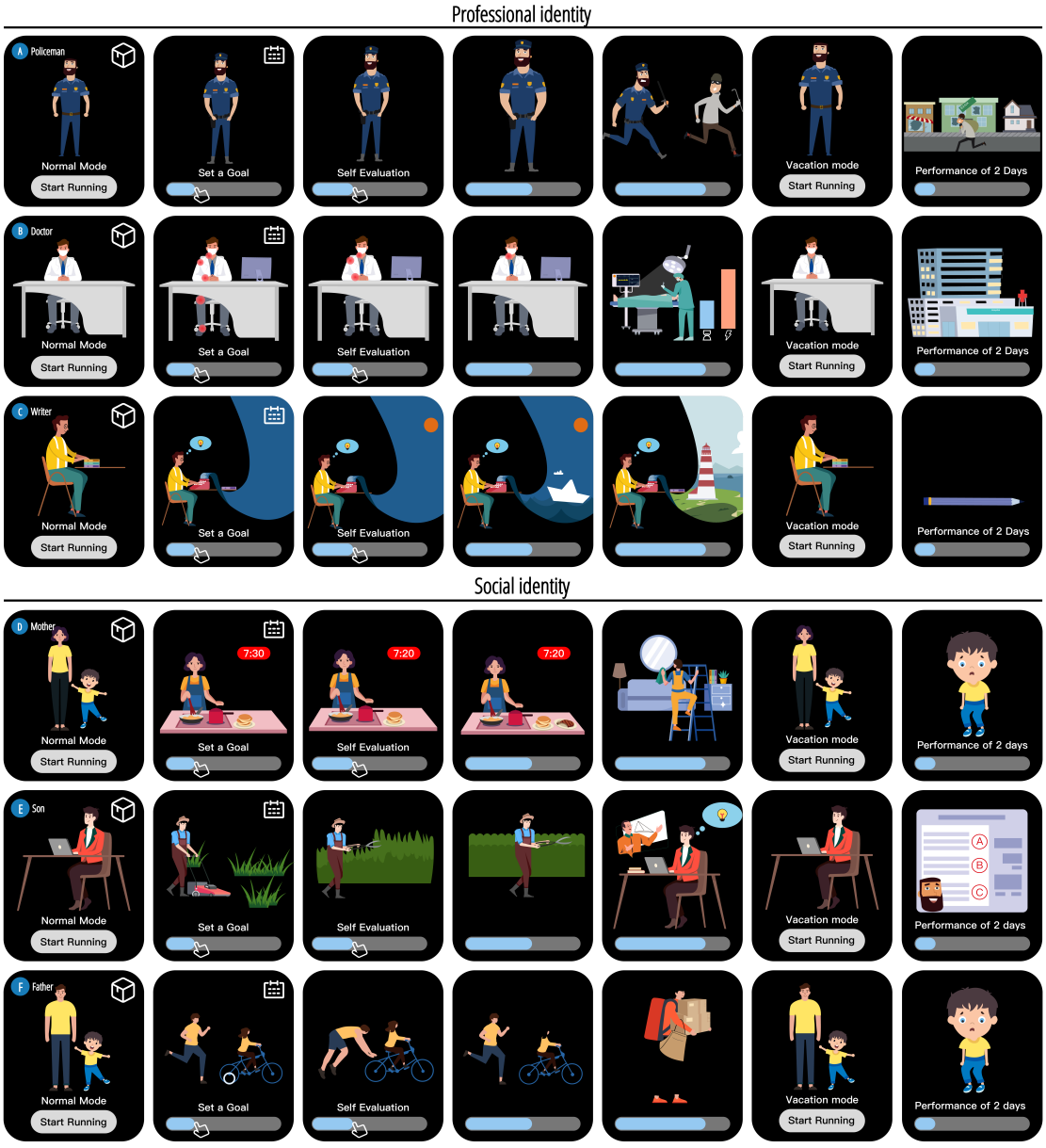

Fig. 3. Three lines selects the typical professional identity. (A) Policeman. (B) Doctor. (C) Writer. Three lines selects the typical social identity. (D) Mother. (E) Son. (F) Father.

choose such identities as their ambitions. To generate elaborate tales and images, we painstakingly chose and presented ten personalities. To further fulfill our customers' demands, we have now provided the option for them to build their own identity using adaptable text. As users form their own identities, they see the benefits of running for their chosen occupation/identity and build endogenous desire to continue the practice.

