Usability of Wearables without Affordances

Full Paper

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Abstract

The research question guiding this study is whether the absence of visible interaction cues in minimalist wearable devices affects the user experience. This question is answered theoretically with an affordance framework and empirically with a qualitative analysis of online user reviews about a specific fitness tracker wristband. Our theoretically-driven affordance-based analysis attributes usability challenges to affordance integration failures and contradictions. Minimalist devices with inconspicuous interfaces need compensating affordances to make them easy to use. Additionally, given the integration of affordances in the context of the user experience, there is a need for consistency among them. Integration failures and inconsistent affordances impair usability. Overall, the findings suggest that a minimalist design results in a more complex user experience if affordances are not properly balanced and integrated. These results have implications for researchers and practitioners seeking to understand what makes modern IoT devices transparent to use at the physical and digital level.

Keywords

Affordance, design, Internet of Things, usability, wearables.

Introduction

The proliferation of the Internet of Things (IoT) devices presents new opportunities to study the usability modern technology. One of the most promising arenas, due to its popularity, is wearable technology. Projection figures provide evidence of the mass appeal of wearables. Estimates by CCS Insights indicate that the wearables market will be worth $25 billion by 2019, with more that 245 million wearable devices forecast to be sold that year (CCS Insight 2014). The wearable IoT market encompasses a collection of different "smart" devices, such as watches, eyewear, clothing, jewelry, and fitness bands. The top wearable category is wrist worn devices, which includes smart watches and wristband fitness trackers. Market analysts indicate that the wearable space is bifurcating between single-function wearables, such as fitness trackers, and more multi-function devices that accept third-party applications, such as smart watches. Single-function wearables are the most popular and account for almost 83% of the market, with fitness wrist bands dominating the market to date (Gagliordi 2016).

Fitness devices, the biggest wearables category by unit sales, is dominated by Fitbit, which has retained its strong market share despite the presence of competitors (such as Jawbone and Nike Fuel band) and the entrance of new companies like Xiaomin (Gagliordi 2016). These companies are capitalizing on the fitness "tracker craze" (Rettner 2013), which has been fueled by increased consumer interest in self-monitoring of physical activity to improve quality of life. This trend, known as the "quantified self" movement, is possible due to the availability of low cost sensors that can be embedded in wearable devices. The sensors collect activity data from movement or steps, which is wirelessly transmitted to the Internet where it is aggregated and analyzed by specially designed software programs. Thus, from the technology viewpoint, the functionality of wearable fitness devices is achieved by the integration of several interacting components: sensor, data, and software (typically delivered via a smart phone app, or a web dashboard). Given the interrelatedness of these components, a usability evaluation of wearable fitness devices ought to examine not only the *physical* product (wristband) and the *digital* components (data and software), but also their interaction.

Usability consists of achieving transparency in use, such that the technology is easily operated and seamlessly integrated into human activities. For individual technology whose adoption is voluntary, and there is no possibility of training, usability analyses are key to understand the success or failure of new devices. Ensuring usability is more challenging in minimalist devices. Therefore, the research question guiding this study is whether the absence of visible interaction cues in minimalist wearable devices affects the user experience. Accordingly, this paper presents the results of the usability evaluation of a fitness wristband (Fitbit Flex) that lacks any visible buttons or controls. Theoretically, the analysis is based on the concept of affordance, and the use of an affordance framework adapted from Kaptelinin and Nardi (2012). Empirically, the data comes from a sample of online user reviews related to the initial launch of the Fitbit Flex model. To present the results of this study, this paper proceeds as follows: the first section presents the theoretical background regarding usability analysis from an affordance perspective. The second section explains the research methods, sample, and data analysis. The next section provides the results of applying the affordance framework. The paper closes with a discussion of results, implications, and conclusions.

Theoretical Background: Usability and Affordances

A unifying concept that enables a complete usability evaluation of physical and digital components of wearable devices is the notion of *affordances*. The term was originally coined by Gibson (1986) to refer to what the environment offers to an organism, to what it provides or furnishes, for good or ill. He used the noun affordance to capture the complementarity of a subject (a human being or other animal) and its environment. In Gibson's original conceptualization and his examples, affordances refer to physical properties of the environment and are thus independent of the needs and goals of the subject.

