Exploring Wearable Stress Feedback: A Mixed-Methods Approach to Perceived Stress and Challenge-Threat Appraisals

Kaj Zwakenberg

Faculty of Behavioural, Management and Social Sciences (BMS), University of Twente

202000384: BSc Thesis Psychology

1st supervisor: Prof. Dr. Matthijs L. Noordzij

2nd supervisor: Dr. Christina Bode

24 June, 2024

Acknowledgements

I would like to express my gratitude to my first supervisor prof. dr. Matthijs Noordzij for his invaluable guidance throughout the whole process. Among other things, this guidance included his provided expertise and feedback, and his availability in answering questions and assisting with encountered problems. This has been essential in the successful completion of this thesis. I would also like to acknowledge my second supervisor dr. Christina Bode for her feedback on the concept versions of this thesis. These valuable insights undoubtedly helped to improve this final version.

I would like to extend my sincere thanks to Jip for his collaboration throughout the development and execution of this study. His dedication, input in discussions, and persistent efforts were crucial in successfully completing our theses. Thanks should also go to all participants for their efforts in their participation in this study. Without their efforts, it would not have been possible to complete this thesis.

Lastly, I would like to express my heartfelt gratitude to my parents. Without their never-ending support and the opportunities they provided, it would not have been possible for me to successfully complete my bachelor's degree.

Abstract

This pilot study explored the effects of wearable stress feedback on perceived stress and tendencies to appraise stressors as a challenge or a threat. A mixed-methods approach was used to combine the measurement of the effect of wearable stress feedback with an exploration of experiences getting this stress feedback within the same participants (n=26, 84.6% male, M_{age}=25.9). The quantitative data was collected using repeated measures for two weeks in which participants filled in the Perceived Stress Scale (PSS-10) and the Challenge and Threat subscales of the Stress Appraisal Measure (SAM) daily. Linear mixed models were used to examine the impact of wearable stress feedback on perceived stress and challenge and threat appraisals. No significant effects of wearable stress feedback were found on either outcome variable. The qualitative data was collected using semi-structured interviews with a subsection of the sample of the quantitative data collection. Thematic analysis was used to determine themes encompassing physiological and behavioural insight, alignment to existing beliefs, attitudes towards wearables regarding the value of real-time wearable data, measurement accuracy, the impact of wearable use, and cognitive and behavioural adjustments made. Experiences of increased stress-coping abilities and unchanged or decreased demands of stressors were more often expressed. Future research should focus on the amount of interaction with wearable stress feedback, alignment with perceived stress, and confidence in stress-coping capabilities in the context of perceived stress and challenge and threat appraisals.

Exploring Wearable Stress Feedback: A Mixed-Methods Approach to Perceived Stress and Challenge-Threat Appraisals

Wearables are integrated into the daily lives of many people worldwide. In 2022, there were over 1.1 billion connected wearable devices worldwide (Number of Connected Wearable Devices Worldwide From 2019 to 2022, 2023). Although several studies found strong positive health effects of wearables on physical activity (e.g., amount of steps) and positive or non-significant effects on physiological measures (e.g., blood pressure), few considered psychosocial measures (e.g., quality of life) or found weak and/or non-significant effects when they did (Ferguson et al., 2022). Even fewer studied the effect of wearables on the use of stress management. So, more insights into the psychosocial impact of wearables in the context of stress are necessary since lifespan stress is a risk factor for disease onset and early ageing (Epel et al., 2018), and recent evidence has shown that wearables are an effective stress management intervention (González Ramírez et al., 2023; Jerath et al., 2023; Smith et al., 2020; Yen, 2021). The current pilot study aimed to get insights into how wearable stress feedback influences people's perceived stress and stress appraisals, and user's experiences receiving stress feedback from a wearable.

Existing research on the effect of wearables in the context of stress management indicates promising results. A recent scoping review by González Ramírez et al. (2023) has shown that the use of wearables for stress management decreases perceived stress. They argue that wearables support users in stress awareness and self-regulation. In other words, wearables support users in recognizing and understanding their stress, while simultaneously supporting them in regulating their behavioural and emotional responses in stressful situations. Moreover, it has been shown that commercial wearable devices are, among other outcomes, beneficial for stress management and subsequent mental quality of life (Yen,

2021). Another study on commercial wearable devices has suggested that wearables play an important role in, among other health aspects, effective stress management (Jerath et al., 2023). However, much of the research up to now on the effect of wearables on perceived stress has not focused on the specific effect of stress feedback in a naturalistic setting and failed to integrate qualitative data to explain the process behind the found effects.

Challenge vs. Threat Appraisal

A specific stress management technique that could arguably be effectively integrated into wearables is arousal reappraisal. Cognitive and physiological responses to stressors can be understood through the biopsychosocial (BPS) model of challenge and threat (Blascovich & Mendes, 2010). According to this model, people appraise stressors through demand and resource appraisals. Demand appraisals contain the perceived amount of danger and uncertainty a stressor evokes, and the effort required to deal with a stressor. Resource appraisals contain the perceived relevant skills and knowledge one possesses to deal with the stressor. Stressors are appraised as a challenge when one's resources level with or exceed the stressor's demands, and as a threat when its demands exceed one's resources. It is not the case that people either appraise a stressor as a challenge or a threat, they can experience challenge and threat appraisals simultaneously to varying extents. Even though a bias towards threat-related information is functional for detecting danger and taking effective actions to deal with the danger, but can become dysfunctional when it causes and maintains feelings of anxiety (Jamieson et al., 2012). Negative health outcomes of threat appraisals involve, among others, cognitive decline, increased risk of vascular disease (Jamieson et al., 2012), and shorter telomere length (i.e., increased cellular ageing) (O'Donovan et al., 2012).

Because of the potential negative health outcomes of threat appraisals, it is important to get insights into the potential of wearables to reappraise their perceived stress as more

beneficial. Previous research by Jamieson et al. (2018) has shown that negative physiological responses and experiences of negative affect can be reduced through arousal reappraisal. In this process, individuals are taught to reinterpret physiological arousal signs (e.g., a high heart rate) in the context of their beneficial effects for coping with stressors. It can be argued that this effect can be used to help wearable users reappraise physiological arousal signs positively through notifications. However, previous research has not focused on the effect of wearable stress feedback on the tendency of users to appraise stressors as a challenge and/or threat.

User Experience of Wearables

A lot of research has focused on user experience regarding the physical outcomes of using wearables, however, research on the perceived usefulness regarding the psychosocial outcomes of wearable stress feedback is lacking. There are several dimensions to the user experience of wearing wearables and reasons for engagement and abandonment of these devices. In the first 9 months of use, periods of engagement, disengagement, and re-engagement are common (Nelson et al., 2020). Enjoyment of gamified elements to compete with others (Nelson et al., 2020), and feelings of physical thriving (i.e., increased self-esteem and competence) and relatedness (i.e., social support from people with similar goals) (Karapanos et al., 2016) characterize periods of engagement. Attig and Franke (2020) name decreased tracking motivation, disturbed tracking routines, obsessive tracking and stressed feelings as the most common reasons for disengagement. The latter can result from feedback from wearables that contradicts users' beliefs, causing them to either or simultaneously question themselves or the wearable (Nelson et al., 2020). However, little is known about user experience regarding wearable stress feedback specifically.

It can be argued that users' perceived stress changes when introduced to stress feedback that contradicts their existing beliefs on their stress level. In line with Nelson et al. (2020), people can either change their existing beliefs or adjust their perceived stress based on the stress feedback. Also, it can be argued that users experience more stress because of this contradiction. In the study by Nelson et al. (2020) participants reported, among others, feelings of missing the technology and regulating routines again as reasons for re-engagement with wearables.

Current Study

The current pilot study aimed to combine the measurement of the effect of wearable stress feedback on perceived stress, and challenge and threat appraisals with an exploration of experiences getting this stress feedback within the same participants. For the quantitative component, a replicated simple counterbalanced single-case AB design (Lane & Gast, 2014; Michiels & Onghena, 2019) has been used, including the presence of a wearable as an intervention. There have been few studies that employed a mixed-methods approach using an intervention.

Schneeberger et al. (2021) employed a mixed-methods approach and found a positive effect of biofeedback by a social agent and stress management training on effective stress management. However, this study has little validity to real-life situations in which people do not use a social agent. In line with these findings, a randomized controlled trial by Smith et al. (2020) found significant decreases in reported stress, distressing symptoms, and fewer reported days of feeling anxious or stressed in a group that received a wearable-based treatment, compared to a wait-list control group. Contrary, Millings et al. (2015) found impeding effects of a prototype wearable sensor kit in reducing stress in comparison to only a stress management program group. Qualitative insights about perceptions and experiences of

individuals regarding the usefulness of the wearable sensor kit in combination with a stress management program from their study related this impeding effect to participants who experienced participation burden. Therefore, it can be argued that research on the influence of wearable stress feedback on perceived stress is necessary to add daily-life validity to the mostly cross-sectional, one-off questionnaire knowledge on this aspect.

Furthermore, the current study will employ a similar method as Lentferink et al. (2022). This study investigates the receptivity of employees to just-in-time messages for stress management using quantitative data that was collected through an app and qualitative data that was obtained using semi-structured interviews. The researchers combined these findings to find that there is generally an overlap between the moments at which the JIT-messages are deemed most necessary and at which receptivity of these messages is low, impeding the effectiveness of the messages. Similarly, the current study will collect quantitative data using repeated measures and qualitative data using semi-structured interviews. These will be integrated to hypothesize explanations for the quantitative findings.

So, the aims of the current study led to the following research questions:

(1) How does the introduction of wearable stress feedback influence individuals' perceived stress?

(2) What are the perceptions and experiences of individuals regarding the usefulness of wearable stress feedback?

(3) How does the introduction of wearable stress feedback influence individuals' tendencies to appraise stress as either a challenge or a threat?

(4) How does getting wearable stress feedback change individuals' perceptions of stressor demands and their own capabilities to deal with stressors?

