# Tailoring Behavior Models based on Gender and Users' Exercise-Type Preference: A Social Cognitive Approach

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**Abstract.** In recent years, behavior modeling in fitness apps has become popular. However, there is little work on the implication of tailoring behavior models to their target users in fitness apps. Using the Social Cognitive Theory as a theoretical framework, we conducted a study on the efficacy of tailoring behavior models based on gender and exercise-type preference. Specifically, we investigated the social-cognitive-beliefs profile of participants when observing behavior models performing Push Up and Squat bodyweight exercises and the moderating effect of gender and exercise-type preference. Our results show that, regardless of exercise type, males' *perceived self-efficacy* and *projected exercise performance level* are higher than females', with males preferring Push Up and females preferring Squat the most. Thus, males are more likely to engage in Push Up than females. However, there is no significant difference between both genders with respect to Squat. Our findings underscore the need for tailoring exercise behavior models based on gender and exercise-type preference. We provide design guidelines on tailoring behavior models in fitness apps to increase their effectiveness.

**Keywords:** Virtual Coach, Behavior Modeling, Social Cognitive Theory, Personalization, Persuasive Technology, Gender, Exercise-Type Preference.

## 1 Introduction

The advances recorded in mobile technology and the need to perform exercises correctly to prevent injuries—especially outside the gym environment, where there are no personal trainers or professional guidance—have fueled the rise of fitness apps, modeling behavior change through the use of instructions and animations such as behavior models, virtual coaches, etc. Moreover, the need to be physically active in order to maintain optimal health and attain longevity has resulted in an evolving interest in home-based bodyweight exercises, which require no equipment or gym-access fees. According to the annual global survey on trending topics in the health and fitness domain, bodyweight exercise has remained in the top two positions of the chart for the last three years [1]. A systematic review also found that behavior modeling through video animations and instructions was the most commonly employed behavior change technique in fitness apps on the market [2]. Specifically, behavior modeling is defined

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as a behavior change technique in which "*an expert shows [a] person how to correctly perform a behavior, for example, in class or on video*" (p. 382) [3]. It has almost entirely replaced the traditional use of leaflets providing instructions and demonstrations on how to correctly and effectively perform certain exercise behavior.

However, there is limited research in persuasive technology (PT) on the effectiveness of tailoring behavior models based on gender and exercise-type preference to amplify the effectiveness of fitness apps on the market. Consequently, using the Social Cognitive Theory, which has been widely employed as a theoretical framework to study behavior change [4–6], we investigated the potential effect of tailoring behavior models based on gender and exercise-type preference on the social-cognitive determinants of behavior. We used Push Up and Squat bodyweight exercises as a case study. We based our results on: (1) the analysis of variance of users' *perceived self-efficacy*, *perceived self-regulation*, *outcome expectation* and *projected exercise performance level*; and (2) the analysis of participants' comments on the visual design of the behavior models.

## 2 Background

This section provides an overview of behavior modeling and social-cognitive determinants of behavior change.

### 2.1 Behavior Modeling

Behavior modeling refers to the demonstration of the correct performance of a given behavior to an observer in order to facilitate the performance of the behavior. Health behaviors such as exercises are often modeled by social agents such as virtual coaches [7, 8] and humanoid robots [9] in virtual or physical environments, respectively. The focus of this paper is on the former in a virtual environment such as a fitness app.

### 2.2 Social-Cognitive Determinants of Behavior

Social Cognitive Theory is a behavior theory that holds that personal factors, environmental factors and behaviors reciprocally influence one another [10]. In our study, we classify "behavior models" as technology-based social or environmental factors that can influence users' cognitive beliefs such as *self-efficacy*, *self-regulation* and *outcome expectation* [11, 12]. According to Bandura [10], social systems can potentially impact human behaviors, with social-cognitive beliefs such as *self-efficacy* acting as mediators. PTs, in particular, are regarded as social actors [13–15] through which individuals can learn certain behaviors vicariously by observing them and their outcomes [10].

