

# Fitness Technology and Exercise Engagement: How Technology Affordances Facilitate Fitness Goal Attainment

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## Abstract

*To realize desired health returns, fitness technology providers, users, and corporate wellness program managers need to understand how individuals' different uses of fitness technologies influence their fitness experience and fitness goal achievements. Thus, this study draws on the theory of affordances and the concept of engagement to develop and empirically test a model of fitness technology use as goal-directed behavior. Doing so highlights the relationship between trying to use fitness technologies and trying to perform fitness activities with fitness goal attainment. Our results show that while actualized self-appraisal affordance amplifies users' cognitive exercise engagement, cognitive exercise engagement does not significantly influence fitness goal attainment. Furthermore, actualized self-appraisal and social appraisal affordances enhance users' emotional exercise engagement, positively influencing fitness goal attainment. Thus, facilitating the actualization of self-appraisal and social appraisal affordances that increase individuals' emotional exercise engagement is essential to the effective use of fitness technologies.*

**Keywords:** goal-directed behavior, trying, actualized fitness technology affordances, exercise engagement, fitness goal attainment

## 1. Introduction

Fitness technologies (e.g., fitness trackers, wristbands, smartwatches, smart rings, and fitness apps) are popular among consumers and have also become an important component of corporate wellness programs [1]. Many organizations invest heavily in fitness technologies as part of corporate wellness programs to boost workforce wellness and reduce health insurance costs [1]. Yet, it is unclear whether using fitness technologies provides long-term benefits to end-users. The extant literature offers mixed results regarding fitness technology's effectiveness in improving health outcomes [2]. While some studies claim that the use of additional fitness technology features increases the number of physical activities that individuals engage in [1], not all features are

effective [3]. For example, prior research has found that use of data management features (i.e., data analysis, data collection, progress updates, and information searching) and exercise control features (i.e., rewards, reminders, goal management) has no effect on users' subjective vitality [3]. While the use of social interaction features (i.e., fitness data sharing, encouragement, competition, comparison, and coaching) positively influences users' subjective vitality [3], the effects of social sharing features on physical fitness diminish over time [4].

Additionally, research has rarely explored mediation mechanisms or factors upon which positive benefits of fitness technology use may depend [2]. Finally, it's reasonable to assume that individuals use fitness technologies to achieve fitness goals [5]. However, despite the popularity of fitness technologies, the impact of fitness technology use on fitness goal achievement has yet to be studied. For organizations to benefit from their investments in corporate wellness programs, there is a need to understand better how individuals engage with fitness technologies and achieve their fitness goals.

Against this backdrop, this study explores fitness technology use and its consequences from the goal-directed behavior perspective. Informed by the goal-directed behaviors literature [5,6,7], we articulate that fitness technology use is a process of goal-striving. In this process, trying to use fitness technologies and trying to perform fitness activities are concrete enactments of interrelated, intermediate, behavioral goals in the pursuit of end-state fitness goals. Fitness goal attainment is the progress that individuals make toward fitness goal achievements. We propose that trying to use fitness technologies influences fitness goal attainment through individuals' attempts to perform fitness activities. Based on this reasoning, our research question is: *What are the influences of trying to use fitness technologies and trying to perform fitness activities on users' fitness goal attainment?*

This study incorporates the lenses of affordance and engagement into a framework of fitness technology use as a goal-directed behavior to address this question. The affordance lens sheds light on understanding *trying to use fitness technologies* [8,9]. Thus, trying to use fitness technologies manifests as various actualized fitness technology affordances.

Technology affordances represent various action potentials of technology that are made possible through use of technology features [10]. Affordances must be actualized to achieve intermediate outcomes of some action and become empirically observable [8,9]. Thus, trying to use fitness technologies manifests as various actualized fitness technology affordances (*i.e., the use of fitness technology features for some action in support of fitness goals*).

We believe it is more fruitful to study the effectiveness of fitness technology by focusing on actualized fitness technology affordances than by focusing simply on technology features. Depending on individuals' goals, the same technology feature(s) may evoke different affordance(s) for different users [11]. Also, individuals may actualize the same affordance(s) via the use of different fitness technology features or the use of the same features on different fitness trackers and apps [12]. In other words, different fitness technologies provide some common affordances. Thus, identifying key fitness technology affordances may help explain mixed results regarding the effectiveness of fitness technology features in prior research.

