Motivation to Use Fitness Application for Improving Physical Activity Among Hispanic Users: The Pivotal Role of Interactivity and Relatedness

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ABSTRACT

Is the current state of fitness applications effective at motivating and satisfying the needs of Hispanic users? With most mHealth research conducted with a predominantly white population, the answer to this question is lacking. In this study, we address this question through a survey study with Hispanic users of fitness applications (N= 211) and use the Motivational Technology Model (MTM) and Self-Determination Theory (SDT) as theoretical frameworks. We found that using interactivity features is essential to inspire more autonomous forms of motivation to use fitness applications. This is because interactivity helps satisfy users' needs for relatedness. However, interactivity also decreased autonomy and competence suggesting the need to design fitness applications that increase relatedness without compromising autonomy. Implications for the design of fitness applications for the population at large and Hispanics, in particular, are discussed.

CCS CONCEPTS

• **Human-centered computing** → Human computer interaction (HCI); Empirical studies in HCI.

KEYWORDS

mHealth, fitness motivation, motivational technology, self-determination, fitness application

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1 INTRODUCTION

Sustained use of fitness applications (e.g., mHealth technology or health practice supported by a mobile device) to increase physical activity (PA) has proven difficult. A national survey reveals approximately 46% of people who start using fitness applications (Apps) eventually stop using them [31]. This trend is heightened when looking at minority populations. For example, while Hispanics have a higher rate of smartphone adoption compared to the general U.S. population (98% vs 93%), they engage with mobile health (mHealth) apps at a much lower rate than the national average (36% vs 58%) [3, 42]. The lower usage of mHealth apps across the Hispanic population, and other underserved communities, may occur because these technologies do not align with users' unique characteristics, socioeconomic, and cultural settings [16]. Most studies testing the efficacy of mHealth technologies have been conducted with a predominantly white population [19], and do not address the specific needs of non-white communities. Hispanics can view PA as "a waste of time," hold different norms regarding weight and body shape, and value social support with close family ties and obligations [5, 12, 24, 34]. Such culture-specific values may detract Hispanics from engaging with fitness Apps for improving PA. In this study, we investigate Hispanic users' experience with fitness-tracking apps. Specifically, we test if the current state of fitness Apps is effective at satisfying the needs of Hispanic adults, and the effects of need satisfaction on intrinsic motivation to use the device. We use the Motivational Technology Model (MTM) [54] and Self-Determination Theory (SDT) [50] as theoretical frameworks and explain them in the sections that follow.

2 BACKGROUND

2.1 Need Satisfaction and Intrinsic Motivation

According to the Self-Determination Theory (SDT), all human beings have an innate tendency for growth and to extend their own capacities. This inherent tendency is known as intrinsic motivation, and it is defined as the natural enjoyment of a particular behavior. Intrinsic motivation is considered to be "the prototype of self-determined activity" (p. 10) because intrinsically motivated people perform activities autonomously and for reasons relevant to self without being influenced by external factors [52]. Intrinsically motivated people tend to enjoy activities to a greater extent and

tend be more persistent, compared to users who perform activities due to extrinsic factors [9, 52]. Although innate in nature, intrinsic motivation can be acquired through a supportive environment that satisfies the basic psychological needs for autonomy, competence, and relatedness [10]. Autonomy refers to the perceived control over one's actions. Competence refers to the feeling of confidence about accomplishing the desired behavior. Relatedness concerns the feeling of being socially related and cared for among others. When the basic needs of autonomy, competence, and relatedness of an individual are met, the performance of an activity is internalized and more likely to be performed for intrinsic (compared to extrinsic) reasons. For example, intrinsically motivated individuals are more likely to engage in PA and be adherent over time compared to individuals performing PA because of non-internalized extrinsic motivators [52].

Modeled on the SDT, the Motivational Technology Model (MTM) [54] proposes that technology can be designed to satisfy users' psychological needs. According to the model, the use of technological affordances, specifically interactivity, customization, and navigability can satisfy the needs of relatedness, autonomy, and competence, respectively. Satisfying users' needs, in turn, can enhance their intrinsic motivation *to use the device*. Motivated users could benefit from the device's fitness features and become physically active as a result. Several researchers have empirically tested the MTM (primarily among Caucasians) finding support for its propositions [6, 61]. Given the unique barriers and motivations to PA among the Hispanic population, we examine if existing affordances of fitness Apps satisfy the basic physiological needs of autonomy, competence, and relatedness of Hispanic users and in turn motivate them to use fitness Apps.

Affordances, or "action possibilities" [17] are properties of the technology understood in respect to how users interact with it [15]. Even though affordances exist in relation to the user, they can exist independently of user perception. As such Norman [45] distinguishes between real or objective affordances (properties of the system suggesting user action) and users' perceived affordance (users' perceptions of the actions available in the system). From a design point of view, testing objective affordances allow the assessment of the contributions of properties of the technology on users' motivations and behaviors [53]. Thus, in this paper, we analyze the effects of the use of objective affordances of fitness Apps on the need satisfaction and motivation of Hispanic users. We operationalize the use of objective affordances by the self-reported use of different features of the technology known to afford interactivity, agency, and competence.

2.1.1 Effects of Interactivity on Intrinsic Motivation. Interactivity is defined as the degree to which fitness Apps provide an environment where users can communicate with each other, synchronously and asynchronously [30]. The MTM posits that affording interactivity increases users' sense of relatedness by facilitating interaction and communication among users [54]. For example, Jung and Sundar [27] found that the number of comments received from Facebook friends and the comments sent to Facebook friends improved relatedness among older adults. Improved relatedness, in turn, increased users' enjoyment of the social media platform. Likewise, in the context of fitness Apps, a recent study reported that perceived interactivity increased sense of relatedness, in turn increasing engagement with the fitness application [61]. It is likely that the effects of interactivity also hold for the Hispanic population. A review of mHealth intervention across Hispanic communities reveals that targeted text messages can be successful at increasing adherence to medication and access to care, especially when text messages are paired with support from community health workers [19].

