Unravelling the complex relationship between a user and technology in the activity tracking domain

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Preface

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Abstract

In the domain of activity tracking, a complex interplay of emotional and rational reactions is evoked by an activity tracker. In order to fulfil the technology's full potential and to support for physical activity, a better understanding of this complex interplay is needed. This thesis extends on the complex relationship between a user and technology in the activity tracking domain. Because of this complex interplay it is difficult to determine how a good relationship between the user and the tracker is established. By gaining more insights into the effect of the role that a user perceives of their activity tracker on the perceived user-tracker relationship, a contribution is made to enhance our understanding of relational, experiential and emotional responses to activity trackers and to help close the knowledge gap regarding possible relationships that users build with their devices. Three different roles that participants perceived of their activity trackers were identified: (1) 'boss and manager, (2) 'friend and mentor' and (3) 'tool'. It was shown that the perceived activity tracker role of 'friend and mentor' has a positive effect on the total user-tracker relationship as well as on the relationship constructs of commitment, closeness and complementarity. The relationship construct of commitment was positively related to commitment to activity tracking in general so when an activity tracker is perceived as 'friend and mentor', people generally are committed activity tracking. This, in turn, increases the chance that the technology's full potential can be reached and users optimally benefit from using their activity tracker.

Keywords: activity tracking, user-tracker relationship, commitment, tracker role

Introduction

Over the past decades, obesity has been a problem that has grown tremendously. Obesity is defined as having a body mass index of over 30 kg/m3 (Rapp et al., 2005). It is a worldwide problem which increases the risks of cardiovascular diseases and certain types of cancer and it is also associated with risk of premature death (Adams et al., 2006). Furthermore, obesity has been linked to higher mortality rates for people infected with the H1N1 influenza virus or the current COVID-19 virus pandemic since obesity negatively impacts pulmonary functions (Dietz & Santos-Burgoa, 2020). From 1980 to 2014, obesity rates have tripled (Pineda et al., 2018) and a recent study has predicted an even further increase in obesity, leading to a shocking 37% of obesity amongst the Scottish population in 2025 (Pineda et al., 2018). For the Netherlands, a percentage of 14% obesity was predicted by Pineda et al. (2018), which would mean a small increase in the next couple of years. A lack of physical exercise is one of the factors contributing to the so called “obesity epidemic” (Tudor-Locke, 2002).

Also for people that are not in risk of obesity, physical exercise is important since it helps people stay healthy, helps prevent health issues and lower back pains (Biddle & Fox, 1989) and mental health can be improved by low- or moderate-intensity activity (Weyerer & Kupfer, 1994). Especially during the COVID-19 pandemic when people all over the world are forced to say at home and work from home, these benefits of physical exercise are important and people should stay active. However, when offices, schools, restaurants, shops and sports facilities are closed, some support for physical exercise is needed in many cases.

A technology that is very well suited for support of physical activity are wearable sensors, or trackers. This technology increases possibilities for tracking daily life activities as well as vital body signs like heart rate and is at the origin of a patient-driven healthcare information systems (HIS) trend (Gimpel et al., 2013). Two main approaches of using health trackers exist; professional approaches with healthcare professionals advising and monitoring

on health data and health, or users can start tracking themselves (Gimpel et al., 2013). Healthcare is defined as "efforts made to maintain or restore physical, mental, or emotional well-being especially by trained and licensed professionals —usually hyphenated when used attributively" in the dictionary (*Health Care | Definition of Health Care by Merriam-Webster*, n.d.). However, this definition of healthcare is now changing because of the self-tracking trend where patients track their own health without interference of professionals (Gimpel et al., 2013). Self-tracking can vary from activity tracking to financial tracking or tracking sleep patterns and it may help the user to better understand behavior in daily life (Li et al., 2010). Furthermore, engaging in self-tracking was found to encourage the development of healthy eating patterns (Orji et al., 2012), increase physical activity (Bravata et al., 2007; Tudor-Locke & Bassett, 2004), adopt to better sleeping rhythms (Kim et al., 2008) and lead users to reflect on their everyday patterns (Li et al., 2010) which makes users more aware of their health. In this study, the activity tracking part of self-tracking is of particular interest.

To benefit from health tracking for improving health, an optimal user experience and user engagement or commitment needs to be designed as the health tracking systems that require much effort on the user's side are less likely to be successfully adopted (Fritz et al., 2014). Optimizing user experience can increase chances on commitment to self-tracking and a positive attitude towards the tracking device and it can be done by either technological improvements (e.g. faster processing of data, better measurement hardware, etc.) or by optimizing emotional or experiential responses to the technology and improving self-trackers based on the outcomes of such research. Optimizing emotional or experiential responses to self-trackers involves the social roles that self-tracking devices may have. Lyall and Robards (2018) argue that the role of the device seems to extend beyond the role of a functional tool (e.g. use for information or data collection alone) and social dynamics of the interaction with the device become important as well. The emotional or experiential responses to these social

dynamics with self-trackers can be described by the perceived relationship between the user and their tracker (Hancı et al., 2019; Jowett & Ntoumanis, 2004).

Although it might seem easy to simply study emotional responses to activity trackers and improve the technology accordingly, it is important to note that a user's experience regarding such a tracking device is highly dependent on many different factors (e.g. commitment or engagement, motivation, wellbeing, autonomy, the role of an activity tracker) that are difficult to unravel. Besides that, these factors are difficult to control, identify and classify. Peters, Calvo and Ryan (2018) even refer to factors of engagement, motivation and wellbeing in technology as a black box. Furthermore, as Attig and Franke (2019) note, previous research has identified many different reasons for people to stop using self-trackers but only little is known about the details of these reasons to stop and why the perceived relationship between the user and their tracker might fail.

We need to keep in mind that in the domain of self-tracking, a complex interplay of emotional and rational reactions is evoked by the tracking device (Sjoklint et al., 2015). For example the role that people perceive of their activity tracker might affect the user's experience, which in turn affects the relationship between a tracker and its user. Furthermore, the user's motivation for a user to engage in activity tracking might be an important determinant for the effect of the perceived role of an activity tracker in this relationship. However, because of this complex interplay of emotional and rational reactions to activity trackers it is very difficult to determine how a good relationship between the user and the tracker can be established. A better understanding of this relationship can help to improve the technology in order to fulfill the technology's full potential and to ensure users stay engaged in the long term.

This thesis will extend on the complex connection between different roles that an activity tracker can fulfill and the relationship between a tracker and its user for different motivations to engage in activity tracking. An important notion for this connection is that it is

not the technology that matters, but its relationship to humans (Weiser & Brown, 1997). As a consequence of the intimacy of wearing an activity tracker on the body and for most part of daily life and the privacy sensitive nature of data that is collected, a relationship between a user and their tracker is formed (Hancı et al., 2019). Hancı et al. (2019) have explored a possible psychological relationship between the user and the self-tracker that might evolve as a consequence of the intimacy of the interaction with self-tracking devices. In this explorative study, it was found that users actually reported feelings of established relationships with the trackers after using it. The device was described as a close and helpful friend when numerical feedback from the tracker was provided in comparison to those who did not receive the numbers. The study by Hancı et al. (2019) focused on the relationship that users build with their tracking devices in general and with regards to receiving or not receiving numerical feedback. However, this study only was a first exploration of the relationship that users build with their devices. How this relationship is established, which factors affect the perceived relationship and what kind of relationships is developed remains unclear.

Existing knowledge gaps in the activity tracking domain could be bridged by looking at the sports domain. The knowledge gap that is of main interest in this thesis regards the relationship that users build with their devices. The relationship between an athlete and their trainer is crucial for physical as well as psychosocial development and it is a key factor to successful outcomes in coaching (Jowett, 2009; Jowett & Ntoumanis, 2004). Looking at the trainer-athlete relationship in the sports domain is relevant since it might provide a basic understanding of the tracker-user relationship in the activity tracking domain. Furthermore, the assumption that phenomena of roles, motivation and relationship with activity trackers can be inspired on phenomena in the sports domain is theoretically supported by the CASA paradigm of Reeves and Nass's (1996) media-equation theory, stating that social heuristics of

interpersonal relationships in human-human interaction are also witnessed in human-computer interaction.

In the next sections, background literature on motivational role attribution and the trainer-athlete relationship in the sports domain is introduced. After that, the concepts of motivation and activity tracker roles will be discussed in more detail and a two-dimensional model that can help in unraveling the complex relationship between a user and technology in the activity tracking domain is introduced.

Background Literature

A substantial part of literature regarding self-tracking is dedicated to the impact of tracking on behavioral changes, like changes in activity levels when feedback is or is not provided. Not a lot of research has been conducted regarding emotional, experiential and relational responses to tracking devices, users' commitment with trackers or users' perceptions of the self-tracking device (Gouveia et al., 2015; Hancı et al., 2020; Hancı et al., 2019; Yoo, 2010). According to Peters et al. (2018) the fact that not a lot of research has been conducted regarding experiences of technology might be due to the difficulty of explaining a person's needs in the context of Human-Technology Interaction. As Peters et al. (2018) state: "There are many constructs that describe the positive elements of human psychological experience (serendipity, fun, praise, gratitude, etc.) and any of these can be very useful to design for ideation and insight." (Peters et al., 2018, p. 3). Yoo (2010) states that "technology is not being interpreted, nor is it being experienced as an end in itself. Instead, it directly shapes and occasionally transforms our lived experience (p.218)" and he calls for research on experiential effects of technology. Such experiential effects in the activity tracking domain are the factors that influence the relationship between the user and the tracker, like motivation to engage in activity tracking and the role that people perceive of their activity.

Motivation is important in the field of psychology and experiential research because, as Ryan and Deci (2000) frame it, “motivation produces”. Besides that, the role that people perceive of their activity tracker (e.g. being a coach, supportive friend, advisor, tool or toy) might influence the motivation of a user to engage in activity tracking. For this reason, background literature on motivation and role attribution is introduced in this section. The motivation of the user and the role that people perceive of their activity tracker might also influence the relationship between a user and a tracker, but as already mentioned, how this relationship is established and which factors exactly affect the perceived relationship remains unclear. Therefore, the trainer-athlete relationship in the sports domain and the effect of a coach’s role on this relationship are also explained in this background literature chapter. Gaining more knowledge about motivations and reasons to engage in activity tracking, commitment to activity tracking, the trainer-athlete relationship in the sports domain, and possible coaching roles within this relationship can help unravel the complex interplay of different factors that influence the relationship between users and their activity trackers.

Self-Determination Theory. People can be motivated to engage in certain behaviors for which the underlying motives come from either internal or external sources. Self-motivation and self-regulation are two of the many psychological phenomena that can be explained by self-determination theory (SDT). Ryan and Deci (2000) state that "the self-determination theory arena is the investigation of people's inherent growth tendencies and innate psychological needs that are the basis for their self-motivation and personality integration, as well as for the conditions that foster those positive processes.” (Ryan & Deci, 2000, p. 1). The innate psychological needs that are referred to are feelings of competence, autonomy and relatedness. Competence is represented by the feeling and confidence of people that they have the abilities to perform certain actions or reach certain goals (Wagner & Morse, 1975; White, 1963). Relatedness can be described in terms of attachment and relationships and is a person’s

need or desire to feel connected to others or belonging (Deci, 1975). And finally, autonomy refers to feeling of being autonomous or independent and having the power to decide on own behavior and goals (Ryan et al., 1995). In the work of Niess et al. (2018), autonomy was one of the terms used to describe the role of a digital companion, where the roles were either active or passive. It affects how a digital companion is perceived and how it motivates its user.

Types of motivation. SDT considers perceived forces that motivate people to behave in specific ways and consequently identifies several main types of motivation (amotivation, intrinsic and extrinsic motivation, Ryan & Deci, 2000). All types of motivation have specific characteristics in terms of personal experience, well-being, performance, learning and origin. Amotivation is irrelevant in the context of this thesis since research will be conducted with people who engage in activity tracking and do not lack the intention to act. The other two types of motivation can be subdivided in several regulatory styles: external regulation, introjected regulation, identified regulation, integrated regulation and intrinsic regulation (Ryan & Deci, 2000). The SDT continuum showing types of motivation and the regulatory styles is shown in Figure 1. These regulatory styles range on a continuum between non-self-determined and self-determined motivation. Intrinsic, integrated and identified regulation together form a sub-category of motivation called autonomous or internal motivation (Teixeira et al., 2012) When a person has high levels of intrinsic, integrated or identified regulation, their motivation for engaging in a certain behavior is voluntary and without a lot of external pressure (Pelletier et al., 2013). For individuals that are autonomously motivated, higher levels of concentration, better performance and higher levels of persistence were reported (Mageau & Vallerand, 2003). Introjected and external regulation form a sub-category of controlled or external motivation (Teixeira et al., 2012). When a person has a high level of controlled motivation, it is likely that they engage in activity tracking because of external influences like gaining rewards or being

pushed. In the SDT continuum shown in Figure 1, these internal and external (or autonomous and controlled) sub-categories are called the perceived locus of causality.

For individuals engaging in sports, long term engagement or commitment to physical activity is considered to be influenced by the motivation to improve performance (Gavin, McBrearty, Malo, Abravanel, & Moudrakovski, 2016). This motivation to improve performance is a sense of self-efficacy; the mastery of experiences (Bandura, 1994). When an individual tries to master their experiences, but fails, the sense of self-efficacy and the chance of long term engagement decrease when they are not intrinsically motivated. According to Gavin et al. (2016), commitment to sports and physical activity originates from intrinsic motivation instead of it being an action originating from extrinsic motivation.

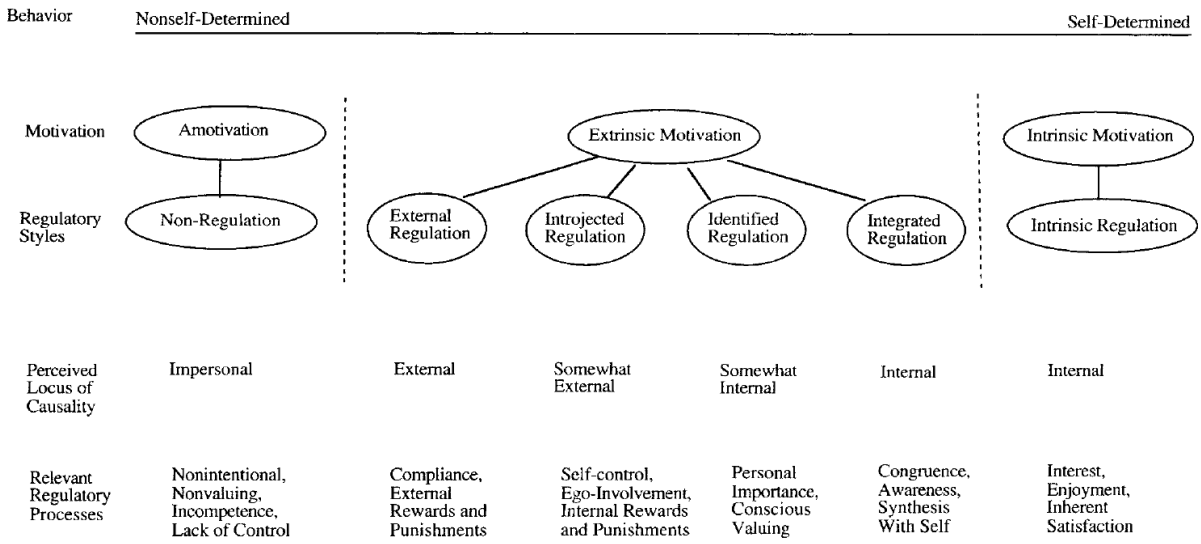

Figure 1. SDT continuum showing types of motivation, the regulatory styles, the perceived locus of causality and the relevant regulatory processes. Retrieved from Ryan and Deci (2000).

Reasons for self-tracking. Using the SDT continuum as a framework, it is logical to assume that users have different reasons for using self-tracking technologies which can range from fully internal to fully external reasons. This leads to certain behaviors and levels of commitment to self-tracking. People are different in their behaviors and it is difficult to reveal a person's motivation for specific behavior since people find it hard to explain what their motivation for certain behavior is. Therefore, reasons for people to engage in specific behaviors

should be identified. By examining these reasons, the motivation to engage in that behavior can be inferred and by doing that, the motivation of a person to engage in activity tracking can be revealed without directly asking for it.

In the activity tracking domain, a study that includes both intrinsic and extrinsic motivation as well as reasons that people give for why they use trackers is the study by Li et al. (2010). This study reported that the reasons that participants gave are related to the following matters: (1) "trigger events" like sleep problems, obesity or other health problems, (2) an interest in experimenting with new technology, (3) an interest in data and numbers, (4) curiosity about what this data might show, or (5) suggestions from other people (Li et al., 2010). Such trigger events are different for every individual, but important trigger events might be the same for groups of people with similar motivations to engage in activity tracking.

An analysis based on this study outlines five different modes of self-tracking: private, communal, pushed, imposed and exploited (Lupton, 2014). The private self-tracking mode is purely intrinsically motivated. Communal self-tracking is a mode of tracking where motivation results from being part of a community. Pushed, imposed and exploited self-tracking are modes of self-tracking that purely result from external regulation. Exploited self-tracking refers to a mode of self-tracking where an individual's personal data is used for the (often commercial) benefit of others. The individuals do not benefit from it at all but only engage in it, for example as a part of a loyalty program and to earn rewards. Pushed self-tracking and imposed self-tracking are both encouraged by others but the main difference is that in pushed self-tracking, the individual engages in self-tracking voluntarily and also benefits from it. In imposed self-tracking, mostly the external party benefits from it. By asking questions belonging to each of these identified modes of self-tracking, motivations of people for engaging in self-tracking could be revealed. However, the modes proposed by Lupton (2014) do not cover all of the previously mentioned motivations for behavior.

For this reason the study by Rooksby et al. (2014) that covers reasons that people give for why they use self-trackers is also considered. In their study, they propose categories that encompass reasons why people engage in self-tracking. However, they do not refer to it as modes but as styles of personal tracking. The five styles that are proposed are directive tracking, documentary tracking, collecting rewards, diagnostic tracking, and fetishized tracking.

Directive tracking is the most goal-oriented approach of these five tracking styles. Many people that engage in this style of self-tracking have a goal of losing weight or having higher activity levels. Their motivation is extrinsic but still mostly internal and so this self-tracking style corresponds to SDT's integrated regulation. Sometimes people did not have clear goals of changing behavior, but just were interested in documenting their activities or sometimes the documentation of the activities was used to obtain information about daily life and to improve daily life. The documentary tracking style and corresponds to purely intrinsic motivations and documentary tracking also overlaps with Lupton's (2014) mode of private self-tracking. This is only self-determined behavior. The tracking style of collecting rewards is aimed at documenting activities for gaining achievements or rewards and belongs in the category of introjected regulation since reasons for this behavior are influenced externally but incorporates ego-involvement. Lupton's (2014) mode of communal self-tracking also belongs in this category since people who engage in activity tracking to be part of a community also do it for themselves but also to a large extent for others. A fourth tracking style that Rooksby et al. (2014) mention is diagnostic tracking. This is aimed at looking for a link between two things, for example physical activity during the day and the quality of sleep during the night. Diagnostic tracking corresponds to some extend to identified regulation, but the reason why people are looking for a connection may be external. Finally, Rooksby et al. (2014) mention fetishized tracking. Some of their participants engaged in self-tracking just for the sake of interest in gadgets and technology; for example because it looks cool. None of previously

mentioned motives or motivations clearly corresponds with this tracking style. Furthermore, it is expected that fetishized tracking hardly ever is the main motivation for people to engage in self-tracking and therefore this tracking style will not be considered.

Commitment to self-tracking. Motivation and reasons for a behavior in itself do not require action. The motivation of a person to engage in a certain behavior is an inner psychological state, as Sheeran and Webb (2016) describe it. Commitment, on the other hand, can be seen as a consequence of the motivation. A user's commitment to self-tracking is defined as the dedication that the user has to the self-tracking activity. A committed user generally puts in extra effort in self-tracking. Furthermore, when an individual tries to master their experiences, but fails, the sense of self-efficacy and the commitment to the behavior decreases when the individual is not intrinsically motivated (Bandura, 1994). According to Gavin et al. (2016), commitment in sports and physical activity originates from intrinsic motivation instead of it being an action originating from extrinsic motivation. Since this is the case in the sports domain and it results from literature about human behavior in general as well, it is likely that the same effects of motivation to engage are found in the domain of activity trackers and physical activity. Although commitment to self-tracking clearly relates to motivation to engage in self-tracking, it is important to note that a one-to-one comparison cannot be made since being a committed user is related to more than just internal states and drives of a user (Hancı et al., 2020). Furthermore, it is uncertain how commitment to self-tracking affects the relationship between the user and the tracker. Again, it is clear that the relationship and the interaction between a user and a self-tracker is very complex but knowledge gaps about the tracker-user relationship could be bridged by looking at the trainer-athlete relationship in the sports domain.

Coaching roles. Given the different reasons why people engage in self-tracking and the broad range of capabilities of self-tracking devices, it is possible that users attribute a certain

role to their activity tracker the same way they attribute roles to their sports trainer as suggested by the CASA paradigm of Reeves and Nass's (1996) media-equation theory. The sports trainer is the person with the coaching role in a trainer-athlete relationship and the role that the trainer adopts could have a lot of impact on the relationship between the athlete and the trainer (Short & Short, 2005). A good trainer should be able to motivate their athlete, have the same goals and long-term engagement (commitment) and have a broad set of skills like: communicating, knowing when to be strict, knowing when to be active and take control (complementarity) and knowing when to keep or not keep some distance from the athlete (closeness). A combination of how a trainer puts these coaching skills into practice defines the role of a trainer (Short & Short, 2005).

Short and Short (2005) define five different roles in the sports domain of coaching and relationships with the trainer namely: (1) organizer, (2) competitor, (3) teacher, (4) learner and (5) friend and mentor. The roles of organizer and competitor are related to training and competition. As an organizer, the coach makes a schedule and planning but also arranges transportation for athletes. The coaching role of competitor involves all the mental and physical actions during a competition day. In a coaching role of teacher, the athlete or user is also coached mentally. This role is more related to the knowledge of the trainer and teaching the user than the actual behavior of the trainer, while in the role of a trainer as learner it is the other way around and a trainer wants to keep learning to improve. Finally, the role of friend and mentor is aimed at improving the personal bond between the trainer and the athlete and to improve the athlete’s life inside as well as outside the sport. It is aimed at guiding the athlete. Identifying such coaching roles is relevant since it helps raise awareness about the way the trainer and the athlete interact and it could affect the trainer-athlete relationship.

Sports domain extended into activity tracking domain. The coaching roles proposed by Short and Short (2005) can be extended to the domain of activity trackers. Short and Short's

(2005) first two coaching roles of organizer and competitor are less relevant in the domain of activity tracking since an activity tracker in daily life does not have to provide coaching during competitions and transportation or sponsorship. Furthermore, the role of learner is not relevant since the activity tracker does not learn from the user. An application of a teacher role in an activity tracker would be giving daily tips about activity levels. When an activity tracker adopts the role of friend and mentor, the role is aimed at guiding the user in the tracking goals they have and in their daily life.

The trainer-athlete relationship. From the sports domain it is clear that the effect that a trainer has on the performance of the athlete is vast. The nature of the relationship between an athlete and their trainer can be identified by a set of concepts. These concepts are closeness, complementarity and commitment (Jowett & Ntoumanis, 2004).

The perception of closeness can be defined in many ways, for example in terms of emotional feelings like trust, feeling of being valued and shared goals but also in terms of proximity like time and activities spent together (Berscheid et al., 1989; LaVoi, 2007). The construct of complementarity refers to how trainer and athlete are able to channel their efforts in order to reach the goals they set. The construct of commitment is defined as "Coaches' and athletes' intention to maintain their athletic relationship and implies the athletic dyad's cognitive orientations for the future" (Jowett & Ntoumanis, 2004, p.249). Besides providing an insight into the nature of the relationship, the constructs of closeness, commitment, and complementarity are also associated with interpersonal satisfaction in a theoretically meaningful way (Jowett & Ntoumanis, 2004).

Sports domain extended into activity tracking domain. Besides the coaching roles introduced in the previous section, the trainer-athlete relationship can also be extended into the activity tracking domain. Given that these devices are known as e-coaches that help users to be more active, it is possible that each of the three relationship constructs can be applied to the

relationship between a user and their tracker. In the interaction between a user and an activity tracker, a certain level of intimacy is experienced with self-tracking devices, which relates to the construct of closeness. The way a tracker's software and a user's behavior are complementary are part of the user experience. If and how users stay engaged in the long term refers to the third construct, commitment. The three concepts combined indicate whether the relationship between the user and the tracker is strong or weak.

Commitment and the trainer-athlete relationship. As explained earlier, commitment to physical activity is affected by the type of motivation (Gavin et al., 2016). Apart from an effect on commitment to a behavior like physical activity itself, the effects of motivation also influence an athlete's commitment to the trainer-athlete dyad (Adie & Jowett, 2010; Jowett et al., 2017). An athlete's commitment to the trainer determines part of the trainer-athlete relationship. Adie and Jowett (2010) found that intrinsic motivation and self-determined extrinsic motivation (autonomous motivation) are positively correlated with the relationship constructs of complementarity and closeness that determine the perceived strength of the trainer-athlete relationship. Reported effects of non-self-determined (controlled) motivation on the trainer-athlete relationship were not found in existing literature. Although the research by Gavin et al. (2016) implies that intrinsic motivation is positively correlated with commitment to physical activity as well, Adie and Jowett (2010) state that an athlete's perception of commitment in the trainer-athlete relationship is not positively correlated with intrinsic motivation. However, the commitment to a behavior like physical activity and the commitment in the trainer-athlete relationship are slightly different concepts. Once again, the contradictory research findings nonetheless indicate that the trainer-athlete relationship is very complex.

Sports domain extended into activity tracking domain. Research in the sports domain has shown that if an athlete is intrinsically or extrinsically motivated, the perceived relationship constructs of complementarity and closeness are likely to be high as well. Since this is the case

in the sports domain, it is likely that the same effects of motivation on the relationship between a user and a tracker are found in the domain of activity trackers. However, it still remains unclear how each type of motivation affects the relationship between a user and a tracker exactly. Furthermore, reported effects of non-self-determined (controlled) motivation on the trainer-athlete relationship were not found in existing literature. Since controlled motivation has less positive effects on performance, persistence and concentration than autonomous motivation (Mageau & Vallerand, 2003) it could be that it also has less positive effects on the trainer-athlete or user-tracker relationship.