**Self-Efficacy.** Self-efficacy refers to the cognitive belief in one's ability to perform a given behavior. It is the strongest (proximal) determinant of behavior according to Bandura's Social Cognitive Theory [11]. It entails a feeling of a sense of control over one's environment and behavior, which can facilitate behavior change [16, 17].

**Self-Regulation.** Self-regulation refers to the management of one's thoughts and feeling towards achieving one's goal. Bandura [18] posited that human behaviors are highly regulated by self-influence. He identified three major subfunctions through which self-regulatory mechanisms can occur; they include: (1) monitoring of one's behavior, its causes and effects; (2) judgment of one's behavior relative to personal standards and environmental conditions; and (3) affective self-reaction. In the context of physical activity, self-regulation, which is one of the strongest determinants, refers to the ability of individuals to set goals, organize, plan, monitor and evaluate their behaviors [6].

**Outcome Expectation.** Outcome expectation refers to one's judgment of the possible consequence of one's behavior. In the context of Social Cognitive Theory, research has shown that the expectation one has regarding the outcome and consequences of a given behavior can affect the actual performance of the behavior [11]. Outcome expectations are classified as physical, social and self-evaluative [19].

## 3 Method

This section covers our research design, instruments and participants' demographics.

### 3.1 Research Question

In recent years, behavior modeling has become one of the most popular behavior change techniques employed in fitness apps [2, 20]. However, there is limited knowledge on the potential effectiveness of tailoring based on gender difference and exercise-type preference. Thus, in this study, which is a part of an ongoing research [20–22] on tailoring fitness apps to make them more effective, we aim to answer the overarching research question, "*How do the gender and exercise-type preference of users of fitness apps moderate the perceived effectiveness of behavior modeling?*

### 3.2 Research Design

To answer our research question, we designed a fitness app prototype, called "*Homex App*," which features an avatar animation (aka behavior model) demonstrating the correct performance of Push Up and Squat bodyweight exercises. In designing the behavior models, we considered gender, race and exercise-type preference. This resulted in eight versions of the behavior models (see Figure 1 for two of the versions). Push Up and Squat were chosen since they are commonly a part of home workouts and exercise important muscle groups. Thus, in the animations, we emphasized (highlighted) the muscle groups that are being impacted by each exercise performance to increase its effectiveness. Moreover, to contextualize our investigation, we provided the study participants with a description of the home-based fitness app at the beginning of the survey. The description was adapted from [23]. We then proceeded to present each version of the behavior models to each participant in a randomized fashion and asked them to respond to a questionnaire on social cognitive determinants of physical activity.

### 3.3 Participants

Our survey was approved by the ethics department of our university. After approval, the survey was posted on Amazon Mechanical Turk (a crowdsourcing platform) to recruit participants resident in North America. In appreciation of their time, each participant was compensated with $0.6. Table 2 shows the demographic of participants and the randomized distribution of the eight versions of the behavior models.