However, research also suggests that user interactivity may negatively impact motivation and behavior because of social comparison tendencies that are known to lower self-esteem and self-perception [57]. For example, not achieving the expected social rankings and user position in leaderboards decreases users' motivation and users' overall attitudes toward fitness Apps [25, 36]. Even for users who achieve the expected social ranking, interactivity may be counterproductive, especially when users have a strong tendency to compare themselves to others [36]. While the negative effects of interactivity on engagement with fitness Apps have predominantly been analyzed with respect to leaderboards due to their inherent nature to facilitate social comparison, other interactivity features designed to facilitate communication across users may also have similar negative effects. For example, Vogel et al. [58] found that participants' self-esteem decreased when presented with a profile from another user that follows healthy habits and with high activity social network, compared to a profile of a user with unhealthy habits and with low activity social network. In fitness Apps, interactivity features, or those that allow users to communicate with one another, are centered around the notion of the "quantifiable self," with users typically sharing achievements and other positive outcomes in their profiles [59]. These tendencies are more conducive to social comparison. Thus, it may be that the interactivity afforded by fitness Apps may decrease relatedness (rather than increase it), in turn decreasing intrinsic motivation to use the device.

2.1.2 Effects of Customization on Intrinsic Motivation. The MTM also predicts that customization affordances can satisfy users' need for autonomy by allowing the user to tailor to his/her specific needs, imbuing a sense of control [54]. Molina and Sundar [41] found that allowing users to choose workout routines using fitness Apps increased the amount of weight lifted by users as well as aerobic exercise duration. Even cosmetic customization has been associated with better attitudes toward fitness trackers and workout intentions. Kang et al. [29] found that simple cosmetic customization like changing the color of the band and clock faces on a wearable can make users feel more identified with the product, and was associated with better attitudes toward the device and higher intentions to engage in PA. Interventions to enhance PA among Hispanics have also employed customization successfully. Pekmezi et al. [48] found participants who received a personalized PA manual and customized motivational messages had a larger increase in PA compared to the control condition.

Nonetheless, while customization of current fitness technologies can create an impression that the application understands the unique needs of the user, it does not account for the user's norms, values, and worldviews—important components of an individual's identity and behavioral intentions [47]. Research suggests certain

cultural expectations and practices may serve as barriers to health promotion, while others can serve as motivators. For example, barriers to PA that exist in the Hispanic community include balancing caregiver and household responsibilities as well as cultural norms like social support, collectivism and community orientations, and self-sacrifice [48]. Health promotional strategies using technology for Hispanics are likely to be more successful if customization elements are also culturally tailored to consider the specific barriers, needs, shared values, and norms of this population. Nonetheless, the Hispanic community is not a monolith, as such, barriers, need, and values may differ across members of the population. Taking this into consideration, Kreuter et al. [32, 33] differentiate between cultural targeting and cultural tailoring. Cultural targeting refers to taking into consideration the characteristics (values, norms, worldviews) of a subgroup when developing a *single intervention* aimed at that specific subgroup [33]. On the other hand, cultural tailoring acknowledges that variations exist among members of a subgroup regarding a particular belief, and suggests *customizing the user experience individually* based on "understanding how individuals perceive their own culture, the extent to which they identify with it, and the specific cultural values that are important to them" [32] (p. 137). A tailoring approach may allow for customization, by taking into consideration the importance of cultural elements *for each individual* with the understanding that there is great heterogeneity in the cultural characteristics among communities and subcommunities. Such cultural tailoring at the individual level may increase intrinsic motivation to use the device by considering cultural values and acknowledging individual-level variations across the population. Given that current fitness Apps lack this type of cultural tailoring or customization, it is possible that the current customization features are not able to satisfy the need for autonomy among Hispanic users, impeding the development of intrinsic motivation.

2.1.3 Effects of Navigability on Intrinsic Motivation. Finally, the MTM argues that affordances of navigability can satisfy the need for competence by allowing users to explore the environment and access different spaces of an interface [54]. Affording navigability can increase participants' spatial mental models, which predicts the perceived usefulness of smartphone Apps [8, 28]. Perceived usefulness, in turn, increases intrinsic motivation to use a smartphone App, as well as user satisfaction with the App [28]. In this paper, we focus on two features that afford navigability commonly found in fitness Apps: data visualizations and search features.

Data visualizations, or the expression of data in a visual format, are considered integral to data presentation architecture delivering data efficiently for ease of understanding and interpretation [7]. Fitness Apps have traditionally employed data visualizations to allow users to explore their progress and utilize the achievement of goals as benchmarks of success [20]. Goal setting and monitoring strategies are essential to motivate users by enhancing self-efficacy or perceived competence [4]. For example, using PA monitors to visualize progress was considered useful and easy to use by older adults with little technology experience and low overall PA levels [39]. Likewise, a fitness App linking users' daily steps with the growth of a virtual fish improved users' attitudes towards PA and helped them establish new PA routines [37].

However, data visualization can negatively impact motivation for individuals who fail to achieve desired goals especially when they struggle to align qualitative goals with quantitative goals [43, 44]. Thus, it is of utmost importance to redesign data visualizations to avoid demotivating users [2]. While this holds true for the population at large, it may be especially true for Hispanic users, whose goals are not typically considered during the initial stages of the design process of fitness Apps. It is possible that the goals of Hispanic users are less likely to align with the goal-setting format available through current fitness Apps, decreasing their motivation to use the device and the likelihood of them achieving the goals that they have set for themselves. Thus, impacting Hispanic users' alignment with the fitness App. This is supported by the findings of Hill et al. [22] who reported setting personal goals and monitoring progress did not improve PA among Hispanics. Nonetheless, Leeman-Castillo et al. [35] reported that receiving graphical feedback to explore progress significantly improved PA among Hispanic users. Importantly, different from traditional visualization strategies, visualizations in Leeman-Castillo et al. [35] were presented alongside a computerized role model who encouraged a behavioral change goal and anticipated possible barriers. Furthermore, participants received community resources to help them meet their goals. Leeman-Castillo et al.'s work represents simple design elements where visualizations and goal-setting strategies can be adjusted to meet the needs of participants. These design ideas, however, are not yet available in current fitness Apps in the market.

