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Physical Activity Motivational Factors of Activity Trackers
for Young Adults

Amy L. Dalton

A thesis submitted to the faculty of
Brigham Young University
in partial fulfillment of the requirements for the degree of
Master of Science

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ABSTRACT

Physical Activity Motivational Factors of Activity Trackers for Young Adults

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BACKGROUND: Physical activity for the majority of individuals is below recommended levels despite strong evidence of its significant health benefits. Activity tracker devices present as a promising and affordable tool to help promote physical activity and active choices. Additionally, young adults present as an ideal age group to implement behavior change interventions.

OBJECTIVE: To determine what features of activity tracker hardware and software are helpful in motivating active choices.

METHODS: This cross-sectional study included 149 participants ranging in age from 18-29 years old who wore an ActiGraph GT3X+ accelerometer for one week. They then continued to wear the accelerometer in addition to a randomly assigned activity tracker (Apple Watch, Fitbit Surge, Basis Peak, or Microsoft Band 2) for an additional week. They also used the corresponding app for their activity tracker. Participants filled out a survey about their experience at the end of the study

RESULTS: Overall hardware rating ($p = 0.162$) and overall software rating ($p = 0.125$) did not differ between the four devices. Degree of motivation of the hardware ($p = 0.177$) and software ($p = 0.120$) was also similar for all the activity trackers. There were 625 positive comments made about tracker hardware with the majority of these comments concerning mode options ($n = 149$), other ($n = 94$), and battery ($n = 79$). There were 287 positive software comments with the majority in the categories of other ($n = 78$) and information ($n = 68$).

CONCLUSIONS: The analyses of our data did not show a significant difference between devices in any category. Furthermore, results indicated a high number of positive comments for both hardware and software overall. Users also reported device hardware and software to be personally motivating.

Keywords: physical activity, activity tracker, motivation, young adults, electronic activity tracker

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Physical Activity Motivational Factors of Activity Trackers for Young Adults

Physical activity (PA) has significant health benefits including reduction of the risk and onset/severity of chronic conditions, such as diabetes, certain cancers, cardiovascular disease, and obesity (Shiroma & Lee, 2010; Warburton et al., 2006). Leisure time physical activity has also been found to considerably decrease all-cause mortality risk (Arem et al., 2015). Despite this knowledge, sedentary behavior (SB) is a prominent occurrence, averaging 7.7 hours/day or 54.9% of monitored time for Americans (Matthews et al., 2008). In addition, less than half of U.S. adults and high-school aged youth reach the public health target range for daily moderate-to-vigorous physical activity (Physical Activity Guidelines Advisory Committee, 2018). According to research, many Americans understand that regular PA is beneficial to health yet, despite this, the majority of individual's PA levels remain insufficient (Physical Activity Guidelines Advisory Committee, 2018). For this reason, interventions designed to supplement knowledge with specific approaches and strategies are crucial to increase PA levels.

Of the populations studied, U.S. college students reported notably low levels of PA and high levels of SB (American College Health Association, 2019). Emerging adulthood, generally defined between 18-25 years in age, is a significant transitional period because young adults experience substantial changes in lifestyle, their ability to practice autonomy, and develop self-identity (Arnett, 2000). This unique era of change is a crucial period to implement strategies to motivate healthy behaviors, which can have a long-term benefit. The formation of a positive self-identity in relation to healthy lifestyle during this period has led to healthier behavior patterns in later life (Miller et al., 2002; Nelson et al., 2008). Emerging adulthood presents itself as a promising period for PA promoting interventions.

