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Behavior Change Techniques and Physical Activity Using the Fitbit Flex®

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ABSTRACT

International Journal of Exercise Science 11(7): 561-574, 2018. Due to the availability of low-cost accelerometers, there has been an increase in the adoption of physical activity monitors (e.g., Fitbit®) (14) accompanied by a desire to understand the behavior change techniques (BCTs; 15) present in such monitors. One specific Fitbit® monitor incorporates 20 BCTs (15), but how users experience these BCTs has yet to be explored. The purpose of this study was to explore user's experience with the Fitbit Flex® regarding physical activity behavior and BCTs. The specific research objectives were to: 1) describe Fitbit Flex® users and 2) explore user's engagement with the 20 BCTs. Participants (n=28) completed an online survey composed of questions about demographics, step volume, and perceived importance and/or frequency of use of the BCTs. Participants were mostly female (82.1%), between the ages of 18-71 years, and had used the Fitbit® for an average of 5 months. There was a significant increase of almost 2000 steps per day (p=0.003) from participants' first week to their past week (i.e., last 7 days) of monitor use. The BCTs rated among the highest for perceived importance for physical activity behavior (i.e., step volume) were "feedback on behavior", "self-monitoring of behavior", and "goal setting (behavior)". In brief, Fitbit® devices have the potential for increased step-based physical activity. As well, the present study contributes to understanding how user's experience BCTs in the Fitbit Flex® which can inform future physical activity promotion and interventions.

KEY WORDS: Wearable trackers, exercise, eHealth, mHealth

INTRODUCTION

Every year, 3.2 million deaths are attributed to physical inactivity, making it the fourth leading risk factor for global mortality (24). However, based on the current Canadian guidelines for weekly minutes of moderate-to-vigorous activity (i.e., 150 minutes/week), only 15% of adults are achieving the recommended amount of exercise (3). The rapid expansion of body-worn technologies, including pedometers and accelerometers, has allowed the general population to quantify physical activity patterns and volume using objective data (23).

Due to advances in technology and increased availability of low-cost accelerometers, there has been a surge of consumer-based activity monitors (14). These devices not only allow for self-monitoring but a host of other features related to behavior change, such as feedback based on self-monitoring, goal-setting, highlighting current behavior, and goal behavior discrepancy (15). Electronic activity monitors interface with a computer or mobile application thus permitting the storage of daily physical activity information, which can provide detailed, personalized feedback for individual progression and social comparison (15). Interventions that utilize monitors have seen preliminary success. For example, after 8 weeks of using a Nike Fuelband® monitor, Bice et al. (1) saw aspects of user motivation for physical activity (such as enjoyment) improve significantly. However, electronic activity monitors are becoming a popular tool to use in multi-faceted interventions that incorporate an activity monitor in addition to other components such as social media (4), text messaging (10), or telephone counseling (16). Despite the comprehensiveness of these interventions, a recent systematic review by Goode and colleagues (11) concluded that studies using accelerometers in multi-component interventions pose challenges determining the sole influence of activity monitors on physical activity and physical activity outcomes. In addition, with a few exceptions (1, 9, 12, 15), there have been limited attempts to assess how these monitors alone directly influence user behavior and how users experience these monitors.

For instance, Fritz et al. (9) conducted in-depth semi-structured interviews with 30 long-term users (for 3 to 54 months) of a variety of wearable activity tracking devices, including Fitbit®, Jawbone UP®, Nike Fuelband®, Striiv®, and Bodybugg®. This investigation was based on "naturalistic use" as these wearers had adopted these devices on their own, and aimed "to learn about the use and influence of these technologies on people's activity" (9). Findings from this study highlighted four general themes about how wearing these devices influenced fitness and activity among the participants. These include "motivation and reflection", "accounting and getting credit", "goals and rewards", and "sharing of data and social effects" (9). In addition, although engagement with devices changed over time, Fritz et al. (9) surmised that these devices were able to "influence and provide support for activity awareness and increased activity in general" (9).

