information

*Article*

# Can Message-Tailoring Based on Regulatory Fit Theory Improve the Efficacy of Persuasive Physical Activity Systems?

**Leila Sadat Rezai [1,*], Jessie Chin [2], Reicelis Casares-Li [1], Fan He [1], Rebecca Bassett-Gunter [3] and Catherine Burns [1]**

1 Department of Systems Design Engineering, University of Waterloo, Waterloo, ON N2L 3G1, Canada; rcasaresli@uwaterloo.ca (R.C.L.); f24he@uwaterloo.ca (F.H.); catherine.burns@uwaterloo.ca (C.B.)
2 School of Information Sciences, University of Illinois at Urbana-Champaign, Urbana, IL 61801, USA; chin5@illinois.edu
3 School of Kinesiology & Health Science, York University, Toronto, ON M3J 1P3, Canada; rgunter@yorku.ca
* Correspondence: leila.rezai@uwaterloo.ca

Received: 30 September 2019; Accepted: 6 November 2019; Published: 8 November 2019


**Abstract: Background:** Many behaviour-change technologies have been designed to help people with a sedentary lifestyle to become more physically active. However, challenges exist in designing systems that work effectively. One of the key challenges is that many of those technologies do not account for differences in individuals' psychological characteristics. To address that problem, tailoring the communication between a system and its users has been proposed and examined. Although in the research related to public health education, message tailoring has been studied extensively as a technique to communicate health information and to educate people, its use in the design of behaviour-change technologies has not been adequately investigated. **Objective:** The goal of this study was to explore the impact of message tailoring, when tailoring was grounded in Higgins' Regulatory Fit Theory, and messages were constructed to promote physical activity. **Method:** An email intervention was designed and developed that sent participants daily health messages for 14 consecutive days. There were three categories of messages: reminders, promotion-, and prevention-messages. The effect of the messages on behaviour was compared between those who received messages that fitted their self-regulatory orientation, versus those who received non-fitted messages. **Results:** Participants who received promotion- or prevention-messages walked for longer periods of time, compared to those who received reminders in the control group. When comparing the first two groups, promotion-message-recipients on average walked more than those who received prevention-messages. In other words, promotion messages acted more persuasively than prevention-messages and reminders. Contrary to our hypothesis, those individuals who received messages that fitted their self-regulatory orientation did not walk more than those who received non-fitted messages. **Conclusions:** The efficacy of Higgins' Regulatory Fit Theory in the design of tailored health messages was examined. This study did not find support for the use of that theory in guiding the design of persuasive health messages that promote physical activity. Therefore, more research is necessary to investigate the effectiveness of tailoring strategies.

**Keywords:** persuasive technology; personalization; message tailoring; adaptive technology; behaviour-change-support-systems; technology to promote physical activity; Higgins' Regulatory Focus Theory; Regulatory Fit Theory

## 1. Introduction

Regular physical activity positively affects mental and physical health and reduces the risk of a variety of chronic conditions, including cardiovascular disease and hypertension, type 2 diabetes, certain types of cancer, and depression [1,2]. However, about 69% of Canadians conduct a sedentary life, and only 5% of adults perform 150 moderate-to-vigorous physical activity per week [1].

Numerous technological interventions have been designed to help individuals adopt a healthier lifestyle and to become more physically active. However, many systems fail by not considering users' differences in their design. Therefore, further research is necessary to investigate how technology can communicate health-related messages to individuals more effectively by tailoring the communication in order to increase the chance of users performing the target behaviour.

Although public health researchers have studied a wide variety of techniques for tailoring health messages, their findings have not been employed broadly in the design of persuasive systems.

The goal of this research was to investigate a particular message tailoring approach that was grounded in Higgins' Regulatory Fit Theory. According to Higgins, individuals will be more likely to change their behaviour if they receive persuasive messages tailored to their psychological characteristics.

In this paper, we will first discuss some background research, including techniques and behavioural theories that have been studied and utilized by researchers over the past decades for tailoring the persuasive communication. Then, we explain our approach, experimental design, and the results of our study. Finally, we discuss our findings, study limitations, and research contributions.

## 2. Background and Related Work

Those technologies designed to support users in adopting healthier habits are known as persuasive technologies.

According to O'Keefe [3], persuasion means "*[An] intentional effort at influencing another's mental state through communication in a circumstance in which the persuadee has some measure of freedom*"(p. 5). Briñol and Petty [4] highlight the fact that persuasion, which happens in a particular context, requires an intervention such as a persuasive message (or a persuasive image).

Scholars, including Oduor, Alahäivälä, and Oinas-Kukkonen [5], believe that interactive communication is the best mechanism to use for persuasive systems. Given the increasing availability of computational technologies with various communication modalities, these technologies could act even more effectively than humans to persuade individuals.

Persuasive systems have evolved over time. Simple persuasive interventions that used phone conversations as a communication means [6] have been transformed into advanced mobile or web-based applications that are paired with wearable sensors, such as activity trackers or blood pressure monitors. These systems can continuously measure and analyze users' physiological data and change the content or the tone of the persuasive health messages that users receive [7–9].

Persuasive systems that are designed based on behavioural models have a higher chance of leading to behaviour change [10]. Many persuasive interventions have been grounded in well-known behaviour change theories, such as the Health Belief Model [11], Prospect Theory [12], Social Cognitive Theory [13], Theory of Planned Behaviour [14], Trans-theoretical Model [15], Self-Determination Theory [16], and Fogg's behaviour change model [17]. Among all those theories, Fogg's model [17] has earned the most attention, and since its emergence, many experiments have been conducted to examine its efficacy.

Based on a variety of behaviour change theories, Fogg introduced a set of strategies for creating effective persuasive technologies. Later, other researchers, including Oinas-Kukkonen and Harjuma [18], extended his framework and defined a persuasive design model that incorporated 28 different persuasive techniques for designing behaviour-change support systems.

A number of these techniques, including tailoring, are intended to optimize how persuasive systems communicate with their users to promote target behaviour (e.g., performing regular physical activity).

### 2.1. Message Framing

Over the past decades, researchers have examined a variety of psychological theories, including Prospect Theory [12], to develop effective persuasive messages.

In the context of promoting physical activity, message framing can be described as "*emphasizing the benefits of engaging in a behaviour*" (i.e., gain-framed messages) or "*the costs of not engaging in a behaviour*" (i.e., loss-framed messages) [10]. By knowing the benefits of regular physical activity, or the risks of a sedentary lifestyle on health, people would potentially perform physical activity more regularly [19]. However, the extent to which this approach can be effective is still unclear [19].

