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Emilia Duarte  
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# Developments in Design Research and Practice II

Best Papers from the 11th Senses  
and Sensibility 2021: Designing Next  
Genera(c)tions

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Emilia Duarte · Annalisa Di Roma  
Editors

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Sensibility 2021: Designing Next  
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*Editors*

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# Kinetic Calendar for Emotional vs Physical Stress Tracking in Women

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**Abstract.** This work aims to address the need of creating visualization tools for better self-awareness of not visible daily life conditions, such as stress and emotional peaks, to facilitate the detection of patterns that could be related to some physical symptoms. It is focused on women because of the constant hormonal changes and the close relation of these with stress responses; and the fact that women are more likely to present psychosomatic disorders.

Women who reported been affected with this condition, remembered not being able to relate the emotional cause of the symptom until after the diagnose. That would usually trigger a vicious cycle of stress and frustration that would worsen symptom.

In the literature review it was found that psychosomatic disorders affect women in a 2:1 ratio compared to male pairs, due to biological, socio-economic, and cultural differences. It was also found that emotional self-awareness might decrease somatic related symptoms and that heart rate variability might be a valuable tool in the target tracking of users' physical conditions in a near future. This kind of tools might not only serve as visual feedback but also it can help the physicians to detect patterns or relations for some common mental-related affections.

**Keywords:** User-centred design · Emotional Design · Stress · Gender Equality · Women's Health

## 1 Introduction

### 1.1 Importance of Self-awareness

This paper presents the design research aimed at developing an integrative model to increase the self-awareness of emotional status in women. The human centred design (HCD) was considered for the methodology, since this approach is now being applied also inside the health and wellbeing field, taking in consideration that physical and emotional health are affected by several interrelated factors (Bazzano 2017).

If we set ourselves inside the post-industrial era, we will find that the importance of the object is as valuable as the experience it gives us, or the feedback we receive from it. If the objects that surround us are in some way a reflection of our personality, and

therefore of our past experiences, what this work intends is to work as a mirror. Not to judge the physical features, but to capture in some way the emotional journey of the user over a period of time; to work as a visual diary where the user can get some insight of her daily sensations and make a relation of how this might turn in to unperceived state of stress or discomfort, and that could in a long term affect their physical state.

This work is inspired by the need to remember that we are affected at many levels by things we cannot see: from microscopical reactions to thoughts and feelings, society needs to pay more attention to what happens inside of us more than around us, and historically, it has been the role of design to bring them to somewhat visible. Starting from fact that all humans have feelings regardless of if they are positive or negative; and the necessity of expressing them even if that might result uncomfortable under some circumstances.

In the late years popular culture surrounds us with more external stimuli than ever before. Everyday life challenges give us access to unlimited sources of information from all around the world. We get to see what our friends and idols are eating, wearing, where they are going; we have immediate access to stores, museums, TV channels, football team's staff, etc. Giving us constant examples as how life should be and therefore attracting our attention to the social dimension of the world and triggering a constant need for approval even if it means forgetting our deepest feelings.

Upon that, the competition and the current social standards prize popularity, productivity, and aesthetic, leaving knowledge and spirituality out of the priorities of our everyday lives. However, running away from the fact that coherent expression of emotions is a human need is what is getting many people in a stress-depression spiral, causing that at some point these emotions are expressed through physical symptoms. The path to emotional wellness may involve awareness of thoughts and feelings.

Using a positive attitude and recognizing the own signature strengths, seeking support, and expressing emotions in a suitable manor, setting priorities, accepting mistakes, and learning from them.

**Psychosomatic Disturbances.** Those who experience discomfort, pain, or physical symptoms for long periods or even chronically, may feel great confusion and worrisome when visiting medical services after being told that no apparent organic cause is found for their problem. Some people could even adopt a disqualifying attitude by mentioning that perhaps these ailments are due to psychological causes, making the patient believe that he is emotionally weak or that he is crazy, however, psychosomatic disorders show how emotions and stress really affect the organs of the body, through chain reactions that alter the chemical balance of the body.