In an attempt to classify activity monitors using established components of behavior change, Lyons et al. (15) systematically described 13 commercially available electronic physical activity monitors using behavior change techniques (BCTs) based on a taxonomy created by Michie et al. (19). BCTs are defined as the "observable and replicable components of behavior change interventions" (18). This taxonomy is an extensive collection of 93 distinct BCTs categorized into 16 groups and offers a method for specifying interventions. Overall, Lyons et al. (15) found that physical activity monitors, as compared to traditional behavioral interventions, include a similar number of BCTs. Based on a taxonomy of 26 BCTs, traditional interventions (i.e., non-app) for physical activity and healthy eating had an average of 6 BCTs per intervention (17), whereas physical activity monitors had an average of 8 BCTs per monitor (15). As such, monitors have the potential to incorporate as many, if not more, BCTs than traditional behavioural interventions (15). Thus, physical activity monitors not only allow for a convenient method of BCT delivery to support behavioural intervention but also provide access for the general population to a high quantity of BCTs that might improve the likelihood of successful behaviour change.

One wrist-worn monitor (the Fitbit Force®[1]) incorporated 20 of 93 specific BCTs[2]. In 2013, Fitbit® accounted for 68% smartphone enabled activity monitors sold (5). A recent systematic review revealed generally high validity and interdevice reliability for step count for a variety of Fitbit® monitors (6). Fitbit® monitors can track a wider range of behaviors and outcomes relating to physical activity beyond the accumulation of step volume, including active minutes, distance traveled, stairs climbed, and calories burned (7).

Due to increased adoption and since physical activity monitors can include a similar number of BCTs to those in traditional behavior interventions (15), there is a high potential for these monitors to positively influence physical activity. Yet, how users experience BCTs through physical activity monitors such as the Fitbit Flex®, has yet to be explored.

Thus, the purpose of this study was to explore user's experience with the Fitbit Flex® as it relates to physical activity behavior and BCTs. The specific research objectives of this study were to: 1) describe Fitbit Flex® users (e.g., demographics, change in step-based physical activity level) and 2) explore user's engagement (e.g., frequency of use, perceived importance) with various behavior change features (i.e., BCTs) of the Fitbit Flex®.

METHODS

Participants

The Fitbit Flex® is a wrist-worn device that track steps, active minutes, distance traveled, calories burned, and sleep (7). By tapping the device, a series of dots appear, each which represents 20% of an activity goal (i.e., number of steps). It syncs to a personal account on the Fitbit® website, an application on a smartphone, or a computer. There is also data sharing and interaction between Fitbit® users available in online communities and through social media.

Ethics approval was obtained from the Wilfrid Laurier University's Research Ethics Board. Participant recruitment was performed by word-of-mouth through email and Facebook®, posters on one university campus and around the city in which the institution belongs, and a post in the online Fitbit® community board. Individuals were eligible to participate if they were over the age of 18 and owned and had used a Fitbit Flex® for at least a week.

Protocol

This study was of cross-sectional design. The participants were asked to complete one online survey on SurveyMonkey®. The survey was open from January 20th to March 5th, 2015 and all participants provided informed consent for survey participation and use of quotations. The survey was divided into three parts and took between 15-20 minutes to complete. Part A included questions about demographics and Fitbit® acquisition. These questions were used to describe Fitbit® users. Part B asked participants to input their Fitbit® daily number of steps for each day of the past week (i.e., the last 7 days) and the total number of steps for the first full week of use by accessing personal Fitbit Flex® dashboard history. These questions were used to describe participants' change in steps. Part C included questions about user's perceived importance and/or use or frequency of use of the 20 BCTs associated with the Fitbit Flex® (as identified by Lyon's et al.'s (15) work on the Fitbit Force®). Some open-ended questions were used to examine how these behavior change features were related to changes in physical activity. These questions were used to describe participants' perceptions of BCTs. Due to the specificity of the distinction between BCTs, each question was designed to best assess each BCT based on the discretion of the researchers (see Table 1).

Table 1. BCT Questions.