Due to the uncertainty in the best approach to frame persuasive health messages in the context of physical activity, we conducted a preliminary experiment [20], where we developed and tested a set of persuasive messages to be used in this study. In that experiment, participants rated developed health messages to indicate each message's level of persuasiveness. The messages were of three different categories: (1) Promotion (or gain-framed) messages (messages that promoted the benefits of performing regular physical activity), (2) Prevention messages (messages that highlighted physical and mental health problems that can be avoided by performing regular activity), and (3) Loss-framed messages (messages that stressed the risks and consequences of not engaging in regular activity). (See Table 1).

**Table 1.** Lists examples of each message category tested in the preliminary experiment.

| | |
|---|---|
| **Promotion/gain-framed Message** | People who participate in aerobic activities such as jogging, swimming, and basketball are more likely to improve their cardiovascular fitness. |
| **Prevention Message** | Physical activity can alleviate the symptoms and effects of conditions such as high blood pressure, diabetes, and heart disease. |
| **Loss-framed Message** | Physical inactivity can increase the symptoms and effects of conditions, such as high blood pressure, diabetes, and heart disease. |

Our findings revealed that among the three different message categories we tested in that experiment, promotion-messages (or gain-framed messages) were perceived to be the most persuasive. The second most-persuasive category of messages was the prevention-message category. The least-persuasive messages were loss-framed messages. Therefore, for the purpose of the current study, we used messages that were framed either as promotion- or as prevention-messages, and we did not use any loss-framed messages.

### 2.2. Message Tailoring

Tailoring is the process of designing persuasive communication based on individuals' characteristics, needs, and interests [18]. According to Kreuter, Farrell et al. [21] tailoring means "*any combination of strategies and information intended to reach one specific person, based on characteristics that are unique to that person, related to the outcome of interest, and derived from an individual assessment*" (p. 277).

Research shows that different individuals may perceive the same persuasive message differently, and as a result, their responses to a message would not necessarily be identical [6,22].

Scientists have indicated that individuals tend to read and remember tailored information more than untailored information. Thus, in order to increase the efficacy of a persuasive system, the messages should be tailored to the user's psychological characteristics [23].

Over the last decade, researchers have investigated a variety of tailoring approaches to inform the design of persuasive systems. For instance, based on a psychological construct named Need for Cognition [24], Kaptein and colleagues [25] developed a Susceptibility to Persuasion Scale (STPS) that measures individuals' susceptibility to six different influence strategies, including commitment, scarcity, authority, and consensus.

Other examples include the work of Halko and Kientz [26], who used tailoring based on the Big Five personality traits [27] to design a system that promotes exercising, or the work of Orji and colleagues [28], who used tailoring based on Bartle's taxonomy of gamers [29] to design a persuasive health game that improves individuals' eating habits.

These are only a few examples of studies in which tailoring of persuasive communication was done based on users' psychological characteristics, and although in recent years, numerous studies have examined diverse tailoring strategies, many questions have remained unanswered, and there are not sufficient guidelines on the best approach to tailor the messages of a persuasive systems.

### *2.3. Using Regulatory Fit Theory to Tailor Persuasive Messages*

According to Higgins [29], there are two different self-regulatory orientations that individuals are inclined to while pursuing their goals: promotion-orientation and prevention-orientation. "*Promotion-oriented individuals focus on advancements, growth, and making progress toward their hopes and aspirations, whereas prevention-oriented people are more concerned about safety, security, and fulfilling their responsibilities*" [30].

When individuals' self-regulatory orientation fits their goal-pursuit strategy, they are more engaged in the process of pursuing their goals.

This theory has played an essential role in persuasion [31], and since its introduction, many public health scholars have conducted studies to investigate its efficacy in tailoring health-related content that can persuade individuals to adopt a healthy lifestyle [32–34].

Health messages can be framed to have either a promotion or a prevention focus. An example of a promotion-focus message is, "*A flu vaccine helps you to continue achieving your goals even during a flu season*." An example of a prevention-focus message is, "A *flu vaccine helps you avoid strength-sapping illness during a flu season*" [30].

According to Regulatory Fit Theory, promotion-orientation individuals are more influenced by promotion-focus messages and prevention-oriented people by prevention-focus ones [20].

In the context of our study, we hypothesize that:

> *Tailoring health messages to individuals' self-regulatory-orientation increases the chance of them become more physically active.*

In other words, persuasive messages delivered to individuals via communication technologies would be more effective if they fit recipients' self-regulatory orientation.

There is no known research on the relative effectiveness of physical activity promoting systems that send persuasive messages that may fit or may not fit users' self-regulatory orientation repeatedly and over an extended period of time. The purpose of this study was to examine the efficacy of that approach.

## 3. Method

To examine the effectiveness of tailoring grounded on Regulatory Fit Theory for physical activity promoting systems, we designed and conducted two experiments [35,36]. In the first experiment [35], we developed and tested a series of health messages for use in the current study.

### *3.1. Messages*

Messages were adapted from those used in similar research, and their persuasiveness was rated by a group of participants whose demographic characteristics matched those of this study [35]. There were three types of messages (see Table 2):

(1) Promotion-messages, which were framed to promote the benefits of performing regular physical activity.
(2) Prevention-messages, which highlighted the health problems that can be avoided by performing regular physical activity.

(3) Reminder messages, which had a neutral tone and were used for the control condition.

**Table 2.** Lists examples of the promotion- and prevention-messages used in our study, as well as the reminder.

| | |
|---|---|
| **Prevention-message** | By adding 10-min bouts of regular leisure-time physical activity, you will reduce your risk of heart attack and stroke. |
| **Promotion-message** | In the short-term, physical activity can improve body composition, glucose levels, and cholesterol levels. |
| **Reminder-message** | Don't forget to go for your 20-min brisk walk today. |

### *3.2. Participants and Recruitment Process*

Upon receiving ethics approval from the University of Waterloo's Office of Research Ethics, the recruitment posters were sent via email to the students of the University of Waterloo, and they were also posted on notice boards around the campus.

Individuals who performed less than 150 min/week moderate to vigorous physical activity were invited to take part in the study.

Eligibility criteria also included:

- At least 18 years of age
- Free of medical concerns that prohibit participation in moderate physical activities (i.e., not prohibited to walk at a fast pace by physician), and
- Perform less than 150 min/week leisure time moderate to vigorous physical activity.

In the poster, the definition of moderate to vigorous physical activity was explained as: "According to the definition provided by Centers for Disease Control and Prevention: 'If you're doing moderate-intensity activity you can talk, but not sing, during the activity. If you're doing vigorous-intensity activity, you will not be able to say more than a few words without pausing for a breath.'"

Participants were provided with a web address where they could read the study information letter and consent form.