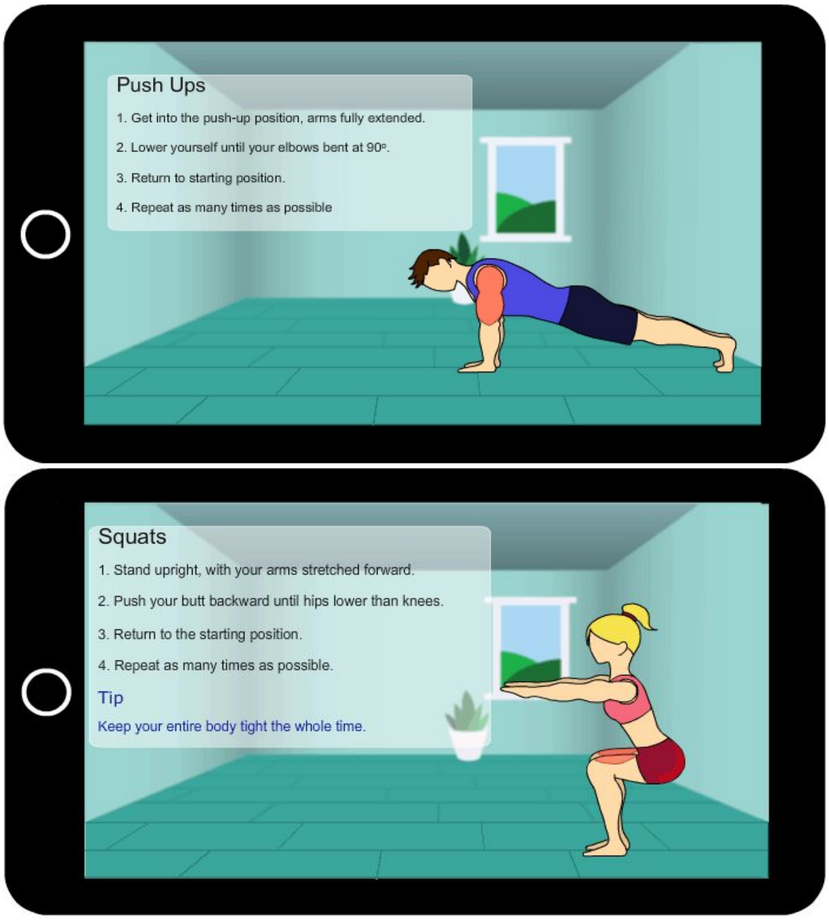


**Figure 1.** Two of the eight race- and gender-based push-up/squat behavior models [24]

**Table 1.** Participants' demographics based on gender (n = 669). BM = Black Male, BF = Black Female, WM = White Male, WF = White Female; PU = Push Up, SQ = Squat.

| Criterion | Breakdown [(Female, Male) = (327, 342)] |
|---|---|
| Age | 18-24 (56, 70); 25-34 (139, 157); 35-34 (79, 76); 45-54 (38, 22); 54+ (15, 17) |
| Education | Technical/Trade School (47, 39); High School (66, 70); BSc (154, 162); MSc (42, 54); PhD (9, 6); Others (9, 11) |
| Country of Origin | Canada (104, 110); United States (194, 184); Others (26, 51) |
| Years on Net | 0-3 (2, 2); 4-6 (18, 13); 7-9 (20, 40); 10+ (287, 287) |
| Behavior model distribution | BM-PU (50, 45); BF-PU (43, 39); WM-PU (39, 47); WF-PU (39, 44); BM-SQ (46, 42); BF-SQ (25, 46); WM-SQ (42, 41); WF-SQ (43, 38) |

### 3.4 Measurement Instruments

Table 1 shows the instruments used to measure our target behavior (exercise) and social-cognitive constructs in the order they were presented. They were adapted from [6, 17, 19, 25]. Before asking the first question in each construct, we requested the study participants to "*please kindly watch the [name of exercise] video and answer the question below.*"

**Table 2.** Instruments used for measuring social cognitive constructs

| Criterion | Overall Question and Items |
|---|---|
| Projected Exercise Performance Level | Assume you were to perform this exercise at home throughout the week.<br>(1) What average number of Push Ups do you think you can do per day?<br>(2) How many days per week do you think you can do the [exercise name]? |
| Self-Efficacy (0 – Not Confident to 100 – Confident) [17] | How confident are you that you can complete at home the proposed weekly number of Push Ups (entered previously) for the next 3 months.<br>(1) Even when you have worries and problems?<br>(2) Even if you feel depressed? (3) Even when you feel tense?<br>(4) Even when you are tired? (5) Even when you are busy? |
| Outcome Expectation (1 – Strongly Disagree to 5 – Strongly Agree) [19] | The [name of exercise] will...<br>(1) Improve my ability to perform daily activities.<br>(2) Improve my overall body functioning.<br>(3) Strengthen my bones.<br>(4) Increase my muscle strength.<br>(5) Improve the functioning of my cardiovascular system.<br>(6) Improve my social standing.<br>(7) Make me more at ease with people.<br>(8) Increase my acceptance by others. |
| Self-Regulation (1 – Strongly Disagree to 5 – Strongly Agree) [6] | To achieve my proposed weekly average number of push-ups....<br>(1) I will set a goal.<br>(2) I will develop a series of steps to reach my weekly goal.<br>(3) I will keep track of my progress in meeting my goal.<br>(4) I will endeavor to achieve the set goal for myself.<br>(5) I will make goal public by telling others about it. |
| Visual Design Impression | (1) Please kindly tell us the impression the visual design above had on you. |
| Exercise-Type Preference Question | (1) Please tell us your most preferred work out (physical activity) among the 12 shown above [a screenshot of behavior model images].<br>(2) Please give the reason behind the choice of your most preferred workout.<br>(3) Please tell us your least preferred work out (physical activity) among the 12 shown above.<br>(4) Please give the reason behind the choice of your least preferred workout. |

