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RESEARCH ARTICLE

Think About It: Promoting Physical Activity With a Mobile App With a Theory-Based Approach

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ABSTRACT Currently, people's highly busy lifestyles and sedentary behavior contribute negatively to multiple health factors. During the COVID-19 pandemic, the different sanitary measures, such as limited mobility and the closing of gyms and sports centers, have contributed to limited physical activity. In this context, there are several apps to enhance physical activity across all mobile stores with an emphasis on mobile sensing. However, the use of a formal theory incorporated into the app development and interventions is less evident. A theory-based approach contributes to understanding the reasons and situations in which an intervention strategy can have an impact. The present work considers the Elaboration Likelihood Model (ELM), which addresses persuasion and attitude change. Can we develop a persuasive app that promotes physical activity based on contemporary attitudes and behavioral change theories? We developed a mobile application for Android OS. Then, 63 participants tested it, and were encouraged to think of ideas or arguments in favor of doing physical activity in a high elaboration task. A mediation analysis was done, with results showing that attitudes partially mediate the association between thought and physical activity. Participants' thoughts were seen to be positively correlated with their attitudes; and, in turn, participants' attitudes were correlated with their behavioral intention (to do physical activity). This suggests that a theory-based approach for the active production of biased beliefs is effective when designing an app that encourages positive attitudes toward physical activity.

INDEX TERMS Mobile devices, mobile applications, persuasion, public healthcare, pervasive computing.

I. INTRODUCTION

Obesity and excessive weight are global problems linked to numerous health problems. The population's existing way of life is directly tied to these issues [1]. People have busy lifestyles, with limited knowledge about nutrition, where they are constantly on the go and have little time to shop for and prepare wholesome meals.

Additionally, the closure of public spaces and sports centers due to the COVID-19 pandemic has diminished the possibility of carrying out physical activity (PA), which is undoubtedly somewhat worrying, since the pre-pandemic figures for physical inactivity reached values close to 60% at the national level, worldwide [2], [3].

This favors a more critical scenario in terms of the health of the population, considering that there are numerous conclusive studies on the regular practice of exercise and its potential as a non-pharmacological treatment that contributes to reducing the incidence and/or slowing down the worsening of symptoms associated with diseases, such as psychiatric, neurological, cardiovascular, pulmonary, musculoskeletal disorders, and cancer, among others [4].

Regarding physical effects, an increase in sedentary lifestyle rates has been observed in the population, associated

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with effects such as loss of muscle mass, obesity, and development of cardiovascular diseases [5]. Furthermore, regular physical activity could even exert a protective effect against SARS-CoV-2 infection, as well as limit the risk of developing severe symptoms and reducing the probability of requiring admission to an intensive care unit for treatment [6]. In addition, regarding the emotional impact, it has been documented that a sedentary person is more likely to suffer from insomnia, depression, anxiety, and stress, among others [7].

Nowadays, a range of strategies have been employed to inform people and communities on topics pertinent to nutrition behaviors, such as the use of social media [8], multimedia health promotion and preventive initiatives [9], websites and online forums [10], [11], exercise games, virtual reality, and mobile apps [12], [13].

Mobile apps are relevant because of their ubiquity in the daily routine of users and because apps can be distributed easily through different stores. In this context, apps have been used in several areas to promote healthy nutrition, as well as sexual and mental health.

Some of the technologies involved in this research are: 1) Contextualized preventive messages [13]; 2) The use of localization and geofencing to detect a target zone or area [14]; 3) The detection of apps running on the device [15]; 4) Integration of social support [16]; and 5) The use of gamification as a motivator to perform a behavior [14], among others (see Figure 1-a).

Even though the literature has shown that the use of mobile phones and virtual-based strategies are effective in promoting healthy behaviors [14], [17], [18], [19], the use of a formal theory incorporated into the app development and interventions are less evident. A theory-based approach is particularly relevant since it allows the comprehension of the reasons and situations in which an intervention strategy can have an impact, whether positive or negative.

In this context, there is a need to integrate a strategy where persuasive apps are technologically adequate and based on theories that predict the ways in which beliefs can be changed, created, and, more importantly, predict behavior.

The present work takes into account both technical and theoretical elements to promote healthy behaviors in a context where mobility has been limited and where there is a significant increase in the use of technologies. Therefore, this paper seeks to promote physical activity through a mobile application based on attitudinal change theory.

II. LITERATURE REVIEW

The use of mobile applications in physical activity has become increasingly common, positioning smartphones as a powerful resource for improving and increasing physical activity [20]. Given their great accessibility and reach, mobile devices are an adequate and effective means to promote physical activity through online interventions, especially during the pandemic.