The engagement concept [13] aids understanding of the cognitive and emotional efforts involved in *trying to perform fitness activities*. Cognitive exercise engagement and emotional exercise engagement are the resulting intermediate outcomes of actualized fitness technology affordances, demonstrating the impact of trying to use fitness technologies on trying to perform fitness activities. Specifically, we hypothesize that four distinct actualized fitness technology affordances (*i.e., self-appraisal affordance, social appraisal affordance, rewards affordance, and reminders affordance*) exert differential effects on individuals' cognitive and emotional exercise engagement. Cognitive and emotional engagement subsequently influence fitness goal attainment.

This paper makes several contributions. For theory, our overarching framework of fitness technology use as a goal-directed behavior extends current understanding of the relationship between fitness technology use and fitness goal achievement by emphasizing the importance to fitness goal attainment of trying to use fitness technologies, as well as trying to perform fitness activities. Drawing upon the concepts of actualized affordances and engagement, the study examines these relationships by linking actualized fitness technology affordances and fitness goal attainment through an intermediary: exercise engagement. Thus, this study provides a theoretical explanation of how fitness technology helps individuals achieve fitness goals. For practice, we provide actionable suggestions for fitness technology users and designers that involve uses of fitness

technologies that emphasize specific designs to facilitate the actualization process of self-appraisal and social appraisal affordances. We also provide advice for building successful corporate wellness programs utilizing fitness technologies.

## **2. Theoretical background**

### **2.1. Fitness technology use as a goal-directed behavior**

Goals play a central role in guiding human behaviors subject to impediments [6,7]. Individuals use fitness technologies to achieve fitness goals, such as losing weight, improving physical endurance, and reducing stress. They often stop using fitness technologies when they encounter obstacles to success. Thus, fitness technology use is goal-directed behavior. According to the goal-directed behaviors literature, goal-directed behavior is oriented toward attaining specific outcomes. It can be viewed as a process of goal setting, goal-striving, and goal attainment [5,6,7].

Note that fitness technologies do not perform fitness activities for the person and that fitness goals cannot be realized without performing fitness activities [14]. In the goal-striving stage, individuals need to conduct a sequence of trying to use fitness technologies and trying to perform fitness activities for fitness goal achievement. In the goal attainment stage, the person constantly evaluates the progress of achieved fitness goal achievements (*e.g., achieved weight loss*). Fitness goal attainment is a direct outcome of trying to perform fitness activities and an indirect outcome of trying to use fitness technologies. Thus, exploring the relationships between trying to use fitness technologies, trying to perform fitness activities, and fitness goal attainment can provide insight that fosters the beneficial effects of fitness technology use for fitness goal pursuit.

### **2.2. Trying to use fitness technologies: actualized fitness technology affordances**

To understand how users try to use fitness technologies, we draw on the perspective of affordance. The affordance concept is proposed by Gibson [15] to express his view that humans perceive an object in the environment in terms of what it can do (*i.e., possibility for an action*) rather than what it is (*i.e., physical properties, such as feature*). Gibson's definition of affordance has been widely adopted in the IS field to understand technology use and its consequences [8,9]. In line with Gibson's view, IT affordances refer to "the possibilities for goal-oriented action afforded to specified user groups by technical objects" [10, p. 622]. IT affordances are not IT features

or the capabilities of a technical object [10]. The same technology features may enable different affordances for different users [11].

Strong et al. [9] advance Gibson's definition by distinguishing between affordance as an action potential and an actualized affordance. As an action potential, an IT affordance must be actualized to achieve intermediate concrete outcomes of some action and become empirically observable [8,9]. Thus, an actualized IT affordance manifests as the purposeful use of technology *for some action* [9]. Immediate outcomes are intermediaries between users' actualization actions and goal achievements [9,11]. Note that technology use and actualized affordances are different concepts. Technology use describes the direct interaction between users and technology features, but target outcomes are achieved by actualizing an affordance, not technology use [16].

Consistent with most of the literature derived from Gibson's work, we define actualized fitness technology affordance as *the use of fitness technology features for some action in support of fitness goals*. While various motivational and informational features are embedded in fitness technology [17], these features typically support four actions that users perform to pursue their fitness goals: self-appraisal, social appraisal, rewards, and reminders.

**Actualized self-appraisal affordance** is the use of fitness technology features to assess fitness activity performance based on real-time and historical performance data in support of fitness goals. Actualized self-appraisal affordance enables users to monitor fitness activities and assess performance from a personal perspective.

**Actualized social-appraisal affordance** is the use of fitness technology features to assess fitness activity performance based on other people's performance data, others' way of performing fitness activities, and others' comments in support of fitness goals. Actualized social-appraisal affordance enables users to evaluate their fitness activity performance to judge their success from a social perspective.