After indicating their consent, participants were navigated to a web page, where they were asked about their physical activity behaviour (see Table 3).

Only two categories of individuals passed the eligibility screening test: (1) those who indicated that they were not performing regular leisure-time physical activity but were motivated to do so, (2) those who said they were participating in leisure-time physical activity regularly for less than six months.

Participants were asked to provide an email address, where they could receive the health messages sent to them by the persuasive messaging system throughout the study.

Based on those criteria, 122 participants with self-reported sedentary lifestyles were recruited (see Table 4).

**Table 3.** Screener to determine participants' eligibility.

| **Participation Eligibility Measure** | |
|---|---|
| Definitions:<br>• Leisure-time physical activity is defined as any physical activity done during one's free time.<br>• Regular physical activity means accumulating at least 150 min of moderate- to vigorous-intensity aerobic physical activity per week, in bouts of 10 min or more.<br>• Moderate-intensity physical activity includes activities such as brisk walking, gardening, slow cycling, dancing, or hard work around the house.<br>• Vigorous-intensity physical activity includes activities such as jogging, running, fast cycling, aerobics, and swimming laps. These types of activities usually increase your heart rate, make you sweat, and make you feel out of breath.<br>Question:<br>Do you participate in regular moderate- to vigorous-intensity leisure-time physical activity? | |
| 1 | Yes, I have been participating in leisure-time physical activity regularly for MORE than six months, |
| 2 | Yes, I have been participating in leisure-time physical activity regularly for LESS than six months, |
| 3 | No, but I intend to start participating in leisure-time physical activity regularly in the next 30 days, |
| 4 | No, but I intend to start participating in leisure-time physical activity regularly in the next six months, or |
| 5 | No, and I do NOT intend to start participating in leisure-time physical activity regularly in the next six months. |

**Table 4.** Participant demographic.

| | |
|---|---|
| **Age** | Between 18 and 65<br>Mean = 23.55, SD = 5.8 |
| **Gender** | Female = 71.31%<br>Male = 28.69 |
| **Education** | High school diploma = 29.51%<br>Undergraduate degree = 38.51%<br>Graduate degree = 22.13%<br>Post-graduate degree = 9.02% |

### *3.3. Study Design*

On the first day of the study (Day 1), participants were assigned to one of the following three categories: (1) reminder-message-recipient, (2) promotion-message-recipient, or (3) prevention-message-recipient.

They were assigned to one of those three groups in the order they signed up for the study and regardless of their self-regulatory orientation (see Figure 1).

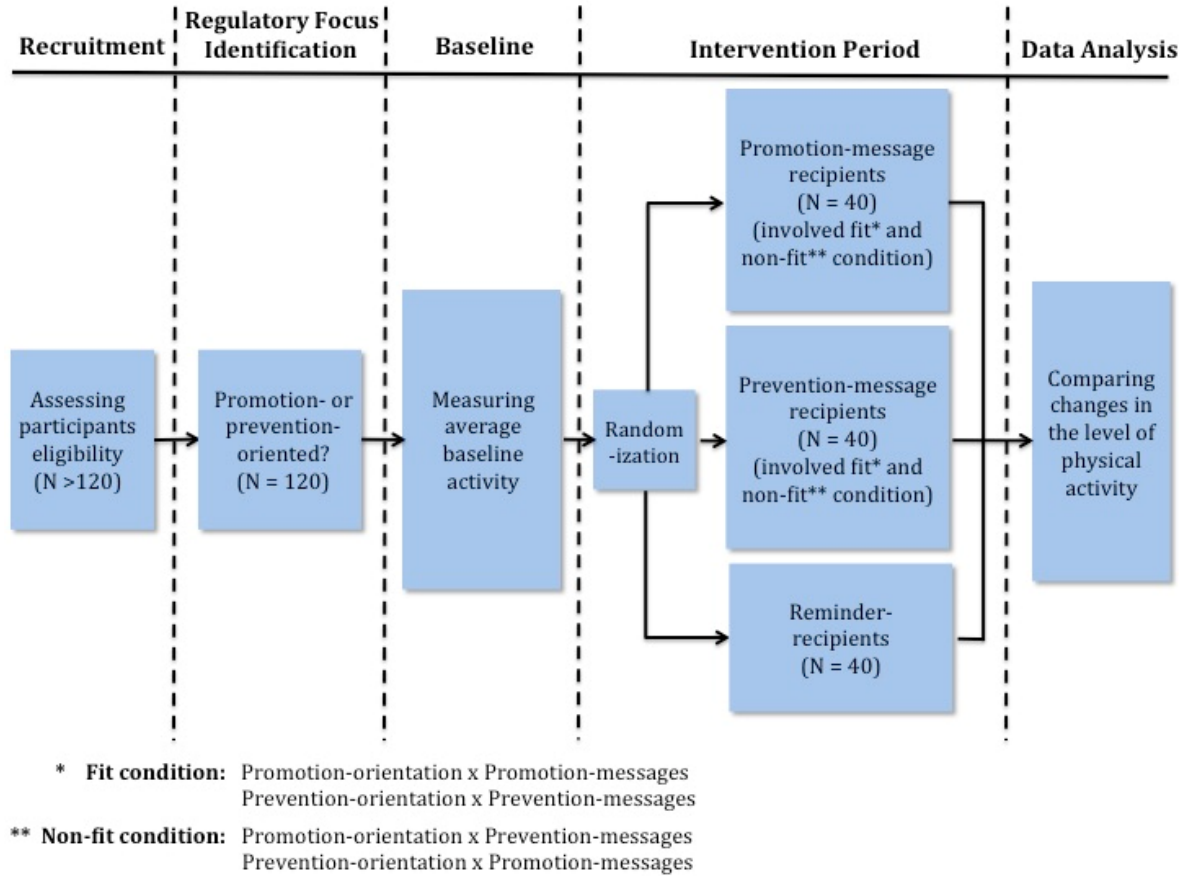


**Figure 1.** Study procedure.

Because of the way participants were assigned into the three experimental conditions, in each group, there were both fit and non-fit conditions. In other words, within the prevention-message-recipient group, there were prevention-oriented individuals, as well as promotion-oriented individuals. Therefore, some promotion-oriented individuals experienced the fit condition (fit between their self-regulatory-orientation and the messages' type), and some promotion-oriented individuals experienced the non-fit condition (no fit between their self-regulatory-orientation and the messages' type).

Similarly, in the prevention-message-recipient group, there were promotion-oriented participants, as well as prevention-oriented participants. Promotion-oriented participants experienced the fit, and prevention-oriented participants experienced the non-fit condition.

The regulatory orientation of the individuals in the third group (reminder recipients) was not a matter of interest.

