How Does Quantified Self Run?

Full Paper

Ruth Baumgart
Goethe University Frankfurt am Main
rbaumgart@wiwi.uni-frankfurt.de

Abstract

While self-tracking applications are often advertised with a healthier life and more movement scant studies investigate the effect of self-tracking and those few studies reported contradictory reactions of self-tracking users. Hence, we conducted 12 interviews with self-tracking users to find out which psychological mechanism explains the different responses. As a foundation the cognitive dissonance theory from Festinger (1970) was used. The theory states that people who are aware of two different cognitions feel psychological stress and try to reduce this stress by changing their behavior, finding new information or ignoring the inconsistent information. While the theory was often criticized because of an experimental testing which also allowed other interpretations, our qualitative analysis gives further support to this theory. Furthermore, we found out that self-tracking increases the awareness of two different cognitions and reduces the tendency of denying.

Keywords

Quantified Self, self-tracking, wearable, cognitive dissonance theory.

Introduction

The era of cloud computing, smartphones and wearable sensors has facilitated the launch of the self-tracking movement in 2007 (Swan 2013). Self-tracking is thereby defined as utilizing technology to monitor one's own behavior e.g. steps, running pace, pulse or mood for the purpose of self-reflection and self-knowledge (Choe et al. 2014). In line with the growing conscientiousness of the danger of physical inactivity (WHO 2015), self-tracking applications are often advertised with a healthier life and more movement through greater self-awareness (Microsoft website 2015, Apple website 2015). Even insurances and other companies enable self-tracking as a health protection intervention (AOK 2015, Nikayin et al. 2014).

While the necessity of research in the area of computing in everyday life is highly acknowledged (Yoo 2010; Hess et al. 2014) and the usefulness of self-tracking is widely assumed, scant studies investigate the effect of self-tracking and those few studies report conflicting results (Bravata et al. 2007; Shin et al. 2015; Sanchez-Vales and Trivino 2015; Sjöklint et al. 2015). Whereas, some studies found out that self-tracking leads to a desired behavior change (Bravata et al. 2007) other studies found different reactions to self-tracking usage (Sanchez-Vales and Trivino 2015; Sjöklint et al. 2015).

Hence, the goal of this study is to understand the psychological mechanism behind these varying reactions in order to provide an explanation for these different responses. This psychological comprehension is critical importance for the design of effective applications which motivate people to change their behavior (Wendel 2013). Therefore, we based our study on the cognitive dissonance theory by Festinger (1970) because it combines motivation with cognition and is one of the most important theories in social psychology (Aronson 1992). This theory states that people feel cognitive dissonance, which is a psychological tension, when their attitude and behavior are not in line with each other (Festinger 1970). Since dissonance is perceived as displeasure, people try to reduce dissonance with three different approaches: They change their behavior, add new cognitive elements by finding new information or change cognitive elements of the environment by ignoring or denying.

Researchers in psychology have tested the cognitive dissonance theory with experiments in which subjects could reduce dissonance in only one predetermined way (Elliot and Devine 1994; Menasco and Hawkings
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1978). A reaction in a way that the dissonance theory predicted was interpreted as a support of the theory. Since this approach is criticized as a built-in artifact or as biased and the results of the experiments can also be explained through competing theories (Oshikawa 1969) we use a qualitative approach to obtain a detailed explaining of the different reactions and to find support for the cognitive dissonance theory in a self-tracking context. Furthermore, because Yoo (2010) has emphasized the necessity of studying the nature and consequences of the digital mediation of everyday experiences we also investigated in which way self-tracking interacts with cognition, emotion and behavior.

This leads to the following central research questions:

1. How can the different reactions to self-tracking be explained?
2. How does self-tracking interact with cognition, behavior and emotion?

To answer these questions we conducted interviews with 12 self-tracking users and analyzed the results inductively and deductively by using open and closed coding. Qualitative methods are useful to arrive at a deeper understanding and to answer how and why questions (Myers 2013).