Norman (1988) used the term to indicate that affordances provide clues on the operation of things. In this interpretation, affordances are considered properties of an artifact, whose presence suggest functionality and use via action possibilities, which could be real or perceived (Norman 1999). In the IS literature, affordances are the possibilities for goal-directed action provided by an object in relation to a goal-oriented actor (Markus & Silver 2008). Recent conceptualizations adopt a relational view and consider affordances as a socially and culturally constructed relationship between users and artifacts in real-life contexts (Kaptelinin and Nardi 2012, Leonardi 2001, Vyas et al. 2017). This new perspective recognizes that affordances are realized in the interaction of organisms with objects in their environment. The two main theories in support of this relational view are Activity Theory (e.g. Kaptelinin and Nardi 2012), and Adaptive Structuration Theory (Markus and Silver 2008, Vyas et al. 2017). Each theoretical lens yields a different classification of affordances. The mediated-action perspective of Activity Theory is particularly well suited for the study of artifacts voluntarily adopted by individuals for use outside organizations. In contrast, the view of affordances provided by Adaptive Structuration Theory is particularly useful for the study of technology within organizational contexts.

Kaptelinin and Nardi (2012) emphasize the mediated-action perspective of Activity Theory and conceive affordances as a relational property of the interaction between the Person (P), the mediational means given by the Technology (T), and the Object (O) on which the technology is expected to have an effect. In this context, the action possibilities afforded by the technology include its direct manipulation by the person (P<->T), called *handling* affordances, and the indirect effect that the technology is expected to have on an object (T<->O), called *effecter* affordances. When combined, these two types of affordances are *instrumental* because they complete the cycle of action of the technology as an instrument.

One of the assumptions of the mediated-action perspective is that the object on which an effect is expected to occur is external to the person. However, when people use wearable fitness devices, the object anticipated to be affected is the person's own body, rather than a separate entity in the environment. Furthermore, wearable technology devices are attached to the body and carried around, as opposed to temporarily handled when needed to perform an action, as is the case for other technology tools. This embedding of technology on the body is analogous to the notion of "functional organs" proposed by Kaptelinin (1996), through which humans can extend their capabilities and perform new functions, or perform existing functions more efficiently. This dual embedded-ness whereby the technology is worn on the body, and is expected to have an impact on oneself (i.e. *on* the users' body or mind with respect to her own fitness goals), transforms this affordance into a *self-effecter*. Self-effecter affordances are intrinsically related to motivation, particularly in the case of wearable fitness technology. Not only because its adoption and use is voluntary, but also because these affordances determine whether technology artifacts can support one's motivational needs, in areas such as psychological, social, cognitive, and emotional (Zhang 2008).

In addition to the instrumental affordances, Kaptelinin and Nardi's (2012) framework includes a set of *auxiliary or supplemental* affordances. These allow for the *maintenance* or upkeep of the technology instrument (e.g. charging, and cleaning the device), *aggregation* of the technology with other artifacts (e.g. effective integration of the device with the companion software), and *learning* how to use the technology (e.g. didactic information on how to operate the device and related artifacts to achieve personal fitness goals). Figure 1 shows the framework of affordances.

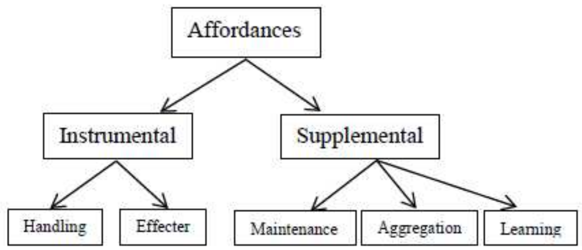

Figure 1. Affordance Framework

The success of wearables depends on their perceived ease of use and their ease of integration into the users' everyday life (Altenhoff et al. 2015, Vella 2013). A number of contemporary studies in the media and in academia have evaluated the usability of fitness wristbands. The results suggest that the device should be durable and ready to interact with the user when needed (Vella 2013). The software (delivered via a mobile app or a web dashboard) should be easy to navigate and easy to synchronize with the device (Altenhoff et al. 2015). The data should correctly reflect user activity levels, must be available when needed, and should be easy to understand to produce the intended effects (Mackinlay 2013). These effects are reinforced with individual rewards (such as badges for achieving goals) and social rewards when activity data is shared with friends or in online communities (Fritz et al. 2014).