It should be noted that it is not the self-regulatory orientation of the participants that was of interest, but whether a fit between messages' type and participants' self-regulatory orientation would lead to a more effective behaviour-change.

We postulated that using this approach to tailor the communication between a persuasive system and its users would increase the chance of participants adopting the target behaviour—in this case, going for a 20-min brisk walk every day during the study period.

A statistically significant difference in the outcome behaviour between the Fit and Non-fit conditions would test the hypothesis, which was:

> *Tailoring health messages to individuals' self-regulatory orientation increases the chance of them become more physically active.*

In this study, the independent variables were:

- Promotion-messages vs. prevention-messages vs. reminders
- Fit vs. non-fit condition

The dependent variable was the average self-reported amount of time (in minutes) that participant spent brisk walking throughout the study.

### *3.4. Procedure*

On Day 1, participants' self-regulatory orientation and the average time they spent performing regular leisure-time physical activity were determined.

Between Days 2 and 15, depending on their experimental condition, the participants either received daily reminders or received messages that fitted or did not fit their self-regulatory orientation. Each day and after reading that message, they had to answer a short online questionnaire (through a link provided in the email). Starting from Day 2, participants were asked to report how many minutes they spent on a leisure-time brisk walk the day before, and if they did not go for a walk, what was the reason for not walking.

In the Fit condition, participants received messages that fitted their self-regulatory orientations, and in the Non-fit condition, participants received messages that did not fit their self-regulatory orientation. In addition to these two conditions, there was a control group in which participants only received reminders (as opposed to tailored health messages).

The daily reminders that the third group participants received did not contain any explicit health-related information (see Table 2 for message examples). This third experimental condition was designed to reveal whether any observed effect in each of those two groups that receive tailored health messages, was as a result of simply receiving messages (regardless of what information those messages conveyed about physical activity), or from receiving informational content that fitted participants' regulatory orientation.

In order to compensate participants, at the end of the study, two draws took place to determine the winners of the two $200 cash prizes.

The collected data was analyzed, and a series of between- and with-subjects analysis of variance were conducted.

### *3.5. Expected Outcomes*

It was expected that the level of physical activity (i.e., time participants spent brisk walking) for all three groups would increase during the study period. However, we hypothesized that the group of individuals who received messages with a structure that fits their self-regulatory orientation (i.e., promotion-oriented individuals receiving promotion-focus messages and prevention-oriented individuals receiving prevention-focus messages) would become more physically active and would walk more than those of non-fit condition, and those of the control condition (reminder-recipients group).

We also hypothesized that if no statistically significant difference were observed between the outcome measures of the prevention-/promotion-message-recipients and the reminder-recipient groups, then exposing individuals to messages that contain health-related information (regardless of fit or non-fit condition), would not play a role in changing people's attitudes or behaviour about physical activity.

## 4. Results

Six participants were disqualified due to signing up for the study more than once or due to answering the same questionnaire multiple times. Only 34 participants answered all of the questionnaires. Figure 2 shows the number of participants who answered the study questionnaires each day during the intervention period. Table 5 demonstrates participant dropout rates over the intervention period. One-way ANOVA test revealed that there were no statistically significant differences in the dropout rates of the participants of the different message conditions.

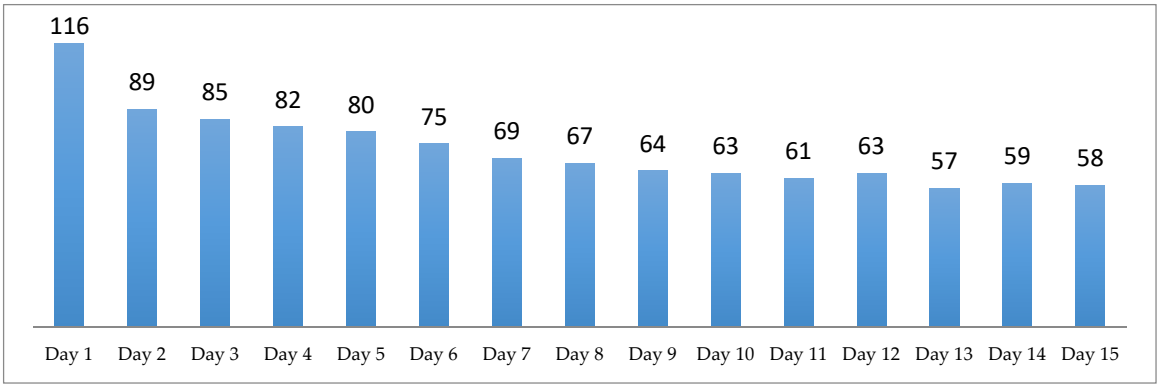


**Figure 2.** Number of participants who answered the study questionnaires during the intervention period.

**Table 5.** Participant dropout rates over the intervention period.

| Dropout Rates and Pattern | % |
|---|---|
| Percentage of participants who dropped out just after the first day: | 23.3 |
| • Prevention-message recipients | 8.6 |
| • Promotion-message recipients | 4.3 |
| • Reminder recipients | 10.3 |
| Percentage of participants who dropped out after one week of receiving messages: | 44.8 |
| • Prevention-message recipients | 14.6 |
| • Promotion-message recipients | 15.5 |
| • Reminder recipients | 14.6 |
| Percentage of participants who dropped out after two weeks of receiving messages: | 44 |
| • Prevention-message recipients | 12.1 |
| • Promotion-message recipients | 13.8 |
| • Reminder recipients | 18.1 |

From those individuals who withdrew from the study, 41.27% were promotion-oriented, and 58.73% were prevention-oriented. The data for all participants who completed the questionnaires for at least four days were included and analyzed.

Participants were asked to fill out an exit questionnaire, should they decide to drop out. From the 69 participants who withdrew, only 45 people completed that questionnaire. Participants were also asked to choose one of the given options (listed in Table 6) in the questionnaire form to indicate the reason for their withdrawal.

**Table 6.** Reasons for participants dropped out of the study.

| Dropout Reasons | % |
|---|---|
| I have become very busy and have no more time to continue. | 62.22 |
| I don't think the weather is appropriate for 20-min brisk walks anymore. | 26.67 |
| I have time but was not motivated enough to continue. | 20.00 |
| I do not wish to respond. | 13.33 |
| Because of a physical health problem (e.g., injury, cold, etc.). | 4.44 |
| Because of a mental health problem (e.g., feeling stressed, anxious, and/or depressed, etc.). | 4.44 |
| I don't have the support of my friends/family anymore. | 0.00 |

### 4.1. Brisk Walk Time Averages

A two-way repeated-measures ANOVA was conducted to compare individuals' average brisk walk minutes at three different time periods. (See Table 7 for descriptive statistics.).