Another navigability feature commonly found in fitness Apps is search functions. The inclusion of a search function is considered integral for the user experience of mobile Apps because it allows easy information retrieval [23]. Nonetheless, search capacities should also be strong. In other words, their effectiveness is contingent on the capability of the search to yield relevant and comprehensive results [23]. One benefit of navigability available on popular search engines is that results are uniquely tailored to each user. This type of personalization is achieved through user data such as browsing history. When the results of searches match the expectations and needs of users, users tend to judge that application as more credible and useful [56]. However, search features of current fitness Apps have not been built with the Hispanic population (or other minorities) in mind. As such, resources available may not pertain to needs or barriers that are important for these users. For example, research suggests family and community obligations, as well as norms about body shape, are barriers to PA among some Hispanic [5, 12, 24, 34]. Not finding resources or necessary information to overcome these barriers and meet fitness goals may reduce competence satisfaction among these users. The reduced competence may result in lower intrinsic motivation to use the device [52].

2.2 Need Satisfaction and Internalization

Importantly, behavior is not always driven by intrinsic motivation (e.g., using fitness Apps due to sheer pleasure) [52]. In fact, behavior related to PA is mostly driven by extrinsic motivational factors (or motivations that are external to the self). SDT distinguishes between four forms of extrinsic motivation that range in a continuum based on the degree that an individual has internalized and integrated the behavior into the self and go from external regulation (e.g., reward,

social recognition), introjected regulation (e.g., avoid anxiety or self-disparagement), identified regulation (e.g., engagement due to health reasons) and integrated regulation (e.g., reasons for engaging align with the values of the user) [11, 50–52]. Integrated regulation is the nearest to intrinsic motivation and is desired for the sustained use of fitness Apps. Sustained use of the device could result in long-term PA adherence.

Users' motivations to engage in a particular behavior can lie anywhere in the continuum, but the closer the user is to intrinsic motivation (also referred to as intrinsic regulation), the more adherent they are likely to be [50]. Such internalization can be achieved by an environment that satisfies users' needs of autonomy, competence, and relatedness. The importance of internalization and the different forms of extrinsic motivation on health and well-being has been well-documented [11, 18]. However, the MTM [54] and previous research testing the model [27, 61], typically discuss and test the relationship between affordances of technology and intrinsic motivation to use the device neglecting the effects on external regulations. We address this gap in the current paper.

In sum, while empirical research has tested the effects proposed by the MTM model [6, 61], these effects have been tested with a predominantly white population. It is unclear if the current state of fitness Apps may help satisfy the needs of relatedness, autonomy, and competence among Hispanic users. Importantly as well, previous research has only considered the effects of technological affordances on intrinsic motivation to use the device and not extrinsic motivation and its different forms. In this study, we investigate Hispanic users' experience with fitness Apps and test if the current state of fitness Apps is effective at satisfying the needs of relatedness, autonomy, and competence among these users. We also test the effects of the satisfaction of the three needs on the different types of motivation to use the device. Conflicting evidence in the literature, however, does not allow us to propose directional hypotheses, as evidenced in the preceding sections. Thus, we pose the following research questions:

RQ1: What is the relationship between the key indicators of the MTM (interactivity, customization, and navigability) a) and need satisfaction (relatedness, autonomy, and competence) b) and the different types of motivation to use the device?

RQ2: Do the satisfaction of a) relatedness, b) autonomy and c) competence mediate the relationship between the key indicators of the MTM and the different types of motivation to use the device?

2.3 Need Satisfaction and PA

To understand the impact of technology on users' well-being, it is essential to look beyond the effects of need satisfaction on engagement with the technology and assess its impact on behavior [49]. In other words, the satisfaction of the basic needs through the use of technology should result in intrinsic motivation to use the fitness App. Users who are more intrinsically motivated to use the fitness App *could* become more physically active as a result of their deeper engagement with the App. However, motivation to use fitness Apps does not guarantee that users will indeed become more physically active. For fitness Apps, the ultimate goal of satisfying users' psychological needs through technology use is to incentivize habit formation that drives PA adherence [54]. Habits are implicit associations between contexts and responses and are developed by repetition of the intended behavior. Habits are known to predict self-regulation and long-term goals, and thus are important to develop in order to achieve PA adherence [60]. Another important goal of satisfying users' psychological needs through the use of technology is to increase the perceived impact that PA has on users' quality of life. As Alloway and colleagues [1] explain, positive and negative emotions about an activity, often linked to particular events and stored in our long-term memory, are an important predictor of commitment to PA because when faced with a similar situation, these emotions drive behavior. In our study, we test if need satisfaction achieved through the use of features of technology that afford interactivity, customization, and navigability indeed results in PA indicators (habit formation and a higher perceived impact of PA). More formally:

RQ3: What is the relationship between the key indicators of the MTM (interactivity, customization, and navigability) a) and PA habit formation b) and perceived impact of PA?

RQ4: Do the satisfaction of a) relatedness, b) autonomy and c) competence mediate the relationship between the key indicators of the MTM and PA indicators (PA habit formation and perceived impact of PA)?

3 METHOD

To answer our research questions, we conducted a survey study using a Qualtrics national panel to recruit participants who self-identify as Hispanic. We received 229 responses from users of fitness Apps[1]. After deleting those who failed more than two attention check questions, the final sample consists of 211 users. Participants' ages ranged from 18 to 71 (M = 35.66, SD = 12.71), 32.7% were male, and 67.3% were female.

3.1 Procedure

After consenting to participate in the study, participants were asked to provide the name of the fitness App they primarily used and the approximate year they started using the App. Next, participants were asked to answer the remainder of the questionnaire thinking about their experiences with the application they listed. We embedded the application listed by participants in the instructions of the following questions to ensure that participants' answers reflected only the experience with their primary application and not another application or fitness device they utilize (see supplemental material for complete questionnaire). Finally, participants were asked to answer questions about their PA (habit formation and perceived impact of PA).

3.2 Measures

3.2.1 Features of Technology (Interactivity, Customization, Navigability). To determine the specific features hypothesized to support or inhibit need satisfaction present in current fitness Apps, we selected the top fifteen Android and Apple fitness apps in the App store based on rankings as of July 21, 2021. Then, a research assistant signed up and created an account for each App. Once the account was created, the research assistant explored the App

[1]As part of a larger project, we collected data from both users and non-users. The current paper only reports findings about users of fitness Apps.