Coaching and the trainer-athlete relationship. Only a few studies have examined the relationship between the athlete and the trainer in combination with possible coaching roles of the trainer. As already mentioned, Short and Short (2005) state that the role that the trainer adopts could have a lot of impact on the relationship between the athlete and the trainer. They found that the roles of teacher, learner, organizer and competitor did not impact the trainer-athlete relationship to a high extent. In the role of friend and mentor, a trainer develops a strong relationship with the athlete or user (Short & Short, 2005). A comparable study that also combines coaching roles with the three relationship constructs (closeness, commitment and complementarity) is the study by Jowett, Nicolas and Yang (2017). In their study, a set of coaching behaviors for sports are compared to each of the three relationship constructs to see if there is a connection between them and to see if the trainer-athlete relationship can predict how an athlete perceives the role of their coach. In the study of Jowett, Nicolas and Yang (2017), the following coach behavior categories are compared to the three relationship constructs (closeness, commitment and complementarity): (1) physical skills and planning, (2) technical skills, (3) mental preparations, (4) goal setting, (5) competition strategy, (6) positive personal report and (7) negative personal report. These coach behaviors originate from the Coach Behaviors Scale for Sports (CBS-S) which is a research tool that provides more insight

in coach's behaviors (Côté et al., 1999). CBS-S consists of 37 items describing the beforementioned coach behaviors. No CBS-S items were linked to the competition strategy coach behavior but since competition strategies are not relevant in the context of this thesis, this coach behavior was not reported.

The CBS-S items corresponding to the coach behavior categories are shown in the table in Appendix A. The table in Appendix A also shows the corresponding relationship path coefficients (retrieved from Jowett, Nicolas and Yang, 2017) that indicate the correlation between the relationship constructs and the specific coach behavior categories. All of the relationship path coefficients for the total relationship score are positive, meaning that a higher score on the coach behavior (more clearly this type of behavior) corresponds to a higher (more positive) relationship score.

Negative personal report. One of the coach behavior categories from CBS-S and Jowett, Nicolas and Yang (2017) is negative personal report. For the coach behavior category of negative personal report, the path coefficient for the total relationship score as retrieved from research by Jowett, Nicolas and Yang (2017) is lowest of all coach behavior categories (relationship path coefficient of 0.11). Negative personal report is mostly predicted by closeness (relationship path coefficient of -0.33 compared to 0.02 for complementarity and 0.04 for commitment) and the path coefficient of the relationship construct of closeness is even negative, indicating that closeness is perceived as less when negative personal report is scored higher.

Technical skills. The coach behavior category of technical skills predicts the relationship score most according to the findings by Jowett, Nicolas and Yang (2017). The category of technical skills consists of the coach providing specific feedback, feedback on technique, reinforcement, cues, demonstrations, immediate feedback and the coach asking questions and using examples, and these behaviors affect the trainer-athlete relationship to a

high extent. However, the behaviors corresponding to the categories of physical skills and planning, goal setting and positive personal report also affect the trainer-athlete relationship to a relatively high extent.

Physical skills and planning. The coach behavior of physical skills and planning consists of the coach making a detailed program, plan for physical preparations, coordinating training, coordinating competition, providing structured sessions and providing confidence in the program. These are all very practical skills. The path coefficient for the effect of physical skills and planning on the total relationship is almost equal to the path coefficients for the effects of goal setting and positive personal report. However, the relationship score on complementarity is affected negatively by the coach behavior of physical skills and planning since the path coefficient for this relationship construct is negative.

Goal setting. The relationship score on complementarity is also affected negatively by the coach behavior of goal setting since the path coefficient for this relationship construct is negative as well. When coach behavior includes goal setting, the relationship constructs of closeness and commitment on the other hand are both positively affected to a relatively large extent. The path coefficient for the total relationship score is positive with the coach behavior of goal setting.

Positive personal report. The total relationship score is also positive for the coach behavior of positive personal report. The path coefficients for coach behaviors of goalsetting and positive personal report are the same but for the coach behavior of positive personal report, none of the individual relationship constructs are affected negatively and the path coefficient for the construct of complementarity is high. The table in Appendix A indicates that scores on closeness and commitment predict most of the scores on coach behaviors and that complementarity only predicts positive personal rapport.

Mental preparations. For the coach behavior category of mental preparations, the effect on the total relationship score is positive, but the path coefficient is relatively low (relationship path coefficient of 0.20) in comparison to the path coefficients for the other coach behavior categories. This indicates that the coach behavior of mental preparations does not affect the total relationship score to a very high extent. However, the path coefficient for the relationship construct of commitment is relatively high and the path coefficient for the relationship construct of complementarity is low. So when coach behavior includes mental preparations, the perceived commitment is affected relatively much and complementarity is almost not affected at all.

Sports domain extended into activity tracking domain. Jowett et al.'s (2017) coaching behavior categories include organization, competition and training components. And although these mostly overlap with Short and Short's (2005) coaching roles of organizer and competitor, which are less relevant in the activity tracking domain than in the sports domain, the findings of the study can still be used to examine the connection between coaching roles and the relationship between a user and a tracker in the activity tracking domain by using the CBS-S items with coach behavior descriptions and the linked relationship path coefficients.

Revealing People's Motivations

In the domain of self-tracking, the different possible motivations for people to engage in self-tracking can provide an insight in the different possible outcomes in terms of the perceived relationship between the user and the tracker. Jowett and Ntoumanis (2004) conducted research on the coach-athlete, or trainer-athlete, relationship in the sports domain and suggest future research questions such as "does the nature of coach–athlete relationship affect the manner in which the motivational climate is perceived or vice versa?" and "does the coach–athlete relationship affect, or is it affected by coaches' and athletes' motivational and

confidence levels?". The modes, styles and reasons for engaging in activity tracking that were introduced in the background literature can be linked to a main motivation to engage in activity tracking but a clear overview is lacking.

Table 1 shows an overview of the literature review on different styles and modes of self-tracking for different possible motivations to engage in self-tracking. By asking questions corresponding to the modes proposed by Lupton (2014) and the styles proposed by Rooksby et al. (2014) and analyzing people's answers, the motivation for people to engage in activity tracking can be discovered. The right column in Table 1 shows key terms that may hint towards a specific motivation to engage in self-tracking, based on descriptions of SDT's motivations (Ryan & Deci, 2000) and findings and statements from the studies of Lupton (2014), Rooksby et al. (2014) and Li et al. (2010). Keep in mind that the key terms as well as tracking styles or modes can overlap. By examining which of these key terms occurs most often in a content analysis, a person's main motivation to engage in self-tracking can be revealed.

The motivation to engage in activity tracking might not only affect the relationship between a user and their tracker but it might also influence the perception of the role of an activity tracker is perceived. In the next section, the different possible roles of activity trackers that were identified by other researchers and the activity tracker roles that will be used in this thesis are explained.

Table 1. *Overview of SDT's motivation categories, regulatory styles and corresponding tracking styles or modes with key terms that may hint towards a specific style.*

SDT's motivation and regulatory styles		**Corresponding tracking style or mode**	**Key terms**
Intrinsic	Intrinsic regulation	Documentary tracking and/ or private self-tracking	Interest, compare, document, information, data collection, lifestyle, experiment, private, personal
Extrinsic	Integrated regulation	Directive tracking	Goal, health, lifestyle
	Identified regulation	Diagnostic tracking	Link, connection, health, illness, sleep, diagnose, doctor, problem
	Introjected regulation	Communal self-tracking and/ or collecting rewards	Together, social, community, engage, share, belong, compete, show, prove, achieve, reward
	External regulation	Pushed, exploited and/ or imposed self-tracking	Others, extrinsic, encouraged, persuaded, help, obliged, forced, reward, pressure, punished

Activity Tracker Roles

In the section on coaching roles, it was stated that the role of a trainer is defined by how a trainer puts their skills into practice and this could also be applicable to for the role of activity trackers. Recently, an article has been published in which psychological qualities of digital companions were examined. In this study by Niess et al. (2018), one of the findings was that a digital companion can be described in terms of a spectrum ranging from active to passive roles. Even though the research was focused on digital companions, which is not the same as activity trackers, the use and possible interaction approach of both technologies is somewhat similar. Furthermore, the article claims that the way participants in a focus group talked about their digital companions and the relation they built with it depended on the active (actively starting interaction with the user) or passive (waiting to be called for assistance) role that the product

played and was independent of the product category. Passive companions were described in terms of caring, empathetic, cautious and subdominant. Active companions were described in terms of innovative, dominant, proactive and independent (Niess et al., 2018). Besides that, people reported feelings of decreased autonomy and being under surveillance in the latter group. Although the terms used to describe the passive or active role seem to be positive and negative relatively, a clear preference in the applied approach was not reported.

Weiser and Brown (1997) mention that in interaction with technology, it is not the technology that matters, but its relationship to humans. A study that considers the relationship to humans is one that examines how wearable activity trackers makes their owners feel (Lyall & Robards, 2018). Lyall and Robarts (2018) approached the relationship between a user and their tracker from a different angle and distuinguish three distinct roles of activity trackers; tool, toy and tutor. The role of an activity tracker as a tool is that it is helpful and used for the enhancement of tracking to improve daily life. This role is mentioned as a cause for a satisfying relation between the tracker and the user. Lyall and Robards (2018) mention that participants felt like “a lived experience” was supported by the tracker in the role of tool. When the activity tracker is more seen as a toy, it is not seen as something that is needed but more as something that is desired. Key terms are “fun” and “play” and a reward system works well for technologies that adopt the role of toy. And finally, in the role of tutor an activity tracker is seen as a coach or guide. Especially in this role, long term user engagement is important and therefore the “tutor” has to create a reciprocal relationship with the user.

Short and Short’s (2005) previously introduced role of friend and mentor overlaps with the role of technology as a tutor although it might also, to some extent, overlap with the role of technology as a toy due to the “friend” part or the role. However, these roles are still quite distinct since a tool can be seen as a novelty, light-hearted and not serious while a friend isn’t. Furthermore, Niess et al. (2018) mentioned roles of friend, advisor, teacher and coach that also

overlap with roles in an trainer-athlete relationship. Short and Short's (2005) role of teacher also is categorized together with coach-tutor since these three roles are all aimed at personal coaching and development. The role of advisor identified by Niess et al. (2018) is also used as an expected distinct category in this thesis since the traits used to describe this role are different from the traits that are used to describe previously mentioned roles. The role of advisor is comparable to the coach-tutor-teacher role, but can also be negative in terms of coaching. And finally, the role of a tool is also added as a distinct category. This role is more functional than the other identified roles.

Table 2 provides an overview of all of the different roles that were identified by other researchers. Every role can be identified by a specific set of traits. However, an approach that allows for differentiation of an activity tracker on a set of traits is needed. Furthermore, a conceptualization or a model is needed to map these sets of traits, which can be provided by means of a two-dimensional model. Such a model is presented later in this thesis.

Table 2. *Overview of different roles identified in previous research*

Niess et al. (2018)	Short & Short (2005)	Lyall and Robards (2018)
Advisor Fast, stepwise, instant, constant, direct, spatial proximity, precise, powerful, targeted, covered, active		
Coach	**Teacher** Knowledge related, mental coaching, coaching role, different from friend	**Tutor** Instructive, lifestyle, "everyday domestic discipline", guide, teacher
Friend Stepwise, instant, modest, constant, direct, spatial proximity, precise, gentle, targeted, apparent	**Friend and mentor** Friendly, close relationship, support, emotional, guide, coaching	
		Toy Fun, play, novelty, light-hearted, not serious, friendly
	Learner (N/A)	
		Tool Functional, useful, optional, means to an end, informative
	Organizer (N/A)	
	Competitor (N/A)	

Activity Tracker Roles and Relationship.

The identified roles of advisor, coach-tutor-teacher, friend and mentor, toy and tool are roles that are relevant in the content of this thesis and these roles can be linked to the coach behavior or skill descriptions that were introduced in the table in Appendix A. The CBS-S (Côté et al., 1999) items and Jowett, Nicolas and Yang's (2017) coach behavior categories that are originally from the sports domain can be extended into the activity tracking domain. By linking the activity tracker roles from Table 2 to CBS-S items from the table in Appendix A, an expectation about the effect of possible activity tracker roles on the relationship between a user and a tracker can be formed. The expectations of the effect of each previously introduced possible activity tracker role on the user-tracker relationship are further explained next.

Advisor. In the role of an advisor, the tracking device gives feedback, helps set goals and monitors progress but it is not necessarily friendly or positive as it can be tough and strict. Therefore, the coach behavior categories of mental preparations, technical skills, goal setting and negative personal report can be linked to the activity tracker's role of advisor. For all of these coach behavior categories, complementarity was not or negatively correlated. So for the role of advisor, complementarity is probably not very influential in the relationship between the user and the tracker.

Coach-tutor-teacher. In the role of coach-tutor-teacher, the tracking device gives feedback, helps set goals and monitors progress and the guidance is knowledge related. Furthermore, mental coaching is involved. Therefore, Jowett et al.'s (2017) coach behavior categories of mental preparations, physical skills and planning, technical skills and goal setting can be linked to the activity tracker's role of coach-tutor-teacher. The coach behaviors that can be linked to the activity tracker's role of coach-tutor-teacher are very similar to the behaviors that can be linked to the activity tracker's role of advisor but the main difference is that negative personal report is linked to the latter one. For this reason, it would be logical if the relationship score for activity trackers with the role of advisor is generally lower than the relationship score for activity trackers with the role of coach-tutor-teacher.

Friend and mentor and toy. For the role of friend and mentor as well as the role of toy, positive personal report can be linked to the role and positive personal report shows a high correlation coefficient with complementarity. Therefore the score on complementarity could be higher for the roles of friend and mentor and toy than for the other roles. In addition to positive personal report, the coach behavior category of mental preparations also is linked to the role of friend and mentor. However, mental preparations do not have a lot of effect on the relationship score so it can be expected that strength of the relationship for activity trackers with the role of friend and mentor or toy is similar.

Tool. When an activity tracker adopts the role of tool it can be described by being functional, useful, optional and informative. These descriptions relate to the CBS-S items of monitor progress, help set goals, give feedback and coordinate training and the coach behavior categories of goal setting, physical skills and planning and technical skills. No positive or negative personal report is involved when the activity tracker adopts the role of tool and no mental guidance. Jowett et al. (2017) showed that complementarity has a negative path coefficient for each of the coach behavior categories that are linked to the role of tool and therefore it could be that when a user perceives the role of their tracker as a tool, this user perceives complementarity with their tracker negatively. However, the total relationship path coefficients for each of the coach behavior categories that are linked to the role of tool are relatively high. So it could be that when the role of the activity tracker is perceived as a tool, the relationship between the user and the tracker is perceived as positive and receives a relatively high score.

Semantic Differentiation Task.

It is important to remember that a perceived role of an activity tracker is to a high extent dependent on the perceived traits of that activity tracker. A set of traits or characteristics can be used to learn more about the perceived role, but such traits are often not mutually exclusive. Perhaps it is easy to explain this in terms of a Semantic Differentiation Task. A Semantic Differentiation Task approach allows for differentiation of a certain concept on a set of non-material traits (Osgood, 1964). It is well established in literature and was compared across cultures. The set of non-material traits consists of bipolar verbal opposites like good-bad, passive – active, subdominant-dominant, empathetic-cold blooded, independent-dependent, powerful-weak and rational- emotional. A seven-step scale is used to score every trait. However, a clear set of traits designed specifically to score a self-tracker using semantic

differentiation was not found in literature. The interaction vocabulary as developed by Diefenbach, Lenz and Hassenzahl (2013) may be seen as a type of Semantic Differentiation Task. This interaction vocabulary can be used by a person to "score" a technology along a spectrum of eleven pairs of words in descriptive, non-judgmental and non-technology bound traits. The combination of the score on the specific traits can be distinctive for a specific role of the technology. For example, a more gentle, fluent and apparent interaction is seen as appropriate for a technological companion that has the role of a friend (Niess et al., 2018). Niess et al. (2018) used the interaction vocabulary to create an interaction profile of technological companions in their roles as either friend or advisor. Figure 2 gives an idea of what such an interaction profile looks like. Creating interaction profiles for various roles that an activity tracker may adopt can help in providing a better understanding on how a user perceives the activity tracker.

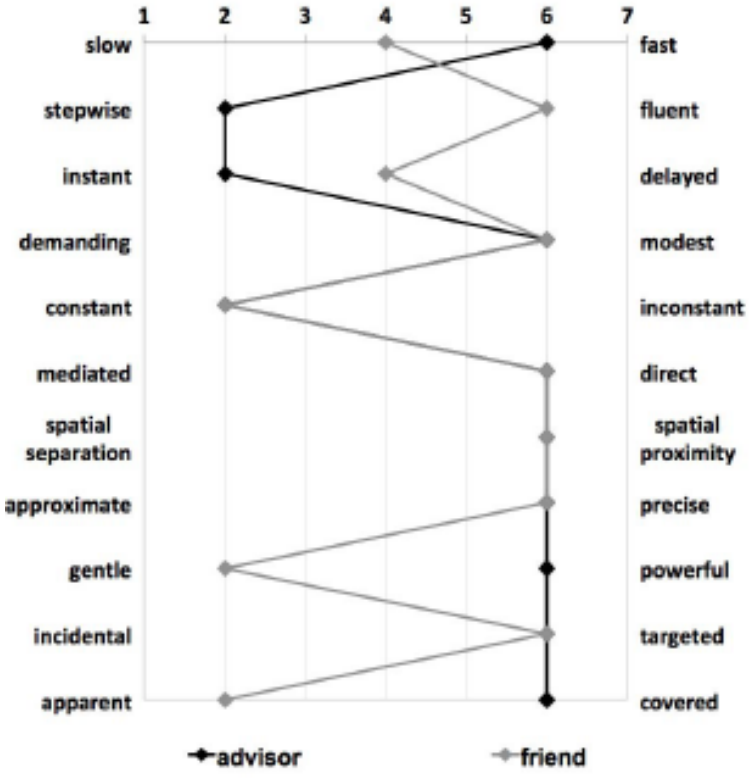

Figure 2. Interaction profile for a technological companion in role of friend or advisor. Retrieved from Niess et al. (2018).

Two-Dimensional Model for Conceptualization of Roles

Word pairs that are used in a Semantic Differentiation Tasks often have a main dimension in terms of the trait they refer to. For example gentle-powerful is, in a way, comparable to weak-strong since a certain concept cannot be weak and powerful at the same time but it can be weak and gentle at the same time. These word pairs have a certain dimension in common. By combining such dimensions into a model, a conceptualization can be provided that helps in mapping perceived traits or characteristics of an activity tracker. That way, the perceived role of an activity tracker can be identified based on scores on a set of traits.

It is not new that a dimensional model is used to provide such a conceptualization. Ruble and Thomas (1976) used a two-dimensional model to classify conflict behavior and Moliner (1995) used a two-dimensional model for social representations that people have of a firm. The models are both based on how people perceive other people, concepts or behaviors and both models use an evaluative dimension.

The evaluative dimension can be explained by the very simple distinction of "good or bad". It ranges from functional to normative descriptions and differentiates between a representation that is functional, instrumental and action oriented, or normative, expressive and judgement oriented (Moliner, 1995). Ruble and Thomas (1976) have used terms to define the evaluative dimension. The terms used to describe this dimensions consist of a set of word pairs. The word pairs in a Semantic Differentiation Task: hostile-friendly, hard-soft, unfair-fair, greedy-not greedy, and stubborn-willing to give and take are examples of such word pairs. Based on participants' scores on the word pairs, several conflict handling modes were identified: competing, avoiding, accommodating, compromising, collaborating. Figure 3 shows what the representation of conflict handling modes in the two-dimensional model of Ruble and Thomas (1976) looks like. This is used as an inspiration for the representation of perceived roles of activity trackers. However, the two-dimensional model of Ruble and Thomas

(1976) has two positive axes, but to visualize the location of the word pairs that describe roles of an activity tracker in a more intuitive way, a positive and a negative axis should be used.

As a second dimension, a dominance dimension can be used. Charles Berger (2008) states that studies on judgements of social relationships have demonstrated the importance of a dimension in terms of dominance. He states that the dimension of dominance is used to judge and experience social relationships and the communication associated with the relationship for judgements during or after interaction (Berger, 2008). Furthermore, the concept of dominance can include word pairs of powerful-weak, active-passive and dominant-subdominant that were used in the original Semantic Differentiation Task. Therefore, the dimension of dominance is suitable to use in a two-dimensional model that conceptualizes roles of activity trackers. In combination with the evaluative dimension, traits that are used to describe the role of an activity tracker can be mapped.

If all of the word pairs are placed in a two-dimensional model with evaluative and dominance dimensions, based on expectations and descriptions in literature (explained in detail in Appendix B), the conceptualization would look like the one depicted in Figure 4. Lines are drawn between each word pair. Based on a user's scores on the word pairs during a Semantic Differentiation Task, a position on each line can be determined which helps in the activity tracker's perceived role attribution.

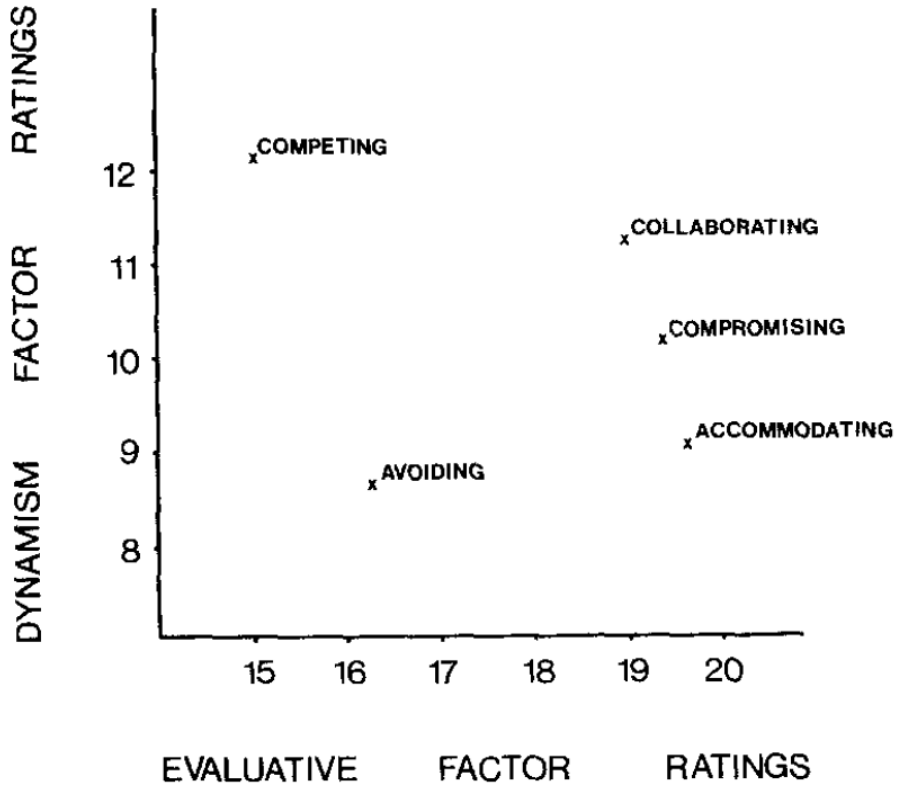

Figure 3. Representation of different concepts of conflict handling modes in a two-dimensional model. Retrieved from Ruble and Thomas (1976).

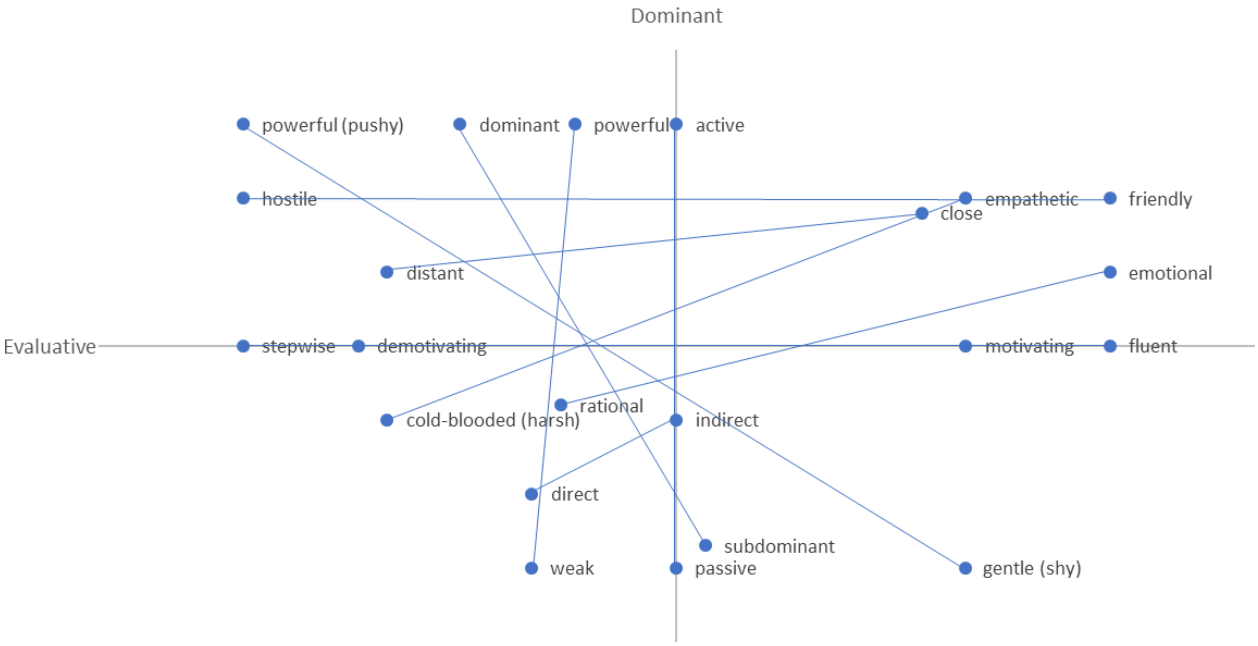

Figure 4. Conceptualization of what an activity tracker's traits represented in a two-dimensional model with an evaluative and dominance dimension would look like. Lines are drawn between each word pair.

Research Question

As already mentioned, research on experiential effects in the domain of self-tracking is important since the emotional user experiences that accompany a behavior are an influential factor in commitment and determining if that certain behavior is maintained over a longer period of time (Hancı et al., 2019). The relationship between a user and their tracker can be described by the constructs of closeness, commitment and complementarity, as suggested by Jowett and Ntoumanis (2004). However, which factors affect this relationship is difficult to unravel. The role that people perceive of their activity tracker could influence the relationship between the user and the tracker and the user's motivation to engage in activity tracking could also influence the relationship between the user and the tracker. However, the user's motivation could also affect how the role of the activity tracker is perceived and vice versa.