The reason for the focusing this research on women is that some studies stipulate that the females are more prone to emotional affectations derived from stress, including the major prevalence of psychosomatic associated symptoms. The term psychosomatic refers to real physical symptoms "that arise from or are influenced by the mind and emotions rather than a specific organic cause in the body" such as an injury or infection (American Psychology Association). One of the possible explanations could be the hormonal changes that take place, not only monthly but during each stage of the woman's life according to their age and reproductive system's condition.

Technology gives us possibility now the of measuring physiological data in real time and at somewhat affordable prices. Thanks to wearables and tracking devices; as well as human-centred design approach to better grasp some of the user's perceptions, we have now the opportunity to compare the physical stress versus the emotional stress. We should remember that physical stress could be any change in the environment that puts cells or organs under pressure, such as dehydration, menstruation, training, pollution, etcetera. On the other hand, mental stress originates in the cognitive processes of the subject, even without being aware of it. Thoughts and emotions are sometimes translated to bodily sensations (Nummenmaa 2014) and can also turn into an almost palpable sensation of stress while other daily stimuli can fail to be noticed by the individual, but at the end of the day, all of these mental and physical processes, can have an important impact on mental health. Some examples in this wide spectrum of experiences can vary from traffic, relationships, economy, to the social environment or the predisposition to depression or anxiety amongst other conditions.

A common misconception is that psychosomatic conditions are "imaginary" when these physical symptoms of conditions are real and require treatment. Thus, a qualitative analysis took place by interviewing women at reproductive age with long term physical disturbances without apparent medical causes. From that point, an objective parameter that could reflect stress was considered: Heart Rate Variability (HRV) was selected as measure that could give a range of valuable data about physical stress (Campos 2021) and it could be enriched with the subjective perception of emotional stress of the user and registered according to each day in a calendar, to better understand the possible relationship between emotional peaks, mental or physical stress, and hormonal phases.

Although design has always been a tool to visually communicate intangible information about sensations and emotions, thanks to technology and teamwork between several disciplines applied around the user's everyday objects, today we are able to show the variations of such information more and more quickly, so both the field of health care, are a perfect canvas for proposals aimed at physical and emotional well-being.

For the concerns of this thesis work, we will also consider the concept of Integrative Medicine in western culture, which is grounded in in the definition of health. The World Health Organization (WHO) defines health as "a state of complete physical, mental and social wellbeing and not merely the absence of disease or infirmity" (World Health Organization 2021). Therefore, it "seeks to understand the patient's unique set of circumstances and to address the full range of physical, emotional, social, spiritual and environmental influences that affect health" (Weisfeld 2009). Being emotionally healthy means being aware of your emotions and how they affect you and others: "being attentive to your thoughts, and feelings, and behaviours whether they're positive or negative. It implies the ability to accept our feelings rather than deny them. Being emotionally healthy means that you take a positive attitude about your ability to acknowledge your emotions. You feel that you can make choices and decisions based on a synthesis of your feelings, thoughts, and behaviours, rather than behaving in an immediate and reactive way to your emotions" (Jones 2014).

The biopsychosocial model is not only a medical care approach widely accepted in recent years, but the scientific confirmation of a holistic philosophy that searches

for evidence-based medical data that includes several explanations to confirm the relationship between physical and mental aspects, with a circular causality nature, instead of visualizing body, mind, and the emotions as separate entities. Therefore, it is now more than ever that user centred design can be nurtured by the spectrum of therapeutic approaches for participating in new product or system proposals, in an interdisciplinary work, hand in hand, not only with users, but also with healthcare professionals to achieve optimal health and healing.

This approach for holistic and integrating techniques towards well-being is therefore, a model of health care that combines both conventional and unconventional therapies that serve the whole person and focus on prevention and whole health. Women are the highest utilizers of health care and Integrative Medicine for a variety of reasons. Integrative Medicine represents a more “female energy” in the field of medicine, which is needed even more today as health care moves toward value-based care and out of high-cost and high-harm care. Integrative Medicine can be incorporated into medical practice and into health workers’ lives for wellness (Phillips, Cockrell, & Parada 2018).