Table 1: List of Features of Technology by Affordance

Features of Navigability	Features of Interactivity	Features of Customization
Use the search function of the app to look for resources that I need.	Send messages to other users.	Upload a profile photo.
Use the search function of the app to look for other functionalities of the application.	Receive messages from other users.	Update information about myself (i.e.: weight, height, body composition).
Navigate through the interface to look for resources.	Check the activities of other users.	Log my workout to the application.
Check my performance after each workout through data visualizations.	Post my workout of the day or my running map for other users of the app to see.	Follow a workout recommended by the application.
Check my overall periodic and/or life-time progress through data visualizations.	Share my workout activities to other social media platforms (Facebook, Twitter, Instagram, etc.).	Follow a workout recommended by other users of the application.
	Compete with other users.	Customize a workout from the application to match my own preference.
	Check the leaderboard of the app.	
	Follow/friend other users.	

entirely and made note of all of the features available that corresponded to features that afford interactivity, customization, and navigability, following the conceptualization from the MAIN model [54] and Molina and Sundar's [41] approach. The research assistant also engaged in a sample workout to observe features that may be available during and after logging workout data. Finally, the research assistant searched through the documentation of the apps and frequently asked questions to ensure features were not missed. After gathering data from all of the apps in the ranking, the team conducted a thematic analysis of the observed features and selected the features that were more widely available and grouped them based on the affordance they represent. As such, we grouped features as follows: 1) Navigability features encompass features that allow users to navigate and explore the interface, and features that allow users to explore their own data such as data visualizations. 2) Customization features encompass features that allow users to customize their workouts and routines, as well as features that allow the user to customize their profile. 3) Interactivity features encompass features that allow users to communicate and interact with other users. Then in the survey, we asked participants how often they use each of the identified features on a 7-point Likert scale (never- very frequently). For a complete list of features identified and asked to participants see Table 1. Items corresponding to each identified feature were summed up for data analysis, resulting in three measures representing the use of features that afford users navigability (M = 25.07, SD = 6.34), that afford users interactivity (M = 27.86, SD= 15.20), and that afford users customization (M = 27.94, SD = 7.91).

3.2.2 Need Satisfaction. We assessed users' perceived autonomy (M = 5.35, SD = 1.20, α = .73) competence (M = 5.34, SD = 1.30, α = .79), and relatedness (M = 4.65, SD = 1.33, α = .72) using Peters et al.'s [49] Technology-based Experience of Need Satisfaction questionnaire. Participants were asked to rate their agreement with the items on a 7-point Likert scale (1 = Strongly Disagree, 7 = Strongly Agree). Sample items include the following: for perceived autonomy "the technology provides me with useful options and choices" and "I can get the technology to do the things I want it to." For perceived competence "I feel very capable and effective at using the fitness tracking application" and "I feel confident in my ability to use the technology." For perceived relatedness: "the technology makes me feel connected to other people" and "the technology helps me to feel part of a larger community."

3.2.3 Types of Motivation. The different types of motivations were measured using the self-regulation scale applied to the technology context from Peters et al. [49]. The measure, like other measures of behavioral regulation, does not include an integrated regulation subscale because integrated regulation is empirically difficult to distinguish from identified regulation and intrinsic motivation. Thus, integrated regulation is often not included or is combined with intrinsic motivation (to represent the more autonomous forms of motivation). Consistent with Peters et al. scale [49], we measured intrinsic motivation and three forms of extrinsic motivation—identified, introjected, and external. Participants rated their agreement on 12 items (1 = Strongly Disagree, 7 = Strongly Agree) about the reasons why they use fitness Apps. Items to measure intrinsic motivation (M = 5.68, SD = 1.17, α = .81) included "it is interesting to use," "I think it is enjoyable," and "it is fun to use." Items to measure identified motivation (M = 5.65, SD = 1.18, α = .80) included "it improves my life," "it helps me do things that are important to me," and "it is of value to me in my life." Items measuring introjected motivation (M = 3.62, SD = 1.82, α = .76) include "I want others to know I use it," "I feel bad about myself if I don't use it," and "it looks good to others that I use it." Finally, items to measure external motivation (M = 2.65, SD = 1.76, α = .79) were "other people want me to use it," "I am required to use it (e.g., by my job, school)," and "I feel pressured to use it."

3.2.4 Perceived Impact of Physical Activity. We assessed participants' perceived impact of PA using an adapted measure from Alloway and colleagues [1]. Participants responded to a battery of 14 questions on a 7-point Likert Scale (1 = Strongly Disagree, 7 = Strongly Agree). Sample items included: "I feel more energized after participating in physical activity" and "I get pleasure out of participating in physical activities" (M = 4.99, SD = .95, α = .83).

3.2.5 Habit Formation. To measure the extent to which PA has become a habit for participants, we used the 12 items from Gardner's Self-Report Behavioral Automaticity Index (SRBAI) [14]. The scale asked participants to rate their agreement (in a 7-point scale) with statements regarding their engagement with PA. Items included: Engaging in physical activity is something that "I do automatically"

and "I do without having to consciously remember" (M = 4.65, SD = 1.38, α = .941).

3.2.6 Power Use. We statistically controlled for power usage, defined as the efficacious and comfortable use of technology because power users are known to use technology more than the average user and feel more comfortable using it. We measured power use through Sundar and Marathe's [55] scale and asked participants to rate their agreement with a battery of 12 items on a 7-point Likert scale (1=Strongly Disagree, 7=Strongly Agree). Items included: "I think most technological gadgets are complicated to use (reverse coded)" and "I make good use of most features available in any technological device" (M = 5.03, SD = .96, α = .84).

3.3 Data Analysis Plan

First, to test RQ1and RQ3 asking about the relationship between types of features (interactivity, customization, and navigability) and need satisfaction (RQ1a), motivations (RQ1b), habit formation (RQ3a), and perceived impact of PA (RQ3b), we run a series of hierarchical linear regression analyses, one for each dependent variable. It is suggested that hierarchical regressions are employed when the intent is to examine "the contributions of specific variables after controlling for general variables" (p. 205) [26]. This is because, in hierarchical linear regressions, predictors are entered in blocks, each representing one step [13]. The predictors entered in the first block are statistically controlled for in the second block, and thus the second block represents the effect of the second set of predictors after controlling for the variables entered in the first block. This analysis method allows us to predict the effects of each feature or indicator of the MTM (interactivity, customization, and navigability), after controlling for other variables that may influence these effects. As such, in the first block, we entered control variables (the year that users started using the app, gender, age, and power use), and in the second block the use of features of fitness Apps. Thus, the reported results represent the effects of features of interactivity, customization, and navigability after controlling for the year that users started using the app, gender, age, and power use.