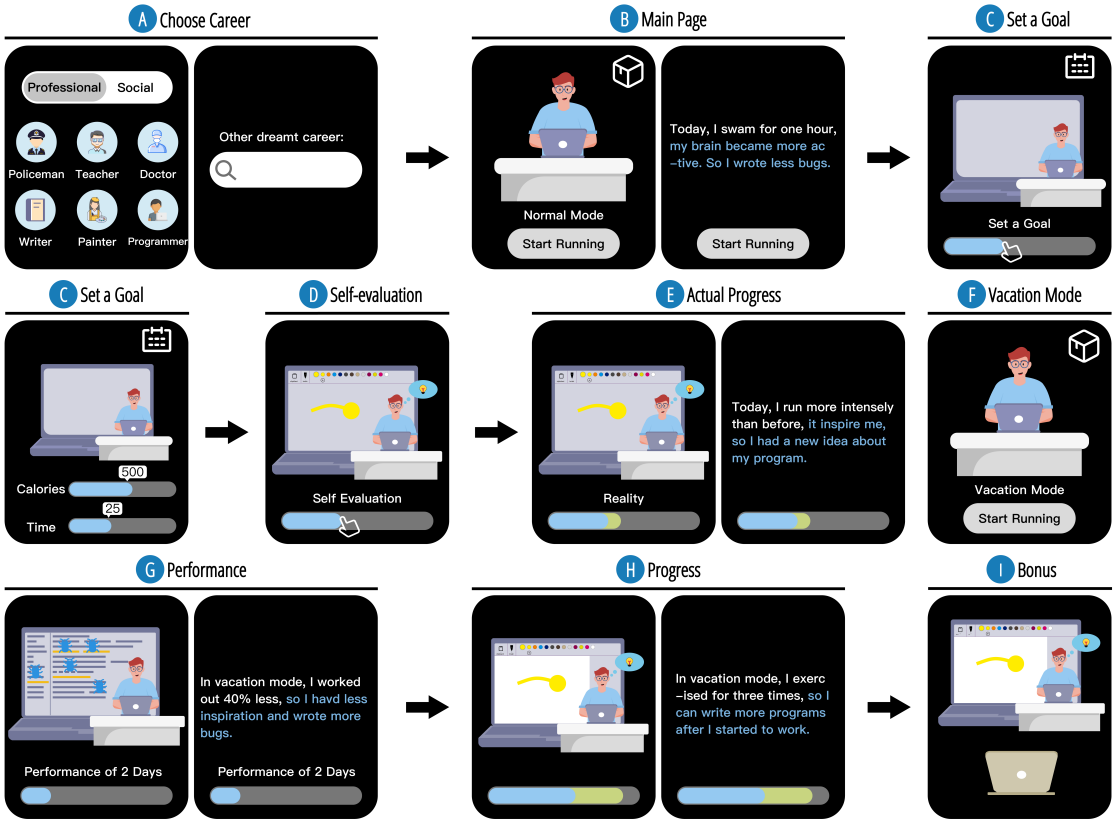

Fig. 4. The complete workflow when the user selects programmer as the desired career. (A) The user chooses an identity from our list of ten, or texts in his dream identity excluded from the list. (B) The user starts exercising from the main page. (C) The user has to set a goal for this exercise, indexes include calorie and time. (D) After exercising, the user has to first evaluate intensity of this exercise, the index is calorie consumption. (E) Real intensity of this exercise is revealed to the user via figure or AI text based feedback. (F) During vacation mode, the interface is locked and the user cannot use our app. But data is kept recording in background as usual. (G) Performance page shows accumulate value of the user's history exercise data. (H) Progress page will only be shown on the last day of vacation mode, indicating the user's performance during vacation mode, via figure or AI text based feedback. (I) If the user performs well in vacation mode, he will be awarded with an ornament that fits his figure.

5.3.1 Professional Identity. For users who value individual improvement, job-based specific self-identities, including policemen, doctors, engineers, writers, etc. are prepared for selection. Linking exercising and the need of the user's dream job (doctors need great strength for a long operation and policemen need to run to catch criminals, etc.) will assist users forming the perception that exercise is beneficial to career development (DS3). From a perspective of "What does the user want to do" to initialize the beginning that "exercising is part of my life and job".

5.3.2 Social Identity. For users who value interpersonal correlation, more common life-based social identities are included (DS3). For example, a parent/grandparent who shall get prepared to someday chase their naughty child/grandchild running all around the park, or a passenger who shall prepare to run fast to catch the bus, etc. From the standpoint of "What should the user do?" social identity stresses people's socialites, that is, users take on different roles and are

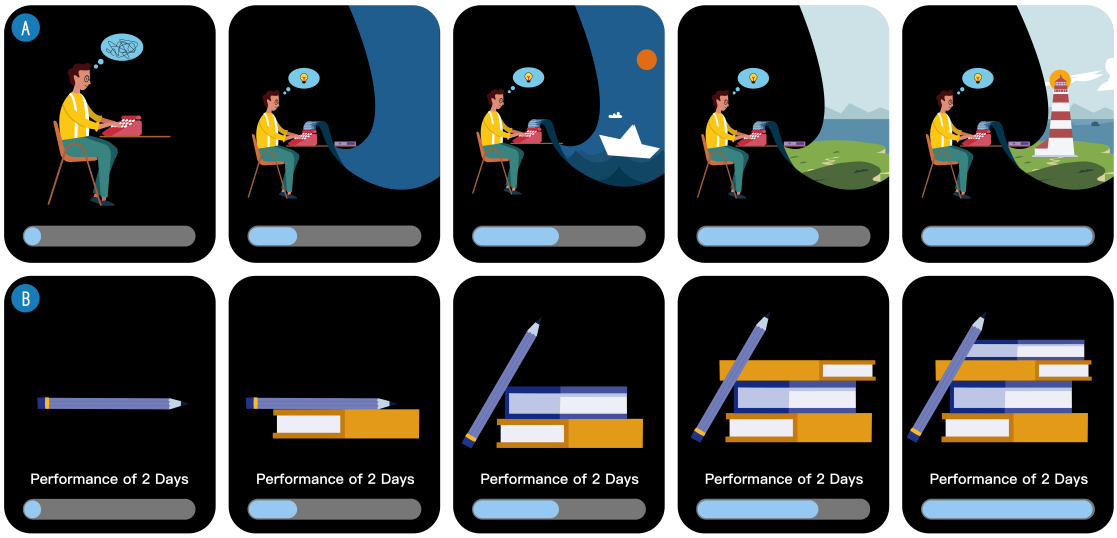

Fig. 5. An example of how our identity figure improves as the user exercises. (A) When the user chooses a career as a writer, the progress of the run is reflected in the writer's inspiration and writing progress. (B) How well users perform in vacation mode is measured by how many books the writer has written.

accountable to different persons in society (fathers are responsible for protecting their children and children are also responsible for making parents happy).

5.4 Normal and Vacation Mode

The dual-mode mechanism is one of the feature identity of our design, which is important for building independent habits and reducing over-reliance (DS5).

5.4.1 Normal mode. In the normal mode, users can use the app for continuous guidance. The main features that users interact with are goal setting (see Fig. 4 C) and self evaluation (see Fig. 4 E). Users set objectives the day before running, and the app monitors their real status after analyzing their running state after jogging.

