

# On the Fit in Fitness Apps: Studying the Interaction of Motivational Affordances and Users' Goal Orientations in Affecting the Benefits Gained

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**Abstract.** Lacking regular physical activity is a pertaining problem in most western societies. Fitness apps are positioned to address this issue by offering motivational affordances to the user, which aim to enhance motivation and increase physical activity: self-monitoring, rewards, and social comparison. Yet research provides inconclusive results about their effectiveness. For clarification, this paper draws upon Achievement Goal Theory and theorizes how and why motivational affordances vary in dependence of users' motivation-relevant goals in supporting motivation and physical activity. Empirical validation among 283 fitness app users generally supports that motivational affordances need to be congruent with users' underlying goal orientations to achieve the benefits. As such, this paper contributes to fitness app research by resolving prior inconsistencies, offers a theorizing on motivational affordances and individual motivation-relevant differences, and aids practice in designing fitness apps.

**Keywords:** Fitness apps, Motivational affordances, Achievement goal theory.

## 1 Introduction

January, 12th is unofficially called the *Quitters Day* [1]. According to recent analytics of millions of fitness app users, most of them give up their New Year's resolutions to be more physically active only twelve days later [1]. This insight remarkably echoes two prevalent issues: lacking regular physical activity and questionable effectiveness of fitness apps to sustainably motivate users.

The lack of regular physical activity is a pertaining problem for most western societies [2]. Although of high importance for health and well-being, most people are not regularly physically active as recommended [3]. For instance, only 43% of the German population meets the recommended minimum of physical activity in 2018 – a serious downward trend compared to 60% who met the recommendation in 2010 [4]. Initiating and sustaining physical activity is a great challenge for health promotion [2].

Fitness tracking applications and devices aim to address this issue [5, 6, 7] and gain huge public interest [7, 8]. In 2018, about 489 million people already use a fitness

tracker [9]. Today, the worldwide market has an estimated revenue of 16 billion USD and is expected to increase in the next years [9]. To motivate people for physical activity, fitness tracking applications ('fitness apps') provide different 'motivational affordances' to the users: self-monitoring, rewards, and social comparison [10, 11].

Although these are expected to benefit individuals by increasing motivation and physical activity, studies draw an overall inconclusive picture about their influence raising controversial discussions about the role these affordances play [5, 6, 7]. It is known that the expected benefits do not unfold to the same extent for every fitness app user: each motivational affordance can be 'motivating' for some – but 'demotivating' for others [5, 6, 7]. Today, however, we lack an understanding as to *why* the motivational affordances are not necessarily of equal benefit for everyone. Understanding the particular effects and causes allows to tailor the motivational affordances and hence to design effective fitness apps that motivate users individually.

Although it is well-known that individuals, and hence fitness app users, can greatly differ in their underlying motives and goals for physical activity [12, 13], little attention has been paid to such motivation-relevant differences of the users and their interplay with motivational affordances in affecting the benefits gained from fitness apps. Therefore, this paper asks: *How do motivational affordances and motivational differences of the users interact in affecting the benefits gained from using fitness apps?*

To provide answers to this question, this paper develops a parsimonious theoretical understanding of how motivational affordances and motivation-relevant user characteristics interact in providing the expected benefits. Drawing upon the key tenets of Achievement Goal Theory [14, 15], we discuss that motivational affordances serve as 'goal structures' that need to be congruent with the 'goal orientations' of the users in order to provide the expected benefits. Quantitative data (N=283) generally lend support for our theoretical considerations, so that this paper contributes to 1) fitness app research by resolving parts of the inconclusive findings about motivational affordances by taking user characteristics into account [5, 6, 7, 16] and 2) by offering a theorizing on motivational affordances [17] explicating their motivation-theoretical characteristics and their interaction with individuals' motivational goals in unfolding their potentials.

The rest of this paper unfolds as follows. Next, we outline the theoretical background of motivational affordances in the context of fitness apps and introduce the key tenets of Achievement Goal Theory. Then we develop our theoretical considerations and detail our hypotheses subsequently. Finally, we lay out our methodological approach and the research results before discussing the findings, implications, and limitations.