Then, to test RQ2 and RQ4, asking about the mediating role of need satisfaction, on the relationships between the use of each type of feature (interactivity, navigability, and customization) and the different types of motivation (RQ2) and PA indicators (RQ4), we conducted a series of mediation analyses using PROCESS macro model 4 [21], with 95% bias-corrected confidence intervals based on 5000 bootstrap iterations. We run one mediation for each type of feature and dependent variable. The year that users started using the app, gender, age, and power use were entered as control variables. We additionally entered the features not used as independent variables as control variables. For example, when analyzing the effects of the use of navigability on intrinsic regulation, we entered the features of interactivity and customization as controls.

4 RESULTS

4.1 Main Effects of Features of Technology

In examining the relationship between the indicators of MTM and need satisfaction (RQ1a), the hierarchical linear regressions (reported in Table 2) reveal that although using navigability features was a positive predictor of autonomy and competence, it had no statistically significant effect on relatedness. Interestingly, while the use of features of interactivity was a positive predictor of relatedness, it was a negative predictor of autonomy and competence. Customization features did not satisfy any psychological needs outlined by SDT, as evidenced by non-significant effects on the three outcome variables.

In investigating the relationship between the indicators of MTM and the types of motivations (RQ1b), the hierarchical linear regressions (reported in Table 3) reveal that using features of navigability was a positive predictor of intrinsic motivation and identified regulation but a negative predictor of introjected regulation. Features of navigability had no effect on external regulation. Secondly, using features that afford customization, was a positive predictor of introjected regulation but had no statistically significant effect on intrinsic motivation, identified regulation, or external regulation. Lastly, using features of interactivity was a positive predictor intrinsic motivation, introjected regulation, and external regulations, but not identified regulation (as evidenced by the non-significant effect).

In testing the relationship between the indicators of MTM and the PA indicators (RQ3), the hierarchical linear regressions (reported in Table 4) show that only interactivity was a significant positive predictor for impact of PA and habit formation. There was no statistically significant effect of navigability or customization for any of the PA variables.

4.2 Mediating Role of Need Satisfaction

Results of RQ2 asking about the mediating role of need satisfaction on the relationships between the use of each type of feature (interactivity, navigability, and customization) and the types of motivation are presented in Table 5. When entering the use of navigability features as the independent variable, our mediation analyses reveal that using features of navigability satisfies the need of autonomy of users. Autonomy satisfaction, in turn, increases identified regulation and decreases external regulation. Patterns of the mediations are illustrated in Figure 1 and reveal that a unit increase in the use of navigability features increases autonomy satisfaction by .23 units. A unit increase in autonomy, in turn, increases identified regulation by .23 units and decreases external regulation by .42 units. There were no significant indirect effects when entering intrinsic motivation as the dependent variable. Neither when entering introjected regulation as the dependent variable.

When entering interactivity features as the independent variable our mediation analyses (Table 5) reveal that interactivity features increase relatedness satisfaction. Relatedness satisfaction, in turn, increases intrinsic motivation, identified regulation, and introjected regulation. Patterns of the mediation are illustrated in Figure 2 and reveal that a unit increase in the use of interactivity features, increases relatedness by .32 units. A unit increase in relatedness satisfaction, in turn, increases intrinsic motivation by .40 units (panel A), identified regulation by .25 units (panel B) and, introjected regulation by .18 units (panel C).

Interestingly, using interactivity features also reduced autonomy satisfaction, resulting in an overall decrease in identified regulation. The reduced autonomy also increased external regulation. Patterns

Table 2: Predictors of Need Satisfaction

	Autonomy β	Competence β	Relatedness β
Step 1: Controls			
Year of membership	-.03	-.03	.04
Gender (1= Female)	.09	.03	.03
Age	.14*	.05	-.09
Power Use	.33***	.30***	.38***
R^2	.15	.10	.16
Step 2: Ind. Variables			
Interactivity	-.40***	-.40***	.32***
Customization	-.03	-.14	.16
Navigability	.23*	.33***	-.04
Incremental R^2	.12	.13	.16
Total R^2	.27	.22	.32

* $p < .05$, ** $p < .01$, *** $p < .001$. β represents standardized coefficients.

Table 3: Predictors of Types of Motivation

	Intrinsic Motivation β	Identified Regulation β	Introjected Regulation β	External Regulation β
Step 1: Controls				
Year of membership	.02	.06	.04	.06
Gender (1= Female)	.08	.09	-.07	-.11
Age	.08	.10	-.15*	-.19**
Power Use	.43***	.44***	.15*	-.06
R^2	.21	.23	.04	.05
Step 2: Ind. Variables				
Interactivity	.19*	.08	.61***	.63***
Customization	-.06	.02	.20*	.05
Navigability	.29**	.24**	-.17*	-.12
Incremental R^2	.12	.08	.41	.35
Total R^2	.33	.30	.46	.40

* $p < .05$, ** $p < .01$, *** $p < .001$. β represents standardized coefficients.

Table 4: Predictors of PA Variables

	Impact of PA β	Habit Formationβ
Step 1: Controls		
Year of membership	.03	.10
Gender (1= Female)	-.04	-.15*
Age	.14*	-.02
Power Use	.46***	.35***
R^2	.23	.13
Step 2: Ind. Variables		
Interactivity	.20**	.45***
Customization	.12	.03
Navigability	.07	-.03
Incremental R^2	.10	.20
Total R^2	.33	.33

* $p < .05$, ** $p < .01$, *** $p < .001$. β represents standardized coefficients.