**Actualized rewards affordance** is the use of fitness technology features to obtain rewards for fitness activity in support of fitness goals. Actualized rewards affordance enables users to receive rewards for performing fitness activities.

**Actualized reminders affordance** is the use of fitness technology features to obtain reminders for fitness activity in support of fitness goals. Actualized reminders affordance enables users to receive reminders about performing fitness activities.

### 2.3. Trying to perform fitness activities: cognitive and emotional engagement

We draw on the engagement concept [13] to consider users' attempts to perform fitness activities. The engagement concept helps understand how and why people focus, invest, act, involve, and interact in an activity or a contextual setting in the moment or across time [18]. Engagement is central to individuals' task performances and outcomes [18]. Previous literature has conceptualized engagement as either a unidimensional or a multidimensional construct with two or three dimensions (i.e., cognitive, emotional, and behavioral) depending on the contextual characteristics of interest [19].

To study how people perform fitness activities in the context of fitness technology use, we define exercise engagement as *the level of cognitive and emotional effort individuals invest in performing fitness activities*. Cognitive exercise engagement refers to a person's level of engrossment (i.e., mental focus) in performing fitness activities. In contrast, emotional exercise engagement refers to *the level of positive feeling about performing fitness activities*. We exclude the behavioral dimension for two reasons. First, in the context of performing fitness activities, the conceptual meaning of behavioral engagement (i.e., physical energy that individuals exhibit) is equivalent to the actual behavioral act of performing fitness activities (i.e., physical action), causing a conceptual overlap problem. Second, it has been shown that behavioral engagement can be the extra effort and behavior instigated by cognitive or emotional engagement [19]. We argue that the physical action of performing fitness activities is a consequence of exercise engagement rather than part of it.

### 3. Research model

Figure 1 depicts the research model, explaining the effect of four actualized fitness technology affordances on users' cognitive and emotional exercise engagement and resulting variations in their fitness goal attainment.

Trying to Use Fitness Technology    Trying to Perform Fitness Activities    Fitness Goal Attainment

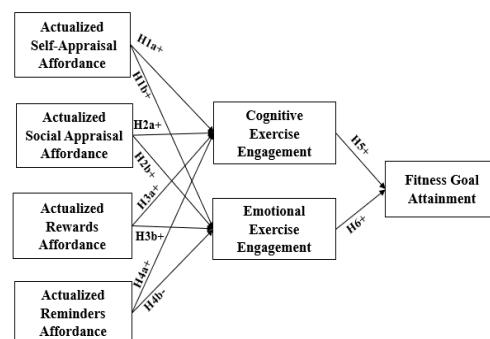


Figure 1. Research model of fitness technology use as a goal-directed behavior

### 3.1. Actualized self-appraisal affordance and exercise engagement

The actualized self-appraisal affordance supports users in collecting, quantifying, observing, and visualizing their body and fitness activity performance [20]. The actualized self-appraisal affordance meets individuals' needs to increase the accuracy of fitness activity performance [14,20]. Thus, the actualized self-appraisal affordance increases users' awareness of their fitness goal progress in a self-referential manner by identifying the discrepancies between the current state and desired state [21]. As users become more aware of their body and fitness activity progress, they are more likely to concentrate and maintain attention in performing a fitness activity. Hence, we hypothesize:

**H1a.** Actualized self-appraisal affordance positively influences cognitive exercise engagement.

The actualized self-appraisal affordance also increases users' interest in recording and observing their own data [2]. The actualized self-appraisal affordance enables people to feel that these steps or activities are valuable and that their workout has been recognized by the technology medium, which helps them realize a sense of self-worth and self-efficacy [22]. Self-efficacy leads to positive responses to exercise [22]. Moreover, when users are notified of their fitness activity progress via real-time prompts or auditory signals, they develop a sense of accomplishment and control over their body and health [21]. Further, they find it more enjoyable to exercise. Hence, we hypothesize:

**H1b.** Actualized self-appraisal affordance positively influences emotional exercise engagement.

### 3.2. Actualized social appraisal affordance and exercise engagement

The actualized social appraisal affordance enables people to satisfy their social motivations through various kinds of social interaction, such as comparing against others, presenting their fitness activity performance to others, communicating fitness-related information with others, and gaining comments from others [21]. The actualized social appraisal affordance not only helps people gain a social reference for self-improvement, but also helps people generate a greater sense of public commitment to the goal [21]. These further help users become more cognitively absorbed into performing a fitness activity. Hence, we hypothesize:

**H2a.** Actualized social appraisal affordance positively influences cognitive exercise engagement.

The actualized social appraisal affordance helps users build a more affective social connection and friendly social comparison environment by identifying people with similar exercise backgrounds or interests and staying connected with them [22,23]. These social connection and comparison environments are helpful for users to develop positive feelings about performing fitness activities. Because people are more likely to receive favorable comments when their fitness performance looks good and receive encouragement and help from their friends within this social connection if their fitness performance looks not good [22,23]. Hence, we hypothesize:

**H2b.** Actualized social appraisal affordance positively influences emotional exercise engagement.

### 3.3. Actualized rewards affordance and exercise engagement

The actualized rewards affordance is intended to motivate users to exercise more, because the possibility of rewards is a source of extrinsic and intrinsic motivation to exercise. This affordance makes goal achievements more visible with the help of various presentation styles (e.g., points, levels, badges, trophies, congratulatory messages, friendly faces, or monetary rewards) and delivery styles (e.g., vibrate, make a sound, message prompt, display badges) [2]. Thus, this affordance helps users stay focused on performing fitness activities. For example, when people receive a reward notification, their attention shifts to the task of performing fitness activities itself. When people focus attention on what they are doing, it stimulates their interest, which reduces feelings of boredom and prevents them from becoming distracted during a workout. Hence, we hypothesize:

**H3a.** Actualized rewards affordance positively influences cognitive exercise engagement.

As rewards represent completed success, achievement, and triumph, feelings of accomplishment and self-satisfaction arise when people are awarded for fitness activities [17]. As the feeling of accomplishment enhances enjoyment of workout sessions, receiving a reward should create an emotional rush [20]. Also, since rewards signal users' mastery of the exercise, the actualized rewards affordance enhances feelings of competence, leading to enjoyment in performing a fitness activity [21]. Hence, we hypothesize:

**H3b.** Actualized rewards affordance positively influences emotional exercise engagement.

### 3.4. Actualized reminders affordance and exercise engagement

The actualized reminders affordance helps users deal with the problem of losing enthusiasm for exercise or forgetting about their exercise plans [23]. People usually get notifications when they have not reached a pre-set exercise goal [20]. People can personalize their reminders settings [20]. Besides receiving notifications, some people get reminded to take exercise regularly by looking at their weekly fitness activity reports or their ranks on the leaderboard [23]. The actualized reminders affordance helps users bring fitness goals back into their mind, enhancing their concentration on performing fitness activities [20]. Hence, we hypothesize:

**H4a.** Actualized reminders affordance positively influences cognitive exercise engagement.

Not every user needs a reminder for fitness activities, such as regular exercisers [3]. People who actualized the reminders affordance tend to think that reminders are helpful for their fitness goals pursuit. Despite that, they may not act on reminders for every instance, especially when they are under a particular stressful context that they cannot maintain a recommended level of exercise [20]. In these situations, users are more likely to become frustrated, distressed, and irritated about the reminders. This is not helpful for users to develop positive feelings about performing fitness activities. Hence, we hypothesize:

**H4b.** Actualized reminders affordance negatively influences emotional exercise engagement.

### 3.5. Exercise engagement and fitness goal attainment

Fitness goal attainment is defined as a user's perception of the progress of fitness goal achievements, which reflects how well an individual accomplished his or her fitness goals at a specific time. Since the realization of fitness goals is influenced by the end-performance of a sequence of trying to perform fitness activities [6], fitness goal attainment can be regarded as a task outcome variable. As people become more mentally focused on performing fitness activities, they are more likely to proactively react to the exercise feedback and suggestions sent from the fitness technology at a behavioral level [24]. This helps further their process of fitness goal attainment. Hence, we hypothesize:

**H5.** Cognitive exercise engagement positively influences fitness goal attainment.

When people experience positive feelings about performing fitness activities while using fitness

technologies, they tend to exert greater tolerance and effort in completing fitness activities even under any difficulties [25]. Past work has demonstrated that a positive affective response to performing fitness activities leads to better fitness activity performance (e.g., longer exercise duration) and more future exercise behaviors [25]. Hence, we hypothesize:

**H6.** Emotional exercise engagement positively influences fitness goal attainment.

## 4. Research method

### 4.1. Data collection and measurement development

We examined the research model empirically using a longitudinal survey design. Our sampling frame included only those individuals who, at the time of data collection, were using a fitness technology to support some fitness goal and expressed a willingness to complete a survey at two different time points. 270 fitness technology users were recruited through MTurk for the initial survey. Participants answered questions about their fitness technology use behaviors, exercise engagement, and demographic information. Two weeks later, participants were invited to take a short follow-up survey in which they answered questions about their fitness goal attainment. We used the TurkPrime website to administer both surveys. Finally, 221 matched responses from both surveys were retained for subsequent analyses.