## **2 Theoretical Background**

### **2.1 Motivational Affordances within the Fitness App Context**

Fitness apps – such as Strava or Nike+ Running – aim to increase motivation and physical activity. These apps record and document physical activity metrics such as distance, speed, or heart rates and can be used standalone or in combination with devices such as Fitbit wristbands [8]. To augment the recorded data, to induce

motivation, and to sustain physical activity, fitness apps provide a set of ‘motivational affordances’ to the user [5, 6, 7, 16] that build upon self-quantification, gamification, and social network capabilities [16, 18].

The general concept of ‘*affordances*’ is defined within the information systems (IS) research context as “*the possibilities for goal-oriented action afforded to specified user groups by technical objects*” [19, p. 622]. Affordances reflect the potential ways of using IT and aid understanding how the benefits of IT unfold [19]. Using this general notion of affordances in the motivation context, ‘*motivational affordances*’ denote “*the properties of an object that determine whether and how it can support one’s motivational needs*” [17, p. 145]. Popular motivational affordances in fitness apps (Table 1) include ‘self-monitoring’, ‘rewards’, and ‘social comparison’ [10, 11].

**Table 1.** Popular motivational affordances of fitness apps [10]

<i>Affordance</i>	<i>Definition: The possibility to...</i>	<i>Feature examples</i>
Self-monitoring	... systematically document and observe one’s sport behavior	Logs of activity metrics (e.g., time, distance, pulse)
Rewards	... obtain cognitive or virtual rewards for physical activity	Points, badges, trophies
Social comparison	... compare one’s performance against others	Leaderboards, competitions, activity reports, profiles

The *self-monitoring affordance* of fitness apps provides the possibility to systematically document and observe one’s sports behavior [10] and reflects the cornerstone of the self-quantification [8]. When monitoring themselves, fitness app users seek to observe trends and patterns about their sports behavior. This includes among others whether they are making progress, to ensure that they are maintaining their physical activity or to increase self-awareness about (un)healthy behavior [10]. The *rewards affordance* provides users the possibility to obtain cognitive or virtual rewards for physical activity such as through virtual points or trophies [10] and reflects the gamification aspect of fitness apps [16]. Rewards can be given for achieving self-set activity goals and for making progress (e.g., running a certain distance) but also on normative bases, such as in leaderboards where users obtain trophies for the best sports performance [5]. The *social comparison affordance* reflects the social network aspect [16] that allows fitness app users to compare their performance against other users, for instance through leaderboards, competitions, or others’ activity reports and profile pages [10].

However, little is known about the role these motivational affordances play for increased motivation and physical activity. On the one hand, prior research neglected the particular influence of these motivational affordances as fitness apps have been most often examined as a ‘whole’ [5]. Studies devoted to these particularities, on the other hand, give rise to skepticism about the expected benefits emerging from the motivational affordances. Here, literature reviews draw an overall inconclusive picture reporting positive, neutral, and mixed effects on benefits-related outcomes for the motivational affordances in fitness apps [cf. 5, 6, 7]. As equally accentuated by user stories [e.g., 20], it can be increasingly observed that the achieved benefit of each

motivational affordance differs for users. For instance, due to the self-monitoring affordance, users report higher health awareness, higher satisfaction when achieving sports goals, and heightened sports motivation but for others, this affordance is demotivating because of not making visible progress [20, 21]. As for the rewards affordance, studies observed increases in motivation and physical activity, whilst others detected these effects only in short-term or even found no effects at all [5]. The social comparison affordance can be beneficial by inducing fun and affiliation but it also results in peer pressure, negative self-evaluations, or unwanted competition [20, 22].

Whilst research is aware that the expected benefits do not necessarily unfold for all fitness app users to the same extent [5, 6, 7], we do not know a lot about *why* this differs. Scholars point to potential motivation-relevant individual differences of the users [5, 6, 7], such as different motives [16] or goals [18], that can be influential for the motivational affordances used in fitness apps. Thus, taking motivation-relevant user differences into account may provide a more complete understanding of the role motivational affordances play in accounting for the benefits gained from fitness apps. To understand this potential interplay, we draw upon Achievement Goal Theory next.