A study carried out in South Korea found that sending alert messages to mobile devices increases the chances of adopting preventive behaviors for COVID-19 in public spaces [19]. In another area, evidence has been found supporting the use of mobile devices in interventions focused on sleep disorders and improving sleep quality [18]. It has also been observed that the number of hospitalized patients that smoked, who declared that they could not quit, decreased considerably after using a mobile app that actively processed knowledge about the risks of smoking and attitudes towards smoking, among other variables [17]. Studies have also been done regarding the use of mobile apps for promoting healthy nutrition and sexual behaviors using different capabilities of smartphones in terms of connection and sensors [13], [14], [15], [21].

These studies indicate that mobile devices are a valuable alternative for promoting healthy behaviors, becoming a powerful tool to promote personal resources and combat situations that produce a high level of stress, such as the COVID-19 pandemic. In the case of physical activity, studies show a significant increase in the use of mobile apps to monitor the level of exercise and to promote related behaviors.

However, there are discrepancies about the effect that mobile apps can have. On the one hand, some studies show positive consequences of the use of apps to promote physical activity. For example, in a study of 15,000 people in a recreational marathon, where participants answered a survey on various aspects of sports practice, such as their level of physical activity, preparation for the run, perceived level of health, self-image, lifestyle and use of apps, mobile devices were shown to support exercise. The results showed a positive and significant relationship between the use of apps, the level of physical activity and the perception of feeling healthier [22]. Additionally, users of sports apps reported greater chances of feeling like an athlete, motivating others to participate in marathons, and losing weight, supporting the effectiveness of mobile apps in promoting health and physical activity.

However, other studies show negative effects of the use of apps [23]; and others do not identify differences between using or not using mobile apps to promote physical activity [24].

A. ATTITUDES AND THEIR IMPORTANCE

Historically, the concept of attitude has been, and is, one of the most studied topics in Psychology [25]. For almost a century, various paradigms have proposed countless definitions for this term, managing to reach a certain consensus on the meaning attributed to this psychological construct. Attitudes are understood from social psychology as global and relatively stable evaluations that people have about other people, ideas, things, issues and proposals, which are conventionally called the attitudinal object [26], [27]. In other words, the concept of an attitude refers to the positive or negative degree to which people tend to judge any aspect of reality, which may be a very specific issue (e.g., drinking soda) or very abstract (e.g., cultural heritage [28]).

Attitudes are important to people because they fulfill a series of relevant functions for daily life. Research has

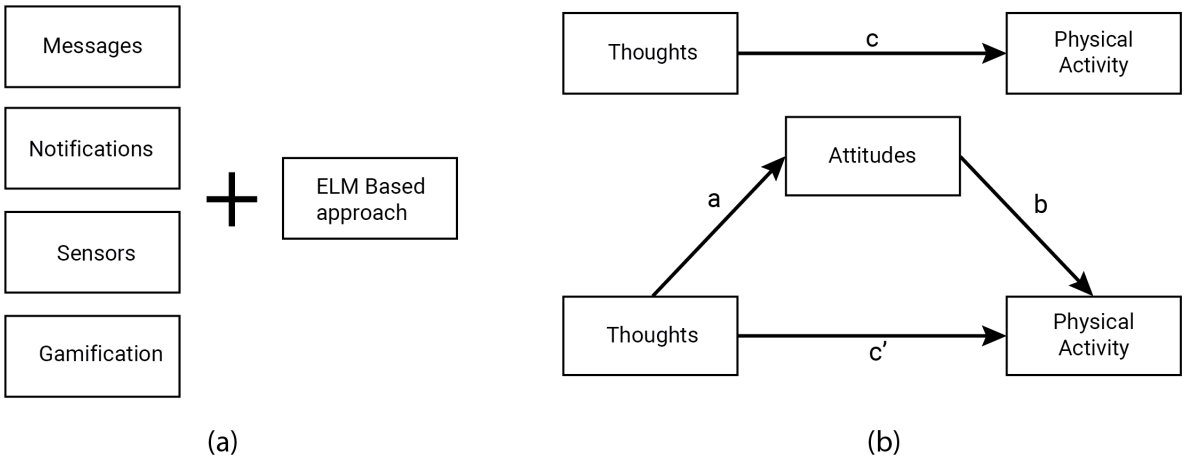


FIGURE 1. (a) Elements or modules that have been considered in previous apps to promote health; (b) The ELM based approach and its mediation model with thoughts as an independent variable, attitudes as a moderator, and behavioral intention (physical activity) as a dependent variable. This model shows how the relationship between thoughts and behavioral intention is mediated through attitudes.

coincided in indicating at least three functions of attitudes: organization of knowledge, instrumental function, and expression of values. In the first place, attitudes help to achieve a better adaptation to the environment with which we interact [29] through the structuring of information in positive or negative terms.

Finally, the attitudes formed from cognitive information refer to the judgments generated through the experience of the object in relation to our thoughts about it; in this sense, negative thoughts about an object would lead to a negative attitude towards it, and positive thoughts would lead to a positive attitude [30]. On the other hand, although there are objects to which one may not be directly exposed, cognitive information delivered by third parties helps to generate thoughts about these elements, mobilizing attitudinal valence based on the thoughts generated (e.g., [31]).