Methods

Research Design Overview

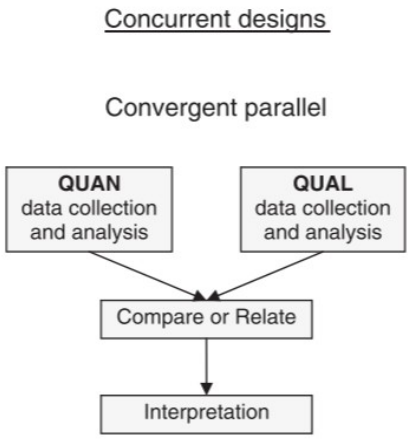
Previous studies on wearable stress feedback in this context only used either quantitative or qualitative measurements to get insights into this effect. However, the main disadvantage of this approach is that it gives limited insights into the effect of wearable stress feedback within the same participants (Plano Clark, 2017). For example, when a significant effect of wearable stress feedback on perceived stress is found, insights into the mechanisms behind this effect are still unknown. Given the exploratory nature of this research, integrating the results of the quantitative data with insights from the qualitative data allows comprehensive insights into the effect and the mechanism behind it within the same participants. So, a mixed-methods approach allows for deeper insights into the effect of wearable stress feedback and thus more ecological validity and stronger findings. The current study was executed together with another bachelor student. The other researchers focused on health anxiety, but this is beyond the scope of this study so this will not be regarded further.

More specifically, the present study used a concurrent and triangulation within-subjects design. Figure 1, taken from the article of Bishop (2015), illustrates this design. In this design (1) data is collected simultaneously, (2) there is no emphasis on either qualitative or quantitative data, and (3) participants all participate in the same condition. The present study used a (repeated) questionnaire for quantitative data collection because it is a practical method for collecting data from a larger group of participants simultaneously. Furthermore, the present study used semi-structured interviews for qualitative data collection because this method is appropriate for exploratory research and allows for deeper exploration of experiences while maintaining comparability of data. The interviews were conducted within five weeks after the participant wore the wearable. Because of this timing, there may be a

discrepancy between how participants remembered their experiences and how they actually experienced it. Therefore, these data possibly do not reflect the experiences of the participants very accurately so caution in interpreting these data is necessary.

Figure 1

Illustration of a Concurrent Design



Note. This illustration was taken from Bishop (2015). QUAN and QUAL respectively indicate the quantitative and qualitative components. Separate boxes on the same level and capitals for both indicate that the components occur simultaneously and that none is prioritized over the other.

Participants

The participant group for the qualitative data partly overlapped with that for the quantitative data. Some participants in the quantitative component participated in the qualitative component. Not all participants took part in the qualitative component because the final sample size was larger than expected. Participants from the quantitative component were drawn in a random order and approached for participation in the qualitative component in that

order. Participants from the quantitative component were drawn in random order and approached for participation in the qualitative component accordingly. When the desired number of participants (n=16) was reached, this process was stopped. The qualitative sample size was slightly lower than the pre-determined sample size.

The sample characteristics of the quantitative and qualitative components were very similar. Participants in the quantitative component were aged 20 to 59 years old, predominantly male (n=22, 84.6%), and mostly full-time working or students with a (side) job (n=8, 30.8%). Participants in the qualitative component were aged 20 to 59 years old, predominantly male (n=12, 75.0%), and mostly working students (n=5, 31.2%). A detailed overview of both samples can be seen in Table 1.

Table 1

Demographic Characteristics of Participant Groups

Characteristic	Quantitative		Qualitative	
	n	%	n	%
Gender				
Male	22	84.6	12	75.0
Female	4	15.4	4	25.0
Non-Binary	0	0.0	0	0.0
Age (mean ± SD)	25.9 ± 10.0		24.9 ± 9.3	
Occupational Status				
Student (not working)	6	23.1	4	25.0
Student (working)	8	30.8	5	31.2
Full-time working	8	30.8	4	25.0
Unemployed	1	3.8	0	0.0
Other	3	11.5	3	18.8

Note. This table provides an overview of the demographic information of participants in the quantitative component (n=26) and the qualitative component (n=16).

Researcher Description

Both researchers were third-year bachelor's students in psychology. They were educated in the aspects of scientific research relevant to this study, i.e. test construction, quantitative data analysis, interview techniques, and thematic analysis. However, some of these aspects were less frequently present in their education than others. For example, they had more experience with quantitative data analysis than with thematic analysis. The researchers familiarized themselves again with these aspects by searching for information on the internet, textbooks and previous reports and assignments in which these aspects were used. On the other hand, the researchers had limited education in perceived stress and wearable stress feedback. So, their limited understanding of phenomena had to be managed for this study.

Two strategies were used to manage the influence of this limited understanding on the study. First, the researchers were guided by a supervisor with much experience in research on wearables. Some of his research focused on stress in the context of wearables. He guided the researchers, among other things, in directing their literature review with relevant literature, designing the study, and providing feedback. Second, the researchers familiarized themselves with the phenomena through a literature review. Through the proposed literature from the supervisor and other literature that was found the researchers enhanced their understanding of the phenomena and were inspired for their separate focuses.

Participant Recruitment

Before participant recruitment, a minimum sample size of 15 participants was determined for the quantitative and qualitative components. However, the aim was to get as many participants as possible within the limits of available time and materials. Therefore, participant recruitment for the quantitative component was stopped when the maximum amount of participants that could participate, given the time frame for data collection and the amount of available wearables, was reached. Participant recruitment for the qualitative component was stopped when the maximum amount of participants that the researchers could realistically interview within the time frame for data collection was reached. Inclusion criteria were that participants spoke Dutch and had access to a device on which they could fill in the questionnaires (i.e., a mobile phone). Exclusion criteria were a serious psychological condition, having regularly worn a wearable device, regardless of which brand, in the months before the study, or filling in less than 80% of the questionnaires. After data collection, two participants were excluded because during their interview they had revealed they already regularly wear a wearable.

Given that the sample for the qualitative component was drawn from the quantitative sample only one sampling procedure was used, in contrast to what is common in mixed-methods research. Convenience sampling was used and participants were friends and family of the researchers who were approached face-to-face or via text. Of all approached people, 28.3% participated (n=26). One of these participants dropped out because of logistic reasons. Participants were drawn at random to determine the order in which they were approached for an interview. From all approached participants in the quantitative component, 94.1% agreed to be interviewed (n=16). Ethical approval was given by the BMS Ethic Committee / Domain Humanities & Social Sciences of the University of Twente under request number 240270.

Several agreements were made with participants. Regarding the quantitative component, they agreed to take part in the study for two weeks, to wear a wearable for one of those weeks, and to fill in questionnaires daily during their participation. Regarding the qualitative component, they agreed that they could be approached for an interview and that they could deny this request. Regarding their overall participation in the study, they agreed that they could stop their participation at any time and have their data removed without having to give any reason. Participation was voluntary and participants received no payment for their participation. One participant received 3.5 SONA credits for their test subject hours.

Data Collection

The quantitative data was collected from 17 March 2024 up until 21 April 2024. Participants wore the wearables and filled in the questionnaires during their everyday lives. The informed consent form, questionnaire regarding demographic information, and all the questionnaires for measurement were distributed to the participants using the Twente Intervention and Interaction Machine (TIIM) software (Version 6) developed by the Behavioural, Management and Social Sciences (BMS) lab of the University of Twente (University of Twente, n.d.). The interviews, i.e. qualitative data collection, were conducted from 8 April 2024 up until 19 April 2024 either online or in-person at the participants' homes or the campus of the University of Twente.

Quantitative Data Collection Procedure

Before participants could fill in any questionnaires they were instructed to download the TIIM app (https://play.google.com/store/apps/details?id=nl.bmslab.utwente.tiimapp&hl=en_US), make an account on this app, and fill in a code for participation in this study. After they were added to the correct intervention by the

researchers they could fill in a form for informed consent and their demographic information (i.e., gender, age, and occupational status). They were asked to do this the day before they started with their participation (i.e., on day 0).

Participants wore either the Garmin Forerunner 255 (n=22) or the Garmin Vivosmart 4 (n=4). Participants were informed that they could download the Garmin Connect app, which gives more insight into the measurements compared to only the interface of the wearable. However, it is not known how many participants did that in this study, but the participants who wore the Vivosmart 4 had to download this app because they could otherwise not get an overview of their average daily and weekly stress levels.

Their participation consisted of filling in daily and weekly questionnaires. The daily questionnaires, that were distributed from day 1 to 14, started with a question of whether the participant had worn a wearable that day. If yes, participants were asked to fill in the average stress level measured by the wearable for that day as a manipulation check. The aim of this was to prompt the participant to think of the stress feedback from the wearable and to ensure that they had checked the stress feedback from the wearable at least once before filling in the questionnaire to be able to measure the effect of the stress feedback more valid. However, this average stress level was not considered further in the data analysis. This approach is a variation of that by Montagna et al. (2021) where they measured cognitive stress appraisal of an upcoming exam. Their participants were asked to name the title of the upcoming exam and consider this exam when filling in the questionnaire. If they had not worn the wearable that day, this question was skipped and the participant was directed to the questions regarding the measures of interest.

The weekly questionnaires, that were distributed on days 7 and 14, started with a question of whether the participant had worn a wearable that week. If yes, questions about the

average stress level of the participant measured by the wearable and the estimated time the participant wore the wearable on average per day followed. The latter aimed to control for wearing time of the wearable but this was not further considered in the data analysis. If they had not worn the wearable that week, these questions were skipped and the participant was directed to the questions regarding the measures of interest. The measures of interest were measured using three existing questionnaires. However, while downloading and merging the data from these weekly questionnaires, it was noticed that this process went wrong beyond restoration and that these data were no longer reliable. Because of that, it was decided not to include these data in the data analysis. Thus, the weekly questionnaires will not be discussed further.

Perceived Stress Scale. Participants' perceived stress was measured using a validated Dutch translation of the Perceived Stress Scale (PSS-10) consisting of ten items (Cohen et al., 1983), see Appendix A. Using a five-point Likert scale, participants were asked to rate how often they had certain thoughts and feelings that relate to perceived stress. The scale ranged from 0 (never) to 4 (very often). In a review by Lee (2012), Cronbach's alpha of the PSS-10 varied from 0.74 to 0.91 and was shown to have acceptable test-retest variability. The PSS-10 was included in the daily questionnaires of days 1 to 14 and a prompt underneath the item specified that the item related to that specific day.