The goal setting and preparation section allows users to set exercising goals the day before a run (DS4). Users can drag the gray progress bar to set goals of different running intensity according to their different physiological states, so that users can fully control their body without following the rhythm of the motion detection app. This helps users regain a sense of control over their behavior. Meanwhile, users can develop the habit of making plans before exercising instead of relying on the instructions on the sports watch, so that users can develop the habit of exercising independently. After setting the goal, the user will see that the virtual character in the leisure state becomes the state of preparation, which is used to remind the user to prepare for sportswear. By removing sportswear, exercising preparation costs can be reduced. It is said to be an excellent tool for teaching users the method of habit formation.

The self-evaluation page is performed after the user has completed an exercise by dragging the blue progress bar after your run to evaluate your exercising results (DS4). After the self evaluation, the green progress bar indicates the results of the actual progress (see Fig. 4 E). By continuously comparing the self-assessed results with the actual results, users can better understand their body and gain greater control over their body and behavior [DI3]. When the user

completes a run, the character image is improved in terms of health, competence, skills, etc. (see Fig. 5). If you click on the character image, it will show the corresponding text of the image change and the reason for the change, and finally form a complete story.

If the user chooses professional-identity, the character changes start in normal mode from the "me" perspective (I want to be a writer and publish a lot, I want to be a policeman and become strong). Such incentives measures can show users that persistence in running is perfect for their dream career/vocation, so users get used to running. If the user chooses the social-identity, the character changes will start in normal mode from the point of view of "interpersonal relations" (I am a mother and I can make my children a more delicious and rich breakfast, I am a child and I can study hard, doing housework makes parents happy). (DS3)

5.4.2 Vacation Mode. In the vacation mode (see Fig. 4 F), the app basically does not provide users with running guidance, but runs in the background to record the user's daily exercise indicators such as performance (see Fig. 4 G and Fig. 5), progress and bonus (see Fig. 4 H, Fig. 4 I and Fig. 5) features are introduced in this mode.

To prevent users from feeling uncomfortable in vacation mode without feedback, we designed the Performance feature (see Fig. 4 G and Fig. 5). If the system detects that the user has checked the app multiple times during this period, it will remind the user of the current operating situation. When the user chooses profession-identity, the user's performance will manifest itself in the perspective of "I" (how many works have been published by the writer, whether there are bugs in the program written by the programmer); when the user chooses the social identity, the user's performance will be reflected from the perspective of "interpersonal relationships" (whether mothers can raise positive and healthy children, and whether children can make parents feel comfortable and at ease). Compared to the normal mode, the vacation mode's graphics are more plain and brief, which urges users to independently evaluate their progress in a more fine-grained approach.

When the vacation mode is over, users will be shown the results of the running during that period (see Fig. 4 H and Fig. 5), if the user's performance in the vacation mode matches those in normal mode, then the user receives a bonus (see Fig. 4 I). The bonus is stored in collection boxes, and by clicking on them, you can change the virtual character's outfit. This can build the connection between each effort/laziness and perceptible outcomes (DS2).

During this period, after vacation mode ends, users can see the character image progress animation or see significant progress in the text and get additional rewards for good performance.

6 USER STUDY

After developing our app through a design workshop, we conducted a 6-week field study to investigate how our app could impact people's over-reliance on smartwatches for physical activities. We looked at both the extent of physical activity autonomy and actual exercising performance using smartwatch tracked data and subjective feedback.

Predicting or even "proving" behavioral change and identity shift is impractical in a genuine setting, thus throughout this implementation, we just collect and evaluate these data, as did the old HCI researchers [32]. Moreover, to test the sustained effects of the system, longitudinal studies will be conducted based on the consistent dataset so that users' transformation of motivation, system's validity to mitigate over-reliance could be detected outside the laboratory Despite these targets, collecting natural and qualitative information on a daily basis can, meanwhile, benefit our understanding about people's reactions to the novel behavioral change design strategies that we have integrated into the Watchoff system [51]. In other words, our research is expected to make influential contributions in both the practical and theoretical aspects of developing tools to reduce the over-reliance of monitoring [12, 13, 50].

6.1 Research Questions

- RQ1: To what extent can our dual-channel design evoke users to resonate with the virtual character and renew their identity
- RQ2: To what extent can our identity-based motivation design enhance users' consciousness about the link between self-identity and exercises?
- RQ3: To what extent can our design features (e.g., vacation mode, self-assessment) help users feel comfortable about and keep running (form a habit) after leaving the monitoring tool?

6.2 Participants & Apparatus

We selectively recruited participants (N = 30) via social media propaganda. These participants were newly recruited for the intersubjective assessment, which differed from the formative investigation, the design workshop, and the pilot study. All of them had prior experience with smartwatches and admit to having an over-reliance tendency while using them. All participants signed IRB-approved informed consent forms.

To understand the participants' physical activity habits, all participants attended our one-hour pre-interview and completed a self-assessment questionnaire about the recent physical activity in everyday life, called the Recent Physical Activity Questionnaire (RPAQ) [4]. We randomly divide participants into two groups while avoiding demographic sampling errors by balancing age, gender, and the results of RPAQ of each group.

Group A is the experimental group, where all participants use our personalized identity-based on Watchoff application. Group B is the control group where users use a most downloaded physical activity supporting app of the month from the app store. This app should have all of the features and functionalities we need, such as qualitative feedback, daily sports reminders and rankings, and so on, all of which were over-reliance-causing features we were researching.

Group	N	ID Range	Gender	N	Age	RPAQ
A-Experimental	15	P01-P15	Female	6	22.7±1.1	2550.0±464.7
			Male	9	20.6±0.5	
B-Control	15	P16-P30	Female	7	21.3±0.7	2548.4±301.1
			Male	8	20.8±0.6	

Table 1. The demographic, biometric and physical activity information of our participants. Participants were divided into two balanced groups based on this information.