Table 5: Mediating Role of Need Satisfaction in the Relationship Between MTM Indicators and Types of Motivation

	Intrinsic Motivation Indirect Effects	Identified Regulation Indirect Effects	Introjected Regulation Indirect Effects	External RegulationIndirect Effects
IV: Navigability				
Autonomy	.01, CI: [-.03, .05)]	**.05 [.01, .12])**	-.04, CI: [-.11, .003)]	**-.10, CI: [- .21, - .02]**
Competence	.03, CI: [-.02, .10]	.03, CI: [-.01, .10]	-.04, CI: [-.11, .01]	-.03, CI: [-.09, .03]
Relatedness	-.01, CI: [-.09, .07]	-.01, CI: [-.06, .04]	-.01, CI: [-.04, .03]	-.001, CI: [-.02, .01]
IV: Interactivity				
Autonomy	-.02, CI [-.08, .04]	**-.09, CI [-.17, -.03]**	.07, CI [-.004, .15]	**.17, CI [.08, .27]**
Competence	-.04, CI [-.10, .02]	-.04, CI [-.11, .02]	.04, CI [-.02, .12]	.04, CI [-.03, .11])
Relatedness	**.13, CI [.04, .23]**	**.08, CI [.02, .16]**	**.06, CI [.01, .12]**	.01, CI [-.02, .05]
IV: Customization				
Autonomy	-.001, CI: [-.02, .02]	-.01, CI: [-.05, .04]	.01, CI: [-.02, .06]	.01, CI: [-.06, .11]
Competence	-.01, CI: [-.05, .01]	-.01, CI: [-.06, .01]	.02, CI: [-.01, .06]	.01, CI: [-.02, .05]
Relatedness	.06, CI: [-.02, .15]	.04, CI: [-.01, .10]	.03, CI: [-.01, .07]	.01, CI: [-.01, .03]

Note: Indirect effects represent standardized indirect effects. Brackets indicate 95% confidence intervals. Significant indirect effects are presented in bold.

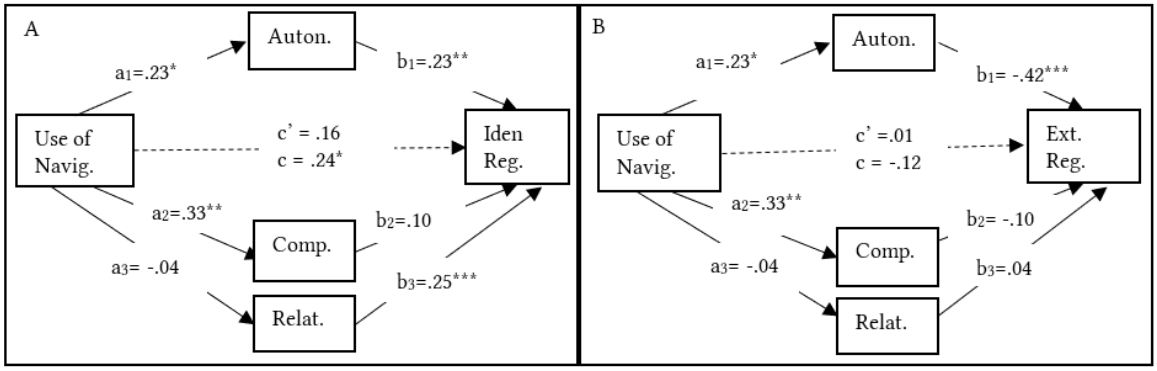

Figure 1: Mediating effect of need satisfaction (autonomy (auton.), competence (comp.), and relatedness (relat.), on the relationship between the use of navigability features (use of navig.) and motivation: identified regulation (iden reg.) [A] and external regulation (ext reg.) [B]. Results reveal significant indirect effects of autonomy such that the use of navigability features, increases users' sense of autonomy. Autonomy, in turn, is a positive predictor of identified regulation, but a negative predictor of external regulation. All presented effects are standardized coefficients (β). c' represents the direct effects of navigability; c represents the total effect of navigability. $^{***}p < .001$; $^{**}p < .01$; $^{*}p < .05$.

of the mediation analysis (Figure 2) indicate that a unit increase in the use of interactivity decreases autonomy by .40 units. However, a unit increase in autonomy increases identified regulation by .23 units (panel B), but decreases external regulation by .42 units (panel D). All other mediation effects with interactivity as the independent variable were non-significant.

There was no significant indirect effects of need satisfaction when customization was entered as the independent variable.

Results of RQ4 asking about the mediating role of need satisfaction on the relationships between the use of each type of feature (interactivity, navigability, and customization) and PA variables, are presented in Table 6. Results reveal that when entering interactivity features as the independent variable, there was a significant positive mediation of relatedness satisfaction on impact of PA. Patterns of the interaction (Figure 3) reveals that a unit increase in the use of interactivity features increases relatedness satisfaction by .32 units. A unit increase in relatedness satisfaction, in turn increases the perceived impact of PA by .32 units. No other mediation analyses were significant.

5 DISCUSSION

The findings of this study reveal the pivotal role of features that afford interactivity and relatedness satisfaction at motivating fitness application use among Hispanic users. Consistent with the MTM model [54], we found that using features that afford interactivity increased relatedness satisfaction among users. Relatedness satisfaction, in turn, increased their intrinsic motivation to use the fitness App (or enjoyment for using the App). The increase