These previous usability studies underscore two key methodological considerations for future research. First, the object of evaluation should be an entire artifact and the study should include not only the device but also the corresponding software and data that complete its function (Altenhoff et al. 2015). Second, the subjects at the center of the evaluation should be actual users in realistic contexts. Usability of wearable technology is best studied when consumers use the product in a real life setting, or "in the wild" (Fritz et al. 2014). This study seeks to accomplish both goals by applying the affordance framework to actual user experiences with a popular fitness band. However, by using a theoretically-driven affordance framework, this study seeks to provide new insights on the origin and nature of usability challenges and ways to address them.

Research Methods

Typical usability studies involve a trade-off between sample size and the nature of the data and analysis. Small samples are usually examined with qualitative techniques, while large samples are investigated with mostly quantitative methods. The approach adopted in this study combines the advantages of a large sample with the richness provided by qualitative data gleaned from user reviews posted on Amazon. Contemporary research in other contexts has shown the informational value of Amazon Reviews (Ghose & Ipeirotis 2011, McAuley *et al.* 2015) but to the best of our knowledge, the textual content of the reviews has not been leveraged to examine usability. By using a collection of Amazon Reviews about a particular fitness wristband, this study applies the affordance framework to identify the most salient usability issues reported by the users themselves.

Selection of Wearable Device

Fitbit, the top brand in the market of fitness trackers, offers a variety of models with different features and capabilities at different price points. One popular wristband model, located at the low end of the price spectrum, is Fitbit Flex (FF). Its distinctive characteristic is its simplistic design. The wristband only shows five minuscule light indicators (or LEDs). There are no other visible controls. Due to the absence of obvious design affordances, Fitbit Flex (FF) is the product selected for this study. Launched in April of 2013, FF is a digital pedometer with wireless connectivity. Tracking is done via a sensor that turns acceleration movement into digital measurement data when attached to the wrist. Acceleration data about frequency, duration, intensity, and patterns of movement is used to estimate steps, calories burned, and sleep quality.

FF is basically a sensor encased in a rubber wristband that closes by snapping a set of prongs into their holes (Johnston 2013). The only visible display is a set of five LEDs that can be activated to represent step progress during the day. The LEDs light up progressively to indicate percentage of goal completed. Aside from the light indicator, FF is devoid of any other buttons or noticeable controls. See Figure 2.

Figure 2. Fitness Wristband.

To activate the light display, users need to tap twice on the device. When the step goal for the day has been achieved the device vibrates and all lights are on. In addition to tracking steps, the device can be used to track sleep. A series of rapid taps on the wristband activates the "sleep mode." The band is in sleep mode when it vibrates and the lights flash in a specific sequence. Periodically, the sensor needs charging. In order to do so, the user needs to remove it from the bracelet and insert it in a special USB adapter. See Figure 3. Since there is no visible battery indicator on the device, the battery level can only be checked by synchronizing it with the software, or by setting up email notifications to send low battery alerts. The device wirelessly sends the data collected to a compatible smartphone (via Bluetooth 4.0), or to a computer when the device is nearby. For the wireless transmission to occur with the computer, a small custom dongle must be plugged into one of the USB ports. See dongle in Figure 4.

Figure 3. Charging Cable

Figure 4. Dongle

The software component of FF is used to set goals and check the data collected by the device. Activity data is displayed via statistics in charts and tables. The software is accessible via a web-based dashboard (Figure 5), or via the Fitbit mobile app. See Figure 6. With the software, users can set activity goals, check battery status, customize parameters, log additional data, and visualize the results.

Figure 5. Web-based dashboard

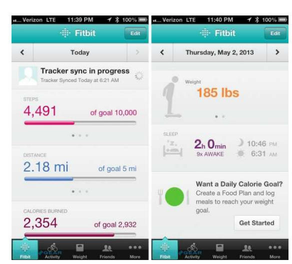

Figure 6. Mobile App.

Sample Selection

A sample of Amazon Reviews for FF was assembled from the dataset compiled by McAulay et al. (2015). The entire set of reviews corresponding to FF contains 6,022 reviews, posted between 4/15/2013 and 7/21/2014, with an average length of 106 words and an average rating of 3.7 stars. From this set, a custom-developed program extracted the reviews about FF with 300 words or more. A total of 373 reviews met the selection criteria. The average length of the FF reviews in the sample is 494 words and the average rating is 3.5 stars. Since FF was launched in mid-2013, these reviews capture the initial reactions of the users to the 1.0 version of the product.