6.3 Procedure & Task

6.3.1 Pre-task. To draw a responsible conclusion, we conducted a pre-test, including an one-hour preliminary interview and a RPAQ test to get informed of participants' exercise condition before experiment. Then we asked participants to put on our wearable device a week in advance to record their past running pattern without any app intervention. This baseline data will be utilized for reference to afterwards exercise data. We also conducted a 7-point Likert scale that provided us with a quantified measure of 4 metrics, which include users' dependency, identity, authority, and motivation status. According to these pre-data collected, we divided the participants evenly on exercise condition and dependency. To facilitate future studies, we stored the voice recording of the interview and all questionnaires after obtaining written informed consent from the participant. After all the verbal and paperwork, we handed the participants the smartwatch with our Watchoff or selected commercial app implemented on it and guided them to familiarize themselves with its use and all features.

6.3.2 Task. As the goal of our experiment was facilitating the spontaneous formation of habit and independent exercise behavior without over-relying on monitoring support, all exercise tasks were non-compulsive for the participants. However, for group A, in order to have experiences that are both emotionally and physically pleasurable and beneficial with identity-based motivation for group A, we asked them to choose their ideal identity. If all of our pre-setting identity does not meet, he can customize it in the input box. To prevent the requirement to interfere users behavior, we gave the participants the authority of freely deciding whether to exercise or not on any specific day, and they can self-input the goal of their physical activity before running. In this case, we could understand the change of behavior and even cognition that emerges under influence of our system. For both groups, they need to finish two tasks.

Week	Proportion for One Week
First Week	5 Days of Normal Mode & 2 Days of Vacation Mode
Second Week	4 Days of Normal Mode & 3 Days of Vacation Mode
Third Week	3 Days of Normal Mode & 4 Days of Vacation Mode

Table 2. Layout of experiment period for Group A

- **Exercising with app (three weeks).** In this task, two groups both exercise with monitoring app. This means that their exercises are supported to some degree. As aforementioned, the participants of Group A used our new system, which is characterized by its dual-mode mechanism including "normal" and "vacation" mode. The entire experiment was divided into three 7-day phases, and as phases progressed, the proportion of vacation mode increased as shown in Table.2. Group B participants used the traditional running app continuously for a total of 21 days.
- **Exercising without app (three weeks).** After three weeks, we banned all participants' apps. During this time, the smartwatch just collects data for our study and provides no input to the user, altering their physical activity. This allowed us to track whether users continued with the exercise behavior and determine whether the over-reliance was eliminated by sticking with the habit.

6.3.3 Study Survey and interviews. Given the frequent interference of stressing identification, we only adopted the remaining three of these four metrics scales on a weekly basis so that the usage curve concerning dependency, authority, and motivation is available. We performed semi-structured interviews on a regular basis based on their ratings to discover why they rated that value. An unstructured interview followed after specific questions were asked, and participants had extra opportunity to share their opinion on whatever they wanted to express, advise, or complain about, including emotions, running experience, the app, and so on Each "running cycle" lasts seven days, comprising both normal and vacation modes, and the end of each "running cycle" indicated the step-up of one phase. We enlarged the scope of the controlled group's interviews after three weeks of use owing to a system upgrade and the addition of vacation mode features, which included extra questions about their experience, minimizing over-reliance. After six weeks, each participant will have a final closing interview, and the whole 4-metrics 7-point Likert scale will be utilized again to help with the post-test of users' perceptions of their reliance, identity, authority, and motivation. Having been previously authorized, we also recorded every word of each participant for further study. The whole procedure of user study is shown in Fig6. In this design, we hope to explore how traditional applications and our new system affects them differently in terms of identity and authority.

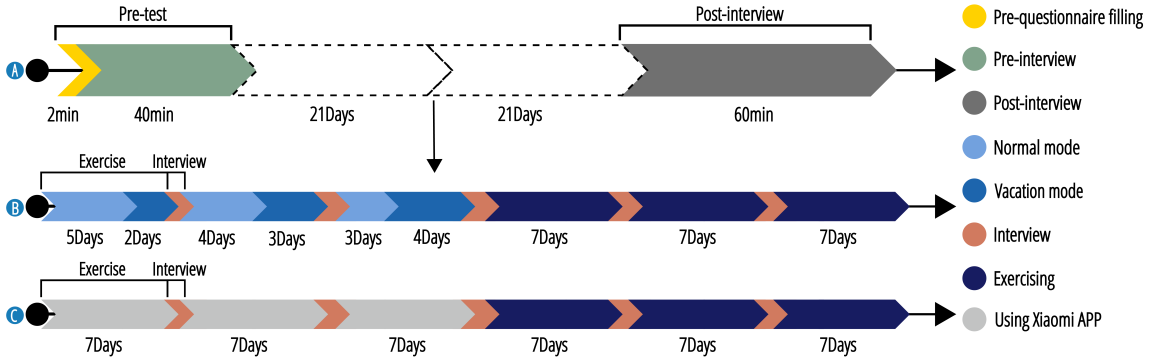

Fig. 6. The specific process of the experiment include (A) general layout of the whole experiment period, (B) specific layout of six weeks for Experiment Group, (C) specific layout of six weeks for Control Group.

6.4 Metrics

To understand our research questions and validate our identity-based design, we collected both objective and subjective data from tracked physical activity usage curve and post-survey and interview. Objective data mainly refers to the captured data by wearables and monitors throughout the experiment, while the subjective data includes the results of 4-metric 7-point Likert scale and the supporting qualitative interview data.

6.4.1 Physical Activity Performance and Usage Curve Tracking. Physical activity performance is the major objective measure of users' exercise condition, including frequency and intensity. It measures participants' exercising level. Our design adopted trackers and sensors to capture users' exercising data including their actual calorie-consumption, heart rate, exercise amount (duration and frequency) and their estimation of it. Following that, we intended to rate the workout scores, as the usual app and device would do. As the primary objective measure, this component of the score directly demonstrates how users have formed independent habits and actually eliminated over-reliance. The better the individual exercised, the higher the score. These quantitative scores were employed in the study of one of our primary research interests: physical activity performance and utilization curves, the specifics of which are presented in the table below (Fig.7). In each part, we first performed an inter-rater reliability analysis on 20% users and optimized our calculation method according to the real situation, before completing the analysis of all users' data.

