MoodTurner: A Self-Tracking Smart Jewellery to Support Awareness and Reflection in Sensory Processing Sensitivity Self-Care

Maysoon Al-Quran*
Faculty of Electrical Engineering, Mathematics and Computer Science, University of Twente
m.alquran@student.utwente.nl

Dominique Geißler, MSc†
Faculty of Electrical Engineering, Mathematics and Computer Science, University of Twente
dominique.m.geissler@gmail.com

Ceri Kamoen‡
Faculty of Engineering Technology, University of Twente
ceri.kamoen@gmail.com

Nathalie Overdevest, MSc§
Faculty of Engineering Technology, University of Twente
n.overdevest@student.utwente.nl

Marijke van Lune¶
Faculty of Engineering Technology, University of Twente
marijkevanlune@gmail.com

Iris Weijers‖
Faculty of Engineering Technology, University of Twente
iris.weijers@hotmail.com

Rúben Gouveia
Faculty of Engineering Technology, University of Twente
r.h.gouveia@utwente.nl

ABSTRACT

This paper introduces MoodTurner, a wearable and mobile system that supports individuals in the self-care of high sensory processing sensitivity. We discuss how different aspects of personal informatics and embodied perception can be combined to help individuals in the tracking and reflecting on episodes of high sensory processing sensitivity, and overcome stigmatisation associated with the use of tracking tools. We present the design of a smart jewellery that tracks where episodes take place as well as their severity and a complementary mobile application that allows users to review and document episodes of high sensory processing sensitivity.

CCS CONCEPTS

• **Human-centered computing** → Interaction design; Interaction design process and methods; User interface design..

KEYWORDS

High Sensory Processing Sensitivity, Interaction Design, Interactive Technology, Smart Jewellery, Wearables

*These authors contributed equally.
†These authors contributed equally.
‡These authors contributed equally.
§These authors contributed equally.
¶These authors contributed equally.
‖These authors contributed equally.

CHI '22 Extended Abstracts, April 29–May 05, 2022, New Orleans, LA, USA

ACM ISBN 978-1-4503-9156-6/22/04.
https://doi.org/10.1145/3491101.3519803

ACM Reference Format:
Maysoon Al-Quran, Dominique Geißler, MSc, Ceri Kamoen, Nathalie Overdevest, MSc, Marijke van Lune, Iris Weijers, and Rúben Gouveia. 2022. MoodTurner: A Self-Tracking Smart Jewellery to Support Awareness and Reflection in Sensory Processing Sensitivity Self-Care. In *CHI Conference on Human Factors in Computing Systems Extended Abstracts (CHI '22 Extended Abstracts), April 29–May 05, 2022, New Orleans, LA, USA*. ACM, New York, NY, USA, 6 pages. https://doi.org/10.1145/3491101.3519803

1 INTRODUCTION

High Sensory Processing Sensitivity (high SPS) is a neurological trait that predisposes individuals to become hyper-aware of and overstimulated by their physical and social surroundings [1, 4, 6]. High SPS is characterised by a response to lower thresholds of information and heightened detection of subtle changes in the surrounding environment [18]. Individuals with high SPS are highly sensitive to changes in the environment. When in noisy, smelly, brightly lit or busy surroundings, individuals with high SPS have high chances of being overstimulated, resulting from the deep processing of stimuli [1].

Approximately 15-20% of the population, equally divided between male and female, is believed to be highly sensitive [13, 15]. Most people with high SPS receive their diagnosis during young adulthood and can experience high heart rate, high-stress levels, physical illness [3], depression and anxiety [5] caused by overstimulation. Individuals with high SPS are prone to more negative emotional states and have been found to withdraw themselves from social situations as a result of overstimulation [1]. It is thus important for individuals with high SPS to be able to recognise when and why they are getting overstimulated and how to cope in these situations.