B. A THEORY OF ATTITUDE CHANGE

A contemporary theory to understand persuasive processes is the Elaboration Likelihood Model (ELM) [32].

The ELM posits that the amount of thought (i.e., further elaboration) directly influences the resulting attitude; in this sense, those attitudes formed by processes of high elaboration of thoughts are more durable over time [33], are more resistant to information contrary to attitudes [34], [35] and tend to better predict behavior [36], [37] than those formed in processes with a low number of thoughts.

The elaboration of thoughts can be easily prompted by asking users to think and write an idea or thought. In order to do that task, users have to think constantly, come up with an idea and then write it. This process enhances elaboration and therefore influences attitudes.

For example, in relation to physical activity and sports, a study examined whether attitudes about legalizing doping behaviors were resistant to change, and whether they could predict behavioral intentions when they were formed through high elaboration versus low elaboration processes. Participants read persuasive messages in situations of relatively high or low deliberative thinking. Greater attitude-consistent intentions were shown in participants when they formed their attitudes through high elaboration thinking. In addition, greater resistance to attitude change was shown [38].

Therefore, a thought about engaging in physical activity is more likely to lead to consequent behavior when the attitude that precedes it is generated under conditions of a high amount of thinking. Otherwise, the thought generated may not be relevant when evaluating whether or not to practice a physical activity, since people are more likely to give up in the face of adversity or to base their behavior on different, non-attitudinal reasons (e.g., peer expectations) [39]).

In line with the above, research has shown that the biased and active generation of thoughts (compared to the passive reception of information) leads to greater elaboration and, therefore, to stronger attitudes. One study showed that asking people to generate thoughts or ideas about a topic was an efficient way of manipulating the direction of thoughts, thereby allowing the resulting attitudes to be consistent with them [40]; this was in comparison to situations where people were mere recipients of information, generating their thoughts in response to a stimulus (e.g., a persuasive message).

More recent research has shown that even when attitudes could have a similar valence in response to active or passive manipulations (from reading a written message) of thought generation, active conditions lead to comparatively stronger attitudes than passive ones [41].

Together, these investigations show that the active generation of thoughts is related to the generation of attitudes consistent with their direction. However, the relationship of said sequence with the behavior is a theoretically possible element, but less evaluated.

C. AN INTEGRATION BETWEEN THEORY AND MOBILE TECHNOLOGY

Taking into account all of the above, for the development of an app that promotes positive attitudes in relation to physical

activity, it is important to consider theoretical elements about actively producing biased beliefs. In this context, four important factors are outlined below.

First, if users are prompted to come up with an idea in a positive or negative direction in a situation of high elaboration thinking, then they will be encouraged to have attitudes in the same biased direction. [30], [32].

Second, the more information that users process, the more likely they are to have strong attitudes, that is, attitudes that are resistant to change, stable, long-lasting, and able to predict behavior [42], [43], [44].

Third, regarding smartphones as a device for generating thoughts, since these devices are personal and part of a daily routine, they have great potential. Apps on smartphones are used to interact with our environment, permitting users to come up with or write thoughts on their devices in a situation of high elaboration thinking [45].

Fourth, with respect to how ideas and behavior are related, as the theory discussed in the present work and previous studies suggest, attitude direction can mediate and explain the relationship. [30], [45]. That is, high elaboration processes have an impact on attitudes, then they will modify behavioral intentions. In this context, we proposed the following two hypotheses:

- H1: There will be a significant association between positive thoughts and positive attitudes.
- H2: The association between thoughts and behavioral intention to do physical activity would be partially and significantly mediated by attitudes; to see the model, Figure 1-b.

The present work has the following structure. The first section presents the methodology and an evaluation of the mobile application. Secondly, the results are presented with Pearson's correlations and a mediation analysis. The final section discusses the results and outlines future work.

III. METHODS

This study was carried out following the design and creation method to research IT artifacts [46], with a mobile application and a study that is non-experimental that evaluates the presented theory-driven hypothesis.

A. MOBILE APPLICATION

We developed a mobile application, called *Think about it*, for Android OS; details about the implementation can be found at [47]. The main functionalities of the app are:

- Allows users to write self-generated ideas or thoughts in the app.
- Users evaluate each written idea or self-generated thought.
- Users reply to a questionnaire associated with their attitudes and behavioral intention.

Think about it was developed using Flutter as a framework for development. The architecture of the solution (scheme with three layers, see Figure 2) shows the interaction between components to implement a distributed system that is scalable and independent.

On the server side, we used Firebase services to store the information registered by the clients. This allows the saving of data anonymously from each user that follows the procedure to test the app.