Stress Appraisal Measure. Participants' challenge and threat appraisals were measured using a non-validated Dutch translation of the challenge and threat subscales of the Stress Appraisal Measure (SAM) developed by Peacock and Wong (1990). These subscales consisted of eight items and were translated using ChatGPT. The translated version was checked separately by the researchers until agreement was reached on the final version. Using a five-point Likert scale, participants were asked to rate their thoughts and feelings towards

expected stressors. The scale ranged from 1 (not at all) to 5 (extremely). Since a non-validated translation was used, no psychometric properties of the used version can be reported. For the original version, Cronbach's alpha of the Threat and Challenge subscales varies from 0.65 to 0.75 and 0.66 to 0.79 respectively (Peacock & Wong, 1990). According to a review by Carpenter (2016), no studies have reported on the validity of the SAM. The Cronbach's alpha of the Challenge and Threat subscales in this study are discussed in a later section. The Challenge and Threat subscales of the SAM (see Appendices B and C respectively) were included in the daily questionnaires of days 1 to 13 because the items measured appraisals of expected stressors. A prompt underneath the item specified that the item related to the next and explained that the item referred to expected stressors in that time frame.

Also, a questionnaire measuring health anxiety was included in the weekly questionnaires. However, this is not relevant to the scope of this study.

Qualitative Data Collection Procedure

The data collection of the qualitative component consisted of semi-structured interviews. The questions were developed by the researchers and aimed to explore the experiences of the participants regarding their use of the wearable, possible changes in their behaviour, receiving (stress) feedback, use of wearables in general, and health anxiety and stress appraisals after having used the wearable for one week. Follow-up questions were developed to allow a deeper exploration of these experiences. Most questions were open-ended and follow-up questions were developed for the closed questions to ensure deeper exploration. After the first interviews were conducted the researchers adjusted and added questions, after deliberation, based on experiences conducting the interviews. See Appendix D for the final interview scheme in Dutch.

The interviews were conducted online or in person at the participants' homes or on the campus of the University of Twente. The interviews were recorded and transcribed, for which the participants gave informed consent when the recording started. Online interviews were conducted, recorded, and transcribed using Microsoft Teams. In-person interviews were conducted, recorded, and transcribed using Microsoft Word. Transcriptions were checked and corrected by the researchers in cases of mistakes, using the records.

Data Analysis

Quantitative Data Analysis

Statistical analysis was performed using R software version 4.1.1-2021-08-10 (R Core Team, Vienna). A linear mixed-effects model was used to investigate how wearable stress feedback affects perceived stress. The dependent variable was the PSS-10 score. The model included a fixed effect for the baseline stress level (intercept), the presence of the smartwatch (yes/no), and whether the participant wore the smartwatch in their first week of participation (yes/no). A random effect was included to account for variations in PSS-10 scores between individuals. These included individual variations in the intercept and slope concerning the presence of the smartwatch. All random effects were assumed to be normally distributed.

Furthermore, linear mixed models were used to determine whether threat and challenge appraisals were influenced by the presence of a smartwatch (yes/no) and whether the participant wore the smartwatch in their first week of participation (yes/no). Models similar to the aforementioned model were used. However, instead of the PSS-10 score, the score on the Challenge and Threat subscales were separately used as outcome variables.

Qualitative Data Analysis

Each researcher transcribed the interviews they had conducted themselves. A pseudonym was given to each participant, which would be referred to in the Results section when presenting a quote. The transcriptions were uploaded to ATLAS.ti software version 7.7.1-2024-04-25 (Scientific Software Development GmbH, Berlin). Thematic analysis (Braun & Clarke, 2006) was used to identify recurring themes in the interviews regarding (thoughts on) wearables and their usage. To become familiar with the data and to establish an initial coding scheme, both researchers independently constructed codes while coding two transcripts of each other. The researchers coded each other's transcripts to avoid bias, as they conducted interviews with friends and family. All initial codes were discussed and evaluated. Codes were adjusted, added, or deleted throughout this discussion to construct an initial coding scheme that both researchers agreed on. All transcripts would be coded with this coding scheme, including the transcripts that were already coded.

While coding all interviews, the researchers added, deleted, or adjusted codes as deemed necessary by both. After coding all interviews, they discussed any uncertainties about coding certain sections until agreement was reached. An inductive approach was used to identify main themes and subthemes, except for themes related to stress appraisals. For these themes, a deductive approach was used to identify themes related to the perceived demands of stressors and the capacities of participants to deal with stressors. The researchers identified main themes and subthemes based on quotations that stood out, recurring themes from the coding process, and constructed codes. Some main themes were identified when researchers agreed that some subthemes were similar and could be grouped under one main theme. Conversely, some subthemes were identified by the researchers when they decided not all aspects of a main theme were covered by the already identified subthemes. One main theme

was identified without subthemes because the researchers agreed that this theme was equally important throughout the interviews as the other themes but that some subthemes it could contain would cause some confusion. The researchers agreed that these subthemes would have too much overlap with other subthemes. However, the main theme would not have that much overlap with the others and would reflect the participants' experiences more comprehensively.

Mixed-Methods Analysis

At the beginning of the data analysis, the quantitative and qualitative data were analysed separately. After this, an explanatory concurrent design (Schoonenboom & Johnson, 2017) was adopted to explain and contextualize the outcomes of the quantitative data analysis using the identified main themes and subthemes resulting from the qualitative data analysis. This mixed-methods design was adopted to explore the effects of wearable stress feedback on perceived stress, challenge and threat appraisals, and the mechanisms behind these effects.

Validity, Reliability, and Methodological Integrity

Given the fact that the researchers are bachelor's students who have little experience with this kind of research and that, to the knowledge of the researchers, there is no previous study that has adapted a similar mixed-methods approach, it can be argued that the mixed-methods validity of the study is low to moderate. The used translated versions of the PSS-10, and the Challenge and Threat subscales of the SAM showed somewhat acceptable internal consistency. This can be seen in the Cronbach's alpha's of these versions which were respectively 0.664, 0.704, and 0.628.

Results

Throughout the data collection and data analysis procedures, it was necessary to exclude a few participants and specific observations because of various reasons. From all participants (n=26) that enrolled in the quantitative data collection procedure, all data of four participants had to be excluded because of filling in less than 80% of the questionnaires (n=1), not being capable of wearing a wearable for logistic reasons (n=1) or revealing in the interviews that they already wore a wearable regularly (n=2). The qualitative data from the latter were for the same reason excluded. This means that from all participants that enrolled in the qualitative data collection (n=16), the final qualitative dataset included fourteen interview transcripts. Specific observations (n=4) were excluded because these contained (half) missing data. This resulted in a quantitative dataset with 304 observations (12-14 per participant). Weekly averages of the outcome variables were used for data analysis to control for autocorrelation, hence the dataset for data analysis contained 44 observations (2 per participant). An overview of the outcome variables is given in Table 2. This overview does not give indications for floor or ceiling effects in the data.

Table 2

Descriptive Statistics and Correlations of Weekly Averages of the Outcome Variables

	n	*M*	*SD*	1	2	3
1. Perceived Stress (PSS-10)	44	9.82	3.27	-	.15	.65***
2. Challenge Appraisal (SAM – Challenge)	44	11.20	2.55		-	.06
3. Threat Appraisal (SAM – Threat)	44	6.24	1.71			-

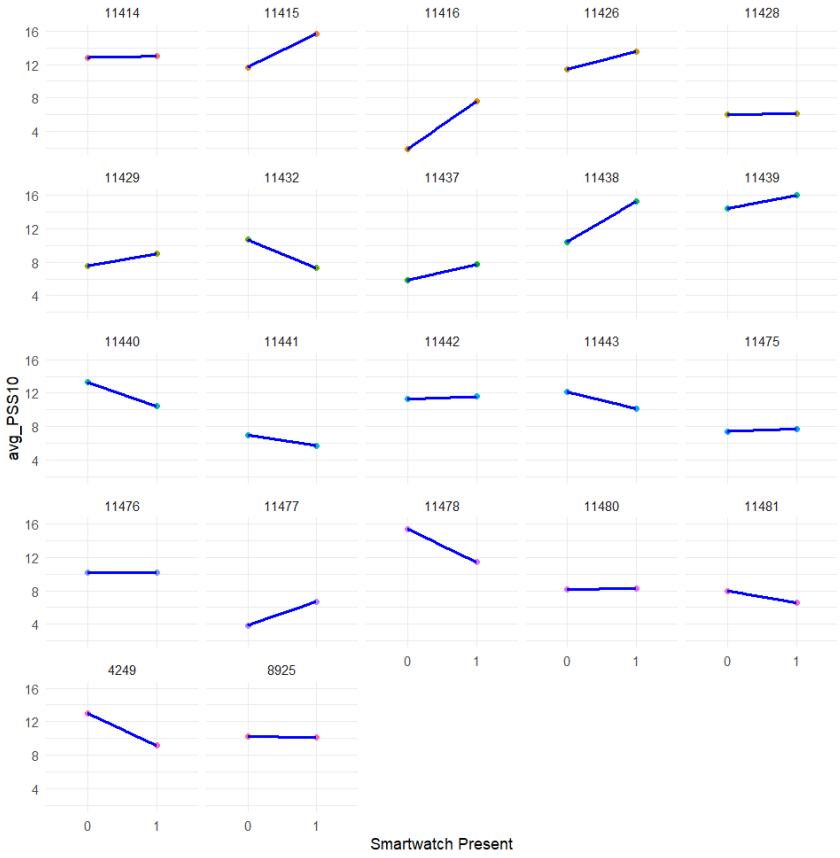
Note. *p<0.05; **p<0.01; ***p<0.001. Possible scores on the PSS-10 ranged from 0 to 40 and scores on the Challenge and Threat subscales of the SAM ranged from 4 to 20.

Effect of Stress Feedback on Perceived Stress

To determine the effect of stress feedback on perceived stress, a linear mixed model was fitted, using fixed effects for the dichotomous categorical predictor variables smartwatch presence and wearing the smartwatch in the first week, and random effects for the variable participant with the weekly average PSS-10 score as the outcome variable. No significant effects were found for both smartwatch presence (estimate = .297, SE = .570, $t(21) = .521$, p = .608, 95% CI: -.888; 1.483), and wearing the smartwatch in the first week (estimate = -.560, SE = 1.479, $t(20) = -.379$, p = .709, 95% CI: -3.643; 2.523) on the weekly average PSS-10 score. The variance of the random effect was 7.763 (SD = 2.79), showing considerable variation in weekly average PSS-10 scores between individuals in this sample. See Figure 2 in which all weekly average PSS-10 scores are compared per participant.

Figure 2

Comparison of Average PSS-10 Scores Per Participant



Note. These plots show the differences between the average PSS-10 scores (avg_PSS10) per participant (see the participant number above each plot) for the week in which they did not wear the wearable (Smartwatch Present = 0) and the week in which they did wear it (Smartwatch Present = 1).