Regarding the sample characteristics of our 221 respondents, 57.9% of the respondents were male, and 42.1% were female. The average age of respondents was 36 years old. Nearly 55% of respondents had used fitness technology for more than a year. Most participants (92.3%) use fitness wearables and fitness apps together. Of 37 fitness wearables listed, the most popular were Apple Watch (27.9%), Fitbit Charge (13.1%), and Fitbit Inspire (11.7%). Of 43 fitness apps listed, the most popular were Fitbit Coach (26.7%), MyFitnessPal (25.7%), and Apple Health (22.5%). Most participants (89.6%) had more than one fitness goal when using fitness technologies. Of 17 fitness goals, the top goals included "improve my health" (66.7%), "increase my physical activity" (61.3%), "lose weight/fat" (55.9%), "reduce stress" (43.6%), and "sleep better" (39.6%).

We used existing validated scales whenever possible. A popular engagement scale [13] was adapted to measure cognitive and emotional exercise engagement. Goal attainment [26] was adapted to measure fitness goal attainment. New measurements were developed for the four actualized fitness technology affordances, because of the lack of

consistency in the measurement and use of actualized fitness technology affordances in the IS literature. Based on the item sources [3,21], our scale development process resulted in four items measuring actualized self-appraisal affordance, six items measuring actualized social appraisal affordance, four items measuring actualized rewards, and four items measuring actualized reminders affordance. Survey items (see Table 1) were measured on a seven-point Likert scale ranging from “strongly disagree” to “strongly agree”. All latent constructs were modeled as reflective.

**Table 1. Survey items**

<b>Actualized fitness technology affordance items [3,21]</b>	
<b>Prompt:</b> Thinking about your use of one or more fitness technologies together in the past two weeks, to what extent do you agree with the following statements. <b>When I use one or more fitness technologies, I use features that allow me to ...</b>	
Actualized self-appraisal affordance (SEAA)	1.record my fitness activities.
	2.run statistics on my fitness activities.
	3.examine performance metrics in detail.
	4.statistically analyze my fitness performance indicators.
Actualized social appraisal affordance (SOAA)	1.earn compliments from others for my fitness activities.
	2*.earn respect of others for my fitness activities.
	3.get recognized by others for my fitness activities.
	4.get noticed by others for my fitness activities.
	5.follow fitness activities of other people.
	6*.keep an eye on other people’s way of performing fitness activities
Actualized rewards affordance (ARWA)	1.get my fitness activities rewarded.
	2.receive more rewards if I try harder.
	3.obtain virtual rewards (badges, trophies) for my fitness activities.
	4.earn virtual rewards as a token for my efforts in fitness activities.
Actualized reminders affordance (ARMA)	1.get reminded to do a fitness activity.
	2.get notified to perform a fitness activity.
	3.receive reminders when I need to do a fitness activity.
	4.get reminded to reach my fitness activity goals.
<b>Exercise engagement items [13]</b>	
<b>Prompt:</b> Thinking about your fitness activities in the past two weeks, to what extent do you agree with the following statements. <b>When I am performing exercises, ...</b>	
Cognitive exercise engagement (CEE)	1.My mind is focused on performing the fitness activity.
	2.I focus attention on performing the fitness activity.
	3*.I become absorbed in performing the fitness activity.
	4*.I pay attention to perform the fitness activity.
	5.I concentrate on performing the fitness activity.
	6*.I devote attention to perform the fitness activity.
Emotional exercise engagement (EEE)	1.I am enthusiastic in relation to performing the fitness activity.
	2.I feel energetic in relation to performing the fitness activity.
	3*.I feel positive about performing the fitness activity.
	4.I am excited about performing the fitness activity.
	5*.I am interested in performing the fitness activity.
<b>Fitness goal attainment items [6,26]</b>	
<b>Prompt:</b> Thinking about your fitness activities in the past two weeks, to what extent do you agree with the following statements. <b>During the past two weeks, ...</b>	
Fitness goal attainment (FGA)	1.I have made considerable progress toward attaining my fitness goals.
	2.I accomplished what I set out to do with my fitness goals.
	3.I am getting closer to my fitness goals.
	4.I was able to carry out my decision to progress my fitness goals.

5*.I was successful in acting on my decision to pursue my fitness goals.
6.I have had success in achieving my fitness goals.
<i>Notes:</i> * Item SOAA2,6, CEE3,4,6, EEE3,5, and FGA5 were dropped because their modification indices (MI) values suggested there were redundant items.