Data Analysis

The text of the reviews was content-analyzed with QSR NVivo 11 Pro, using a combination of deductive closed coding guided by the categories of the affordance framework, with inductive open coding within each affordance category to identify emerging themes (Mayring 2014). For the deductive coding, two research assistants were trained to parse the reviews and recognize indications of affordances. The codebook was developed by defining each affordance in the framework and providing examples of its potential appearance in the text. To validate the manual coding, keyword searches based on the codebook confirmed that affordance occurrences were properly coded. Then, working independently, the coders classified the valence of each reference within each affordance into two types: positive (or descriptive) and negative. Inter-rater reliability results for the valence coding all affordance categories was higher than .80. For the inductive coding, coders examined each affordance category to identify common themes.

Findings

A total of 2,319 stripes (sentences or text excerpts) were coded in the entire sample. Table 1 shows the distribution of reviews by rating category, and the number of stripes identified in each rating category divided into instrumental and supplemental

Rating	Number of Reviews (%)	Number of Words Mean (*sd*)	Total Number of Coded Stripes	Instrumental Affordance Category	Supplemental Affordance Category
1	38 (10%)	447.24 (*151.48*)	155	86	69
2	54 (14%)	464.91 (*171.39*)	287	168	119
3	69 (18%)	518.67 (*288.51*)	415	245	170
4	122 (33%)	504.87 (*227.28*)	903	560	343
5	90 (24%)	497.2 (*260.95*)	559	350	209
Total	373 (100%)	493.87 (*235.11*)	2319	1409	910

Table 1. Characteristics of the Sample.

On the *instrumental* side, the results of open coding suggested two distinct sub-categories for the handling affordance, one refers to issues related to *wearing* the device, and the other refers to *interacting with* the device. Henceforth, the handling results will be related to these two categories. In *wearing*, the coded excerpts mentioned the design of the wristbands, in particular their look and feel, as well as the closing mechanism, the durability of the band material, and its water resistance. In *interacting*, the features referenced were sleep mode activation and performance, mechanics of communication with the device via taps, and the response of the device with vibration and lights. In *self-effecter*, the topics are related to issues about the data collected by the device in terms of accuracy and awareness, and the effect the device has on the user by increasing his/her motivation to be more active, to compete with friends, or to obtain support from the online community of users.

On the *supplemental* side, the results of the open coding detected three main themes in each category. In *maintenance*, the reviews reported their experiences regarding battery life, charging the device, and cleaning the wristband. In *aggregation*, the themes are related to the synchronization of the device (with a smartphone or with a computer), the features of the software delivered via the dashboard, and the characteristics of the mobile app. In *learning*, the coded excerpts refer to the first interaction of the user with the device (i.e. set up and initial experiences), customization, and availability of instructions.

Table 2 shows the results of the valence coding per affordance category. Chi-square tests confirm the unbalanced distribution of affordances within each category, and a Z-statistic shows the significance of the differential breakdown in valence.

	Wearing	Interacting	Effecter	Maintenance	Aggregation	Learning	**Total**
Pos/Desc	310	336	430	152	449	83	1760 (76%)
Negative	127	121	85	81	114	31	559 (24%)
Total	437	457	515	233	563	114	2319
	χ^2=23.68 (df=2), p<.0001			χ^2=12.99 (df=2), p<.0001			Z-stat=25.04 P<.0001

Table 2. Results of Valence Coding.

Figure 7 illustrates the distribution of negative experiences across affordance types. About 45% of the negative experiences are located in the handling category (127 in wearing, and 121 in interacting), followed by aggregation with 20% (114 out of 559). Effecter and maintenance are next with about 15% each and learning is the last with only 5%. The themes identified via open coding shed light on the nature of these affordances and the usability problems reported in the reviews.

