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Master's Thesis
Academic Year 2018

HESS: a Wearable Device to Induce and Enhance
the ASMR Phenomenon for Mental Well-being



Keio University
Graduate School of Media Design

Safa Jalloul

A Master's Thesis
submitted to Keio University Graduate School of Media Design
in partial fulfillment of the requirements for the degree of
Master of Media Design

Safa Jalloul

Master's Thesis Advisory Committee:

Associate Professor Kai Kunze (Main Research Supervisor)

Professor Matthew Waldman (Sub Research Supervisor)

Master's Thesis Review Committee:

Associate Professor Kai Kunze (Chair)

Professor Matthew Waldman (Co-Reviewer)

Professor Keiko Okawa (Co-Reviewer)

Abstract of Master's Thesis of Academic Year 2018

HESS: a Wearable Device to Induce and Enhance the ASMR Phenomenon for Mental Well-being

Category: Design

Summary

In our fast-paced society, stress and anxiety have become increasingly common. The ability to find coping mechanisms becomes essential to reach a healthy mental condition. The starting point of this study is that ASMR is a tingling and pleasant feeling that proves to be therapeutically helpful in promoting subjective well-being or happiness, which can be considered synonymous with mental health. But the ASMR phenomenon is an exclusive atypical perceptual experience specific to some individuals. Therefore “HESS” aims at providing users with an immersive sensory experience allowing them to feel the ASMR sounds in their body through re-creating and enhancing the ASMR phenomenon. This project explores the feasibility of “HESS” in enhancing the listening experience and creating an immersive and inclusive ASMR experience even for non-ASMR users.

Keywords:

Affective computing, Embodied music cognition, ASMR, Cross-modality, Haptics, Stress management

Keio University Graduate School of Media Design

Safa Jalloul

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Chapter 1

Introduction

1.1. Motivation

Stress is a serious condition that, if left untreated, could lead to dangerous health outcomes, and people lack awareness in that matter. Poor stress coping mechanisms might lead to anxiety, depression, and suicide as a last resort, in cases of chronic stress.

Most people suffer from serious symptoms with unrecognized causes and it might as well be caused by stress.

For it has moults effects such as **Behavioral** (e.g change in sleep patterns, decreased efficiency, and effectiveness, etc.) **Psychological or Emotional** (e.g feeling overwhelmed, helpless or hopeless, sadness, moodiness, grief or depression, etc.) **Physical** (e.g decreased resistance to colds, flu, and infections, feeling a "lump in the throat", etc) **Cognitive** (e.g Difficulty Concentrating, memory problems/forgetfulness, etc) and **Social** (e.g withdrawing or isolating from people, intolerance of group process, difficulty in giving or accepting support or help, etc). As the author of this study, my motivation comes from a personal standing point, I deal with stress daily. Like many of my peers of young adults, I am an expatriate in Japan looking for international experience as a student at a Japanese University. Living abroad, in a new culture, where speaking the language is not a given proves itself to be extremely tiring and stressful. Everyday tasks in a new environment are challenging. Stress, loneliness, and isolation can result from it. It is exhausting. The methods of emotional recovery vary between individuals and are often based on forming negative health habits such as over-consumption of coffee or tobacco use [47]. Just like for many people, despair took over me fast, and I tried everything from bad coping mechanisms (e.g overeating, smoking, drinking etc) to healthier and more zen coping mechanisms like (e.g exercising, meditation,

deep breathing etc). Nonetheless, sometimes stress becomes too intense, too persistent that meditating becomes an inadequate solution, and the results require a lot of hard efforts to achieve.

That is why this study focuses on coming up with an appropriate design for augmented mindfulness to create calmness and maintain stress levels within a manageable range.

1.2. Background

Modern society is becoming increasingly competitive. It is thriving on performance and perfection. Leading to an insidious increase in stress and social isolation, two factors that might cause mental issues if untreated, and are often underestimated. Several studies have proven that one of the age groups that are more prone to stress symptoms of stress and loneliness are young adults, who experience stress for intervals of six hours or more a day¹. Another study, a survey of more than 4,500 people, conducted as part of the Mental Health Awareness Week by the Mental Health Foundation showed that millennials, young adults of ages between 18 and 38 years old, experience feeling under pressure more than older adults. Young adults are finding it challenging to cope and manage stress on a daily basis. Long work hours, heavy task load, social interactions, the commute etc.

Stressed and isolated, a community had risen on the internet exploring ASMR as a means to maintain stress levels within a manageable range, deal with insomnia, depression and create a state of calmness and relaxation [1]. Scientific evidence affirms the anecdotal evidence that the ASMR experience provides physiological indications of a decrease of the heart rate activity and respiration rates [5].

In an era where we eat our meals in front of a screen, where young kids spend more times in front of their phones and tablets instead of playing outside with their friends, and where social isolation becomes the norm, the internet has introduced some of that human connection back, through the screen. A one-sided intimacy,

1 <https://www.independent.co.uk/life-style/mental-health-young-adults-stress-depression-anxiety-ocd-study-a8233046.html>

where a stranger on the internet, referred to as ASMR artists on YouTube, makes viewers in the comfort of their homes feel better using ASMR triggers, clicks and taps and whispers, an individually catered interactions to create calmness.

There is an emergent interest in the ASMR experience, both scientific and artistic, trying to make sense of this atypical sensory-emotional experience.

- ASMR Documentary



Figure 1.1 “Follow This” - ASMR episode “The Internet Whisperers”

A documentary made by BuzzFeed² for a series called “Follow me” available on Netflix, (Figure 1.1). Where the Journalist interviews a ASMR artist Maria with a YouTube channel called “GentleWhispering”³ with more than 1 Million subscribers, An ASMR scientist, Stephen Smith, Ph.D, in the University of Winnipeg, who led two of the first studies on ASMR. An individual that benefits from ASMR daily to alleviate the symptoms of stress, insomnia and depression and finally, her experience in an ASMR spa, the Whisperlodge.

² <https://www.theverge.com/2018/4/25/17279762/netflix-buzzfeed-follow-this-short-form-documentary-series>

³ <https://www.youtube.com/user/GentleWhispering>



Figure 1.2 ASMR as Anxiety Relief” documentary featuring an ASMR artist

ASMR as Anxiety Relief” documentary⁴featuring an ASMR artist, Spirit Payton, who, several years ago, was diagnosed with severe degenerative bone disease, leaving her with anxiety and chronic pain. She found relief via an unlikely source: ASMR, (Figure 1.2). For the uninitiated, ASMR refers to feelings triggered by visual or auditory stimuli, perhaps by the tapping of nails against glass, or the crinkling of a candy wrapper. Realizing the healing power it had for her, Payton became an ASMR artist, hoping to help others battling their own ailments.

- ASMR Project / Business

The Whisperlodge⁵is an intimately-sized immersive theatre performance spa for the senses, coaxing individuals to tune in to themselves with live ASMR, (Figure 1.3). A one-to-one ratio between guides and guests, designed to relax the body and mind, expand awareness, and heighten the senses.

4 <https://vimeo.com/255733143>

5 <https://whisperlodge.nyc>

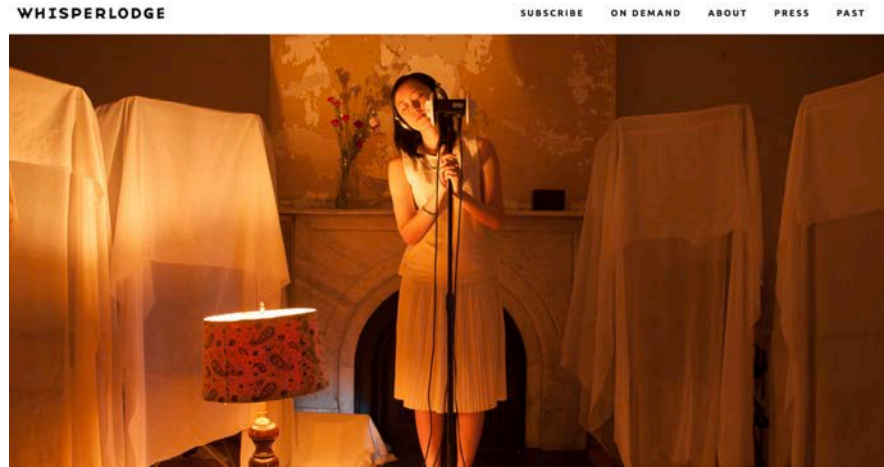


Figure 1.3 What is ASMR and how does it work? — The Stream

1.3. Objective and Hypothesis

This study explores a possible solution for inducing calmness and improving mental health and well-being by the means of ASMR audio and wearable haptic technologies cross-modality. The objective of this project is to design a wearable haptic device "HESS" that provides vibrotactile sensations synchronized with matching ASMR audio. This research focuses on creating a salubrious experience, that provides an augmented Mindfulness experience by establishing self-awareness, a state of relaxation, calmness and maintaining stress levels within a manageable range. The other goal of this study is to make the ASMR experience inclusive so that even the non ASMR can benefit from the experience.

The hypothesis Number 1 proposed is that; ASMR audio-haptic cross-modality creates a calm sensation and manages stress.

The hypothesis Number 2 proposed is that; ASMR audio-haptic cross-modality enhances the ASMR phenomenon for both ASMR users and non ASMR users.

1.4. Contribution

The usage of, ASMR audio and Haptics, cross-modal effects and correspondences to increase immersion and assisted meditation. The contributions are as follows:

1. The design of the "HESS" system, a wearable haptic device.
2. Exploring the feasibility of ASMR audio-haptic feedback cross-modality for stress management.
3. Exploring the ASMR phenomenon and the feasibility of enhancing the feeling of the ASMR audio in the body for ASMR users and non ASMR users.
4. Synthesized results with valuable qualitative responses from users, that discuss the findings in the context of design considerations for future work in this area.