Behavior change is a complex process that is influenced by varying factors, such as physical and social environmental influences. Effective health behavior change must consist of an initial behavior modification, but it is crucial to maintain this modification over long periods of time. Activity trackers are emerging as a promising tool for promoting active choices. As technology advances, wearable activity trackers have become more popular. These devices offer features ranging from step counting, heart rate tracking, calories burned, and active minutes. According to several studies, various activity trackers have been found to be accurate in the assessment of PA (Hochsmann et al., 2018; Tophoj et al., 2018). Some studies have even correlated activity trackers with a positive motivating effect on physical activity (Lynch et al., 2019; Goode et al., 2017). Unfortunately, many users abandon activity tracker use after only a few months, displacing any significant health effects (Attig & Franke, 2020). The role of wearable activity trackers among health behavior change interventions is promising, but further research is needed to evaluate tracker features that people use and appreciate to increase compliance. Despite high levels of potential, these devices will not be motivating if they are not being used. The purpose of this cross-sectional study was to determine what aspects of activity tracker hardware and software are helpful in motivating active choices.

Methods

Participants

After approval by the university's institutional review board, participants were recruited from campus and the surrounding community. Males and females aged 18- to 29-years were eligible to participate in the study as long as they could wear the activity tracker on the non-dominant wrist, had a smartphone compatible for using the activity tracker app, and did not have any type of body injury or condition (ex.: use of crutches, pregnancy) that altered normal body movement.

Sample and Setting

This research was part of larger study with an intended sample size of 37 participants per device. Participants wore ActiGraph GT3X+ accelerometers alone for one week and in combination with activity trackers for one week in the daily living setting and instructed to maintain their regular routine.

Procedures

Participants met researchers in a research center to review and complete consent forms. Basic demographic and body size (height and weight) were measured in duplicate and averaged to allow for BMI calculation. Participants wore an ActiGraph GT3X+ accelerometer alone on the non-dominant wrist for one week. Participants then returned and were randomly assigned an activity tracker to wear in addition to the accelerometer. Participants returned one week later to return the devices and complete the Activity Tracker Usefulness Questionnaire (see Appendix A) via a Qualtrics survey. Participants were compensated with \$10 cash for completing all aspects of the study.

Instruments

The four activity trackers and a post-study questionnaire were used to gather data. The four activity trackers were FitBit Surge, Basis Peak, Microsoft Band 2, and Apple Watch (Series 2). These same devices were validated in a laboratory setting (Peterson et al., under review). These devices were selected for two reasons. First, all these devices are comparable in use, functional abilities, and design. Second, they represent some of the most popular bands on the market. All include step counting, active minutes, calories burned, and heart rate monitoring directly on the device, and all are worn on the wrist. The post-study Activity Tracker Usefulness Questionnaire contained 16 questions and was used to gather feedback regarding the hardware,

software, motivating factors, and overall opinions on activity trackers (see Appendix A). Both closed- and open-ended questions were used.

Statistical Analysis

Statistical analyses were performed using SPSS 25.0 (IBM Corp., Chicago, IL). First, basic activity tracker assignment and past use (see questions 1, 2, 3, 13, and 14 in Appendix A) and demographics were analyzed using simple descriptive statistics with univariate analysis. A simple ANOVA was used to determine if any of the activity trackers had significantly different results in how participants ranked them regarding hardware, software, and motivating factors (see questions 4, 7, 8, 11, and 12 in Appendix A). If significance was found, a Bonferroni post-hoc test was planned to determine which activity trackers significantly differed. Quantitative content analysis was used to count the number of times topics were mentioned in the open-ended questions (see questions 5, 6, 9, 10, 15, and 16 in Appendix A).

Results

Demographics

The 149 participants of this study consisted of 56.4% males with the majority self-identifying as Caucasian (83.9%). They ranged in age from 18 to 29 years old. The participants were primarily university students (94%) but also included a small sampling of community members (6%). The participants were mostly (85.9%) right hand dominant. The four activity trackers used were randomly assigned to each participant, including Apple Watch (n = 41), Basis Peak (n = 16), Fitbit Surge (n = 45), and Microsoft Band 2 (n = 47). Further demographic characteristics of the 149 participants appear in Table 1.