# 4 Result

In this section, we present our results, including the reliability analysis of the instruments and the interaction analysis based on gender and exercise-type preference.

## 4.1 Reliability Analysis

To ensure that the social-cognitive constructs were reliably measured, we conducted a non-parametric McDonald's omega reliability test [26, 27] due to the non-normality of our dataset. The results for each construct met the reliability requirement: omega (ω) was greater than 0.7.

## 4.2 Performance of Study Measures

This subsection covers the rating of the various constructs/measures we investigated.

**User Preferences of Bodyweight Exercise Based on Gender.** To determine exercises preferences, we asked the study participants in the survey to tell us their most preferred and least preferred exercises among a list of twelve (12) bodyweight exercises, which we adapted from [28]. The exercise types include Push Up, Squat, Crunch, Plank, Side Plank, Chair Dip, Lunge, Push Up and Rotation, Wall Sit, Step Up, Running in Place, Jumping Jack. Figure 2 shows the percentages of participants (based on gender) who preferred Push Up and Squat the most and the least. Overall, males preferred Push Up (17.8%) to Squat (6.3%), while females preferred Squat (9.1%) to Push Up (1.6%). We present a snippet of the main reasons why the study participants preferred Push-Up or Squat the most or the least in the discussion section.

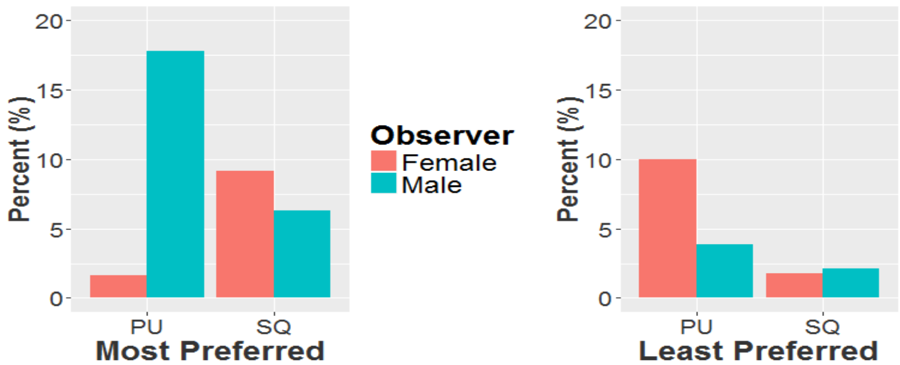


**Figure 2.** Users' most preferred and least preferred exercise types based on gender

**Average Rating of Social-Cognitive Beliefs.** Figure 3 shows the overall mean ratings for *self-efficacy belief*, *self-regulation belief* and *outcome expectation* for both genders and exercise-types. Overall, the three social-cognitive beliefs were rated above the neutral value of 50%. This is replicated across both genders and exercise types. For example, with respect to *self-efficacy*, males' mean ratings for Push Up and Squat are 64.21% and 62.07%, respectively; while females' mean ratings are 52.25% and 55.46%, respectively. Overall, the mean rating for *self-regulation* is the highest, followed by that of *outcome expectation* and that of *self-efficacy*.