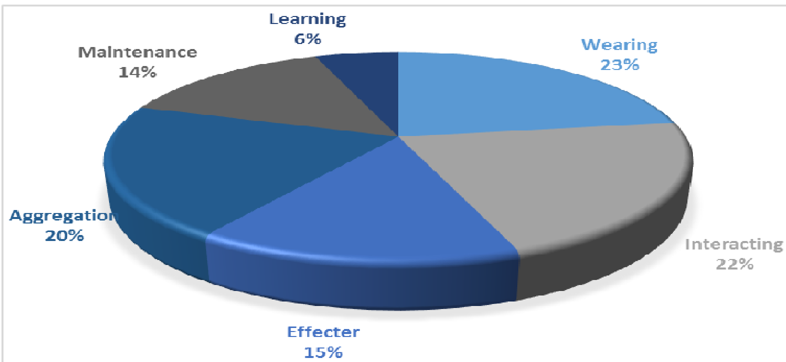

Figure 7. Negative References per Affordances

Instrumental Affordances

The themes in the instrumental affordances category refer to the handling of the device (wearing and interacting), and its effect on the user. Wearing affordances describe the design of the wristband, including its look, feel, material and durability. The reviewers praise the appearance of the device, and the ease of wearing it on the wrist: "*The wristband itself is comfortable and stylish. And this is coming from a guy who never wears watches or any other type of wristband.*" While others are not as impressed by the aesthetics and take issue with the durability of the band material: "*I have had my Fitbit for a month and a half and the seam where the plastic of the band meets the translucent viewing area has started to separate.*"

In addition to reports of band tear, the bracelet is difficult to close due to the fastening mechanism, and over time tends to get loose, resulting in accidental opening of the wristband and lost devices: "*First, the band it futzy [sic] and virtual impossible to put on. Some of the worst industrial design I've seen in years. And when it is on it doesn't stay on.*" Although the wristband is for continuous use and marketed as water-resistant, some reviews report problems when the wristband is exposed to water: "*The wristband and Flex are water resistant, but the band traps water and sweat inside the cavity that holds the Flex. Washing hands, taking a shower, and sweating will result in a plethora of bacteria building up inside the band.*" This issue has implications for maintenance and charging.

With respect to the interaction, the user communicates with the device via taps, and the device responds with vibrations if there is a change of mode (from sleep-mode to step-mode or vice versa), or with flashing lights to show progress towards the step goal. "*The lights don't light unless you double-tap the device. So there is nothing to attract anyone to it, if you'd like to keep it discrete. It just looks like a bracelet.*" However, the minimalist light indicator means that the user must get specific data from the software that works along with the tracker: "*…you cannot look at the Flex and know how many steps you have taken - you have to go to your dashboard on your computer or your phone to know the actual number.*" Taken together, the "*language of the flashing lights*" and the Morse-like requirements of the unique tapping code decrease the quality of the user experience: "*I gave this 3 stars because while it works well the display on the Flex is pretty minimal and the control for the unit is done by tapping it which is a pretty nebulous process most of the time.*"

Interacting with the device via taps to change from step-tracking to sleep-monitoring is challenging due to a lack of awareness about the number of taps required: "*To control the functions of the Flex you have to tap the wrist band or the unit itself and maybe i'm not doing it right but it always seems to take a random number of taps to get what I want.*" The tap code is not only confusing for some users but also unreliable, as some arm movements are interpreted as taps, which puts the tracker in sleep mode accidentally: "*Also, when hitting bumps or going fast on the bike, the band will vibrate a lot to notify me it has changed into the sleep setting. I then have to tap it to get it back to recording my steps…*" Activation of sleep mode (accidental or otherwise) is manual. Thus, the user needs to remember to set the device in or out of this mode: "*Sleep mode is a pain. I forget to enable it probably 25% of the time. Wish it would automatically detect non-movement and enable sleep mode like the jawbone.*"

In the effecter category, the themes reflect the importance of receiving feedback with data collected by the device, and the motivational effects associated with it. Regarding activity data, the reviews report issues of accuracy, or lack thereof: "*The only reason I didn't give this 5 stars is because of the wiggle room with accuracy. I don't like how moving my wrist a lot adds to the step count. That's misleading!*"

Despite issues regarding accuracy, the motivational effects of the device directly on the user, or indirectly via the social features (online community and/or competition), are highlighted in the reviews: "*As far as accuracy, who can really be sure? What it is doing, however, is forcing me to get out and get moving. I've upped my walks, and I take little breaks during work to walk around a bit. It's making me conscious of how much I am moving, and, accurate or not, that can't be a bad thing.*" For other users, the motivational power comes primarily from the social features, via competition with friends or support from online user communities: "*The Fitbit is a really great motivator to stay active, especially when you throw a couple of friends into the mix via the Fitbit community on the website and mobile app.*"