Activity Tracker Findings

The ANOVA analyses of data did not show a significant difference between devices in any category. Overall hardware rating ($p = 0.16$) and overall software rating ($p = 0.13$) did not differ between the four devices. Degree of motivation of the hardware ($p = 0.18$) and software ($p = 0.12$) was also similar for all the activity trackers. See Table 2 for further ANOVA results. Due to lack of difference in ANOVA results, a Bonferroni analysis was not necessary.

Research participants commented on likes, dislikes, and self-assessed motivation concerning device hardware and software. Responses to the Activity Tracker Usefulness Questionnaire were classified into ten different categories for hardware likes/dislikes, which included: band, design, button use, button place, battery, size, modes, screen, simplicity, and other. Similarly, responses related to software likes/dislikes were classified into five categories, which included: ease of use, pairing, information, syncing, and other. The last question asked for other comments, and due to the variety of comments reported, the category of *other* was used to group responses that did not fit into the other 13 categories. Some topics included in the other category were: notifications, goals, accuracy, data display, and tracking automaticity. Comments in each of the fifteen categories were further organized as positive, or negative and quantified for each device type. Mean values were calculated based on total comments per device per number of users. Across all ten categories, the activity trackers with the highest mean for total positive hardware comments were the Microsoft Band 2 (4.51) and Apple Watch (4.34). In contrast, the activity trackers with the highest mean for hardware dislike comments were the Basis Peak (2.56) and Microsoft Band 2 (2.13). Overall, 625 positive comments were made about tracker hardware with the majority of these comments concerning mode options ($n=149$), other ($n=94$) and battery ($n=79$). Additionally, there were 225 negative comments regarding tracker hardware with the majority in the categories of other ($n=68$) and size ($n=29$). See Table 3 for further detail.

There were significantly more positive hardware comments than negative ($t = 12.23, p < 0.01$).

The same was also true of software comments ($t = 9.49, p < 0.01$).

The activity tracker with the highest mean for positive comments related to software across all five categories were the Apple Watch (2.27) and Fitbit Surge (2.13). The highest mean for negative software comments were for the Basis Peak (1.19) and Microsoft Band (1.17).

Overall, 287 positive software comments were made with the majority in the categories of other (n=78) and information (n=68). In comparison, there were a total of 147 negative software comments with the majority being in the categories of other (n=68), syncing (n=30), and ease of use (n=20). (See Table 4)

The category of *other* included a variety of topics that were commented on. For example, some positive hardware comments stated, “I liked being able to read my text messages inconspicuously,” “I love that it tracked my activity through my heart rate. I didn’t have to open the workout section of the watch to use it. When I was running, it knew I was running. When I was walking, it knew I was walking,” “I used the timer multiple times...,” “I loved the reminders for my steps and the notifications when I reached my steps goal. That kept it exciting,” “I also liked how you could see the updates on your progress discreetly on the watch face,” and “I liked how it would remind me to get up and move if I sat too long...” Some examples of negative hardware comments were, “I question how accurate they are, especially how many calories I burned each day. It seemed to be abnormally high,” “the screen is breakable,” “confusing interface,” “The screen easily scuffs and leaves white scuff marks that are difficult to get off,” “The consistently blinking greenlight got annoying on more than one occasion,” “It could have smarter timers and chronometer,” “With text message syncing, messages disappeared too quickly,” and “It was annoying to have all of my notifications show up on there too.” When it

came to software, some comments left about positive features included: “The interface was reasonably intuitive,” “a quick overview look of daily progress,” “easy to set goals and see where you are at with your goals,” and “the advice and information it gave based on how much activity I was engaging in.” In contrast, some examples of negative software comments included: “The app took forever to load,” “Amount of phone battery used, especially considering blue tooth must be enabled to use,” “erasing all the previous days’ data,” and “I thought the software was somewhat redundant and didn’t use it very much.” Overall, comments left in the other category varied widely.