## 2.2 Achievement Goal Theory

Human motivation considers the processes that give behavior its energy and direction [12]. Motivation scholars seek to understand the sources of human motivation and their resulting behavior, such as physical activity, suggesting that both the person oneself as well as her/his environment are influential [12, 23]. Achievement Goal Theory (AGT) is a dominant motivation-theoretical framework that considers these dual sources of human motivation and their influence on motivation-relevant cognition, affect, and behavior particularly in the physical activity context [13, 14, 15, 24]. AGT rests on the assumption that individuals are goal-directed beings and achievement goals guide their beliefs, decision making, and subsequent behavior in achievement contexts, such as in the physical activity context [13]. Here, ‘achievement’ reflects the attainment of a personally or socially valued goal that has meaning for the person, such as improving physical abilities, sports performance, or beating others [13]. AGT hence considers two major achievement goals: *mastery goals* focusing on competence development and *performance goals* focusing on competence demonstration [24]. These two achievement goals are salient within the individual – known as ‘goal orientations’ – but also within one’s social environment – known as ‘goal structures’ [24].

*Goal orientations* are dispositional tendencies of the individual [24] where the outlined mastery and performance goals are of centrality. Individuals with a *mastery goal orientation* focus on competence development believing that effort and hard work will lead to competence and mastery [15]. These persons assign value to progress in a self-referenced manner, focusing on learning rather than on the outcome [14, 25]. Thus, fitness app users holding a mastery goal orientation may be eager to improve their physical abilities, to run faster or longer than before, and to observe the progress they made. Individuals holding a *performance goal orientation*, in contrast, define achievement on normative bases and focus on competence demonstration, to show superior ability, to outperform others, and to gain favorable judgments [15]. Fitness

apps may be thus motivating and beneficial for users with a performance goal orientation as the social network functionalities allow them to compare themselves with other users, engage in competitions, and to earn trophies for their sports performance.

*Goal structures*, also referred to as the ‘motivational climate’ [14], are the achievement-relevant and goal-related emphases within the social environment of the individual [14]. They are caused by environmental practices such as specific messages sent by social actors like teachers, sports coaches, or peers [14, 24]. Equally, goal structures can have an emphasis on mastery and performance goals [24]. A *mastery goal structure* emphasizes improvement and understanding where individuals perceive that effort and learning are valued. A *performance goal structure* stresses relative ability, social comparison, and interpersonal competition [14, 24]. We theorize the role of goal structures in our context subsequently (chapter 2.3).

As goal orientations and goal structures are influential for motivation-relevant outcomes, including heightened motivation and physical activity, linkages between these two constructs have been established [13, 24]. One specific linkage considers the interaction between goal orientations and goal structures in beneficial but also detrimental ways [24]. This interactionist approach proposes a conventional ‘*matching hypothesis*’ suggesting that the most positive outcomes are expected when goal orientations and goal structures are congruent concerning their emphasis on mastery and performance goals [24]: individuals holding a mastery goal orientation are expected to achieve higher motivational outcomes when acting within a mastery goal structure whereas individuals high in a performance goal orientation are best situated within a performance goal structure [24]. Hence, goal orientations and goal structures can reinforce or diminish each other in affecting motivation-relevant outcomes depending upon whether the same goals are emphasized [24].

Next, we discuss how the key tenets of AGT with respect to goal orientations and goal structures with differing emphases on mastery and performance goals as well as their interaction translate into the fitness app context to understand how the benefits of fitness apps to induce motivation and heightened physical activity unfold.

### 2.3 Theoretical Considerations

Based on these considerations, we aim to use the key tenets of AGT to better understand the role of motivational affordances in promoting the expected benefits of fitness apps.