1.5. Thesis Outline

This thesis consists of five chapters.

Chapter 1: The Introduction, presenting a basic understanding and outline of the motivation and background behind this study.

Chapter 2: The Literature Review, a deeper understanding of the elements, notions and previous research that relate to this study.

Chapter 3: The HESS Design, an overview of the concept making, ideation and product design process.

Chapter 4: The Evaluation, testing the prototype, proof of concept and experimental setups of the study.

Chapter 5: The Conclusion, summary and future expansion of the study.

Chapter 2

Related Works

As mentioned in the previous chapter, this project aims at proposing a nonintrusive solution for stress management, that promotes mindfulness, self-awareness, and creates a unique and salubrious experience. Through the design of "HESS" a wearable haptic device that enhances ASMR audio. Some stressful situations might need to be defused in the immediate vicinity without making pre-arrangements, and self-initiated interaction of affective computing systems offers a convenient and neutral positioning for approaching assisted emotional change. Therefore, to better understand the issue and come up with the adequate technology to support mindfulness, I looked into the benefits of affective computing as a means to creating a new effective sensation and previous researches related to stress, mindfulness, ASMR and audio-haptic cross-modality.

2.1. Stress

2.1.1 Stress Definition

There is no universal agreement on the definition of stress. Defining it is not a simple task. Like emotions, stress represents a subjective experience and rather unconscious. In other words, stress perception is subjective. Nonetheless, it is possible to define stress from a scientific point of view. Hans Selye (considered as the father of stress studies) defines stress as "the nonspecific response of the body to any demands upon it" in his article [2]. In sum, we can say that stress is a response to either inner (thoughts, psychological effects...) or outer (life threats, fight or flight situations...) stimuli/stressors. In other words, stress is the reaction of the body to any outer stimuli in the environment that through you out of your homeostasis balance, nonetheless, further studies [3,4] that came later noted that

the cognitive factors of the individuals also play a major role on stress.

Good Stress vs Bad Stress

Stress is not always bad, but rather is crucial for our life. A lot of evidence has pointed out the major role played by stress to enable individual in dealing with urgent situation [5] (it ' s what helps rapid reflexes while driving or fleeing a fire...), furthermore, other studies have highlighted the importance of stress in the student ' s life during university (mainly good stress or eustress).

On the other hand, many studies have shown how stress could be fatal for any human being. Chronic stress is involved in cardiovascular diseases, strokes, sudden heart attack deaths, diabetes, ulcers... Stress is also considered as one of the main reasons for depression [6], so, the stress (bad or good) depends on the nature of the stressor.

Types of Bad Stress

Stress can be divided into three types, mainly, acute stress, episodic acute stress, and chronic stress ¹.

- **Acute stress** : Many people exhibit some form of acute stress during their life. It occurs with the daily pressures and demands. Instances of acute stress exist with incidents such as small accidents, work pressure, deadlines and traffic among others. Fortunately, acute stress symptoms are recognized by most people. And because it is short term, acute stress doesn't have enough time to do the extensive damage associated with long-term stress. However, as an individual is subject to an extended amount of acute stress, he becomes a victim of multiple types of diseases such as upset stomach, distress, and tension headaches among others.
- **Episodic acute stress** : As acute stress occurs more frequently/periodically, it transforms to episodic acute stress. In this form, people become short-tempered, tense, easily irritated, and anxious. Often, they describe themselves as having "a lot of nervous energy". Always in a hurry, they tend

¹ <https://www.apa.org/helpcenter/stress-kinds.aspx>

to be abrupt. Sometimes their irritability comes across as hostility. Interpersonal relationships deteriorate rapidly when others respond with real hostility. The workplace becomes a very stressful place for them. They suffer from symptoms such as persistent headaches, hypertension, and heart disease. Episodic acute stress requires professional intervention to avoid severe consequences.

- **Chronic stress** : The third and most problematic type is chronic stress. This type exists with unrelenting demands and requirements as well as terrible experiences such as wars, struggles, poverty, childhood abuse, and traumatic memories. Chronic stress affects personality and wears down an individual to a final, fatal breakdown. Because physical and mental resources are depleted through long-term attrition. It could be fatal in many cases and results in suicide, heart attacks, violence, and stroke. The symptoms of chronic stress are difficult to treat and may require professional intervention, extended medical as well as behavioral treatment and stress management.

Nature of Stressors

In his book [7], Sapolsky defines stressors “ as anything that throws your body out of allostatic balance and the stress-response is your body ’ s attempt to restore allostasis ” . In general, stressors, which are the factors triggering different levels of stress, can be divided into physical and psychological stressors. Physical stressors are in direct contact with the human body, injured, starving, too hot, too cold, while psychological stressors affect the individuals emotionally and/or mentally. The majority of stressors fall in the psychological category, as noted by Lazarus and other researchers, they are not always part of an outer environment, but also, are a matter of inner environment, stress is an interaction between internal and external factors.

2.1.2 Stress Impact on Physiological Signals and Affect

The body’s response to stressors is called the general adaptation syndrome. Regardless of the stressor nature, you turn on the same stress pathway. It does not matter whether the stimuli are good or bad, pleasant or not, it does activate the

same physiological adaptive process, what differs though, is the intensity of the stressor. Which have a major influence on the mood, the sense of well-being, behavior, and health.

In response, the body tries to readjust the homeostasis balance which will cause rapid blood pressure, rapid heartbeats and very rapid breathing [8]. It also inhibits the processes that are expensive in term of energy, so it inhibits digestion, reproduction, and growth until the stressful period 's end. Stress is widely recognized as a threat to a large proportion of people in society, it has a deleterious effect on a wide range of physical and mental health outcomes with accumulating evidence that it which can lead to a decreased quality of life and lack of productivity. Alterations in the immune system by stress are well-established. Furthermore, there is evidence that stressful life events are causal for the onset of depression. Stress is associated with a host of mental symptoms as well, including cognitive dysfunction, dementia, and excessive fatigue [9] and can even cause chronic diseases [10]. In some cases, people may not even realize their stress before it is too late, and medical interventions are required [11].

Stress's Physical Signals Measurement

Stress causes physiological signals, which are the basic manifestation of short-term stress, a combined physiological and psychological state with a direct relationship to increased responsiveness and alertness leading to increased cardiovascular activity (e.g. increased heart rate), blood pressure, electrodermal activity (i.e. changes in the skin conductance of electricity due to emotionally related perspiration) and perspiration.

Therefore, sensing systems include heart rate, Electrocardiography (ECG), Electrodermal Activity (EDA), Electroencephalography (EEG), respiration rates, and skin temperatures. Different measurements of heart activity are more promising [12]. Heart rate, or pulse, is both an easily measured feature, strongly related to arousal and stress. Heart rate can be measured by detecting peaks in the signal collected from sensors on the wrist or finger by using blood volume pulse sensors [12].

2.1.3 Stress Coping Mechanism

Acupressure Points

The acupressure points in the upper back that are known for stress and anxiety relief are; in the shoulder Region: **Shoulder Well**- this point is located on the shoulder muscle, halfway between the base of the neck and the end of the shoulder muscle. And in the neck Region: **Heaven ' s Pillar**- this point is located on the occipital ridge, just at the side of where the spine enters the skull in the tendon. The emplacement of the wearable device is considering these acupressure points in the design of the device.

Music

Music is widely used for emotional manipulation. It allows artists not only to convey their emotions but also elicit an emotional response in the audience. Music therapy has also been shown to be an effective treatment for a variety of neurological and psychiatric disorders, including stroke, dementia, and depression [13]. Reynolds [14] showed that music can be an effective self-regulatory mechanism to reduce arousal. Music can powerfully evoke and modulate emotions and moods, along with changes in heart activity, blood pressure (BP), and breathing.

2.2. ASMR

2.2.1 ASMR Definition

autonomous sensory meridian response (ASMR) is a perceptual phenomenon in which specific stimuli, known as “ASMR triggers” frequently elicit tingling sensations on the scalp, neck, and shoulders, often spreading to the body ' s periphery. These sensations are generally accompanied by a sense of calm, a general feeling of relaxation and peace, as well as by a positive emotional state that may last up to several minutes [1].

Capable individuals typically experience the sensation as originating at the back of the head, spreading across the scalp and down the back of the neck. Those who can experience ASMR, reported that this sensation typically spreads to the

shoulders and back with increasing intensity. Though this diagram represents the most common areas involved in the tingling sensation, there is a huge amount of individual variation in where tingles spread to with increased intensity, with legs and arms also commonly reported as hot spots in some individuals [1]. Figure 2.1, shows the rear view of the head and upper torso and the route of ASMR's tingling sensation.