Perspective	Measure	Description
Physical Activity Performance and Usage Curve	Exercise Intensity	We used calorie consumption to evaluate users' exercise frequency, which was calculated by a widely-adopted algorithm based on user's heart rate and distance of exercise and other factors like change of altitude.
	Exercise Frequency	The watch was equipped with the function of auto-detecting the user's exercising statue via motion sensors, thus we could get knowledge of whether the user was exercising and record its frequency.

Fig. 7. Physical Activity Performance and Usage Curve Measures.

6.4.2 *Dependency, Identity, Authority and Motivation.*

- **Dependence and Over-reliance.** Dependence measures participants' reliance on the wearable device. Metrics see Table.3. During the interview, questions like *"Do you have a clear arrangement for future exercise after leaving the app?"* and *"Can you still exercise if you forget to wear your smartwatch?"* are asked to inspect whether participants have been prepared to leave the watch and begin real independent exercise. Independence is positively related to the user's motivation, identity, and authority. The more his drive, power over physical activities, and development of a runner personality, the more likely he is to build an autonomous habit. When the user can exercise independently without the intervention of tracking devices, over-reliance is eliminated as we wish. The higher the dependence and over-reliance score, the more the user is relying on the smartwatch and the less he has developed a true habit.
- **Identity.** Identity acts as our main channel to access users' inner motivation and integrate exercise into their daily routines. Metrics see Table.3. Identity measures participants' recognition of their identity. As a mostly subjective index, we conducted several regular interviews and a post-experiment interview to talk to participants about their feeling after periods of running. During the interview, we asked them questions like *"Do you think exercising is part of your life?"* or *"Do you feel there is an eager to exercise everyday now?"* We reviewed their present perceptions of their realistic identities and other topics based on their responses in order to evaluate each participant. The more natural users' impulses to exercise, the better they renew their prior identity, or, to put it another way, implant sports integrity in their own identity. When the participant recognized himself as an exercise guy or incorporated exercise into his life, it was apparent that he had created the habit spontaneously, or rather, he would no longer rely on sport tracking equipment to keep exercising. The higher the score, the better the participant's identification.
- **Authority.** Authorities examine how users recovered control over their own physical activity and were willing to abandon sport monitoring gadgets, as well as the usefulness of vacation mode. Metrics see Table.3. Participants' sense of control over their own physical activity is measured by authority. Through interviews, we assess users' authority and dependency as another subjective metric. During the interview, questions like *"Do you think your judgement of distance and speed is more precise now?"* and *"Does your self-notion of your everyday exercise getting clear?"* are asked to judge whether they have regained their authority from the device and mitigate over-reliance. We debated further based on their responses to arrive at an appraisal of each participant. Other questions include, but are not limited to, future willingness to exercise without the use of equipment. The higher the score, the more their influence over their own sport. As we assisted the participant in regaining control of his activity, they had a better understanding of the size of their exercise and how it affected their everyday life. One significant reason users rely on sport monitoring gadgets is that they give a sense of control over physical activities (how far you run, how fast you run, etc.), so after we helped users restore their own power over exercise, there would be no need to rely on those devices.
- **Motivation, Attitude and Goal.** Motivation, attitude, and goal indices are critical in assessing their exercise initiative. Metrics see Table.3. Participants' motivation and willingness to practice are assessed. This index analyzed whether the subject had formed and how strong his intrinsic drive to exercise was, which displays his initiative, qualities for his automation, and is the foundation for overcoming over-reliance. The bigger the value, the more motivated he is. Attitude reflects consumers' emotional reaction to sports. As the participant's drive to exercise grows, his attitude should improve. They love exercising more when the value is higher. Goals

demonstrate users' willingness and capacity to organize their workouts. As one works and improves his physical condition, identifies himself as a runner, and desires to achieve more in this sector, his ambition may grow. Users with better ratings in this area are more capable of formulating a complex and attainable aim. We will be able to identify motivation change if we analyze attitude and objective together, representing the trend of inner starting, leading to the overcome of over-reliance.

Perspective	Aspect	Metrics
Dependence and Over-reliance	Comfort Level	How comfortable it is to exercise without a watch
	Concern Extent	How much you pay attention to the information on your watch
Identity	Identity Recognition	How is your identity close to a runner
	Identity Effectiveness	How is identity affect attitude
Authority	Sense of Authority	Whether you can arrange appropriate exercise according to actual needs of your body
	Control of Behavior	How are you aware of your actual exercise intensity.
	Awareness of Benefit	How are you aware of benefit brought by exercise
Motivation, Attitude and Goal	Motivation Rate	To what extent is inner motivation developed
	Attitude	How happy the emotion is while exercising
	Impression	How interesting you are when thinking of exercise in spare times
	Automation	Can you exercise regularly without a reminder

Table 3. Metrics of Likert Seven Point Scale.

7 RESULT

In this section, we report the quantitative results and qualitative findings of the user study to understand user performance and user experience with our Watchoff.

7.1 Quantitative Results

Our objective is to examine how participants react to our identity-based system and investigate its automation feasibility. The measurable emphasis is whether an independent exercise habit is developed, which may be seen in participants' exercise frequency and intensity, as well as mood aspects such as identification, authority building, and motivation.

7.1.1 Exercise Frequency and Intensity. "To rebuild your exercise habit while eliminating over-reliance". The primary goal index is indicated in the improvement of users' exercise condition curves, including frequency and intensity during the procedure.

To begin with, we introduced exercise frequency and intensity as essential evidence of participants' habit-forming condition. Users went through the whole experiment period doing their favorite sports. After correcting error caused by different types of sports, we logged totally 374 activities. Members from experiment group contributed 227 of all exercises, on average 2.5 times/(week × member). Members from compare group completed 147 of all exercises, on average 1.6 times/(week × member).