This thesis will extend on the complex relationship between different motivations to engage in activity tracking and the relationship between a tracker and its user for different roles that an activity tracker can adopt. Up until now, the connection between these concepts remains unclear and it is even unexplored whether there is a connection at all. Using SDT as a backdrop, examining perceived relationships between people that engage in activity tracking and their devices could meaningfully enhance our understanding of relational, experiential and emotional responses to self-tracking and help close the knowledge gap regarding possible relationships that users build with their devices. Based on previous literature and research findings, as well as research from the sports domain, the research question is:

"Does a connection between a user's motivations to engage in activity tracking and how a user perceives the role of their activity tracker exist and if so, how do these concepts affect each other and the relationship between the user and the tracker?"

To be able to answer the research question, the users' motivations to engage in activity tracking will be examined. Revealing motivations to engage in activity tracking helps in

understanding the users and in possibly finding connections between the different concepts in this thesis. It is expected that the perceived role of an activity tracker and the user's motivation to engage in activity tracking are related to each other. This exploratory study should reveal more about the connection between these two concepts.

Secondly, based on literature in the sports domain, it is hypothesized that if autonomous motivation is high, commitment to activity tracking is higher than for people with high levels of controlled motivation. In addition to that, it is expected that commitment to activity tracking is positively correlated with the commitment to the tracker in the user-tracker relationship.

Furthermore, it is expected that if autonomous motivation is high, the perceived relationship between the user and the tracker is also better than for people with high levels of controlled motivation. Especially for the relationship constructs of complementarity and closeness, a high correlation between these constructs and the level of autonomous motivation is expected, based on literature from the sports domain. Reported effects of controlled motivation on the trainer-athlete relationship were not found in existing literature but since controlled motivation has less positive effects on performance, persistence and concentration than autonomous motivation it is expected that it also has less positive effects on the user-tracker relationship.

Another hypothesis concerns the connection between different activity tracker roles and the relationship between the user and the tracker, as introduced earlier, for each of the identified activity tracker roles in this thesis, an expected correlation with the relationship can be based on literature from the sports domain. It is hypothesized that the perceived role of an activity tracker indeed is correlated with the perceived relationship between the tracker and its user.

Finally, when combining the key concepts of this thesis, the hypothesis for the connection between the motivation, role and relationship is that the effect of the perceived

activity tracker's role on the perceived tracker-user relationship is different for different motivations to engage in activity tracking.

Method

Participants

Participants were collected by using an online survey. Participants in this study were people between 18 and 64 years old with at least 3 months of previous experience in using an activity tracker. At least 3 months of previous experience with using an activity tracker was required because users have different needs and interaction behaviors with their device after the initial weeks of use (Fritz et al., 2014) and a novelty effect in the use of an activity tracker could disrupt the research findings of this thesis.

The total sample size was 196 participants with 19 participants who had fewer than three months of previous experience in using an activity tracker. These 19 participants were excluded from the dataset, resulting in a sample size of 177 participants (68 male and 109 female). 155 out of the 177 participants were between 18 and 44 years old and only 22 participants were 45 or older. A visual representation of the age and gender distribution of participants is added in Appendix C.

Measures

Since variation in the level of technological affiliation was desired, a short questionnaire was administered that examined technological affiliation. The questions were based on the Computer Self-Efficacy Measurement of Compeau and Higgins (1995). As Bandura (1986) stated, self-efficacy measures need to be adapted to the domain of interest, and therefore the original Computer Self-Efficacy questions and scenario were slightly changed (see Appendix D). Furthermore, the number of questions was reduced. Answers to the

statements ranged from 1 (extremely disagree) to 7 (extremely agree). The mean of the scores on each statement indicates the level of technological affiliation of the participant. 1 indicates a very low level of technological affiliation and 7 indicates a very high level of technological affiliation. Internal consistency for this scale was good (Cronbach's alpha = .62).

Several open-ended questions were added to the online survey as well. These questions were aimed at revealing participant's motivations to engage in activity tracking and at the connection between the concepts of role, motivation and relationship in the activity tracking domain. The questions asked participants why they use their activity tracker, to describe their activity tracker and ask about benefits, disadvantages, needs, wishes and desires for their activity tracker. This set of questions concerned about the participant's satisfaction about the activity tracker and can be an indicator for motivation and the perceived relationship. Three of the open-ended questions were a creative writing task. The creative writing questions were: "*If your activity tracker could talk, what do you think it would say about you? And why?", "If your activity tracker was a type of animal, what animal would it be? And why?"* and *"If your activity tracker would be your colleague at your job, how would you describe your colleague? And why?"*. These questions were less direct and more reflective than the other open-ended questions. The aim of the creative writing task was to get an insight into participants' descriptions of their devices in relation to self-evaluation. The complete list of open-ended questions is added in Appendix E. The key terms provided in Table 1 that describe SDT's motivation categories and corresponding tracking styles were used as a coding scheme for analyzing the participants' answers.

In addition to the open-ended questions that are aimed at revealing the participant's motivation, a Motivation for Self-Tracking Scale was administered to be able to classify the participants in the correct category of motivation to engage in activity tracking and to obtain a score for the motivation categories. This scale was adjusted from the revised Sport Motivation

Scale (SMS) (Pelletier et al., 2013) as suggested by Hancı et al. (2020) and consists of 15 statements about reasons for self-tracking. For each of SDT's regulatory styles, three items were included. Participants could answer these statements on a Likert scale ranging from 1 (extremely disagree) to 7 (extremely agree). The used Motivation for Self-Tracking Scale is added in Appendix F. Items 1 to 9 that measure intrinsic, integrated and identified regulation together form a subscale for autonomous motivation (Cronbach's alpha = .85). Items 9 to 15 measure introjected and extrinsic regulation and form a subscale for controlled motivation (Cronbach's alpha = .78). Mean scores for autonomous and controlled motivation were calculated by combining the scores of intrinsic, integrated and identified motivation or by combining the scores of introjected and external motivation respectively. This resulted in continuous value variables and the variable with the highest score indicated the participant's main motivation category. After the main motivation category was identified, participants were grouped based on their main motivation which resulted in a categorical variable of either autonomous or controlled motivation.

In combination with examining the reasons that people give for engaging in activity tracking, the commitment to the practice of activity tracking was measured by the Commitment to Self-Tracking (C2ST) scale designed by Hancı et al (2020). This scale consisted of 12 items containing statements aimed at revealing the user's commitment to the practice of self-tracking. Answers to each of the statements are scaled on a 7-point Likert scale ranging from extremely disagree to extremely agree. Internal consistency for this scale was high (Cronbach's alpha = .84).

To be able to measure the perceived nature of the relationship between the participant and their activity tracker, the Coach–Athlete Relationship Questionnaire (CART-Q) proposed by Jowett & Ntoumanis (2004) was used. CART-Q is a good measure for the experiential effects of activity trackers and the relationship a user builds with their tracking device.

Statements from Jowett and Ntoumanis' (2004) CART-Q were used and the terms of athlete/coach were adapted to be applicable for activity trackers. This resulted in a list of 15 statements. Furthermore, for each of the three constructs that define the relationship, two reciprocity statements were added since reciprocity measures allow for a detailed evaluation of an interaction between the self and something or someone else. The resulting list of statements to measure the perceived relationship between the user and the tracker is added in Appendix G. Answers to the statements can vary on a 7-point scale ranging from 1 (Extremely disagree) to 7 (Extremely agree). A high score means a more positive attitude towards the activity tracker. By examining the total score for each of the three constructs, a score for perceived nature of the relationship was revealed. The internal consistency for each of these item groups was high where Cronbach's alpha was 0.91 for commitment, Cronbach's alpha was 0.85 for closeness and Cronbach's alpha was 0.88 for complementarity.

The perceived role of an activity tracker was measured by means of a Semantic Differentiation Task. Participants were asked to score their activity trackers on every trait (word pair) that can describe the role of an activity tracker in terms of the dominance or evaluative dimensions from the two-dimensional model that was introduced. If a score of "neutral" is attributed to a specific trait, the trait was not taken into consideration in the analysis. Based on research by Niess et al. (2018), research by Ruble and Thomas (1976) and the word pairs from the original Semantic Differentiation Task proposed by Osgood (1964), traits were added to the original interaction vocabulary by Diefenbach et al. (2013). The resulting list of traits is added in Appendix H. The traits gentle (shy) - powerful (pushy), powerful – weak, trait empathetic - cold-blooded (harsh) and indirect- direct were reverse coded since the description of these traits were the other way around in terms of direction on the evaluative and dominance dimension in comparison to the other traits. The scale reliability coefficients (Cronbach's alpha) for the Semantic Differentiation Task for the evaluative dimension was 0.30 and for the

dominance dimension was 0.36, which were not good. In the results section, it is explained how this was dealt with.

Procedure

This study was conducted by using an online survey. The survey was distributed on prolific.co, an online participant recruitment website for research purposes. Participant screeners for age and the use of a self-tracking device were used to find the target audience. After providing the informed consent and prescreening the Computer Self-Efficacy Measurement questionnaire was administered first since it asked the participant to think about a technology that they are not familiar with, which is easier before the participant starts answering questions about their activity trackers.

The open-ended questions were next. The set of open-ended questions also included the creative writing task questions. These questions were asked prior to the other measurements to prevent participants from being primed with an expectation bias when answering the open-ended questions.

When the participant had answered the open-ended questions in the survey, the Semantic Differentiation Task, Motivation for Self-Tracking Scale, Commitment to Self-Track (C2ST) Scale, and CART-Q followed. Order of the items in each of the scales was randomized. Finally, a set of demographical questions was added. After the survey was completed, participants were thanked and rewarded according to the reward system of Academic Prolific. Completing the entire survey took approximately 20 minutes.

Analyses

Answers to the open ended questions were analyzed by means of a content analysis. By examining which key terms (from Table 1) or themes occurred most often in participants'

answers on the questions about motivation *("Why do you use the activity tracker you are currently using?", "What are your needs, wishes and desires for your activity tracker and how do you think your needs, wishes and desires for your activity tracker affect the way you think about your activity tracker?"* and *"What do you think are your biggest personal benefits of activity tracking? And what are the biggest benefits in general? And why?"*) a participant's main motivation to engage in self-tracking was revealed in addition to the outcome of the Motivation for Self-Tracking scale. The question about needs, wishes and desires was only partly used in the analysis. The question consisted of two parts: "*What are your needs, wishes and desires for your activity tracker?...*" and *"...how do you think your needs, wishes and desires for your activity tracker affect the way you think about your activity tracker?*" and only the first part revealed insightful information about participant's motivations.

The outcomes of the content analysis on the open-ended questions that could reveal more about the perceived role of the activity tracker *("Why do you use the activity tracker you are currently using?"* and *"What 5-10 terms would you use to describe your activity tracker?"*) and the creative writing questions *"If your activity tracker would be your colleague at your job, how would you describe your colleague? And why?"* and *"If your activity tracker was a type of animal, what animal would it be? And why?"* were used to identify patterns or groups in the data about how participants perceived their activity trackers.

The third creative writing question was *"If your activity tracker could talk what do you think it would say about you? And why?".* For this question a thematic analysis was conducted instead of a content analysis, the difference being that no coding scheme was created upfront. Identified themes in the data were used to further reveal information about identified patterns or groups in the data.

After the quantitative data was inspected and participants with fewer than 3 months experience of using an activity tracker were excluded from the dataset, the scores on the

different constructs in the scales were calculated by computing the mean of the scores on each scale's items and the results were compared to the results of the qualitative analyses.

The Semantic Differentiation Task was based on a seven-point scale and the combination of scores on every trait identified how the user perceives the role of the activity tracker by using the proposed two-dimensional model with the evaluative and dominance dimensions. The scores that participants gave for each trait in the Semantic Differentiation Task were transformed to scores in terms of the evaluative and dominance dimensions. This was done by determining the position on the line between the two words of each trait and calculating the corresponding data points on the dominance dimension as well as on the evaluative dimension. If a score of 0 (corresponding to neutral) was attributed to a specific trait, the trait was not taken into consideration in the analysis. To validate if and how the traits used in the Semantic Differentiation Task loaded on two different dimensions, a principle component analysis was conducted as well.

After that, data of all participants on the traits of the Semantic Differentiation Task were analyzed by conducting a hierarchical cluster analysis in STATA. A hierarchical cluster analysis can reveal homogenous groups of cases in the data if a grouping is not previously known by combining cases based on the distance between the cases. The resulting groups could represent the different activity tracker roles that participants perceived. For the cluster analysis, Ward's clustering method was applied while calculating the distance between observations using Euclidian distance intervals. An example of how the Eucledian distance between two points can be calculated is illustrated in Figure 5.

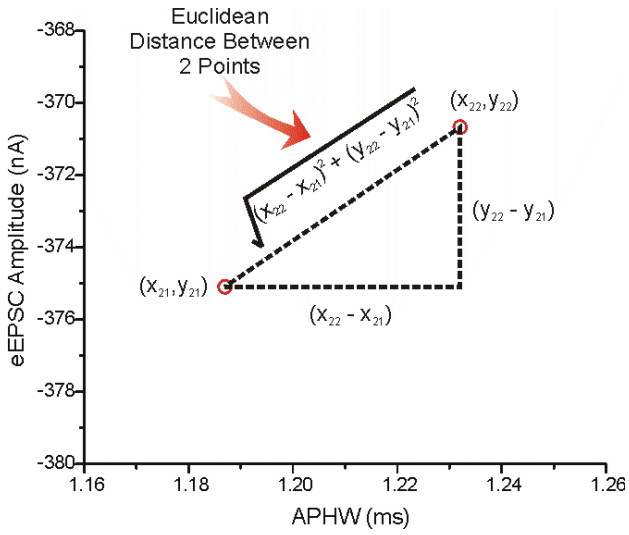

Figure 5. Example of calculating the Eucledian distance between two points. *Retrieved from Halabisky, H. https://hlab.stanford.edu/brian/making_measurements.html*

After the cluster analysis, the resulting dendrogram was visually inspected to see how many roles could be identified from the data and if and how these roles related to each other in terms of the cluster level. The results from the content analysis on the creative writing questions and the questions about roles were combined with the resulting clusters to identify each cluster.

To examine the perceived nature of the relationship between the user and their tracker, another principle component analysis was conducted to test correlations amongst the constructs of CART-Q. The answers on the adapted CART-Q items were processed by obtaining the mean of each participant's answers on each of the three constructs (closeness, commitment and complementarity) as well as on the three constructs combined. The mean score of the three constructs combined indicated the nature of the tracker-user total relationship based on CART-Q, which resulted in continuous variables.

The mean score on the relationship construct of commitment was compared to the mean score of commitment (based on the C2ST scale) using a correlation coefficient calculation to see if the commitment to the practice of self-tracking in general correlated to the commitment to the tracking device.

To examine the link between motivation and commitment (C2ST scale) and between motivation and the tracker-user relationship (for the total relationship score as well as for each of the different constructs separately), independent sample t-tests were planned and to compare the perceived role of an activity tracker and the user's motivation a Pearson's chi-square test was planned. However, as will be explained in the result section, the distribution of participants in different categories of motivation was very unequal and therefore these analyses were not conducted because the result would have been unreliable.

Results

The collected data on the quantitative measurements was used to reveal more about the participants. Results of the levels of technological affiliation as obtained from the Computer Self-Efficacy Measurement, participants' motivations to engage in activity tracking as obtained from Motivation for Self-Tracking scale, perceived traits of the activity tracker as obtained from the Semantic Differentiation Task which are used for a cluster analysis and the perceived user-tracker relationship as obtained from CART-Q are provided in the following sections. In addition to the results on the quantitative measurements for the different concepts in this thesis, results of the qualitative measurements are provided in the section on a participant's motivation and in the sections on the perceived roles of an activity tracker; attributing activity tracker roles to identified clusters and expected comments of activity trackers for each activity tracker role.

Technological affiliation

The Computer Self-Efficacy Measurement indicated participants' self-reported technological affiliation. Only one participant self-reported technological affiliation of less than 3. The mean of self-reported technological affiliation on a scale from 1 to 7 was 5.21. 83 participants scored above this mean. It was desired that participants with different levels of

technological affiliation were included in the sample size, but the level of technological affiliation among participants was not as equally distributed as desired. However, this did not impose influential problems for the analyses since the level of technological affiliation did not directly impact categories of participants or their scores on the main concepts in this thesis. Nonetheless, it is important to keep in mind that the level of technological affiliation could affect personal preferences in the interaction with an activity tracker.

Participant's motivation

Participants' main motivations to engage in activity tracking were revealed by calculating the mean scores in the Motivation for Self-Tracking scale and categorizing participants based on their main motivation which resulted in a categorical variable of either autonomous or controlled motivation. 161 out of the 177 participants fell into the autonomous motivation category and only 16 participants fell into the controlled motivation category. This distribution of the main motivation category is very unequal.

When looking at participants' answers to the open ended questions by means of a content analysis, participants' answers were coded based on SDT's key terms in Table 1. When inspecting how often participants mentioned a reason or motivation for activity tracking, it was clear that no participants reported only autonomous motivations. 17 participants did not mention any reason for activity tracking that was either autonomous or controlled. Two of them answered questions in a language other than Dutch or English. For the other 15 participants it could be that they did not answer the question properly or that their motivation type is amotivation. Therefore, data of these participants were not used in further analyses. The number of participants in each motivation category were compared, resulting in the distribution that is visually displayed in Figure 6. The table with the corresponding values was added in Appendix I. Most of the participants (87.57%, 155 participants) mentioned autonomous as well

as controlled motivation reasons for engaging in activity tracking, but most of them (140 participants, 79.10%) still reported more reasons to engage in activity tracking that fell into the category of autonomous motivation. Only 35 (13+15+7) out of 177 participants (19.76%) mentioned one or more reasons to engage in activity tracking that fell into the category of controlled motivation. So also after analysis of participants' answers, the distribution of the main motivation category again is very unequal. The main motivation categories consist of five regulatory styles (Table 1). When subdividing the main motivation categories of autonomous and controlled motivation in the corresponding regulatory styles, the distribution of participants across the categories is still unequal. 62.14% of all participants fell into the categories with only or mostly intrinsic or integrated regulatory styles and in addition to that, 24.29% of the participants reported reasons for activity tracking that point towards multiple regulatory styles but with no clear main regulatory style. Because of the unequal distribution in motivation types, further analysis on a participant's motivation is not possible and hypotheses about effects of the motivation to engage in activity tracking on perceived activity tracker roles and the relationship between the user and the tracker cannot be confirmed or rejected. How this influences the interpretation of other important concepts in this thesis will be discussed later.

The remaining hypotheses in this thesis were that commitment to activity tracking is correlated with the commitment to the tracker in the user-tracker relationship and that the perceived role of an activity tracker is correlated with the perceived relationship between the tracker and its user.

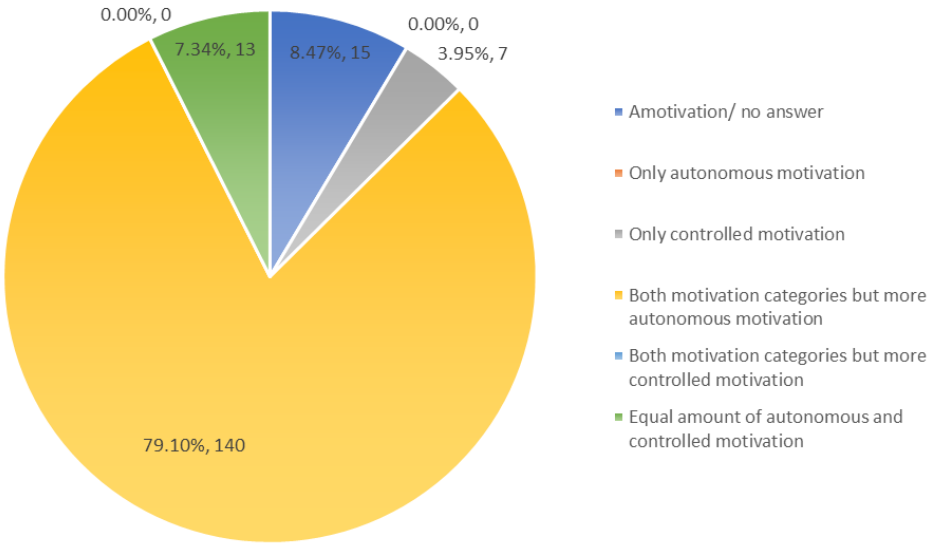

Figure 6. Distribution of motivation categories after content analysis.

Activity trackers' traits in two-dimensional model.

The Semantic Differentiation Task consisted of word pairs of traits that described the role of an activity tracker in the two-dimensional model. A principle component analysis revealed what traits loaded on which dimension. The analysis showed a Rho value of 0.40 from the principle component analysis, which is not good since it indicates that only 0.40 of the variance of the variables was contained in these two components. The traits stepwise- fluent, rational- emotional and gentle (shy)- powerful (pushy) did not load on either of the components and had high unexplained eigenvectors (.91, .94 and .91 respectively). Therefore, these three traits were removed from the analysis. When a principle component analysis was conducted without these traits, Rho was 0.54, which indicated that the variance of the variables contained in the two components increased with 14%. The output of the principle component analysis after promax rotation and removing traits of stepwise- fluent, rational- emotional and gentle (shy)- powerful (pushy) is shown in Table 4. After the three items were removed, internal consistency was 0.68 instead of 0.57. The traits distant- close and hostile – friendly described the evaluative dimension and loaded only on component 2 while the traits direct- indirect,

passive- active, powerful- weak, and subdominant- dominant described the dominance dimension and loaded only on component 1. So, component 1 represented the dominance dimension and component 2 represented the evaluative dimension. Although the trait empathetic- cold-blooded (harsh) loaded on both components, the component loading on the evaluative component (0.59) was much higher than the component loading on the dominance component (-0.31) so this trait was attributed to the evaluative component anyway. The trait motivating – demotivating could not be attributed to one component alone. Since it is very difficult to describe motivation in either the dominance or evaluative dimensions, it was not a surprising result.

Scale reliability coefficients (Cronbach's alpha) for the Semantic Differentiation Task for the evaluative dimension were evaluated again and internal consistency was 0.60 (opposed to 0.30 before principle component analysis) and for the dominance dimension was 0.56 (opposed to 0.36 before principle component analysis), which were much better than they were before.

Table 4. *Output of the principle component analysis after promax rotation*

Trait	**Component 1** Dominance dimension	**Component 2** Evaluative dimension	**Unexplained eigenvectors**
Distant- close		0.3089	0.535
Cold-blooded (harsh) - empathetic	-0.3166	0.59	0.3929
Hostile - friendly		0.5859	0.3094
Demotivating- motivating	0.2715	0.334	0.4246
Indirect - direct	0.4724		0.5556
Passive- active	0.336		0.4391
Weak - powerful	0.3813		0.7057
Subdominant - dominant	0.5597		0.3342

Identifying clusters in descriptions for activity trackers

Cluster analysis. The dendrogram in Figure 7 resulted from the hierarchical cluster analysis with Ward's Linkage method and the distance between observations calculated with Eucledian distance intervals. In this dendrogram, a measure of difference (dissimilarity

measure) of either individual data points or grouped data points was represented on the y-axis and the data points or grouped data points were represented on the x-axis. The dendrogram showed high dissimilarity measures for two clusters but distraction of three or four clusters also was a possibility. Eucledian distances were plotted in a scatter plot (Figure 8) and a higher variation in distance for three and four clusters was clear, meaning that either three or four clusters could be retained from the data. A screeplot from the data points of the traits on both dimensions after principle component analysis (Figure 9) was decisive since it clearly showed three components, so three clusters were retained from the data.

65 participants were grouped in cluster 1, 84 participants were grouped in cluster 2 and 28 participants were grouped in cluster 3. 17 participants could not be grouped in any of the three clusters.

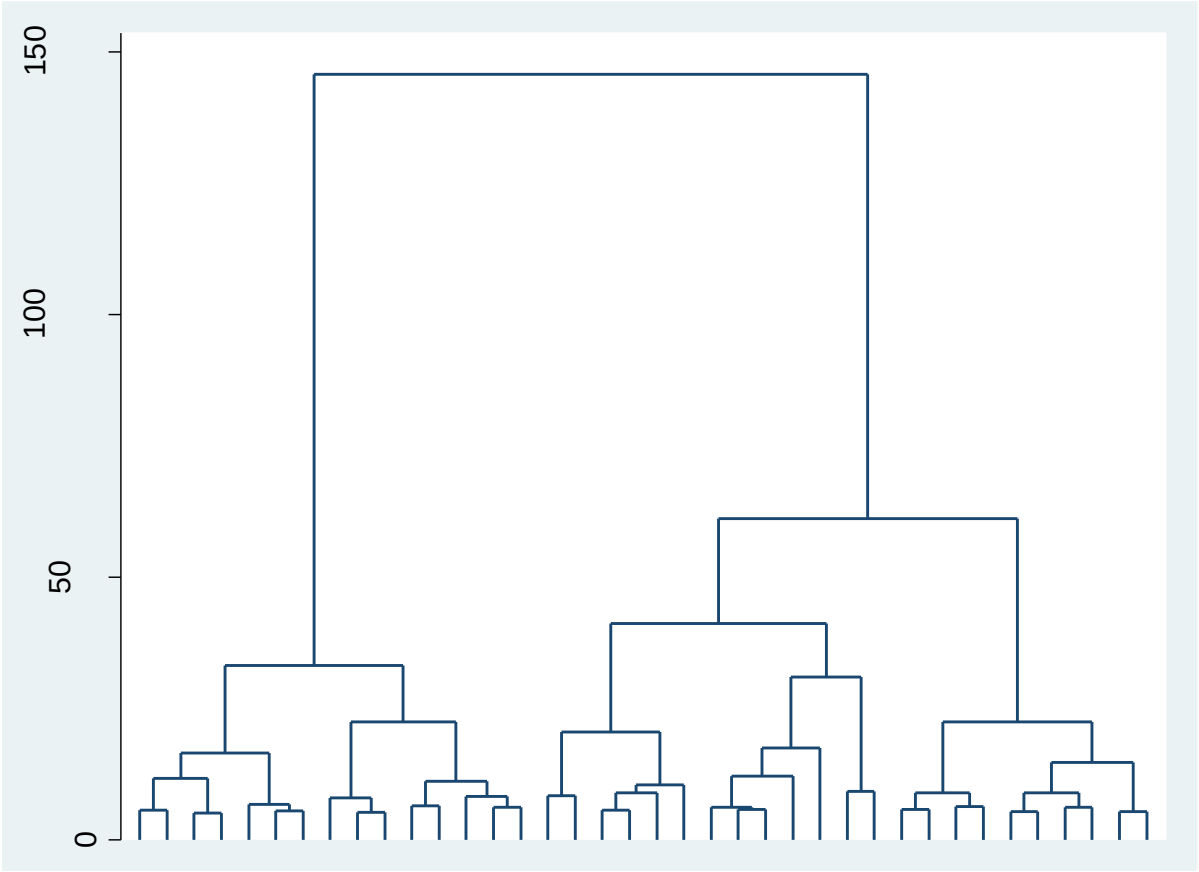

Figure 7. Dendrogram resulting from cluster analysis after Semantic Differentiation Task

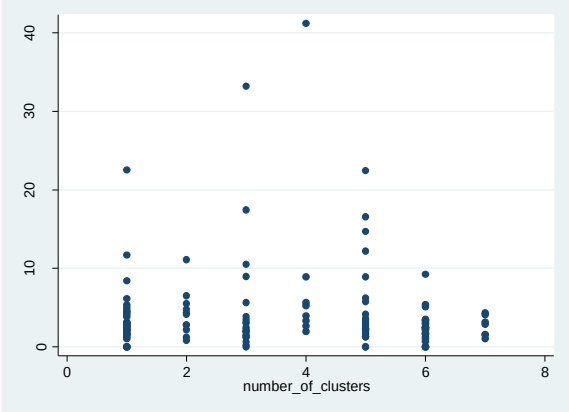

Figure 8. Plot of Eucledian distances between data points

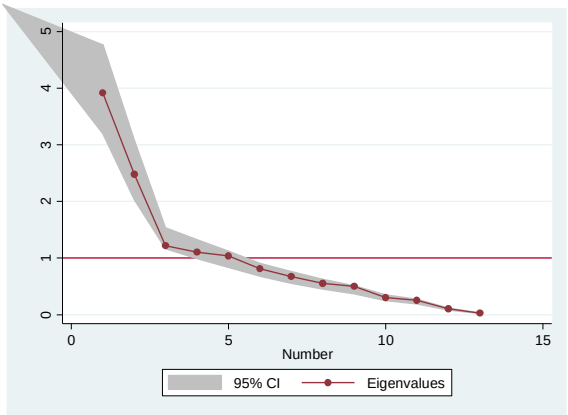

Figure 9. Scree plot of eigenvalues after PCA

Clusters in the two-dimensional model. The mean of the data points of all traits on the evaluative and dominance dimensions resulted in single data points in the two-dimensional model for each participant. A visual representation of these mean data points in the two-dimensional model for participants in the three clusters is provided in Figure 10. The individual graphs per cluster are added in Appendix J. These representations of the datapoints on the evaluative and dominance dimensions of the two-dimensional model were compared with findings based on participants' answers on the creative writing questions and the questions about roles. Coding participants' answers on these questions resulted in a list of 47 terms that participants used to describe their activity trackers. This list was added in Appendix K. The terms were combined into groups representing the traits corresponding to the evaluative and dominance dimensions in the two-dimensional model. The mapping of terms to the traits in the two-dimensional model was based on statements that participants made when giving an answer containing a specific term or trait as well as on common sense. The codebook for the mapping of terms on traits is added in Appendix K as well.