Type of Question	BCTs
Frequency of use Likert Scale[1]	1.5 Review behavior goal(s)
	1.7 Review outcome goal(s)
	2.4 Self-monitoring of outcome(s) of behavior "app"
	2.4 Self-monitoring of outcome(s) of behavior "online"
	5.4 Monitoring of emotional consequences
	6.2 Social comparison
Perceived importance Likert Scale[2]	1.1 Goal setting (behavior)
	1.3 Goal setting (outcome)
	1.6 Discrepancy between current behavior and goal
	1.7 Review outcome goal(s)
	2.2 Feedback on behavior
	2.3 Self-monitoring of behavior
	2.7 Feedback on outcome(s) or behavior
	3.1 Social support (unspecified)
	3.3 Social support (emotional)
	5.4 Monitoring of emotional consequences
	8.7 Graded tasks[3]
	10.3 Non-specific reward
	10.4 Social reward
	10.10 Reward (outcome)
	15.3 Focus on past success
Open-ended	1.1 Goal setting (behavior)
	1.3 Goal setting (outcome)
	2.3 Self-monitoring of behavior
	12.5 Adding objects to the environment
Other (yes/no, select answer or input answer)	1.1 Goal setting (behavior)
	1.3 Goal setting (outcome)
	2.3 Self-monitoring of behavior
	2.6 Biofeedback
	3.1 Social support (unspecified)
	3.3 Social support (emotional)
	6.2 Social comparison
	10.4 Social reward

BCT #'s correspond to Michie et al.'s (19) taxonomy. [1]Rated on frequency of use 5 point Likert scale (1= never, 2= rarely, 3= occasionally, 4= frequently, 5= very frequently).[2] Rated on perceived importance 5 point Likert scale (1= unimportant, 2= of little importance, 3= moderately important, 4= important, 5= very important). [3]Rated on perceived difficulty 5 point Likert scale (1= very difficult, 2= difficult, 3= neither easy nor difficult, 4= easy, 5= very easy).

Statistical Analysis

Descriptive and frequency statistics were performed to describe Fitbit Flex® users and analyze engagement (use of and/or perceived importance) with BCTs. Responses to open-ended questions were coded and grouped together by the first author based on content similarity.

Finally, a related samples t-test was performed to assess the change in step volume from participants' the first week of monitor use to their past week of use. All data, excluding the open-ended answers, were analyzed using SPSS Version 23, using an alpha of .05 to determine statistical significance.

RESULTS

Fitbit® Users: There were 45 consenting, eligible respondents. To answer the key research questions (and be included in the analysis), participants must have completed the demographic questions and have provided usable step data and/or BCT data. Seventeen individuals were excluded for incomplete answers to: demographic information (n=3), step data (n=2), or both step data and BCT questions (n=12). Eight participants were retained in the analysis because they provided at least usable step data (n=5) or answers to questions regarding BCTs (n=3) while a remaining 20 participants provided some information across all three areas. Thus, the final sample was composed of 28 individuals[3]. The final sample was composed of 28 individuals, most of who were female, from Canada, had a BMI within a healthy range, had acquired a post-graduate degree, and had gym memberships. The mean age was approximately 40 years old (see Table 2). Participants had been using the Fitbit Flex® for an average of 5.5 months (range 2 weeks- over 2 years). Most participants (82.1%, n=23) reported wearing their device 7 days a week. See Table 3 for the results for reasons of use, physical activity related outcomes tracked, how participants connected their device, and social media accounts.

Table 2. Demographics of participants (n=28).

Demographic Item	Result
Gender	82.1% Female (n=23), 17.9%Male (n=5)
Country	82.1% Canada (n=23), 17.9% US (n=5)
Year of Birth	*M*= 1975 (approx. 40 years of age), Range= 18-71 years old
BMI*	*M*=24.10 (SD=3.92)
	71.4% "Healthy weight" (n=20), 21.4%"Overweight" (n=6), 7.1%"Obese" (n=2)
Education	35.7% Postgraduate (n=10), 28.6% College/university degree (n=8), 32.1% Some college/university (n=9), 3.6% High school (n=1)
Gym/Fitness club membership	53.6% Yes (n=15)
Training for an event	53.6% Yes (n= 5)

*Based on participant-reported height and weight.

Change in steps: A related samples t-test based on 21 participants (participants who reported valid usable step data for first week and past week of use) revealed a significant increase in average number of steps per day from the first week of use ($\bar{x}$= 8418.54, SD= 2220.88) to the past week of use ($\bar{x}$= 10390.33, SD=3371.45) of 1971.79 steps (SD= 2721.47) [$t(20)= 3.320$, p=0.003].