The remainder of this paper is structured as follows. In the following section we provide the theoretical background and related work in the area of self-tracking and cognitive dissonance theory. Second, we describe our research methodology. Next we present our findings and illustrate a conceptual model. After that, we discuss the results and conclude with a brief discussion as well as the limitation of our investigation.

Theoretical Foundation

Quantified Self

Gary Wolf and Kevin Kelly started the Quantified Self movement in 2007 after the release of the first iPhone (Gimpel et al. 2013). The members of this community attend online social platforms and worldwide in-person meetings to talk about new technologies and their self-tracking experiences. Self-tracking is thereby defined as the collection of data regarding the own behavior with the aid of technology (Choe et al. 2014). Thereby, different technological possibilities for self-tracking exist. The most common options are portable devices, wearable devices and placeable devices (Trickler 2013): Portable devices have to be carried by the consumer. Their functions are invoked on demand. Mobile phones are one example of portable devices. They primarily contain data which is manually inserted e.g. data about one’s mood or emotional status. Wearable devices, in contrast, provide sensor-based data which require close proximity to the body e.g. heart rate, pulse or galvanic skin response. In contrast, placeable devices must not be carried by their users instead they are placed at relevant locations for their usage. Examples of placeable devices are wirelessly connected treadmills or weighting scales.

Until now there are only a few investigations concerning self-tracking and those few studies report contradictory reactions of self-tracking users. While some studies show behavior changes in outpatients who use pedometers in a clinical context (Bravata et al. 2007), Sancez-Valeds and Trivino (2015) could not show the desired behavior changes in a single-subject experimental design. Furthermore, Sjöklint et al. (2015) showed diverse reactions to self-tracking usage. In a qualitative study, they found four different coping strategies when people did not reach their goal. These coping strategies are disregard, procrastination, selective attention or neglect. Disregard means that the self-tracking users start to formulate excuses when they do not reach their goal. Procrastination refers to the tendency of self-tracking users to invest in short-term or long-term plans to achieve the goal at a later point in time, selective attention is used when users primarily focus on goals that are more likely to reach than on those that are more difficult to achieve and neglect means that the users neglect the data until it is sure that they have reached their goal.

While these studies investigate how users react to self-tracking activities we want to find out why there are different reactions and which psychological processes take place. To do that, we use the well established cognitive dissonance theory by Festinger (1970).
Cognitive Dissonance Theory

Cognitive dissonance can be defined as a psychological discomfort similar to the notion of hunger, frustration or disequilibrium that arises when a person is simultaneously aware of two inconsistent cognitions (Festinger 1970). For example, dissonance can occur when people’s action and attitude are not in line with each other and little justification is available for this inconsistency (Festinger, 1970). Since dissonance is seen as an uncomfortable state, it leads to different actions aiming to reduce it. Table 1 describes the three possible ways of dissonance reduction:

<table>
<thead>
<tr>
<th>Dissonance reduction strategies</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Changing a behavioral cognitive element</td>
<td>The dissonance is reduced through the modification of an action. For example, if the behavior is not in line with the attitude, the behavior is changed in order to reduce this inconsistency.</td>
</tr>
<tr>
<td>Adding new cognitive elements</td>
<td>Reduction of the dissonance through the addition of new cognitive elements e.g. a person actively searches for new information to bring two inconsistent cognitions in line which each other.</td>
</tr>
<tr>
<td>Changing an environmental cognitive element</td>
<td>The dissonance is reduced by ignoring the situation or by changing the attitude so that the two cognitions are not inconsistent anymore.</td>
</tr>
</tbody>
</table>

Table 1. Dissonance reduction strategies

The cognitive dissonance theory was tested through psychological experiments in which participants could reduce dissonance in only one predestinated way (Elliot and Devine 1994; Menasco and Hawkings 1978). If the subjects reacted in a way predicted by the cognitive dissonance theory the theory was seen as supported.