**Table 7.** Average walking times for each study condition during the three different study periods.

| | Fit/Non-Fit Condition | Message Condition | Mean (Minutes) | Std. Dev. |
|---|---|---|---|---|
| **Baseline** | Non-fit | Prevention-Message-Recipients | 27.06 | 13.85 |
| | | Promotion-Message-Recipients | 8.08 | 8.68 |
| | Fit | Prevention-Message-Recipients | 15.00 | 8.33 |
| | | Promotion-Message-Recipients | 15.78 | 14.87 |
| | N/A | Reminder-Message- Recipients | 10.44 | 11.09 |
| | | Total | 13.90 | 12.53 |
| **>Week 1** | Non-fit | Prevention-Message-Recipients | 27.20 | 8.05 |
| | | Promotion-Message-Recipients | 23.42 | 9.73 |
| | Fit | Prevention-Message-Recipients | 22.81 | 10.07 |
| | | Promotion-Message-Recipients | 24.38 | 4.45 |
| | N/A | Reminder-Message- Recipients | 23.95 | 4.42 |
| | | Total | 24.19 | 7.25 |
| **Week 2** | Non-fit | Prevention-Message-Recipients | 28.97 | 8.58 |
| | | Promotion-Message-Recipients | 24.64 | 13.59 |
| | Fit | Prevention-Message-Recipients | 23.80 | 5.59 |
| | | Promotion-Message-Recipients | 28.62 | 5.92 |
| | N/A | Reminder-Message- Recipients | 24.24 | 7.76 |
| | | Total | 25.63 | 8.89 |

### 4.2. The Effect of Intervention Messages

We then conducted a mixed-factor repeated-measures ANOVA to examine the effect of conditions (between-subject: promotion-focus messages vs. prevention-focus messages vs. reminders) and time (within-subject) on average brisk walk times (minutes) (see Figure 3).

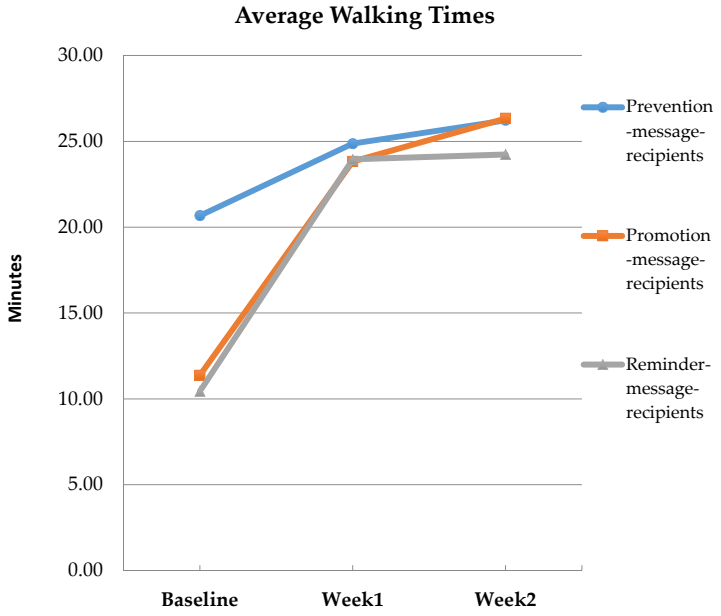


**Figure 3.** Average time participants of each message condition spent walking per day at different periods of the study.

There was an interaction effect between the message condition and individuals' average brisk walk times during the three different periods [$F(4, 106) = 2.62$, $p < 0.05$, partial eta squared = 0.1].

The finding revealed that participants who received prevention-messages continued (on average) to walk more during Week 2 than Week 1 and Baseline, and the descriptive statistics revealed a trend that promotion-message recipients also tend to walk more during Week 2 compared to Week 1 and compared to the Baseline period. However, a similar effect was not detected for the reminder-message-recipients.

### *4.3. The Effect of Regulatory Fit*

To examine the effects of regulatory fit, we first excluded participants who were assigned to the reminder condition, in which no manipulation of regulatory fit was applied. A three-way mixed-factor repeated-measures ANOVA was conducted to explore the effects of conditions (between-subject: promotion-focus messages vs. prevention-focus messages) when the messages did or did not align with individuals' self-regulatory-orientation (between-subject: Fit or Non-fit conditions) on the average times individuals spent brisk walking during the intervention period (within-subject: Baseline, Week 1, and Week 2), (see descriptive statistics in Table 7).

Findings revealed that there was a significant main effect of time on the average time individuals spent brisk walking [$F(2, 102) = 33.11$, $p < 0.001$]. That is, once the study started, the average time each individual spent brisk walking increased—regardless of their experimental condition. This effect was expected.

There was also an interaction effect of message condition and Fit/Non-fit condition on individuals' average brisk walk times [$F(1, 51) = 6.32$, $p < 0.05$], which means depending on the message type, we could see the regulatory fit effect. The regulatory fit effect was only observed for prevention-orientation individuals, meaning those participants who were prevention-oriented and received prevention messages increased their average brisk walk times more than those promotion-oriented participants who received prevention messages.

Moreover, the three-way interaction effect of message condition and Fit/Non-fit condition on the time individuals spent brisk walking [($F(2, 102) = 2.15$, $p = 0.12$)] was not significant. In other words, the increase in the brisk walk times during the intervention period did not differ based on whether the messages did or did not fit participants' self-regulatory orientation.

To further explore the trend, we conducted a two-way repeated-measures ANOVA to examine the effects of Fit/Non-Fit and individuals' self-regulatory-orientation on average brisk walk times.

**Analysis of promotion-message condition.**

There was a main effect of time, meaning during the intervention period, and while participants were receiving promotion-focus messages, they were walking more and more [$F(2,38) = 17.93$, $p < 0.001$)].

However, there was no effect of Fit/Non-fit [($F(1,19) = 1.51$, $p = 0.25$)], meaning regardless of individuals' self-regulatory-orientation, promotion-messages could help participants become more physically active during the intervention period (see Figure 4).

Findings revealed that promotion-oriented participants of this study walked more than prevention-oriented participants during the intervention period—regardless of the message type they received, (see Table 8. This observation is independent of this study manipulation and was related to the participants' characteristics.

**Analysis of prevention-message condition.**

In the prevention-message condition, no main effect of time on the average minutes spent brisk walking (within-subject effect) was found [$F(2,30) = 2.4$, $p = 0.108$)], which could have been due to the fact that during the baseline period promotion-oriented participants, on average, walked more than the prevention-oriented individuals.