Supplemental Affordances

The supplemental category, which includes maintenance, aggregation and learning, increment the device with needed functions. In maintenance, the coded references refer to the upkeep of the device battery. Some users shared various experiences regarding the duration of each charge (i.e. battery life), and the process of charging via the proprietary charging cable: "*It takes a really long time to charge, as well--and even then it only lasts a few days.*" Since the device has no battery indicator, users rely on email notifications to learn when the device needs to be charged: "*I even get an email message when my battery is low, about once a week.*" However, the emails do not always line up with the true battery status. The charging process is unsuccessful when the buildup of dirt around the sensor prevents it from charging properly: "*The contacts on the actual device have also gotten pretty dirty and have had to be cleaned out in order to charge correctly. This is due to the fact that the device slides into the wrist band and sweat and dirt and moisture build up inside. This to me is one of the worst design aspects of the device.*"

In aggregation, the themes reflect issues of synchronization (with phone or computer), web-based dashboard, and mobile app characteristics. While the synchronization with the computer is straightforward (as long as the dongle is plugged and the device is nearby), the synchronization with smartphones is not as simple. Since the device requires Bluetooth 4 for real time syncing, some smartphone models are not compatible: "*I have a smart phone but its not one that Fitbits sync with so I couldn't even look at my phone for the number.*" For Android phones there are some compatibility and dependability issues: "*Android Phone sync not dependable (don't worry, you never lose you data [sic], seems like I have to sync it several times before it works).*"

The software delivered via the dashboard or mobile app plays a key role in the FF user experience: "*As many media reviewers have said, it's not the hardware that makes Fitbit special, it is their web site. It saves your data and displays it in easy to digest dashboards, and you can't lose the data.*" However, the features of both versions (web-based and mobile) are different, which makes some users have some specific preferences for one over the other: *"I find that I have to use the FitBit web portal to log most of my activities more easily than the bland app."*

In learning, the least populated category of coded affordances, the themes describe the first time the user encountered the device, as well as stories of success and failure in the first use. The lack of printed instructions on the package and the requirement to go to the Fitbit website made a negative first impression for some users: *"I received a Fitbit Flex as a gift, knowing little about it. It does not come with a user manual. I went to the web site where I wasted my time finding out how unnecessarily complicated it is to use Fitbit and how little it actually does."* Incomplete instructions diminish the quality of the overall experience with the product: "*I gave it 3 stars b/c of the poor instructions*."

The reliance on online instructions presents challenges in learning how to use the device, which causes gaps in the mastery of some features. *"I keep having to refer to the on-line guide to remember how to put the thing into sleep mode, how to wake it up, and what it means when various lights are flashing."* Other knowledge gaps are related to the functions available on the device: *"I owned this device for two weeks before I realized there was an alarm on it. I'm not sure what other things I'm missing, because there is no simple manual."* The learning process is continuous as users become familiar with the device: *"You just learn as you go, which personally drives me crazy."*

Cross-Affordance Analysis

The inter-relatedness of affordances is key to ensure a positive user experience, particularly in the case of minimalist devices. This intertwining is illustrated with excerpts regarding the device's battery indicator: "*No on-device power indicator. You have to make sure to sync it regularly so it can tell your FitBit dashboard to send you an email reminding you to charge it. If you don't sync it, the device doesn't tell you when it is low on juice and will just die quietly*." When this integration between affordances does not work properly due to contradictions or failures, poor usability follows. This excerpt illustrates a contradiction: "*On one hand, I've got 5 blinking lights indicating a full charge, on the other my iPhone is telling me the battery is empty and I'm getting emails from FitBit telling me my battery is empty and it needs to be charged. This is infuriating*." An example of integration failure is the lack of warning email, which is also problematic: "*Well, now the battery goes dead within 3 days of a full charge. In addition, there is no warning email*." Table 3 summarizes the usability challenges encountered in each affordance category.