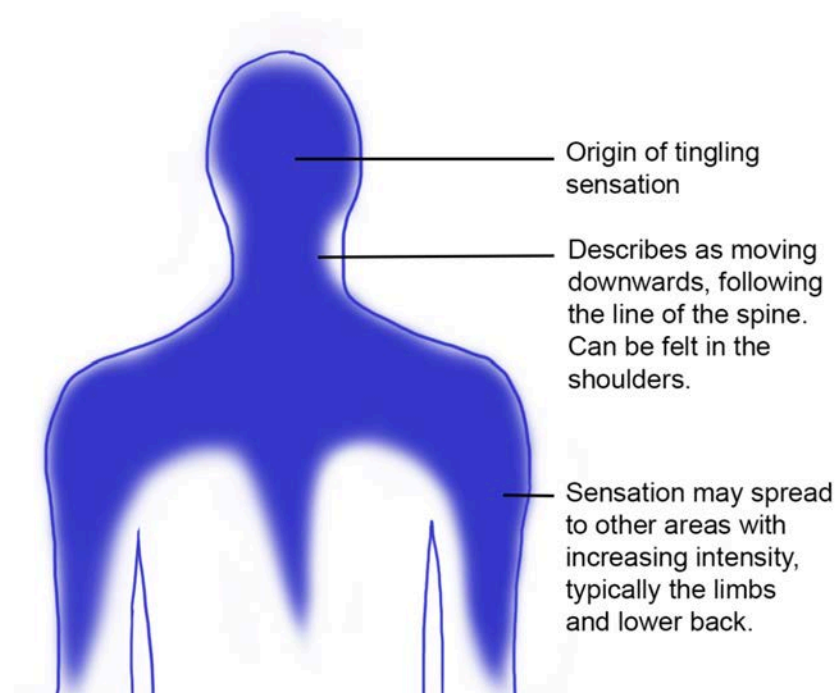


Figure 2.1 ASMR tingles Map

ASMR Triggers Checklist

Although stimuli used to induce ASMR are widely varied, and devotees report that individual differences play a pivotal role in the effectiveness of each video, distinct themes appear to be present in ASMR media. Exploration of the most viewed ASMR media on YouTube uncovers what may be discrete categories of common triggers. For example, triggers may be auditory, like gentle sounds (whispers, crinkles or tapping, etc), visual, tactile, and olfactory in nature. Despite their heterogeneity, the most popular ASMR triggers tend to be audiovisual. A recent

survey study of individuals with ASMR found that whispering and close-up attention (like the touch of a hairdresser or a masseur) elicited tingles in over half of the 450 respondents [1]. Interestingly, In their survey study [1], there is a relatively low agreement for “Chewing Sounds” and “Dentist Simulation”. “Mouth sounds” tended to differentially affect individuals with ASMR by either eliciting the pleasant tingling sensations or sensations related to misophonia (hatred of specific sounds)

Social Component of ASMR Videos

Watching YouTube videos of ASMR gives you intimacy without vulnerability. ASMRtists’ reverence for the viewers and viewers’ trust in the artists’ genuine intents are the very same pillars of an effective interaction (in terms of recovery from illness) between patients and health care providers [15]. The mechanisms at play during such encounters are clearly psychological or even psychosomatic and can be construed as a modern equivalent of the interaction with, and effect of, healers. The atmosphere of closeness and intimacy thus generated seem to have a potent effect on many individuals who seek strategies to cope with stress, anxiety, pain, depression, and insomnia [1]. This suggests that the ASMR experience may increase connectedness. Most likely because of the social and interpersonal context in which ASMR is triggered [16]. One possibility is that ASMR simulates a form of social grooming (e.g., being calmed and soothed by another through the tactile tingling sensations induced by ASMR triggers), which facilitates well-being and interpersonal bonding (e.g., through reductions in heart rate and release of endorphin [17]).

2.2.2 ASMR and Changes in Physiology and Affect

Changes in Affect

The first study of the ASMR condition provided a quantitative analysis of the ‘triggers’ as well as an examination of the effects on mood and on the relationship with flow-state [1]. It provided useful survey data on the use of ASMR videos (for relaxation, sleep, and stress), the age of first ASMR experience (5 - 10 years), and common triggers (whispering, personal attention, crisps sounds, and

slow movements). Healing is sometimes the thematic reference and/or intent of ASMR videos. Surveys of viewers' background, motivations and habits revealed that ASMR content is often utilized as a vehicle to relaxation and as a coping strategy against anxiety. In fact, ASMR audio recordings are marketed, and sold, as therapy aids for relaxation [18], indicating that the triggering of the tingling sensation is not necessarily the only goal sought by ASMR viewers. Furthermore, the therapeutic dimension of ASMR is reported to work by several of the viewers. Anecdotally, these videos help them to sleep, relax, and combat stress and anxiety [1].

ASMR and Aesthetic Chills from Music

ASMR appears to share similarities with more well-established sensory experiences including the shivers-down-the-spine that some (but not all) people experience during music-listening and profound aesthetic experiences (such as those associated with the emotion of awe). Research on aesthetic chills has assessed the physiological parameters that correspond with these complex emotional experiences, typically by presenting participants with chill-inducing stimuli (e.g., self-selected musical excerpts) and measuring aspects of physiology (e.g., [19–22]).

Changes in Physiology

However, unlike these well established and accepted phenomenon, the experience of ASMR has gone virtually unnoticed by psychological science. Is ASMR a genuine feeling in those that claim to experience it. Does it produce reliable changes in affect and physiology?

Recent investigations had revealed that the results are consistent with the idea that ASMR videos regulate emotion and may have therapeutic benefit for those that experience ASMR, for example reducing heart rate and promoting feelings of positive affect and interpersonal connection [23]. It is notable that the reductions in heart rate observed (-3.41 bpm) are comparable to those observed in clinical trials using music-based stress reduction in cardiovascular disease [24], and greater than those observed in a mindfulness/acceptance based intervention for anxiety [25], suggesting that the cardiac effects of ASMR may have practical significance.

A number of studies have consistently associated aesthetic chills, (i.e., “frisson or chills” elicited by music or an emotional experience) with increased heart rate, excitement and physiological arousal [19], a finding that may be specifically linked with the onset of piloerection associated with chills [26] whereas ASMR is typically considered to be relaxing and soothing. Despite the potential parallels between both sensations, they present distinct physiological profiles. For instance, unlike other sensory-emotional experiences such as aesthetic chills, which tend to last up to 10 s, individuals with ASMR may experience the tingling sensations induced by a triggering stimulus for several minutes or more [27, 28].

Taken together, the current evidence showing that ASMR is associated with reduced heart rate and increased skin conductance levels should help to dispel skepticism over whether ASMR is a ‘real’ phenomenon and a reliable and physiologically-rooted experience that may have therapeutic benefits for mental and physical health. And also provide the foundation upon which future research can build. Having established the reliability and validity of ASMR, future research can start to explore exciting questions like its potential therapeutic applications.

2.2.3 ASMR and Self-awareness

Flow

Reports of ASMR experiences also appear to share some features with the state of “flow”, which is the state of intense focus and diminished awareness of the passage of time that is often associated with optimal performance in several activities, including sport [29, 30]. Anecdotal reports of ASMR describe states of focus, of greater “presence” and of relaxation which are consistent with the non-active aspects of flow.

Mindfulness

One conscious state that shares some phenomenological characteristics with ASMR is mindfulness [1]. In their operationalization of mindfulness [31], defines the construct as a two-component process by which one engages in both intentional self-regulation of attention and a nonjudgmental awareness and acceptance of the present moment. Other researchers have suggested that mindfulness in-

volves an openness to sensations, attentional control, emotional regulation, and resilience [32]. Both of these complementary descriptions of mindfulness overlap with the phenomenological elements of the ASMR experience. For example, the focused attention method of mindfulness meditation requires individuals to focus on a specific external stimulus or internal thought [33]. During ASMR experiences, individuals focus attention on an external stimulus that triggers tingling sensations. Other studies [34] strongly supports the hypothesis that ASMR is related to mindfulness as well. The data would provide novel insight into the phenomenology of ASMR, while also showing how this atypical conscious state is related to mindful states and traits. Both mindfulness and ASMR can lead to a feeling of relaxation that enhances people ' s subjective well-being [1,31].

2.2.4 Individuals with ASMR and non ASMR

ASMR is an exclusive experience to those who can feel it, it seems to be linked with particular brain patterns, and emotional openness in situations of contemplative rest. More recently, neuroimaging research has revealed trait-level differences in resting state brain activity between people who experience ASMR and those that do not [16]. In this study, the authors linked the ASMR condition to particular patterns of the Default Mode Network, the system of interacting brain regions that activate during states of rest and mind-wandering. Subjects who experience ASMR show a higher-than-average ability to activate multiple resting modes and lower their inhibition towards emotional experiences while doing so.

An investigation into the psychological dimension of ASMR has begun only very recently and some preliminary results have indicated a correlation between predisposition to ASMR and certain personality traits [35].

It investigated whether individuals with ASMR differed from matched control participants on five broad personality domains of the BFI (The Big Five) [11]: Openness to Experience (sometimes called Intellect or Intellect/Imagination). Includes traits like having wide interests, and being imaginative and insightful. Conscientiousness. Includes traits like organized, thorough, and playful. Extraversion (sometimes called Surgency). The broad dimension of Extraversion encompasses such more specific traits as talkative, energetic, and assertive. Agreeableness. Includes traits like sympathetic, kind, and affectionate. Neuroticism (sometimes

reversed and called Emotional Stability). Includes traits like tense, moody, and anxious.

The surveys of individuals with ASMR as well as from examinations of similar conditions showed that individuals with ASMR would differ from matched controls on the personality dimensions of Openness-to-Experience and Neuroticism. Openness-to-Experience is associated with curiosity, unconventionality, artistic or aesthetic tendencies, wide interests, and fantasy [36]. Neuroticism is associated with anxiety, angry hostility, depression, and self-consciousness [36].

A statistically significant proportion of [1] participants experienced higher-than-normal levels of depression and reported using ASMR-triggering stimuli to temporarily attenuate symptoms of depression and/or anxiety. Elevated Neuroticism scores for individuals with ASMR may be explained by increased self-consciousness, a sub-facet of Neuroticism, due to heightened awareness of physiological and/or psychological states during the ASMR experience. Consistent with this hypothesis [37], found that Neuroticism correlated positively with a variety of somatic symptoms tied to internal bodily states.