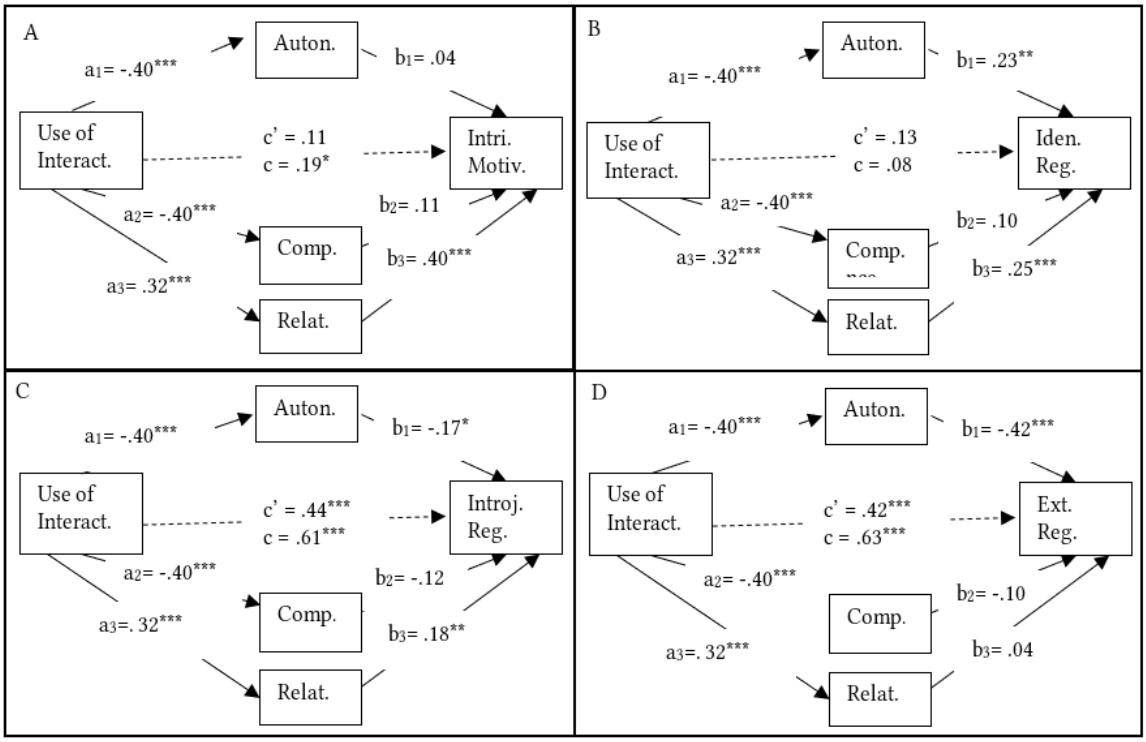

Figure 2: Mediating effect of need satisfaction (autonomy (auton.), competence (comp.), and relatedness (relat.)), on the relationship between the use of interactivity features (use of interact.) and motivation: intrinsic motivation (intri motiv.) [A], identified regulation (iden reg.) [B], introjected regulation (introj reg.) [C], and external regulation (ext reg.) [D]. Results reveal a significant and positive indirect effect of relatedness satisfaction for intrinsic, identified, and introjected regulation. Results also reveal a negative indirect effect of autonomy satisfaction on identified regulation and a positive indirect effect on external regulation. All presented effects are standardized coefficients (β). c' represents the direct effects of interactivity; c represents the total effect of interactivity. $^{***}p < .001$; $^{**}p < .01$; $^{*}p < .05$.

in relatedness via interacting with other users was also a positive predictor of identified regulation (motivations for reasons that are personally important) and introjected regulation (motivations to avoid anxiety and ego protection), but a negative predictor of external regulation (external rewards and recognition). This suggests that interactivity is helpful in internalizing the behavior (use of the fitness App) toward more internal forms of regulation. This finding is also consistent with SDT's suggestion that an activity does not have to necessarily be driven by intrinsic motivation but can be driven by highly autonomous extrinsic motivators [49]. Consistent with previous research [41, 61], our data shows that interactivity is essential in providing meaningful motivation for using fitness Apps.

Interestingly, the use of interactivity was the only significant predictor of the perceived impact of PA and habit formation. Mediation analyses suggest this occurs because interactivity increases relatedness satisfaction. This finding is consistent with Molina et al. [40] who found that Hispanic students' learning is motivated by features of an application that satisfied their relatedness needs. This is also consistent with previous research suggesting social support is integral for motivating PA among Hispanics [48] and the population at large [38, 46].

Nonetheless, our study also found that interactivity decreases autonomy and competence satisfaction. The decrease in autonomy, in turn, decreased identified regulation. These effects likely occur because interactivity that signifies communicating and interacting with others may result in social comparison and using the fitness application for reasons that are more external to the self, rather than relevant to the users' values and personal satisfaction. The SDT suggests that the reduced autonomy and competence is problematic because autonomy and competence are essential for achieving the internalization of behavior [50]. Furthermore, the opposing directionality of the effects of features of interactivity on relatedness and autonomy suggests that interactivity may be a double-edged sword. When interactivity features increase relatedness satisfaction, the use of interactivity features increases identified regulation to use the App. However, when the use of interactivity features decreases autonomy satisfaction, they decrease identified regulation. Thus, in designing fitness Apps, designers should incorporate interactivity in a way that foments relatedness without compromising autonomy. One idea is to have features of interactivity that detract

Table 6: Mediating Role of Need Satisfaction in the Relationship Between MTM Indicators and PA

	Impact of PAIndirect Effects	Habit FormationIndirect Effects
IV: Navigability		
Autonomy	-.03, CI [-.09, .02]	-.002, CI [-.06, .04]
Competence	.01, CI [-.05, .06]	.02, CI [-.03, .09]
Relatedness	-.01, CI [-.07, .04]	-.01, CI [-.05, .03]
IV: Interactivity		
Autonomy	-.01, CI [-.11, .07]	-.003, CI [-.08, .08]
Competence	-.03, CI [-.11, .04]	-.03, CI [-.10, .04]
Relatedness	**.10, CI [.04, .18]**	.06, CI [-.004, .14]
IV: Customization		
Autonomy	-.001, CI [-.03, .02]	-.0002, CI [-.02, .03]
Competence	-.01, CI [-.05, .02]	-.01, CI [-.06, .02]
Relatedness	.05, CI [-.02, .13]	.03, CI [- .01, .08]

Note: Indirect effects represent standardized indirect effects. Brackets indicate 95% confidence interval. Significant indirect effects are presented in bold.

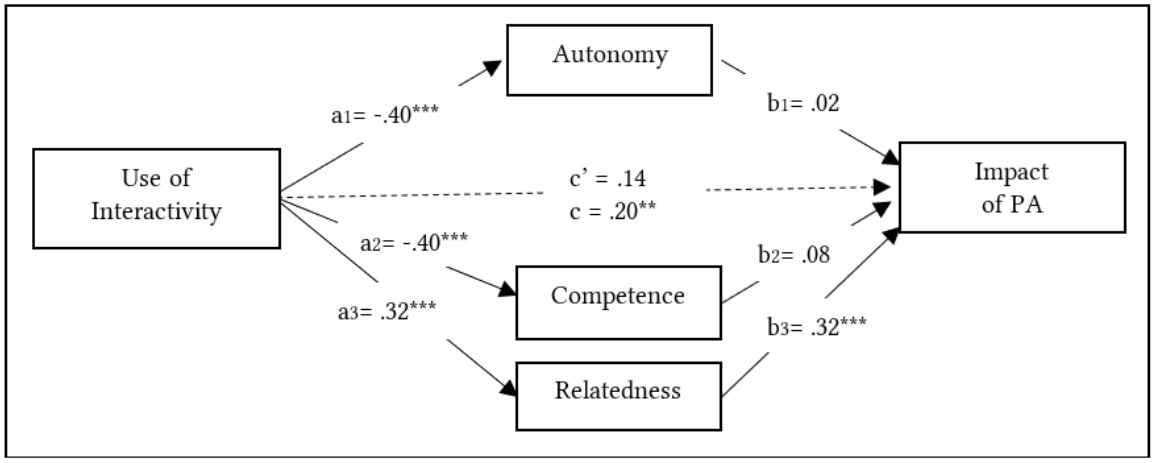

Figure 3: Mediating effect of need satisfaction (autonomy, competence, and relatedness), on the relationship between the use of interactivity features and perceived impact of PA. Results reveal a significant and positive indirect effect of relatedness satisfaction such that using interactivity features increases sense of relatedness. The increased sense of relatedness, in turn, increases perceived impact of PA. All presented effects are standardized coefficients (β). c' represents the direct effects of interactivity; c represents the total effect of interactivity on impact of PA. $^{***}p < .001$; $^{**}p < .01$; $^{*}p < .05$.