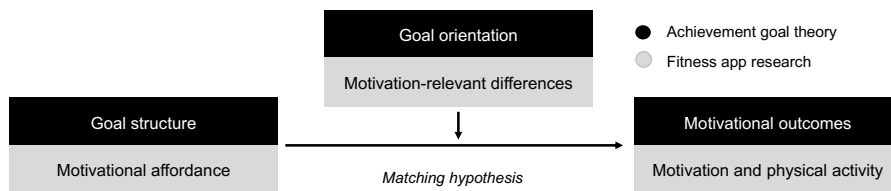


Figure 1. Theoretical considerations

As depicted in Figure 1, we observed parallel lines between fitness app research and AGT. Both fitness app research and AGT are concerned with motivation-relevant

outcomes, particularly heightened motivation and increased physical activity. Moreover, fitness app research indicates the necessity to take motivational differences of the users into account which parallels individuals' goal orientations in AGT. Lastly, AGT considers goal structures as an important environmental factor which shares commonalities with the motivational affordances of fitness apps as follows. Information technology, such as a fitness app, is part of an individual's environment including its associated features and capabilities [23]. These features and capabilities, in turn, have certain qualities making them significant for human motivation [23] as posited by the concept of motivational affordances [17]. Motivational affordances can be thus generally understood as environmental factors which are important sources of human motivation [12, 23]. In terms of AGT, motivational affordances act as goal structures with different emphasis on mastery and performance goals.

In short, the *self-monitoring affordance* provides a mastery goal structure given its emphasis on understanding and improvement in a self-referenced manner [10]. The *rewards affordance* can serve as both mastery and/or performance goal structure because sports performance can be either rewarded due to own achievements and improvements but also on normative bases, such as by leaderboards [5, 10]. The *social comparison affordance* serves as a performance goal structure given its emphasis on normative evaluations of one's sports abilities and achievements [10, 16].

In line with the 'matching hypothesis', the motivational affordances are thus expected to interact with users' goal orientations where higher benefits of fitness apps emerge out of a fit between mastery and performance goal emphasis. We detail our arguments subsequently in our hypotheses development.

### 3 Hypotheses

Because of the inconclusive results about the role motivational affordances play in promoting motivation and physical activity in fitness apps, it is important to understand how and why these benefits do not unfold to the same extent for each user.

In IS research, the benefits gained from IT use are usually labeled as 'net benefits' [26]. As fitness apps aim to enhance motivation and physical activity, net benefits are defined in that context as the extent to which the fitness app has positive impacts on motivation and resulting physical activity. Based on our theoretical considerations just developed (cf. chapter 2.3), we now detail our hypotheses how motivational affordances pronounce mastery and performance goals and thus interact with users' goal orientations in accounting for variations of these net benefits gained.

The *self-monitoring affordance* provides a mastery goal structure to the user [10]. Because it grants the possibility to document sports behavior and to monitor progress in physical activity [8, 10], the self-monitoring affordance focuses on the user's competence and ability and hence emphasizes a mastery goal [14, 24]. As such, the self-monitoring affordance should be particularly beneficial for users holding a mastery goal orientation as it complements their striving to improve their physical abilities and to observe their progress in a self-referenced manner [14, 27]. Recent research in the strand of fitness apps has shown that users holding this mastery goal orientation [18] or

pursuing related physical improvement and achievement motives [16] are more inclined towards features that allow evaluation of performance and progress as resembled in the self-monitoring affordance [16, 18]. This evidence suggests that mastery goal orientations match with the self-monitoring affordance making its positive influence even stronger. Fitness app users holding a performance goal orientation, on the other hand, seek to evaluate their sports ability and performance against other users [15]. Here, the self-monitoring affordance does not provide a complementary goal structure that satisfies their performance goals.

*H1(a-c): The self-monitoring affordance a) poses a positive relationship with net benefits and this relationship is b) stronger for users high in a mastery goal orientation and c) weaker for users high in a performance goal orientation.*

The *rewards affordance* provides a mastery and/or performance goal structure to the user. Rewards can be granted on self-referenced attainments when a user achieved her/his self-set goals such as running 5km, but also on normative bases where a user receives a trophy when her/his performance is better than those of others [5, 10, 16]. Hence, the rewards affordance can be particularly beneficial for users holding a mastery or performance goal orientation. For users with a mastery goal orientation, this affordance values their improvement efforts. Fitness app research tends to support this consideration as users are more attracted by reward-related features of fitness apps when they seek to compare current against past physical conditions or aim at reaching a particular activity goal [18]. For users with a performance goal orientation, this affordance makes their achievements visible to others and awards outperforming other users [5, 10, 16]. Here, fitness app research equally lends support as users high in a performance goal orientation place higher importance on reward-related features [18]. Thus, this affordance supplements mastery and/or performance goal orientations.