- The presentation layer of the Android client: The presentation layer contains three main parts:
  1) The interface for writing self-generated ideas or thoughts.
  2) A listView with the ideas or thoughts written for evaluation.
  3) A questionnaire with differential semantics scales and slider widgets implemented to collect data.
- The domain layer of the Android client: In the domain, the data collected by the Graphical User Interface (GUI) is processed and stored in Firebase. The implementation is based on the services and API of Cloud Firestore and Firebase core.
- The data layer of the Android client: The data layer corresponds to the app's preference settings, and also contains the strings associated with the app, which are independent of all the other layers.

  As shown in Figure 2, the implementation of new functionalities on the client side (mobile app) is straightforward. The package *Future implementation* collects different modules that can be implemented on the domain layer that interacts between the bussiness and the service of the operating system. Some functionalities could be the detection of steps, geolocalization, and the implementation of maps, among others. The use of the notification manager can be use to enhance user experience through messages, reminders, and gamification, among other strategies to enhance the user experience.

  It is important to note that *Think about it* attemps to isolate the theory based on the ELM approach in the mobile device environment to understand and detect the main effect based on theory and not enhanced by sensors or contextualized messages.

IV. EVALUATIVE STUDY OF THE MOBILE APPLICATION

The design is non-experimental since no variables were manipulated, and the measurement was carried out in a single instance.

A. PARTICIPANTS

The sample consisted of 63 people selected for convenience, through an open call spread through social networks. However, only 45 managed to complete the process, so those participants with incomplete information were discarded. Individuals from various cities in Chile participated, and most of them were university students. This includes: 24.4% males N = 11, 75.6% females N = 36. The age ranges from 18 to 43 years, with the average age of 23 years old, with a standard deviation of 4.054.