When asked to rate hardware overall on a scale from 0 to 10, the participants’ mean ratings for Apple Watch, Basis Peak, Fitbit Surge, and Microsoft Band 2 were 7.73, 6.69, 7.83, and 7.53, respectively. In terms of rating how motivating the activity tracker hardware was, with 0 being not motivating at all and 10 being highly motivating, the mean ratings for Apple watch, Basis Peak, Fitbit Surge, and Microsoft Band 2 were 5.41, 4.81, 5.98, and 6.21, respectively.

Similarly, activity tracker software overall mean ratings for Apple Watch, Basis Peak, Fitbit Surge, and Microsoft Band 2 were 6.83, 6.31, 7.43, and 6.53, respectively. Also, on a scale from 0 to 10, the mean ratings for the activity tracker software related to motivation for Apple watch, Basis Peak, Fitbit Surge, and Microsoft Band 2 were 5.54, 4.00, 5.02, and 4.34, respectively.

Discussion

The focus of this study was to determine what features of activity tracker hardware and software are identified as motivating in making active choices. The four activity trackers selected were similar in cost, features, and what they measured. The ANOVA results identified device similarities because there were no significant differences between devices hardware and software

ratings. Additionally, there were no significant differences in the number of positive or negative comments between devices, suggesting the devices were comparable to each other. Due to this lack of variation in device, data collected in this study may be even more applicable to the general population. Overall, study data collected indicates a much higher occurrence of positive comments regarding both hardware and software activity tracker features.

Our data indicates that physical design does have an influence on user acceptability, but a more notable influence is usable features and modes of the device for physical activity tracking and goal setting. A recent study found that motivation cues, general health information and challenges were the most helpful aspects of devices reported, but improved aesthetic designs would possibly produce a more ideal device for users than current models (Lewis et al., 2020). Other research suggests that two-thirds of individuals believe that activity trackers are helpful in motivating active choices, but 72% of this research sample admitted to using their trackers for less than 6 months (Alley et al., 2016). Our data agrees with this finding that most users believe activity trackers are motivating. However, sustained compliance may present a challenge. Future research should investigate and acknowledge this study's limitation in regard to its short duration. A literature review of 463 articles found that a common conclusion among acceptance and abandonment research was that a universal, all-purpose activity tracker is unreasonable given the variety of personal preferences; however, features such as self-monitoring, goal-based gamification, continuous feedback, and social support seem to encourage increased activity for many users (Shin et al., 2018). Our research agrees with this statement due to the wide range of positive comments gathered.

Our participants reported the devices were motivating. They also made more positive than negative comments about device hardware ($p < 0.01$) and software ($p < 0.01$). Because of

this finding, we can infer that user-liked features may be associated with activity tracker motivation. Features that are liked and perceived as useful promote tracker use and positive behavior changes. Activity trackers include a variety of evidence-based behavior change techniques with the most found being self-monitoring, feedback provision, and goal setting (Lyons et al., 2014). These techniques may lead to increases in active choices and promote physical activity when devices are utilized. Hardware and software features that are reported as positive, or liked by users, can assist with continued tracker compliance.

Limitations

There are a few limitations of this study worth noting. As previously mentioned, the sample used was primarily of young adult university students. This population was selected because of the potential to influence activity patterns early that could last a lifetime. This sample yields applicable results to this specific population but may be limited when generalizing data to other adults and diverse populations. Our sample of participants reported higher levels of regular pre-study physical activity in comparison to national averages (unpublished data). This study most likely attracted participants with a pre-existing interest in physical activity and activity trackers due to its subject matter. Individuals without these characteristics might have a different response to activity trackers and would be worthy of future research. In addition, one of the activity trackers, the Basis Peak, was recalled during the study. This negatively affected the number of users who were assigned to the Basis Peak ($n = 16$). Also, the Activity Tracker Usefulness Questionnaire (Appendix A) used to collect feedback from participants post intervention had not previously undergone psychometric testing to determine how scientifically rigorous it is. This may be a limitation if participants' answers were guided towards one response based on the wording of the questionnaire. Lastly, it is worth mentioning the short duration (one

week) of the study during which participants utilized the activity trackers. Longer duration may have resulted in further findings.