## 1.2 Body and Mind

Our bodies consist of several biological systems that carry out specific functions necessary for everyday living that we will explain very briefly just to keep in mind the intricate self-contained ecosystem that we hold in our bodies. Conscious and unconscious processes take place thanks to the relation between all our organs and our mind that are biologically programmed to search for equilibrium. When external or internal stimulus put any of these systems under pressure, a whole complex reaction of neurologic and endocrinologic systems is unleashed, reflecting either bodily or mental tension to which we refer as stress (Fink 2010). Fig. 1.

According to the context and/or disciplines, there is some confusion about the precise meaning of the term “stress” even if it’s widely recognized as a central problem in human life, as underscored by Lazarus: “*For the sociologist, it means disturbances in the social structure. Engineers conceive it as some external force which produces strain in the materials. Physiologists deal with the physical stressors that include a wide range of stimulus conditions that are noxious to the body...In the history of psychological stress research, there has been no clear separation between physical stressor which attack biological tissue systems and psychological stressor which produce effects purely because of their psychological significance*” (Lazarus 2006).

However, stress can have a different meaning for different people under different conditions. The most generic definition of stress is that proposed by Hans Selye: “Stress is the nonspecific response of the body to any demand”; and he also underscored that stress should not and cannot be avoided, since just staying alive creates some demand for life-maintaining energy. It is associated with a great variety of dissimilar problems, such as:

*...Surgical trauma, burns, emotional arousal, mental or physical effort, fatigue, pain, fear, the humiliation, frustration, loss of blood, intoxication with drugs or environmental pollutants, or even the kind of unexpected success that requires an individual to reformulate his lifestyle. It is present in the businessman under constant pressure, in the athlete*

*straining to win a race; in the air traffic controller who bears continuous responsibility for hundreds of lives; in the husband of a sick wife; in a racehorse, its jockey, and the spectator who bets on them.*

While all these problems are quite different, individuals respond with different degrees of intensity of patterns of biochemical, functional, and structural changes essentially involved in coping with any type of increased demand upon vital activity and adaptation whether the situation is perceived as pleasant or unpleasant. (Selye 1976). Many times, we fail to realize the extent to which these internalized habitual emotional patterns dominate our internal landscape, diluting and limiting positive emotional experience, and eventually becoming so familiar that stress essentially becomes a defining part of their sense of self-identity. (LeDoux 2015).

Stressful life experience can have significant effects on a variety of physiological systems, including the autonomic nervous system, the hypothalamic-pituitary-adrenal axis, and the immune system. These relationships can be bidirectional; for example, immune cell products can act on the brain, altering mood and cognition, potentially contributing to depression. Although acute physiological alterations may be adaptive in the short term, chronic or repeated provocation can result in damage to health. (Kemeny 2003).

Stress arises not only in direct response to external situations or events, but also, to a large extent, involves the ongoing internal emotional processes and attitudes individuals perpetuate even in the absence of any identifiable extrinsic stimulus (Arnetz & Elkman 2011). Recurring feelings of agitation, worry, and anxiety; anger, judgment, and resentment; discontentment and unhappiness. Insecurity and self-doubt often consume a large part of our emotional energy even when we are engaged in the activities of everyday life.

The mind can be defined as a person's set of intellectual or mental faculties and refers to the group of cognitive psychiatric processes that includes functions like perception, memory, reasoning, etc. According to the Oxford English Dictionary, it "is the element of a person that enables them to be aware of the world and their experiences, to think, and to feel: the faculty of consciousness and thought"; and we hold it responsible for processing feelings and emotions, resulting in attitudes and actions. Mental processes clearly play a role in stress, it is most often unmanaged emotions that provide fuel for their sustenance. It is well recognized that thoughts carrying an "emotional charge" are those that tend to perpetuate in consciousness (Arnetz & Elkman 2011). It is also emotions that activate the physiological changes comprising the acute stress response. This -also known as- "fight or flight" response, refers to a physiological reaction that occurs in the presence of something that is terrifying, either mentally or physically and it's triggered by the release of hormones that prepare your body to either stay and deal with a threat or to run away to safety (Goldstein 2010).