For example, in a classic experiment by Festinger and Carlsmith (1959) participants had to perform a lengthy and boring task. After completion the participants were asked to tell the fellow subjects that the task had been pleasant. Half the participants were compensated for this lie with $1 and the other half received $20. In a follow-up questionnaire, the participants who had received $1 rated the task more enjoyable than the participants who obtained $20. Festinger and Carlsmith (1959) explained their findings on the grounds of cognitive dissonance. The participants who had received $1 experienced tension stemming from two inconsistent cognitions. They experienced the task as being boring but stated that the task had been pleasant. To reduce this tension they changed their attitude and rated the task as enjoyable so that attitude and behavior were consistent again. For the participants who received $20, the inconsistency between attitude and statement was balanced out by a consistency between the statement and the external motivator ($20). This leads to only little tension and the participants were therefore not motivated to change their attitude.

While most examinations of this theory were conducted with experiments, Oshikawas (1969) criticized this approach as biased because other theoretical explanations for the same results are possible. Although the theory is still well established in social psychology, in recent years, different interpretations have become available for diverse cognitive dissonance experiments. Cooper (2007) for example, provides a different explanation for the results of the aforementioned experiment. He stated that it had been the negative emotion resulting from harming someone else and not the need for cognitive consistency which led the participants of the $1 condition to change their attitude. To provide further support for the cognitive dissonance theory, we conducted a qualitative study to test this theory deductively.

Research Approach

We undertook semi structured interviews with twelve self-tracking users in Germany to find out if the cognitive dissonance theory provides an explanation for the different reactions to self-tracking activities and how and why self-tracking interacts with cognitive consonance searching. Qualitative research
methods are useful for this investigation because they provide a deep understanding of the phenomena in a social context and answer “how” and “why” questions (Myers, 2013). Furthermore, qualitative research is well-established in information system research studies (Sarker et al. 2013).

For the interviews, a guideline with open questions was used to ask the participants about their perception of self-tracking. Furthermore, questions about their experience in situations when the self-tracking goal was not reached were asked. The interviews lasted 30 to 50 minutes and were recorded, transcribed and translated from German into English. At the beginning of each interview, the anonymity of each participant was guaranteed to encourage open and honest answers. The interviewees were randomly acquired from sport clubs and one university. A few interviewees also recommended other potential research participants. The age of the interviewees ranged from 24 to 53 with 2 females and 10 males and the duration of self-tracking usage ranged from between one month to 7 years. In addition, the running distance of the participants differs from between 5 kilometer to 20 kilometers. Different hardware were used by the interviewees e.g. Garmin Sport watch, Nike Fuelband, Microsoft Band, Apple Watch or smartphones. All interviewees tracked their running effort. In addition, some interviewees tracked sleeping habit, strength training, bicycling, steps and finance. Different apps were used e.g. Nike Running App, Garmin Connect, Microsoft Health, Suuntu, Running Dashboard and Apple Health.

During the analysis phase, a predefined code-scheme based on the cognitive dissonance theory was used. The transcript interview paragraphs were then assigned to the predefined code-scheme. In addition, open coding was also utilized to account for the different interrelations between self-tracking and the cognitive dissonance theory as well as for alternative explanations. In order to allocate the different codes to the interview passages, the software MAXQDA was used. In a next step, the logic between the single pieces of information was analyzed through the comparison of different text passages. This step was important to find out if there are relationships between different categories or contradictions between different interviews. In the following the results are presented for each part of the cognitive dissonance theory.

Results

Awareness of two inconsistent cognition

All interviewees mentioned that they are more aware of their achievements through self-tracking activities. Parameters such as the number of steps or their pace were hardly quantifiable without technical support. The applications help the user furthermore, to set a goal e.g. through predefined targets and to track whether the aim had been achieved. This leads to a greater awareness when the attitude to achieve a goal is not in line with the behavior and two inconsistent cognitions exist.