2.3. Audio-haptics Cross modality

2.3.1 Audio-haptic Composition

The link between sound and touch is inherent, hearing is, essentially, "a specialized form of touch"

Deaf musician Evelyn Glennie

This statement [38], could be explained in physical terms by the fact that sound is the rapid vibration of molecules in the air, which excite the membranes, hair, and fluid inside of our ears, allowing us to hear. Furthermore, our perception of sound goes beyond just the penetration of the auditory canal, and in fact is felt by our whole body, through vibrations within the organs and the bones [39].

Human-computer haptic interfaces may be described as any device that incorporates an element of force feedback through actuators: mechanical systems that can offer a wide range of accurate motion, such as motors. Rovan and Hayward distinguish these devices from what they call tactile stimulators [40], which consist of, for example, small groups of pins that tap at the skin, vibrating at controllable frequencies to achieve different intensities. Thus Revesz ' s distinction between active and passive perception manifests itself in these contrasting systems: the vibro-tactile systems allow the user to passively experience sensations.

2.3.2 Affective Haptic Technology

According to Harry Harlow, a well-known American psychologist (1959), research, touch is one of the most important elements that living beings develop in the earliest stages of life as embryos [41]. Skin is the most important organ of our whole body, as noted in the article "Psychology of touch " [42]. When other senses fail, the sense of touch prevails and allows humans to re-create feelings and sensations through the whole sensory system. Touch is the most powerful non-verbal communication asset, it allows the expression of emotions and distinct feelings either by touching or by being touched [43]. Emotional touch is simply defined as the action of placing your hands or getting close to someone in order to show them empathy and affection [44]. Clinically, the sense of touch is also

important in nursing care homes. Touch is an essential element for emotional stability and overall well-being [45].

According to the "A guided tour in haptic audiovisual environments and applications" article [46], haptics, is a term that comes from the Greek verb "haptesthai" that means to touch. It is the technology of adding the sensation of touch and feel to computer systems. Touch is considered one of the most important senses of the human's body and to communicate affection, a research area defined as affective haptics is focusing on the acquisition of human emotions via tactile sensors and haptic interfaces. The paper [46] stated that affective haptics focuses on how users emotionally react to haptic stimuli and feedbacks. It is also proven that psychological health will benefit from the use of affective haptics since it is able to recreate the sense of touch and physiological reactions such as heart-beat, breathing, body-warmth [47] etc. In accordance with previous studies, it is possible to notice that affective haptics is an interesting field that needs to get more attention since it is proven that has beneficial effects on humans' life. This research will take into consideration the field of emotional communication and affective haptics in order to further explore the possibilities of reducing daily stress.

2.3.3 Immersion and Focus Meditation

Cross-modal effects in human perception are defined as interactions between two or more different human senses. Effects concerning audio and vision are very well understood and often used in Human-Computer Interaction as well as other disciplines. As haptic feedback technologies are more broadly available, there are more and more works that tackle cross-modal effects with touch and vision as well as audio [48]. Still, only very few researchers use these principles for interaction or user experience designs [49–51].

Audio and Haptic Cross-modal Correspondences are still not well explored in related research. Even though, there are interesting applications to induce a state of immersion with this phenomenon in HCI research. Methods to calm us down and bring us back to the current moment are needed and Meditation techniques seem to be well suited for this [52].

The use of cross-modal effects and correspondences to increase immersion and

focus meditation is explored with, the AtmoSphere, (Figure 2.2). It consists of a sphere shaped device which provides haptic feedback [53, 54]. It explores cross-modal correspondence between haptic and audio output for meditation support. The aim of the haptic/audio design is to guide the user into a particular rhythm of breathing to enhance meditation.



Figure 2.2 the AtmoSphere

Audio-based meditation comes in many forms. For example, in Mantra meditation, practitioners repeatedly chant a mantra [55]. Nature sounds and singing bowl sounds have also been used [56–59]. Touch-based (sometimes called body-based) meditation exploits the principle of relaxation response theory [60] which states that slow deliberate movement can stimulate heightened attention. This principle is reflected in many traditional meditation methods such as Tai Chi, Yoga, and Qigong [60, 61]. Moreover, meditation inducing technology also leverage combinations of audio, vision, and touch to support meditation but prior studies reveal that little evaluative work has been done on the effects of the various human senses in meditation relaxation applications.

2.4. Summary

In summary, **autonomous sensory meridian response (ASMR)** is a perceptual phenomenon in which “ASMR triggers” frequently elicit tingling sensations on the scalp, neck, and shoulders, often spreading to the body’s periphery. These sensations are generally accompanied by a sense of calm, a general feeling of relaxation and peace, as well as by a positive emotional state that may last up to several minutes [1]. Stress causes physiological arousal, increased cardiovascular activity (e.g. increased heart rate) among many other negative impact on the individual. Anecdotal claims (ASMR is beneficial against insomnia, depression and helps manages stress and establish calmness), and empirical evidence (ASMR is associated with reduced heart rate and increased skin conductance levels [23]), should help dispel skepticism over whether ASMR is a ‘real’ phenomenon, a reliable and physiologically-rooted experience that may have therapeutic benefits for mental and physical health. Having established the reliability and validity of ASMR, future research can start to explore exciting questions like its potential therapeutic applications.

These are some points that the study can be built on and expand: ASMR triggers can be; auditory, visual, tactile, and/or olfactory. And touch is an extremely personal and intimate sense. It is used to create a personal space, only experienced to those directly exposed to the action. There is evidence of the sense of touch being incorporated into traditional relaxation practices (e.g. massages, ASMR massage, stress balls, boding balls, prayer beads). ASMR is a pleasant feeling, calming but also activating experience but it an exclusive phenomenon specific to some individuals.

Therefore, this study aims to implement ”HESS”; an ASMR audio-haptic cross-modal wearable device and test its reliability in reducing stress and establishing calmness as well as enhancing the ASMR experience and recreating it for both individuals who can experience ASMR and those who can not.

Chapter 3

HESS Design

3.1. Design Concept

"HESS" is named after a Tunisian word that means "Feel" and "Sound" at the same time. One word to describe two experiences that are the essence of the "HESS" project. Based on ASMR audio and haptic feedback Cross-modality. (Figure 3.1) puts the concept of "HESS" into a visual image. Users put on headphones and wear the "HESS" device on their shoulders. They can start listening to a track of ASMR binaural sounds. The device provides the user with auditory ASMR triggers, specific sounds, and tactile ASMR triggers via synchronized haptic feedback vibration to recreates the ASMR phenomenon and or enhance the tingling sensation.

In the previous chapter, I discussed the tight relationship connecting stress management and ASMR audio-Haptic cross-modality. "HESS" is an idea that the combination of ASMR audio with haptic feedback will provide the user of new sensory experience by feeling the ASMR sounds through the synchronized haptic feedback.

"HESS" is to be designed to aim at ultimately creating an immersive experience with psychological and physiological benefits, that inspires self-awareness, induces calmness and thus helps reduce stress levels. Psychologically, "HESS" should provide the user with a sense of calmness and relaxation, and an immersive listening and feeling experience of the ASMR audio. Physiologically, "HESS" intervention should show a decrease in the heart rate.

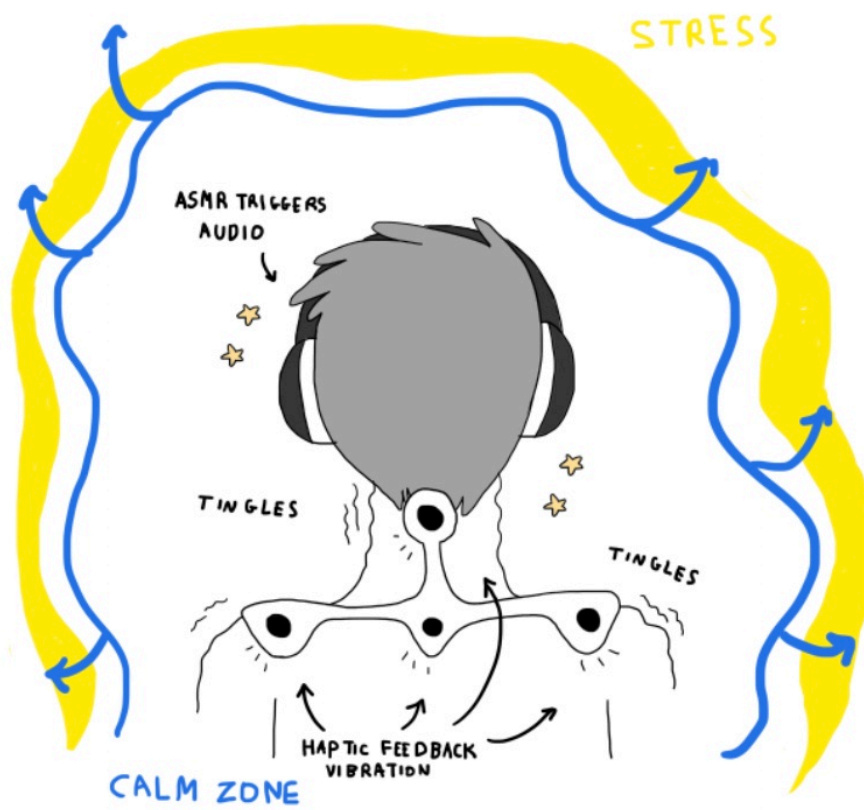


Figure 3.1 Concept visualization of "HESS"

3.2. Design Objective

1. **ASMR audio:** Specific audio triggers that create self-awareness of the body 's sensations.
2. **A wearable haptic device:** To wear on the shoulders and nape of the neck to recreate the ASMR induced tingles.
3. **Haptic feedback:** The wearable device provides the user with vibration.