People with high SPS usually develop better coping mechanisms as they grow older and more mature, either by themselves or with the help of a coach or therapist [8, 12, 21]. Nonetheless, this is a trial and error process and will therefore often develop later in adulthood. Hence, support in the development of coping mechanisms at an earlier age is needed. However, this support should not be too early in life, as people with high SPS are strongly shaped by their childhood. So, a person will only know the full impact of their sensory processing sensitivity in their early adulthood. Therefore, the design concept focuses on young adults, aged 18-30, because in this age range the design can support this group in fully understanding their experiences with high SPS. Moreover, this group is more familiar with wearables and hence more open to using it.

In this paper, we show how the combination of personal informatics and embodied perception can lead to the conceptualization of a tool that supports individuals with high SPS in developing coping skills. Coping skills can be divided into three categories: preparation so that overstimulation can be avoided, in-situation support to decrease overstimulation during an event, and winding down to relieve stress. We describe the MoodTurner, a self-tracking concept that gives in-situation support and a complementary mobile application that allows users to prepare for and reflect on events.

2 RELATED WORK

The design of MoodTurner follows recent research on embodied perception and self-tracking.

2.1 Self-tracking as a tool for action and reflection.

Personal Informatics (PI), or Quantified-self (QS) tools have received an outburst of interest both in research and commercial products. The main premise of these tools is to collect data about one's behaviours so as to generate a new understanding of oneself. PI tools have been used to inform the design of a number of health management tools, such as tools for physical activity and sports [16], chronic illness management, diabetes, as well as conditions that are poorly understood [19]. In a similar line, we propose that PI/QS tools can be particularly useful in supporting individuals during episodes of high SPS. An immediate response can be formed to the physical and mental impacts of such episodes while creating an opportunity to learn about oneself through the use of continuous and automatic monitoring of symptoms in an unobtrusive way.

2.2 Stigmatisation of health monitoring

The concept of situated activity of the embodied perception theory focuses on the relationship between the user and it's environment [8, 21]. The concept states that the perception of a product will differ between the user and the user's environment and that this can change the behaviour of both the user and their environment. This means that if people see a person using health tools, they might assume that the person is sick and treat them differently. Recent literature has found that people are often worried to be perceived as in poor health or frail once they are seen using technology that is associated with health monitoring [22]. This fear of stigmatisation can be very powerful – devices for health have been described as wearing "badges of dishonor" [22]. This might be exacerbated with wearable devices, which have high chances of being seen by others.

2.3 The role of aesthetics for fostering adoption of self-tracking technologies

In the past few years, a growing body of research has investigated the role of aesthetics and style for the adoption of mobile and wearable self-tracking technologies (e.g. [13, 24]). These studies often explore how the visual appearance of self-tracking technologies can be tailored to promote the adoption of these tools. For example, Jarusriboonchai and Häkkilä [13] highlight several techniques for customising and personalising self-tracking technologies, such as do-it-yourself toolkits and freestyle customization. Kang et al. [15] further highlight the importance of the aesthetics of self-trackers. Results from a field study indicate that people's attachment to their trackers is strongly interconnected with the extent to which trackers reflect people's personality, self-image, and style. These studies have inspired recent discourses on the relationships between technologies, bodies and fashion. Wallace et al. [27] explore craft practices in jewellery design as an approach to enmesh wearable devices into people's everyday lives. Still, the aesthetics of tracking is rather overlooked in research and commercial products, with a large majority of work on self-tracking rather focusing on the functional or technical features that these tools implement [9, 10, 27].

2.4 Current solutions on the market and their shortcomings

There are already some products on the market that can help a person with high SPS to recognize when they are overwhelmed. These are wearables that track your stress levels, such as Spire Health [25], Ouraring [26], and WellBe [28]. These products measure biometrics such as heart rate, respiration, and/or skin conductance to see whether the user is stressed. Additionally, there are products on the market which can help the user figure out why they are overstimulated. Examples are the apps Reflection Questions [23] or Müse [21]. Such apps guide the user in creating self-awareness and thus, can also help with guiding the user towards finding out why they are feeling overstimulated. Lastly, there are products that aid the user in relieving stress at a desired moment. Examples for these are Headspace [11], a weighted blanket, or colouring books.

Hence, there are already products on the commercial market that help the user recognize when they are overwhelmed, products that help the user find out why they are overwhelmed, and products that help relieve stress at a desired moment.