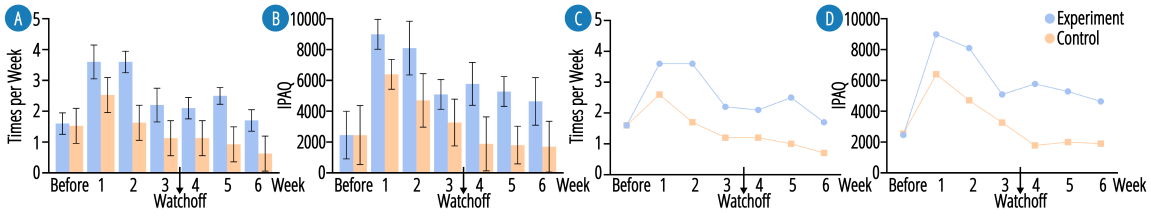

Fig. 8. Weekly trends over the course of the field study in the average number of activities logged by (A) Experiment Group and (B) Control Group. And their curve respectively for (C) Experiment Group and (D) Control Group.

Graphs above (Fig. 8) show participants' exercise frequency. Feedback based on graphic and feedback based on numbers did influence users differently. Members who used our graphic-based technology exercised much more frequently in all weeks than those who used a standard app. Experiment Group members exercise averagely 0.9±0.3 times/(week × member) more than Control Group members, nevertheless, whose original average exercising frequency being the same at the beginning of the experiment (Fig. 8). More interestingly, exercise intensity varied among the two groups. We used the improved algorithm in IPAQ to represent users' exercising intensity, which corrected error caused by different types of sports and unified recorded data with participant's original exercise data. As is shown in the graph, members in Experiment Group consumed averagely 309.2±43.7 kCals per exercise, while members in Control Group consumed averagely 226.3±39.4 kCals per exercise (Fig. 8). Experiment Group members consumed 26.8% more energy than Control Group members on average (**p<.01, *p<.05). We found out that in the conversations with our researchers in the third regular interview, six Experiment Group members expressed satisfaction at seeing the graphic figure on their watches improve. They found the character to be relatable and felt compelled to assist the small person. As a result, they attempted to run or bicycle more frequently. When we checked in with other individuals, they expressed similar feelings.

It is worth mentioning that the frequency of both group experienced a significant drop, respectively 41% in Experiment Group on Week 3 and 36% in Control Group on Week 2. We assumed it was due to the disappearance of novelty, and our suspicion was confirmed in the third regular interview. Both groups felt that the lack of novelty was a key factor in their motivational decline. True habit, on the other hand, is what remains after novelty has been gone, and you have become accustomed to it. We see the loss of novelty as an unavoidable step in that direction. After the significant drop, frequency of both group kept floating stably near an average number, Experiment Group being 2.0±0.8 times/week, and Control Group being 1.2±1.0 times/week. We were also ecstatic to learn that our solution was more resilient in terms of preserving user novelty. Additionally, frequency experienced a huge rise at the beginning of the experiment for the same reason of novelty, 126% in Experiment Group and 43% in Control Group compared to their original data.

7.1.2 Habit Maintaining. The key metric of our trial is whether people could continue to exercise after they removed the smartwatch. We evaluated each participant's data after the experiment for three weeks and questioned them in the final interview. Those who continued to exercise at a consistent frequency near to their performance over the trial time and claimed exercising automation in interviews and quantitative surveys were considered to be keeping habits. Combining each user's exercise data and their interview results, 83% members in the Experiment Group and 34% members in the Control Group maintained a regular habit of exercising.

7.1.3 Dependence and Over-reliance. The major emphasis and aim of our experiment is dependence and over-reliance, and this section explains it from a subjective perspective by analyzing participants' Likert scale scores and comments

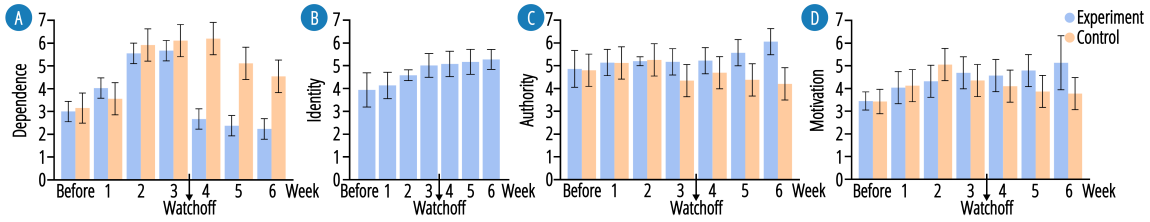

Fig. 9. (A) Average dependency and over-reliance score of both groups. (B) Average identity score of Experiment Group. (C) Average authority score of both groups. (D) Average motivation, attitude and goal score of both groups.

acquired through interviews. In the graphs (Fig. 9 A), we first see the interesting fact that in the first three weeks both groups increased in dependence by a huge but close rate of 96.2%. However, in week four, the dependence rate of Experiment Group declined significantly by 65.8% when users left the sport app. Then the value was stable around a pretty low value of 2.34 scores with minimum fluctuation within 20%, meaning participants in Experiment Group perceived themselves to have significantly reduced dependence on the smartwatch and maintained for a long time of 21 days (**p<.01, *p<.05). While in Control Group, members' dependence score remained high with low decline rate of 14.6±6.5% per week after leaving the traditional app in the last three week. Based on data above and Fig. 9 A, our system remained much less over-reliant after leaving the app than traditional apps.

7.1.4 Identity. The most important and promising component in eliminating over-reliance is the formation of sport identity. We didn't divulge participants' identities until the post-study interview, therefore we only included questions about this emphasis in the final Likert scale. We may utilize the findings to analyze quantitatively how users created such identities and whether they correspond to the degree of over-reliance (Fig. 9 B). In experiment period with smartwatch on, we saw a trend of rising identity recognition, quantitatively at a speed of 9.1±2.3%/Week. In observation period though the extent grew slow at a rate of 1.3±0.2%/Week, it was still growing steadily. Compared to pre-study, participants' recognition of identity grew by 33.8% in total. In interviews, we also confirmed this point. 77% participants in Experiment Group reported acknowledgement of an identity who have integrated exercising into their daily life.