A marginal main effect of Fit/Non-Fit (between-subject) [$F(1,15) = 4.32$, $p = 0.055$)] was found, but no interaction effect of average brisk walk times and the Fit/Non-Fit condition [$F(2,30) = 1.39$, $p = 0.266$] (see Figure 5).

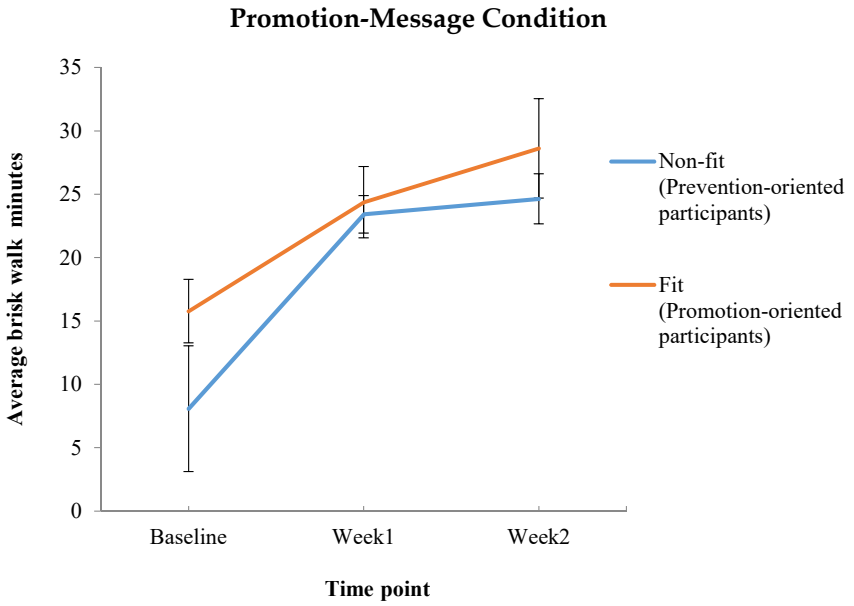


**Figure 4.** Average time promotion-message-recipients spent walking.

**Table 8.** Average brisk walk times of participants in promotion-message condition.

| | Participant's Self-regulatory Orientation | Mean (Minute) | Std. Deviation |
|---|---|---|---|
| **Baseline** | Prevention-oriented | 8.10 | 2.51 |
| | Promotion-oriented | 15.80 | 4.96 |
| **Week 1** | Prevention-oriented | 23.42 | 2.81 |
| | Promotion-oriented | 24.38 | 1.48 |
| **Week 2** | Prevention-oriented | 24.60 | 3.92 |
| | Promotion-oriented | 28.62 | 1.97 |

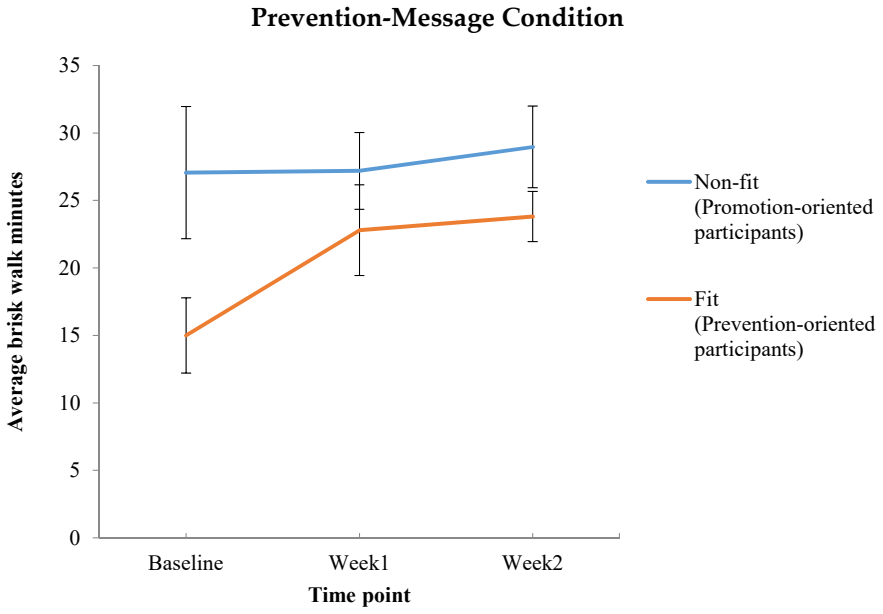


**Figure 5.** Average time prevention-message-recipients spent walking.

The analysis also revealed that during the intervention period, the promotion-message-recipients continued to walk more than prevention-message-recipients in this experimental condition. However, we did not find a regulatory fit effect, meaning promotion messages persuaded participants to walk more regardless of their regulatory focus.

## 5. Discussion

Although we hypothesized that tailoring health messages based on Higgins' Regulatory Fit Theory would increase the efficacy of our persuasive physical activity intervention, and the participants in the Fit condition would become more physically active than those in the Non-fit condition, we observed regulatory fit effects only partially. However, the results demonstrated that promotion-messages were more persuasive than prevention-messages and reminders.

These findings are aligned with that of our previous study [35], in which we demonstrated that between the two types of the promotion- and prevention-messages, promotion-messages were perceived to be more persuasive, and therefore more motivating to the participants. This finding is also in line with those of other researchers, including Martinez and colleagues [37], Latimer and colleagues [33], and Pfeffer [35]. In her study, Pfeffer compared the effects of promotion- and prevention-messages and realized that when participants were provided with promotion-messages, they become more physically active compared to when they received prevention-messages. Martinez and colleagues [37], also found that compared to the prevention-messages, promotion-framed messages had a greater effect on individuals' intention to become more physically active. Similarly, in their studies, Latimer and colleagues [33] learned that those participants who received promotion-messages became more physically active compared to those in other experimental conditions.

The current study has limitations. Like any experiment with self-reported data, our study inherited potential risks induced by participants' bias or inaccuracies in reporting the data (i.e., the time they spent brisk walking).

The sample size was another issue, as more than half of the participants withdrew before the end of the study. The high dropout rate was attributed to a variety of factors, including extreme winter weather conditions that arose during the course of the study, participants' demographic, and the simplicity of the email intervention. The study took place in Waterloo, Canada, where people experience subzero temperatures for a large portion of the year. In winter, the temperature of that region can fall below −20 °C (−4 °F) [38].

Apart from the weather conditions, the characteristics of the sample population (mostly university students) could have been one of the factors for the high attrition rate. Over 62% of the participants stated lack of time as their primary dropout reason.