Perceptions of BCTs: Of the fifteen BCTs rated on perceived importance, those with the highest average importance included "feedback on behavior" for both knowing the personal step volume and for when the Fitbit device vibrates when the step goal is achieved, "self-monitoring of behavior", "goal setting (behavior)", and "discrepancy between current behavior and goal" (see Figure 1). For the five BCTs rated by frequency of use, participants rated infrequent use of the BCTs "review behavior goal(s)" and "review outcome goal(s)", "self-monitoring of outcome(s) of behavior" for both monitoring online and via the companion app, and "monitoring of emotional consequences" (see Figure 2). The BCT "graded tasks" was rated for perceived difficulty and yielded an average rating of 2.83 (SD= 0.64).

Table 3. Fitbit use questions (n=28).

Question	Result
Reasons for acquiring	28.6% received it as a gift (n=8) 25% to track or monitor physical activity (n=7) 21.4% to provide motivation to maintain or improve physical activity level (n=6) 14.3% to track sleep (n=4) 10.7% to better understand or become more aware of personal activity level (n=3) 3.6% weight loss (n=1)
Physical activity-related outcomes	100% tracked 'steps' (n=28) 96.4% tracked 'active minutes' (n=27) 78.6% tracked 'distance traveled' (n=22) 60.7% tracked 'calories burned' (n=17)
Additional logged features	78.6% logged 'sleep' (n=22) 53.6% logged 'weight' (n=15) 53.6% logged 'activities' (e.g., swimming, biking) (n=15) 35.7% logged 'food' (n=10) 3.6% logged 'mood' (n=1) 3.6% logged 'heart rate' (n=1) 7.1% logged 'water' (n=2) 0% logged 'journal entries' (n=0) 0% logged 'glucose levels' (n=0) 0% logged 'blood pressure' (n=0) 10.7% logged no additional features (n=3)
Connecting Fitbit	64.3% connect their Fitbit Flex® to both a personal Fitbit Flex® account online and an app on a smartphone or iPad (n=18) 14.3% connect to account online only (n=4) 21.4% connect to the app on a smartphone only (n=6)
Social media accounts	85.7% of participants have a Facebook® account (n=24) 71.4% of participants have a Twitter® account (n=20) 7.1% of participants have a Wordpress® account (n=2)

Eight BCT questions were answered in yes/no format, forced choice format, or inputting a numerical response (see Table 4). Although Fitbit® allows the step goal to be individualized, most participants still had the default goal of 10,000 steps ("goal-setting (behavior)"). With respect to "biofeedback", no participants paid for a Premium account which allows access to more detailed food and activity reports, and only a few had an Aria Scale, that tracks weight, body fat percentage, and BMI (8). Of the online communication features for physical activity purposes, only few post in community discussions online ("social support (unspecified)"), none of the participants had set up their personal Fitbit Flex® account to share daily statistics on social media ("social reward"), and of the participants that have 'friends' on the Fitbit website and/or app, they reported 'occasionally' comparing their steps to their friends on average ("social comparison").