When looking at these visual representations of each participant's score on the evaluative and dominance dimension for each cluster, a fairly clear distinction between the clusters was visible. Two-dimensional model data points for participants in both cluster 2 and cluster 3 were positive on the dominance dimension but data points in cluster 3 were distributed

more around the neutral axis on the evaluative dimension and data points in cluster 2 were positive on this dimension. Data points of participants in cluster 1 were clearly more often negative on the evaluative dimension than data points in the other clusters. On the dominance dimension, some data points of participants in cluster 1 were very negative on the dominance dimension, but on average, the data points were spread around the neutral axis of the dominance dimension in the two-dimensional model.

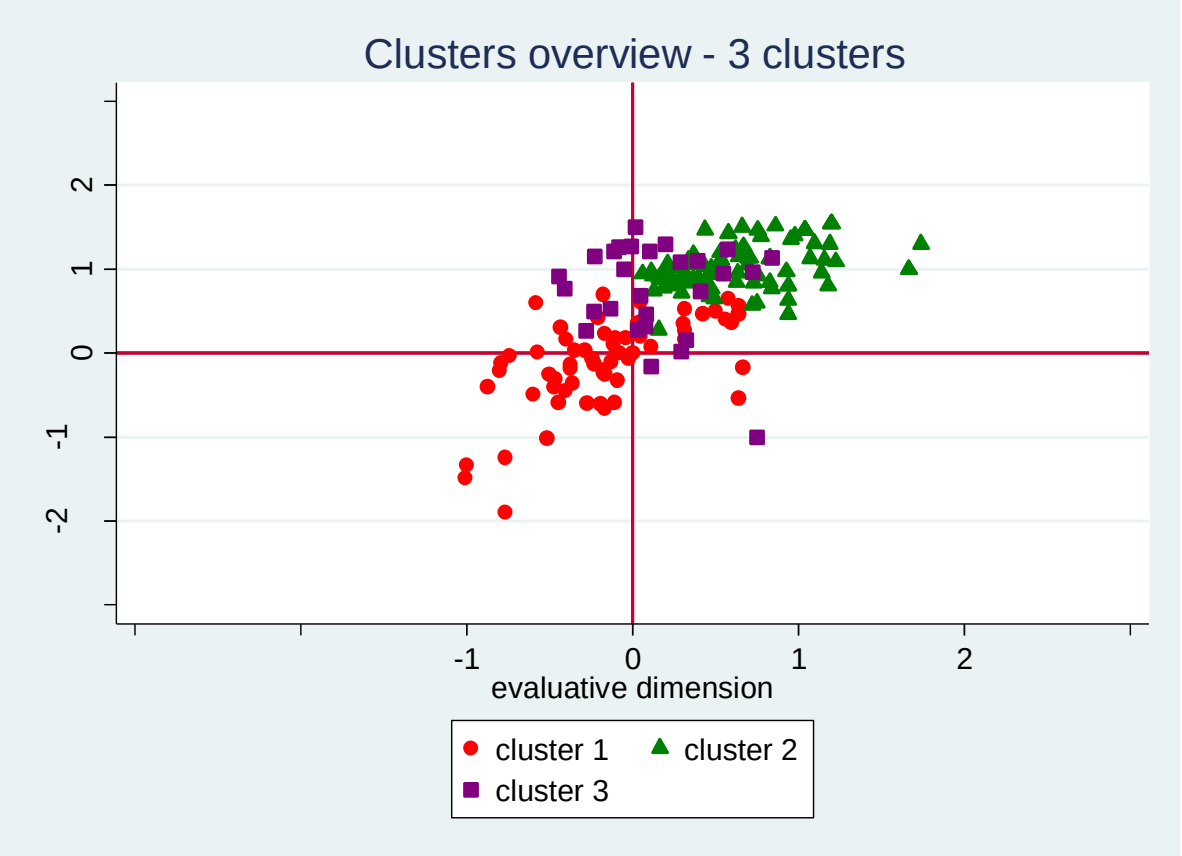

Figure 10. Visual representation of individual participants' mean data points in the two-dimensional model with participants grouped into 3 clusters, based on Cluster Analysis after Semantic Differentiation Task.

Based on the mapping of terms on traits, the number of times that terms for each specific trait of the two-dimensional model was divided by the number of participants in each cluster so the average number of occurrences of each trait could be compared per cluster. Figure 11 shows the visual representation of these average number of occurrences per cluster. The table containing the corresponding mean values per cluster was added in Appendix L.

Cluster 1. For participants in cluster 1, the mean of the occurrences of traits on the dominance dimension was highest for the traits of indirect and weak/ subdominant. This could be caused by the few data points in Figure 10 that were very low on this dimension in comparison to the other data points. Although the mean for the trait of indirect was clearly higher than the means in the other clusters, the mean for the trait of weak/ subdominant was almost equal for participants in cluster 1 and cluster 2. The position of data points on the dominance dimension of the two-dimensional model could not be further explained by the findings of the means for the traits of the two-dimensional model. On the evaluative dimension, participants in cluster 1 perceived their activity tracker as distant and cold-blooded. These traits were described by terms like independent, unobtrusive-discrete, strict, private- individual, powerful – strong- pushy- bossy, mean- judgmental and precise-timely and the terms and traits were clearly negative on the evaluative dimension. Furthermore, the traits of distant and cold-blooded were not in contrast with each other. Even though the means were not very high, they did support the finding that participants in cluster 1 perceived their activity tracker slightly negatively.

Cluster 2. Participants in cluster 2 used terms to describe their activity tracker that mapped to the traits of friendly, motivating, gentle and active. The means of the number of occurrences of each of these traits were clearly higher than the means in the other clusters. From inspecting the means it was concluded that participants in cluster 2 described their activity tracker as positive on the evaluative dimension and positive on the dominance dimension and this finding was supported by the distribution of the data points in the two-dimensional model in Figure 10.

Cluster 3. The means of the number of occurrences for traits of passive and powerful-dominant-direct on the dominance dimension and for the traits of close, hostile, demotivating and motivating on the evaluative dimension were highest for participants in cluster 3. It was

noteworthy that terms mapped to the trait of demotivating as well as terms mapped to the trait of motivating were mentioned most by participants in cluster 3 while they were part of the same word-pair. However, the average number of occurrences for the trait of motivating was equal for participants in cluster 3 and cluster 2 while this average was not equal for the trait of demotivating. The other traits for which the number of occurrences represented on the evaluative dimension was highest were close and hostile. These two traits were also in contrast to each other as one would usually not expect to feel close to someone or something that is hostile.

On the dominance dimension, results showed the highest means for the number of occurrences of a trait in cluster 3 for the traits of passive and powerful-dominant-direct. However, the number of occurrences for terms used to describe the trait of active were relatively high as well. The fact that participants in cluster 3 often used terms to describe their activity tracker as active was in contrast with the high score on the trait of passive in comparison to the other clusters since the two traits together formed one word pair for the representations in the two-dimensional model. However, when looking at the means for the two traits, terms describing the trait of active occurred more, even when correcting for the higher number of terms used to describe the trait of active in comparison to the trait of passive. The trait of powerful-dominant-direct on the other hand clearly showed a high mean score in comparison to the other clusters and the contrasting traits of weak/ subdominant, indirect and gentle showed the lowest means in comparison to the other clusters.

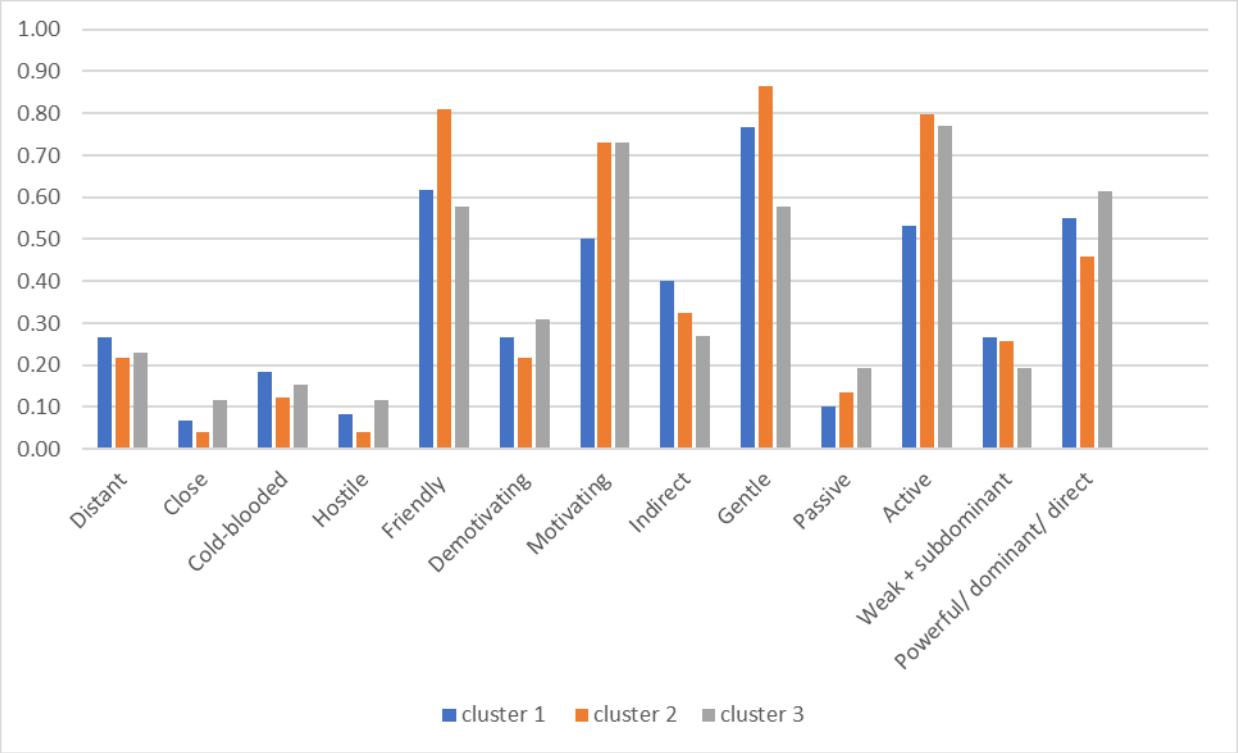

Figure 11. Visual representation of means of number of occurrences in participants' answers per trait for each cluster

Attributing activity tracker roles to identified clusters

Characters. During the content analysis it became clear that participants regularly used a human character (like trainer, cheerleader etc.) to describe their activity tracker. The list of 47 terms that were used to describe activity trackers (Appendix K) were used to create nodes for all the characters that participants mentioned in their answers on the open-ended questions. 16 different characters were mentioned by participants. The codebook was added in Appendix K as well. First, the correlations between the characters were examined to inspect if any of the characters overlapped. Only moderate to high correlations (above correlation coefficient of 0.5) were reported. Since the distribution of participants in each cluster was not equal, inspecting occurrence of traits divided by the specific number of participants in each cluster was more meaningful than a frequency distribution. The means of the number of times that participants mentioned terms corresponding to the characters were compared for each cluster. Table 5 showed the resulting means per cluster.

Advisor. The character of ‘advisor’ did not have significantly moderate to high correlations to any of the other mentioned characters. The average number of times participants used terms in the character of ‘advisor’ was .73 for cluster 1, .78 for cluster 2 and .69 for cluster 3. Cluster 2 was described most as advisor but the averages were close to each other, so a conclusion about what cluster could be described as advisor could not be based on these results.

Attention seeker and charmer. The characters of ‘attention seeker’ and ‘charmer’ did not have moderate to high correlations to any of the other characters either. However, since the average number of times participants used terms corresponding to these characters were mentioned at least once by participants were .43 or less for ‘attention seeker’ (.33 in cluster 1, .43 in cluster 2 and .42 in cluster 3) and .31 or less for ‘charmer’ (.23 in cluster 1, .26 in cluster 2 and .31 in cluster 3), these two characters were not considered as possible distinct roles to describe any of the clusters.

Army sergeant, cheerleader, motivator, trainer and coach. The character of ‘army sergeant’ was correlated to ‘cheerleader’ (r = .69, p< .001), ‘motivator’ (r = .65, p< .001) and ‘trainer’ (r= .71, p< .001). Besides a correlation coefficient with ‘army sergeant’, ‘cheerleader’ was significantly correlated to ‘coach’ with a correlation coefficient of 0.47 (p< .001), which was a low but almost moderate correlation, and ‘coach’ was correlated to ‘motivator’ (r= .62, p< .001) and to ‘trainer’ (r= .53, p< .001). Therefore, characters of ‘army sergeant’, ‘cheerleader’, ‘motivator’, ‘trainer’ and ‘coach’ could be grouped together as one possible role to describe any of the clusters, despite some apparent differences between these characters. All of these characters were described by the term of encouraging – motivating – energizing and 4 out of 5 were described by the term active-energetic. Furthermore, the terms inspiring and supportive corresponded to three of these characters and the terms invasive-annoying, fast, caring, rewarding and supportive corresponded to two of these characters. Since most of the terms used to describe these characters are on the positive axis of the dominance dimension it

makes sense that cluster 2 and 3 have a higher average number of times participants used terms in the character of ‘army sergeant’ to describe their activity tracker than participants in cluster 1. Even though ‘army sergeant’ might not sound very positive, the terms used to describe this character and the correlations to other characters indicated that it was perceived as a positive character in terms of the evaluative dimension but it was also positive on the dominance dimension. The average number of times participants used one or more terms to describe characters of ‘cheerleader’, ‘motivator’, ‘trainer’ and ‘coach’ were also higher in cluster 2 than in the other clusters. For some characters (like ‘motivator’) the difference with other clusters was large and for other characters (like ‘cheerleader’) the difference with one of the other clusters was smaller, but for all characters cluster 2 clearly showed the highest average number of times participants used terms in the specific characters.

Friend and personal assistant. The average number of times participants used one or more terms to describe the activity tracker as the character of ‘friend’ also were highest for participants in cluster 2. .72 for the participants in cluster 1, .81 for the participants in cluster 2 and .58 for the participants in cluster 3 used one or more terms that described these characters so the difference in these averages between the clusters was large. The characters of ‘personal assistant’ and ‘friend’ were correlated to each other and were mostly described by the terms of friendly-nice, helpful, social and reliable-trustworthy. Besides that, the terms caring, love-lovely-pleasant, loyal, non-judgmental, unobtrusive-discrete and useful-practical-convenient were used to describe these characters so both of these characters were clearly positive on the evaluative dimension. However, the correlation coefficient between the characters was only 0.54 ($p < .001$). The character of ‘personal assistant’ scored high (over .80 for all clusters, and the difference between the clusters was not that large (.80. for cluster 1, .82 for cluster 2 and .89 for cluster 3). So, even though ‘personal assistant’ was correlated to the character of ‘friend’, the correlation coefficient was not that strong, and the clusters that had the highest

percentage of participants who describe the characters were different. For that reason, ‘personal assistant’ and ‘friend’ were each considered as unique characters that could describe a cluster. ‘Personal assistant’ could describe cluster 3 and ‘friend’ could describe cluster 2.

Boss and manager. Characters of ‘boss’ and ‘manager’ were correlated with a correlation coefficient of .50 ($p < .001$). Both characters were describe by the terms accurate, effective, strict and powerful – strong – pushy – bossy. In addition to that, the terms monitoring, precise- timely, invasive- annoying, advising and independent were used to describe one of these two characters. Some of these terms are clearly negative on the evaluative dimension and positive on the dominance dimension. The average number of times participants used a term to describe the character of ‘boss’ was .48 in cluster 1, .36 in cluster 2 and .38 in cluster 3 so the participants in cluster 1 most often used terms to describe their activity tracker as a boss. Participants in cluster 1 also most often used terms to describe their activity tracker as a manager (.57 in cluster 1, .45 in cluster 2 and .50 in cluster 3). So, even though the correlation coefficient was not strong, these two characters were grouped together and were very well suited to describe cluster 1.

Expert, gadget, guard, project planner. The character of ‘expert’ was moderately to highly correlated to ‘gadget’ ($r = .59$, $p < .001$), ‘guard’ ($r = .55$, $p < .001$), and ‘project planner’ ($r = .62$, $p < .001$). And there were no other correlated characters for each of them so ‘expert’, ‘guard’, ‘gadget’ and ‘project planner’ were grouped together as well. The terms accurate, effective, monitoring and useful-practical-convenient were used most to describe these characters. Besides that, terms used to describe one or more of the characters were advising, calm-modest-quiet, fast, helpful, informative-interesting-insightful, precise-timely, reminding and reliable-trustworthy. The difference in percentages of cluster 3 compared with the other clusters was large for the character of ‘expert’. The average occurrence of terms used to describe the activity tracker as an expert was .72 in cluster 1, .72 in cluster 2 and .88 in cluster

3. The same held for the character of ‘gadget’ (.58 in cluster 1, .51 in cluster 2 and .77 in cluster 3) and the character of ‘project planner’ (.78 in cluster 1, .70 in cluster 2 and .88 in cluster 3). In addition to that, the percentages of occurrence of the character of ‘guard’ was also highest in cluster 3 (.83 in cluster 1, .66 in cluster 2 and .88 in cluster 3). So, this group of characters was very well suited to describe cluster 3. It was noteworthy that terms used to describe the role of tool in Table 2, overlapped a lot with the terms used to describe characters of ‘expert’, ‘guard’, ‘gadget’ and ‘project planner’ so the role of tool was used to describe cluster 3, encompassing characters of ‘expert’, ‘guard’, ‘gadget’ and ‘project planner’. In addition to the previously mentioned characters in this group, the character of ‘personal assistant’ also had the highest average number of times participants used terms for this character in cluster 3. However, when the terms used to describe the character of ‘personal assistant’ were compared to the terms of the group with the role of tool, this character could not be added to the group.

Table 5. *The means per cluster that participants who mentioned terms corresponding to the characters at least once.*

Character	Cluster and mean		
	cluster 1	cluster 2	cluster 3
Advisor	0.73	0.78	0.69
Army sergeant	0.75	0.86	0.81
Attention seeker	0.33	0.43	0.42
Boss	0.48	0.36	0.38
Charmer	0.23	0.26	0.31
Cheerleader	0.55	0.77	0.73
Coach	0.52	0.78	0.73
Expert	0.72	0.72	0.88
Friend	0.72	0.81	0.58
Gadget	0.58	0.51	0.77
Guard	0.83	0.66	0.88
Manager	0.57	0.45	0.50
Motivator	0.42	0.74	0.54
Personal assistant	0.80	0.82	0.88
Project planner	0.78	0.70	0.88
Trainer	0.57	0.77	0.69

Activity tracker roles. So, ‘attention seeker’ and ‘charmer’ were not used as characters that could uniquely describe a cluster. Participants in cluster 1 clearly described their activity tracker as boss and manager and participants in cluster 3 clearly described their activity tracker as a tool. Participants in cluster 2 described their activity tracker as ‘army sergeant’, ‘cheerleader’, ‘motivator’, ‘trainer’, ‘coach’ but also as ‘friend’. These characters were combined into the description of ‘friend and mentor’ from Table 2 since this description encompasses the terms used to describe the characters and the terms correspond to the terms used by Short and Short (2005) to describe the role of friend and mentor.

New variables that described the clusters were created by combining de characters that were grouped together as a descriptor for a cluster. These new variables represented the clusters’ roles. To inspect if and how well these new variables represented the clusters’ roles, the means of the number of times participants used terms in the clusters’ roles were compared for the clusters. This was done by examining the means and by conducting multiple mean comparison tests.

When the means for the number of times participants used terms to describe their activity tracker with terms or descriptions corresponding to a specific role, it was logical that the mean score of role 1 was highest for participants in cluster 1, the mean score of role 2 was highest for participants in cluster 2 and the mean score of role 3 was highest for participants in cluster 3 since the roles were based on the terms that people used to describe their activity tracker and the cluster analysis was based on the descriptions as well. Mean comparison tests were conducted to examine if the differences between the observed means between the clusters were significantly different between the roles, which indicated if the roles used to describe the clusters were distinct descriptors. For each role, three tests were conducted where the means for number of times a participant used terms that describe that role in cluster 1 was compared to cluster 2, cluster 1 was compared to cluster 3 and cluster 2 was compared to cluster 3. By

applying Bonferroni correction, the alpha level was controlled for the fact that multiple tests were conducted. The applied alpha level was .016 (0.05/ 3). For the mean comparison for all clusters and roles, Mann –Whitney two-sample statistic was applied since assumptions for t-tests were not met. The number of times a participant used terms that describe each specific role was divided by the number of participants in each cluster and Table 6 shows the resulting means for each role per cluster. The results of the mean comparison tests were shown in Table 7. For role 1, the differences between the clusters were all significantly different but the difference between role 2 and role 3 was not significant.

Table 6. *Overview of means for the number of times participants used one or more terms to describe each specific role together with the output of the Shapiro-Wilk W test.*

		Cluster 1	Cluster 2	Cluster 3
Role 1 ‘boss and manager’	Mean	1.30	1.08	1.15
	Shapiro-Wilk W test output	***W* = .95, *p* =.01**	***W*=.90, *p*< .001**	***W*= .91, *p* = .02**
Role 2 ‘friend and mentor’	Mean	7.08	10.62	8.81
	Shapiro-Wilk W test output	***W*= .93, *p* <.01**	*W*=.98, *p* =.15	*W*= .96, *p*= .40
Role 3 ‘tool’	Mean	5.60	4.85	5.73
	Shapiro-Wilk W test output	***W*=.95, *p*=.01**	***W*=.89, *p*<.001**	*W*=.97, *p* = .57

Table 7. *Results of the mean comparison tests of the clusters for each role.*

	Role 1 ‘boss and manager’	Role 2 ‘friend and mentor’	Role 3 ‘tool’
Cluster 1 & cluster 2	$z = 11.53$, $p < .001$	$z = -11.53$, $p < .001$	$z = 11.53$, $p < .001$
Cluster 2 & cluster 3	$z = -9.95$, $p < .001$	$z = 9.95$, $p < .001$	$z = -9.95$, $p < .001$
Cluster 1 & cluster 3	$z = 9.22$, $p < .001$	$z = -9.22$, $p < .001$	$z = -9.22$, $p < .001$

Expected comments of activity trackers for each activity tracker role

A thematic analysis was conducted for the third open-ended creative writing question: *“If your activity tracker could talk, what do you think it would say about you? And why?”*. Themes of comments that people expected their activity trackers to say if it could talk were compared for each perceived activity tracker role. Main themes that were identified in the data were: (1) negative comments, containing comments about too much or not enough exercise of

the user, complaints about commitment of the user or any statements with yelling, angry or negative tone, (2) positive comments, containing comments about a good amount of exercise, compliments for the user, or positive comments about commitment of the user (3) comments with specific feedback for the user, (4) comments about goals or goalsetting, (5) comments about sleeping more or better and (6) motivational comments. The average of the number of times participants in each cluster mentioned one of these themes are displayed in Appendix M and Figure 12 shows the sum of these results for the main themes visually.

Negative comments. It was noteworthy that the number of times participants mentioned that their activity tracker would make negative comments if it could talk was highest for participants in all clusters. Sub-themes in the negative comments were: (1) Too much variation in being active, (2) Comments about too much exercise, (3) Complaints about laziness or not being active, (4) Negative comments on commitment of the user and (5) yelling, angry or negative tone. This suggested that in general, participants expected their activity trackers to have negative comments on their activities or behavior, regardless of the perceived role of their activity tracker. Examples of comments that participants expected their activity trackers to make were *"Move your butt you lazy human!"* as a negative comment, or *"I think it would say I'm active and enthusiastic about exercise and movement!"* as positive comment. More examples of comments for each identified theme were added in Appendix M as well. The sum of the average times that a negative comment was expected for the activity tracker was highest for participants in cluster 1 (0.72 times per person). The perceived role of cluster 1 was boss and manager. The role of 'boss and manager' was perceived as demotivating, powerful/ dominant/ direct in terms of traits of the two-dimensional model so it did make sense that the expected number of negative comments was highest for this role. The sum of the average expected number of negative comments was almost equal for participants in cluster 2 and cluster 3 (0.53 and 0.54 respectively). However, it was noteworthy that comments with yelling,

angry and negative tone were expected most by participants who perceived their activity tracker as a tool.