However, there is no product, to the best of our knowledge, that incorporates all three elements into one product. The MoodTurner intends to fill this gap by offering overstimulation measurement, management and relief all in one product.

3 THE DESIGN OF MOODTURNER

Our approach for conceptualising MoodTurner draws on autobiographical and speculative design methods. One of the authors of this paper used their own experience with high SPS to help inform the looks and interactions of the MoodTurner, and how to integrate such a product in daily life. The main question being asked throughout the conceptualization was: "What would it look like to design a piece of jewellery that could be worn to support the management of high SPS". Multiple rounds of iterations were performed with all

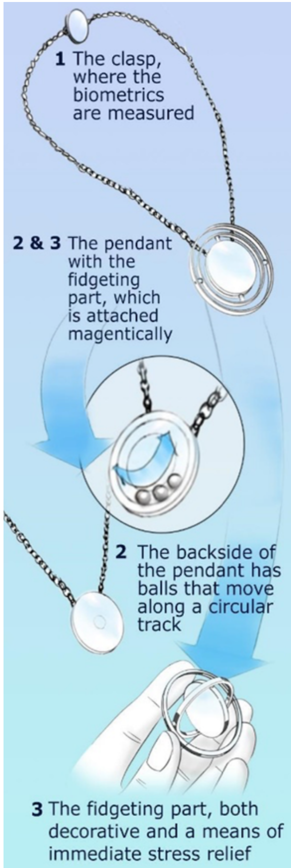

Figure 1: The MoodTurner interactive necklace.

the first authors of this paper, where the aesthetics and functional features of MoodTurner were discussed.

In an attempt to minimise stigmatisation, the MoodTurner makes use of the emerging area between technology and fashion to conceptualise a wearable device that does not look like a therapeutic aid. In this sense, the MoodTurner was designed to be perceived as a piece of jewellery, rather than a wearable device and was conceptualised as an interactive necklace, as shown in Figure 1. Further, we focused on a wearable for the areas of the shoulder and neck as these body areas have been associated with stress and relaxation – two key parameters for high SPS management [25]. The shape of the fidgeting part (see Figure 1) is inspired by the Time-Turner™ as seen in the Harry Potter™ movies [6] which is designed with three metal bands that can be turned in different directions. Many young adults grew up with the Harry Potter™ movies and are therefore very familiar with it, so by using this shape, the MoodTurner can have an extra appeal to the user.

The MoodTurner leverages the use of heart and respiratory rate detections, GPS and vibrotactile feedback to continuously monitor and track high SPS episodes that occur during individuals' days. GPS is used to track locations where a high SPS episode took place. A photoplethysmogram (PPG) sensor [20], embedded in the necklace clasp, detects overstimulating events through a significant elevation of heart and respiratory rate, which have both been associated as indicators of stress in general, and stress caused by high SPS specifically [5, 29]. PPG is a pulsating wave produced by a pulse oximeter and has been successfully used in the throat and neck area for measuring heart rate, oxygen saturation, swallowing and respiration rates [30].

The user interactions are shown in Figure 2. When an occurrence of elevated heart rate and respiration is identified, MoodTurner logs this instance and prompts users through a brief, 3-second, activation of a vibration motor, placed inside the pendant. By prompting users, MoodTurner invites immediate attention towards early symptoms, thoughts and triggers and indicates an opportunity for immediate action.

The MoodTurner leverages on the PPG sensor and small metal spheres that can rotate placed inside the pendant (see Figure 1) to engage users in a breathing exercise, aimed at minimising the effects of high SPS. This exercise is based on the 4-7-8 breathing technique, which commonly follows three steps: (1) breathing in for 4 seconds, (2) holding the breath for 7 seconds and (3) exhaling for 8 seconds. Breathing techniques, such as the 4-7-8 have been shown to be effective ways to regulate heart rate, stress levels and help individuals be more mindful about one's current situation while experiencing episodes of high SPS [17].

As Figure 2 shows, a tap on the MoodTurner's pendant initiates the exercise, either after receiving a notification form the pendant or upon the user's own initiative. The balls on the back of the pendant guide the user through the exercise by. For example, the balls roll in one direction for the duration of a breath in, stay in place when the user is supposed to breathe in, and move in the opposite direction when the outwards breath takes place.