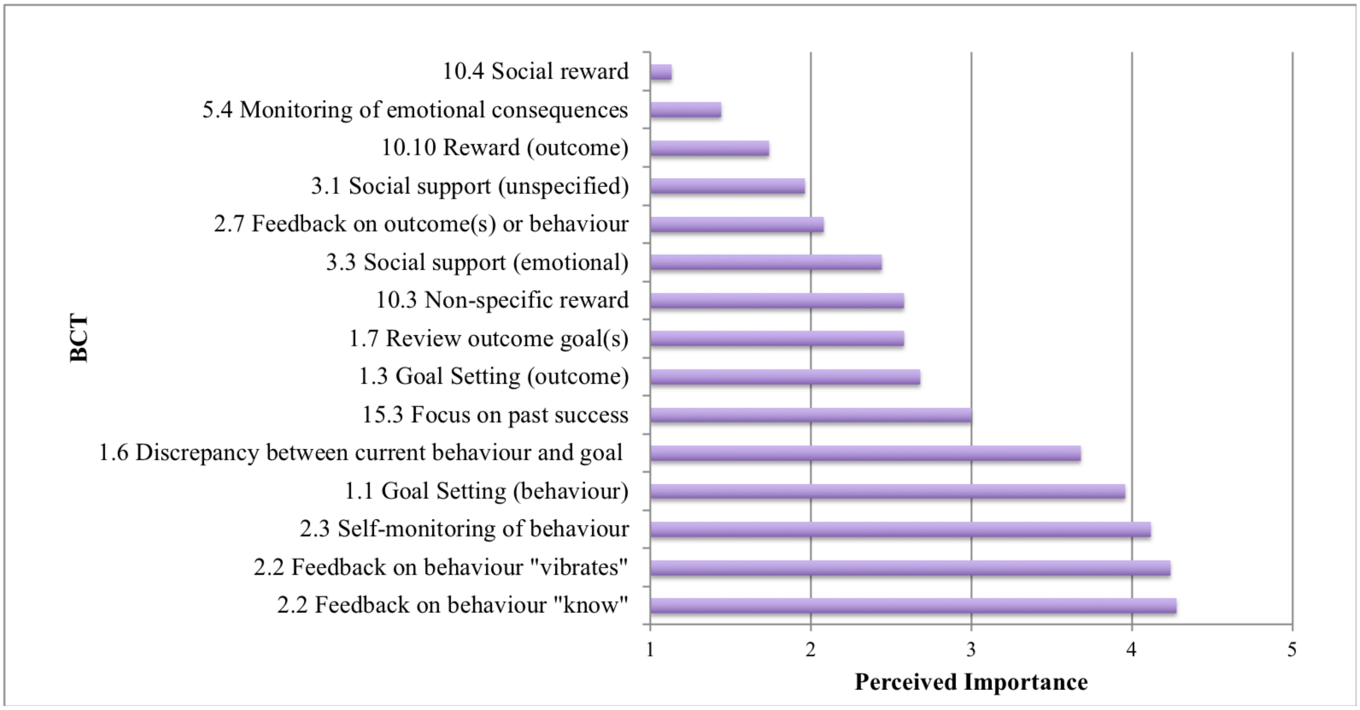

Figure 1. Average ratings of perceived importance of BCTs. *Five point Likert scale for perceived importance (1= unimportant, 2= of little importance, 3= moderately important, 4= important, 5= very important).*

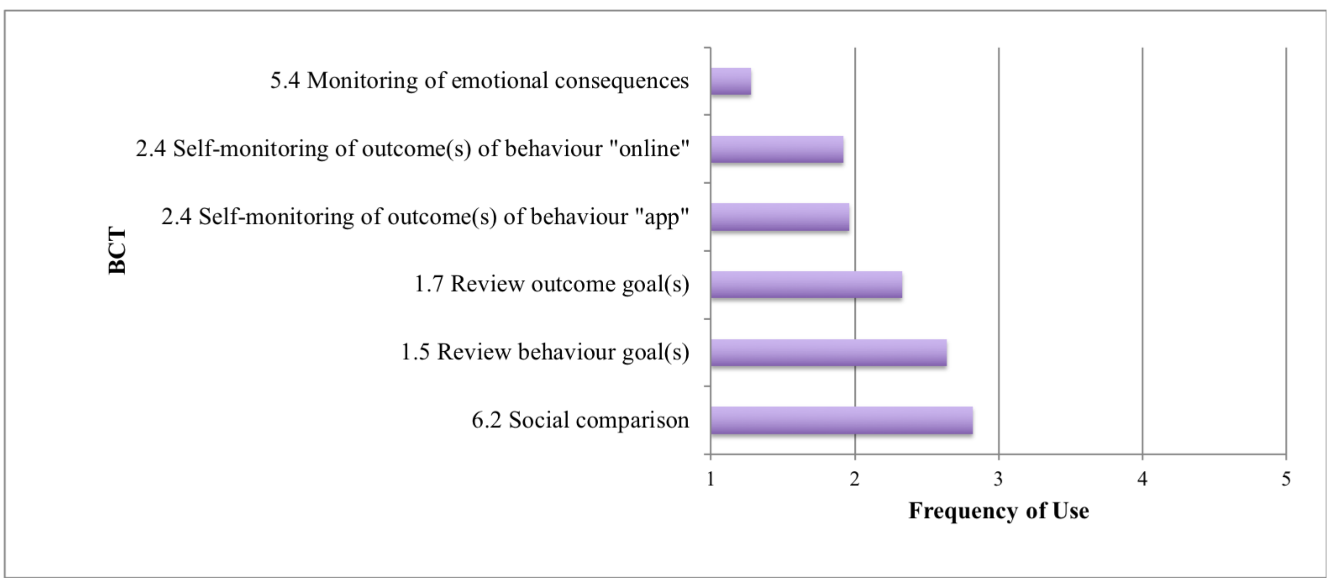

Figure 2. Average Rating of Frequency of use of BCTS. *Five point Likert scale for frequency of use (1= never, 2= rarely, 3= occasionally, 4= frequently, 5= very frequently).*

Table 4. Non-Likert BCT questions.