In response to acute stress, the body's sympathetic nervous system is activated due to the sudden release of hormones. The sympathetic nervous systems stimulate the adrenal glands triggering the release of catecholamines, which include adrenaline and noradrenaline. This results in an increase in heart rate, blood pressure, and breathing rate. After the threat is gone, it takes between 20 to 60 min for the body to return to its pre-arousal levels (Gordan, Gwathmey, & Xie 2015). Fig. 2.

McCarty explains that stress research has traditionally been oriented towards studies examining the cognitive processes that influence the perception of stress (a cognitive perspective) or the body's response to stress (a physiological perspective). Surprisingly, however, comparatively little attention has been given to the role of the emotional system in the stress process. From a psychophysiological perspective, he says, emotions are central to the experience of stress; indeed, it is the emotions activated in response to perceiving a stimulus as threatening—feelings such as anxiety, irritation, frustration, lack of control, or hopelessness—that are truly what we are experiencing when we describe ourselves as “stressed.” All the above examples of “stressors”—whether minor inconveniences or a major life change—are experienced as “stressful” to the extent that they trigger these emotions.

In the last decades, research in the neurosciences has made it clear that emotional processes operate at a much higher speed than thoughts, frequently bypassing the mind's linear reasoning process entirely (McCarty 2006). And although emotions can be induced by thoughts, they may also arise from unconscious associations triggered by external or internal events. In other words, not all emotions follow thoughts: emotions often occur independently of the cognitive system and can bias the cognitive process and its output or have a physical consequence without any perceived emotional background, that given the relation between bodily systems, can give origin to a chain reaction.

Most of these reactions involve chemical substances produced by the body, including hormones, which is why it's the study women can be of huge interest; in addition to the higher reported stress and because of the particular hormonal changes that take place in their body. Hormones are important agents of protection and adaptation, but stress and stress hormones, such as the glucocorticoid cortisol, can also alter brain function, including the brain's capacity to learn. Severe and prolonged stress can impair the ability of the brain to function normally for a period of time, but the brain is also capable of remarkable recovery.

**Emotions.** In psychology and philosophy, emotion typically includes a subjective, conscious experience characterized primarily by psychophysiological expressions, biological re-actions, and mental states. Emotional systems comprise both neural and bodily states that provide immediate means for protection of the individual and that maximize adaptation to survival-salient events (Saarimäki, y otros 2016). Categorical emotion models argue that evolution has shaped a limited set of basic emotions (anger, fear, disgust, happiness, sadness, and surprise) with different neural and physiological substrates to support different survival functions. These basic emotions are also characterized by distinctive feelings and culturally universal expressions (Tracy & Randles 2011).

Humans -and most other animals- appear to be equipped with a set of predictable but complex responses to situations. We call these the basic emotions: anger, fear, surprise, disgust, joy, and sadness, as described in the 1970s by anthropologist Paul Eckman. According to some theories, they are states of feeling that result in physical and psychological changes that influence our behaviour (Schacter, Gilbert, & Wegner 2011) (Scherer 2005) The physiology of emotion is “closely linked to arousal of the nervous system with various states and strengths of arousal relating, apparently, to particular emotions”, and it's precisely emotions that activate the autonomic nervous system and hypothalamic-pituitary adrenal axis, leading to changes in the activity and function of

the body's systems and organs. Thus, many of the deleterious effects of stress on the brain and body are in fact physiological repercussions of negative emotions. It is also the emotions activated in response to perceiving a stimulus as threatening—feelings such as anxiety, irritation, frustration, lack of control, or hopelessness—that are truly what we are experiencing when we describe ourselves as “stressed.” From a psychophysiological perspective, emotions are central to the experience of stress.