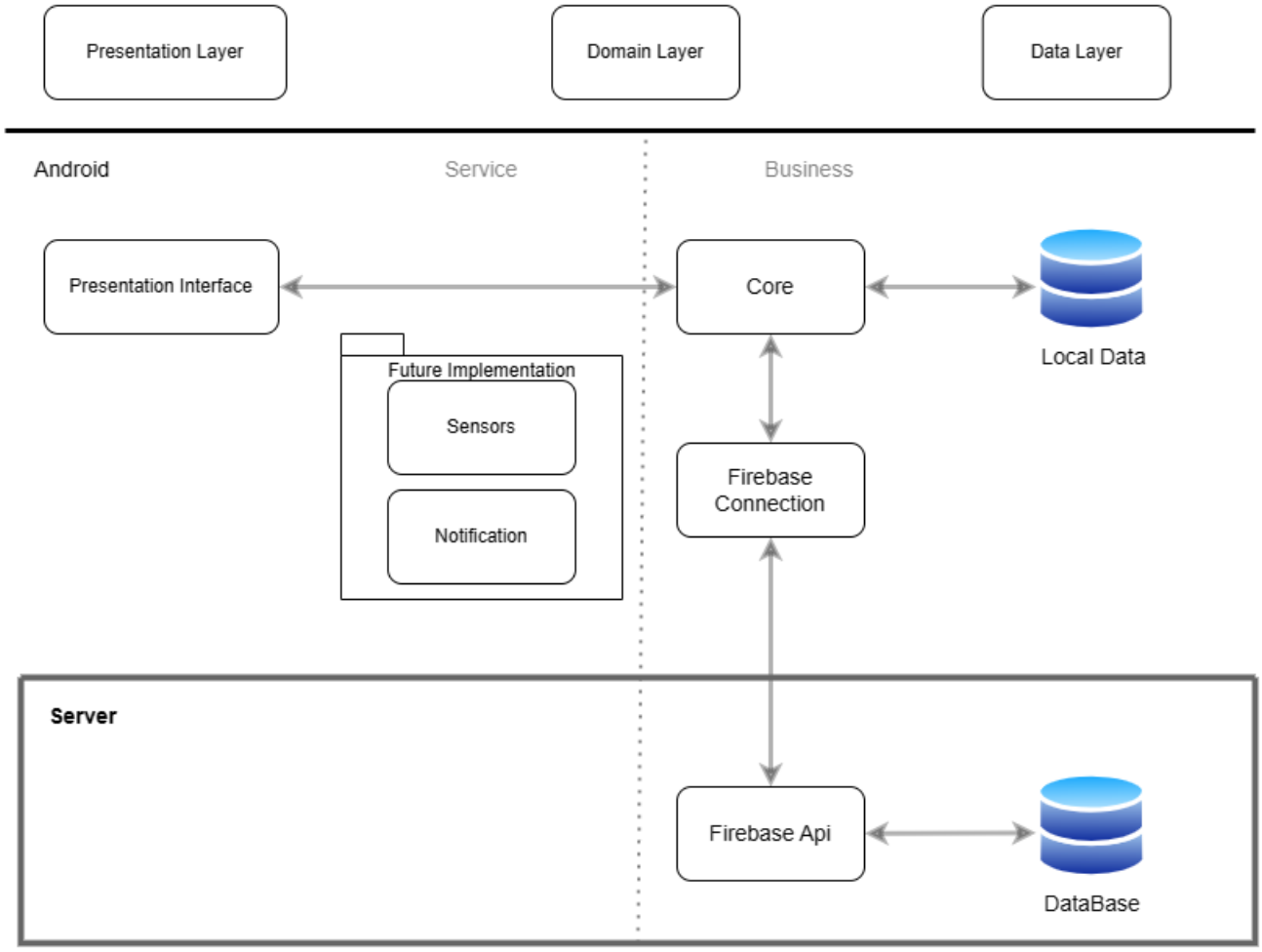


FIGURE 2. Architecture of the solution, three layer diagram with a representation of Client (Android devices) - Server (Backend) with their components. The package *Future Implementation* refers to technological components that can be added to the mobile app to enhance its functionalities.

B. PROCEDURE

The invitation to participate in the study was made through social networks, specifically through an invitation with a link to a custom form made through the Google Docs platform. The web form presents:

1) The instruction for participation and use of the mobile application
2) A brief consent to participate
3) The application downnload link.

In the app, users were asked to write ideas or arguments in favor of physical activity (this instruction biased the elaboration process of the user with a specific valence, in this case, positive thoughts). This instruction was adapted from [40], who showed that thinking about arguments in a particular direction can be a very effective procedure for changing people's attitudes in that direction.

When opening the app for the first time, an informed consent was displayed that explained the purpose of the research and that it had to be accepted to proceed. Once accepted, a first tab was presented, "Home", with a space to enter thoughts in favor of physical activity, without a minimum or maximum (see image 1). The second step consisted of users going to the "Evaluate" tab, in which the list of previously entered arguments was displayed (see image 2). When entering each one of them, a series of characteristics attributable to the exercise was shown in a semantic differential format, and participants had to indicate their preference (see image 3). As a last step, the participants had to return to the "Start" tab and select the "End participation" button, taking them to a last questionnaire referring to the probability of carrying out actions related to physical activity (see image 4). Once the process was finished, the data was backed up in a database, to be later organized and analyzed.

C. INSTRUMENTS

1) THOUGHT FAVORABILITY

With the aim of directing the thoughts of the participants in a favorable direction, they were asked to open the app and write arguments in favor of performing physical activity