*H2(a-c): The rewards affordance a) poses a positive relationship with net benefits and this relationship is stronger for users b) high in a mastery goal orientation and c) high in a performance goal orientation.*

The *social comparison affordance* provides a performance goal structure to the users as it promotes interpersonal competition and public evaluation [14, 28] through features that allow fitness app users to compare their performance against others users' performances [10]. This affordance is thus expected to be most beneficial for users holding a performance goal orientation [24]. Users holding a performance goal orientation describe their achievements on normative bases and seek to become better than others [15]. The social network capabilities of fitness apps allow to observe other users' profile pages and activities or to enter competitions where performances are displayed within leaderboards [10]. The social comparison affordance should thus reinforce their striving for interpersonal performance comparisons. Research indicates that fitness app users pursuing social motives for engaging in sports, such as affiliation and recognition from others, as well as users pursuing competitive motives are more likely to draw upon features allowing performance comparisons against others as well as on features where they can receive recognition from their social network, such as 'likes' [16]. Similarly, performance-oriented users assign higher importance to social network features including other users' activity logs and leaderboards [18]. Mastery-

oriented users, in contrast, should receive fewer benefits from the social comparison affordance because those users focus on self-referenced achievements.

*H3(a-c): The social comparison affordance a) poses a positive relationship with net benefits and this relationship is b) weaker for users high in a mastery goal orientation and c) stronger for users high in a performance goal orientation.*

## 4 Research Method

To test our hypotheses, empirical data with specific characteristics is needed. First, as the functionalities vary between apps [29], a single fitness app providing our focal affordances is required to prevent outside effects. Second, to assess the effects of the ‘social comparison’ affordance, users need to be connected with other users. Third, the fitness app needs to target the same class of activities, such as cardio-intense sports like running or cycling, to assess the achieved benefits (motivation and physical activity).

We chose the fitness app ‘Strava’ ([www.strava.com](http://www.strava.com)), which meets above-mentioned criteria and anecdotal user stories indicate varying benefits [e.g., 20]. As a large number of users is needed, mainly to test interaction effects, we recruited respondents using an online panel of Amazon Mechanical Turk that gained widespread attraction as a viable and reliable source for research [30]. Following recent guidelines [30], we restricted our sample to the United States as such responses provide reliable results similar to regular consumer panels [30, 31]. Our study was conducted in May 2018.

As depicted in Table 2, our measurement instrument was derived from prior literature. Items for motivational affordances [10] were adapted to our context. Goal orientation items were assessed by instructing respondents to think about their sports and exercises [25, 27]. Items for net benefits were based on our definition, compiled from related studies [32], and adapted. We used a 7-point Likert scale for all items.

**Table 2.** Measurement instrument

<i>Construct</i>	<i>Items</i>
<b>Affordances</b>	<i>When I use Strava, I use features that allow me...</i>
Self-monitoring [10]	... to monitor my sport behavior. ... to keep track of my exercise activities. ... to record my physical activities.
Rewards [10]	... to make my physical activity rewarded. ... to get more rewards if I try harder. ... to earn virtual rewards as a token for my efforts in physical activity.
Social comparison [10]	... to compare my performance with the performance of others. ... to compare myself with others regarding what I have accomplished in exercising. ... to find out how I am doing in exercise compared to what others have done.
<b>Mastery goal</b> [25, 27]	It is important to me to perform as well as I possibly can. I prefer challenging goals so that I’ll improve a great deal. I am willing to take on a difficult challenge if it helps me reach my goals.



<b>Performance goal</b> [25, 27]	It is important for me to perform better than others.
	It is important to me to do well compared to others.
	To be honest, I really like to prove my abilities to others.
<b>Net benefits</b> [32]	Using Strava has helped me being physically active.
	I gained motivation to exercise from using Strava.
	I exercise more since using Strava.
	Using Strava makes my sport more enjoyable.