### 1.3 Women's Health

Even if women represent the 49.58% of the world's population (UN World Population Prospects 2019), women are still not proportionally included in clinical research in numbers that reflect the prevalence and impact of disease in women. This means that clinical practices (including treatment guidelines and medication dosages) are derived largely from the male physiological perspective. Even at the very early stages of scientific discovery, a gender lens is not considered as there remains a strong bias in research studies to use male animals to study treatments for disease (Johnson 2017).

Psychosomatic pathology has a greater frequency in females (Hange, y otros 2013), and different risk factors have been described in medical literature. Among them there is an association of sexual hormones with body symptom expressions, a higher perception of emotional distress in women, and mood swings related to endocrine patterns and the normalization of physical symptoms as expressions of emotional distress or even with long term somatization. These changes can be reflected along many stages that can or cannot be present during the life of a female, as well as other physical changes can appear during menstrual cycles. (Table 1).

**Table 1.** Hormonal Changes during a women's lifetime

Stage	Years	Experiences + hormones
Puberty	9–21 years old	Irregularity with the menstrual cycle. It takes time for the body to build up enough of a hormonal concentration that you can ovulate and menstruate regularly, as well as develop secondary sex characteristics
Adult Menstrual Years	21–35 years old	In this maturation period, the physiological changes unique to women are menstruation-related disorders and uterine or ovarian diseases. An increase in the lifetime frequency of menstruation due to recent changes in women's lifestyle. Contraception, changes in habits and substance regular intake play fundamental roles during this stage
Pregnancy/ Post pregnancy	Age varies	Large increases in estrogen and progesterone that produce changes in the amount and function of a number of other hormones and organs. After pregnancy, estrogen and progesterone drop significantly before readjusting causing mood imbalances and further physical changes

(continued)

**Table 1.** (continued)

Stage	Years	Experiences + hormones
Perimenopause Phase one	35–45 years old	Lower reproductive disposition. Increased risks depending on lifestyle and genetical factors, such as of breast cancer, high blood pressure, and heart disease
Perimenopause Phase Two	45–55 years old	Follicle stimulating hormone (FSH) levels change until ovulation stops. The body manufactures slightly less, but ideally, a balanced amount of estrogen and progesterone and testosterone
Climacteric Period	55 + years old	Estrogen deficiency, osteoporosis and other psychiatric symptoms may occur more frequently, as vertigo, migraines, and urinary problems

The menstrual cycle is a direct indicator of the overall health, and periods are the body's way of saying that things are working as they should. Having an extremely irregular or heavy period, or losing it altogether, can indicate an existing underlying condition. By tracking various details of the cycle, we will be able to recall things that otherwise would have been forgotten when speaking with a healthcare provider.

### Some Facts

- One study of 58 women showed an increase in oxidative stress and cellular aging in those suffering from high levels of stress.
- A 2006 survey conducted by the American Psychological Association found that 51% of women reported stress to influence their lives, versus 43% of men. (American Psychological Association 2006).
- Women's stress tends to manifest itself more often in physical ways as compared to men, with medical conditions that include obesity, depression, hypertension, and anxiety.
- Women are twice as likely to be diagnosed with depression as men, and often that depression traces back to stress as a key root cause.
- The journal *Personality and Individual Differences* reported that out of 2,816 people tested, women scored much higher than men did on chronic stress tests.
- The National Institute of Mental Health advises that a big part of the higher stress numbers in women is they tend to play multiple roles at work and at home, they are often single mothers, women are more likely to live in poverty than men are, and they are also at risk for domestic violence.
- Women attribute children as a much more significant source of stress than men do. In the modern day, the stress equation for women has become further compounded by the commonly seen working mother, who must juggle a demanding career, kids, house, spouse, and everything else.



In 2001, the U.S. Institute of Medicine declared that ‘every cell has a sex’ (Pardue et al. 2001). In the past decade, some progress has been made to understand how to analyze sex in tissues and cells. The notion that there are biological differences between the sexes is most evident and comfortable when it is applied to the reproductive system. However, sex differences have been identified or suggested at many levels of biological organization, from biochemical to behavioral. For most of the population, as well as a substantial fraction of scientists, not all known differences are obvious, and not all of those that have been suggested or suspected are easily explainable in biological terms.