“Well, with the [predefined] step goal, actually 5000 steps are not very much. [...] But if I see it in the evening and think: Damn! Today I have not even reached the 5000 steps then you think: Crazy, this was really a day of hardly any movement.” (I3)

“And that you have the possibility to set yourself a daily goal. I always use the standard because I do not want to change the goal every day [...]” (I1)

“Without this data I would not have the opportunity to recognize where I stand and insofar is this an activator for decisions and feelings.” (I9)

Cognitive Dissonance

The awareness of the inconsistency between the attitude to achieve a goal and the behavior leads to cognitive dissonance which is a psychological tension. 11 of 12 participants mentioned that they are angry about themselves or that they are frustrated in situations where they do not reach their goals.

“Yes clearly, [if you do not reach your goal] you will be angry with yourself.” (I6)

“Well I am not in a bad mood the whole day if I did not reach the goal I wanted to reach but it can happen that it rankles me [...] or that I am frustrated at this moment. (I11)

“Well if I really would have had a bad week and I had reached no goal at all [...] then I would be dissatisfied with myself and mad with me [...]. (I8)
“Stupid. No, if I have not reached the goal then I find this is not good. That gets on my nerves.” (I11)

One participant mentioned that he always achieves his running goals and therefore feels no cognitive dissonance. If he realized that he was too slow during the run, he counteracted immediately to achieve his goal.

“I do not have these performance fluctuations anymore that I have a bad day and say this is not possible. I exactly plan what I want to run and then I run this” (I1)

**Changing a behavioral cognitive element**

To reduce the unpleasant feeling of dissonance, all participants reported situations where they changed their behavior to bring their attitude (the goal) and their behavior in line with each other. For example, one participant increased his running distance, when he had not done enough running the previous days, in order to reach the average running distance for his age group. Other self-tracking users try to improve the pace in the next run if the last run was too slow or they run faster the next kilometer if the last one was not fast enough. Hereby, self-tracking supports this action again because it provides relevant information about the pace, the distance or the average achievements of the relative age group available.

“[…] Then, there is a cinema movie in the evening and you are not in the mood for running in between. And then, the motivation is there to increase the distance the following days to reach the bar [the average achievements for your age group].” (I7)

“If the bar chart was not right I doubled the distance to catch up.” (I7)

“If I have run badly, I try to run better the next time. I reflect on this after the run if it was good or bad and then I do it better the next time.” (I6)

“If I do not reach the goal, it is okay but the next day is always better. […] That is what I have realized […].” (I8)

**Adding new cognitive elements**

Another strategy of dissonance reduction is to add new cognitive elements. A person actively searches for a new cognitive element which brings the two dissonant elements in line with each other. Six participants explain that they search for new information to find out why they have not reached their goal e.g. that there was more important work to do or that they felt unwell. It was also mentioned that this justification helps to admit failure to oneself. This also shows that adding new cognitive elements help to reduce the dissonance.

“There are days when I do not [reach my goal]. I do not know whether this was because I felt unwell or I got up with headaches. Then I can admit it to myself more easily compared to thinking: This should be possible.” (I11)

“If I have not reached the goal, I always reflect on it. Was there a lot of work to do? I start thinking about it.” (I6)

“I then do a short internal analysis. Why was I slower today?” (I12)

“[Not reaching the goal] can happen because of homework or so and then I think, well there were more important things to do”. (I8)

**Changing an environmental cognitive element**

Changing an environmental cognitive element is another strategy that helps to reduce dissonance. Thereby, a person can change e.g. the attitude or deny the situation. Through self-tracking it is more challenging to ignore or deny different performance parameters because the self-tracking tools provide the quantification of the achievements. As 6 participants mentioned self-deception is more difficult through the quantification. The amount of movement, the pace and the burned calories per unit of time are more apparent through the self-quantification.
“Before I had the watch, I thought that I stand up every hour. But when this watch tells you every time you should stand up then you realize that what you thought before had nothing to do with reality.” (I8)

“I think without measuring you run partially slower or faster. A little bit at the whim of yourself. [...] The motivation is different if you quantify yourself because [the app] points out if you are too slow. Then you can betray yourself to a lesser extent and you are more motivated.” (I9)

“The only thing which has shocked me a little bit was that cycling burns reportedly much less calories per unit of time than running. You have to invest much more.” (I10)