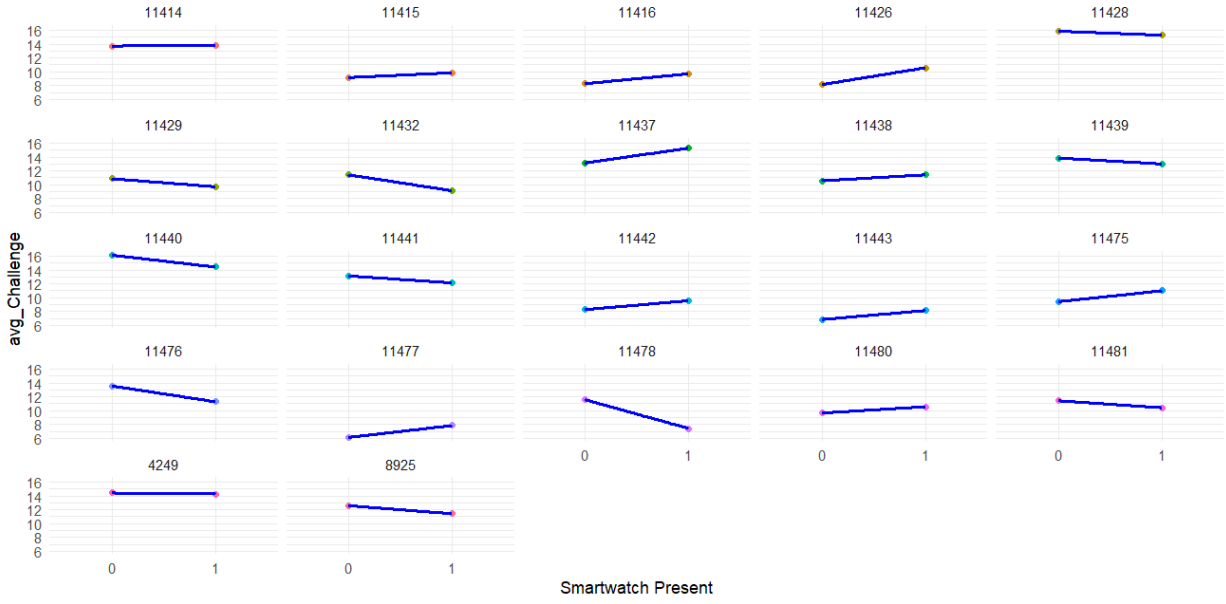
Effect of Stress Feedback on Stress Appraisals

The impact of stress feedback on challenge appraisal was analysed using a linear mixed model with fixed effects for the dichotomous categorical predictor variables smartwatch presence and wearing the smartwatch in the first week, and random effects for the

variable participant with the weekly average score on the Challenge subscale of the SAM as the outcome variable. No significant effects were found for both smartwatch presence (estimate = -.085, SE = .359, $t(21)$ = -.236, p = .816, 95% CI: -.787; .618), and wearing the smartwatch in the first week (estimate = .269, SE = 1.196, $t(20)$ = .225, p = .824, 95% CI: -2.073; 2.612) on the weekly average Challenge subscale score. The variance of the random effect was 5.532 (SD = 2.35), showing considerable variation in average Challenge scores between individuals in this sample. See Figure 3 in which all weekly average Challenge scores are compared per participant.

Figure 3

Comparison of Average Challenge Scores Per Participant

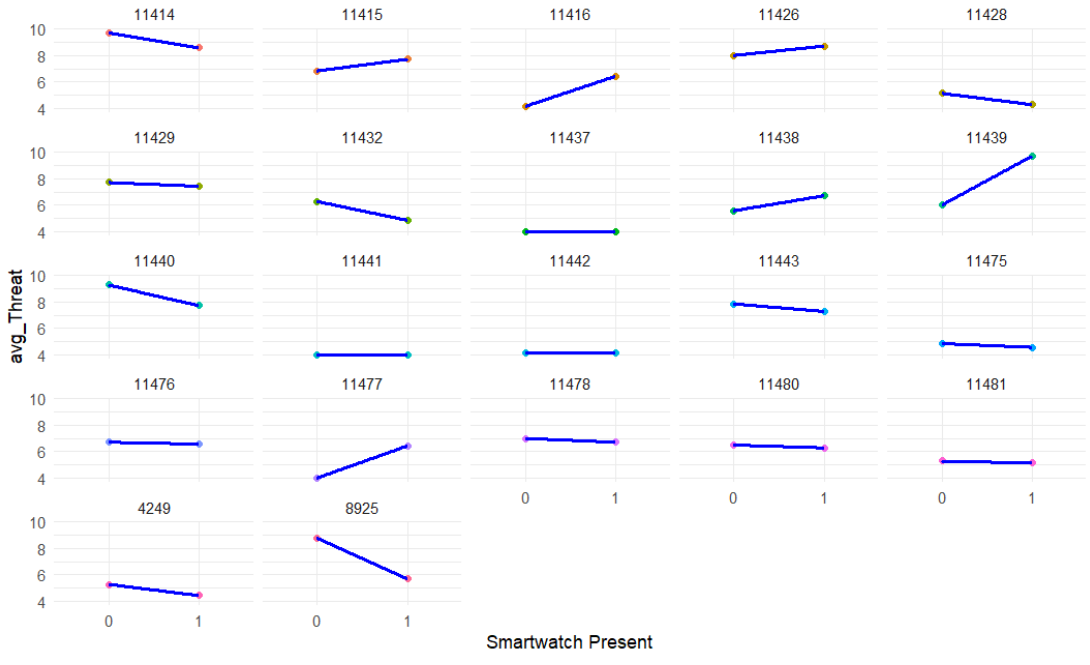


Note. These plots show the differences between the average Challenge scores (avg_Challenge) per participant (see the participant number above each plot) for the week in which they did not wear the wearable (Smartwatch Present = 0) and the week in which they did wear it (Smartwatch Present = 1).

A linear mixed model was also used to determine the impact of stress feedback on threat appraisal. This model included fixed effects for the dichotomous categorical predictor variables smartwatch presence and wearing the smartwatch in the first week, and random effects for the variable participant with the score on the weekly average Threat subscale of the SAM as the outcome variable. No significant effects were found for both smartwatch presence (estimate = .013, SE = .312, $t(21) = .043$, p = .966, 95% CI: -.600; .624), and wearing the smartwatch in the first week (estimate = .101, SE = .767, $t(20) = .132$, p = .897, 95% CI: -1.401; 1.603) on the weekly average Threat subscale score. The variance of the random effect was 2.028 (SD = 1.42), showing some variation in average Threat scores between individuals in this sample. See Figure 4 in which all weekly average Threat scores are compared per participant.

Figure 4

Comparison of Average Threat Scores Per Participant



Note. These plots show the differences between the average Threat scores (avg_Threat) per participant (see the participant number above each plot) for the week in which they did not wear the wearable (Smartwatch Present = 0) and the week in which they did wear it (Smartwatch Present = 1).

Themes

A total of four main themes and eight subthemes were identified. The main themes cover what participants concretely used the wearable for, cognitive and/or behavioural adjustments they made, opinions regarding wearables and their usage, and how they perceive stressor demands and their own capabilities to cope with these stressors. The subthemes are constructed based on observed variations within the main themes. Since the interviews were conducted in Dutch, the quotations used to illustrate the themes have been translated from Dutch to English.

Main Theme 1: Insight

Throughout all interviews, participants most commonly expressed an interest in or increasing insights into various aspects of their body and experience. Particularly, all participants (14/14) expressed that they used real-time data (either intentionally or unintentionally) to gain insight into their (physiological) experiences and behavioural activity patterns. These insights can be divided broadly into three categories that will be discussed in the following sections.

Subtheme 1a: Physiological Insight. All participants (14/14) expressed that they used the wearable to gain insights into how their body works and what physiological changes occur in response to certain efforts, like exercise (2/14). Participants generally expressed

using measurements to check whether their physiological functions were within normal ranges, with respiration (2/14) and heart rate (12/14) being the most common in this context. Noteworthy, these participants often mentioned that they checked how their heart rate changed as a consequence of for example cycling, as illustrated by one participant when they were asked how often they checked the wearable's measurements.

For example, when I cycle to the football I think on the way oh I am actually curious what it does to my heartbeat. I think I only really looked at that, because I was intrinsically curious about it myself. [participant #11429]

This expression further highlights that participants often gained more insight into physiological functions for which they were intrinsically motivated to check the related measurement. For example, almost half of the participants (6/14) expressed they gained more insight into their sleeping patterns while also expressing an interest in the measurement. In contrast, even though most participants (10/14) expressed they checked the stress feedback when asked which measurements they checked the most, they often expressed that they did that so often only because it was specifically requested in the questionnaire. A common reason for interest in the sleeping measurement was that it gives a unique and uncommon insight, as one participant illustrates.

That you know how your sleep quality is. And I found that very interesting. Because you cannot normally really measure that yourself. [participant #4249]

Subtheme 1b: Alignment. Participants already had pre-existing beliefs about their physiological functions and how they experience stress. However, most of the participants (11/14) expressed that they had used the wearable to check whether its measurements correspond to these beliefs. In other words, participants assessed whether their inner sensations aligned with real-time data from the wearable. Throughout the interviews,

expressions of confirmation (n=28) were more common than contradiction (n=13). A contradiction of inner sensations was often expressed in the context of stress (n=8) and entailed that stress feedback was higher than expected by the participants. This either led to attempts to explain this high stress feedback (n=3) or doubts about how accurately they can assess their stress (n=5). The latter is illustrated by one participant as follows when they expressed that they felt like they assessed their stress differently after wearing the wearable.

Yes at times, when I had moments when I thought I was not so stressed or something and that thing indicated that I in fact was stressed. That I think like maybe I can not recognize my own stress signals very well so to speak. [participant #8925]

Contrary to expressions of contradiction, expressions of confirmation by the wearable's measurements occasionally made the participant feel reassured. Expressions of confirmations were, like those of contradictions, often done in the context of stress (n=7). Expressed consequences of confirmations were increased confidence in estimating inner sensations like stress and letting go when they were reassured that their general stress level was not very high. One participant expressed they checked the stress feedback to see whether this reflected their increasing perceived calmness during a stressful conversation.