Age, gender, exercise frequency, exercise recency, frequency of using fitness technologies, recency of using fitness technologies, and experience with fitness technology were included as control variables for fitness goal attainment.

## 4.2. Data analysis and results

Covariance-based structural equation modeling (i.e., CB-SEM) method was applied to analyze both the measurement model and the structure model. As our model is built with all reflectively measured latent variables, the CB-SEM technique is the most appropriate method [27]. We used AMOS 27.0 as the primary statistical tool.

For the measurement model testing, we conducted confirmatory factor analysis (CFA) using the Maximum Likelihood procedure. As shown in Table 2, the goodness of fit indices met their respective recommended values [28].

**Table 2. Summary of goodness of fit statistics for CFA and SEM**

Model	$\chi^2/df$	CFI	NFI	SRMR	RMSEA
Measurement model	2.144	0.927	0.872	0.051	0.072
Structural model (without control variables)	2.132	0.926	0.871	0.053	0.072
Structural model (with control variables)	1.978	0.902	0.819	0.072	0.067
Recommended value	<3.0	>0.90	> 0.80	< 0.08	< 0.08
<i>Notes:</i> $\chi^2/df$ = the ratio of chi-square ( $\chi^2$ ) to degrees of freedom (df); CFI = comparative fit index; NFI = normalized fit index; SRMR = the standardized root mean square residual; and RMSEA = root mean square error of approximation.					

We further assessed the measurement model by examining convergent validity, discriminant validity, and reliability of all reflective constructs. Cronbach’s alpha and composite reliability scores of all constructs were greater than 0.70, demonstrating high levels of reliability for each construct (see Table 3).

**Table 3. Reliability**

Construct	Items	Composite reliability	Cronbach’s alpha	AVE
SEAA	4	0.817	0.813	0.727
SOAA	4	0.949	0.946	0.907
ARWA	4	0.941	0.940	0.894
ARMA	4	0.913	0.912	0.850
CEE	3	0.859	0.854	0.819
EEE	3	0.847	0.844	0.806
FGA	5	0.907	0.905	0.814

All items loaded significantly on their respective constructs with loadings higher than 0.65, and the average variance extracted (AVE) for all constructs exceeded 0.50, demonstrating good convergent validity. All items loaded more strongly on their corresponding construct than on other constructs, and the square root of AVE for each construct, as reported in the diagonal of the correlation matrix, was greater than the inter-construct correlations, demonstrating good discriminant validity (see Table 4).

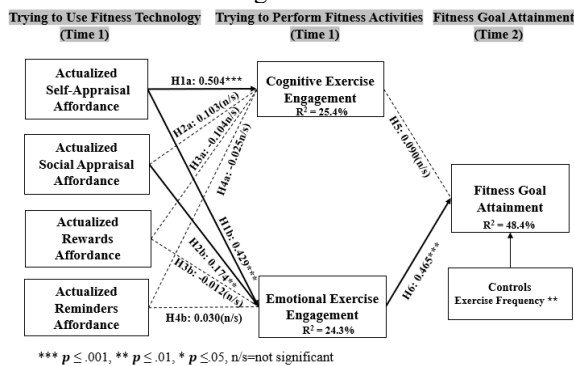
**Table 4. Correlation table**

	1	2	3	4	5	6	7
1.SEAA	<b>0.720</b>						
2.SOAA	0.130	<b>0.907</b>					
3.ARWA	0.168	0.550	<b>0.894</b>				
4.ARMA	0.422	0.387	0.555	<b>0.851</b>			
5.CEE	0.570	0.069	0.014	0.122	<b>0.819</b>		
6.EEE	0.577	0.302	0.198	0.296	0.699	<b>0.798</b>	
7.FGA	0.444	0.222	0.158	0.205	0.344	0.671	<b>0.814</b>

Notes: Square root of AVEs on the diagonal

The marker variable technique evaluated common method variance (CMV) [29]. We examined the revised correlations among the constructs after correcting the correlations for the marker variable and found that the significance of these variable correlations did not change. Thus, common method bias was unlikely to be a concern.

We analyzed the hypothesized relationships and included the control variables to test the structural model. The bootstrapping method with 5000 resamples and a 0.95 confidence interval (CI) was used to test the significance of path coefficients. Results are shown in Figure 2.