3.1 Reflecting on past episodes of high SPS

MoodTurner also supports delayed reflection, in which episodes of high SPS are stored as cues, and reflection is carried out after an episode takes place. Due to the high chances of becoming overwhelmed by their physical surroundings, individuals with high SPS may be affected in their abilities to process information and recall detailed information from episodes; which may further suffer from biases over time. Insights on actual behaviours and experiences are likely to be forgotten (e.g. forgetting about where an episode took place or the factors leading up to it) or overlooked (e.g. underestimating the frequency in which episodes occur over a certain day, week or month). By tracking the duration, frequency, location and physical symptoms (i.e. one's heart rate and respiratory rates) of these episodes, we aim to help individuals' in better recalling their thoughts, emotions and feelings.

This data is available on a mobile application, of which examples of screens are shown in Figure 3. The app provides a view of users' daily episodes of high SPS (Screen A in Figure 3). Each episode has a starting time and duration, as well as the GPS-based location where it took place. Episodes are colour-labelled according to the duration and intensity of the episode, ranging from red (long and/or high fluctuations in heart and respiratory rates), through orange, to green (brief and/or moderate fluctuations in heart and respiratory rates). Users can edit or delete instances where they believe their data to be misrepresented, as well as manually add episodes which

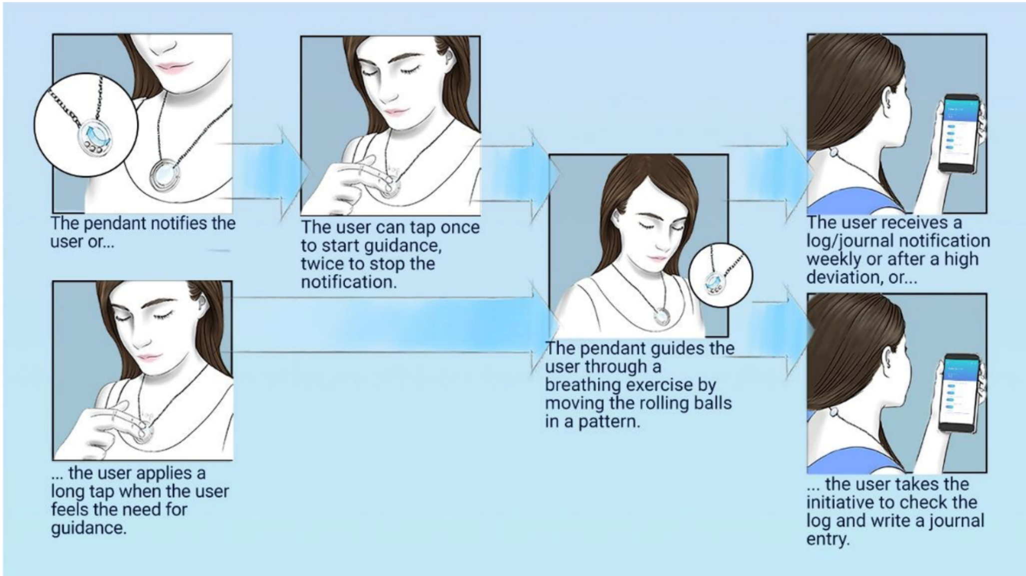

Figure 2: User Interactions with MoodTurner

were missed. It is also important that individuals can annotate additional cues for later visitation (such as their thoughts, feelings, and emotions). This is provided in the form of journal entries, shown in Screen B in Figure 3. Individuals can submit journal entries by tapping on an event and entering information via text.

4 DISCUSSION

With the MoodTurner, we created a design concept that attempts to support people with high SPS in gaining awareness of the thoughts, symptoms and triggers that are associated with high SPS. However, the MoodTurner is only a conceptual design. It has not been evaluated or tested by users and therefore it is unsure if the concept would actually work. For example, it is unsure whether the pendant can accurately support people in calming down when overwhelmed. The movement of the back-side rotation on the skin might not be intuitive to the user, and the vibrations might actually be contributing to the feeling of overwhelm, as they are additional stimuli. Furthermore, the used trackers to measure stress should be tested. It is unsure whether a PPG sensor is the best option, and the concept should be tested on whether placing the sensor in the neck will be accurate enough.