Affordance	Themes
Wearing	Band Durability, Closure Mechanism, Water-resistance/Moisture buildup
Interacting	Taps Sequence, No display, Sleep mode Activation, Random Vibration
Self-Effecter	Data accuracy and awareness, Individual Motivation and Social features
Maintenance	Battery life, Charging Process, Device Cleaning
Aggregation	Phone/Computer Synchronization, Dashboard Website, Mobile App
Learning	Setup, No Instructions, Knowledge gaps

Table 3. Usability Challenges.

Discussion

The content analysis of coded excerpts according to the framework shows the importance of balancing affordances to ensure their proper integration. When affordances are missing in one area, they must be compensated with additional ones in another area. In the preceding analysis, there are clear instances of transfer from the instrumental to the supplemental category. For example, the lack of visual numeric display in the device implies that the user must check his/her step progress through the software (app or dashboard). Similarly, the lack of a battery status indicator in the device merits email alerts when battery charge is low. When compensating affordances are not found, usability problems may ensue. For instance, the absence of printed instructions "out-of-the box" implies that users must learn from online sources, primarily the Fitbit website. If these instructions are not easily found, users are frustrated and unable to learn how to operate the device. Some of the usability problems encountered in this analysis are related to failures in affordance transfer.

The second type of usability problem is due to contradictions between affordances. For example, the lack of battery status indicator is compensated via an email notification that alerts the user when the device needs charging. If the battery status information is inaccurate, the device may stop working without the user realizing it. Another example is the inconsistency between the step count data (shown digitally) and the steps physically taken by the user. In fact, most of the negatively coded excerpts in the self-effecter category were related to inaccuracies in the data collected by the device. These contradictions between affordances reduce the quality of the user experience.

In some instances, the integration of affordances has the power to compensate deficiencies. The analysis of affordances within the *self-effecter* category shows the countervailing forces of low data precision against the motivational power of wearing a fitness band. For FF users, motivational affordances stem from direct effects of data awareness on the individual wearer (feedback and goal setting), or from indirect effects as users cooperate or compete with other users of the same wristband to achieve their fitness goals (social affordances). This self-effecter paradox whereby data collection and display increases fitness motivation despite its questionable accuracy is one of the most intriguing findings of this study.

The findings herein must be interpreted with caution in light of the selected device and sample characteristics. Only one wearable fitness tracker was selected for analysis. Fitbit Flex was chosen because it was newly launched in the time period covered by the reviews, and it was one of the first wrist-worn tracker models with minimal interaction cues (no display, no buttons). From all the reviews available for the sample period, only those with 300 words or more were selected for this analysis. Despite the restrictions to the generalization of results stemming from a single wearable product and the selection of lengthy reviews, this study shows how an affordance lens provides important insights regarding the design and use of the selected fitness wristband.

Contributions and Implications

Our theoretically-driven affordance-based analysis attributes the causes of usability challenges to integration failures and contradictions. On the one hand, minimalist devices with inconspicuous interfaces need well-developed supplemental affordances on the digital side to make them easy to learn and accessible. When physical affordances are missing, digital affordances must be provided to fill the void. Appropriate substitutions of instrumental for supplemental affordances promote ease of use. Additionally, given the integration of affordances in the context of the user experience, there is a need for consistency among them. In the presence of inconsistencies or paradoxes, such as the self-effecter paradox identified in this study, personal preferences will determine the acceptance of the device. Our findings suggest that the motivational effects of the device seem to outweigh data inaccuracies for some users but not for others.

For researchers and practitioners, the study of wearable tech offers a valuable context to understand what makes modern technology transparent to use at the physical and digital level. The value of usability analysis after technological artifacts are released to the market is realized in subsequent versions, or generations, of the same product. Moreover, due to the theoretical framework, the lessons drawn from this type of usability examination are also potentially applicable to similar or competing artifacts, while they are being developed.

Conclusion

The availability of low cost sensors embedded in wearable devices to collect and wirelessly send personal activity data is defining a new category of individual technology products with physical and digital components. Some of these wearable products have a minimalist design devoid of visible interaction affordances. To analyze their usability, this study applies an affordance lens to qualitative data contained in online user reviews. An affordance lens shows that the main causes of usability problems are failed affordance integration and affordance contradictions. The findings show that simplicity in design may result in complexity of use, if implicit affordances in the physical device are not balanced with supplemental affordances on the digital side.

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