The relative roles of the sex chromosome genes and their expression explains X-chromosome-linked disease and is likely to illuminate the reasons for heterogeneous expression of some diseases within and between the sexes (Wizemann & Pardue 2001).

Hormonal changes throughout the menstrual cycle have been suggested to cause changes in mood like irritability and anxiety, but a definitive link between mood and the menstrual cycle is still under study. However, if we could be able to notice recurrent changes in the mood during a cycle, and learning when these changes happen, it could be another piece of information to help understand the rhythm of it. Tracking the many emotions and mental states all people experience, as well as being aware of changes can prepare the user for them and to better manage them.

Whereas emotions are direct responses to external events, mood is a diffuse experience of the balance between one’s overall personal resources and one’s life challenges. Mood passes and changes: they can last for hours, or sometimes even days, but they are constantly changing and converging into other moods. At the same time, moods are pervasive. They represent the no reflective feeling state that forms the core of our affective being (Russell 2003), and they are a direct indicator of our general subjective well-being (Diener, Fujita & Sandvik 1994).

Design can also influence mood by enabling and stimulating people to engage in a broad range of mood-regulating activities. It is very useful for this project to research some novel mood-regulation strategies and explore how these strategies can inspire design interventions (Desmet, Hekkert, & Hillen 2003).

#### **1.4 Tracking and Health**

In the simplest terms, emotion tracking is the ability to measure and gauge the emotional status across a period. Tracking emotions is one of the fastest growing ways to help quantify our mental health. Technology companies have worked over the last few years to create a solution that best helps us to identify and understand our emotions. The sole act of tracking the own sensations and states, our routines and changes has meaning, not only for ourselves but for the sake of medical research and other women will reflection self-steam and self-knowledge (Feldman Barret & Russell 2015).

Sensing physiological patterns is not a new thing; ambulatory medical devices have been under development for years, helping people with various medical complications, to monitor heart rate, blood pressure, and more. Affective wearables overlap with medical wearables in that both may sense physiological signals (Mann 1997). Both may be concerned with sensing signals that indicate stress or anxiety, an application of interest not just for people suffering from anxiety attacks or other medical conditions, but also for healthy people who are interested in staying healthy.

Miniaturization of components has enabled systems that are wearable and nearly invisible, so that individuals can move about and interact freely, supported by their personal information domain. Current efforts that use physiological sensing are focusing on: Gestures, GSR (Galvanic Skin Response), EKG (Electrocardiogram), EMG (Electromyogram), BVP (Blood Volume Pressure), Respiration and temperature, and in the late years smartphones have allowed us to get a little familiar with the concept of Heart Rate Variability outside a health facility context.

There are currently no clinical studies using ambulatory auscultation or pulse oximetry for HRV studies, but such are possible. In clinical use since 1970, Holter ECG recorders have evolved by incorporating advances in electronic amplifiers, processors, solid state memory, batteries and wireless communications (Khairuddin & Ku Azir 2017).

### 1.5 Heart-Rate Variability (HVR)

We've described some highlights of the critical function of input from the body's organs to the brain in contributing to the input patterns that ultimately determine the emotional experience. Although complex patterns of activity originating from many different bodily organs and systems are involved in this process, it has become clear that the heart plays a particularly important role. The heart is the primary and most consistent source of dynamic rhythmic patterns in the body from many different bodily organs and systems are involved in this process, it has become clear that the heart plays a particularly important role. It is the primary and most consistent source of dynamic rhythmic patterns in the body. Thus, with each beat, the heart not only pumps blood, but also continually transmits dynamic patterns of neurological, hormonal, pressure, and electromagnetic information to the brain and throughout the body.

In general, emotional stress including emotions such as anger, frustration, and anxiety, lead to heart rhythm patterns that appear incoherent, disordered, and jagged. In contrast, sustained positive emotions, such as appreciation, care, compassion, and love, generate a smooth, ordered, sine wave-like pattern in the heart's rhythm.