BCT	Response
1.1 Goal-setting (behavior)	80% of participants had default goal of 10,000 steps (n=20/25)
1.3 Goal-setting (outcome)	60% have set a weight goal using the Fitbit Flex® (n=15/25)
2.6 Biofeedback	No participants had a Premium account (n=0/24) 12% had an Aria Scale (n=3/25)
2.3 Self-monitoring of behavior	Participants reported reviewing their steps per day: 0-5 times by tapping the device (58.3%, n=14/24) 0-2 times via their account online (95.83%, n=23/24) 0-5 times via the companion app on their smartphone (60.9%, n=14/23)
3.3 Social support (emotional)	72% of participants reported that they feel the Fitbit Flex® offers emotional social support (n=18/25)
3.1 Social support (unspecified)	12% post in community discussions online (n=3/25) 4% uses social media to connect with Fitbit® users (n=1/25)
10.4 Social reward	No participants set up their personal Fitbit Flex® account to share daily statistics on social media (n=0/25)
6.2 Social comparison	60% of participants that have 'friends' on the Fitbit® website and/or app (n= 15/25) % of 'friends' known ($\bar{x}$= 83.40%, SD= 33.61) % of 'friends' never met ($\bar{x}$= 4.33%, SD=8.21)

Four open ended-ended questions assessed the experience of four specific BCTs. Participants reported several ways setting a goal is related to personal physical activity ("goal-setting (behavior)"), including: 1) it provided a target to work towards and motivation to reach target (n=8), 2) having a goal held them accountable for their activity level (n=6), 3) it ensured they were active through the day (n=5), 4) having a goal led to choosing activity over inactivity (n=4), 5) achieving the goal can lead to a sense of achievement (n=2), and 6) having a goal helped with self-monitoring (n=2).

When asked how (if at all) setting a goal was related to personal weight change ("goal-setting (outcome)"), some participants (n=8) reported a positive impact, citing it as important. However, others (n=3) highlighted that it was not as important to them, and further still, a few responses (n=2) were negative, citing that it was unimportant. A few participants (n=4) noted that setting a weight goal was related to eating and nutrition. In addition, similar to goal-setting for behavior (i.e., step volume), two participants (n=2) noted that having a goal provided a target to work towards.

When asked why or why not monitoring the number of steps achieved each was important to personal physical activity ("self-monitoring of behavior"), participants (n=7) noted that it encouraged activity throughout the day. Also, participants (n=5) linked self-monitoring to their goals citing that it was important because it provided progression towards their goal. Participants (n=5) also noted that monitoring the number of steps provided an indicator of how active/inactive the user has been. In addition, a few participants (n=3) highlighted that it helped with tracking and comparing day-to-day activity. Similar to responses for goal setting for physical activity, two participants (n=2) mentioned that it also held the user accountable. Only one person noted that monitoring steps was not important for them.

Finally, participants described the impact of wearing a Fitbit Flex® on their physical activity ("adding objects to the environment"). Three popular responses were that wearing a Fitbit®: 1) resulted in an actual improvement in physical activity (n=6), 2) provided motivation to be physically active or increase level of physical activity (n=6), and 3) resulted in greater awareness of physical activity levels and habits (n=3).

DISCUSSION

The purpose of the present study was to explore users' experience with the Fitbit Flex® as it related to physical activity behavior and BCTs. Observed in this study was an average increase in step volume of approximately 2000 steps. This is similar to previous physical activity intervention research involving pedometer use, in which pedometer users have shown to significantly increase steps by a range of above 2000 and below 2500 steps per day (2, 22). This suggests that the Fitbit Flex® might be just as effective at increasing step volume as pedometers for this sample of participants. However, Bravata et al. (2) found that interventions that also incorporated setting a step goal and using a step diary (i.e., self-monitoring steps) in conjunction with a pedometer significantly increased physical activity from baseline compared to interventions that did not. Therefore, a pedometer intervention alone without including these key BCTs may not be as successful. The advantage of using Fitbit® devices is that it incorporates these BCTs, by having default goals and automatically monitoring and recording steps. As well, the findings from the present study offer support that users are engaging in additional features associated with modern physical activity monitors, beyond just monitoring step volume, a defining characteristic of a traditional pedometer.