An additional challenge is differentiating exercise from a high SPS episode. Exercise might create a similar response in the PPG sensor as a high SPS event. When further developing this concept, a way to indicate exercise in the log will be important.

To optimise the design, the concept needs to be tested on different types of bodies and different ways of wearing. For instance, would the necklace be comfortable to wear when the user has chest hair – which might get caught in the ball mechanism? And would the necklace still work well when there is fabric in between the necklace and the skin? This both refers to the use of the PPG sensor as well as the tactile feedback of the pendant. Furthermore, there are questions about the design of the necklace. Would other types of jewellery work better for certain populations than for others? The necklace used in the MoodTurner can be viewed as a more feminine piece of jewellery and it is questionable whether men would be willing to wear it. Would an item that they identify with work better?

5 CONCLUSION

This paper has shown an attempt to combine personal informatics and embodies perception leading to the concept of a tool that supports individuals with high SPS in reflecting upon the thoughts, symptoms and triggers as episodes take place (i.e. reflection-in-action) as well as when looking back at episodes (i.e. retrospective reflection). With this piece of work we hope to encourage discussions on how self-tracking technologies can be designed by considering fashion and identities. Recent studies have attributed the relatively low adoption of wearable trackers to social stigmatizations associated with the use of these tools. Trackers are usually perceived as tools for the frail and ill [29], which often clashes with people's actual reasons for purchasing and using a tracker (e.g. for empowerment). The upcoming market of wearable devices will only make this space more important.

We want to encourage the further development of a piece like the MoodTurner. In particular, there are several open questions about how to best design such tools, like: What are the various dimensions of data that need to be supported by smart jewellery to be able to best support reflection? Would it be relevant, for example, to track additional contextual cues (e.g. people; noise)? Do certain jewellery work better for certain individuals, and how can we support individuals in designing jewellery based on their own preferences? How are these tools perceived by people with high SPS, and how do they support this group of people in managing high SPS?