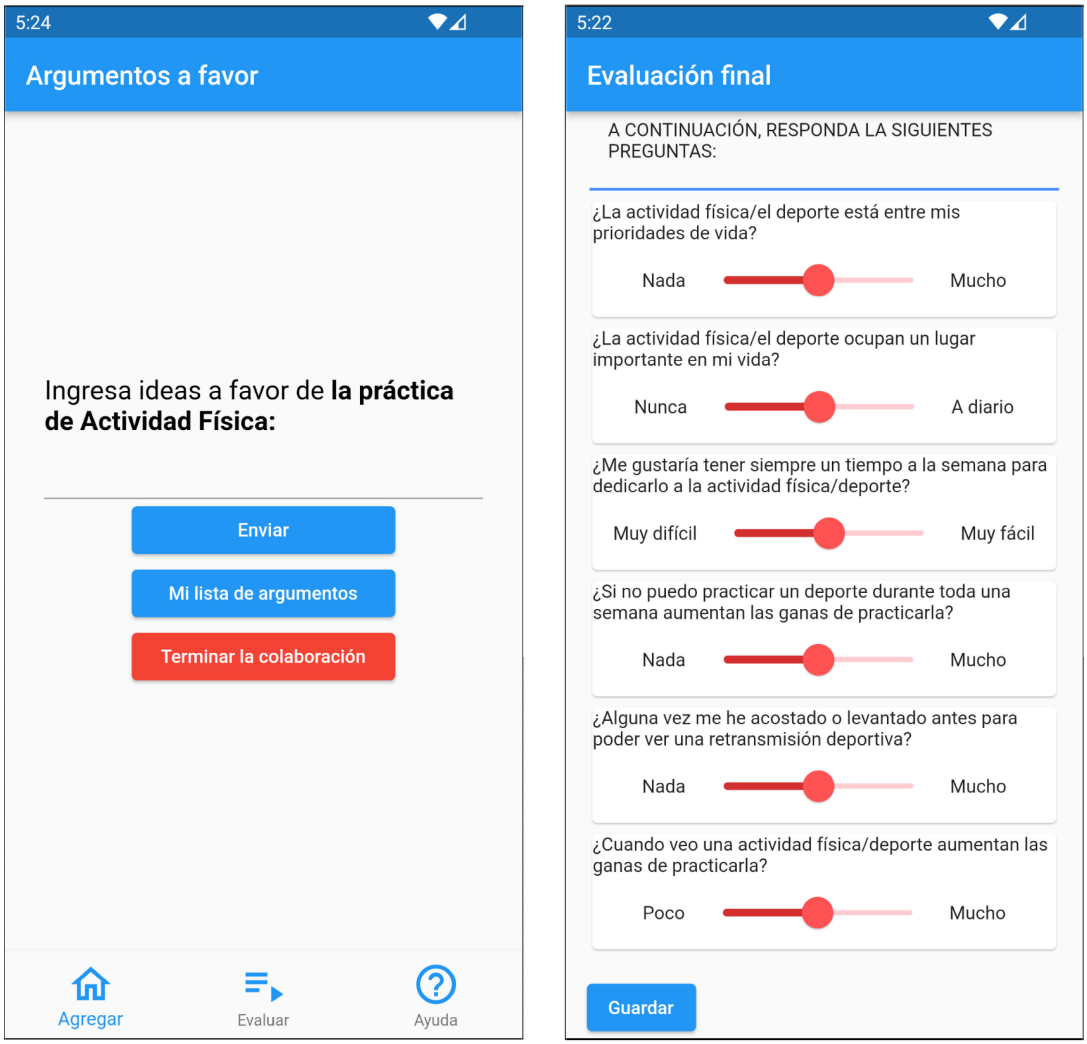


FIGURE 3. (a): The interface is shown where users write arguments in favor of physical activity (Translation from the image: Title: Arguments in favor; Write ideas in favor of Physical Activity; Buttons from top to bottom: (blue button) Send, (blue button) My list of arguments, (red button) Finish the collaboration); Bottom buttons from left to right: Add, Evaluate, Help; (b) Questionnaire about attitudes (Translation from the image: Title: Final evaluation; From top to bottom, please evaluate the following ideas; Is physical activity/sports a priority in my life? (Not at all - A lot); Does physical activity/sports have an important role in my life? (Never - Daily); Would I like to always have time during the week to dedicate to physical activity/sports? (Very difficult - Very easy); If I can't play sports during the week, does that make me want to play sports even more? (Not at all - A lot); Have I ever gone to bed late or gotten up early to watch a sports event on TV? (Not at all - A lot); When I watch a physical activity/sports, does that make me want to do a physical activity/play sports even more? (A little - A lot); Button: Save.

in a textfield. Participants then rated these ideas or arguments based on persuasiveness, convincibility, and favorability, using a 10-range scale delivered via a slider (from −50 to 50) [48]. Due to the high consistency between those items (Cronbach's $\alpha = .865$), the means of the thought evaluations were averaged together configuring the thought favorability index. This procedure has been carried out in accordance with previous research [45]. Higher values indicate stronger and more convincing thoughts.

2) ATTITUDES TORWARDS PHYSICAL ACTIVITY

Two indices were generated to assess attitudes towards physical activity:

- The first index measures attitudinal valence through seven semantic differential items that categorize physical activity into parameters of unhealthy-healthy, unpleasant-pleasant, unnecessary-necessary, useless-useful, unsatisfactory-satisfactory, good-bad and boring-fun, on a differential scale of 10 ranges emitted by means of a slider pointer (from −50 to 50). The items of this index reported an Cronbach's $\alpha = .745$. Scores for items with negative adjectives on the right were reversed, so that positive values (above zero) indicate more favorable attitudes.
- The second index measures attitudes towards physical activity through six items adapted from the Scale of

Attitudes towards Physical Activity and Sport [49]. The original instrument consists of 12 items, with a reported Cronbach's $\alpha = .90$. This instrument seek to measure the possibility of practicing physical activity. For example: *I would like to always have time during the week to dedicate to physical activity* and the perceived importance that the subjects attribute to it. For example: *Physical activity is among my life priorities*.

The responses were issued using a sliding pointer in a range from −50 to 50. The 6 items with the highest factorial load were chosen and adapted for this study, 2 of them related to the possibility of practicing physical activity and 4 referring to the perceived importance, thus forming the attitudinal index. The items of this index reported an Cronbach's $\alpha = .79$.

Due to the high internal consistency between both indices (Cronbach's $\alpha = .80$), all the items were averaged in a single index. In this way, the index of attitude towards physical activity is composed of the average of the 7 semantic differential items and the 6 adapted items of the Scale of Attitudes towards Physical Activity and Sport [49]. Higher values indicate more favorable attitudes towards physical activity.

3) BEHAVIORAL INTENTION

The behavioral intention was measured through 4 items in the final stage of the questionnaire, presented in the format of probability of execution of behaviors related to the practice of physical activity (for example: *What is the probability that I perform physical activity this week*; *What is the probability that I invite my friends to do physical activity*). The responses were issued using a slider with a range of values from 0 to 100 points, the later being the maximum probability of performing the behavior. The items of this index presented an Cronbach's $\alpha = .83$. Higher values indicate a greater probability of engaging in physical activity.

D. STATISTICAL ANALYSIS

The statistical analysis was performed with the SPSS tool. The data described in the arquitecture of solution (see Figure 2) was stored on Firestore Cloud. Data was downloaded in a CVS format and processed and parsed locally with Python and Pandas library, generating a CVS ready for analysis with the statistical software.