Motivational comments. The main theme of motivational comments consisted of the following sub-themes: (1) I can help you, (2) Keep going/ you are doing well, (3) You are capable/ you can do it and (4) Push yourself. The sum of the average number of times participants in each cluster mentioned one of these motivational sub-themes was highest for participants in cluster 2 (0.03 in cluster 1, 0.18 in cluster 2 and 0.08 in cluster 3). The role of activity tracker of participants cluster 2 was perceived 'friend and mentor' so it made sense that the sum of the average times per person that a motivational comment was expected was highest for cluster 2.

Positive comments. Just like the sum of the average times per person that a motivational comment was expected was highest for cluster 2, the sum of the average times per person that a positive comment was expected was highest for cluster 2 as well (0.10 in cluster 1, 0.24 in cluster 2 and 0.15 in cluster 3). The main theme of positive comments consisted of the combined sub-themes of positive comments on amount of movement or activity and positive comments on commitment. Some positive comments could also be seen as motivational comments. For example, when a participant mentioned the expected positive comment: *"It tells me to keep going and you are doing great."*. However, comments that were specifically focussed on positivity about the amount of exercise, or positive comments about commitment of the user were attributed to the theme of positive comments and only several positive comments where participants expected their activity tracker to give them compliments also were motivational comments. This latter type of comments was attributed to the theme of motivational comments.

Again, the fact that the average times per person that a positive comment was expected was highest for cluster 2 could be explained by the fact that participants in cluster 2 perceived

the role of their activity tracker as ‘friend and mentor’ and this role was described by terms like friendly-nice, helpful, social and reliable-trustworthy. In addition to that, the role of ‘friend and mentor’ scored high on traits of friendly, motivating and gentle in the two-dimensional model.

The least average amount of positive comments that would be made by an activity tracker if it could talk was expected by participants in cluster 1 with the role of ‘boss and manager’. This finding was in concordance with the results on the sum of the average amount of expected negative comments.

Comments about sleeping more or better. It was noteworthy that comments about sleeping more or better were expected by participants to a relatively large extent. After negative and positive comments, comments about sleeping more or better were expected most when adding the number of times participants in the clusters mentioned the themes. Since comments about sleeping more or better do not clearly overlap with traits or terms used by participants to describe the activity tracker, several different possibilities existed for participants from what cluster said their activity would make such comments most. It could be expected that participants in cluster 3 would expect their activity tracker to make comments about sleeping more or better most often since such comments seem rather functional and participants in cluster 3 perceived their activity trackers as a functional tool. However, comments about sleeping more or better could also be perceived as effective, strict or powerful – strong – pushy – bossy comments, which overlap with the role of ‘manager and boss’ in cluster 1. Or such comments about sleep could be perceived as an advice, which would mean participants in cluster 2 would expect their activity tracker to make such comments.

From the results it was clear that comments about sleeping more or better were expected most by participants in cluster 1 if their activity tracker could talk. The average number of times per person that a comment about sleeping was expected was 0.27 for participants in cluster 1, 0.15 for participants in cluster 2 and 0.04 for participants in cluster 3. This indicated

that comments about sleeping more or better are likely to be perceived as effective, strict or powerful – strong – pushy – bossy comments.

Comments about goals or goalsetting. The number of times that participants expected their activity tracker to make comments about goals or goalsetting if it could talk was highest for participants in cluster 2 (0.13 in cluster 1, 0.19 in cluster 2, 0.08 in cluster 3). These participants perceived the role of their tracker as 'friend and mentor', which was role that scored high on motivating and active traits. Furthermore, characters to describe cluster 2 were 'army sergeant', 'cheerleader', 'motivator', 'trainer', 'coach' and 'friend' which were characters described by terms like encouraging – motivating – energizing, inspiring, supportive, fast and caring. So, it made sense that comments about goals or goalsetting were expected most by participants in cluster 2. However, participants in cluster 1 (role of 'boss and manager') also expected comments about goals or goalsetting relatively much. This was explained by the fact that a boss or manager also often focuses on goals.

Comments with specific feedback. The main theme of comments with specific feedback was made up from feedback on improving activeness or feedback on improving health or lifestyle. For both of these sub-themes, participants in cluster 1 most often expected their activity tracker to make comments with specific feedback. This was possibly explained by the 'coach' character in the role of 'friend and mentor'. The average number of times per participant that comments with specific feedback were expected were 0.10 in cluster 1, 0.04 in cluster 2 and 0.08 in cluster 3. In comparison to the highest score in cluster 1, the score in cluster 3 was also relatively high. This made sense since comments with specific feedback are often useful-practical-convenient, functional, accurate, effective, advising, helpful and informative-interesting-insightful, which were terms that were used to describe the role of 'tool' of cluster 3. However, the number of times that participants expected their activity

trackers to make comments about specific feedback was very low and therefore no real conclusions could be based on the results of this category.

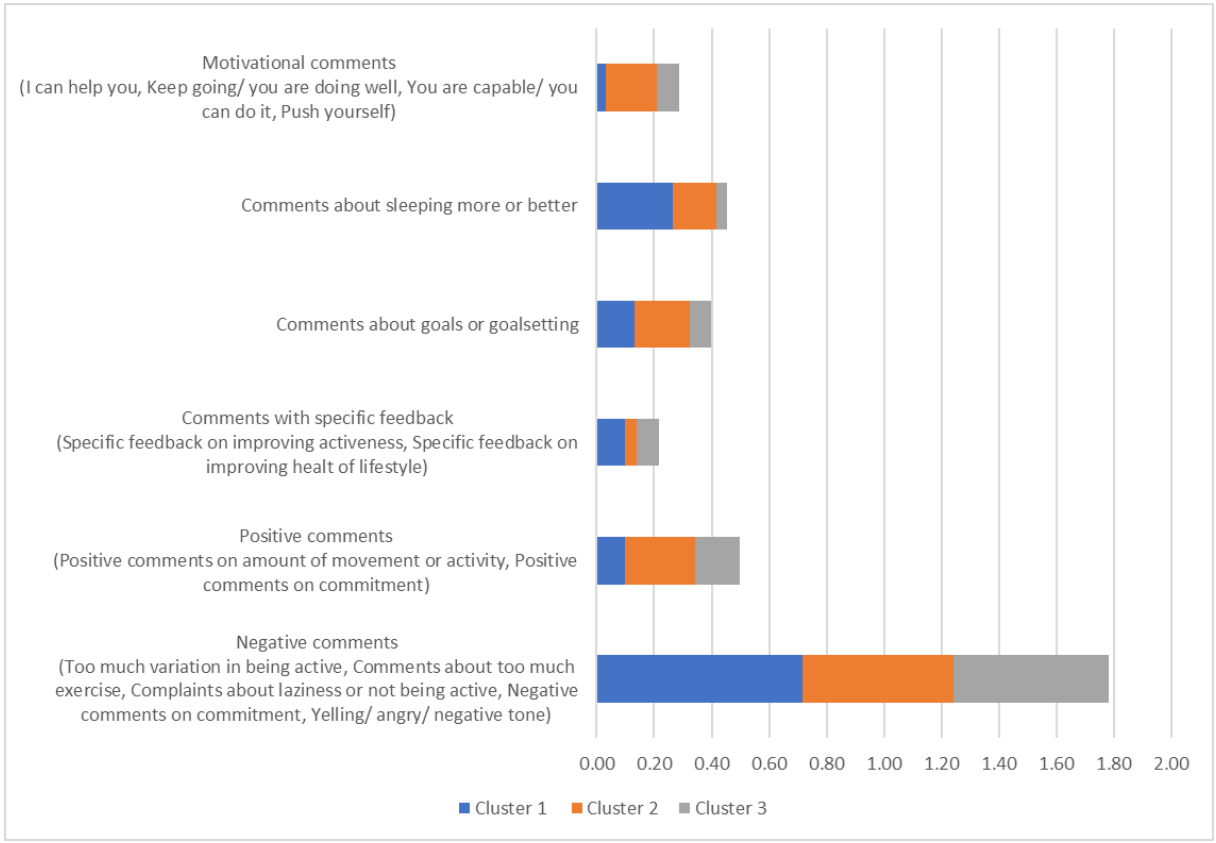

Figure 12. Visual representation of the average of the number of times participants in each cluster mentioned terms corresponding to the identified themes to answer the question *""If your activity tracker could talk, what do you think it would say about you? And why?"*.

User-Tracker relationship

CART-Q items. The perceived nature of the relationship between the user and their tracker was derived from participants' answers on CART-Q. A Principal Component Analysis with three factors to test the correlations amongst the relationship constructs (closeness, commitment and complementarity) of CART-Q resulted in a Rho value of 0.69 and relatively low unexplained eigenvectors. The output after promax rotation is shown in Table 9. Component loadings below 0.25 are shown as blanks since these loadings were too low to be relevant.

Almost all of the CART-Q statements aimed at the relationship construct of commitment (statement 1 to 6) clearly loaded on component 1. Only the statement *"My activity tracker is committed to me"* (statement 5) did not load on this component. Component 1 was nonetheless identified as the component of commitment. In addition to most of the statements aimed at commitment, one of the statements aimed at the relationship construct of closeness, *"I like my activity tracker"* (statement 7), loaded on component 1 as well. No clear reason was found why this statement of closeness loaded on the component of commitment. The statement *"My activity tracker is committed to me"* (statement 5) did not load on the component of commitment (component 1) but instead it loaded on component 3. Although this statement loaded on component 3, it did not strongly load the component (loading = 0.26, unexplained eigenvector = 0.36) and since it also did not load strongly on any of the other components, so this statement was removed for further analysis.

Component 2 was identified as the component of complementarity since most of the statements aimed at complementarity (statement 12 to 17) loaded on this component. However, statements *"Me and my activity tracker function well in achieving goals." "When my activity tracker interacts with me, it does the best it can."* (statements 12 and 17 respectively) did not load on this component. These statements did not load on any of the other components either and explained eigenvectors were relatively high (.47 and .40 respectively) so these statements were removed for further analysis.

Finally, component 3 was identified as the component of closeness. However, not all of the statements aimed at the relationship construct of closeness loaded on component 3. In addition to the statement *"I like my activity tracker"* (statement 7) that loaded on the component of commitment, the statement *"I trust my activity tracker"* (statement 8) did not have a component loading above 0.25 on any of the components in the principle component

analysis and the unexplained eigenvector was 0.38, which is relatively high. Therefore this statement was removed as well.

A principle component analysis with the removed statements resulted in a Rho value of 0.74, which indicated a 5% increase in the contained variance in comparison to the Rho value without the removed statements. Furthermore, individual variances for the components were lower. The variance of component 1 was 4.14 with the items removed and 4.95 without the items removed. The variance of component 2 was 2.89 with the items removed and 3.16 without the items removed and the variance of component 3 was 2.13 with the items removed and 2.50 without the items removed. The obtained components were used for further analysis with CART-Q to examine the user-tracker relationship.

The internal consistency for each of the obtained components was examined again after removing the four statements and internal consistency was somewhat lower for the constructs of closeness and complementarity, but the difference could be neglected since values for Cronbach's alpha were still high. Cronbach's alpha was 0.83 for closeness (opposed to 0.85 without removing items) and Cronbach's alpha was 0.85 (opposed to 0.88 without removing items) for complementarity. Internal consistency for the construct of commitment was 0.94 (opposed to 0.91 without removing items), which was still very high.

Table 9. *Output of the principle component analysis and promax rotation for CART-Q items. Factor loadings below 0.25 are blank. Question numbers 5, 8, 12 and 17 were removed before further analysis.*

Question		**Component number and description**			**Unexplained eigenvectors**
Nr.	**Description**	**1.** Commitment	**2.** Closeness	**3.** Complementarity	
1	I feel close to my activity tracker.	0.29			.38
2	I feel committed to my activity tracker.	0.34			.31
3	I want to use my activity tracker every day.	0.45			.23
4	I want to keep using my activity tracker for a long time.	0.47			.21
5	My activity tracker is committed to me.			0.26	.36
6	I feel like my activity tracker will keep helping me for a long time.	0.45			.15
7	I like my activity tracker.	0.38			.37
8	I trust my activity tracker.				.47
9	I respect my activity tracker.			0.32	.31
10	My activity tracker respects me.			0.65	.13
11	My activity tracker likes me.			0.66	.11
12	Me and my activity tracker function well in achieving activity goals.				.47
13	When I interact with my activity tracker, I feel at ease.		0.43		.40
14	When I interact with my activity tracker, I am ready to do my best.		0.43		.31
15	When I interact with my activity tracker, I adopt a friendly stance.		0.54		.21
16	When my activity tracker interacts with me, it adopts a friendly stance.		0.53		.29
17	When my activity tracker interacts with me, it does the best it can.				.40

Relationship scores. The answers on the remaining CART-Q items were processed by obtaining the mean of participants' answers on each of the three components as well as on all items combined. The mean score of the three components combined indicated the nature of the tracker-user total relationship based on CART-Q. Furthermore, the scores for the user-tracker relationship were compared for each perceived role of an activity tracker. The resulting mean and standard deviations are shown in Table 10.

Scores on the items ranged from 1 to 7 and as can be seen in Table 10, none of the participants gave an average score below 1.67 on the component of commitment. Furthermore, none of the participants perceived the relationship with their tracker with an average score below 1.64. The mean for the component of commitment was highest (M = 5.56, SD = 1.16). The mean for the component of closeness was 4.48 (SD = 1.39) and the mean for the component of the component of complementarity was 4.96 (SD= 1.08). The total mean for the tracker-user relationship across all participants was 5.00 (SD=1.04), which is a high value on a scale from 1 to 7.

Table 10. *Overview of the mean and the standard deviation of the relationship scores for each of the relationship constructs as well as the total relationship score.*

Role		Commitment	Closeness	Complementarity	Total relationship score (CART-Q)
'Boss and manager'	Mean	5.05	4.10	4.44	4.53
	SD	1.27	1.38	1.07	1.03
'Friend and mentor'	Mean	6.15	5.02	5.56	5.58
	SD	0.71	1.18	0.89	0.76
'Tool'	Mean	5.04	3.73	4.42	4.40
	SD	1.21	1.14	0.65	0.84
Total	Mean	5.56	4.47	4.96	4.99
	SD	1.17	1.35	1.09	1.03

Data of the total relationship score was normally distributed for all of the three different roles (W=.98, p = .26 for 'boss and manager', W=.99, p= .58 for 'friend and mentor' and W=.98, p = .80 for 'too'). Multiple two-sample t-tests were conducted to compare the means of the relationship scores per perceived role. By applying Bonferroni correction, the alpha level was

controlled for the fact that multiple tests were conducted. The applied alpha level was .016 (0.05/ 3).

The 60 participants who perceived their activity tracker as ‘boss and manager’ (role 1) (*M* = 4.53, *SD* = 1.03) compared to the 74 participants who perceived their activity tracker as ‘friend and mentor’ (role 2) (*M* = 5.58, *SD* = 0.76) demonstrated a significantly lower value on the total user-tracker relationship score, $t(105) = -6.57$, $p < .001$. The 74 participants who perceived their activity tracker as ‘friend and mentor’ (role 2) (*M* = 5.58, *SD* = 0.76) scored significantly higher on the total relationship score compared to the 26 participants who perceived their activity tracker as ‘tool’ (role 3) (*M*=4.40, *SD* = 0.84) with $t(40) = 6.33$, $p < .001$. However, when the 60 participants who perceived their activity tracker as ‘boss and manager’ (*M* = 4.53, *SD* = 1.03) were compared to the 26 participants who perceived their activity tracker as ‘tool’ (*M*=4.40, *SD* = 0.84), the mean for the total relationship score was higher for the group that perceived their activity tracker as ‘boss and manager’ than for participants who perceived their activity tracker as a tool but there was no significant difference between the total relationship scores for these roles *(*$t(58) = 0.62$, $p = .54$).

Commitment. Data for the relationship construct of commitment was not normally distributed in all of the three different roles. Shapiro-Wilk W test showed that for the perceived roles of ‘boss and manager’ and ‘tool’, data was normally distributed (*W* = .96, p= .06 and *W* = .95, *p*= .20 respectively) but for the perceived role of ‘friend and mentor’, the null hypothesis of normal distribution could not be rejected (*W*=.95, $p < .01$). The relationship score on the construct of commitment was highest for the 74 participants who perceived their activity tracker as ‘friend and mentor’ (*M*= 6.15, *SD* = .71) and this score was significantly higher than the relationship score on the construct of commitment for the 60 participants who perceived their activity tracker as ‘boss and manager’ (*M*= 5.05, *SD* = 1.27) with $z = -5.41$, $p < .001$ as well as for the 26 participants who perceived their activity tracker as ‘tool’ (*M*= 5.04, *SD* =

1.21) with $z = 4.13$, $p < .001$. The relationship score on the construct of commitment was not statistically different for participants who perceived their activity tracker as 'boss and manager' compared to participants who perceived their activity tracker as a tool (t (49) = 0.01, p = .99).

Closeness. Data for the relationship construct of closeness was not normally distributed in all of the three different roles either. Shapiro-Wilk W test showed that for the perceived roles of 'friend and mentor', data was normally distributed (W = .98, p= .16) but for the perceived roles of 'boss and manager' and 'tool', data was not normally distributed (W = .95, p= .01 and W = .85 , p < .01 respectively). Therefore, two-sample Wilcoxon rank-sum (Mann-Whitney) tests were used for comparing means for the three different roles with each other. The relationship score on the construct of closeness was highest for the 74 participants who perceived their activity tracker as 'friend and mentor' (M= 5.02, SD = 1.18) and this score was significantly higher than the relationship score on the construct of closeness for the 60 participants who perceived their activity tracker as 'boss and manager' (M= 4.10, SD = 1.38) with z = -3.78, p <. 001 as well as for the 26 participants who perceived their activity tracker as 'tool' (M= 3.73, SD = 1.14) with $z = 4.26$, p < .001. The relationship score on the construct of closeness was not statistically different for participants who perceived their activity tracker as 'boss and manager' compared to participants who perceived their activity tracker as a tool with $z = 1.28$, p =.20.

Complementarity. Data for the relationship construct of complementarity was normally distributed in all of the three different roles (W = 0.97, p = .08 for the role of 'boss and manager', W = .98, p = .41 for the role of 'friend and mentor' and W= .97, p=.71 for the role of 'tool'). Therefore, two-sample t-tests were used for comparing means for the three different roles with each other. The relationship score on the construct of complementarity was highest for the 74 participants who perceived their activity tracker as 'friend and mentor' (M= 5.56, SD = 0.89) and this score was significantly higher than the relationship score on the construct

of complementarity for the 60 participants who perceived their activity tracker as ‘boss and manager’ (M= 4.44, SD = 1.07) with t (114) = -6.46, p < .001 as well as for the 26 participants who perceived their activity tracker as ‘tool’ (M= 4.40, SD = 0.65) (t (60)=6.89, p< .001). The relationship score for participants who perceived their activity tracker as ‘boss and manager’ compared to participants who perceived their activity tracker as ‘tool’ was again not significantly different (t (74)=0.10, p = .92) just like the difference in means for the relationship constructs of closeness and commitment was not statistically different for the perceived roles of ‘boss and manager’ and ‘tool’.

So, the hypothesis that the perceived role of an activity tracker is correlated with the perceived relationship between the tracker and its user only was confirmed for the perceived activity tracker role of ‘friend and mentor’ since only for this role the total relationship score and the relationship score for each of the different relationship constructs were significantly different from the other roles. The role of ‘friend and mentor’ and the user-tracker relationship were positively correlated so when a user perceives the activity tracker more as a friend and mentor they also perceive the relationship with their tracker as being better.

Commitment to self-tracking

A Shapiro-Wilk W test showed that the C2ST scores were normally distributed (W= .99, p = .09). The means of C2ST per perceived activity tracker role, were inspected and results showed that commitment to self-tracking was highest for participants who perceive their activity tracker as ‘friend and mentor’ (M= 4.60, SD= 0.92), which was clearly higher than the mean for participants who perceive their activity tracker as ‘boss and manager’ (M= 3.83, SD= 1.21) with a significant difference (t(107) = -4.09, p < .001) and for participants who perceive their activity tracker as ‘tool’ (M= 3.64, SD= 1.06) with a significant difference as well (t(39) = 4.11, p < .001). The mean for commitment for participants who perceive their activity tracker

as ‘boss and manager’ was higher than the mean for participants who perceive their activity tracker as ‘tool’ but this difference was not significant ($t(54)= 0.72$, $p = .48$). The total mean for commitment to self-tracking for all participants was 4.18 ($SD = 1.16$) and this mean was compared to the mean score on the construct of commitment in the user-tracker relationship using Spearman’s correlation. There was a significant strong positive correlation between C2ST and commitment to the tracker ($r = .58$, $p = < .001$). So if the commitment to the practice self-tracking in general was higher, commitment to the tracker in the user-tracker relationship also was higher. Spearman’s correlation tests were also conducted for comparing C2ST to the relationship construct of commitment for each perceived role and the same result was found. For each of the perceived roles, significant positive correlations between C2ST and commitment in the user-tracker relationship were found ($r = .54$, p = < .001 for ‘boss and manager’, $r = .48$, $p = < .001$ for ‘friend and mentor’ and $r = .58$, $p = < .01$ for ‘tool’). The correlation coefficients were moderate to strong. These results confirmed the hypothesis that commitment to activity tracking is correlated with the commitment to the tracker in the user-tracker relationship. For each of the perceived roles, significant positive moderate to strong correlations between C2ST and the total relationship score were found as well ($r= .52$, $p<.001$ for ‘boss and manager’, $r = .50$, $p< .001$ for ‘friend and mentor’ and $r = .64$, $p< .001$ for ‘tool).

Discussion

This thesis extended on the complex connection between different roles that an activity tracker can fulfill and the relationship between a tracker and its user. Because of the complex interplay of emotional and rational reactions to activity trackers it is difficult to determine how a good relationship between the user and the tracker is established. By gaining more insights into the effect of the role that a user perceives of their activity tracker on the perceived user-tracker relationship, a contribution was made to enhance our understanding of relational,

experiential and emotional responses to activity trackers and to help close the knowledge gap regarding possible relationships that users build with their devices. The research question was aimed at finding out if there is a connection between a user's motivation to engage in activity tracking and how a user perceives the role of their activity tracker. Furthermore, the research question was aimed at revealing how these concepts affect each other and the user-tracker relationship.

Main results

Commitment to activity tracking and the user-tracker relationship. As mentioned in the introduction, not much was known about the connection between commitment to activity tracking and the user-tracker relationship. The results of this thesis indicate that these two concepts are positively correlated, confirming the hypotheses that if commitment to the practice self-tracking was higher, the commitment to the tracker in the user-tracker relationship was better. This was independent of the role that a user perceives of their tracker. No previous literature was found on how commitment to self-tracking affects the relationship between the user and the tracker but the finding that both concepts are positively correlated sheds a little more light on the tracker-user relationship.

Commitment to activity tracking and type of motivation. Although Adie and Jowett (2010) stated that an athlete's perception of commitment in the trainer-athlete relationship is not positively correlated with intrinsic motivation, the majority of previous literature clearly suggested that commitment to activity tracking is a consequence of motivation to engage in activity tracking (Sheeran and Webb, 2016), especially of intrinsic instead of extrinsic motivation (Gavin et al., 2016). This finding was also reported by Hancı et al. (2020), who found that commitment to self-tracking positively correlated with autonomous motivation for tracking and negatively correlated with controlled motivation. Even though no direct

conclusions about the link between motivation and commitment or motivation and the user-tracker relationship could be made based on the results of this thesis, results combined with previous literature suggest that a higher level of commitment indeed is an indication for more autonomous motivations and when commitment was higher, the perceived user-tracker relationship was also scored higher in the results. It was also found that for the role of 'friend and mentor', commitment was higher than for the roles of 'boss and manager' and 'tool' This could, in turn, mean that more autonomous motivations indicates a better user-tracker relationships and that when an activity tracker is perceived as a 'friend and mentor' people also have higher levels of autonomous motivation, as was hypothesized in this thesis.

User-Tracker relationship for perceived roles. The six main themes of comments of activity trackers (positive comments, negative comments, motivational comments, comments with specific feedback, comments about goals or goalsetting and comments about sleeping more or better) that were derived from participants' answers on the open-ended creative writing question asking what a participant would expect their activity tracker to say if it could talk were linked to Jowett, Nicolas and Yang's (2017) coach behavior categories, the corresponding CBS-S items (Côté et al., 1999) and relationship path coefficients of the table in Appendix A. Results of the relationship scores per perceived role are compared with the findings from Jowett, Nicolas and Yang (2017) and are discussed in the next sub sections.

'Friend and mentor'. From the results on relationship scores of CART-Q, it was clear that participants who perceive the role of their activity tracker as 'friend and mentor' perceived the relationship with their activity tracker as best compared to the other roles. This was the case for the total relationship score as well as for the scores on each of the relationship constructs separately. This result also is supported by findings from existing literature. The descriptions for the role of 'mentor and friend' overlap with the identified role of 'tutor' by Lyall and Robards (2018). In this role, an activity tracker is seen as a coach or guide. Lyall and Robards

(2018) stated that especially in this role, commitment and a reciprocal relationship with the user are important. Short and Short (2005) stated that the roles of teacher, learner, organizer and competitor did not impact the trainer-athlete relationship to a high extent but in the role of friend and mentor, a trainer develops a strong relationship with the athlete (Short & Short, 2005).

In addition to that, positive comments, motivational comments and comments about goals or goalsetting were expected most by participants who perceived their activity tracker as 'friend and mentor'. These types of comments are mapped to Jowett, Nicolas and Yang's (2017) coach behavior categories of positive personal report, goal setting and mental preparations of the table in Appendix A. The relationship path coefficients for the total relationship of these coach behavior categories were positive and relatively high compared to the path coefficients for the other coach behavior categories, indicating that Jowett, Nicolas and Yang (2017) also found a high score on the relationship when a trainer adopts the coach behaviors that were mapped to the role of 'friend and mentor'.

However, although the relationship path coefficients for the total relationship were positive, the relationship construct of complementarity showed negative path coefficients for the coach behavior of goal setting in research by Jowett, Nicolas and Yang (2017). A possible reason that the effect of this negative path coefficient was not directly visible in the relationship score of complementarity obtained from the results of this thesis is that multiple coach behavior categories were combined in the role of 'friend and mentor' and therefore the negative path coefficient might be evened out.