And especially when the conversation went in the right direction. Then I also looked at the overview afterwards and then I also saw that it went kind of from a bit higher to lower. [participant #11477]

Subtheme 1c: Behavioural Insight. Even though it was less often discussed than the other subthemes, almost half of the participants (6/14) expressed increased or perceived importance of behavioural insights as a consequence of or reason for intention to continue wearing a wearable, respectively. It was commonly expressed (n=10) that participants used the wearable to gain insights into their exercising patterns. However, almost as many

expressions (n=8) were done by participants concerning quantifying moving patterns in general and assessing whether they moved enough. For example, the pedometer function was used to make this assessment. One participant even expressed that this kind of insight was the main reason they enjoyed using the wearable

I experienced it as very positive because I could see how much I move during the day. [participant #11428]

Main Theme 2: Attitudes Towards Wearables

Further analysis revealed that participants had a wide range of opinions about wearables, most frequently expressed relating to the extent to which participants valued their experience over measurements, measurement accuracy, and the impact of wearable use generally. These were expressed in all interviews (n=14). Overall, participants expressed positive opinions (n=254) more frequently compared to negative (n=167) and neutral (n=40) ones. It is unclear whether some were pre-existing or formed due to using a wearable because pre-existing opinions were not discussed. In the following paragraphs, we will delve deeper into the varying opinions, providing insights and examples from the interviews.

Subtheme 2a: Experience vs. Measurement. A noteworthy contradiction emerged throughout the interviews. Participants differed regarding the extent to which they valued real-time data from the wearable to describe their real-time experience. This contradiction was not apparent that often (2/14), but because the two extremes were that apparent in these two interviews and subtle references to this contradiction were apparent in other interviews, it was deemed necessary to implement this as a subtheme.

On the one hand, one participant did not value the data to describe their experience. They described that their experience was leading and that the data from the wearable did not influence that. Doubts about measurement accuracy accompanied this expression. They

expressed doubts about accuracy more often than thoughts of accuracy. While discussing their overall experience wearing the wearable, they phrased their doubts about the measurements and prioritization of their experience over measurements as follows.

While I think, yeah, that is also just a measurement. You can not always rely on it, so to say in that sense that the device can tell me whether I slept well, but when I wake up and I am not rested, then I am not rested. Then the device can tell me anything. [participant #11429]

On the other hand, another participant expressed an opposing view. Namely, they did not know how to interpret certain bodily sensations. In this context, they thought that they had experienced a kind of tension and did not want that to have negative consequences. So, they checked the wearable to see their stress level, hoping it would calm them down. However, they expressed that this had not calmed them yet because they had not worn it long enough. Noteworthy, even though they expressed that they wanted to use the wearable to interpret (bodily) sensations, they mentioned a certain doubt about measurement accuracy, just like the other participant but their doubts were not as strong. The participant will likely feel that the measurements are more tailored to them if they would wear the wearable for a longer period, arguably leading them to perceive the measurements as more accurate.

And now I have worn it for a week and of course I am not sure how accurate those measurements are. I trust it, that is not the point. But it is not enough time to actually be able to stick a label on the feeling you have at that moment. [participant #11477]

More specifically, on this side of the spectrum, it comes down to the desire to use the wearable to put labels on (bodily) sensations as the participant expresses. For example, deciding whether certain sensations are a sign of stress. It can be argued that they can manage

their stress more effectively using these labels. The participant describes how they would like to use the wearable to label and understand their sensations as follows.

But it is nice to be able to stick a kind of label to those feelings from time to time. Like okay, on a scale from one to ten regarding stress, what you feel right now might be just a two or something. [participant #11477]

Subtheme 2b: Accuracy of Measurements. Participants differed in their perceptions of measurement accuracy, especially stress feedback. Participants generally expressed thoughts that it was accurate, inaccurate, or had some doubts about it. Expressions of inaccuracy entailed more certainty than doubts about accuracy. Thoughts on accuracy were discussed in almost all interviews (13/14) and there was a balance between participants who generally thought the measurements were accurate, inaccurate, and had some doubts. Throughout all interviews, doubts about measurement accuracy were more frequently expressed (n=30) than thoughts indicating perceived accuracy (n=27) and inaccuracy (n=21).

Participants also expressed their thoughts on measurement accuracy. In response to the interviewer's question about measurement accuracy, participants most commonly (n=9) and often instantly mentioned heart rate as accurate without giving a specific reason. Stress was also expressed as an accurate measurement (n=5). Participants generally argued this through the fact that they could explain their stress level logically, either through events that occurred or what they thought the stress level was derived from, as one participant described.

Well, as I mentioned before, I have mainly looked at the heart rate and stress, which I think it measures quite accurately. I think the stress is derived from the heart rate and your respiration and so on, so that all seemed quite accurate to me. [participant #11414]

Although stress was expressed a few times as accurate, doubts about its accuracy (n=13) and expressions of inaccuracy (n=12) were far more common. In fact, stress was the

most frequently mentioned function in both categories. Some participants described the alignment with their experiences as an argument for the accuracy of stress measurement, but those who disagreed used a lack of alignment to doubt measurement accuracy or describe it as inaccurate. Participants often explained doubts by stating instances where the stress measurement did and did not align with their experiences. Several times, this was accompanied by doubts about their stress experience, as can be seen in the description of one participant's doubts.

How it indicated the stress level often corresponded with my day, but also sometimes not at all. And then I think yeah, did that measurement go completely well or did I feel to myself that I was particularly very busy at work, but that I was not necessarily very stressed? [participant #11426]

Furthermore, participants who expressed doubts regarding the accuracy of stress measurement or thought it was inaccurate generally attributed it to certain circumstances. In multiple interviews (5/14), participants attributed the perceived inaccuracy of measurements (i.e., also others than stress) to the use of alcohol. Three of these instances were in the context of stress measurement. A few others linked the doubts about the accuracy or their perceived inaccuracy to circumstances that involve sports, like one participant who was asked how he experienced getting feedback from the wearable.

Yes, just very neutral. I did not necessarily see it as structural feedback or thus as accurate feedback. For example, my stress levels were just through the roof every day, while that was just because I was exercising every day. (...) Well, for example, I assumed that it was not accurate for me, so you do not do much with feedback then. [participant #11440]

Subtheme 2c: Considerations Impacts of Use. Whether in response to questions from researchers or expressed by themselves, participants expressed varying opinions about

the impact of wearable use on individual and societal levels. Positive opinions regarding the impact of wearable use were expressed more frequently (n=132) compared to neutral (n=44) and negative ones (n=84). Most participants (10/14) expressed more positive opinions than neutral or negative ones. In addition, all participants (14/14) addressed both individual and societal impacts of wearable use. Opinions about the impact on an individual level were more often positive (n=80) than neutral (n=33) and negative (n=40), while those on a societal level were somewhat more often positive (n=53) than negative (n=40). No neutral opinions regarding wearable impact on a societal level were identified.

Positive opinions were generally related to the outcomes of wearable use rather than the wearable itself and were expressed in all interviews. Opinions regarding the outcomes included for example more insights, comforting measurements, and more motivation to watch their health. The latter was commonly mentioned on an individual and a societal level. So, participants became more motivated to watch their health, suspect that others will too, and think this will benefit a lot of people. Regarding positive opinions about the wearable itself, participants mainly expressed they found it easy to use and that it provides a clear overview of measurements. In response to a question regarding the increased use of wearables to monitor health, a participant emphasized enhanced insights while simultaneously suggesting an application for the technology.

It does give you insight, for example the pedometer is very concrete. I wonder if it really measures 100% accurately, but it does indicate that you have really moved a lot. (...) And I think it can really help for certain problems. Take heart rate, for example. My father has a pacemaker and he occasionally has a very low heart rate, and you can only observe that if you are monitored at that moment. If your heart rate drops below forty, for example, you go down, (...) Look, if you have such a watch, you can of course use that data to see what

happens at that moment. Things like that very concretely, as an example, I think it could be very good for that. [participant #11429]

Contrary to the positive opinions, negative opinions regarding wearable use tend to focus primarily on the wearable itself rather than its outcomes and were expressed in almost all interviews (13/14). A few participants (3/14) mentioned that they found the notifications very annoying. For example, the notification that their stress level was high when they disagreed with it or they got it at a stressful moment. Some participants (4/14) expressed financial considerations, either in general or in comparison with how intensely they expect to use a wearable. Expressed negative opinions on a societal level included suspicions that people susceptible to it may become obsessed with the measurements and/or experience more health anxiety. This was expressed by one participant as follows while providing nuance to his opinion that wearables are generally beneficial to individuals.

But I think some people are also going to worry about things that are not there. That is why I think it can be very good on the one hand, but on the other hand it can also make you worry very much about your health, while there is nothing to worry about. [participant #11441]

Besides positive and negative opinions, most participants (11/14) also expressed neutral opinions regarding the impact of wearable use. These opinions were mainly accompanied by already expected measurements or not caring about the feedback.

Main Theme 3: Adjustment

Throughout the interviews, there was a consistent theme regarding changes in behavioural patterns or cognitive schemata resulting from real-time wearable data. Changes in behavioural patterns include daily life adjustments, while changes in cognitive schemata include changes in awareness or thinking patterns. The majority of participants (9/14)

indicated that they had adjusted their behavioural patterns, cognitive schemata, or both. As a result of different types of feedback from the wearable, behavioural patterns and cognitive schemata changed at different levels.

Participants made several behavioural adjustments to improve their health. However, these were not always persistent for a longer period after wearable use stopped because they had no possibility any more to track, for example, heart rate or breathing. Some participants (3/14) expressed that they made changes to improve their sleep (e.g., fewer afternoon naps or going to bed earlier) because of the sleep feedback they received. After adjusting their sleep schedule, one participant reported improved sleep feedback. Furthermore, participants (3/14) expressed that they began moving more during or after wearable use. For example, walking instead of cycling to the supermarket to reach the step goal. Others (2/14) began cycling slower, and breathing slower and more aware to avoid a high heart rate or to decrease it. As one participant expressed, behavioural adjustments were also made as a result of stress feedback.