The findings from the present study reflect similar findings presented by Fritz et al. (9) with long-term users (3 to 54 months of use) of a variety of wearable activity tracking devices. Fritz et al. (9) highlighted general effects of wearing these devices, which included short-term changes to physical activity behavior that were "immediate impacts". With respect to the present study, when participants were asked to describe how goal-setting and self-monitoring impacted their physical activity, they commonly reported how these processes produced immediate effects on physical activity. For example, goal setting frequently lead to choosing activity over inactivity within the short term, and self-monitoring was reported to provide progress in relation to their step goal that influenced personal activity. Fritz et al. (9) also highlighted long-term changes, which they described as "durable changes" Similarly, in the present study, when asked to describe the impact wearing the Fitbit Flex® has had on their physical activity, the two most common responses reflected changes that transpired over the long-term including an improvement in physical activity and greater motivation to be active or increase level of physical activity.

In the current study, the BCTs rated with the highest average importance included "feedback on behavior", "self-monitoring of behavior", "goal setting (behavior)", and "discrepancy between current behavior and goal". These BCTs were also seen in each of the 13 physical activity monitors as coded by Lyons et al. (15). Some of these BCTs have also been shown to contribute to more effective interventions. Although not specific to BCTs, a review by Kwasnicka et al. (13) highlighted that various theoretical factors (such as self-regulation which involves goals and self-monitoring) are related to long-term behaviour change (i.e., maintenance). Further, findings of a systematic review of physical activity and healthy eating interventions concluded that “interventions combining self-monitoring with one or more of four other hypothesized self-regulation techniques were significantly more effective than interventions not including self-monitoring and one other self-regulatory technique” (17). These other self-regulation techniques include prompt intention formation, specific goal setting, review of behavioral goals, and providing feedback on performance (17). Except for intention formation, all of these effective self-regulation BCTs are represented in the Fitbit® and were rated with the highest average perceived importance by participants in this study. Thus, the BCTs that have shown previously to be the most effective are also reported here as the most important by Fitbit® users in the present study. This preliminary association has implications for creating physical activity interventions in the future that incorporate the Fitbit Flex® or other similar monitors. Future research should consider how to include those BCTs that are both effective and important so that participants can expend the least amount of time and effort, but retain the largest positive influence on physical activity.

Furthermore, participants in this study did not seem to value BCTs related to online social interaction or sharing. This is in contrast to Karapanos et al. (12) who found that participants not only described the role of monitors in promoting “a sense of belonging and social support”, but also “feelings of popularity and social affirmation” (12). Despite that the participants in the present study reported regularly interfacing with the online account and/or the mobile app to monitor step volume, the online social interaction features available were used less frequently for physical activity purposes (e.g., posting in online community discussions). In addition, most participants in our study had accounts on Facebook® and Twitter®, but none of the participants had set up their personal Fitbit Flex® account to share daily statistics on social media (“social reward”). Approximately half of the participants in Fritz et al.’s (9) study were users of social features. Greater motivation was derived for some of these participants through new connections through online communities over existing social ties (9). For the participants in the present study who had friends on the Fitbit® website or app, most of their friends were people they knew. Thus, “finding the right community” (9) remains important for different users.

Interestingly, the participants in the present study seemed to value the BCTs relating to physical activity/step volume (i.e., the behavior) over the ones relating to weight change (i.e., the outcome). The BCTs with the highest rated perceived importance in the current study all refer to the behavior, whereas the BCTs related to outcome were rated lower on average. Considering that among this sample, only one participant reported getting the Fitbit Flex® for weight-loss and most participants were within a healthy weight BMI, these findings might only be specific to, and reflect the motivations of these particular participants. Although there have been reviews that have aimed to determine which BCTs are the most effective for physical activity (17), there exists little literature on the comparison of effectiveness for outcome vs. behavior BCTs for physical activity.