The natural fluctuations in heart rate, known as heart rate variability (HRV) or heart rhythms, which are a product of the dynamic interplay of many of the body's systems. It's been demonstrated that distinct heart rhythm patterns characterize different emotional states. Past studies have also indicated that ECG signal can be affected by various environment parameters such as mental issues and different types of physical activities (Takahashi & Suzuki 2015).

Heart rate variability (HRV) is defined as the physiological variation in the duration of intervals between sinus beats; it's a measurable reflection of the balance between sympathetic and parasympathetic systems, and it has been used as a marker for cardiac status and predicting CV outcomes. Recently, the availability of commercially available heart rate (HR) monitoring systems has had important CV health implications and permits ambulatory CV monitoring on a scale not achievable with traditional cardiac diagnostics (Singh, y otros 2018).

In brain-damaged adults, Lowensohn reported that HRV decreased and rapidly diminished in line with increases in intracranial pressure (Lowensohn, Weiss, & Hon

1977) A more recent study in 145 trauma patients confirmed that an increase in intracranial pressure, as measured by invasive ICP monitoring, is preceded by a reduction in HRV. Changes in HRV have also been shown to be an early indication of the occurrence of brain death (Conci, DiRienzo, & Castiglioni 2001). However, some studies show that depending on the artifact, the electrocardiogram (ECG) signal can be misrepresented because of interference and baseline wandering, reducing the accuracy of the data, especially in a moving person (Kim, Noh, & Jeong 2015) and some improvements for complex detection, data compression and data de-noising are still needed.

**Limitations of HRV Measurement.** Although the ability of HRV to provide information on biological systems is promising, there remains a few physiological and technical issues that need to be considered when interpreting HRV clinically. The context of HRV recording is crucial, as numerous factors including age (increased age leads to reduced HRV), gender (higher HRV in females), thought to alter HRV.20 Factors such as posture and movement also need to be considered as it has been shown that HRV is markedly altered between standing and supine positioning (Task Force of the European Society of Cardiology 1996). HRV is also affected by some technical factors such as ECG sampling frequency, length of ECG recording and the presence of artefact or interference (Shaffer & Ginsberg 2017). Despite the potential of HRV measurement, it is still largely a research technique and has not become part of routine monitoring in critical care (Sztajzel 2004).

## 2 Objectives

- Measure the base level stress of the user's body by using the Heart Rate Variability parameters.
- Offer an easy way to register the number of emotional peaks or symptoms around the day.
- Design a calendar-like product where to relate the previous inputs with the months or hormonal cycle.
- Help the user register this data to make available for further statistical or medical purposes.
- Encourage the user to develop a sense of self-awareness in the unseen part of them, giving importance and acceptance of not only of the physical sensations but also of their emotional reactions.

## 3 Hypothesis

Detecting how emotionally volatile the user might be in certain situations can be a huge help in improving her mental health. For example, insights from emotion tracking could help a medical professional provide advice and support on how these feelings can be coped with in everyday activities. This emotional data can then be correlated and reported on to help you unpack the instances and circumstances that lead to distressing situations, or likewise, happier moments.

## 4 Materials and Methods

This is a descriptive, qualitative study, based on semi structured interviews done to a sample of healthy women that have suffered from physical discomfort or symptoms related to somatization, during extended periods, in particular digestive functional symptoms, urinary symptoms, headaches and muscular or joint pain without apparent medical causes. This, in order to understand the possible needs to be addressed and to better frame the design proposal.

The second phase is the theoretical research, in which the Heart Rate Variability was found suitable for the project, since it's a physiological parameter that can be easily measured using available technology already available in smartphone apps (Campos 2019), and it can be a practical and useful way to evaluate somatic stress.

The third stage is developing the design concept that will give didactic feedback to the user, registering the number of emotional peaks or functional symptoms (not caused by a disease), around the day, like; anxiety related with abdominal functional pain, etc. and combining these two inputs into a matrix to be translated into a visual code.

A kinetic calendar is proposed as a suitable way to show the emotional and physical symptoms, registered daily, since it's a visual showcase of the possible transitions and severity of symptoms along the whole hormonal cycle, making it correspond to the menstrual cycle of the user, where each day representative unit, can move into a particular position.