“Now I pay more attention to it. Previously, it was like this: I need 6 hours of sleep, ok then I go to bed at midnight and get up at 6 o’clock. This is naturally rubbish because you need 20 minutes to fall asleep [...]. And then you see [with the app] that you have phases of very light sleep in between which it measures as waking up for two minutes or so [...]. And then you know, ok this is a clear self-deception because I slept 5 hours and 15 minutes instead of 6 hours. From this point of view it helps me in this way.” (I3)

“Yes I mean I trust these functions to some degree. I do not think that it is to 100% correct because it cannot calculate everything. Anyway, through this I am more secure. Previously, the thought was maybe more like: Ah this should be enough now. [...] And with this function I cannot betray myself anymore because I know exactly that I have not reached my goal. If I stop after four kilometers, I can see I have not reached it today. Well it has changed, before using the app you have rather betrayed yourself then with these function.” (I11)

However, the tendency to ignore and deny is still not completely eliminated through self-tracking tools. Some people have problems trusting the functions they use.

“Nowadays there are a lot of people who use fitness programs and a colleague of mine told me that he achieved on average 11.000 steps a day last year. Well, either his tool counts clearly more than mine – he has a similar job to mine – or he simply does more sport. But everything is possible because even on days when I run 9 kilometers – this equates to about 8000 steps – so that I achieve in the evening, when I have been in the office before, 11.000. But then I have run 9 kilometers and I cannot imagine that he run 9 kilometers every day.” (I3)

**Conceptual Model**

Our findings support the cognitive dissonance theory as an explanation for different reactions of self-tracking users and show that self-tracking interrelates with the cognitive dissonance theory. In line with the cognitive dissonance theory, our results suggest that people strive for consistency. The awareness of two inconsistent cognitions therefore has a positive effect on cognitive dissonance which is defined as a psychological tension. Our interviewees report e.g. that they are angry with themselves if they do not reach their goal. Hence, we assume that an increase of the awareness of two inconsistent cognition leads to higher cognitive dissonance.

**Proposition P1:** An increase of the awareness of two inconsistent cognitions leads to an increase of cognitive dissonance.

The results of our interviewees also suggest that self-tracking tools lead to a greater awareness of two inconsistent cognitions because the tools provide information which is otherwise not available. Therefore, we assume that the use of self-tracking tools increases the awareness of two inconsistent cognitions.

**Proposition P2:** The use of self-tracking tools leads to a greater awareness of two inconsistent cognitions.

We also found support for cognitive dissonance being experienced as a psychological discomfort which people try to reduce by using different dissonance reduction strategies. One way of dissonance reduction is to change the behavior in order to bring the two inconsistent cognitions in line which each other again. In our data, we found support for the theory that people change their behavior after feeling discomfort for
not reaching their goal. We therefore suggest that an increase in cognitive dissonance leads to a higher degree of behavior change.

**Proposition P3a**: An increase in cognitive dissonance leads to a change of the behavior.

Another dissonance reduction strategy is to add a new cognitive element e.g. new information which aligns the two dissonant elements in a consistent manner and thus reduces cognitive dissonance. We therefore assume that an increase in cognitive dissonance is related to a higher tendency to add new cognitive elements.

**Proposition P3b**: An increase in cognitive dissonance leads to the adding of new cognitive elements.

Furthermore, people can also change a cognitive element of the environment as a dissonance reduction strategy. This means that they can either really change reality or that they ignore or deny the facts. Our interviewees provide support that they have ignored reality e.g. they denied a lack of physical activity or they ignored that cycling is not as effective as running. Therefore, we assume that an increase in cognitive dissonance leads to the change of a cognitive element of the environment.

**Proposition P3c**: An increase in cognitive dissonance leads to changing of an environmental cognitive element.

The interviewees have also reported that the tendency to deny or ignore reality is impeded by the Quantified Self. The fact that the self-tracking tools provide clear information reduces possibilities for self-deception. Despite the fact that there also are participants who doubt that self-tracking tools measure correctly, we assume that the tendency to ignore or deny is reduced through the quantification and provision of information through the self-tracking tools.