After data collection and preparation, 283 responses were eligible for data analysis [30].<sup>1</sup> The dataset is characterized as follows: 60.4% are male and the average age is 32.4 years (SD 7.96 years). On average, participants use Strava already for 11.5 months (SD 14.1 months) and when it comes to sports, 63.3% use Strava ‘often’ or ‘always’. Participants’ number of followers in Strava is at a median of 16 followers. Asking about their general frequency of performing sports, 78.4% answered with ‘several times a week’ or ‘almost every day’. As such, our sample consists of quite active sports people resonating with recent literature and studies [16, 18, 29].

## 5 Data Analysis

The data was subsequently transferred into Structural Equation Modelling using Partial Least Squares [33] with the software SmartPLS 3. We analyzed the measurement model including common method bias before evaluating the hypothesized relationships [33].

All constructs were modeled using reflective measurements. Evaluation involves indicator and construct reliability as well as discriminant validity (Table 3) [33].

**Table 3.** Measurement model evaluation

<i>Construct</i>	<i>CR</i>	<i>AVE</i>	<i>Discriminant validity</i>						
			1	2	3	4	5	6	
1. Benefits	0.904	0.703	0.838						
2. Monitor.	0.863	0.678	0.667	0.824					
3. Rewards	0.903	0.756	0.397	0.237	0.870				
4. Soc. comp.	0.900	0.750	0.434	0.277	0.595	0.866			
5. Mast. goal	0.862	0.675	0.616	0.537	0.359	0.470	0.822		
6. Perf. goal	0.907	0.765	0.293	0.133	0.490	0.581	0.452	0.875	

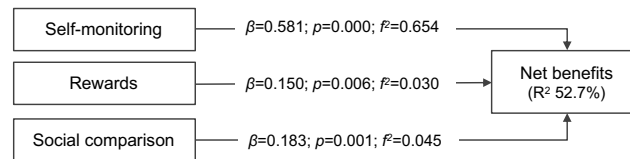
*Indicator reliability* was achieved as all item loadings are greater than 0.707 (0.781–0.892) and are significant ( $p < 0.001$ ). *Construct reliability* was achieved as values for Composite Reliability (CR) and for Average Variance Extracted (AVE) are above 0.7

<sup>1</sup> We received 624 responses whereby 514 passed the screening criteria of currently using Strava. We then removed all non-unique responses based on IP addresses and Worker IDs (N=425). To evaluate the ‘social comparison’ affordance, only participants who indicated being connected with other users were retained (N=293). Finally, responses with failed attention checks and more than five missing answers were dropped (N=283).

and 0.5. Construct reliability is further supported by values for Cronbach's Alpha between 0.760 and 0.859. *Discriminant validity* is supported as 1) each item loads highest on its designated construct, 2) as the Fornell-Larcker criterion is fulfilled given that the inter-variable correlations are smaller than the root of the corresponding AVE as demonstrated in the diagonal lines [33], and 3) as the heterotrait-monotrait ratio with the highest value of 0.81 is below 0.85 [34].

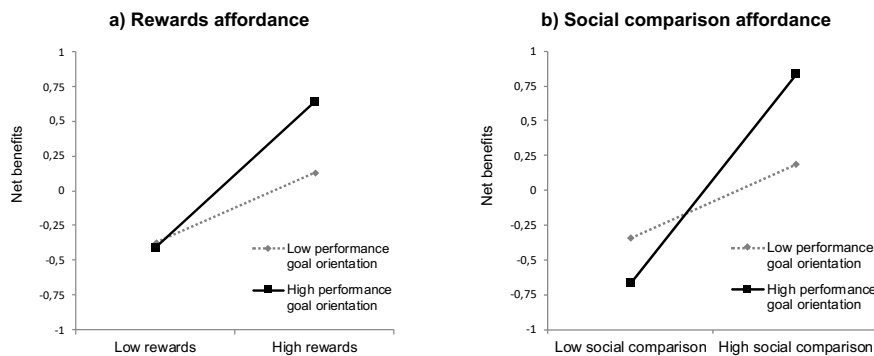
*Common method bias (CMB)* can be of concern when using self-reported data obtained through a single method [35]. To mitigate the potential influence, we stressed anonymity, the academic purpose, that there are no wrong or right answers, and randomized item ordering [35]. To evaluate its presence in our data, two tests were conducted. Results of Harman's single factor test indicate that 39.15% of the variance is attributed to one single factor which is not the majority [35]. Performing an additional test [36] by entering a CMB factor into the model containing all items and observing its respective influence on each construct, the resulting ratio of 1:685 is much smaller compared to prior research [36]. Thus, CMB is not a concern in our data.