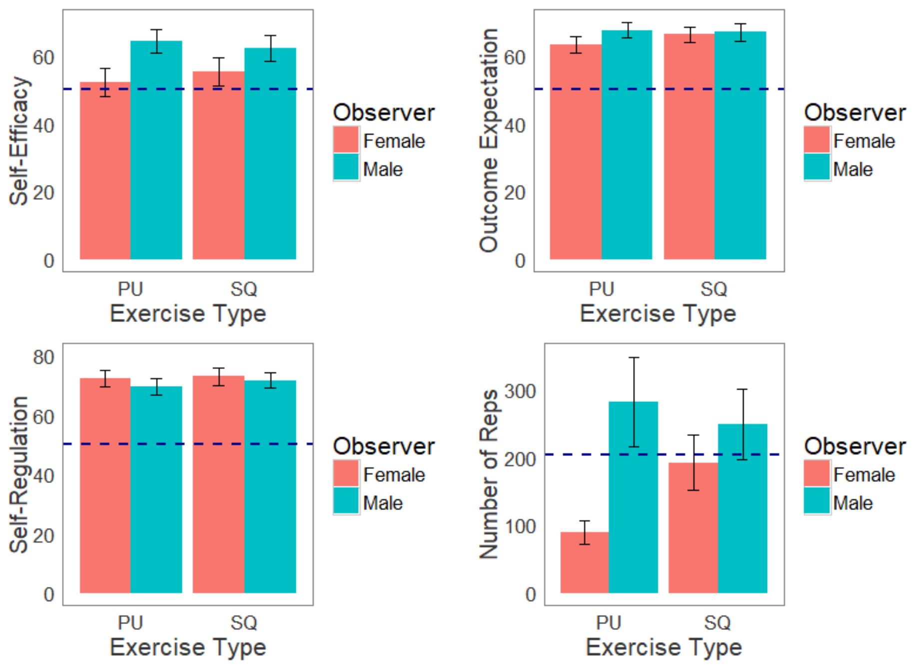


**Figure 3.** Mean rating of perceived self-efficacy, perceived self-regulation, outcome expectation on a 0-100% scale (crossbar represents the neutral value of 50%) and projected exercise performance level in number of reps per week (crossbar represents the overall mean value). Vertical bar represents 95% confidence interval.

**Average Score of Exercise Behavior Performance.** To determine how exercise-type preference affected participants' *perceived projected exercise performance level* of the behavior, we computed the overall average number of repetitions (reps) per week for both genders and exercise types (see Figure 3). For Push Up, based on the mean metric, males (282) projected more reps/week than females (89), just as in *self-efficacy*. Similarly, for Squat, males (248) projected more reps/week than females (192).

### 4.3 Main and Interaction Analyses

We carried out a non-parametric two-way Analysis of Variance (ANOVA) of Aligned Rank Transformed Data in R [29] to determine the main effects of and the interaction between gender and exercise-type preference with respect to the three social-cognitive beliefs and the *projected exercise performance level* for Push Up and Squat.

**Main Effect of and Interaction between Gender and Exercise-Type Preference Regarding Self-Efficacy.** As shown in Figure 3, the result of the two-way ANOVA shows that there is no interaction between gender and exercise-preference. However, there is a main effect of gender ($F_{1,665} = 20.72$, $p < 0.0001$), with males having higher *self-efficacy belief* (64.2%) than females (52.3%).

**Main Effect of and Interaction between Gender and Exercise-Type Preference Regarding Self-Regulation and Outcome Expectation.** The two-way ANOVA, with respect to *self-regulation* and *outcome expectation*, shows that there is neither a main effect of gender and exercise-type preference nor an interaction between both factors.