7.1.5 Authority. Situations concerning identity are similar to those with motivation, attitude, and objective. Using a Likert scale to calculate ratings (Fig. 9 C), the Experiment Group experienced an increase totally by 23.5% in six weeks' time while Control Group declined by 16.3%. Averagely, Experiment Group improves steadily by 3.9±1.2%/week while Control Group declined by 2.7±4.4%/week. In the first two weeks, Control Group members performed better than Experiment Group members, however, a turnaround soon took place with substantial decline on Control Group and a stable increase continues on Experiment Group.This similar situation again confirmed the coherence of our research focus and revealed their similar effect in overcoming over-reliance. In the final interview, 86% Experiment Group participants were able to claim a rebuild of control over physical-activities, while only 40% in Control Group were able to do so. It is worth mentioning that in week four both groups experienced an increase in authority. We assumed and confirmed in interview of that week that it was because of the leave of smartwatch and users suddenly have to exercise on their own judgement.

7.1.6 Motivation, Attitude and Goal. Motivation, attitude and goal rate reflects participants' initiative on exercising, and is one of the major contributions to overcoming over-reliance. In a Likert 7-point scale on this focus, Experiment Group members experienced an increase of 52.9% in six weeks' time, while Control Group members declined by 15.7%.

Averagely, Experiment Group improved steadily by 8.8±3.9%/week while Control Group declined by 2.6±1.1%/week. In the graphs (Fig. 9 D), we can as well see that in the first two weeks traditional sport apps equipped with quantified feedback raised even more motivation by 32.1% (**p<.01, *p<.05) than our figure-based feedback. However, things turned around in a very short period. For Experiment Group members, a steady increase continued in the third week, while in Control Group a sudden decline began early at the same time. After conducting interviews with users, we came to the conclusion that traditional sport applications may increase users' motivation in the short term, but may hinder it in the long run. Though ditching the smartwatch resulted in a little fall in motivation in week four for individuals utilizing our approach, a continual gain began in week five.

7.2 Qualitative Findings

We adopted thematic analysis [5] to examine users' interaction with the apps via feedback provided in interview transcript and background data, reconstructed their experience with the smartwatch to immersively learn how users had been affected by it. The findings were then described below.

7.2.1 Vacation Mode Facilitates Users Regain Authority. Almost all participants confirmed that they can estimate their exercise condition better than former after utilizing this app. When asked about the reasons, six of them attributed this to the vacation mode. Though most of them notice that there is *"a sense of tension when getting away from concrete data"*(P2), the comforting images design in this transitional mode *"convince me that I'm progressing"*(P3). Moreover, the introduction of the self-assessment mechanism also prompted them to *"think more and experience more"*(P8), users in vacation mode have the capacity and authority to look into themselves and gain an insight of themselves. More than one user has informed us that they become *"more accurate in estimating their exercise duration and intensity"*(P1 and P4) after they are ordered to switch to vacation mode and evaluate their effort by they own for a while. *"These feelings and experiences are cool"* One participant stated, *"I just feel I regain the control of my life and no longer in an anxious mood"*. Though many of them are only capable of roughly estimate their outcomes, they benefit from the concession of authorities from the devices to some extents.

7.2.2 Dual-channel Presentation Brings Immersive Experience. Seven participants reported that they engrossed more in the exercise under the guidance of our watch. The dual-channel design makes users feel like *"playing a role-playing games with presentation of text and drawings"(P4), which is more immersible"*. Moreover, as the *"improvements achieved by the virtual character are closely connected with my exercise performance"* (P1), users sometimes recognize virtual images as *"another me in the cyber world"* (P2). That means they project a part of their self-identity onto the images we design and gain a sense of agency in the integration procedure [16]. Notably, these images could also affect the cognition of users in turn, make users feel *"ought to exercise, otherwise my set target might fail and my images and stories will stop moving forward"* (P3). Given the evidence above, we can tell that the dual channel rendering truly offer opportunities for users to resonate with chosen identities immersive and thus promptly renew their identity with desire to exercising. On the contrary, users in the control group rarely mention this, while one participant in the experimental Experiment Group also assumed that *"if I just wear a typical smartwatch, I probably wouldn't have had that charming experience"* (P9).

7.2.3 Multi-identity Serves in Behavior Changes. Though various identities (including customized identity design with GPT-3 technology) are provided in our research, participants need to choose one at the very beginning. However, it occurs that sometimes participants get *"motivated by some other identities in reality to engage in physical activities"* (P2). Five participants mentioned that vibrant identities operate during their engagement, which means they just went

beyond their selected identity and presented more than one identity when exercising (see in DS2). One participant (P6) who chose social identity said, *"When I was exercising in the gym near my lab, I sometimes associate the benefits that exercise can bring to my career rather my social identity."* This taught us that identities are complex and fluid, and that they may be played out differently in different contexts [38]. Our GPT-3 implementation assisted in this process via *"automatically renew the narratives"*(P10), but still has a void in unifying diverse identities since one participant just comment the image as a *"flat character lacking a sense of reality"*(P5). These feedbacks all direct to a conclusion that an integrated and flexible identity design and recommendation will fix users better and thus leading to better outcomes of behavioral changes.

7.2.4 GPT-3 Technology Awakens Participants' Consciousness. During the interview, eight individuals stated that the story provided by GPT-3 was overdone or excessively detailed, which elicited a variety of emotions. Five of the users regarded it as *"an interesting and humorous companion that often says amazing things "*(P4), while others just regarded it as *"ridiculous and unreasonable"*(P5). Our implementation of GPT-3 aims to complete and reconstruct the meaning of text in our design context, yet our users' feedback reflected that they were aware of the gap between the artificial and human. In other words, they might get alarmed by observing this fancy-making narrative and turn to reflect automatically. Just as some users confessed that the "non-sense" of AI helped them *"stay clam and think independently"*(P9), the "intelligent" narrative sequence generator thus engages in promoting participants' self-identity in an unexpected way, which actually drives people back to reality. *"A few times I feel myself nearly addicted to that, but then the story teller will make up an unanticipated end, and I was just like, waking with a start".*(P7)

8 DISCUSSION

8.1 Ignite Users Passion with "AI-generated You"

In our workshop and user testing, we discovered that consumers prefer realistic characters to metaphorical ones, and so on. Our present design employs few human characters and, to some extent, can elicit user resonance and self-reflection. "Do you know the magic mirror?" P2 asked after the interview. People can imagine themselves in many roles."