For hypotheses testing, we first analyzed the motivational affordances on net benefits without the interactions (Figure 2). We obtained an  $R^2$  of 52.7% for net benefits as significantly predicted by the three motivational affordances with medium to large effect sizes [33]. The results hence support hypotheses H1a, H2a, and H3a.



**Figure 2.** Direct effects of motivational affordances on net benefits

Next, we focused on the interactions of each motivational affordance with mastery and performance goal orientations in isolation. As interaction effect sizes are usually small, a conservative interpretation is 0.005 ('small'), 0.01 ('medium'), and 0.025 ('large') [37]. To aid interpretation, we plotted the significant interactions (Figure 3).



**Figure 3.** Interactions of a) rewards and b) social comparison affordance with performance goals

For *self-monitoring*, we did not observe significant interactions with mastery goal orientations ( $\beta=-0.070$ ;  $p=0.091$ ; H1b not supported) nor with performance goal orientations ( $\beta=-0.034$ ;  $p=0.590$ ; H1c not supported) on net benefits. For *rewards*, we found a significant positive interaction with performance goal orientations with a large effect size ( $\beta=0.138$ ;  $p=0.013$ ;  $f^2=0.035$ ; H2c supported) but not with mastery goal orientations ( $\beta=0.010$ ;  $p=0.879$ ; H2b not supported) on net benefits. Lastly, for *social comparison*, we found a significant positive interaction with performance goal orientations with a large effect ( $\beta=0.243$ ;  $p=0.000$ ;  $f^2=0.135$ ; H3c supported) but not with mastery goals ( $\beta=0.048$ ;  $p=0.344$ ; H3b not supported) on net benefits. For all models analyzed, we obtained good model fits with SRMR values of 0.062 to 0.073, which are below the threshold of 0.08. We discuss the results next.

## 6 Discussion

Our research was motivated by the lack of regular physical activity prevailing in most western societies [2] and the inconclusive results about fitness apps and their motivational affordances to increase motivation and physical activity [5, 6, 7]. To resolve the inconsistent findings of prior research, we paid closer attention to the interplay of the self-monitoring, rewards, and social comparison affordances and users' motivation-relevant goal orientations. A quantitative study with 283 users of the fitness app 'Strava' provided support for five of our nine hypotheses. We discuss our findings next before laying out the research contributions, implications, and limitations.

The empirical data highlights the influential role of the three motivational affordances that jointly accounted for 52.7% of the variations of the benefits gained. Self-monitoring emerged to be most influential, which is not surprising as this affordance allows physical activity documentation that is integral to fitness app use [10, 29]. Rewards and social comparison appeared to be less influential, which further increased our interest to take users' goal orientations into consideration. We argued that the influence of motivational affordances varies in dependence upon users' mastery and performance goal orientations. Albeit we only found two significant interactions, these provide meaningful insights for the rewards and social comparison affordances. Because these affordances emphasize a performance goal structure, mostly through leaderboards, they complement particularly performance-oriented users' natural striving for becoming better than others [15] by making their efforts comparable and rewarded on normative bases. Although mastery goal orientations were expected to be a moderating factor as well, we did not obtain the empirical support. This absence can be explained in two ways. First, mastery and performance goal orientations are not mutually exclusive so that individuals can pursue both goals at the same time [13]. Second, Strava positions itself as 'the social network athletes' and our sample consists of quite 'athletic' users holding an above-average mastery goal orientation with little variation (mean 5.52, SD 0.93). As a result, the self-monitoring affordance poses such a strong direct effect that there is little room for variations stemming from users' goal orientations. The rewards affordance in Strava is built on the social network

capabilities, particularly leaderboards, so that rewards are here much more based on normative grounds stressing performance goals rather than mastery goals.

Based on the empirical findings discussed so far, we generally note solid support for our theorized interplay of motivational affordances and users' motivation-relevant goals so that our research makes the following contributions to literature and theory.