3.3. Design Process

The methodology followed to address the problem and to finally propose the "HESS" design, was established by going through some design thinking process tools combined with research analysis and pursuing a human-centered approach. The design process consisted of six main steps.

1. **Observation:** observation and fieldwork led to disclose that when stressed, individuals reach primarily for audio; music, nature sounds, then touch; massages and being held. ASMR is also proven to be effective.
2. **Literature review:** was carried out to study in great detail previous relevant studies and understand the problems in hand and the potential solutions for this study.
3. **Ideation:** this part consisted of the visualization and sketching of the product design and its potential usage scenarios as well as the outline of the concept.
4. **Prototyping:** Three main prototypes were developed in the different stages of this research.
5. **Testing:** the prototypes were tested multiple times in controlled environments to evaluate the effectiveness of the design.
6. **Qualitative data:** To understand users impressions and feelings, concerns and gain insight for the prototype design improvement. Interviews and surveys were carried out in the testing of the prototype.

3.4. Ethnography

To try and understand how young adults deal with stress on a daily basis, three fieldworks were conducted.

3.4.1 Fieldwork Research 1

This fieldwork was conducted in KMD University in Hiyoshi, throughout the day of November 12, 2018. The fieldwork master is a student in her second year of her Master's program. Anon is a Japanese female, 26 years old and living in Yokohama.

Anon looked tired as if she didn't sleep in days. She took the elevator to the 4th floor and looked for an isolated desk in the library. She prepares everything she needs, books, Pc, water and her student card and lays them on the desk. She was writing on her computer with short breaks from the computer to read one of the five books stacked on the desk. Three hours passed with no breaks. Suddenly, she holds her head because of a headache and reaches in her bag for her earphones. Anon is feeling stressed because of imminent deadlines. She plugs the earphones in her computer and looks for ASMR ambiance videos on youtube. Anon takes a deep breath, rolls her head and shakes her shoulders, then gets back to typing on her computer.

Time went by without her taking a break, she was focused and in the flow for two more hours. She gets up from her seat, sips water from her bottle, takes the student card and goes for a bathroom break. When she came back, she took a deep breath and held her hand on her heart. She was panicking and about to cry. She kept focusing her breathing and played an ASMR ear cupping video on youtube. It calmed her down. Minutes later, Anon was smiling from ear to ear because of the ASMR trigger. Her eyes got teary from the intense emotion. She was feeling calm now and got back to typing on her computer and reading the books.

Two hours later of listening to the first ASMR ambiance video played while studying, she checks her phone for messages as she was starting to feel lonely, cooped up in the library all day. No messages, she frowns and leaves the library to go to the convenience store on the 1st floor. She buys strawberry chocolate

bites. On her way back, she avoids the busy elevators in the hope of not running into other students. She checks her messages again, still nothing. She runs her hand in her hair then packs her things and left the university building. She didn't run into any of her classmates all day. This marked the end of my first fieldwork.

3.4.2 Fieldwork Research 2

This fieldwork is conducted in Japan, between Yokohama and Tokyo. On a Friday, November 2, 2018. I chose the train station to investigate how individuals react to stress outside of their comfort zones in public while commuting. I took the train from Hiyoshi station to Shibuya station back and forth.

Passengers looked tired after a day of work, salaryman (the Japanese office workers) and students were restless waiting for the train to come. Students in groups we're talking to each other or texting on the phone. Salary-man where fidgeting with their suitcases or we're holding their phones and checking social media. I focused my attention on a salaryman, standing Tall wearing a suit and a backpack. He was staring in the void waiting for the train. He checked his phone for the time then put it back in his pocket. He kept staring in the void moving his feet drawing on the floor. He kept adjusting his backpack while looking right and left checking the other passengers in the train station. The station got crowded, and he seemed a little bothered. He reached for the headphones in his bag and started listening to music. He was moving slightly from side to side while holding his backpack straps and tapping on them with his fingers. Well having the headphones on he didn't seem to bother anymore about the crowd.

Another passenger, an old man, was constantly checking the time as if he was running late. The speaker announced that the train was going to be late due to some problems. The young man didn't seem to bother. He was still listening to music. Whereas the old man looked stressed and anxious, walking back and forth. After a long wait, the train finally arrived. The old man found a seat in the elderly seating area. He kept his head down avoiding looking at other passengers until he reached his station and got out. Some of the passengers were checking their phones. Some were listening to music with their headphones on and some were reading. The rest were either fidgeting with their hands, holding their arms, playing with objects, making conversations or staring in the void.

The young man seemed to be really bothered by the crowd. He seemed to dislike being touched by strangers. He kept his headphones on and tried the focus on the scenery from the train window until he reached his station. This marked the end of my second fieldwork.

3.4.3 Fieldwork Research 3

The final fieldwork was an interview of 4 people, ages between 21 and 29 years old. Two men and two women. These interviews were conducted face to face and over Skype. Their stress level is quite high, challenging their mental well-being. Some are able to experience ASMR but are oblivious of the term.

Interviewee 1 : Male

The heavy workload of his university classes is stressing him. He is preparing to study abroad, and that is causing him anxiety and moments of panic. He overeats potato chips whenever he feels stressed and shared that it is not about the taste but more about the sound of the crunch that relaxes him. He suffers from insomnia. To help him sleep, he uses a neck pillow massager and listens to gentle nature sounds on his phone.

Interviewee 2 : Male

Domestic problems are wearing him out and causing him a lot of stress. Same goes for the daily commute on the Japanese rails. He feels stressed all the time and to manage it, he listens to calm music while commuting or studying. Social interactions and hugs or being touched also calms him. When he feels overwhelmed and about to cry, he cups his ears. It calms him down immediately and reminds him of the sounds of the ocean or when he used to be a kid and listens to the way a shell sounds.

Interviewee 3 : Female

Her lack of communication with her colleagues at work is causing her a great deal of stress. It started with feeling tension in the interaction at work and ended up isolated avoiding any contact other than a superficial greeting. To counter attack

the toxicity of that environment, she often goes to get manicures, a head spa at the hair salon and neck massages. She confirms feeling tingles that relax her whole body. Although she can experience ASMR, she doesn't know what it is.

Interviewee 4 : Female

Is experiencing extreme psychological stress and is diagnosed with depression. She tried everything. From every positive and negative coping system, right up until she builds immunity. Nowadays, she is investigating ASMR videos on youtube and already has her favorite ASMR artist; Gibi. ASMR relaxes her and keeps her focused while multitasking, she prefers certain types of ASMR triggers such as; ear cupping, hair brushing, mic brushing, etc. ASMR works for her.

3.4.4 Conclusion

In conclusion, throughout the three fieldwork conducted, it is possible to analyze and determine a few main key points that the potential users often mentioned: Many of them try to manage stress in open spaces by using headphones to block sounds and listens to their favorite soundtrack to take their mind off of the current situation that they find stressful. Music is then an instinctive go to, to get relief from stress. Other potential users, found solace in ASMR videos on YouTube. They help them relax, sleep or focus on tasks in hand. Touch is important. Stressed individuals seemed to relax by touching objects tapping on them or by holding their limbs and gently caressing them. Touch and the use of Audio seemed to help them reach a certain level of emotional stability. Furthermore, the final fieldwork, an interview of four individuals, confirmed that ASMR audio-haptic cross-modality is a fine concept to build on a "HESS" the wearable device and explore the psychological and physiological effects and benefits on the user.

3.5. Target Persona

3.5.1 Target Persona 1

Luna Lumiere is 24 years old female university student, (Figure 3.2) dealing with chronic stress and health history of depressive and anxious episodes. Stress



Figure 3.2 Target Persona 1 — Luna Lumiere

warned her out. The symptoms became uncontrollable. She smokes right up until her health takes its toll, then she quits cold turkey. She cares about her health, and she tries to go to the gym when possible. She tried meditation but it was too hard to implement in her busy day to day routine. She likes exploring new ways to help her manage stress, like getting massages and head spa at the hair salon. She also listens to the ocean, rain and fire sound to calm herself. She also brushes her hair often and draws with pencils and charcoal on paper that is how she discovered ASMR. All these sounds calm her and help her relax. Due to the pressure of daily socializing and demanding student life, she finds herself preferring social isolation for lack of a better way to manage stress in public.

Goal: is to have a better ASMR experience to manage insomnia, stress and its symptoms before they worsen.

3.5.2 Target Persona 2

Alex Vegetal is 29 years old male university student, (Figure 3.3). He has a part-time job in a convenience store at night and is living a very busy life trying to manage school work and a few hours of sleep. He studies abroad and doesn't speak the language. Which creates very stressful situations for him, like when he gets lost on the train or doesn't understand what the conductor says and stresses about missing his stop. He does not like commuting in Japan, it causes him a great



Figure 3.3 Target Persona 2 — Alex Vegetal

deal of stress, daily. He also experiences stress, whenever he has a presentation or a meeting with his professors and has to deliver it in the foreign language that he just started dabbling in. He deals with a lot of psychological turmoil and just started to notice his weight fluctuating. The way he deals with all that toxic stress is by listening to music and giving himself head and neck massages. He also enjoys talking to his girlfriend on the phone, especially when she whispers to him.

Goal: is to achieve the relaxation and self-awareness state without putting much time or effort trying. He wants a convenient proactive coping solution for stressful situations on the go.

3.6. User Scenario

Four user scenarios were created to describe the way and occasions of usage, and types of interaction of "HESS".