Triggered by such an idea, we could maybe create a *"magic mirror"* via AI-generated portrayals. As we know, AI-generated portrayals of characters can feature synthesized faces, bodies, and voices of anyone, including ourselves. Specially, GAN architectures can generate images of human faces [48, 79]. And there are some research showing that AI-generated characters can support personalized learning and well-being [60]. In this case, maybe we can replay fixed human figures with personal-face-based figures.

Furthermore, we can generate more than one face for one character. Recent findings exemplify that our minds can inhabit more than one body, and bodies can be shared by more than one mind. For instance, Machinoia [61], for example, is a symbiotic augmentation that corporealizes into two extended physical heads: who you formerly were and who you'll eventually become. We may exhibit the faces of "past you," "current you," and "future you," inspired by our study, to assist people better reflect on their physical activity and identity.

8.2 Eliciting a Sense of Self with HInt

When we talk about linking identity and physical activity motivation via the mobile application, we should also talk about the Sense of Self because the images we present are, after all, virtual. Sense of Self [14, 15, 80, 82], which is named as "core self" [14, 15], "experiential self", or "minimal self" [19, 85]) is a pre-reflective sense that the body moving, or the thoughts formed in one's mind are one's own [19]. Specifically, a sense of self-reference to the individual organism

when events occur to them [15]. When users see the figure changing after running in our program, they may see the query "Is that me?". To some extent, if our program cannot assist users in eliciting a feeling of self, our strategy is more akin to a virtual game than a self-mirror. The findings of our user survey revealed that most of the time, if the identity they pick corresponds to what they actually want to be, they feel as if the figures are themselves. Nonetheless, we discovered that, at times, people believe there is no connection between the image and themselves, particularly when they are experiencing difficulties in the real world and are feeling down.

Furthermore, we wonder if we could better evoke a Sense of Self. While some Human-Computer Integration (HInt) systems have successfully demonstrated that humans and techniques can be physically and functionally integrated, these integrations are not necessarily part of the user's identity (i.e. self-judgment) or felt as part of the user (i.e. with a sense of self) and even exert self-dissociation feelings [17]. Based on our research of the literature, we discovered that in order to elicit a "Feeling of Self," experiential frameworks (e.g., "pre-reflective experience" and "sense of agency") must be developed. In this situation, the experience framework may be used to inform future design.

8.3 Extending to Other Monitoring Application

We focus on allowing users to exit a physical activity tracking tool in this work. This is not to say that our design applicability is confined to this case. The Watchoff principle may also be used to other domains such as time management and sleep management. Many monitoring technologies have been created to record people's amusement time, such as playing games on a smartphone, for time management. These tools are designed to assist people in preventing addiction and thereby better managing their time. However, many people rely too much on such technologies, using them as if they were an alarm clock. For example, even if an app locks the smartphone to prevent people from using it, individuals continue to think about the game and are unable to focus on work, while sitting in front of computers. As sleep becomes a problem for many individuals, the number of sleep tracking applications grows. These applications, however, terminate at the monitoring stage. Some studies demonstrate that if users are told that their sleeping time is adequate, even if they are not receiving enough sleep, they will deceive themselves and feel refreshed the next day. In the long term, this will not only not help, but also harm health. It is also necessary in this scenario to have people accept responsibility for themselves.

8.4 Limitation

The weekly survey that occurs during users' physical activity was discovered to be one of the potentially important elements in our study. Both the physical data and self-report during the interview show slight peaks in physical activity conditions one or two days before our weekly survey, despite the fact that they have been empowered with the flexibility to exercise. For some individuals, the timing of our weekly survey serves as an implicit deadline that reminds them to exercise, but for others, our survey may prime them and make them more susceptible to incentive, authority, and dependency rather than just getting interested in exercise [78]. Given that both groups are touched by the same survey method, we assume that the influence is almost equal. However, in the future, we may collect survey responses more subtly, for as by displaying a popup window on the program.

Furthermore, because identity and agency are frequently formed and restricted by the macro systems that surround them (including culture, power, relationships, media, etc.) [38], our research should broaden to include the sociocultural bases of the identity renewing, over-reliance reduction, and authority regaining processes, so that a more comprehensive and universal knowledge of human habit development may be generated. To accomplish this, perhaps a topic group

with greater diversity has to be recruited and respected since we are investigating a further design, which requires our inclusivity while developing.

9 CONCLUSION

Personal electronic devices are increasingly being developed to track physical activity and hence promote well-being. However, when more individuals rely on such monitoring gadgets, the assistance system assumes too much authority, resulting in a detrimental consequence (e.g., a false sense of security, anxiety emotion of health, and negative mindset of self-integrity). Through identity-driven methodology, our research aims to propose a design strategy to limit over-reliance during habit formation and preserve the molded behavior without the need of assistance wearables. Watchoff is a sports watch application that helps users intuitively comprehend the benefits of continuing this habit by allowing users to renew their recognition through professional or social role-playing to identify healthy conduct. Furthermore, we used GPT-3 and interactive pictures to create an adaptable presentation with text and visuals in order to prevent over-reliance by developing self-perception ability and giving a transition phase. We describe our design approach, which included design requirement interviews, physical theory selection, and ideation and iteration of app features. We did a six-week in-depth research (three weeks with the smartwatch and three weeks without) to investigate the impact of our software on over-reliance reduction by comparing it to a mainstream monitoring tool. The study findings were summarized in four dimensions: dual-channel design immerses users, multi-identity helps behavioral adjustments, tailored tales awaken self consciousness, and vacation mode aids in reclaiming authority. Based on this, we present design ideas such as generating AI with more humanoid qualities and making some future design proposals for over-reliance reduction in related fields.

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