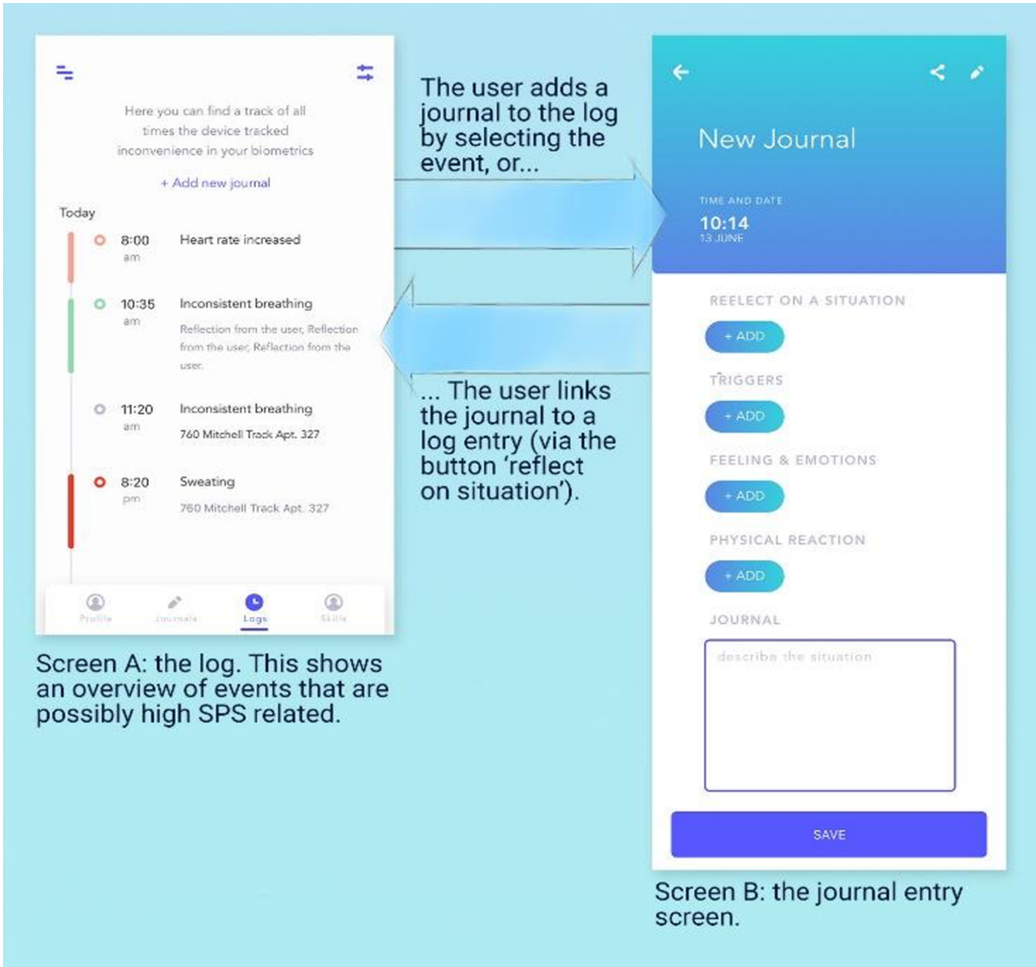

Figure 3: Log and journaling process in the MoodTurner mobile app. The MoodTurner mobile app supports users in reconstructing and reflecting on past episodes of high SPS.

REFERENCES

[1] Aron, E. N. (2013). The Highly Sensitive Person: How to Thrive When the World Overwhelms You. Citadel. (sd).Sam Anzaroot and Andrew McCallum. 2013. UMass Citation Field Extraction Dataset. Retrieved May 27, 2019 from http://www.iesl.cs.umass.edu/data/data-umasscitationfield

[2] Beer, R. D. (2007). Dynamical Systems and Embedded Cognition. In The Cambridge Handbook of Artificial Intelligence (pp. 1-35). Cambridge: Cambridge University Press. (sd).

[3] Benham, G. (2006). The highly sensitive person: Stress and physical symptom reports. Personality and Individual Differences, 40(7), 1433–1440. http://dx.doi.org/10.1016/j.paid.2005.11.021. (sd).

[4] Boterberg, S., & Warreyn, P. (2016). Making sense of it all: The impact of sensory processing sensitivity on daily functioning of children. Personality and Individual Differences, 92, 80-86. (sd).

[5] Caddy, B. (2018). Stress tracking tech: Heart rate monitoring and guided breathing devices. Retrieved from Wareable: https://www.wareable.com/wearable-tech/stress-beating-tech-to-keep-you-sane. (sd).

[6] Cuarón, A. (2004). Harry Potter and the prisoner of Azkaban. Warner Bros., United States of America.

[7] Dunn, W. (2001). The Sensations of Everyday Life: Empirical, Theoretical, and Pragmatic Considerations. 55(6). (sd).

[8] Gibson, J. J. (1986). The ecological approach to visual perception. New York: Psychology Press. (sd).

[9] Gouveia, R., Karapanos, E., & Hassenzahl, M. (2018, April). Activity tracking in vivo. In Proceedings of the 2018 CHI Conference on Human Factors in Computing Systems (pp. 1-13). *DOI*:https://doi.org/10.1145/3173574.3173936

[10] Gouveia, R., Pereira, F., Karapanos, E., Munson, S. A., & Hassenzahl, M. (2016, September). Exploring the design space of glanceable feedback for physical activity trackers. In *Proceedings of the 2016 ACM international joint conference on pervasive and ubiquitous computing* (pp. 144-155). *DOI*:https://doi.org/10.1145/2971648.2971754

[11] Headspace App. https://www.headspace.com

[12] Jagiellowicz, J., Aron, A., & Aron, E. N. (2016). Relationship between the temperament trait of sensory processing sensitivity and emotional reactivity. Social Behavior and Personality: an international journal, 44(2), 185-199. (sd).