'Boss and manager' and 'tool'. The total relationship scores for the roles of 'boss and manager' and 'tool' were close to each other and there was no significant difference in the total relationship score. The scores on each of the relationship constructs were higher for the role of 'boss and manager' than for the role of 'tool'. However, for none of the scores on the

relationship constructs, differences between the means of these scores were significantly different from each other when the role of ‘boss and manager’ and the role of ‘tool’ were compared. These findings are not in concordance with findings from previous research.

When looking at the study by Jowett, Nicolas and Yang (2017), the coach behavior category of negative personal report is mapped to the theme of negative comments if an activity tracker could talk and the score on the theme of negative comments was highest for participants who perceive their activity tracker as ‘boss and manager’. Since comments about goals or goalsetting were expected relatively much for the role of ‘boss and manager’ as well, the coach behavior of goalsetting is linked to this role as well. For the coach behavior category of negative personal report, the path coefficient for the total relationship score as retrieved from research by Jowett, Nicolas and Yang (2017) was lowest of all coach behavior categories. The path coefficient of the relationship construct of closeness was even negative, indicating that the relationship construct of closeness was scored lower when negative personal report was scored higher. Since path coefficient for the relationship construct of complementarity was negative in the coach behavior of goalsetting and almost 0 (neutral) in the coach behavior of negative personal report, a low score for the relationship construct of complementarity was expected as well.

However, both the total relationship as well as each of the relationship constructs were scored higher when the activity tracker was perceived as ‘boss and manager’ than when it was perceived as ‘tool’. In addition to that, Lyall and Robards (2018) already described the role of tool as a possible role of an activity tracker as a cause for a satisfying relation between the tracker and the user and based on combining linked coach behavior categories of goal setting, physical skills and planning and technical skills (Jowett, Nicolas and Yang, 2017) and research of Lyall and Robards (2018), it was expected that when the role of the activity tracker is perceived as a tool, the relationship between the user and the tracker is perceived as satisfying

and positive and receives a higher score compared to the role of ‘boss and manager’. This again is not in concordance with the results obtained in this thesis. The hypothesis that the perceived role of an activity tracker affects how the user-tracker relationship is perceived was only confirmed for the perceived role of ‘friend and mentor’.

Explanation of main results

The contrast in the results of this thesis and findings from previous literature could be explained by several reasons. Especially the representations of perceived roles of ‘boss and manager’ and ‘tool’ showed some surprising results.

‘Boss and manager’ in two-dimensional model. Terms that participants used to describe their activity tracker as ‘boss and manager’ were: accurate, effective, strict and powerful – strong – pushy – bossy, monitoring, precise- timely, invasive- annoying, advising and independent of which many are clearly negative on the evaluative dimension and positive on the dominance dimension. The distribution of data points in figure 10 also showed that the role of ‘boss and manager’ is perceived as negative on the evaluative dimension and this was also supported by the fact that the role of ‘boss and manager’ was perceived as distant and cold-blooded in terms of traits of the two-dimensional model. However, at the same time, activity trackers perceived as ‘boss and manager’ were perceived most as weak/ subdominant in comparison to the other perceived roles. This can be explained by the large spread of data points in figure 10 for the role of ‘boss and manager’. Whereas for the role of ‘friend and mentor’ data points were clearly positive on the evaluative as well as the dominance dimension and data points for the role of ‘tool’ were clearly positive on the dominance dimension and spread around 0 (neutral) on the evaluative dimension, data points for the role of ‘boss and manager’ occurred on the positive and negative axes of both dimensions. It could be that while some participants perceive the relationship with their activity tracker as good when the

perceived role is ‘boss and manager’, other participants perceive the relationship with their activity tracker as negative. The fact that standard deviations in the relationship scores are much larger for the role of ‘boss and manager’ than for the other two perceived roles also indicates this possibility.

Acceptance of negativity on evaluative dimension for role of ‘boss and manager’. It could also be that even when people perceive a boss or a manager as negative in terms of the evaluative dimension in the two-dimensional model, people accept this in the interaction with a boss or manager and therefore it does not have a large impact in the relationship with the boss or manager. For example when a hierarchy between a boss and an employee exists, the evaluative dimension is perceived negative but the relationship can still be good. So, it could be that people do not always perceive the terms and traits used to describe the activity tracker as something negative on the evaluative dimension as something negative in the user-tracker relationship as well.

‘Tool’ in two-dimensional model. Another possible reason for contrast in the results of this thesis and findings from previous literature was the representation in the two-dimensional model of activity tracker with the perceived role of ‘tool’. Lyall and Robards (2018) described an activity tracker with the role of tool as something helpful, functional, useful, informative, optional and as a means to an end. The terms they used to describe a tool did not suggest that an activity tracker with the perceived role of ‘tool’ is dominant. However, results of this thesis showed that the role of ‘tool’ was perceived most as powerful/ dominant/ direct in the two-dimensional model compared to the other roles. At the same time, traits of indirect, gentle and weak/ subdominant were perceived lowest. Furthermore, it was noteworthy that even though activity trackers perceived as a ‘tool’ were perceived as indirect and weak or subdominant, comments with yelling, angry and negative tone were expected most by participants who perceived their activity tracker as a ‘tool’. The fact that negative comments

were expected by participants could explain why activity trackers that were perceived as a tool also were perceived with lower relationship scores than activity trackers that were perceived as 'boss and manager' (even though the difference between these scores was not significant). It could also explain why activity trackers perceived as 'tool' were perceived as dominant.

No effect on relationship. As already mentioned, Short and Short (2005) stated that the roles of teacher, learner, organizer and competitor did not impact the trainer-athlete relationship to a high extent but in the role of friend and mentor, a trainer develops a strong relationship with the athlete (Short & Short, 2005). The fact that only the score on the perceived user-tracker relationship was significantly different from the other roles when the tracker was perceived as 'friend and mentor', seems to confirm Short & Short's (2005) findings from the sports domain in the activity tracking domain. So that only in the role of 'friend and mentor' the perceived role of the activity tracker has an effect on the user-tracker relationship. When looking at the means of the relationship scores for each perceived role, this would mean that total relationship scores of 4.53 for the role of 'boss and manager' (*SD*=1.03) or 4.40 for the role of 'tool' (*SD*= 0.84) (see table 10) on a scale from 1 to 7 are values that do not indicate a strong impact on the user-tracker relationship.

The contrast in the results of this thesis and findings from previous literature could also have been caused by several different limitations, which are discussed in the next section.

Limitations and future research

CART-Q. Two issues arose after a principle component analysis was conducted on CART-Q (Coach-Athlete Relationship Questionnaire). First, according to Jowett & Ntoumanis (2004) the CART-Q statement "*I like my activity tracker"* belongs to the relationship construct of closeness, but the results of the principle component analysis in this thesis showed that this statement loaded on the component of commitment. Jowett & Ntoumanis (2004) also

conducted a principle component analysis and found that items for the constructs of commitment and complementarity loaded on the same factor. They explained this by stating that constructs of closeness, commitment and complementarity can be correlated but claimed that these constructs should nonetheless be conceptualized as different dimensions, even despite potentially high correlations (Jowett & Ntoumanis, 2004). So according to them, a CART-Q statement for one relationship construct that loads on a different components was not a limitation.

A second issue was that the statements that were removed from the list of CART-Q statements for further analysis did not load on any of the components with a component loading above 0.25. The four removed statements were: *"My activity tracker is committed to me",* "*When my activity tracker interacts with me, it does the best it can"*, *"I trust my activity tracker"* and "*Me and my activity tracker function well in achieving goals"*. The first two statements were the added reciprocity items based on research by Biocca & Harms (2002). These reciprocity items added to CART-Q were adapted to be suitable in the activity tracking domain but there was no validation to determine whether they did indeed measure the targeted relationship components. The statements that were removed during the analysis because they did not load on any component were two out of the six reciprocity statements added to the CART-Q statements, which is a lot. So, in future research added reciprocity items should be validated by conducting a pilot study and the statements *"My activity tracker is committed to me",* "*When my activity tracker interacts with me, it does the best it can"* should be replaced by other statements aimed to measure reciprocity in the user-tracker relationship.

Unequal sample sizes. The fact that for the roles of 'boss and manager' and 'tool', findings of the role on the user-tracker relationship are not significantly different and are in contrast with existing research could be because the number of participants who identified their activity tracker as a tool was only 26. This number was 60 for the role of 'boss and manager'

and 74 for the role of ‘friend and mentor’. If the number of participants who identified their activity tracker as ‘tool’ would have been higher, the possibility that relationship scores for the roles of ‘boss and manager’ and ‘tool’ were significantly different could have been higher and the conclusions would have been stronger.

The limitation of the unequal distribution of participants in categories also was relevant for the distribution of motivation categories. Even though an attempt was made to collect participants with different types of motivations by using pre-screeners in the online survey, the results showed an unequal distribution in motivation types. 62.14% of all participants fell into the categories with intrinsic or integrated regulatory styles, which are the two regulatory styles on the left side of the SDT continuum of Figure 1, representing autonomous motivation. Only 3.95% of participants reported purely controlled motivation. In existing literature, reported effects of controlled motivation on the trainer-athlete relationship were not found and the results in this thesis revealed that it was very difficult to gather enough participants with high levels of controlled motivation that engage in activity tracking anyway.

Future research should try to avoid the problem of the unequal distribution of participants in categories by either collecting larger sample sizes or by looking into applying more effective pre-screeners for the study. To make sure participants with controlled motivation to engage in activity tracking are included to an equal extent as participants with autonomous motivation, a pre-selection questionnaire for the type of motivation could be applied where participants are selected based on their answers on this pre-selection questionnaire. One of the possible variables to use in pre-screening is the level of technological affiliation. For this thesis it was desired that participants with different levels of technological affiliation were included in the sample but the level of technological affiliation among participants was not as equally distributed as desired. It could be that participants with lower levels of technological affiliation are often also less autonomously motivated to engage in

activity tracking, that the level of technological affiliation affects personal preferences in the interaction with an activity tracker or that this level affects how a user perceives the activity tracker. However, these suggestions still has to be validated.

To make sure participants who perceive their activity tracker as ‘tool’ are included to an equal extent as participants the perceive their activity tracker as ‘boss and manager’ or ‘friend and mentor’, the findings and descriptions of the identified roles in this thesis could be used in future research to effectively apply pre-screeners for the study as well.

Identified roles. Another limitation was that the role of ‘boss and manager’ was not identified as a coaching role in previous literature whereas the roles of ‘friend and mentor’ and ‘tool’ were identified by Lyall and Robards (2018), Short & Short (2005) and Niess et al. (2018). For this reason the expectations for the effect of the role of ‘boss and manager’ on the user-tracker relationship were merely based on mapping Jowett, Nicolas and Yang’s (2017) coach behaviors to comments that participants expected their activity trackers to make. So the reason that results of this thesis were in contrast with expectations based on literature could be because there was no strong foundation underlying the expectations for effect of the role of ‘boss and manager’ on the user-tracker relationship.

The difference in findings and previous literature for the role of ‘tool’ could be because the description of activity trackers as a ‘tool’ in this thesis might not be the same as the descriptions in previous literature. In this thesis, activity trackers described with the perceived role of ‘tool’ were combined from the characters of ‘expert’, ‘guard’, ‘gadget’ and ‘project planner’. So even if activity trackers that were described as a tool by Lyall and Robards (2018) were not expected to be dominant, it could still be that activity trackers that were described as a tool in this thesis are dominant. Future research should try to validate this thesis’ findings on the representation of the perceived role of ‘tool’ in the two-dimensional model to reveal if this indeed was the case.

Practical implications

Only when the activity tracker was perceived as ‘friend and mentor’, the user-tracker relationship was scored high and significantly different from the other perceived roles, indicating that people perceive the relationship with their activity trackers as good when they perceive their activity tracker as a ‘friend and mentor’. Concepts that describe a technology’s experiential effects on a person can be very useful for ideation and insight (Peters et al., 2018). Experiential effects in the activity tracking domain are the factors that influence the relationship between the user and the tracker, like motivation to engage in activity tracking and the role that people perceive of their activity (Yoo, 2010). While designing for activity trackers and improving them in order to fulfill the technology’s full potential and to ensure users stay engaged in the long term, the positive effect of the perceived role of ‘friend and mentor’ on the user-tracker relationship should be kept in mind. Traits used to describe an activity tracker as ‘friend and mentor’ are: friendly, motivating, gentle and active and activity trackers with this perceived role were positive on the evaluative and dominance dimensions in the two-dimensional model. Furthermore, positive comments on the amount of movement or activity, comments about goals or goalsetting and motivational comments like: keep going/ you are doing well, you are capable/ you can do it and push yourself are expected by participants who perceive their activity trackers as ‘friend and mentor’. These findings can be applied by creating activity trackers that adopt these traits and use these types of comments in order to optimize emotional or experiential responses to activity trackers.

Furthermore, if significant effects of perceived role on user-tracker relationship would have been found for the perceived roles of ‘boss and manager’ and ‘tool’ as well, these findings could be used for personalization in the development of activity trackers as suggested by Lupton (2014) and Gouveia et al. (2015). By first examining a person’s personal preference or

character, the descriptions and findings of this thesis could be used to personalize activity trackers by adapting its role. For example when a person would like to get comments about goals or goalsetting, the tool could adopt the role of 'friend and mentor' or 'boss and manager' but if the person would like the activity tracker to be friendly, active and motivating, the activity tracker should adopt the role of 'friend and mentor'. When the person would not care a lot about positivity of the tracker but wants to receive comments with specific feedback, the activity tracker should adopt the role of 'boss and manager'. A person's motivation could be of influence in the personal preferences.

So, by adapting activity tracker's more to the users' needs, an optimal user experience can be designed, which would increase chances on commitment to self-tracking and a positive attitude towards the tracking device.

Take home message

This thesis has identified three different roles that participants perceived of their activity trackers: (1) 'boss and manager, (2) 'friend and mentor' and (3) 'tool'. It was shown that the perceived activity tracker role of 'friend and mentor' has a positive effect on the total user-tracker relationship as well as on each of the relationship constructs of commitment, closeness and complementarity. The relationship construct of commitment was positively related to commitment to activity tracking in general so when an activity tracker is perceived as 'friend and mentor', people generally are committed to activity tracking. This, in turn, increases the chance that the technology's full potential can be reached and users optimally benefit from using their activity tracker (Yoo, 2012).

The research question "*Does a connection between a user's motivations to engage in activity tracking and how a user perceives the role of their activity tracker exist and if so, how do these concepts affect each other and the relationship between the user and the tracker?"*

could only be answered partly. The part of the research question about the connection between a user's motivations to engage in activity tracking, the user-tracker relationship and how a user perceives the role of their activity tracker could not be examined but since it was shown that the one of the perceived roles positively effected the commitment to activity tracking as well as the user-tracker relationship, the only thing that could not be examined was if there is a difference in this effect for different motivation categories. If the effect of perceived roles on a user's commitment and the user-tracker relationship for different motivation categories would have been examined, it could even be possible that a more clear effect for the roles of 'boss and manager' and 'tool' on the user-tracker relationship was found since participants with different motivations possibly prefer different interactions with their tracking devices.

The findings in this thesis shed new light on experiential effects of technology by exploring the effect of the role of an activity tracker on the user-tracker relationship and trying to unravel the complex relationship between a user and an activity tracker. A substantial part of the used literature originated from the sports domain and expectations in this thesis was partly based on findings from the sports domain. The outcomes of this thesis indicate that knowledge gaps in the activity tracking domain can indeed be closed by looking at the sports domain, as was already suggested by the CASA paradigm of Reeves and Nass's (1996) media-equation theory. A better understanding of the user-tracker relationship can help in developing and designing for activity trackers in order to fulfill the technology's full potential and to ensure users stay engaged and committed in the long term (Yoo, 2010). That way, users of activity trackers are supported in doing physical exercise, which could call a halt on the "obesity epidemic", decreasing negative impacts on pulmonary functions, risks of cardiovascular diseases, certain types of cancer and premature death, but also helps people stay in good mental health.

Scientific Relevance and Ethical Considerations

Trying to unravel the complex relationship between a user and an activity tracker and trying to enhance our understanding of relational, experiential and emotional responses to activity trackers involves some ethical considerations and societal impact. Besides the obvious ethical concerns and considerations involved in handling the privacy sensitive information that activity trackers collect (Solove, 2011; Su et al., 2016; Tuovinen & Smeaton, 2019; Zimmer et al., 2018), an ethical concern closely linked to this thesis is how to deal with the intimacy of activity trackers and the relationship that is built with the tracker. As already mentioned, a high level of intimacy is involved with the use of activity trackers as they are worn on the body for most part of daily life (Hancı et al., 2019). Furthermore, people can get obsessed with an activity tracker and with the amount of sleep, calorie intake or exercise. Many participants mentioned this in the open-ended questions of this thesis as personal or general disadvantages in the use of their activity tracker. For example, participant said: *"When you use a smart gadget like this you get used to it, and you look at is / listen to it / pay attention, even if there's no need of that. So you there can be some kind of bad addiction. It's the biggest disadvantage personal and general: you got much information about your activity, but maybe you don't need those information anyway, and it can take time from your everyday life ."*, *"It can create dependency"*, *"I look at my activity tracking a lot. It is addicting. You have to carry your activity tracker everywhere."* and *"[A disadvantage is] getting obsessed with stats to the point of placing it as a priority above other activities".*

When a user is committed to the activity tracker, they are also committed to activity tracking in general. Even though a higher commitment to the activity tracker and to activity tracking in general can increase the chance that users benefit from using an activity tracker (Fritz et al., 2014), it might also increase the chance that users experience extreme negative consequences from using the activity tracker. Such consequences include creating an obsession

with the data, or becoming overly dependent on the tracking device and not thinking critically anymore but also negative effects on an individuals' sense of competence, possibly resulting in a decrease of self-esteem (Wagner & Morse, 1975; White, 1963). With regards on the disadvantages of activity trackers on the sense of competence of self-esteem, participants said: *"I can feel like I've failed if I haven't met or got close to 10,000 steps in a day. Sometimes it's not possible due to certain work commitments but it has a negative affect on my mood."* and *"[a disadvantage is] consciousness of body image (feeling not fit enough etc)."*. For these reasons, it is important to be aware that making even minor changes in the functionality and software of an activity tracker can have major impact on people's lives. We should ask ourselves if it is desirable that user engagement and commitment are high before implementing the obtained knowledge about the user-tracker relationship and we should handle with care when developing technology that has such relational, experiential and emotional effects on users.

References

Adams, K. F., Schatzkin, A., Harris, T. B., Kipnis, V., Mouw, T., Ballard-Barbash, R., Hollenbeck, A., & Leitzmann, M. F. (2006). Overweight, Obesity, and Mortality in a Large Prospective Cohort of Persons 50 to 71 Years Old. *New England Journal of Medicine*, *355*(8), 763–778. https://doi.org/10.1056/NEJMoa055643

Adie, J., & Jowett, S. (2010). Meta-Perceptions of the Coach–Athlete Relationship, Achievement Goals, and Intrinsic Motivation Among Sport Participants. *Journal of Applied Social Psychology*, *40*, 2750–2773. https://doi.org/10.1111/j.1559-1816.2010.00679.x

Attig, C., & Franke, T. (2019). Abandonment of personal quantification: A review and empirical study investigating reasons for wearable activity tracking attrition. *Computers in Human Behavior*, *102*, 223–237. https://doi.org/10.1016/j.chb.2019.08.025

Bandura, A. (1986). Social Foundations of Thought and Action. In *The Health Psychology Reader* (pp. 94–106). SAGE Publications Ltd. https://doi.org/10.4135/9781446221129.n6

Bandura, A. (1994). Self-efficacy. *Encyclopedia of Human Behavior*, *4*, 71–81.

Berger, C. R. (2008). Power, Dominance, and Social Interaction. In *The International Encyclopedia of Communication*. American Cancer Society. https://doi.org/10.1002/9781405186407.wbiecp093

Berscheid, E., Snyder, M., & Omoto, A. M. (1989). The Relationship Closeness Inventory: Assessing the closeness of interpersonal relationships. *Journal of Personality and Social Psychology*, *57*(5), 792–807. https://doi.org/10.1037/0022-3514.57.5.792

Biddle, S. J. H., & Fox, K. R. (1989). Exercise and health psychology: Emerging relationships. *British Journal of Medical Psychology*, *62*(3), 205–216. https://doi.org/10.1111/j.2044-8341.1989.tb02829.x

Biocca, F., & Harms, C. (2002). Defining and measuring social presence: Contribution to the networked minds theory and measure. *Proceedings of the Fifth Annual International Workshop on Presence*.

Bravata, D. M., Smith-Spangler, C., Sundaram, V., Gienger, A. L., Lin, N., Lewis, R., Stave, C. D., Olkin, I., & Sirard, J. R. (2007). Using Pedometers to Increase Physical Activity and Improve Health. *JAMA, 298*(19), 2296. https://doi.org/10.1001/jama.298.19.2296

Compeau, D. R., & Higgins, C. A. (1995). Computer Self-Efficacy: Development of a Measure and Initial Test. *MIS Quarterly*, *19*(2), 189. https://doi.org/10.2307/249688

Côté, J., Yardley, J., Hay, J., Sedgwick, W., & Baker, J. (1999). An exploratory examination of the Coaching Behavior Scale for Sport. *Avante, 5*.

Deci, E. L. (1975). *Intrinsic Motivation*. Springer US. https://doi.org/10.1007/978-1-4613-4446-9

Diefenbach, S., Lenz, E., & Hassenzahl, M. (2013). An interaction vocabulary. describing the how of interaction. *CHI '13 Extended Abstracts on Human Factors in Computing Systems on - CHI EA '13*, 607. https://doi.org/10.1145/2468356.2468463

Dietz, W., & Santos-Burgoa, C. (2020). Obesity and its Implications for COVID-19 Mortality. *Obesity*, oby.22818. https://doi.org/10.1002/oby.22818

Fritz, T., Huang, E. M., Murphy, G. C., & Zimmermann, T. (2014). Persuasive technology in the real world. *Proceedings of the 32nd Annual ACM Conference on Human Factors in Computing Systems - CHI '14*, 487–496. https://doi.org/10.1145/2556288.2557383

Gavin, J., McBrearty, M., Malo, K., Abravanel, M., & Moudrakovski, T. (2016). Adolescents' Perception of the Psychosocial Factors affecting Sustained Engagement in Sports and Physical Activity. *International Journal of Exercise Science*, *9*(3), 384–411. http://www.ncbi.nlm.nih.gov/pubmed/27766129

Gimpel, H., Nißen, M., & Görlitz, R. (2013). Quantifying the Quantified Self: A Study on the

Motivations of Patients to Track Their Own Health. *ICIS*. https://www.semanticscholar.org/paper/Quantifying-the-Quantified-Self%3A-A-Study-on-the-of-Gimpel-Nißen/7ccbe2e99078317a8657a2d362cdeb755b323cf4

Gouveia, R., Karapanos, E., & Hassenzahl, M. (2015). How do we engage with activity trackers? *Proceedings of the 2015 ACM International Joint Conference on Pervasive and Ubiquitous Computing - UbiComp '15*, 1305–1316. https://doi.org/10.1145/2750858.2804290

Halabisky, H. B. (n.d.). *Classification of Neuronal Data - Measuring Dis/Similarities*. Retrieved April 9, 2020, from https://hlab.stanford.edu/brian/making_measurements.html

Hanci, E., Lacroix, J., Ruijten, P. A. M., Haans, A., & IJsselsteijn, W. A. (2020). *Measuring Commitment to Self-Tracking: Development of the C2ST Scale*.

Hancı, E., Ruijten, P. A. M., Lacroix, J., Kersten-van Dijk, E. T., & IJsselsteijn, W. A. (2019). *Are Trackers Social Actors? The Role of Self-tracking on Self-evaluation* (pp. 31–42). Springer. https://doi.org/10.1007/978-3-030-17287-9_3

Health Care | Definition of Health Care by Merriam-Webster. (n.d.). Retrieved August 22, 2019, from https://www.merriam-webster.com/dictionary/health

Jowett, S. (2009). Validating Coach-Athlete Relationship Measures with the Nomological Network. *Measurement in Physical Education and Exercise Science*, *13*(1), 34–51. https://doi.org/10.1080/10913670802609136

Jowett, S., Nicolas, M., & Yang, S. (2017). *Unravelling the Links between Coach Behaviours and Coach-Athlete Relationships*.

Jowett, S., & Ntoumanis, N. (2004). The Coach-Athlete Relationship Questionnaire (CART-Q): development and initial validation. *Scandinavian Journal of Medicine and Science in Sports*, *14*(4), 245–257. https://doi.org/10.1111/j.1600-0838.2003.00338.x

Kim, S., Kientz, J. A., Patel, S. N., & Abowd, G. D. (2008). Are you sleeping? *Proceedings of the ACM 2008 Conference on Computer Supported Cooperative Work - CSCW '08*, 619. https://doi.org/10.1145/1460563.1460660

LaVoi, N. M. (2007). Expanding the Interpersonal Dimension: Closeness in the Coach-Athlete Relationship. *International Journal of Sports Science & Coaching*, *2*(4), 497–512. https://doi.org/10.1260/174795407783359696

le Bouedec, G. (1984). Contribution à la méthodologie d'étude des représentations sociales. [Contribution to the methodology of the study of social representations.]. *Cahiers de Psychologie Cognitive/Current Psychology of Cognition*, *4*(3), 245–272.

Li, I., Dey, A., & Forlizzi, J. (2010). A stage-based model of personal informatics systems. *Proceedings of the 28th International Conference on Human Factors in Computing Systems - CHI '10*, 557. https://doi.org/10.1145/1753326.1753409

Lupton, D. (2014). Self-Tracking Modes: Reflexive Self-Monitoring and Data Practices. *SSRN Electronic Journal*. https://doi.org/10.2139/ssrn.2483549

Lyall, B., & Robards, B. (2018). Tool, toy and tutor: Subjective experiences of digital self-tracking. *Journal of Sociology*, *54*(1), 108–124. https://doi.org/10.1177/1440783317722854

Mageau, G. A., & Vallerand, R. J. (2003). The coach–athlete relationship: A motivational model. *Journal of Sport Sciences*, *21*, 883–904.