**Figure 2. Research model results**

H1a, H1b, H2b, and H6 were supported. Actualized self-appraisal affordance (H1a) positively influences cognitive exercise engagement, explained 25.4% of the variance in cognitive exercise engagement. Actualized self-appraisal affordance (H1b) and actualized social appraisal affordance (H2b) positively influence emotional exercise engagement, together explained 24.3% of the variance in emotional exercise engagement. Contrary to our expectations,

the effect of actualized rewards affordance (H3a,b) and actualized reminders affordance (H4a,b) on cognitive and emotional exercise engagement were not significant. The relationship between cognitive exercise engagement and fitness goal attainment (H5) was not significant. However, emotional exercise engagement did influence fitness goal attainment (H6). Emotional exercise engagement explained 39.5% of the variance in fitness goal attainment. Regarding the effect of control variables on fitness goal attainment, consistent with the theory of trying [7], exercise frequency had a significant positive influence on fitness goal attainment, explaining another 8.9% of the variance in fitness goal attainment. However, no other control variables exerted an effect.

We also conducted bootstrapping analyses [30] using AMOS to test the mediation effects of cognitive and emotional exercise engagement on the relationships between four actualized fitness technology affordances and fitness goal attainment. Our results indicate that emotional exercise engagement partially mediates the relationships between actualized self-appraisal affordance and fitness goal attainment in our model and fully mediates the relationship between actualized social appraisal affordance and fitness goal attainment. Since actualized rewards affordance and actualized reminders affordance did not influence cognitive and emotional exercise engagement, it was not surprising that no mediation effects were detected regarding these affordances.

## 5. Discussion

This research explores the determinants of fitness goal attainment, focusing on the relative roles of trying to use fitness technologies and trying to perform fitness activities. Using four actualized fitness technology affordances and exercise engagement, we demonstrate how trying to use fitness technologies impacts trying to perform fitness activities. In doing so, this study offers theoretical and practical implications.

This research helps fitness technology literature advance from investigating the main effects between fitness technology use and its outcomes to an explanation of a mediating mechanism of fitness technology use and its outcomes. We explain how fitness goals are achieved via fitness technology use, emphasizing the importance of understanding how trying to use fitness technologies influences trying to perform fitness activities.

We also contribute to fitness technology use literature that calls for research to employ rich use concepts to represent fitness technology use behaviors [31]. We identify and utilize four actualized fitness

technology affordances (i.e., actualized self-appraisal affordance, actualized social appraisal affordance, actualized rewards affordance, and actualized reminders affordance) to represent trying to use fitness technologies. By consolidating similar fitness technology affordances with different labels in the literature, we identified four actualized fitness technology affordances representing the key actions that people perform when they use fitness technologies for fitness goal pursuit. Thus, our research helps build a common language for future research on actualized fitness technology affordances.

This study examines trying to perform fitness activities from the exercise engagement perspective. The effect of cognitive and emotional exercise engagement on fitness goal attainment represents the impact of trying to perform fitness activities on fitness goal attainment. Our results indicate that fitness goal attainment is positively influenced by emotional exercise engagement but not cognitive exercise engagement. This finding demonstrates that individuals' pursuit of fitness goals is likely to be more successful when they are emotionally engaged in performing fitness activities and feel excited about exercising. Thus, understanding how fitness technology promotes or limits users' emotional exercise engagement is key to using fitness technologies effectively for fitness goal pursuit.

Our findings also indicate that actualized self-appraisal and social appraisal affordances exert significant positive effects on users' emotional exercise engagement. Thus, it is important for individuals to put more effort into using fitness technology features that evaluate their performance either in a self-appraisal or a social appraisal manner than into rewards and reminders features.

Although we hypothesized that the actualized rewards and reminders affordances might affect cognitive and emotional exercise engagement, these relationships were found non-significant. A potential explanation is that the effect of reminders and rewards on changing people's attitudes towards exercising is brief and may dissipate before users perform a subsequent fitness activity. This is because receiving reminders and rewards requires no cognitive processing of how these are triggered [32], let alone reflection on how they might improve subsequent fitness activity performance.

This research provides some practical implications. From a social and personal benefit standpoint, this research informs users on making the best use of fitness technology to accomplish fitness goals. From a business perspective, the study provides information for organizations to design the fitness technology component of corporate wellness programs to achieve

an adequate return on investment. Finally, the results may help fitness technology designers improve fitness technology features.

Our results support the notion that fitness technology is a valuable tool for reaching fitness goals when users employ it in a way that boosts emotional exercise engagement. Our results show that actualizing self-appraisal and social appraisal affordances can improve emotional exercise engagement. Therefore, users should use the fitness technology features for self-appraisal and social appraisal of their performance. The first step is knowing what features help actualize self-appraisal and social appraisal affordances. Recommended features include auto-tracking, manual tracking, data analysis, data sharing, social communities, and leaderboards [3]. Using these features to realize fitness activity performance is the next step. Technology-mediated self-evaluation activities include feedback about fitness activity performance and progress, reflection on what was done well, planned improvements, and following through on suggestions provided by technology features.