The continuous observation of the monthly figures or patterns that form in the calendar display, encourage the user to develop a sense of self-awareness, encouraging the understanding and acceptance not only of the physical sensations, but also to link them to their emotional reactions.

The data will remain stored inside the app, to help the user register this data for longer periods and to make available for further statistical or medical diagnoses if the woman decides voluntarily to share her information.

As a further stage, a clinical analytical study will be proposed to look for statistical association between hormonal cycle and nervous autonomic response, to describe the correlation between emotions, stress levels and hormonal cycle. This study phase should be done in collaboration with a liaison psychiatrist and/or endocrinology specialists.

## 5 Discussion

Tracking systems provide a variety of means of monitoring stress and other conditions outside the confines of a medical facility and gathering data as the wearer carries on his or her daily activities. Of course, none of the data collection or analysis implies that a user will choose to change his behavior or lifestyle, but projects in this fields can help a wearer make informed decisions, and can be shared with a physician, if the wearer desires, for help in treating chronic stress related disorders.

Several authors have correlated HRV with inflammatory markers. This suggests that HRV is related to both anti-inflammatory and pro-inflammatory signals with a stronger association being present in patients who are more unwell (Papaioannou, Dragoumanis, Vasiliki, Gargaretas, & Pneumatikos 2009).

HRV analysis offers a unique monitoring modality that provides information regarding variability in complex biological signals. HRV can potentially detect and track the state of the whole physiological system over time and during the development of illness, potentially even before it is clinically apparent. If these challenges are addressed, HRV analysis has the potential to revolutionize critical care monitoring and introduce an era of monitoring based on individualized variability analysis (Johnston, Barret-Jolley, Krige, & Welters 2020).

The health monitoring system has been incorporated slowly in everyday life with enhanced graphics and better user experiences; by using smart phones that display comprehensive information patients are allowed to check some parameters almost anytime and anywhere. This can enable a continuous flow of physiological information by remote monitoring (Ullah, Shah, & Zhang 2016) and lower the cost of public health care by removing the need for health professional to take part in data collection and analysis frequently. In addition, physiological information can be shared through wireless connectivity by a whole team of medical professionals for quicker health recommendations (Satija, Barathram, & Sabarimalai 2017).

IoT can connect medical devices such as ECG, sensors, and other diagnostic and imaging devices. The networks of IoT-based devices are expected to not only improve the detection and prevention of diseases but also reduce medical costs, increase the quality of life as well as enhance the patients' experience of using these devices (Khairuddin & Ku Azir 2017); and by incorporating IoT into existing network configuration, healthcare organizations can modernize the whole healthcare industry using smart resources. However, the integration of existing devices into IoT-based configuration will require backward compatibility and flexibility (Islam, Kwak, Hossain, & Kwak 2015).

## 6 Conclusions

Tracking apps provide a variety of means of monitoring bodily functions and other conditions outside the confines of a medical facility and gathering data in real time as the wearer carries on his or her daily activities, since "mobile phones and wearable devices have become extensions of an increasingly diffused and smart digital infrastructure" (Ghose 2021). However, this focuses only in the physical input, which is why this proposal adds the emotional and sensorial factors to the collected data, making it possible for the user to observe changes of colors, intensities, and shapes on the display in order to make easier the recognition of possible emotional patterns and the relation they might have to chronic pain or disturbance.

The state of the art in computers and materials, as well as the interest from society in the personalization of their environments (Heidmets 1994), opens an opportunity window for design to continue to explore the emotional field. In this case, the suggestion is to merge these efforts and multidisciplinary input, to propose a sort of "emotional mirror", a display where users can leave tracks and patterns of their monthly journey for a further auto-analysis of their own physical and emotional.

Data collection and analysis must be aligned with ethical privacy policies, and only the users will be able to choose if they want to share this information with health specialists or ask for therapeutical advice for any changes in daily choices or coping behaviors,

but this design proposal can help healthy people or patients to have valuable information for treatment of chronic functional symptoms related to stress.

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