Moliner, P. (1995). A two-dimensional model of social representations. *European Journal of Social Psychology*, *25*(1), 27–40. https://doi.org/10.1002/ejsp.2420250104

Niess, J., Diefenbach, S., & Platz, A. (2018). Moving beyond assistance: Psychological Qualities of Digital Companions. *Proceedings of the 10th Nordic Conference on Human-Computer Interaction - NordiCHI '18*, 916–921. https://doi.org/10.1145/3240167.3240240

Orji, R., Mandryk, R. L., & Vassileva, J. (2012). *Towards a Data-Driven Approach to Intervention Design: A Predictive Path Model of Healthy Eating Determinants* (pp. 203–214). https://doi.org/10.1007/978-3-642-31037-9_18

Osgood, C. E. (1964). Semantic Differential Technique in the Comparative Study of Cultures. *American Anthropologist*, *66*(3), 171–200. https://doi.org/10.1525/aa.1964.66.3.02a00880

Pelletier, L. G., Rocchi, M. A., Vallerand, R. J., Deci, E. L., & Ryan, R. M. (2013). Validation of the revised sport motivation scale (SMS-II). *Psychology of Sport and Exercise*, *14*(3), 329–341. https://doi.org/10.1016/j.psychsport.2012.12.002

Peters, D., Calvo, R. A., & Ryan, R. M. (2018). Designing for Motivation, Engagement and Wellbeing in Digital Experience. *Frontiers in Psychology*, *9*, 797. https://doi.org/10.3389/fpsyg.2018.00797

Pineda, E., Sanchez-Romero, L. M., Brown, M., Jaccard, A., Jewell, J., Galea, G., Webber, L., & Breda, J. (2018). Forecasting Future Trends in Obesity across Europe: The Value of Improving Surveillance. *Obesity Facts*, *11*(5), 360–371. https://doi.org/10.1159/000492115

Rapp, K., Schroeder, J., Klenk, J., Stoehr, S., Ulmer, H., Concin, H., Diem, G., Oberaigner, W., & Weiland, S. K. (2005). Obesity and incidence of cancer: a large cohort study of over 145 000 adults in Austria. *British Journal of Cancer*, *93*(9), 1062–1067. https://doi.org/10.1038/sj.bjc.6602819

Reeves, B., & Nass, C. I. (1996). The media equation: How people treat computers, television, and new media like real people and places. In *The media equation: How people treat computers, television, and new media like real people and places.* Cambridge University Press.

Rooksby, J., Rost, M., Morrison, A., Chalmers, M. C., Rooksby, J., Rost, M., Morrison, A.,

& Chalmers, M. C. (2014). Personal tracking as lived informatics. *Proceedings of the 32nd Annual ACM Conference on Human Factors in Computing Systems - CHI '14*, 1163–1172. https://doi.org/10.1145/2556288.2557039

Ruble, T. L., & Thomas, K. W. (1976). Support for a two-dimensional model of conflict behavior. *Organizational Behavior and Human Performance*, *16*(1), 143–155. https://doi.org/10.1016/0030-5073(76)90010-6

Ryan, R. M., & Deci, E. L. (2000). Self-determination theory and the facilitation of intrinsic motivation, social development, and well-being. *The American Psychologist*, *55*(1), 68–78. https://doi.org/10.1037//0003-066x.55.1.68

Ryan, R. M., Deci, E. L., & Grolnick, W. S. (1995). Autonomy, relatedness, and the self: Their relation to development and psychopathology. In *D. Cicchetti & D. J. Cohen (Eds.), Wiley series on personality processes. Developmental psychopathology* (vol. 1, pp. 618–655). Oxford, England: John Wiley & Sons. https://www.semanticscholar.org/paper/Autonomy%2C-relatedness%2C-and-the-self%3A-Their-relation-Ryan-Deci/a398314d42f260e1908e6339b989ba834ee01b64

Sheeran, P., & Webb, T. L. (2016). The Intention–Behavior Gap. *Social and Personality Psychology Compass*, *10*(9), 503–518. https://doi.org/10.1111/spc3.12265

Short, S. E., & Short, M. W. (2005). Essay: Role of the coach in the coach-athlete relationship. *Lancet (London, England)*, *366 Suppl*, S29--30. https://doi.org/10.1016/S0140-6736(05)67836-1

Sjoklint, M., Constantiou, I. D., & Trier, M. (2015). The Complexities of Self-Tracking - An Inquiry into User Reactions and Goal Attainment. *SSRN Electronic Journal*. https://doi.org/10.2139/ssrn.2611193

Solove, D. J. (2011). *Why Privacy Matters Even if You Have "Nothing to Hide."*

Su, X., Hyysalo, J., Rautiainen, M., Riekki, J., Sauvola, J., Maarala, A. I., Hirvonsalo, H., Li,

P., & Honko, H. (2016). Privacy as a Service: Protecting the Individual in Healthcare Data Processing. *Computer*, *49*(11), 49–59. https://doi.org/10.1109/MC.2016.337

Teixeira, P. J., Carraça, E. V, Markland, D., Silva, M. N., & Ryan, R. M. (2012). Exercise, physical activity, and self-determination theory: A systematic review. In *International Journal of Behavioral Nutrition and Physical Activity* (Vol. 9). https://doi.org/10.1186/1479-5868-9-78

Tudor-Locke, C. (2002). Taking Steps toward Increased Physical Activity: Using Pedometers To Measure and Motivate. *President's Council on Physical Fitness and Sports Research Digest*. https://eric.ed.gov/?id=ED470689

Tudor-Locke, C., & Bassett, D. R. (2004). How Many Steps/Day Are Enough? *Sports Medicine*, *34*(1), 1–8. https://doi.org/10.2165/00007256-200434010-00001

Tuovinen, L., & Smeaton, A. F. (2019). Unlocking the Black Box of Wearable Intelligence: Ethical Considerations and Social Impact. *2019 IEEE Congress on Evolutionary Computation, CEC 2019 - Proceedings*, 3235–3243. https://doi.org/10.1109/CEC.2019.8790173

Wagner, F. R., & Morse, J. J. (1975). A Measure of Individual Sense of Competence. *Psychological Reports*, *36*(2), 451–459. https://doi.org/10.2466/pr0.1975.36.2.451

Weiser, M., & Brown, J. S. (1997). The Coming Age of Calm Technology. In *Beyond Calculation* (pp. 75–85). Springer New York. https://doi.org/10.1007/978-1-4612-0685-9_6

Weyerer, S., & Kupfer, B. (1994). Physical Exercise and Psychological Health. In *Sports Medicine: An International Journal of Applied Medicine and Science in Sport and Exercise* (Vol. 17, Issue 2, pp. 108–116). Springer. https://doi.org/10.2165/00007256-199417020-00003

White, R. W. (1963). Ego and reality in psychoanalytic theory: A proposal regarding

independent ego energies. In *New York: International Universities Press*.

Yoo, Y. (2010). Computing in Everyday Life: A Call for Research on Experiential Computing.o Title. *MIS Quarterly*, *34*(2), 213–231.

Zimmer, M., Kumar, P., Vitak, J., Liao, Y., & Chamberlain Kritikos, K. (2018). 'There's nothing really they can do with this information': unpacking how users manage privacy boundaries for personal fitness information. *Information Communication and Society*. https://doi.org/10.1080/1369118X.2018.1543442

Appendix A.

Table Containing an Overview of Relationship Path Coefficients for Different Coach Behavior Categories

Table A1. *Overview of coach behavior categories, CBS-S items and corresponding relationship path coefficients as obtained from Jowett, Nicolas and Yang (2017).*

Jowett, Nicolas and Yang's coach behavior category	**CBS-S items/ coach behavior or skills description**	**Relationship path coefficients**
Physical skills and planning	Detailed program, confidence in program, plan for physical preparations, coordinates training, coordinates competition, structured sessions	Closeness: 0.39 Complementarity: -0.11 Commitment: 0.40 **Total relationship: 0.33**
Technical skills	Specific feedback, feedback on technique, reinforcement, provides cues, demonstrations, uses examples, immediate feedback, ask questions	Closeness: 0.53 Complementarity: -0.07 Commitment: 0.27 **Total relationship: 0.36**
Mental preparations	Be tough, perform under pressure, stay confident, stay positive, stay focused	Closeness: 0.18 Complementarity: 0.03 Commitment: 0.41 **Total relationship: 0.20**
Goal setting	Helps me set specific goals, helps identify strategies, helps identify target dates, monitors progress, helps set goals, demonstrates commitment	Closeness: 0.31 Complementarity: -0.11 Commitment: 0.46 **Total relationship: 0.32**
Positive personal report	Easily approachable, available, demonstrates concern, good listener, maintains confidentiality, trustworthy	Closeness: 0.24 Complementarity: 0.41 Commitment: 0.31 **Total relationship: 0.32**
Negative personal report	Uses fear, disregards my opinion, tough/strict/yells when angry	Closeness: - 0.33 Complementarity: 0.02 Commitment: 0.04 **Total relationship: 0.11**

Appendix B.

Short Rationale for the Expected Score or Position of Each Trait in the Two-Dimensional Model

Trait 1: stepwise - fluent

This trait correlates to the good or bad characteristic (evaluative dimension). In research by Niess et al. (2018), a digital companion with the role of an advisor was perceived less fluent than that with the role of a friend. The role of advisor scores lower in the evaluative dimension and therefore, the term fluent is expected to score high in the evaluative dimension and stepwise is expected to score low in the evaluative dimension. You cannot really describe this word pair in terms of the dominance dimension.

Trait 2: distant- close

The trait of distant-close correlates to the evaluative dimension. A differentiation in terms of 'profit', 'interest', 'boss' and 'friendship', 'joy', 'sharing' is made with regards to the evaluative dimension (le Bouedec, 1984). The first terms (negative in the evaluative dimension) are generally perceived as more distant concepts and the latter terms (positive in the evaluative dimension) are generally perceived as more close concepts.

Trait 3: rational - emotional

This word pair originates from the original Semantic Differentiation Task and describes the evaluative dimension. Rational is somewhat low in the dimension and emotional is clearly high and on the positive axis. In terms of the dominance dimension, these terms are hard to place but rational is expected to be negative but close to neutral and emotional is expected to be positive but close to neutral.

Trait 4: empathetic - cold-blooded (harsh)

Ruble and Thomas (1976) use the word pair of hard-soft for the evaluative dimension. Empathetic – cold-blooded is comparable to hard-soft and also to trait 6 and 8, but again, slightly different. Empathetic is expected to be on the positive side in the evaluative dimension and harsh is expected to be on the negative side. On the dominance dimension empathetic is expected to be on the positive axis and cold-blooded is expected to be just slightly on the negative axis.

Trait 5: hostile - friendly

Hostile-friendly describes the evaluative dimension (Ruble and Thomas, 1976). In this dimension, hostile is lower than friendly. Furthermore, hostile is expected to be on the negative axis and friendly is on the positive axis.

Trait 6: demotivating - motivating

This trait corresponds a lot to "good or bad" and motivation is an important aspect in this thesis. It might be interesting to see how people score their activity tracker on this treat in a Semantic Differentiation Task and how they describe it in an interview.

Trait 7: direct - indirect

Digital companions with both perceived friend or advisor roles score the same on this trait according to research by Niess et al. (2018). If you compare this word pair in terms of the dominance dimension, you may expect that direct is higher on this dimension than indirect and

if you compare this word pair in terms of the evaluative dimension, you may expect that direct is slightly more negative than indirect but all will probably be quite close to neutral.

Trait 8: gentle (shy)- powerful (pushy)

Hard-soft is a term used by Ruble and Thomas (1976) to describe the evaluative dimension. Hard (or powerful/ pushy in this trait) is low in evaluative dimension and soft (or gentle in this trait) is higher. Besides that, to be powerful or pushy the device has to be active, so powerful is high in the dominance dimension and gentle is low and negative in the dominance dimension.

Trait 9: passive - active

Passive-active clearly describes the dominance dimension. Passive is very low and on the negative axis in this dimension and active is very high and on the positive axis in this dimension.

Trait 10: powerful - weak

Powerful-weak is comparable to the word pair in trait 6. However, the interpretation in the perceived traits and roles of an activity might be just slightly different. It is expected that powerful is high in the dominance dimension and weak is low in this dimension, but that weak is slightly lower, and even slightly negative, in the evaluative dimension than shy (from trait 6) but still much higher than powerful.

Trait 11: subdominant - dominant

Trait 10 also originates from the original Semantic Differentiation Task and clearly describes the dominance dimension. Dominant corresponds to active and is positive and high in dominance, but also somewhat negative on the evaluative dimension. Subdominant is more passive and is low and negative in dominance but higher on the evaluative dimension than dominant.

Resulting two-dimensional model with the word pairs.

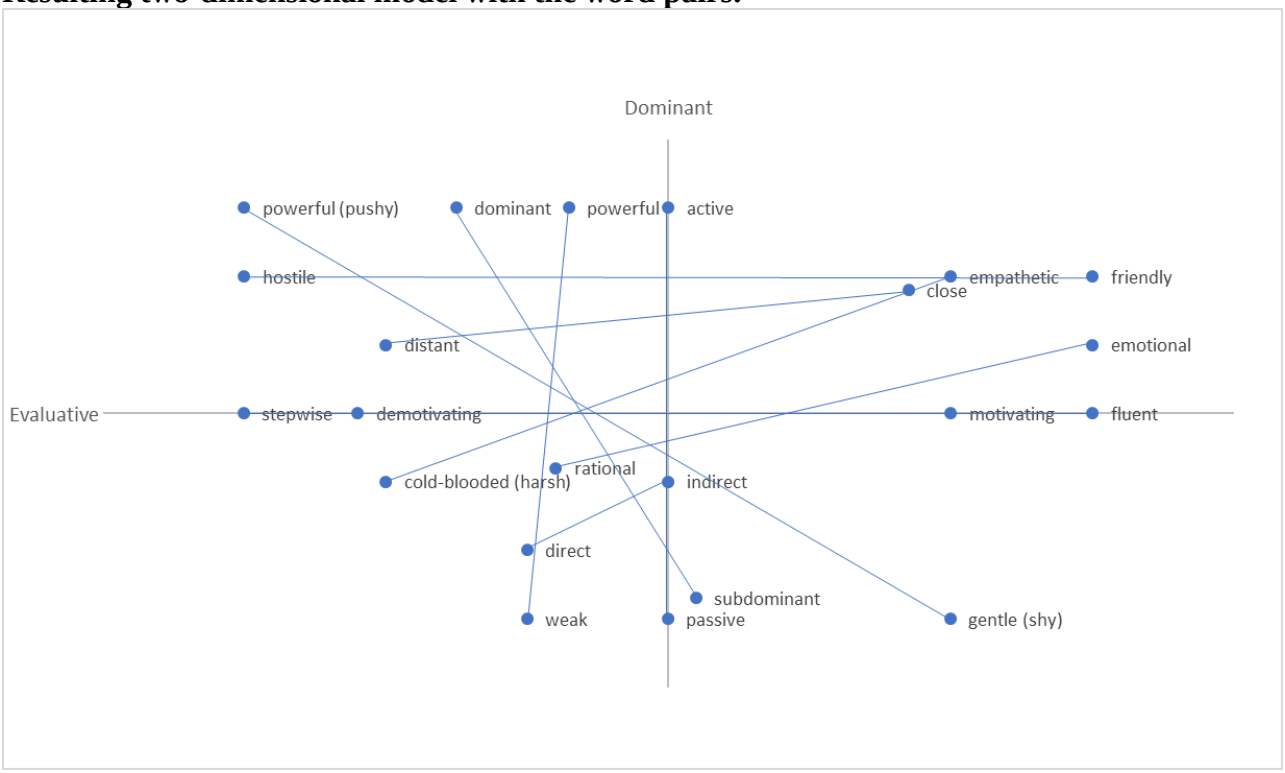

Figure B1. Conceptualization of what the two-dimensional model with the traits would look like. Lines are drawn between each word pair of the list of traits.

Appendix C.

Visual Representation of the Age and Gender distribution of Participants.

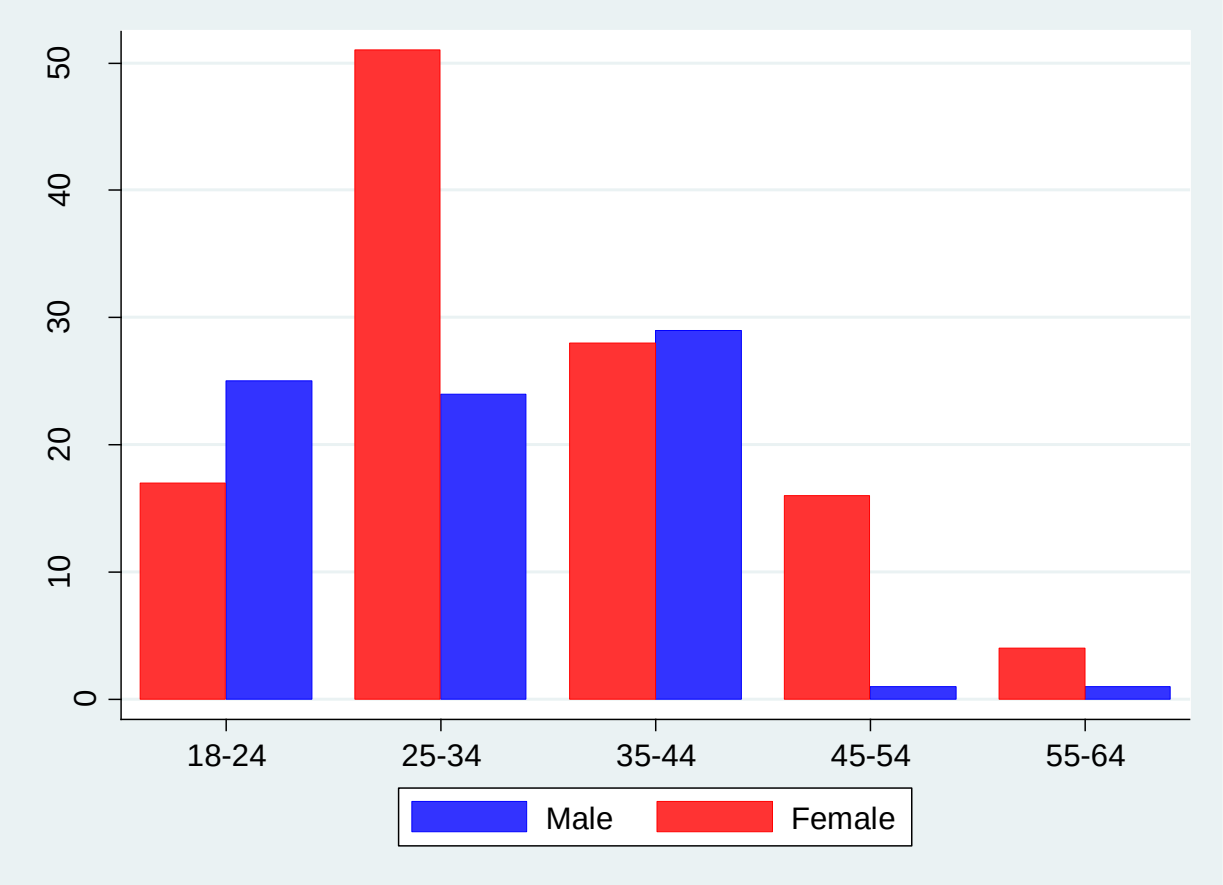

Figure C1. Visual representation of the age and gender distribution of participants in the sample after removal of the 19 participants who had fewer than three months of previous experience in using an activity tracker. 19 participants who had fewer than three months of previous experience in using an activity tracker

Appendix D.

Activity Tracker/ Technological Affiliation Self-Efficacy Based on Computer Self-Efficacy Measurement by Compeau and Higgins (1995).

Scenario:
Often we are told about devices or applications that are available to make things easier in daily life. For the following questions, imagine that you were given a new activity tracker. It doesn't matter specifically what this tracker does, only that it is a new technology intended to make your daily life easier/ better and that you have never used it before.
The following questions ask you to indicate whether you could use this technology under a variety of conditions. For each of the conditions, please indicate your confidence about your how well you would be able to use the device, by choosing a number from 1 to 7, where 1 indicates "extremely disagree", and 7 indicates "extremely agree".

I could use a technology that I am not familiar with (like a new activity tracker) well if…

1. There was no one around to tell me what to do.
2. I had never used any technology like it before.
3. I had seen someone else use it before trying it myself.
4. I could call someone for help if I got stuck.
5. I had plenty of time to Figure out how to do an action I want.

Appendix E.

Open-Ended Questions Aimed at Revealing Participant's Motivations and Unraveling the Connection Between the Concepts of Role, Motivation and Relationship in the Activity Tracking Domain.

1. **Why** do you use the activity tracker you are currently using?
   (question aimed at motivation and role)

2. What 5-10 terms would you use to **describe** your activity tracker?
   (question aimed at role)

3. What do you think are the biggest **personal benefits** of activity tracking? And what are the biggest **benefits in general**?
   (question aimed at motivation)

4. What do you think are the biggest **personal disadvantages** of activity tracking? And what are the biggest **disadvantages in general**?

5. If you had a different purpose or reason for using your activity tracker, do you think the **way you use** your activity tracker would change? And if so, how?

6. What are your **needs, wishes and desires** for your activity tracker? And how do you think your needs, wishes and desires for your activity tracker affect **the way you think** about your activity tracker?

Creative writing task

1. If your activity tracker could talk, what do you think it would say about you? And why?

2. If your activity tracker was a type of animal, what animal would it be? And why?

3. If your activity tracker would be your colleague at your job, how would you describe your colleague? And why?

Appendix F.

Motivation for Self-Tracking Scale: Adjusted from Revised Sport Motivation Scale (SMS) (Pelletier et al., 2013) as Suggested by Hancı et al. (2020)

I self-track…

Intrinsic regulation

1. …because it gives me pleasure to learn more about myself
2. …because it is very interesting to learn how I can improve myself
3. …because I find it enjoyable to discover new performance strategies

Integrated regulation

4. …because self-tracking reflects the essence of whom I am
5. …because through self-tracking, I am living in line with my deepest principles
6. …because self-tracking is an important part of my life

Identified regulation

7. …because I have chosen self-tracking as a way to develop myself
8. …because it is one of the best ways I have chosen to develop other aspects of myself
9. …because I found it is a good way to develop aspects of myself that I value

Introjected regulation

10. …because I would feel bad about myself if I did not take the time to do self-tracking
11. …because I feel better about myself when I do self-tracking
12. …because I would not feel worthwhile if I did not self-track

External regulation

13. …because people I care about would be upset with me if I didn’t do self-tracking
14. …because people around me reward me when I do self-tracking
15. …because I think others would disapprove me if I didn’t do self-tracking

Appendix G.

CART-Q (Jowett & Ntoumanis, 2004) Questions, Adapted to be Applicable in the Domain of Activity Tracking

Statements from Jowett and Ntoumanis' 11-item CART-Q are used and the terms of athlete/coach are adapted to be applicable for activity trackers. For the constructs of commitment and closeness, question regarding sports career or sports performance are removed from the item list. And although in the study of Jowett & Ntoumanis (2004) an original 23-item CART-Q was reduced to 11 items after principal component analysis, several questions (items 4-9) from this 23-item list are added to the item list that is used in this thesis since these questions may be applicable in the activity tracking domain even though they were not found to be meaningful in the trainer-athlete relationship. For the construct of commitment, only two questions remain and therefore two more questions are added: "I want to use my activity tracker every day." and "I want to keep using my activity tracker for a long time.", based on Jowett and Ntoumanis' (2004) description of commitment. And for the construct of complementarity, the statement "Me and my activity tracker function well in achieving activity goals." is added based on Jowett and Ntoumanis' (2004) description of complementarity.

According to Jowett & Ntoumanis (2004) the statement "I feel close to my activity tracker." belongs to the construct of commitment, but it can be doubted if this statement indeed belongs to commitment or to the construct of closeness.

For each of the three constructs that define the relationship, two reciprocity statements are added since a reciprocal measure allows for a more detailed evaluation of interaction (Biocca & Harms, 2002). Items 5, 6, 10, 11, 16 and 17 are the added reciprocity items.

Commitment

1. I feel close to my activity tracker.
2. I feel committed to my activity tracker.
3. I want to use my activity tracker every day.
4. I want to keep using my activity tracker for a long time.
5. My activity tracker is committed to me.
6. I feel like my activity tracker will keep helping me for a long time.

Closeness

7. I like my activity tracker.
8. I trust my activity tracker.
9. I respect my activity tracker.
10. My activity tracker respects me.
11. My activity tracker likes me.

Complementarity

12. Me and my activity tracker function well in achieving activity goals.
13. When I interact with my activity tracker, I feel at ease.
14. When I interact with my activity tracker, I am ready to do my best.
15. When I interact with my activity tracker, I adopt a friendly stance.
16. When my activity tracker interacts with me, it adopts a friendly stance.
17. When my activity tracker interacts with me, it does the best it can.

Appendix H.

Traits for a Semantic Differentiation Task to Establish Perceived Activity Tracker Roles.

Based on research by Niess et al. (2018) and the traits from the original Semantic Differentiation Task proposed by Osgood (1964), traits of passive – active, subdominant-dominant, empathetic-cold blooded, independent-dependent, powerful-weak, rational-emotional (traits 3, 4, 10, 11) are added to the original interaction vocabulary (trait 1, 2, 7, 8, 9) by Diefenbach et al. (2013). Traits of slow-fast, delayed-instant, uniform – diverging, constant-inconstant, incidental-targeted and apparent- covered are removed since they are hardly applicable to activity trackers or they do not refer to the relational aspect. The trait of spatial separation – spatial proximity is rewritten as distant-close and mediated- direct is rewritten as indirect-direct. Besides that, trait of hostile-friendly is added to the list of traits based on the terms used by Ruble and Thomas (1976) to describe the evaluative dimension in the two-dimensional model. Finally the trait of motivation-demotivating is added to the list of traits, since motivation is an important aspect in this thesis.

Traits that describe the evaluative dimension:

Trait 1:	stepwise	- fluent
Trait 2:	distant	- close
Trait 3:	rational	- emotional
Trait 4:	empathetic	- cold-blooded (harsh)
Trait 5:	hostile	- friendly
Trait 6:	demotivating	- motivating

Traits that describe the dominance dimension:

Trait 7:	direct	- indirect
Trait 8:	gentle (shy)	- powerful (pushy)
Trait 9:	passive	- active
Trait 10:	powerful	- weak
Trait 11:	subdominant	- dominant

Appendix I.

Table Containing an Overview of the Number of Participants per Motivation Category

Table H1. *The number of participants and the corresponding percentages for each regulatory style.*

Regulatory style	**Participants per category**	**Percentage**
Only internal regulation	70	39.55%
Only integrated regulation	20	11.30%
Only identified regulation	0	0.00%
Only introjected regulation	2	1.13%
Only external regulation	5	2.82%
Multiple regulatory styles but mostly internal regulation	7	3.95%
Multiple regulatory styles but mostly integrated regulation	13	7.34%
Multiple regulatory styles but mostly identified regulation	0	0.00%
Multiple regulatory styles but mostly introjected regulation	0	0.00%
Multiple regulatory styles but mostly external regulation	0	0.00%
Multiple regulatory styles with no clear main regulatory style	43	24.29%
No answer or amotivation	17	N/A
Total	177	

Appendix J.