Conclusion

In conclusion, we did not find any statistically significant differences between the activity trackers used based on ratings and comments made by participants. However, we did identify several aspects of hardware (band, design, button use, button place, battery, size, modes, screen, simplicity, and other) and software (ease of use, pairing, information, syncing, and other) that were reported as liked or disliked. The majority of comments for all devices were positive for both hardware and software. These findings agree with findings from previous studies and further strengthen hypotheses that certain aspects of activity trackers motivate active choices.

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Appendix A

Activity Tracker Usefulness Questionnaire

1. Study ID Number (entered by Research Staff)
2. Today's date using format: MM-DD-YYYY (entered by Research Staff)
3. What activity tracker did you use? Apple Watch (1)
Basis Peak (2)
Fitbit Surge (3)
Microsoft Band (4)
4. On a scale from 0 (worst) to 10 (best), how would you rate the activity tracker hardware (not the app).
5. Thinking about the activity tracker device, what did you LIKE about it? (example topics: feel of band, button use and placement, battery life, overall size, choices of modes and options, interaction with screen, etc.)
6. Thinking about the activity tracker hardware, what did you DISLIKE or feel could be improved? (example topics: feel of band, button use and placement, battery life, overall size, choices of modes and options, interaction with screen, etc.)
7. On a scale from 0 (not motivating at all) to 10 (highly motivating), how much did the activity tracker device (hardware) motivate you to be active?
8. On a scale from 0 (worst) to 10 (best), how would you rate the activity tracker app?
9. Thinking about the activity tracker app, what did you LIKE about it? (example topics: ease of use, ease of pairing with phone, provides the type of information you want, syncing ability, etc.)
10. Thinking about the activity tracker software, what did you DISLIKE or feel could be improved? (example topics: ease of use, ease of pairing with phone, provides the type of information you want, syncing ability, etc.)
11. On a scale from 0 (not motivating at all) to 10 (highly motivating), how much did the app motivate you to be active?
12. If money weren't an issue, would you want this activity tracker? Yes (1)
No (2). Other: (3). _____

13. Do you use an activity tracker?

Yes, currently (1)

No, but I have in the past (2)

No, but I've thought about using one (3)

No, and I haven't really thought about using one (4)

14. What type of activity tracker do you currently use or have used in the past?

15. Since you currently use, or have used in the past, an activity tracker, how do you feel the activity tracker you tried this last week (Apple, Basis, Fitbit, or Microsoft) compares to your current/past experience?

16. Any other comments about your experience or advice you would give others about making the activity tracker successful?

TABLE 1.

Demographic Characteristics of the Participants

Characteristic	n	%	M	SD
Total	149			
Sex				
Male	84	56.4		
Female	65	43.6		
Race/ethnicity				
White/Caucasian	125	83.9		
Asian	13	8.7		
Hispanic	8	5.4		
Other	3	2.0		
Activity Tracker				
Apple Watch	41	27.5		
Basis Peak	16	10.7		
Fitbit Surge	45	30.2		
Microsoft Band 2	47	31.5		
Age			23.02	3.35
Body Mass Index			24.27	3.76
Underweight (< 18.5 kg/m ²)	4	2.7		
Normal Weight (18.5-24.9 kg/m ²)	91	61.1		
Overweight (25.0-29.9 kg/m ²)	46	30.9		
Obese (≥ 30.0 kg/m ²)	8	5.4		

Note: Values are presented as Mean (SD) for continuous variables and n (%) for categorical variables.

TABLE 2.

ANOVA Results: Difference Between Trackers?