3.6.1 In the Intimacy of your Home while Doing Tasks

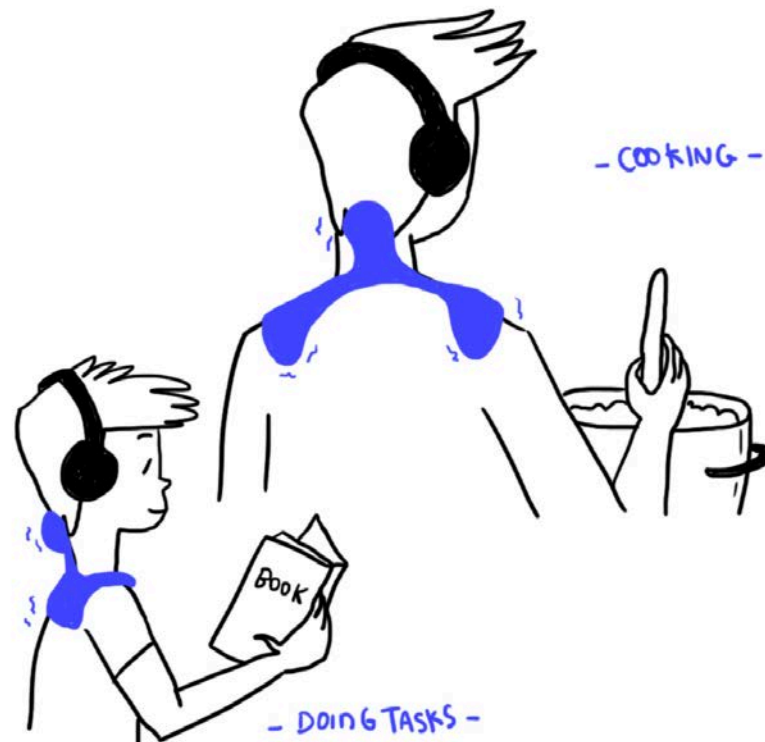


Figure 3.4 User Scenario 1 — at home

In the first scenario (Figure 3.4), the user uses "HESS" in the intimacy of their home. The ASMR audio track and the gentle vibration haptic feedback helps them relax and focus on the tasks in hand. The user can sit and move freely with wearable "HESS" and wireless headphones or earbuds on.

3.6.2 Before Going to Bed



Figure 3.5 User Scenario 2 — Before sleeping

In the second scenario (Figure 3.5), the user uses "HESS" before going to bed. The ASMR audio track and the gentle vibration haptic feedback helps them relax and fall asleep. The user can sit or lay down on their belly with wearable "HESS" and wireless headphones or earbuds on.

3.6.3 During Work or During a Break



Figure 3.6 User Scenario 3 — Break

In the third scenario (Figure 3.6), the user uses "HESS" during work or during a break. The ASMR audio track and the gentle vibration haptic feedback helps them relax and manage the stress created by expectations and heavy daily workload and social interactions. The user can sit and move freely with wearable "HESS" and wireless headphones or earbuds on.

3.6.4 On the Commute

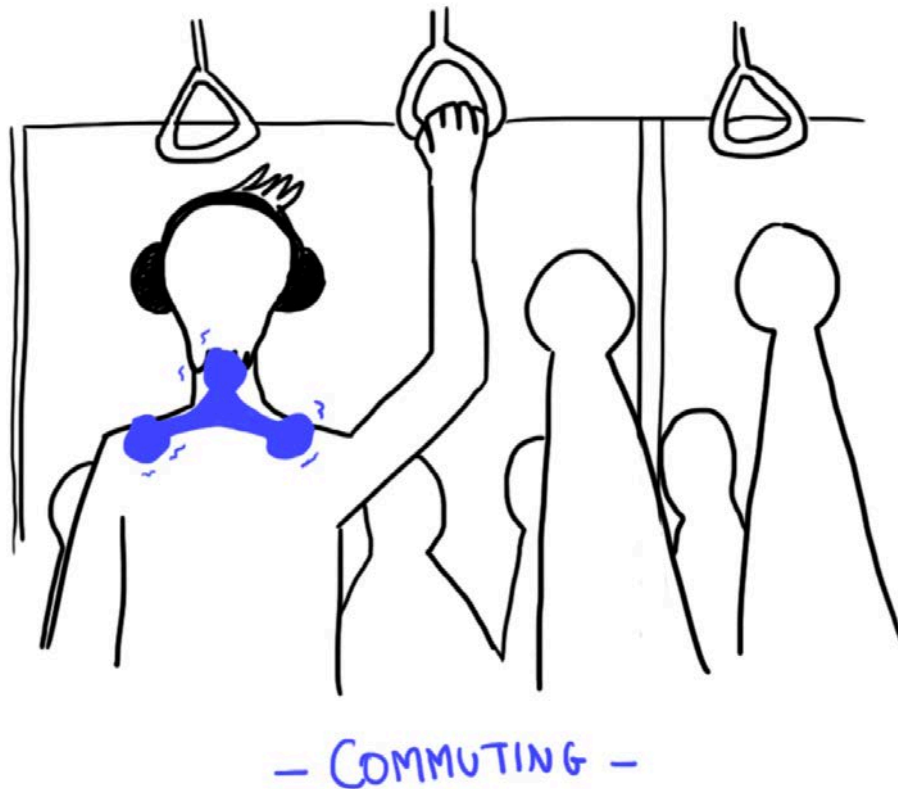


Figure 3.7 User Scenario 4 — On the commute

In the fourth scenario (Figure 3.7), the user uses "HESS" on the commute. The ASMR audio track and the gentle vibration haptic feedback helps them relax and shift their focus to the sensory experience instead of the outside public disturbance. The user can sit and move freely with wearable "HESS" and wireless headphones or earbuds on.

3.7. Design Elements

”HESS” requires the following essential conditions for the final design;

3.7.1 ASMR Audio

The ASMR Audio Library

The ASMR audio library created contains 10 ASMR triggers, chosen from 16 stimuli known to elicit tingles in the ASMR population based on the ASMR Checklist [1, 27], and an examination of social media reports on internet sites such as reddit/ASMR and YouTube. **The List of ASMR triggers chosen:** Whispering - Fizzy drinks - drawing with pencil and charcoal - crunch - box and lid - soft brushing - paper sounds - ear cupping - ear cleaning - hair brushing.

The Recording Equipment

ASMR sounds should be up close and personal, recorded mainly using binaural microphones. For this study, a 3D ambisonics audio recorder, the H3-VR Zoom, was used for the creation of the ASMR audio library. The H3-VR Zoom recorder, (Figure 3.8), has a Binaural recording mode. The pieces of equipment used for the recording are shown below, (Figure 3.9).

Composing the Audio Track

I created a binaural ASMR sound library to design the audio track of 8 minutes, (Figure 3.10), using adobe audition software. Some sounds were not binaural to create contrast for the listener. Some thought was put in the audio track design, there is an illusion of an audio story.



Figure 3.8 the 3D audio recorder

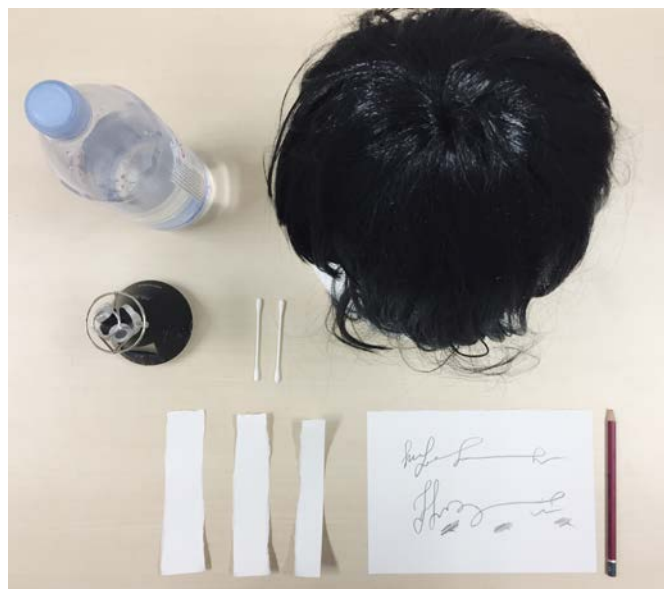


Figure 3.9 the equipments used for recording the ASMR triggers



Figure 3.10 Composing the audio track with Adobe audition

3.7.2 Haptic Feedback

The "HESS" wearable device provides the user with synchronized vibration to the ASMR audio track and is implemented by using an amplifying kit based on study [62]. The amplifying kit receives the audio signal of the ASMR audio track and vibration movement pattern from the computer then sends the vibration output to three connected Vibro-transducer Vp2 Series. Simultaneously, the ASMR audio track is sent to a headphone output channel. The vibration output is achieved by shifting the frequency of the ASMR audio track in the range of 50Hz by using freqshift function in a visual programming language for music, Max/Msp, (Figure 3.11).

A smooth tactile stroke is created that moves across the 3 Vibro-transducers in a loop. This effect is achieved by using the nodes function in Max/Msp. The movement pattern of the vibration, (Figure 3.12), starts from node 1, the neck area, then fades away and splits down to both node 2 and 3, the shoulders area. There is a delay of around 15 seconds before it splits down and 10 seconds before it loops back. Not all the sounds have haptic feedback and not all the vibrations have the same strength. That choice was made to create a variation in the tactile feeling and accentuate the contrast and to prevent the users from losing sensitivity due to persistence vibration.