I have become more aware of my stress I think. (...) Sometimes a bit stressed that I sometimes thought like take a step back, taking back rest and doing slightly less stressful things. And that also gives a bit more concentration when doing things. So, I look at stress differently, yes. (...) When I'm stressed, but don't panic, for example like oh I still have to get this, I still have to get that. Then doing that a bit calmer. Hopefully I will then forget a little less. Usually I have to walk back three times to get my things and now twice. [participant #11438]

Apart from behavioural adjustments, participants also expressed they made adjustments to their cognitive schemata through increased awareness or adjustments in thinking patterns. These adjustments led some participants to behavioural adjustments. For

example, because of stress feedback, one participant became more aware that some stressors they worried about were smaller than they thought and thus paid attention to staying calm when facing these kinds of stressors. Furthermore, participants (2/14) expressed a sense of evaluating and planning their day resulting from wearable use. They received feedback (e.g., unexpected low stress or poor sleep), evaluated their day to explain what caused it, and used these insights to either start planning their day more consciously or change their beliefs about how stressful certain events are for them. As a result of wearable use, a participant became more aware of stressful moments and attempted to consciously cope with these moments.

I think it is mainly that I have become aware of like oh I now see that stress meter or whatever. That I am more aware of like oh I am now stressed and that is why I approach things differently. Like oh be a little less stressed about that, think a little more and that because of that the resistance increased. I don't think that is because I can better estimate how and what stress is. But above all I am more aware that if there is stress, then I have to slow down a bit. [participant #11438]

Main Theme 4: Changes in Stress Appraisals

Resulting from a deductive approach based on the BPS model of stress appraisal by Lazarus and Folkman (1984), a main theme relating to specific changes in stress appraisals was identified and divided into subthemes relating to changes in perceived capabilities to deal with stressors and perceived demands of stressors. Expressions related to (changes in) these aspects were apparent in almost all interviews (11/14) with expressions relating to capabilities (n=15) being similarly apparent throughout all interviews as those relating to stressor demands (n=13). However, participants expressed that wearing the wearable had other effects relating to these aspects.

Subtheme 4a: Stress-Coping Capabilities. Most participants (9/14) expressed experiences related to how they perceived their capabilities to deal with stressors since wearing the wearable. It was far more often expressed that participants perceived increased capabilities (n=11) compared to unchanged (n=3) and decreased (n=1) capabilities. Almost half of the participants (5/14) indicated that they perceived increased capabilities to deal with stressors. Participants reported more confidence that they can handle a stressful situation by employing suitable coping strategies, for example consciously trying to calm down. An overlap with the other aspect of stress appraisal was evident when one participant described how they perceived increased stress-coping capabilities to meet the demands of stressors as follows.

Yes, that I am confident that I recognize those stressors well and that I also know how I normally should act in that situation so to speak, in order to be able to meet that in practice, so to speak. [participant #11426]

Contrary to these experiences, some participants expressed unchanged (3/14) or decreased (1/14) perceived capabilities after wearing the wearable. The latter participant expressed that the wearable made them more stressed and consequently decreased rather than increased their perceived capabilities to effectively deal with stressors. The participants who expressed unchanged perceptions of their stress-coping capabilities related this generally to not valuing the measurements of the wearable in determining their capabilities. This partly overlaps with subtheme 2a (Experience vs. Measurement). However, these expressions related better to the current subtheme since it was specifically expressed when they were asked about whether wearing the wearable changed their perceived stress-coping capabilities. The following participant highlights the fact this has not changed since they believe it is only relevant how their body responds to stressors.

Because I do not feel like the smartwatch has anything to say about me. He just produces data. He just measures things. And how my body responds to stressors, that is something my body knows how to sort out. [participant #11416]

Subtheme 4b: Perceived Stressor Demands. In most of the interviews (8/14), expressions related to (changes in) perceived stressor demands as a consequence of wearing the wearable were discussed. This encompassed whether the stress feedback from the wearable increased, decreased, or did not change how participants generally perceived the demands of stressors. Throughout all interviews, expressions of unchanged and decreased perceived stressor demands were equally apparent (n=6). Participants who mentioned no changes (5/14) did not mention particular reasons for why their perceived stressor demands had not changed. Participants who expressed decreased perceived stressor demands (4/14) generally related this to an experience where stress feedback from the wearable was lower on specific moments they thought the stress feedback would be high. Subsequently, they reported a decrease in specific perceived stressor demands, like how the following participant expresses decreased perceived demands of their work.

For example at work I always had super low stress levels. (...) But now that I know like, oh it gives me so little stress, that I started to stress less for it. [participant #4249]

Notably, this same participant was the only participant who expressed an instance of increased perceived stressor demands. Like how they described a decrease in perceived stressor demands, they related an increased perceived stressor demand to a specific situation. In this specific situation, they had high perceived stress and were notified of high stress feedback which increased their perceived stress at that particular moment. They described how this high stress feedback could increase perceived stressor demands for them as follows.

That if I have it next time I might be more like, oh shit I am going to get stressed from this. Because I knew from last time, it put me under stress. I could literally see that it was stressful, which may make you more aware of it than. If you know okay, yes, I know it makes me a little nervous, I think it is exciting and it can give me light stress. But then it may not be so concrete. Because you also have a concrete number of okay this activity gave me such an amount of stress. [participant # 4249].

Additionally, themes regarding health anxiety were identified, but those are not relevant to the scope of this study.

Integration of Findings

After separately discussing the quantitative and qualitative findings, it is necessary to integrate these findings to give context to them. Even though no significant effects of wearable stress feedback were found, it can be seen in Figures 2 to 4 that participants show variations in the differences in outcome variables between the week in which they wore the wearable and the week in which they did not. These variations will be explored using findings from the interviews.

Perceived Stress

In Figure 2 it can be seen that almost half of the participants show no to very slight differences in average PSS-10 scores between the two weeks. However, a few participants show somewhat bigger differences, like participant 11438. They show an increase of about 5 points in the week in which they wore the wearable, compared to the week in which they did not. A possible explanation for this can be found in how they described the wearable.

Interactive. I was often busy when something happened that I would check my wrist. Like is my heart rate going up or do I experience stress or how and what. [participant #11438].

Even further in their interview, this participant expressed that they became more aware of their stress and their respiration. It can be argued that their perceptions of and interaction with the wearable, created this increased awareness and possibly enhanced their perceived stress. This suspicion can be strengthened when considering a participant who showed a contrary trend in average PSS-10 scores. Participant 11481 showed a slight decrease in average PSS-10 scores of about 2 points (see Figure 2). This participant expressed that they had little interaction with the wearable stress feedback when describing how they used the wearable daily.

Yes, and before I went to sleep to see what my stress had done during the day to complete the questionnaire and just look through it. [participant #11481]

Next to that, this participant expressed that their stress level as indicated by the wearable was lower than they expected (see Subtheme 1b: Alignment) and that they perceived the stress measurement as accurate (see Subtheme 2b: Accuracy of Measurements). These two aspects could indicate that individuals who perceive the wearable stress feedback as accurate while receiving lower stress feedback than anticipated, are less likely to check their wearable stress feedback throughout the day. So, it can be argued that the level of interaction with wearable stress feedback is an effect moderator for a change in perceived stress as a consequence of wearable stress feedback.

Challenge Appraisals

No significant effect was detected for wearable stress feedback on the weekly average Challenge scores. Figure 3 confirms this result as it can be seen that the majority of

participants scored very similar on this scale during their participation. However, participant 11426 shows an increase of about 3 points in the week that they wore the wearable. As discussed in Subtheme 4a (Stress-Coping Capabilities), this participant expressed that they became more confident in recognizing stressors and knowing how to effectively handle them. Given the fact that most of their expressions in their interview were done in the context that their experiences were confirmed (n=7), it can be argued that this confirmation functions as some kind of reassurance of their stress-coping capabilities that consequently enhances their tendency to appraise stressors as a challenge. The link between this confirmation and increased stress-coping capabilities is apparent when this participant was asked whether they became more confident in handling daily stressors.

Yes, yes. At least, because you have had that confirmation again, I also have the confirmation for myself that how I experience my stressors actually correspond to reality. So how I should pick them up myself and how I react to them myself. [participant #11426]

On the contrary, some participants showed a decrease in average weekly Challenge score in the week that they wore the smartwatch. For example, participant 8925 shows a slight decrease of about 2 points (see Figure 3). This could possibly be attributed to their expression that was discussed in Subtheme 1b (Alignment) in which they expressed that they began to doubt their ability to recognize their own stress signals as a consequence of higher wearable stress feedback than anticipated. The fact that almost as many participants generally expressed confirming as contradicting measurements further strengthens this suspicion. This is in line with the opposite trend and a possible explanation for what was discussed for participant 11426. Furthermore, an increased awareness of stressors as a consequence of the research design could also explain a decrease in average weekly Challenge scores. This is apparent in an expression of participant 11429, who shows a decrease of 1 point in average

weekly Challenge score (see Figure 3), when they described that they looked differently at some stressors during their participation.

Well, with the questionnaire they naturally ask, like, it is a bit abstract, I guess. Yeah, you really have to start looking for things. [participant #11429]

It can be argued that this participant experienced more perceived demands from stressors because they became more aware of them as a consequence of the questionnaires. Therefore, perceived demands from stressors would increase relative to perceived stress-coping capabilities, thus decreasing tendencies for challenge appraisals.

Threat Appraisals

Just like the preceding effects, no statistically significant effect of wearable stress feedback on threat appraisals was found. However as can be seen in Figure 4, some participants showed decreases in weekly average Threat scores. Especially participant 8925, who showed the biggest decrease with a little over 3 points. At the beginning of their interview, this participant expressed a confirming experience with the wearable stress feedback. They saw that this increased at a stressful moment for them. As they further expressed they gradually checked the wearable stress feedback less as the week progressed, it can be argued that also in this situation there is a lack of interaction with the wearable stress feedback. This participant expressed a gradually decreasing interaction paired with a lack of interest in the feedback as follows.

No, I think I was checking it a little less with the days. Because in the beginning that is of course new, so then you want to know everything and everything. But at some point you think like, whatever, you know, like that. [participant #8925]

Participant 11477 showed an opposing trend in their weekly average Threat scores by scoring a little over 2 points higher in the week in which they wore the wearable (see Figure

4). Where the decrease of participant 8925 could be explained by the lack of interaction with the wearable stress feedback, the increase of participant 11477 can arguably be explained by high interaction. This is apparent when this participant expressed what changes they noticed in the first days of wearing the wearable.

And then I always wanted to confirm that by looking at that phone or looking at that smartwatch. And in itself the result was quite similar to what I thought indeed, so that was fun. But in that alone my behaviour was a bit different, so I checked that stress level more often. [participant #11477].