Question	<i>p</i>
On a scale from 0 to 10 how would you rate the activity tracker hardware?	0.162
On a scale from 0 to 10 how much did the activity tracker hardware motivate you to be active?	0.177
On a scale from 0 to 10 how would you rate the activity tracker software?	0.125
On a scale from 0 to 10 how much did the activity tracker software motivate you to be active?	0.120
If money weren't an issue, would you want this activity tracker?	0.269
Total of all hardware like comments	0.196
Total of all hardware dislike comments	0.070
Total of all software like comments	0.295
Total of all software dislike comments	0.624

Note. No significant differences between activity trackers on any of the questions.

TABLE 3.

Quantitative Content Analysis of Hardware Comments

	Apple Watch		Basis Peak		Fitbit Surge		Microsoft Band 2		Category Total	
	n	%	n	%	n	%	n	%	n	%
Band										
Like	25	89.3	6	85.7	19	79.2	13	61.9	68	80.0
Dislike	3	10.7	1	14.3	5	20.8	8	38.1	17	20.0
Design										
Like	15	88.2	4	66.7	7	58.3	16	57.1	42	66.7
Dislike	2	11.8	2	33.3	5	41.7	12	42.9	21	33.3
Button Use										
Like	5	71.4	1	100	6	66.7	9	90	21	77.8
Dislike	2	28.6	0	0	3	33.3	1	10	6	22.2
Button Place										
Like	2	33.3	0	0	0	0.0	3	60	5	35.7
Dislike	4	66.7	0	0	3	100	2	40	9	64.3
Battery										
Like	12	57.1	15	100	32	88.9	20	74.1	79	79.8
Dislike	9	42.9	0	0	4	11.1	7	25.9	20	20.2
Size										
Like	13	92.9	8	61.5	8	42.1	10	45.5	39	57.4
Dislike	1	7.1	5	38.5	11	57.9	12	54.5	29	42.6
Modes										
Like	37	90.2	8	57.1	45	91.8	59	95.2	149	89.8
Dislike	4	9.8	6	42.9	4	8.2	3	4.8	17	10.2
Screen										
Like	11	73.3	6	54.5	26	96.3	18	75	61	79.2
Dislike	4	26.7	5	45.5	1	3.7	6	25	16	20.8
Simple										
Like	17	70.8	8	50	15	75.0	32	94.1	72	76.6
Dislike	7	29.2	8	50	5	25.0	2	6.3	22	23.4
Other										
Like	41	74.5	5	26.3	16	41.0	32	65.3	94	58.0
Dislike	14	25.5	14	73.7	23	59.0	17	34.7	68	42.6
Total Comments										
Like	178	78.1	61	59.8	174	73.1	212	75.2	625	73.5
Dislike	50	21.9	41	40.2	64	26.9	70	24.8	225	26.5

TABLE 4.

Quantitative Content Analysis of Software Comments

	Apple Watch		Basis Peak		Fitbit Surge		Microsoft Band 2		Category Total	
	n	%	n	%	n	%	n	%	n	%
Ease of Use										
Like	18	85.7	4	80	17	73.9	23	69.7	62	75.6
Dislike	3	14.3	1	20	6	26.1	10	30.3	20	24.4
Pairing										
Like	11	91.7	2	50	10	66.7	18	75	41	74.5
Dislike	1	8.3	2	50	5	33.3	6	25	14	25.5
Information										
Like	19	70.4	8	100	23	95.8	18	75	68	81.9
Dislike	8	47.1	0	0	1	4.2	6	25	15	18.1
Syncing										
Like	8	80	4	44.4	15	55.6	11	50	38	55.9
Dislike	2	20	5	55.6	12	44.4	11	50	30	44.1
Other										
Like	25	54.3	8	47.1	26	57.8	19	50	78	53.4
Dislike	21	45.7	9	52.9	19	42.2	19	50	68	46.6
Total Comments										
Like	81	69.8	26	60.5	91	67.9	89	63.1	287	66.1
Dislike	35	30.2	17	39.5	43	32.1	52	36.9	147	33.9