Figure 3.11 Haptic feedback — Max/Msp software

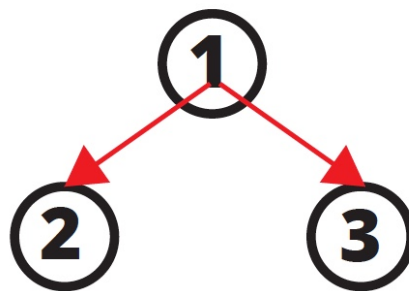


Figure 3.12 Haptic feedback movement pattern

3.7.3 Wearable Haptic Device

The haptic device of "HESS" system is wearable on the upper region of the back. With close contact to the nape of the neck and shoulder blades. The choice of the wearable haptic device is based on two reasons;

1. the nape of the neck and the shoulders zone is the area where the ASMR phenomenon happens, where the tingles are felt; starting from the head going down to the limbs and spine.
2. The acupuncture points in the shoulder Region: **Shoulder Well**- This point is located on the shoulder muscle, halfway between the base of the neck and the end of the shoulder muscle. And in the neck Region: **Heaven's Pillar**- This point is located on the occipital ridge, just at the side of where the spine enters the skull in the tendon. Stimulating this point helps in relieving stress and tension and unhindered flow of energy.

The design process of the device will be dealt with in details next, in the Ideation of the wearable haptic device section.

3.8. Ideation of the Wearable Haptic Device

3.8.1 First Sketches

The first sketches represent the overall idea behind the design of "HESS" and the turn around of the haptic device.



Figure 3.13 Back view of "HESS"

The back view shows the "HESS" system, (Figure 3.13); a haptic device wearable on the nape of neck and shoulders with four main parts that deliver the

vibration haptic feedback. To be used with either wireless headphones or earbuds.



Figure 3.14 Side view of "HESS"

The side view shows the "HESS" system, (Figure 3.14); a haptic device wearable on the nape of neck and shoulders that deliver the vibration haptic feedback, and how it would stand on the body of the user with a hook-like design. To be used with either wireless headphones or earbuds.

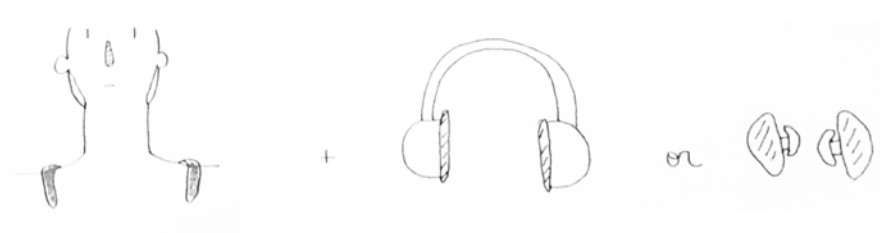


Figure 3.15 Front view of "HESS"

The front view shows the "HESS" system, (Figure 3.15); a haptic device wearable on the shoulders that deliver the vibration haptic feedback, and how it looks like from up front and would stand on the body of the user with a hook-like design. To be used with either wireless headphones or earbuds.

3.8.2 First Prototype

The first prototype was made to test the concept behind the audio-haptic cross-modality of "HESS". This initial prototype is made of 3 components; the wearable

haptic device; a collar, the haptic feedback and the ASMR audio. The audio composed is 8 minutes long ASMR sounds.

The prototype's system,(Figure 3.16), is made out of 3 vibro-transducers Vp2, 2 amplifying kits (Techtile toolkit), 2 USB cords, noise isolation earbuds (NuForce BE Free8) and straps to attach the two vibro-transducers to the body and one vibro-transducers to the neck with a collar. The haptic feedback output, the vibration movement pattern, was achieved by a visual programming language for music, Max/Msp and a computer running Max/Msp.

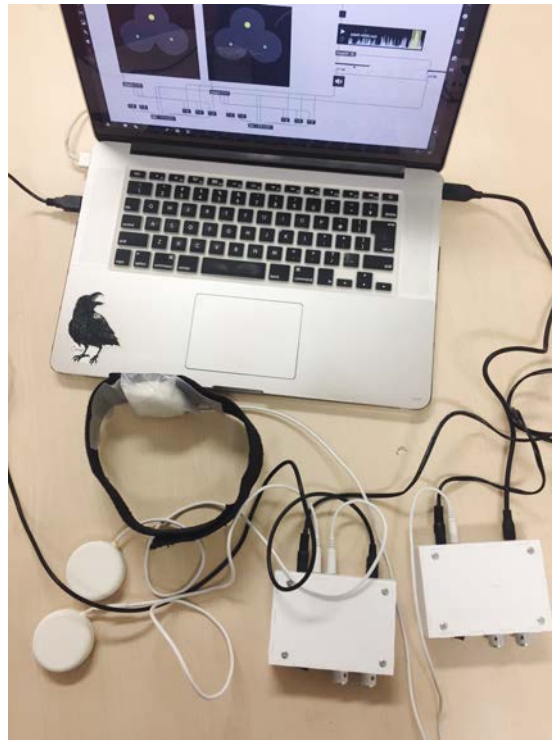


Figure 3.16 First prototype — System

This prototype was tested to verify and understand these main points;

1. The way the vibro-transducers feel on the upper back.
2. The best location for the vibro-transducers on the upper back, considering the acupuncture points.
3. The kind of sensation the vibro-transducers provide to the user.

4. The adequate frequency to use for the vibro-transducers.
5. The user's impression and review of the "HESS" experience.

User understanding

The rough prototype was tested on five users, all female. I didn't explain what to expect before implementing "HESS". I just helped them set up the prototype and asked them to sit and listen, while I sat next to them around a table. The prototype was implemented on top of clothes, (Figure 3.17) and in direct contact with the skin, (Figure 3.18).

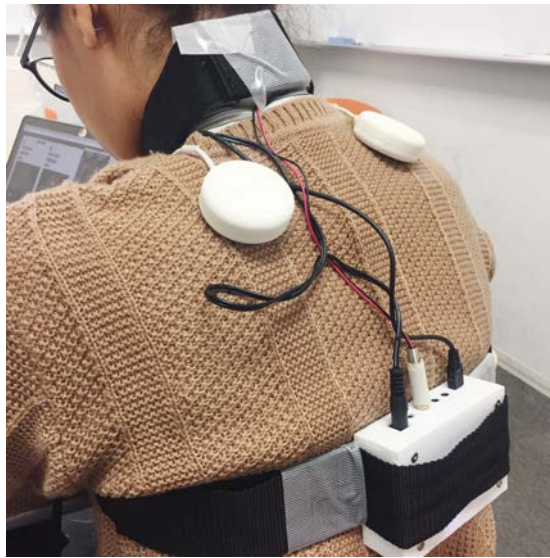


Figure 3.17 First prototype — on top of the clothes

The results: "HESS" was described as, interesting, novel, fun, entertaining, enjoyable, relaxant, immersive, bewitching. The experience was found to enhance the ASMR phenomenon and induce tingles. The audio-haptic cross-modality established a pleasant and relaxant sensation, that made some of the users live the scenario and experience it first hand as the main character.

The positions of the vibro-transducers had positive feedback as well as the synchronized vibration and the ASMR audio track. The user's reviews were in favor of the concept.

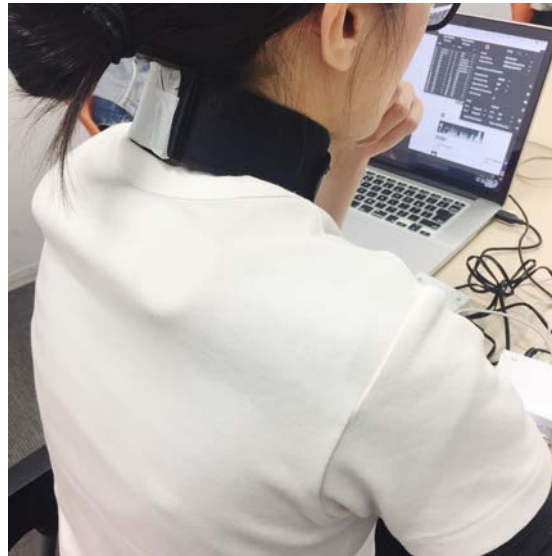


Figure 3.18 First prototype — direct contact with the skin

As for the next user studies, it should be taken into consideration that the experience might be new to the users and that they will not know what to expect. Before introducing "HESS", I need to explain to the users that, ASMR audio and harmless vibrations are to be expected. The participants' reviews are described next;

Participant 1: Can experience ASMR. *"I came here sleepy and tired. Now I feel like I am floating. If one day I lose my sight, this is what I want to have. This is how I will feel like seeing again."*- P1.

The overall experience was found to be immersive, emotional and bewitching. The haptic feedback is perfectly in sync with the audio. Which created an immersive experience. The water sounds made the user feel submerged by water. Feeling the sound on the body was an amazing and enriching experience that leaves you wanting more. The wearable collar on the neck was reviewed to be very relaxant, and the vibration was expected to be uncomfortable but was found to be beneficial and stimulating. The neck vibro-transducer was preferred over the ones on the shoulders. The ASMR audio and the haptic feedback made the user live the scenario and experience it first hand as the main character. The strong vibration felt good. The user experienced an enhanced ASMR experience with strong tingles starting in the head and going down and around to cover their

whole body.

Participant 2: Can experience ASMR and is familiar with haptic feedback. *"This experience is new for me. I like the ASMR audio. The vibration enhanced the ASMR experience. I don't feel the disconnection between the sound and the vibration."*- P2.

The overall experience was found to be new, interesting and pleasant. The haptic feedback, there is no disconnection felt between the haptic feedback and the audio. The ASMR audio was interesting, the woman whispering was the best part, but the water was found to be too high pitched, although its haptic feedback was pleasant. As for the placement of the vibro-transducers, it was preferred to have the prototype directly on the skin to better feel the vibration with no barriers.

Participant 3: Can experience ASMR. *"This is more interesting than ASMR videos on YouTube. I can feel the sounds in my body and the tingles were intense. But some of the vibrations startled me, I was not expecting them to be that strong."*- P3.