Another factor, we believe, was the plainness of the intervention. In the design of our persuasive messaging system, we did not employ other persuasive mechanisms such as gamification (e.g., introducing a reward system) or self-monitoring, etc. The emails in this study were purposefully designed to be simple and did not contain any other forms of communication modality, such as visuals, audio, etc.). The rationale for such design was to isolate the impact of the message tailoring on participants' behaviour. A large body of the Persuasive Technology literature involves descriptions of the studies where the researchers have used a variety of persuasive techniques in the design of their systems and attempted to investigate the efficacy of their persuasive systems. Needless to say, that approach makes determining the effect of each used persuasive technique difficult—if not impossible.

In our experiment, we focused on one persuasive technique, and by designing emails with a simple and minimalistic look, we intended to eliminate the risk of potential confounds. That being said, considering the abundance of the apps or wearables that promote physical activity in the current market, it is reasonable to assume that participants of this study (with the average age of 23.55) might have already been exposed to those kinds of technologies, and as a result, they might have found this email intervention not motivating and uninteresting [39]. So, we believe that the simplicity of the intervention was also one of the main reasons for the high dropout rate.

## 6. Conclusions

The contributions of this message-tailoring research are multifold:

**Contributions to technology design and development.** In our previous study [35], we highlighted the importance of refining message-framing research questions and examined different approaches to frame persuasive health messages that promote physical activity. In this study, we developed a messaging system to examine tailoring based on the Regulatory Fit theory. The purpose of this stepwise methodology was to develop adequate experimental control for establishing an intervention that examines the efficacy of that specific tailoring strategy as a persuasive mechanism in the design of behaviour-change-support systems. By building on simple experiments we attempted to ensure that the experimental intervention works effectively, prior to conducting a large sample size study (e.g., studies with more than 300 participants).

Moreover, although other scholars, such as Kaptein [25], Oinas-Kukkonen and Harjuma [18] have since made efforts to expand the persuasive design model framework, there is still a need to further investigate and define a set of design rules on how to tailor the communication between a persuasive system and its users. This study was an effort to contribute to the creation of such a rule-set.

**Contributions to social psychology.** The outcome of this research provided new insights into the relationship between the Regulatory Fit Theory, persuasive message construction, and behavior change. The experimental design in this study was novel. Contrary to prior studies on The Regulatory Fit theory, in which priming participants with persuasive messages occurred once or only a few times during the experiment, participants of this study were exposed to influencing messages repeatedly, and the effect of those messages on participants' behaviour was measured every day.

**Contributions to healthcare and well-being.** Although extensive research has explored the best methods of framing persuasive-messages in the domain of health communication, no clear results exist on the most effective strategy [39]. Our findings showed that health-message, and particularly promotion-messages, were more effective than reminders to encourage people to go for a brisk walk. However, our results did not replicate those of other researchers who found that tailoring grounded in Higgins' Regulatory Fit theory would make messages more persuasive in the context of promoting regular physical activity [33,34,38].

Future research should consider analysing participants' intention and motivation to become more physically active, as well as their self-efficacy. More importantly, in future studies, participants' physical activity (e.g., the number of steps they take each day) should be measured objectively by means of physical activity sensors to improve the validity of experiments.

Overall, more research is necessary to approve the validity of Higgins' theory in the context of promoting regular physical activity.

**Author Contributions:** Conceptualization, L.S.R.; Methodology, L.S.R., J.C., C.B., and R.B.-G.; Software, L.S.R.; Validation, L.S.R., J.C., C.B.; Formal analysis, L.S.R., J.C., R.C.L. and F.H.; Data curation, L.S.R., F.H., R.C.L.; Writing—original draft preparation, L.S.R.; Writing—review and editing, L.S.R., J.C., R.C.L., and R.B.-G., C.B.; Visualization, L.S.R.; Supervision, C.B.; Project administration, L.S.R.; Funding acquisition, C.B.

**Funding:** This research was funded by NSERC Discovery, grant number 132995.

**Acknowledgments:** The authors would like to thank the Natural Sciences and Engineering Research Canada (NSERC) for funding this research.

**Conflicts of Interest:** The authors declare no conflict of interest.

## References

1. Colley, R.C.; Garriguet, D.; Janssen, I.; Craig, C.L.; Clarke, J.; Tremblay, M.S. Physical activity of Canadian adults: Accelerometer results from the 2007 to 2009 Canadian Health Measures Survey. *Health Rep.* **2011**, *22*, 7. [PubMed]
2. World Health Organization. *A Global Brief on Hypertension: Silent Killer, Global Public Health Crisis: World Health Day 2013*; World Health Organization: Geneva, Switzerland, 2013.