**Main Effect of and Interaction between Gender and Exercise-Preference Regarding Projected Exercise Performance Level.** The result of the two-way ANOVA shows that, with respect to exercise *projected exercise performance level* (number of reps/week), there is a main effect of gender ($F_{1,665} = 47.21$, $p < 0.0001$) and exercise-type preference ($F_{1,665} = 6.52$, $p < 0.05$). Overall, males (265 reps/week) had higher *projected exercise performance level* than females (138 reps/week). Moreover, the *projected exercise performance level* for Squat (220 reps/week) is higher than that for Push Up (186 reps/week). Finally, the two-way ANOVA shows that there is an interaction between gender and exercise-type preference ($F_{1,665} = 9.33$, $p < 0.01$). Posthoc Kruskal-Wallis main effect analysis revealed that males and females differ more significantly in their *projected exercise performance level* for Push Up (282 and 89 reps/week, respectively) at $p < 0.0001$ than they do for Squat (248 and 192 reps/week, respectively) at $p < 0.05$. Moreover, there is a significant difference in females' *projected exercise performance level* for Push Up (89 reps/week) and Squat (192 reps/week) at $p < 0.0001$, but there is none in males' *projected exercise performance level* for Push Up (282 reps/week) and Squat (248 reps/week).

### 4.4 Visual Impact of Behavior Modeling

Apart from the three social-cognitive constructs outperforming the neutral value of 50%, our qualitative analysis shows that behavior modeling has the capacity to impact *self-efficacy*, *self-regulation* and *outcome expectation*. The following are a cross-section of the participants' comments that support the potential effect behavior modeling has on users' social-cognitive beliefs.

1. *A video that['s] available on my phone will have a direct impact as I can watch it any time* [P134, female] – overall positive effect of behavior modeling.
2. *Following along with someone else's direction is easier than maintaining your own motivation* [P235, male] – Self-Efficacy.
3. *Exercise in the mentioned video looks like it makes a person stronger and fit* [P363, male] – Outcome Expectation.
4. *I would personally need to set a goal and keep track of it to make sure I fulfilled my daily pushup requirement in order to meet the weekly target…* [P144, male] – Self-Regulation.

## 5 Discussion

We have presented the social-cognitive-beliefs profiles of males and females with respect to Push-Up and Squat behavior models and their analysis of variance. The results of our analysis showed that there are gender differences in the social-cognitive beliefs, projected exercise performance levels and exercise-type preferences of participants.

Overall, males prefer Push Up to Squat, while females prefer Squat to Push Up. Moreover, regardless of gender, the participants' *self-regulation belief* is highest, followed by *outcome expectation* and *self-efficacy belief*. Regardless of exercise type (see Figure 3), *self-efficacy belief* and *projected exercise performance level* are significantly higher for males than for females. In particular, considering exercise type, *projected exercise performance level* for Push Up is significantly higher for males than for females. However, both genders do not significantly differ regarding Squat. Considering gender, males' *projected exercise performance levels* for Push Up and Squat do not significantly differ although the former (males' most preferred exercise type) is numerically higher. However, females' *projected exercise performance level* is significantly higher for Squat (females' most preferred exercise type) than for Push Up. Our ANOVA-based finding confirms the finding that females prefer Squat to Push Up bodyweight exercise.

### 5.1 Tailoring Based on User Gender and Exercise-type preference

The results of our analysis showed that the ability of people to adopt and carry out the observed target behavior is moderated by both gender and exercise-type preference. This indicates that a "one-size-fits-all" behavior models might be counter-effective, as the user may feel discouraged given that the modeled behavior does not meet his/her need or is beyond his/her physical ability. According to Fogg's Behavior models [30], for a behavior to be performed, the user must have the motivation, the ability and a trigger to carry out the behavior. In other words, if the motivation and trigger are both present, without the ability to perform the behavior, the user cannot be persuaded. For example, among females, we saw in our analysis that they prefer Squat to Push Up, perhaps due to the relative "perceived difficulty" involved in its performance or the perception that Push Up is more of a male's exercise given the targeted muscle groups. As a result, females' average *projected performance level* for Squat (130 reps/week) significantly outweighs that for Push Up (60 reps/week) by over 100%. The following are a cross-section of the female participants' comments on the Push-Up behavior model, which allude to the perceived difficulty in the performance of Push Up:

1. *I have poor upper body strength and they are too hard for me* [P60, female].
2. *It is painful and difficult. It's also boring so I tend to focus on how much it hurts which causes me to quit sooner* [P61, female] – negative impact on self-efficacy.
3. *Push ups are incredibly difficult, in my personal opinion, so I would prefer not to do them if possible* [P71, female] – negative impact of unmet exercise-type preference.