Visual Representations of Individual Participants' Data Points Represented in the Two-Dimensional Model

The figures in this appendix show graphs for clusters of participants as grouped after Cluster Analysis on answers on the Semantic Differentiation Task.

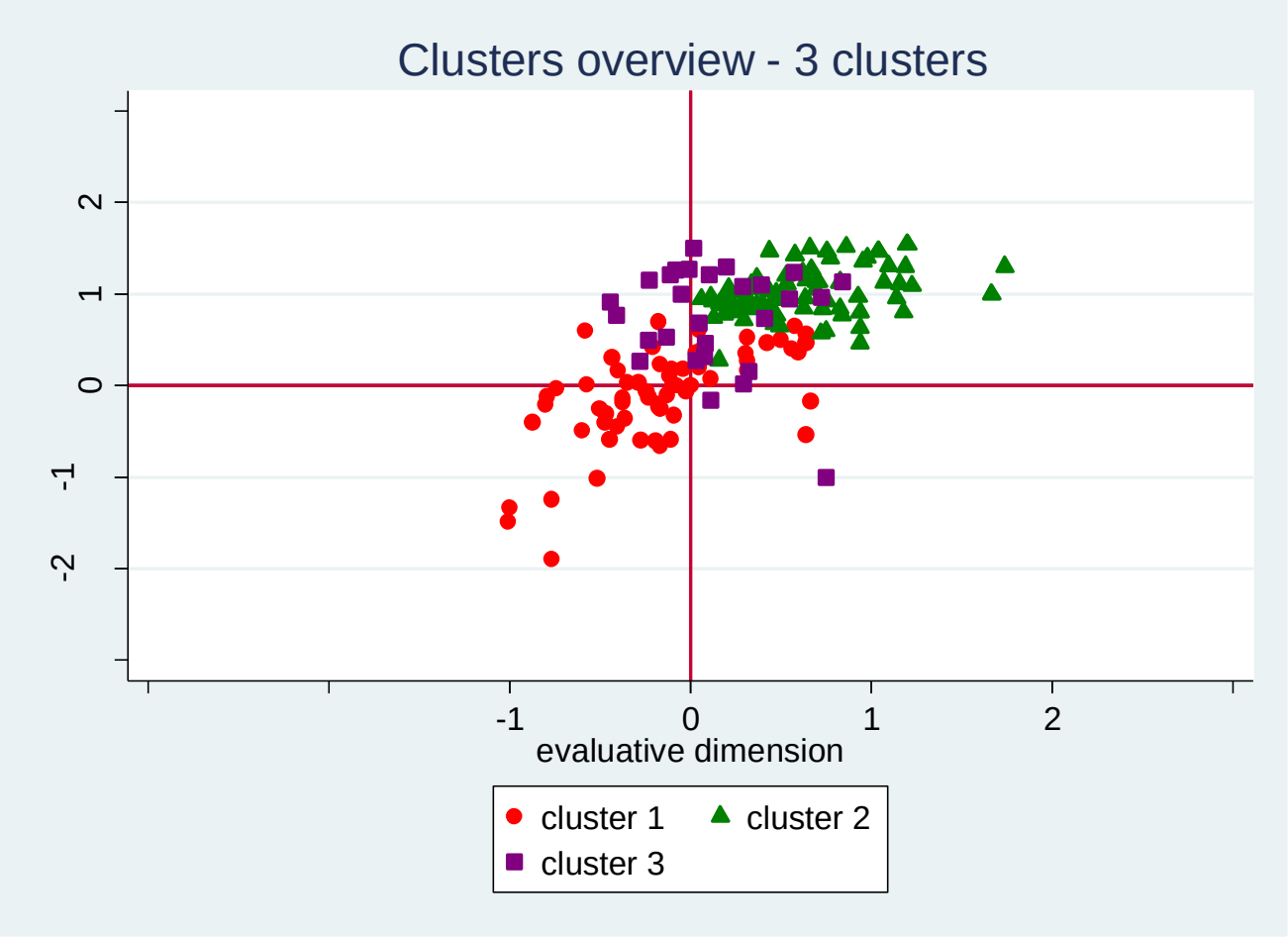

Figure I1. Visual representation of individual participants' mean data points in the two-dimensional model

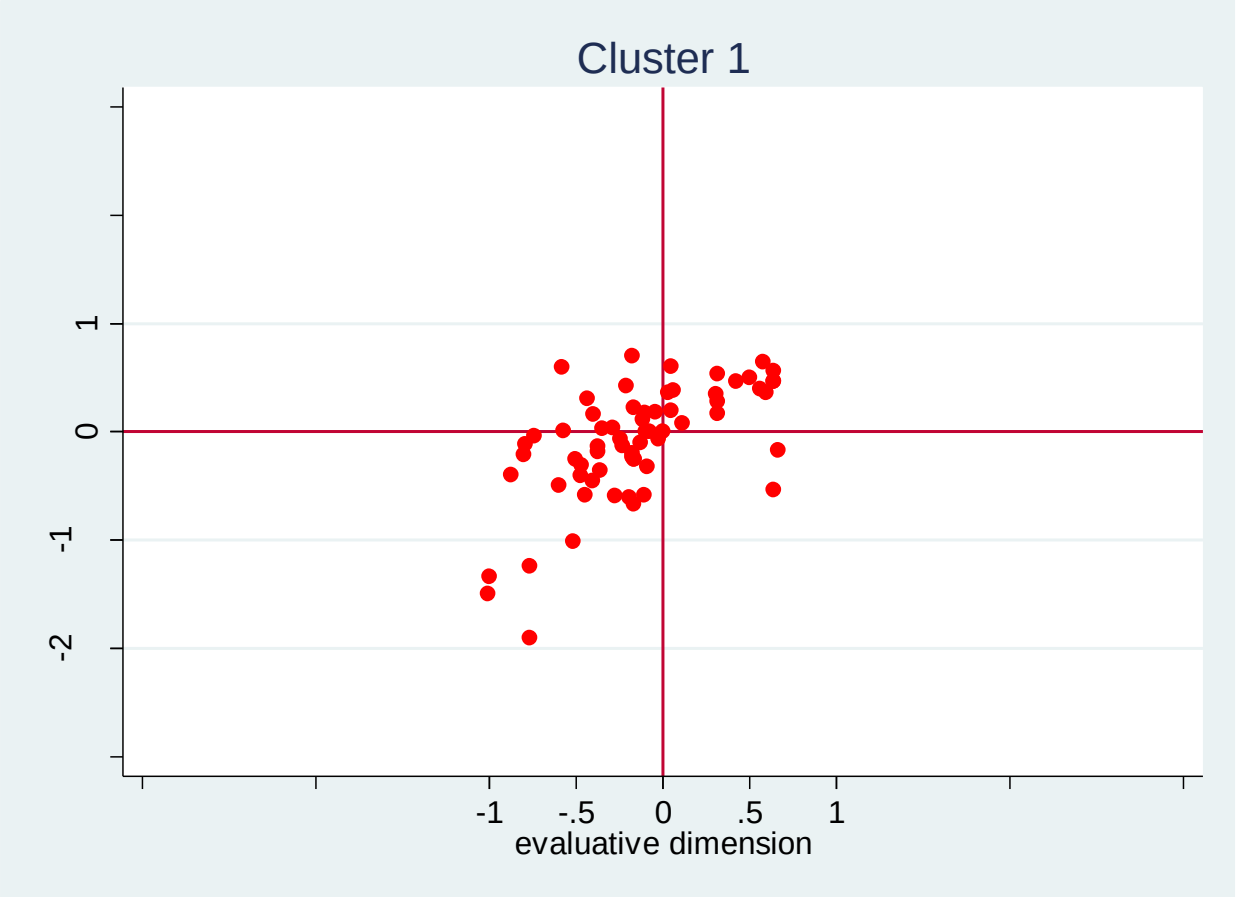

Figure I2. Visual representation of individual participants' mean data points in the two-dimensional model for cluster 1

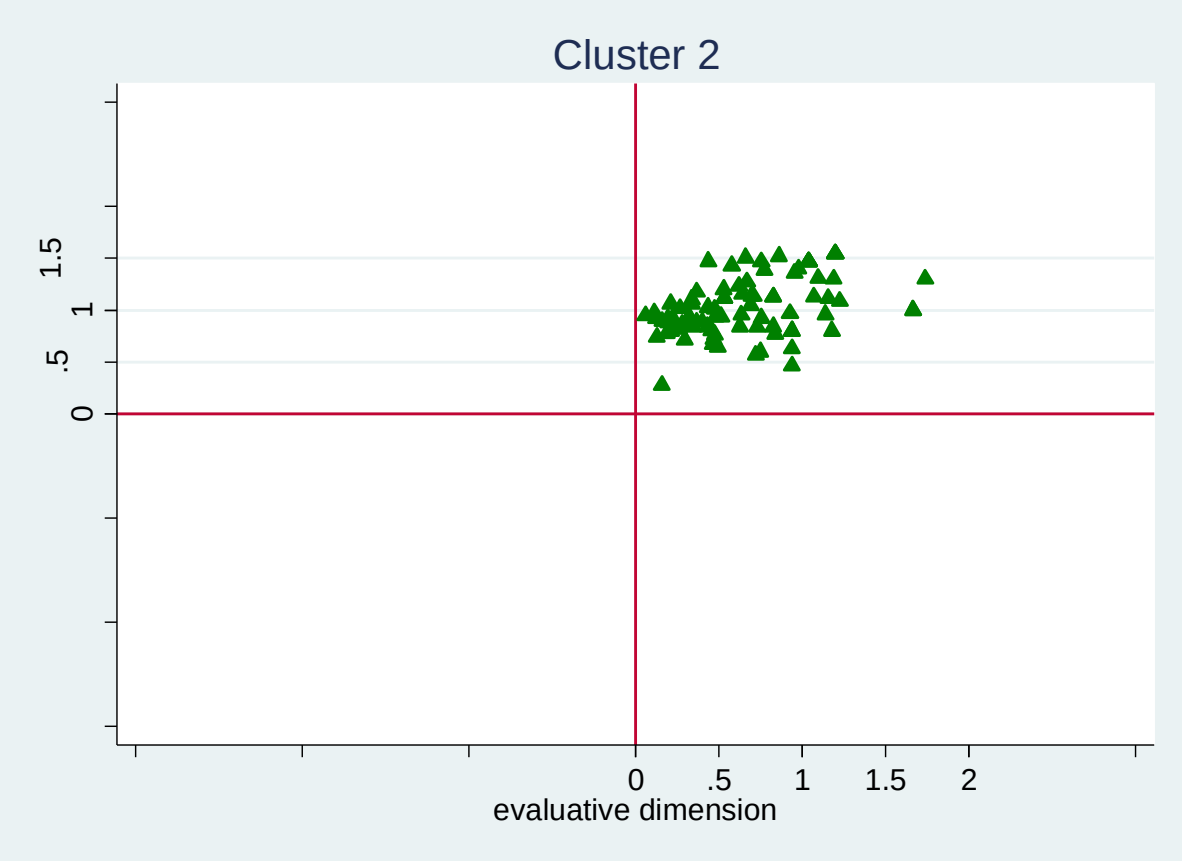

Figure I3. Visual representation of individual participants' mean data points in the two-dimensional model for cluster 2

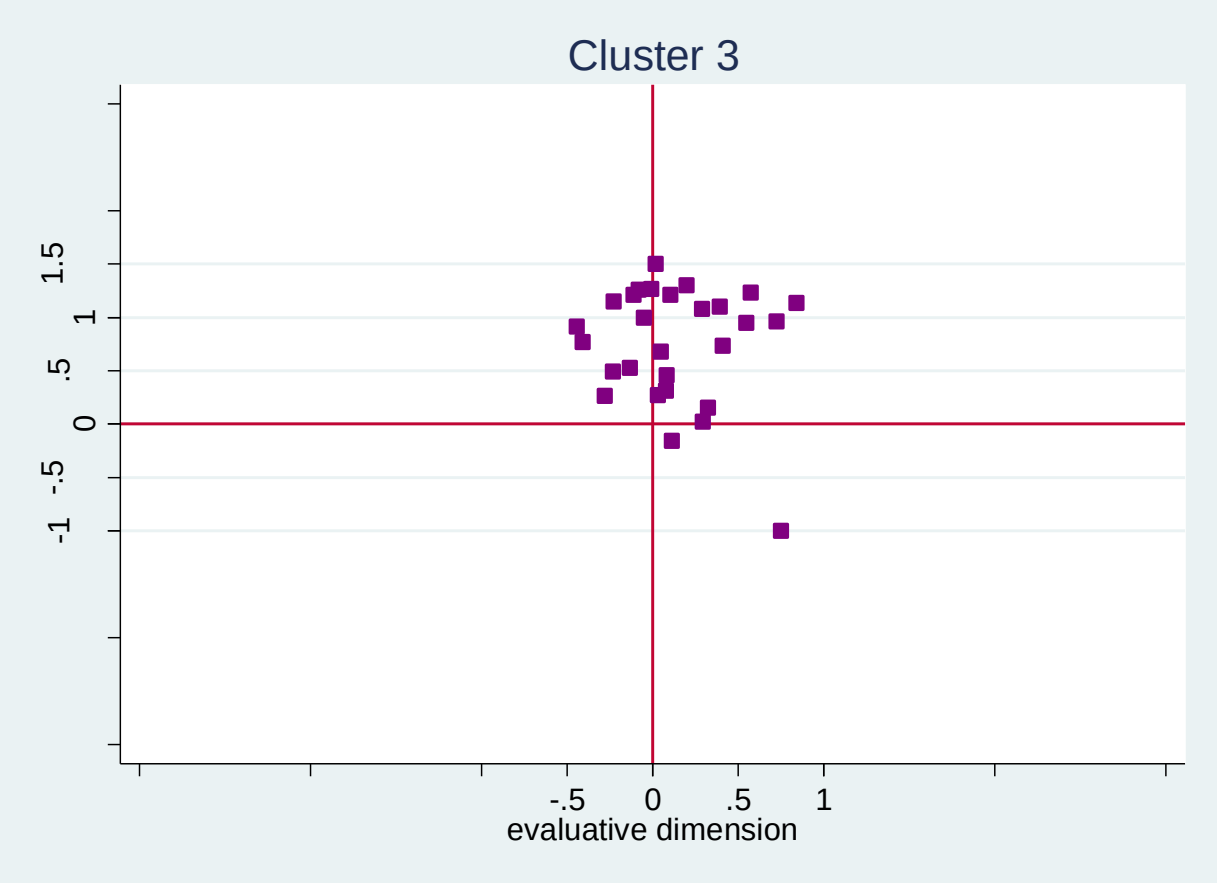

Figure I4. Visual representation of individual participants' mean data points in the two-dimensional model for cluster 3

Appendix K.

Terms and Coding of Terms Resulting from Qualitative Analysis

List of traits identified from qualitative analysis:

1. Effective
2. (Superficial) functionalities
3. Accurate
4. Active - energetic
5. Advising
6. Boring
7. Calm - modest - quiet
8. Caring
9. Close
10. Dependable - needy
11. Easy - simple
12. Encouraging - motivating - energizing
13. Fast
14. Friendly - nice
15. Fun - enjoy - cool
16. Gadget
17. Guard
18. Healthy
19. Helpful
20. Inaccurate - incomplete - unreliable
21. Independent
22. Informative - interesting - insightful
23. Inspiring
24. Invasive - annoying
25. Lazy - ineffective - not productive - slow
26. Life - lifestyle
27. Love - lovely - pleasant
28. Loyal
29. Mean - judgmental
30. Monitoring
31. Necessary
32. Non-judgmental
33. Novelty - new
34. Precise - timely
35. Private - individual
36. Powerful - strong - pushy - bossy
37. Reliable - trustworthy
38. Reminding
39. Rewarding
40. Smart
41. Social
42. Strict
43. Supportive
44. Unnecessary
45. Unobtrusive - discrete
46. Unpredictable
47. Useful - practical – convenient

Table J1. *Codebook for terms in categories of characters*

Friend Caring Friendly - nice Social Love - lovely - pleasant Helpful Loyal Reliable – trustworthy Non-judgemental Calm - modest – quiet Supportive Caring Close Accurate Precise – timely	**Army sergeant** Active -energetic Encouraging – motivating – energizing Fast Invasive- annoying Mean – judgmental Powerful – strong – pushy – bossy Reliable – trustworthy Strict	**Advisor** Accurate Advising Active - energetic Close Necessary Powerful - strong - pushy - bossy Fast Precise - timely Reliable – trustworthy Invasive - annoying
Trainer Active Reminding Invasive - annoying Monitoring Encouraging – motivating	**Guard** Loyal Accurate Useful - practical - convenient Monitoring Invasive- annoying Calm-modest- quiet	**Personal assistant** Reliable - trustworthy Unobtrusive - discrete Precise - timely Helpful Friendly - nice Useful - practical - convenient
Gadget Useful - practical - convenient Informative - interesting - insightful Unnecessary Effective	**Manager** Monitoring Accurate Precise- timely Invasive-annoying Strict Effective Powerful – strong – pushy – bossy	**Attention seeker** Active - energetic Dependable - needy Invasive - annoying
Motivator Active - energetic Caring Encouraging - motivating - energizing Inspiring Supportive Rewarding	**Expert** Advising Helpful Effective Informative - interesting - insightful Useful - practical - convenient Accurate	**Boss** Accurate Advising Effective Independent Powerful – strong – pushy – bossy Strict
Coach Helpful Inspiring Encouraging - motivating - energizing Reminding Rewarding Supportive Strict Caring	**Project planner** Accurate Effective Active - energetic Fast Monitoring Precise - timely Reliable - trustworthy Reminding Useful - practical - convenient	**Cheerleader** Active - energetic Encouraging - motivating - energizing Fast Fun - enjoy - cool Inspiring Love - lovely - pleasant Social Supportive
Charmer Fun - enjoy - cool Unnecessary Social		

Love - lovely - pleasant		

Table J2. *Codebook for terms in categories of evaluative and dominance dimension*

Evaluative dimension	**Dominance dimension**
Distant Independent Unobtrusive – discrete Strict Private - individual Monitoring **Close** Close Dependable - needy Invasive - annoying Loyal **Cold-blooded/ hostile** Strict Powerful - strong - pushy - bossy Private - individual Mean - judgemental Precise - timely **Friendly** Caring Friendly - nice Social Love - lovely - pleasant Helpful Loyal Reliable – trustworthy Non-judgemental **Demotivating** Lazy - ineffective - not productive - slow Boring Invasive - annoying Mean – judgemental Powerful - strong - pushy - bossy **Motivating** Encouraging - motivating - energizing Inspiring Supportive Rewarding Non-judgemental Helpful	**Indirect** Calm - modest - quiet Unobtrusive - discrete Monitoring Private - individual **Gentle** Caring Friendly - nice Calm - modest - quiet Private - individual Non-judgemental Love - lovely - pleasant Helpful Reliable - trustworthy **Powerful/ dominant/ direct** Powerful - strong - pushy - bossy Independent Accurate Strict Invasive - annoying Mean - judgemental Fast Reminding **Passive:** Lazy - ineffective - not productive - slow Boring **Active:** Encouraging - motivating - energizing Active - energetic Fast Advising Invasive – annoying Reminding **Weak + subdominant:** Calm - modest - quiet Dependable - needy

Appendix L.

Table of Means per Trait in the Two-Dimensional Model for Each Cluster

Table K1. *Summary table*

Dimension	Trait	Cluster 1	Cluster 2	Cluster 3
Evaluative dimension	Distant	0.27	0.22	0.23
	Close	0.07	0.04	0.12
	Cold-blooded	0.18	0.12	0.15
	Hostile	0.08	0.04	0.12
	Friendly	0.62	0.81	0.58
	Demotivating	0.27	0.22	0.31
	Motivating	0.50	0.73	0.73
Dominance dimension	Indirect	0.40	0.32	0.27
	Gentle	0.77	0.86	0.58
	Passive	0.10	0.14	0.19
	Active	0.53	0.80	0.77
	Weak + subdominant	0.27	0.26	0.19
	Powerful/ dominant/ direct	0.55	0.46	0.62

Appendix M.

Output of the Number of Times Participants in Each Cluster Expected Themes of Comments If Their Activity Tracker Could Talk and Examples of What Comments They Expected

Table L1. *Overview of means per cluster that participants expected themes of comments.*

Theme	Sub-theme	**cluster 1** 'boss and manager'	**cluster 2** 'friend and mentor'	**cluster 3** 'tool'
Negative comments	Too much variation in being active	0.10	0.04	0.12
	Comments about too much exercise	0.07	0.04	0.00
	Complaints about laziness or not being active	0.45	0.32	0.23
	Negative comments on commitment	0.03	0.07	0.04
	Yelling, angry, negative tone	0.07	0.05	0.15
	Sum	**0.72**	**0.53**	**0.54**
	Average	**0.27**	**0.20**	**0.19**
Positive comments	Positive comments on amount of movement or activity	0.10	0.22	0.12
	Positive comments on commitment	0.00	0.03	0.04
	Sum	**0.10**	**0.24**	**0.15**
	Average	**0.05**	**0.14**	**0.10**
Comments with specific feedback	Specific feedback on improving activeness	0.05	0.01	0.08
	Specific feedback on improving health or lifestyle	0.05	0.03	0.00
	Sum	**0.10**	**0.04**	**0.08**
	Average	**0.05**	**0.02**	**0.04**
Comments about goals or goalsetting	Comments about goals or goalsetting	0.13	0.19	0.08
	Sum/ Average	**0.13**	**0.19**	**0.08**
Comments about sleeping more or better	Comments about sleeping more or better	0.27	0.15	0.04
	Sum/ Average	**0.27**	**0.15**	**0.04**
Motivational comments	I can help you	0.02	0.00	0.00
	Keep going/ you are doing well	0.02	0.08	0.04
	You are capable/ You can do it	0.00	0.07	0.04
	Push yourself	0.00	0.03	0.00
	Sum	**0.03**	**0.18**	**0.08**
	Average	**0.01**	**0.09**	**0.04**

Examples of negative comments expected by participants:

- *"Move your butt you lazy human!"*
- *"I know she is pregnant, but she really needs to make a bit more of an effort. I suggested 10000 steps a day, and she reduced it to 5000. How lazy is that. I mean, everyone else's willing to do the 10000. She may as well have stayed in bed. I just don't think she is committed."*
- *"Oy, bro, move it. You are spending way too much time behind the desk. Do some exercise, go for a walk. You have got a park just outside your place. Can't get along with this guy. He got me and what. Excuses, excuses, excuses... What a hard work. Move it !!! Now.. Can you believe it this guy???"*
- *"It would call me a fat... (then it would insert a rude word). It would say that my goals are quite low and maybe I could up them a bit because I am rather sedentary in my lifestyle. […]"*
- *"It would say that I try my best but am scatterbrained, don't stick to my activity goals and am fairly inactive for long periods of time. It would question whether I was dedicated to my goals or not, but would also appreciate that I am doing my best (I hope!)"*

The comments above were comments that clearly indicated complaints and negativity. However, the comments in the sub-themes about too much variation in being active and too much exercise were also mostly negative. Examples of such comments were;

- *"I think my tracker would say I can be really lazy. It would say some days I can be very motivated but some days the opposite."*
- *"He might say that I run too much with him."*
- *"This man does not stop moving, give me a break!"*

Examples of positive comments expected by participants:

- *"You are a guy that cares about his health. Your daily activity is very good and very beneficial for your health. You walk many miles a day and you burn a lot of calories."*
- *"I think it would say I'm active and enthusiastic about exercise and movement!"*
- *"My activity tracker would probably say that I'm a devoted user of it and very rarely leave it behind!"*

Examples of comments with specific feedback expected by participants:

- *"My activity tracker would tell me all about my current health and lifestyle status. it would inform me of improvements in exercise results. It could also advise ways to improve on exercise results such as tips on diet before cardiovascular exercise or on form while exercising. It would assess my sleep and see what areas my sleep is weak, such as deep sleep, and then also inform on ways to increase this to hit the necessary amounts."*
- *"If my activity tracker could talk, it would probably berate me for using my computer too much and advise me to be more physically active. It would verbally warn me before taking a cab/uber and recommend walking instead. It would also tell me to stay away from sugar and processed carbs."*
- *"It would say that I am very sedentary that I need to be more active and would encourage and motivate me to do more in my life. That would also encourage me to go outdoors more and use less lifts, buses to transport myself in order to have a better health."*

Examples of comments about goals or goalsetting expected by participants:

Expected comments about goals or goalsetting were often combined with comments in other categories.

- *"It would probably encourage me to walk more, get out of the house, do more gym classes and get moving every day. It would remind me of how many steps I still need to finish my daily goal and of the classes I have at the gym that day. It would probably be very supportive. Maybe they'd say I'm lazy because I don't do high intensity workouts in general."*
- *"He would definitely say that I don't accomplish my daily goals, unfortunately, despite being close most of the days. I think he would try to motivate me and cheer me up, and probably we could talk to set a more realistic goal, which I often find difficult to do. But I definitely think he would highlight my effort in doing my weekly physical exercise tasks."*
- *"I think it would say that I have get up and go but only to fill in my numbers. Once I've hit my goals in less likely to participate in activity. I like to complete my goals as early in the day as possible so I don't feel stressed at the end of the day and under presser to meet my goals."*

Examples of comments about sleeping more or better expected by participants:

- *"Based on the data it collects, it would say that my sleeping schedule is pretty okay but when she has day offs, she doesn't like to wake up early. She is a little lazy but not too lazy. […] From the sleeping and steps it's possible to say that she has 9-5 job."*
- *"I think it would say I need to sleep more/work on having better sleep! It would tell me the washing can wait and it's more important to get the extra sleep to help with my general well-being. […]"*

- *"[…] It would also tell me to go to sleep earlier and maybe give me some assistance in getting to sleep"*

Examples of motivational comments expected by participants:

- *"[…] He'd also tell me to stop being lazy some days and finding excuses for not getting at least a few more steps in on my lazier days. He'd congratulate me starting park run though and tell me to keep at it! He knows how hard it is for me due to being overweight but he'd say to keep on powering on and we'll reap the benefits soon enough!"*
- *"I think my activity tracker would say..... "come on" you can do it. You can beat what you did yesterday. It would encourage and behave like a trainer and tell you off when you have been bad and motivate you into good habits. It would wake you up and tell you what you have to do a bit like an army sergeant. I see it as a trainer with a deep and demanding voice."*
- *"Dear user good afternoon. How about you start using me to do actual workout tracking not just as a clock and to walk around to track the km you make during a day, and update you daily goals on Google fit to push yourself more.. Best regards your band."*
- *"I feel that, for instance, on a 20 mile run my tracker would be screaming at me to keep going - feeding me positive affirmations to help me get to the end of the run."*