This expression indicates that, just like with perceived stress, the level of interaction with the wearable stress feedback might be an effect moderator for the tendency to appraise stressors as a threat. Additionally, the expression above indicates that this possible effect moderation is not necessarily dependent on whether the feedback aligns with the individual's experience since the participant expressed that the feedback aligned with their experience. The significant correlation between weekly average scores on the PSS-10 and the Threat subscale of the SAM (see Table 2) could be an indicator of the possible effect moderation of interaction level on the relationships between wearable stress feedback and perceived stress as well as threat appraisals.

Discussion

The current pilot study aimed to explore the effects of wearable stress feedback on perceived stress and challenge and/or threat appraisals, the perceptions and experiences in using a wearable, and how wearable stress feedback changes individuals' perceptions of stressor demands and their own capabilities to deal with stressors. No significant effects for the effect of wearable stress feedback on perceived stress and a tendency to appraise stressors as either a challenge or a threat were found. Several themes were identified regarding user

perceptions and experiences with wearables, such as physiological and behavioural insight, correspondence of measurements to existing beliefs, attitudes towards wearables regarding the value of real-time wearable data to describe the real-time experience, measurement accuracy, the impact of wearable use, and adjustments made as a result of wearing a wearable. As far as participants' experiences of increased or decreased stress-coping abilities and perceptual demands of stressors are concerned, participants more often experienced increased stress-coping abilities, while perceived demands of stressors remained unchanged or decreased.

Regarding the effect of wearable stress feedback on perceived stress, the results indicate that wearable stress feedback does not influence perceived stress in the time frame in which the study took place. So, this study has been unable to build upon the findings by González Ramírez et al. (2023), Jerath et al. (2023), and Yen (2021) which indicate promising effects from wearables on stress management and perceived stress. Next to a small sample size and a short time frame, an explanation for the absence of this effect could be found in subthemes 1a (Physiological Insight) and 2b (Accuracy of Measurements). Regarding the former, participants indicated a lack of interest in the stress feedback. It can be argued that this causes a lack of active engagement with and processing of the stress feedback, diminishing the potential effect of stress feedback on perceived stress. The same argument can be used regarding subtheme 2b since a substantial part of the participants expressed that they doubted the accuracy of the stress measurement or deemed it as inaccurate.

For this short time frame in which the study took place, it is unlikely that engagement as described by Nelson et al. (2020) could have already taken place. Even though some participants expressed high engagement with the wearable stress feedback, most participants expressed a lack of engagement resulting from a lack of interest in the wearable stress

feedback. However, when there was some form of engagement with wearable stress feedback that confirmed individuals' perceived stress, some participants expressed increased stress-coping capabilities and showed an increase in challenge appraisals. This finding is in line with that of Karapanos et al. (2016) who, among other things, found feelings of physical thriving in the form of increased self-esteem and competence as an important aspect of periods of engagement. In line with findings from Attig and Franke (2020), obsessive tracking was often mentioned as a possible negative consequence of wearable use for health tracking.

With regards to the effect of wearable stress feedback on the tendencies of individuals to appraise stressors as a challenge or a threat, over a two-week period, no significant effects were found on either challenge or threat appraisals. This indicates that within this time frame, wearable feedback does not increase or decrease the extent to which individuals appraise stressors as a challenge or threat. These findings either do not support the potential for integrating arousal reappraisals or show that wearable stress feedback and its notifications are not yet suitable for effective arousal reappraisal (Jamieson et al., 2018). The latter would highlight the need for developments in this context to more efficiently support wearable users in arousal reappraisal to reduce negative physiological responses and experiences of negative affect. These findings are in contrast with the findings regarding subthemes 4a (Stress-Coping Capabilities) and 4b (Perceived Stressor Demands). In these subthemes, it was namely found that participants far more often expressed increased perceived capabilities to cope with stressors and more often expressed decreased or unchanged perceived stressor demands. However, it is also apparent that these subthemes were far less discussed during the interviews compared to other measurements of the wearable, further supporting the lack of

engagement with and interest in stress feedback that was identified in subtheme 1a (Physiological Insight).

Limitations

The current study is limited by various aspects. Firstly, the researchers were rather inexperienced in doing mixed-methods research. This was apparent in weaknesses in the study design (e.g., a concurrent instead of a sequential design) and data analysis (e.g., no inter-rater reliability). Because of the concurrent design, the researchers were less able to highlight specific findings in the quantitative data regarding trends in perceived stress and challenge and threat appraisals in general and for specific participants. If they had been able to do this, they could have selected participants for the interviews based on clusters of trends that were apparent and adjusted the interview topics based on the quantitative findings. This would have provided more comprehensive insights into the process behind the (lack of) effects that were apparent in the quantitative data.

Secondly, the researchers experienced problems with the TIIM software with which the quantitative data was collected throughout the research. This was partly due to the inexperience of the researchers with this software, which was for example apparent in the fact that no time limits were put on the questionnaires. This caused that participants were able to fill in the questionnaire a day or even several days later, impacting the reliability and validity of the measurements. Furthermore, the researchers experienced problems with extracting and merging the data from TIIM for data analysis. It took a lot of time, and help from the supervisor, to get to a workable dataset. This limitation in time arguably led to less time that could be spent on the data analysis and integration of the findings.

Thirdly, participants in the qualitative component were friends or family of the researchers. It can be argued that because of this, the researchers might not have asked the

experiences of the participants out that thoroughly. This can either be because the researchers did not want to bother their friends and family too much, but also because they implicitly understood certain experiences better than a stranger would because of their past experiences with the participants. To clarify this more, the researchers coded the transcripts of the other, which could potentially cause some excerpts to be coded wrongly because the other researcher is not as familiar with the participant as the researcher who conducted the interview. Also, the sample size was too small to make inferences on a population level.

Future Research

The current pilot study was aimed to generate hypotheses for further research. Before any recommendations for hypotheses for future research are given, it is important to mention that for any future research that is based on this study, a larger sample size over a longer time frame with more repeated measures is of absolute importance to validly and reliably test these hypotheses on population level.

Future research could focus on the amount of interaction that individuals have with wearable stress feedback since in the current study a lack of significant effects on either perceived stress and challenge and threat appraisals was found in combination with expressions indicating a lack of interaction with and interest in wearable stress feedback. Future research on these aspects could be done by measuring participants' interest in wearable stress feedback and selecting participants to counterbalance participants who show high interest with participants who show low interest in wearable stress feedback. The level of interaction with wearable stress feedback could possibly be investigated using data from the app that participants should be instructed to use to objectively measure it.

Furthermore, future research should investigate the relationship between the alignment of perceived stress and wearable stress feedback with confidence in stress-coping

capabilities in the context of challenge appraisals. Findings in this study indicate that an increase and decrease in challenge appraisals could stem from wearable stress feedback that respectively confirms and contradicts previous beliefs of individuals regarding their capabilities to estimate their stress.

In addition, future research could focus on adapting stress feedback and notifications in this context to stimulate arousal reappraisal. This could explore if and how stress feedback and notifications in this context could stimulate arousal reappraisal in the short term and subsequently lead to positive health outcomes in the longer term.

Regarding the qualitative component, future research will have to be conducted to test the extent to which these identified main themes and subthemes are valid. Factor analysis could be done using a larger population to test these themes. In case of confirmation of these themes, designers of wearables can use these findings to potentially improve wearable design and user experience.

Conclusion

This study aimed to explore the effects of wearable stress feedback on perceived stress and challenge and/or threat appraisals, the perceptions and experiences in using a wearable, and how wearable stress feedback changes individuals' perceptions of stressor demand and their own capabilities to deal with stressors. No significant effects on either perceived stress or challenge or threat appraisals were found. The themes that emerged throughout the interviews extend upon the (lack of) effect on perceived stress and threat appraisals, as participants who showed increased effects expressed more interaction with the wearable stress feedback while participants who showed decreased effects expressed less interaction. Regarding challenge appraisals, a lack of significant effect of wearable stress feedback was extended upon in the interviews through alignment with stress experiences

which possibly influence individuals' confidence in their stress-coping capabilities. Future research should focus on the validity of the identified themes, stress feedback notifications for arousal reappraisal, the amount of interaction with wearable stress feedback, alignment with perceived stress, and confidence in stress-coping capabilities in the context of perceived stress and challenge and threat appraisals.

References

Attig, C., & Franke, T. (2020). 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

Bishop, F. L. (2015). Using mixed methods research designs in health psychology: An illustrated discussion from a pragmatist perspective. *British Journal of Health Psychology*, *20*(1), 5–20. https://doi.org/10.1111/bjhp.12122

Blascovich, J., & Mendes, W. B. (2010). Social Psychophysiology and Embodiment. In *Handbook of Social Psychology* (pp. 194–227).

Braun, V., & Clarke, V. (2006). Using thematic analysis in psychology. *Qualitative Research in Psychology*, *3*(2), 77–101. https://doi.org/10.1191/1478088706qp063oa

Carpenter, R. (2016). A Review of Instruments on Cognitive Appraisal of Stress. Archives of Psychiatric Nursing, 30(2), 271–279. https://doi.org/10.1016/j.apnu.2015.07.002

Cohen, S., Kamarck, T., & Mermelstein, R. (1983). A Global Measure of Perceived Stress. Journal of Health and Social Behavior, 24(4), 385–396. https://www-jstor-org.ezproxy2.utwente.nl/stable/2136404?origin=crossref&seq=7

Epel, E. S., Crosswell, A. D., Mayer, S. E., Prather, A. A., Slavich, G. M., Puterman, E., & Mendes, W. B. (2018). More than a feeling: A unified view of stress measurement for population science. Frontiers in Neuroendocrinology, 49, 146–169. https://doi.org/10.1016/j.yfrne.2018.03.001

Ferguson, T., Olds, T., Curtis, R., Blake, H., Crozier, A. J., Dankiw, K., Dumuid, D., Kasai, D., O'Connor, E., Virgara, R., & Maher, C. (2022). Effectiveness of wearable activity trackers to increase physical activity and improve health: a systematic review of

systematic reviews and meta-analyses. *The Lancet Digital Health, 4(8), e615–e626.* *https://doi.org/10.1016/S2589-7500(22)00111-X*

González Ramírez, M. L., García Vázquez, J. P., Rodríguez, M. D., Padilla-López, L. A., Galindo-Aldana, G. M., & Cuevas-González, D. (2023). Wearables for Stress Management: A Scoping Review. *Healthcare (Switzerland)*, *11*(17). https://doi.org/10.3390/healthcare11172369

Jamieson, J. P., Nock, M. K., & Mendes, W. B. (2012). Mind over matter: Reappraising arousal improves cardiovascular and cognitive responses to stress. Journal of Experimental Psychology: General, 141(3), 417–422. https://doi.org/10.1037/a0025719

Jamieson, J. P., Hangen, E. J., Lee, H. Y., & Yeager, D. S. (2018). Capitalizing on Appraisal Processes to Improve Affective Responses to Social Stress. *Emotion Review*, *10*(1), 30–39. https://doi.org/10.1177/1754073917693085

Jerath, R., Syam, M., & Ahmed, S. (2023). The Future of Stress Management: Integration of Smartwatches and HRV Technology. Sensors, 23(17). https://doi.org/10.3390/s23177314

Karapanos, E., Gouveia, R., Hassenzahl, M., & Forlizzi, J. (2016). Wellbeing in the Making: Peoples' Experiences with Wearable Activity Trackers. Psychology of Well-Being, 6(1). https://doi.org/10.1186/s13612-016-0042-6

Lane, J. D., & Gast, D. L. (2014). Visual analysis in single case experimental design studies: Brief review and guidelines. *Neuropsychological Rehabilitation*, *24*(3–4), 445–463. https://doi.org/10.1080/09602011.2013.815636

Lazarus, R.S., Folkman, S., 1984. Stress, Appraisal & Coping. Springer, New York.