### 5.2 Design Guidelines for Gender and Exercise-Type-Preference Tailoring

Fitness apps can be tailored in several ways. Based on our findings, one way to tailor exercise-type preference to users is by allowing them to customize or organize their exercises according to their preferences. For example, in a list-based fitness app, featuring various exercises demonstrated by behavior models, users should be allowed, through manual sorting, to position their most preferred exercises at the top for quick and easy access. For example, a participant commented that "*crunches lead to the best core muscle strengthening, I think. Helps me with my posture, breathing, singing, and helps me look better compared with all other types of activities*." [P57, female]. For this participant, allowing her to access her most preferred exercises quickly and easily could be one of the motivating factors for choosing a certain fitness app over another.

Further, fitness apps should be personalized to user characteristics, such as gender, for them to be more effective. Users should also be allowed to customize them, as well, e.g., by allowing them to use the avatars of their choice. Failure to do this may result in the user not being able to identify with the modeled behavior or the gender of the demonstrator psychologically. As a participant noted, "*I like it, but hope the videos are either diverse in skin color, hair color, and gender or allow you to choose an avatar*" [P409, female]. This participant (white and female) actually received a white female behavior model, which is tailored to not only her gender but race as well. Another participant's comment that supports system-based personalization to gender is: "*I like the animation and that it shows a female in the video*" [P420, female]. Both of these comments strongly support the need for personalization and customization.

### 5.3 Summary and Implications of Main Findings

The results (see Section 4.4) of our qualitative analysis show that behavior modeling has the potential of motivating fitness app users. This in line with the theory of observational learning (vicarious modeling), which, research has shown, has the potential of increasing the self-efficacy of the observer. According to Bandura [10], "*humans have evolved an advanced capacity for observational learning that enables them to expand their knowledge and skills rapidly through information conveyed by the rich variety of models*" (p. 126). The following summarizes the main findings of this study:

1. Males prefer Push Up to Squat, while females prefer Squat to Push Up.
2. Females differ significantly in their projected performance levels for Push Up and for Squat, but males do not.
3. Males have more confidence in their ability (i.e., higher perceived self-efficacy) to perform body-weight exercises than females.
4. Behavior modeling will be more effective if they are tailored based on the gender and exercise-type preference of the target group.

These findings underscore the need for designers of PTs to avoid the one-size-fits-all approach to persuasive systems design and leverage the more effective system-based personalization and/or user-based customization [31]. In line with this, our findings contribute to the body of knowledge by providing empirical evidence for data-driven tailoring of fitness apps based on user gender and exercise-type preference.

### 5.4 Limitations of Findings and Future Work

The main limitation of our study is that the majority of the sample population we investigated are mainly from Canada and United States. This may threaten the generalizability of our findings to other demographics and cultures. Another limitation of our study is that our findings are based on users' perceptions of behavior modeling as a persuasive strategy for encouraging behavior change, which may not generalize to the actual usage of behavior modeling in a real-life context. Thus, we recommend that, in future studies, the effect of gender and exercise-type preference on users' social-cognitive beliefs and exercise performance levels be evaluated in real-life applications.

## 6 Conclusion

In this paper, we presented the moderating effect of gender and exercise-type preference in behavior modeling as a persuasive strategy for motivating behavior change using the Social Cognitive Theory as a framework for our analysis. The results showed that gender and exercise-type preference moderate the effectiveness of behavior modeling. Overall, males have a higher *perceived self-efficacy* to perform bodyweight exercises than females. Comparatively, males do not significantly differ in their *projected performance levels* for Push Up and for Squat. However, females do, as they are more likely to engage and perform better in Squat than in Push Up. Thus, while males are more likely to engage and perform better in Push Up than females, both genders do not significantly differ regarding Squat. Our findings stress the need for tailoring fitness apps based on gender and exercise-type preference for them to be more effective.

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