[13] Jarusriboonchai, P. and Häkkilä, J.. 2019. Customisable wearables: exploring the design space of wearable technology. In Proceedings of the 18th International Conference on Mobile and Ubiquitous Multimedia (MUM '19). Association for Computing Machinery, New York, NY, USA, Article 20, 1–9. DOI: https://doi.org/10.1145/3365610.3365635

[14] Kagan, J. (1994). Galen's prophecy: Temperament in human nature. New York: Basic Books. . (sd).

[15] Kang, J., Binda, J., Agarwal, P., Saconi, B., and Choe, E. K.. 2017. Fostering user engagement: improving sense of identity through cosmetic customization in wearable trackers. In Proceedings of the 11th EAI International Conference on Pervasive Computing Technologies for Healthcare (PervasiveHealth '17). Association for Computing Machinery, New York, NY, USA, 11–20. DOI:https://doi.org/10.1145/3154862.3154878

[16] Karahanoğlu, A., Gouveia, R., Reenalda, J., & Ludden, G. (2021). How Are Sports-Trackers Used by Runners? Running-Related Data, Personal Goals, and Self-Tracking in Running. *Sensors, 21*(11), 3687. *DOI*:https://doi.org/10.3390/s21113687

[17] Legg, T. J. (2019, February 11). How to use 4-7-8 breathing for anxiety. Opgeroepen op June 26, 2019,van Medical News Today: https://www.medicalnewstoday.com/articles/324417.php. (sd).

[18] Liss, M., Timmel, L., Baxley, K., & Killingsworth, P. (2005). Sensory processing sensitivity and its relation to parental bonding, anxiety, and depression. 39, 1429–1439. https://doi.org/10.1016/j.paid.2005.05.007. (sd).

[19] MacLeod, H., Tang, A., & Carpendale, S. (2013). Personal informatics in chronic illness management. In Proceedings of Graphics Interface 2013 (pp. 149-156). (sd).

[20] Massaroni, C., Nicolò, A., Lo Presti, D., Sacchetti, M., Silvestri, S., Schena, E. (2019). Contact-Based Methods for Measuring Respiratory Rate. Sensors, 19(903). doi:10.3390/s19040908. (sd).

[21] Müse Reflection App. https://www.reflectwithmuse.com/home

[22] Peek, S. T., Wouters, E. J., Van Hoof, J., Luijkx, K. G., Boeije, H. R., & Vrijhoef, H. J. (2014). Factors influencing acceptance of technology for aging in place: a systematic review. International journal of medical informatics, 83(4), 235-248.

[23] Reflection Questions App. https://www.markfritzonline.com/reflection-questions-app/

[24] Seçil Uğur, Raffaella Mangiarotti, Monica Bordegoni, Marina Carulli, S. A. G. Wensveen, and I. Laura Duncker. 2011. An experimental research project: wearable technology for embodiment of emotions. In Proceedings of the 2011 Conference on Designing Pleasurable Products and Interfaces (DPPI ’11). Association for Computing Machinery, New York, NY, USA, Article 32, 1–8. DOI:https://doi.org/10.1145/2347504.2347539

[25] Spire Health. https://spirehealth.com/

[26] Ouraring. https://ouraring.com/

[27] Wallace, J., Dearden, A., and Fisher, T.. "The significant other: the value of jewellery in the conception, design and experience of body focused digital devices." Ai & Society 22, no. 1 (2007): 53-62. DOI:https://doi.org/10.1007/s00146-006-0070-5

[28] WellBe. https://thewellbe.com/

[29] Wijsman, J., Grundlehner, B., Liu, H., Hermens, H., & Penders, J. (2011). Towards Mental Stress Detection Using Wearable Physiological Sensors. 33rd Annual International Conference of the IEEE EMBS, (pp. 1798- 1801). Boston, Massachusetts USA. (sd).

[30] Zhong, Y., Pan, Y., Zhang, L., and Cheng, K.. "A wearable signal acquisition system for physiological signs including throat PPG." In 2016 38th Annual International Conference of the IEEE Engineering in Medicine and Biology Society (EMBC), pp. 603-606. IEEE, 2016. https://doi.org/10.1109/EMBC.2016.7590774