3. O'Keefe, D.J. *Persuasion: Theory and Research*; Sage Publications: Thousand Oaks, CA, USA, 2002.
4. Petty, R.E.; Brinol, P.; Priester, J.R. Mass media attitude change: Implications of the elaboration likelihood model of persuasion. In *Media Effects*; Routledge: Abingdon, UK, 2009; pp. 141–180.
5. Oduor, M.; Alahäivälä, T.; Oinas-Kukkonen, H. Persuasive software design patterns for social influence. *Pers. ubiquitous Comput.* **2014**, *18*, 1689–1704. [CrossRef]
6. Noar, S.M.; Harrington, N.G.; Aldrich, R.S. The role of message tailoring in the development of persuasive health communication messages. *Ann. Int. Commun. Assoc.* **2009**, *33*, 73–133. [CrossRef]
7. Rezai, L.S.; Torenvliet, G.; Burns, C.M. Increasing patient adherence to home health-monitoring systems. *Proc. Int. Symp. Hum. Factors Ergon. Health Care* **2014**, *3*, 8–14. [CrossRef]
8. Logan, A.G.; Irvine, M.J.; McIsaac, W.J.; Tisler, A.; Rossos, P.G.; Easty, A.; Feig, D.S.; Cafazzo, J.A. Effect of home blood pressure telemonitoring with self-care support on uncontrolled systolic hypertension in diabetics. *Hypertension* **2012**, *60*, 51–57. [CrossRef]
9. Cafazzo, J.A.; Casselman, M.; Hamming, N.; Katzman, D.K.; Palmert, M.R. Design of an mHealth app for the self-management of adolescent type 1 diabetes: A pilot study. *J. Med. Int. Res.* **2012**, *14*, e70. [CrossRef]
10. Bassett-Gunter, R.; Stone, R.; Jarvis, J.; Latimer-Cheung, A. Motivating parent support for physical activity: The role of framed persuasive messages. *Health Educ. Res.* **2017**, *32*, 412–422. [CrossRef]
11. Becker, M.H. *The Health Belief Model and Personal Health Behavior*; Thorofare, N.J., Ed.; Slack: Brighton, UK, 1974.
12. Kahneman, D.; Tversky, A. Prospect theory: An analysis of decision under risk. *Econometrica* **1979**, *47*, 263–291. [CrossRef]
13. Bandura, A. Social cognitive theory of self-regulation. *Organ. Behav. Hum. Decis. Process.* **1991**, *50*, 248–287. [CrossRef]
14. Ajzen, I. The theory of planned behaviour. Organizational behaviour and human decision processes. *De Young* **1991**, *50*, 509–526.
15. Prochaska, J.O.; Velicer, W.F. The transtheoretical model of health behavior change. *Am. J. Health Promot.* **1997**, *12*, 38–48. [CrossRef] [PubMed]
16. Ryan, R.M.; Deci, E.L. Self-determination theory and the facilitation of intrinsic motivation, social development, and well-being. *Am. Psychol.* **2000**, *55*, 68–78. [CrossRef] [PubMed]
17. Fogg, B.J. *Persuasive Technology: Using Computers to Change What We Think and Do*; Morgan Kaufmann Publishers Inc.: Burlington, MA, USA, 2002; p. 312.
18. Oinas-Kukkonen, H.; Harjumaa, M. Persuasive systems design: Key issues, process model, and system features. *Commun. Assoc. Inf. Syst.* **2009**, *24*, 28. [CrossRef]
19. Latimer, A.E.; Brawley, L.R.; Bassett, R.L. A systematic review of three approaches for constructing physical activity messages: What messages work and what improvements are needed? *Int. J. Behav. Nutr. Phys. Act.* **2010**, *7*, 36. [CrossRef] [PubMed]
20. Rezai, L.S.; Chin, J.; Bassett-Gunter, R.; Burns, C. Developing persuasive health messages for a behavior-change-support-system that promotes physical activity. *Proc. Int. Symp. Hum. Factors Ergon. Health Care* **2017**, *6*, 89–95. [CrossRef]
21. Kreuter, M.; Farrell, D.; Olevitch, L.; Brennan, L. *Tailoring Health Messages: Customizing Communication with Computer Technology*; Lawrence Erlbaum Associates Publishers: Mahwah, NJ, USA, 2002; pp. 542–543.
22. Batra, R.; Strecher, V.J.; Keller, P.A. *Leveraging Consumer Psychology for Effective Health Communications: The Obesity Challenge: The Obesity Challenge*; Routledge: Abingdon, UK, 2015.
23. De Vries, H.; Kremers, S.P.J.; Smeets, T.; Brug, J.; Eijmael, K. The effectiveness of tailored feedback and action plans in an intervention addressing multiple health behaviors. *Am. J. Health Promot.* **2008**, *22*, 417–424. [CrossRef] [PubMed]
24. Cacioppo, J.T.; Petty, R.E. The need for cognition. *J. Pers. Soc. Psychol.* **1982**, *42*, 116–131. [CrossRef]
25. Kaptein, M.; Ruyter, B.D.; Markopoulos, P.; Aarts, E. Adaptive persuasive systems: A study of tailored persuasive text messages to reduce snacking. *ACM Trans. Interact. Intell. Syst.* **2012**, *2*, 1–25. [CrossRef]
26. Halko, S.; Kientz, J.A. *Personality and Persuasive Technology: An Exploratory Study on Health-Promoting Mobile Applications*; Springer: Berlin/Heidelberg, Germany, 2010; pp. 150–161.
27. John, O.P.; Naumann, L.P.; Soto, C.J. Paradigm shift to the integrative Big Five trait taxonomy: History, measurement, and conceptual issues. In *Handbook of Personality: Theory and Research*, 3rd ed.; The Guilford Press: New York, NY, USA, 2008; pp. 114–158.

28. Orji, R.; Mandryk, R.L.; Vassileva, J.; Gerling, K.M. Tailoring persuasive health games to gamer type. In Proceedings of the SIGCHI Conference on Human Factors in Computing Systems, Paris, France, 2 May 2013; pp. 2467–2476.
29. Bartle, R. Hearts, clubs, diamonds, spades: Players who suit MUDs. *J. MUD Res.* **1996**, *1*, 19.
30. Fridman, I.; Higgins, E.T. Regulatory focus and regulatory fit in health messaging. In *Oxford Research Encyclopedia of Communication*; Oxford University Press: Oxford, UK, 2017. [CrossRef]
31. Cesario, J.; Higgins, E.T.; Scholer, A.A. Regulatory fit and persuasion: Basic principles and remaining questions. *Soc. Pers. Psychol. Compass* **2008**, *2*, 444–463. [CrossRef]
32. Latimer, A.E.; Williams-Piehota, P.; Katulak, N.A.; Cox, A.; Mowad, L.; Higgins, E.T.; Salovey, P. Promoting fruit and vegetable intake through messages tailored to individual differences in regulatory focus. *Ann. Behav. Med.* **2008**, *35*, 363–369. [CrossRef] [PubMed]
33. Latimer, A.E.; Rivers, S.E.; Rench, T.A.; Katulak, N.A.; Hicks, A.; Hodorowski, J.K.; Higgins, E.T.; Salovey, P. A field experiment testing the utility of regulatory fit messages for promoting physical activity. *J. Exp. Soc. Psychol.* **2008**, *44*, 826–832. [CrossRef] [PubMed]
34. Pfeffer, I. Regulatory fit messages and physical activity motivation. *J. Sport Exerc. Psychol.* **2013**, *35*, 119–131. [CrossRef] [PubMed]
35. Rezai, L.S.; Chin, J.; Bassett-Gunter, R.; Burns, C.M. Investigating efficacy of regulatory fit theory in design of persuasive systems that promote physical activity. In Proceedings of the International Personalized Persuasive Technology Conference, Amsterdam, The Netherlands, 4–6 April 2017; pp. 21–25.
36. Weather Spark. Average Weather in Waterloo Canada. Available online: https://weatherspark.com/y/19227/Average-Weather-in-Waterloo-Canada-Year-Round (accessed on 23 September 2019).
37. Martinez, J.L.; Duncan, L.R.; Rivers, S.E.; Latimer, A.E.; Salovey, P. Examining the use of message tailoring to promote physical activity among medically underserved adults. *J. Health Psychol.* **2013**, *18*, 470–476. [CrossRef]
38. Kay, S.A.; Grimm, L.R. Regulatory fit improves fitness for people with low exercise experience. *J. Sport Exerc. Psychol.* **2017**, *39*, 109–119. [CrossRef]
39. Cho, H. (Ed.) *Health Communication Message Design: Theory and Practice*; SAGE Publications: Thousand Oaks, CA, USA, 2010.