Two main analyses were performed:

- Pearson's correlation to evaluate the statistical significance of the correlation a $p-value < .05$ was considered.
- Mediation model: Hayes process Macro model 4 [50] (see Figure 1 -b), was used with 95% boostrap confidence interval (CI) based on 5,000 samples with the objective of evaluating the mediation model's significance [51].

V. RESULTS

A. CORRELATION RESULTS

Bivariate Pearson correlations were performed to assess the linear relationship between the different variables: Thoughts Favorability (Thoughts), Attitudes torwards physical activity (Attitudes), and Behavioral Intention.

TABLE 1. Correlations among study variables.

Variables	1	2	3
1. Thoughts	-	.468**	.367*
2. Attitudes		-	.696**
3. Behavioral intention			-

Note: * the correlation is significant at $p < 0.05$; ** the correlation is significant at $p < 0.01$.

As observed in Table 1, Thoughts (M = 31.72, SD = 15.55), Attitudes (M = 47.52, SD = 14.45) and Behavioral Intention (M = 43.38, SD = 28.47) are positive and significantly related.

In this context, the indexes of Thoughts and Attitudes ($p < .01; r = .468$), indicates that the positive thoughts generated towards physical activity are related positivity with Attitudes torwards it. The same relation can be seen between the indexes of Thoughts and the Behavioral Intention ($p < 0.05; r = .367$). Finally, the indexes of Attitude towards physical activity and the index of behavioral intention ($p < .01; r = .696$) indicates that the more positive the attitudes towards physical activity, the greater the intention to perform the behavior.

B. EXPLORATORY MEDIATION ANALYSIS

Unstandardized regression coefficients were used in the mediation analysis, see Figure 3. An indirect influence of thought favorability on behavioral intention was seen in attitudes' effects (ab = .7493, 95% with a bootstrap CI = .2153 to .3947). The participants' whose thinking was more positive indicated attitudes that were more positive (a = .5177). It is important to note that more positive attitudes had an association with higher behavioral intention (b = 1.4475).

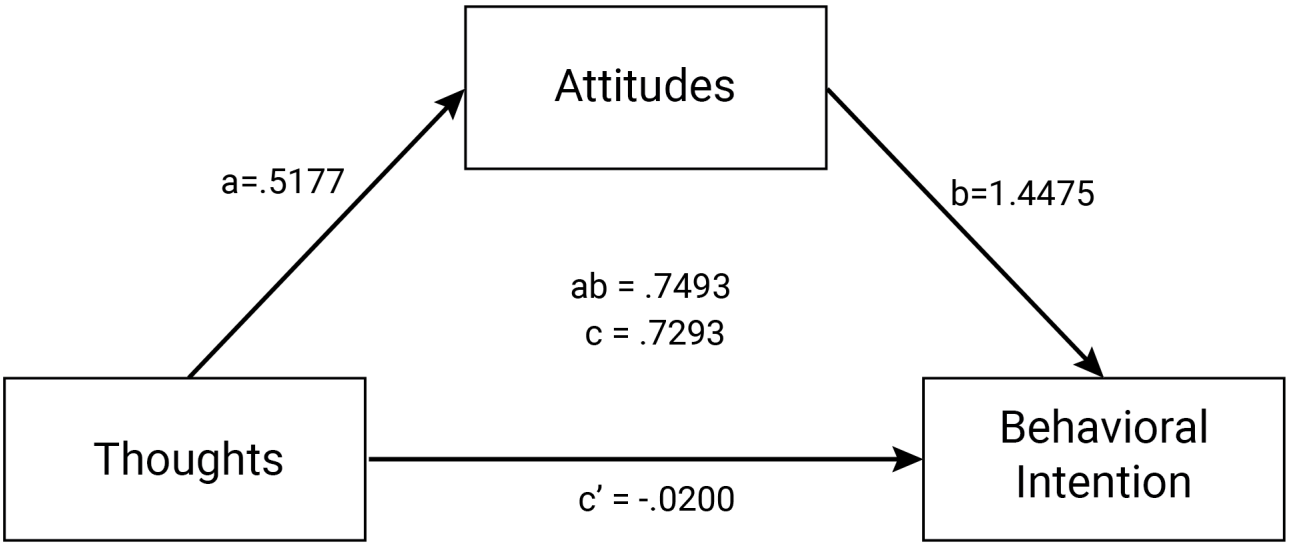
In addition to the the previous results, the attitude instrument can be considered separated between:

1) The seven semantics differential items: In concordance with the main result, attitudes were shown to mediate the how thoughts and BI related to each other. In total, the physical activity intention effect was (c = .7293, se = .2646, p = .0085, CI = .1957 to 1.2629), while the indirect effect was (ab = .2633, se = .1614, 95% bootstrap CI = .0441 to .6801).
2) The six items adapted from the Scale of Attitudes towards Physical Activity and Sport: The total effect of the mediation model was (c = .7293, se = .2646, p = .0085, CI = .1957 to 1.2629) and the indirect effect was (ab = .6301, se = .1841, CI = .3101 to 1.0263).