from social comparison, which has been associated with negative self-esteem and other negative consequences [58]. Features for group comments and discussions based on specific prompts may be one possibility. These features are already available but may be highlighted. Another idea is the use of chatbots that provide personalized behavioral change suggestions and support. These chatbots may provide the conversationality necessary to increase relatedness, without resulting in social comparison or similar tendencies that may decrease user autonomy or control. Leeman-Castillo et al.'s [35] findings reveal this could be a viable alternative. In their study, the use of a computerized role model that encouraged behavioral change resulted in improved PA. It is possible that the conversationality and relatedness provided by the role model in this study may have resulted in participants being more intrinsically motivated to use the technology. Users who were motivated to use the App may have benefited from the features and the suggestions made by the agent, becoming motivated to engage in PA as a result. Social comparison can also be prevented through visualizations and data representation that focuses on collaboration/social support rather than competition. In fact, the results of our study reveal significant effects of data visualizations and other navigability features on competence and autonomy satisfaction. The effects of navigability on competence align with the MTM model [54] and with previous studies that have found that data visualization can increase motivation [37].

However, the finding that navigability features increase autonomy satisfaction and that the increased autonomy satisfaction led to an increase in identified regulation and a decrease in external regulation, was unexpected. It may be that the ability to search and find needful resources from within the application satisfies users' need for autonomy. Autonomy satisfaction, in turn, enhances more integrated and autonomous forms of motivation for using fitness Apps.

Finally, we found that customization features only predicted introjected regulation, or motivation to avoid anxiety and for ego protection. It seems that current customization options centered on selecting workout routines based on personal information such as age, gender, personal fitness goals and workout routines, may not be relevant to Hispanic users' needs and motivations. While these customization options can create a sense that the application understands the unique needs of the user, they do not account for the user's norms, values, and worldviews—which are known to be important drivers of behavior [47]. A viable option discussed by Kreuter et al. [32] is to tailor or personalize activities and messages not only based on personal information like age and gender but also culture by acknowledging how each individual perceives their own culture and the values and norms that are important to them. This approach acknowledges that Hispanics are not a monolith and diverse opinions and values within the community exist. These suggestions can also be applied to members of the population at large. For example, providing customization options that align with different lifestyles may be beneficial for users of different backgrounds and with unique preferences, whose needs are not met by current fitness Apps, as evidenced by the high attrition rates of such Apps.

Our study also extends the MTM model [54] by analyzing the effects of affordances of technology not only on intrinsic motivation to use the App but also on the different forms of extrinsic motivation. This is important because, as evidenced by our results, engagement with mHealth technologies is not only driven by pure enjoyment (intrinsic motivation), but also the different forms of extrinsic motivation (external regulation, introjected regulation, and identified regulation). Understanding the impact of affordances on these extrinsic forms of motivation can guide design practices that align better with users' experiences and needs. For example, our results reveal that using features of interactivity may satisfy the need for relatedness. Relatedness, in turn, increases intrinsic motivation to use fitness Apps. Nonetheless, results also reveal that the use of the same features of interactivity may reduce autonomy satisfaction, in which case it results in an increased external regulation (or the use of the application due to reward or compliance). Research analyzing intrinsic motivation in isolation may only be telling one side of the story, and not the nuances needed to understand user motivation in its entirety.

Our study, however, is not without limitations. First, we recruited participants who are current users of fitness Apps, which means that our findings represent users who already had the initial motivation to use a fitness App toward a healthier lifestyle. The sample was also recruited within the United States, as such it is not representative of Hispanics globally. Diversity within the Hispanic communities could also change the results of this study. Importantly as well, diverse opinions and values exist within the Hispanic community which makes designing Apps specific to the population rather complex. The results of our mediation analyses should also be interpreted considering the cross-sectional nature of this study, preventing us from establishing causal relationships between our variables. Likewise, our operationalization of affordances should be kept in mind. Although the use of certain affordances may support need satisfaction, need satisfaction also depends on the implementation and embodiment of features and the affordance they represent. For example, as our findings indicate, the current state of customization features is not meeting the needs of autonomy hypothesized by the MTM model and empirical research. In other words, the implementation of the features matters, and not all customization options will satisfy its intended needs. Finally, looking at our mediation models, the contributions of the indirect effects seem relatively smaller compared to the direct effects. This indicates the possibility of other mediators aside from need satisfaction that were not accounted for in our study that play a role in the relationship between the use of features and motivations to use the App. One possible mediator is social comparison or ease of use of fitness Apps.

These limitations along with our findings provide rich ideas for future research. First, future research should further assess how to increase relatedness in fitness Apps, while preventing a decrease in autonomy. Furthermore, focus groups and participatory design studies should be conducted to assess the needs and barriers of Hispanic users of fitness Apps, and the specific features of technologies that would be useful to address those needs and barriers. We also call for greater representation of minority populations in mHealth research and encourage scholars from different backgrounds to examine the experiences of understudied communities in the HCI space generally, and mHealth in particular. Engagement in PA and exercise is the most prescribed non-pharmacological method of countering the projected increase in healthcare costs, especially from preventable and manageable chronic diseases. As such, designing fitness Apps with due consideration of the needs of Hispanics (and other minorities) is essential in creating Apps that will motivate long-term use of the fitness App. A higher engagement with the App may increase adherence to PA and exercise guidelines for the population at large, and minorities specifically, toward greater health equity.

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