Due to the recent marketing of these devices at the time of this study, participants in the present study might be considered ‘early adopters’ with respect to the diffusion of innovation theory (20). The sample of participants in this study was small and participants were highly educated, thus, it might be that this sample are most likely to be aware of the benefits of physical activity and be financially equipped to purchase a Fitbit Flex®. As well, considering the average steps in the first week was almost 8500 steps, the sample was on average within a healthy weight BMI range, and the majority of participants have gym memberships, it is possible this sample, despite seeing an average increase of almost 2000 steps, was already fairly active before they began using the Fitbit Flex®. Since these participants adopted a Fitbit Flex® on their own, differences in personal motivation could also influence the change in physical activity behavior with use of the Fitbit Flex®. Overall, the participants in this study might represent a unique population of relatively active, well-informed, and motivated individuals more likely to be positively influenced by wearing a Fitbit Flex® that may not be representative of, or generalizable to, other populations.

Furthermore, the process of recruitment could have influenced the participants that heard about the study, and subsequently decided to participate. With respect to Fritz et al. (9), similar recruitment approaches were used, including posts to the Fitbit community online. As a result, as stated by Fritz et al. (9), “it is likely that our population overall is more active and enthusiastic about their devices than the general population of wearers”, which is potentially true within the present sample too. In addition to the sample characteristics, there are also some limitations present regarding the survey. Since the survey used was created solely for the purpose of this study, it is uncertain that the survey accurately reflects the BCTs coded, which accurately reflects the coding of by Lyons et al. (15). In addition, while the participants were asked to self-report objectively measured physical activity (i.e., step volume) from their own Fitbit®, we cannot confirm that the reported numbers are correct. Finally, despite only a few differences between the Fitbit Force® and Flex®, we assumed that the BCTs of the Force® were the same as the Flex®.

The present study offers a preliminary understanding of how users engage with behavior change features in the Fitbit Flex®. As per recent recommendations (21), further research is warranted to explore long-term interaction with behavior change features in physical activity monitors, how this interaction might be different for an inactive population, and the combination of behavior change features that results in greatest impact on physical activity. Specifically, in the future it would be valuable to recruit inactive individuals for a similar study. Assessing this population could result in meaningful differences in ratings of perceived importance and/or use of BCT features of the Fitbit Flex® that could be associated with the unique transition from an inactive to an active lifestyle. Also, recruiting larger samples to further compare individuals based on age, gender, and other demographic variables will help to further understand personal engagement with devices and relevant features such as social interactions. In addition, utilizing a longitudinal study design of standalone activity monitor use similar to Bice et al. (1) would be beneficial to track how motivation, adherence, and engagement with the Fitbit Flex®, or similar monitors, changes with time.

In conclusion, the present study sheds light on the user experience of the behavior change features of Fitbit Flex®, and the influence wearing a Fitbit Flex® has on physical activity. One specific finding, a preliminary association between what BCTs are perceived as the most important and which BCTs have shown to be the most effective, provides a basis from which further research can be developed in order to contribute to the limited understanding of behavior change associated with physical activity monitors, like the Fitbit Flex®.

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[1]The Fitbit Force® has since been discontinued. At the time of this study, still available for purchase was a similar version, the Fitbit Flex®. Compared to the Fitbit Flex®, the Force® also tracked number of floors climbed, and the monitor displayed more than the 'dots', but an actual numerical representation of activity.

[2]The 20 BCTs as identified by Lyons et al. (14) for the Fitbit Force® are 1.1 Goal Setting (behavior), 1.3 Goal setting (outcome), 1.5 Review behavior goal(s), 1.6 Discrepancy between current behavior and goal, 1.7 Review outcome goal(s), 2.2 Feedback on behavior, 2.3 Self-monitoring of behavior, 2.4 Self-monitoring of outcome(s) of behavior, 2.6 Biofeedback, 2.7 Feedback on outcome(s) or behavior, 3.1 Social support (unspecified), 3.3 Social support (emotional), 5.4 Monitoring of emotional consequences, 6.2 Social comparison, 8.7 Graded tasks, 10.3 Non-specific reward, 10.4 Social reward, 10.10 Reward (outcome), 12.5 Adding objects to the environment, and 15.3 Focus on past success.

[3]To compare the demographic variables described above between participants who completed the survey and those who did not, independent samples t-test were performed for year of birth, number of months of using the Fitbit®, BMI, and number of days wearing the device a week. Chi square analyses were performed for the variables of highest level of education, sex, whether or not they were training for an event (e.g., marathon, triathlon), had a gym membership, or if the week represented a typical week for them with respect to step

volume. There were no significant differences ($p>0.05$) in demographic data found between the participants who did not complete the entire survey and those who did complete the survey.