In summary, it can be seen that the total effect, c, (positive thinking) led to positive BIs. However, this relation occurrs because of the indirect effect, ab (the attitudes resulting from positive thinking partially mediate thoughts and intentions).

VI. DISCUSSION

The results of the study show that a mobile application can serve as a tool to promote physical activity using theoretical



Mediation Model of the effect of thoughts, attitudes, and the use of condoms.

Dependent variable = Practice physical activity	Coefficient of effect	SE	LLCI	ULCI
Direct effect of thoughts on mediator attitudes	.5177	.1186	.2784	.7569
Direct effect of thoughts on BI	-.0200	.2446	-.5137	.4736
Direct effect of attitudes on BI	1.4475	.2618	.9192	1.9758
Indirect effect of thoughts on BI	.7493	.2153	.3947	1.2476
Total effect on BI	.7293	.2646	.1957	1.2629

FIGURE 4. Mediation model for thoughts, attitudes, and physical activity. Thoughts: predictor variable, attitudes: mediator, physical activity: outcome variables (a = unstandardized coefficient of thoughts on attitudes; b = unstandardized coefficient of attitudes on physical activity; ab = indirect effect of thoughts on physical activity; c′ = direct effect of thoughts on physical activity; c = total effect of thoughts on physical activity = ab + c′).

elements derived from attitudinal theory. As hypothesized, it can be observed how in the active generation of thoughts (a situation of high cognitive elaboration), thought favorability and attitudes towards physical activity have a significant and positive realationship (H1), and these, in turn, are related with the intention of carrying out said behavior (H2).

As a consequence, an indirect effect was seen of attitudes on how thoughts and BI relate to each other. This could indicate that attitudes toward physical activity are important factors for the prediction of BIs, both positive and negative (see Figure 4). In other words, the design of an app using ELM elements can contribute to promoting the healthy behavior of physical activity.

Even when the thoughts generated have a positive relationship with the behavior, when serving as a predictor together with the attitudes, it was possible to observe that said relationship ceases to be significant, while that of the attitudes with the intention remains.

In this sense, mobile devices are emerging as an useful tool to promote physical activity, considering the wide accessibility and scope that they have. On the other hand, its effectiveness in promoting healthy behaviors is supported by research in the area, this work being one more example of the feasibility of successfully bringing theoretical principles to the virtual context.

The development of apps to promote healthy behaviors can benefit from a theory-based approach. Technology brings different experiences to users, allowing them to access all the ubiquity of the mobile devices and the context awareness that can be provided through their sensors, but understanding the processes that underlie how the information is processed is crucial to promote attitudes. In this context, information can be distributed in different ways and context, but how this the information is processed by users is crucial.

It is important to note that in this work the instruction given to the users was to elaborate positive ideas or arguments for

physical activity. The lack of those directions could make more likely that users think either positive or negative ideas, or arguments of the same amount, or thoughts about physical activity that could even be negative. As a consequence of this, thoughts may provide both favorable and unfavorable assessments at the same time, resulting in attitude uncertainty, which lessens the effect on BIs [52]. If the negative thoughts are greater than the positive, or only negative, the attitudes torwards physical activity could even be negative and therefore may be used for the prediction of behavior that is unhealthy, for example, avoiding physical activity. Thus, in this context, the direction of the thoughts or prompts for users to think in a biased way is particularly relevant [40].

As a final remark, studies of this type present the opportunity to promote positive changes in the field of health behaviors, which is relevant considering the impact that the pandemic has had on the life of the population. Added to this, the effect of physical activity as a protective factor against pathological conditions, such as high blood pressure, obesity, diabetes, and cardiovascular diseases, as well as psychological effects, such as stress, depression, and anxiety [6], makes it an important area of study today.

A. LIMITATIONS AND FUTURE WORK

In the present work, the principal limitation is that, due to the non-experimental design, it cannot be concluded whether participants had positive thoughts because of the instructions or because rather any thought that is generated in the context of an app tends to be positive.

Future work should address the following lines:

- Integrate into the main app some functionalities related to enhacing user experience (track sports modules and geolocalization, among others) and compare if the main effect is moderated through some contextualized functionalities.
- Evaluate the attitudes and behavioral intention through time.
- Evaluate the relationship between the BI and the intention with the sport module in the app.

Finally, we think that researching modern attitude change theory in electronic and mobile environments will contribute to developing innovative methods of healthcare prevention. Users react differently when receiving information, such as messages about good health. The possibility of developing strong views and, thus, the capacity to anticipate behavior, increases with the amount of information processed. As a result, it is critical to understand how people digest information, in addition to using technology to distribute or convey it.

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