Lee, E. H. (2012). Review of the psychometric evidence of the perceived stress scale. *Asian Nursing Research*, *6*(4), 121–127. https://doi.org/10.1016/j.anr.2012.08.004

Michiels, B., & Onghena, P. (2019). Randomized single-case AB phase designs: Prospects and pitfalls. Behavior Research Methods, 51(6), 2454–2476. https://doi.org/10.3758/s13428-018-1084-x

Millings, A., Morris, J., Rowe, A., Easton, S., Martin, J. K., Majoe, D., & Mohr, C. (2015). Can the effectiveness of an online stress management program be augmented by wearable sensor technology? *Internet Interventions*, *2*(3), 330–339. https://doi.org/10.1016/j.invent.2015.04.005

Montagna, M. J., Marksteiner, T., & Dickhäuser, O. (2021). The Effect of a Computerized Growth-Mindset Intervention on Teaching Students' Mindset and Cognitive Stress Appraisal. Frontiers in Education, 6:634684. https://doi.org/10.3389/feduc.2021.634684

Nelson, E. C., Sools, A. M., Vollenbroek-Hutten, M. M. R., Verhagen, T., & Noordzij, M. L. (2020). Embodiment of wearable technology: Qualitative longitudinal study. JMIR MHealth and UHealth, 8(11), e16973. https://doi.org/10.2196/16973

Number of connected wearable devices worldwide from 2019 to 2022. (2023, May 15). Statista. Retrieved February 21, 2024, from https://www.statista.com/statistics/487291/global-connected-wearable-devices/

O'Donovan, A., Tomiyama, A. J., Lin, J., Puterman, E., Adler, N. E., Kemeny, M., Wolkowitz, O. M., Blackburn, E. H., & Epel, E. S. (2012). Stress appraisals and cellular aging: A key role for anticipatory threat in the relationship between psychological stress and telomere length. Brain, Behavior, and Immunity, 26(4), 573–579. https://doi.org/10.1016/j.bbi.2012.01.007

Peacock, E. J., & Wong, P. T. P. (1990). The stress appraisal measure (SAM): A multidimensional approach to cognitive appraisal. *Stress Medicine*, *6*(3), 227–236. https://doi.org/10.1002/smi.2460060308

Plano Clark, V. L. (2017). Mixed methods research. *The Journal of Positive Psychology*, *12*(3), 305–306. https://doi.org/10.1080/17439760.2016.1262619

Schneeberger, T., Sauerwein, N., Anglet, M. S., & Gebhard, P. (2021). Stress Management Training using Biofeedback guided by Social Agents. International Conference on Intelligent User Interfaces, Proceedings IUI, 564–574. https://doi.org/10.1145/3397481.3450683

Schoonenboom, J., & Johnson, R. B. (2017). How to Construct a Mixed Methods Research Design. *Kolner Zeitschrift Fur Soziologie Und Sozialpsychologie*, *69(Suppl 2)*, 107–131. https://doi.org/10.1007/s11577-017-0454-1

Smith, E. N., Santoro, E., Moraveji, N., Susi, M., & Crum, A. J. (2020). Integrating Wearables in Stress Management Interventions: Promising Evidence From a Randomized Trial. *International Journal of Stress Management*, *27*(2), 172–182. https://doi.org/10.1037/str0000137.supp

University of Twente. (n.d.). Twente Intervention and Interaction Machine (TIIM). Retrieved May 5, 2024, from https://www.utwente.nl/en/bmslab/infohub/tiim/

Yen, H. Y. (2021). Smart wearable devices as a psychological intervention for healthy lifestyle and quality of life: a randomized controlled trial. *Quality of Life Research*, *30*(3), 791–802. https://doi.org/10.1007/s11136-020-02680-6

During the preparation of this work, Jip and I used ChatGPT, Grammarly, Wordtune, and Consensus for translations, writing assistance, correcting grammar and spelling, generating feedback, inspiration for the literature review and research design, searching for literature,

and evaluating our research. After using these tools, we thoroughly reviewed and edited the content as needed, taking full responsibility for the final outcome.

Appendix A

Perceived Stress Scale -10 Translated Items

1. Hoe vaak bent u overstuur geweest door iets dat onverwacht gebeurde?
2. Hoe vaak heeft u het gevoel gehad dat u niet in staat was de belangrijke dingen in uw leven onder controle te houden?
3. Hoe vaak heeft u zich zenuwachtig en gespannen gevoeld?
4. Hoe vaak heeft u zich zelfverzekerd gevoeld over uw vermogen om uw persoonlijke problemen aan te pakken?
5. Hoe vaak heeft u het gevoel gehad dat de dingen u meezaten?
6. Hoe vaak heeft u het gevoel gehad dat u niet opgewassen was tegen al de dingen die u moest doen?
7. Hoe vaak bent u in staat geweest om irritaties in uw leven onder controle te houden?
8. Hoe vaak heeft u het gevoel gehad dat u de dingen de baas bleef?
9. Hoe vaak heeft u zich boos gemaakt om dingen die buiten uw controle om gebeurden?
10. Hoe vaak heeft u het gevoel gehad dat de moeilijkheden zich zo hoog opstapelden dat u ze niet te boven kon komen?

Appendix B

Stress Appraisal Measure – Translated Items Challenge Subscale

1. Gaat dit een positieve invloed op mij hebben?
2. Hoe gretig ben ik om dit probleem aan te pakken?
3. In hoeverre kan ik een sterker persoon worden door dit probleem?
4. In hoeverre ben ik opgewonden als ik denk aan de uitkomst van deze situatie?

Appendix C

Stress Appraisal Measure – Translated Items Threat Subscale

1. Maakt deze situatie mij angstig?
2. Zal de uitkomst van deze situatie negatief zijn?
3. Hoe bedreigend is deze situatie?
4. Gaat dit een negatieve invloed op mij hebben?

Appendix D

Final Interview Scheme in Dutch

Semi-structured interview

Vooraf: Bedankt dat je mee wil werken aan dit interview. Het doel van dit interview is om diepere inzichten te krijgen in jouw ervaringen van deelname aan onze studie. Dit interview zal waarschijnlijk een half uurtje duren. Er worden geluidsopnamen gemaakt van dit interview die wij gaan gebruiken voor transcriberen en coderen voor de analyse. Ga je akkoord met deelname aan en het opnemen van dit interview?

- Hoe ervaarde je het dragen van een smartwatch?
    - Hoe ervaarde je het gebruik van de smartwatch? Zou je er bijvoorbeeld zelf een gaan kopen?
    - Heb je nog functies aan de smartwatch toegevoegd die er eerst niet op stonden?
        - Zo ja, welke? En waarom?
- Merkte je een verandering in je gedrag in de eerste paar dagen?
    - Zo ja: Kan je daar een voorbeeld van geven?
    - Zo nee: Kan je omschrijven hoe je met de smartwatch omging in de eerste paar dagen?
    - Hoe heb je deze verandering(en) ervaren?
    - Zijn er dingen die je sinds het dragen van de smartwatch anders bent gaan doen?
- Hoe ervaarde je het krijgen van feedback van de smartwatch?
- **[Stress feedback niet genoemd]**: Hoe ervaarde je het krijgen stress feedback?
- **[Stress Appraisals]**: Heb je het gevoel dat je je stress anders bent gaan inschatten sinds het dragen van de smartwatch?

    - Zo ja/nee, kan je daar wat meer over vertellen?
- **[Stress Appraisals]**: Heb je het gevoel dat je meer vertrouwen hebt gekregen dat je verwachte dagelijkse stressoren beter aankan? (Voorbeelden dagelijkse stressoren: deadlines, haast hebben, belangrijke afspraak of andere verplichtingen).
    - Zo ja, denk je dat dat komt doordat je meer vertrouwen hebt gekregen in je eigen capaciteiten of dat je de stressoren zelf als minder veeleisend bent gaan inschatten?
    - Zo nee, kan je daar wat meer over vertellen?
- **[Health Anxiety]**: Hoe kijk je naar je eigen gezondheid sinds het dragen van de smartwatch?
- **[Health Anxiety]**: Wat vond je van de smartwatch zijn metingen (hartslag, HRV, respiration, OX, slaap etc.) wat betreft gezondheid?
    - Vraag door over metingen die de deelnemer niet benoemd of niet goed kent/vaag vindt.
- **[Health Anxiety]**: Ben je je meer zorgen gaan maken over je gezondheid sinds het dragen van de smartwatch?
    - Zo ja: kan je vertellen hoe?
- **[Health Anxiety]**: Hoe voel jij je/hoe denk jij over het toenemende gebruik van smartwatches om gezondheid in de gaten te houden?
    - Zijn er volgens jou voor en na delen van het gebruik van smartwatches voor gezondheid?
- **[Eind vraag]**: Heb je nog ervaringen gehad tijdens jouw deelname die wij tot nu toe niet hebben besproken maar die je wel zou willen delen?

Achteraf: Bedankt voor je deelname aan dit interview en onze studie. Als je het leuk vindt kan ik je een rapport sturen met jouw persoonlijke resultaten en een verslag van de gehele studie.