**Proposition P4**: The tendency to ignore or deny facts is reduced through self-tracking tools

**Discussion**

The aim of this investigation has been to find out if the cognitive dissonance theory is applicable in a self-tracking context and can explain the different reactions to self-tracking which are mentioned in the Quantified Self literature. The experimental approach which was used so far in social psychology to
support the cognitive dissonance theory has earned a lot of criticism because different explanations for the results are possible. The “New Look” dissonance theory e.g. suggests that dissonance is only incited when an individual feels personally responsible for harming another person (Cooper 2007). Therefore, a qualitative approach was used in this investigation to gain a deeper understanding of the psychological mechanism taking place in a self-tracking context. For this purpose, we conducted interviews with 12 self-tracking users. The detailed results show that people change their behavior or cognition because they want to reach cognitive consistency and not because they have done harm to another person. Besides this deductive approach, we also tried to find out inductively how Quantified Self interrelates with cognition, emotion and behavior. Overall we found support that the cognitive dissonance theory is applicable to a self-tracking context. When people are not able to reach their goal, they feel cognitive dissonance and try to reduce this psychological tension by changing the behavior, adding new cognitive elements or by changing an environmental cognitive element. Furthermore, we found support that self-tracking has a positive influence of the awareness of two inconsistent cognitions and a negative effect on the tendency to ignore or deny (change of a cognitive element of environment).

Also, the findings of previous studies can be explained by the cognitive dissonance theory. For example the four coping strategies of Sjöklint (2015) are in line with the dissonance reduction strategies. The coping strategy disregard which describes the tendency of people to find reasons or excuses if they do not reach their goal conforms with the strategy of adding new cognitive elements where people also try to find new information which reduces the inconsistency of two cognitions. Furthermore, procrastination is related to the strategy of changing a behavioral cognitive element because the person tries to change the behavior in the future. The coping strategies selective attention as well as neglect are in line with the cognitive dissonance strategy of changing an environmental cognitive element. Self-tracking users follow the strategy of selective attention if they only focus on positive self-tracking results and ignore the negative outcomes. The strategy of neglect means that the results are ignored until the self-tracker knows that the goal is reached. Also, the behavior changes, which were found by Bravata et al. (2007), are in line with the dissonance strategy of changing a behavioral cognitive element where people reduce the dissonance by changing the behavior.

Future research could quantitatively test our research model by using surveys or experiments. Furthermore, it should be taken into account whether diverse self-tracking apps interact in a different way with the cognition and emotion of users. A qualitative study could investigate which different applications are the most promising for people with different dissonance reduction strategies.

For the practice, our research gives important insights for the future design of self-tracking technology because it is fundamental to understand how and why users react in different ways and how self-tracking applications interact with these reactions. To facilitate more movement, it is crucial to understand the undesired dissonance reduction strategies to lower the unhealthy reaction of denying or adding cognition.

This research has several limitations. The external validity is limited because we only interviewed 12 self-tracking users. To reduce this problem, we interviewed people who use different tracking tools for different tracking activities. Our sample consists of users with different sport levels and we interviewed students as well as employed people. Furthermore, we only interviewed German self-trackers and self-trackers from other countries could show different reactions to self-tracking. However, since our findings are in line with Sjöklint et al. (2015) who interviewed Danish, Swedish and English self-trackers we assume that this issue is negligible.

This study contributes to the body of knowledge by suggesting an explanation for the different reactions of self-tracking users. Furthermore, we give further support to the cognitive dissonance theory which was tested in social psychology through experiments. This approach was criticized because the experimental findings are also explainable with other theories. The qualitative study in contrast, is able to provide a more detailed analysis and answer how and why questions. An explanation how self-tracking interacts with cognition, emotion and behavior is also provided in this investigation. Self-tracking applications lead to a greater awareness of two inconsistent cognitions and reduce the tendency to change a cognitive element of the environment.
REFERENCES


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