First, our paper contributes to *fitness app research* [e.g., 5, 6, 7, 16]. As outlined above, little is known about the role motivational affordances of fitness apps play in promoting motivation and physical activity. Parts of this inhibited understanding are caused because prior research mostly examined fitness apps as 'whole' without paying the necessary attention to the particular roles the motivational affordances play [5]. Thus, we first revealed that the reported benefits of heightened motivation and increased physical activity are generally determined by self-monitoring, rewards, and social comparison affordances. Moreover, prior research also raised awareness that each motivational affordance is not necessarily beneficial for every user – but little has been put forth to understand *why* it can differ [5, 6, 7]. To provide the needed explanations, we took motivation-relevant differences of the users, namely goal orientations, into consideration. We found that the benefits gained from the rewards and social comparison strongly depend upon the goal orientation pursued. Thus, by considering these motivation-relevant differences of the users, our paper resolves parts of the inconclusive findings of prior research [cf. 5, 6, 7]. Our considerations developed here enable further research to better understand the motivational affordances of fitness apps, such as their role in causing psychological need satisfaction and frustration [22] or in promoting continued fitness app use [38].

Second, our paper contributes by *theorizing about motivational affordances and individual differences* [17]. Although motivated by the inconsistent findings in our particular fitness app context, we developed a rather general theoretical account of motivational affordances. As detailed in chapter 2.3 and 3, we noted parallel lines with the key tenets of AGT concerning a) the consequences of interest, b) individual differences in terms of goal orientations, and c) the role of motivational affordances in terms of providing goal structures. This approach provides a refined understanding of the motivation-relevant characteristics of motivational affordances: they act as goal structures with differing emphases on mastery and performance goals. Because of this characterization, our theorizing provides explanations as to why motivational affordances interact with individual goal orientations resulting in variations of the motivational consequences. Our theorizing hereto considers that the motivational affordances and users' goal orientations need to be congruent, sharing the same emphasis on mastery or performance goals. When congruent, the positive consequences amplify yet deteriorate when incongruent. As such, our theorizing provides research with a better understanding of the interplay between motivational affordances and individual, motivation-relevant characteristics. Without this cognizance, researchers may otherwise draw insufficient or misleading conclusions about the role motivational affordances play in achieving the desired outcomes. As such, our theorizing is also useful for other contexts where motivational affordances are expected to favor anticipated outcomes, such as for organizational collaboration systems where similar affordances aim to increase employees' knowledge contributions [39].

For practice, our paper guides the application of motivational affordances in fitness apps. Fitness app vendors need to be aware that users' motivational goal orientations can greatly differ and that motivational affordances are thus not necessarily universally effective in promoting motivation and physical activity. The exposure to motivational affordances, particularly to rewards and social comparison, needs to be tailored to the goal orientations of the users. To achieve this, users' motivational goals should be assessed during initial app interactions in order to expose those affordances that provide the best fit. Then, users are expected to achieve higher benefits for motivation and physical activity so that the expected potentials of fitness apps unfold.

Despite these contributions and implications, we acknowledge some limitations. We focused on one single app offering the focal motivational affordances targeting rather intense cardio sports such as running or cycling. Although fitness app users in this context are already exercising [29], the goals and motives users pursue still differ accounting for differences in the use of cardio-targeting fitness apps [16, 18] and resulting benefits. Likewise, issues concerning the effects of motivational affordances, particularly rewards and social comparison, have also been reported in other fitness app contexts in which users are generally less motivated and in which apps target less intense physical activities such as walking [22]. Thus, to provide further confidence in the theoretical considerations developed here, future research should be carried out across a variety of fitness apps and different target groups, particularly to examine the influence of mastery goals. In this vein, our inquiry is bound to fitness apps offering social network capabilities. Although offered by many popular fitness apps, the app landscape is highly diverse and there are also fitness apps without a 'social dimension' [29], that need to be studied and compared. Hereto, other affordances such as 'exercise guidance' are available depending upon the fitness apps of interest [10, 29] and which can provide further insights. Equally, future research should also investigate other sorts of benefits achieved, such as improved health awareness, to better understand the effects of the motivational affordances provided.

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