Organizations seeking to incorporate fitness technology into corporate wellness programs should select optimal fitness technology products that enable users to actualize self-appraisal and social appraisal affordances. As Giddens et al. [1] point out, corporate wellness program managers need to find ways to encourage enrolled employees to maintain their usage. Our findings suggest that these program managers could leverage the power of their offline organizational social structure to facilitate the actualization of self-appraisal and social appraisal affordances among enrolled employees. A user guide to fitness technology can be issued to employees when they enroll in the program, introducing fitness technology features and how to use them to evaluate fitness activity performance from self-reference and a social reference approach. Sharing successful experiences using fitness technologies to pursue fitness goals via email notifications and webinars is another way to keep employees informed and reduce obstacles to the deployment of self-appraisal and social appraisal affordances. Designing virtual and offline team-based, inter-departmental, or CEO-led corporate wellness challenges is one way to offer employees opportunities to use the self-appraisal and social appraisal affordances. Corporate wellness program managers can also organize monthly online or offline group discussions for participating employees to reflect on their fitness activity performance and progress. They can create social interaction groups specific to fitness technology products and invite interested employees to join these



groups. Further, managers can design group policies to create a friendly social comparison environment for employees.

Fitness technology designers can work to make the actualizing process of self-appraisal social appraisal affordances easier and more accessible. Designers should emphasize the features that enact self-appraisal and social-appraisal affordances by making these features default or by adding hints on how to use them [12]. Another approach is to add features that allow users to track reflections on their fitness activity performance, like adding a short survey or journal to the data analysis feature. Designers can also work with fitness technology users through a discussion board to welcome ideas about potential features that expand fitness technology affordances.

## 6. Limitations and future research

Our research has some limitations. Due to participant subjectivity in self-rating fitness goal attainment, social desirability bias is a possible concern. Since self-report measures are used in the study, recall bias may be a methodology limitation. We ask participants questions about their fitness activities and their use of one or more fitness technologies in the past two weeks. Performing fitness activity is a time-consuming and explicit behavior that may be easy to remember. Thus, we believe that a two-week interval helps ensure a smaller recall bias.

Note that there might exist time differences between the actualization of fitness technology affordances and the time when people perform fitness activities. We treated the time differences as a systematic error. We measured the general level of each actualized fitness technology affordance based on the use of fitness technology within the past two weeks and the general level of cognitive and emotional exercise engagement when users perform fitness activities within the past two weeks. Given the dynamic nature of user interactions with fitness technology and of exercise progress, individual levels of actualized fitness technology affordances, exercise engagement, and fitness goal attainment may fluctuate within short periods. An experimental study design is needed to measure these constructs in real-time. Future research can examine how temporal differences change these relationships between fitness technology affordances and exercise engagement. Such a study could help capture the richness of real-world fitness technology use and its consequences.

Although we have distinguished participants' exercise patterns (e.g., exercise frequency and recency) in the data collection, there is no information on how people view themselves in relation to exercise.

Individuals' exercise identity (i.e., who I want to be in terms of exercising) [33] and their fitness level (e.g., novice, intermediate, and advanced) [32] may influence exercise engagement. Our survey did not collect information regarding the types of fitness activities participants performed. Thus, this study cannot reveal how the difficulty of exercise tasks (e.g., yoga) influences exercise engagement.

We acknowledge the possibilities that fitness technologies might provide challenges for users' exercise engagement and fitness goal attainment due to their features and the way they play into users' experience. Because previous literature suggests that technology affordances can limit as well as enable [9,11]. Thus, future research could look at that perspective and draw a more complete picture of how fitness technology improves/worsens users' fitness experience.

## 7. Conclusion

Fitness technology has been promoted as a facilitator of individuals' fitness goals. However, to realize desired health benefits, fitness technology users, designers, and organizations that incorporate fitness technology into wellness programs need a richer understanding of how fitness technology drives fitness goal attainment. To support this aim, this study looks at fitness technology use behavior from the goal-directed behavior perspective. Specifically, we seek to understand whether and how different uses of fitness technology exert differential effects on individuals' fitness experiences and fitness goal achievements. Our results suggest that fitness technology users benefit from using fitness technologies for fitness goals when they use features to evaluate their fitness activity performance from a self-appraisal or a social appraisal perspective. These two types of fitness technology use increase emotional engagement in exercising. Emotional exercise engagement is a key mediator for the effectiveness of fitness technology use in achieving fitness goals.

## 8. References

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