The overall experience was found to be interesting, fun and entertaining. The haptic feedback was pleasant and felt nice. The placement of the vibro-transducers didn't cause any comments, and the perceived emotional state was joy and excitement. The ASMR audio was interesting, and the synchronized vibration made the experience feel immersive and added layers in the perceived story behind the audio.

Participant 4: Can not experience ASMR. *"Felt like a horror movie, I was the main character and someone was after me, trying to eat me. It felt scary. I felt like in a 4D cinema. It could be a good experience if the vibration were more gentle."*- P4.

The overall experience was too novel, hard to grasp and scary. The user felt apprehensive of it and threatened by the audio and the vibration and the possibility of its effect on the body and health. The user was taken to a dark place in their imagination while trying hard to make sense of the experience. The haptic feedback was judged to be perfectly matching the sounds, which was nice. The user expressed feeling not ready for such experience and not being able to go through it, perceived as too much to be processed. The immersion was too much to handle.

Participant 5: Can experience ASMR. *"Very interesting and the vibration felt good on my body, especially neck. It was as if I was on a slow swing or a wave, rocked to sweet calmness. I felt the tingles going from my head to my spine. I want to do it again every day with short breaks in between to enjoy it all over again."*- P5.

The overall experience was perceived as very enjoyable and extremely interesting. The ASMR experience felt amazing. The user felt strong tingles all over her back starting from the head down. The contrast in soft vibration and strong vibration was strong and interferes with the state of relaxation established. The experience felt good, and the user showed strong enthusiasm in doing it again.

3.8.3 Second Sketches

Based on both of the initial sketches and the user understanding, I refined the design both the inner parts and the outside shape, (Figure 3.19). The dimensions are roughly shown in the sketches as a first step for the 3D modeling and printing; (Figure 3.20), (Figure 3.21), (Figure 3.22).

3.8.4 Second Prototype

The second "HESS" prototype, (Figure 3.25), is made of 3 components; the haptic feedback, the ASMR audio and the wearable haptic device; modeled using Maya and then 3D printed, the material is PLA. The artifact is composed of 6 parts; 3 boxes for the vibro-transducers, (Figure 3.23), the body and 2 hooks, (Figure 3.24). The 6 parts can be easily assembled and disassembled before and after use. The audio composed is 8 minutes long ASMR sounds.

The prototype's system, (Figure 3.26), is made out of 3 vibro-transducers (Acouve Laboratory Vp2), 2 amplifying kits (Techtile toolkit), 2 USB cords and noise isolation earbuds (NuForce BE Free8). The haptic feedback output, the vibration movement pattern, was achieved by a visual programming language for music, Max/Msp and a computer running Max/Msp.

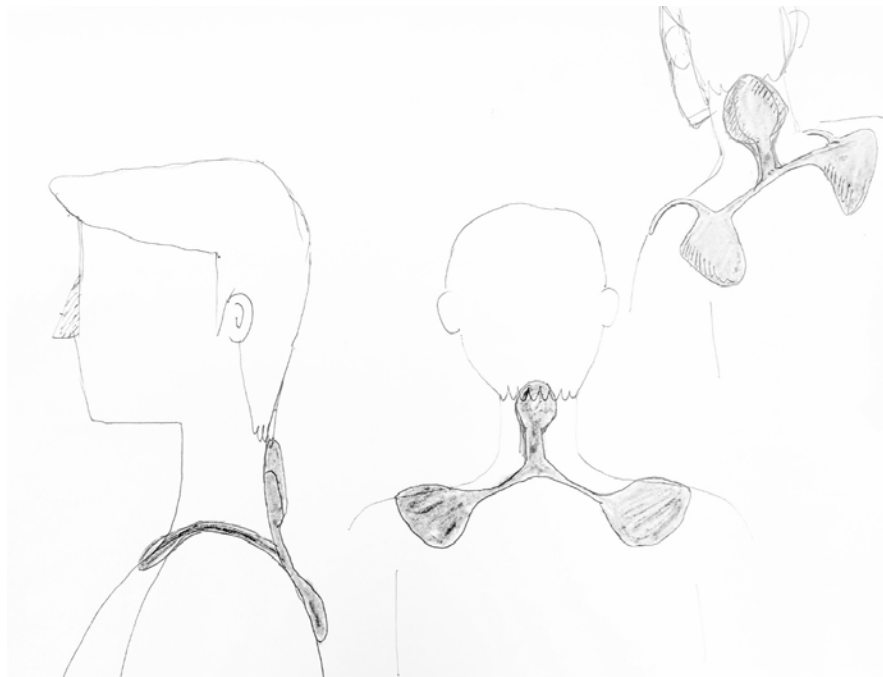


Figure 3.19 Final sketch of the "HESS" prototype

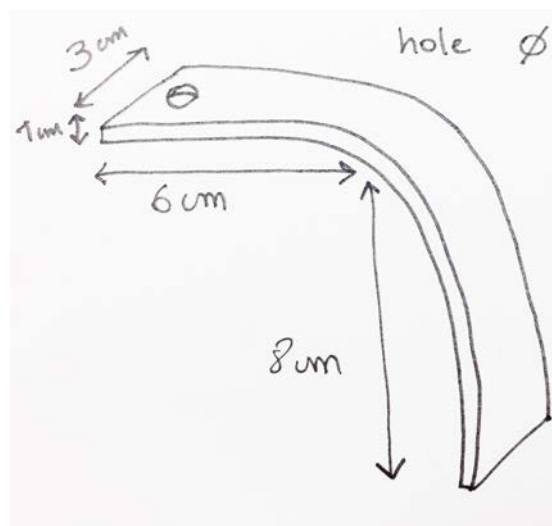


Figure 3.20 Final sketch of the "HESS" prototype (the shoulders hooks)

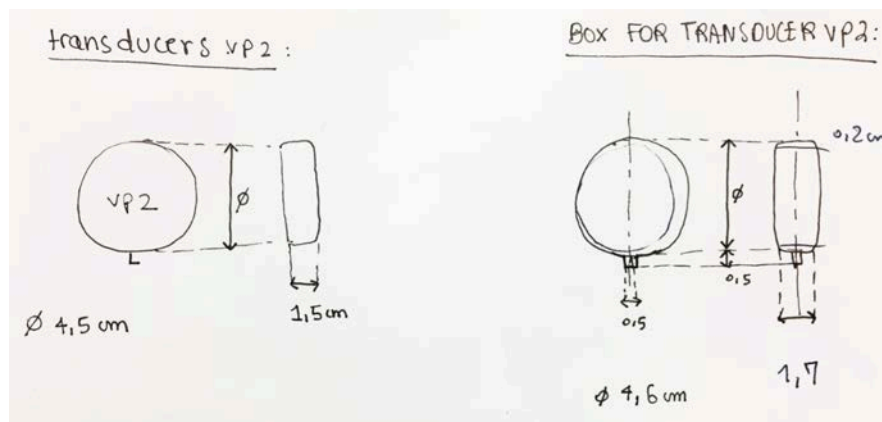


Figure 3.21 Final sketch of the "HESS" prototype (the transducers' containers)

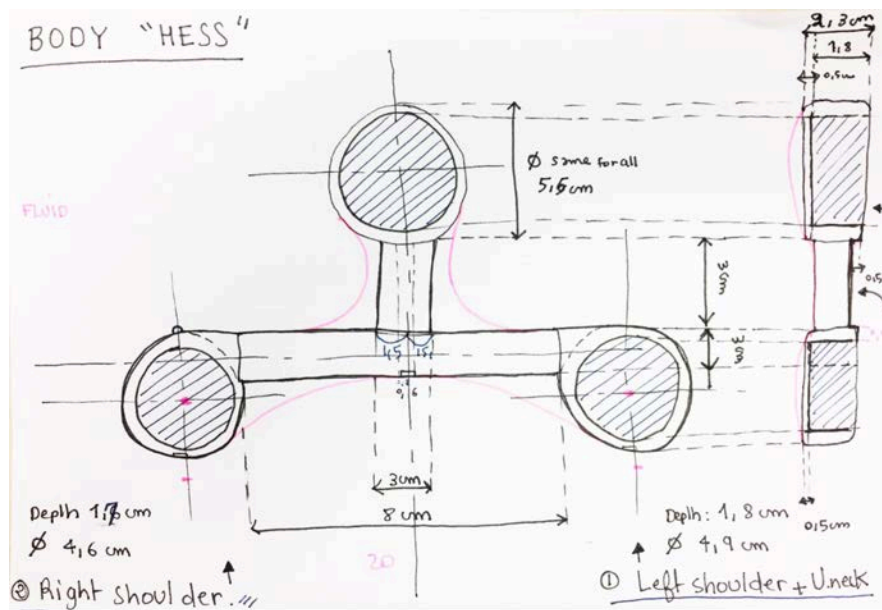


Figure 3.22 Final sketch of the "HESS" prototype (the body)

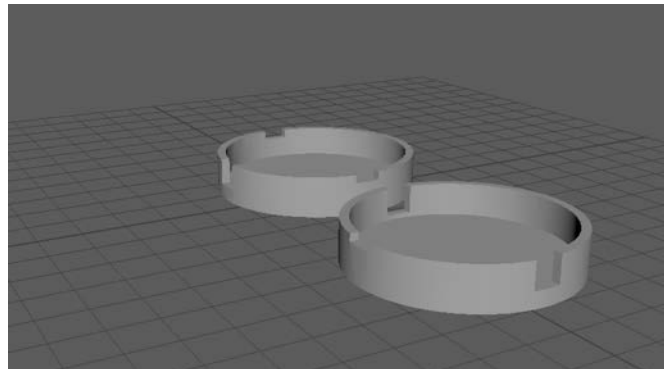


Figure 3.23 3D modeling — second prototype components

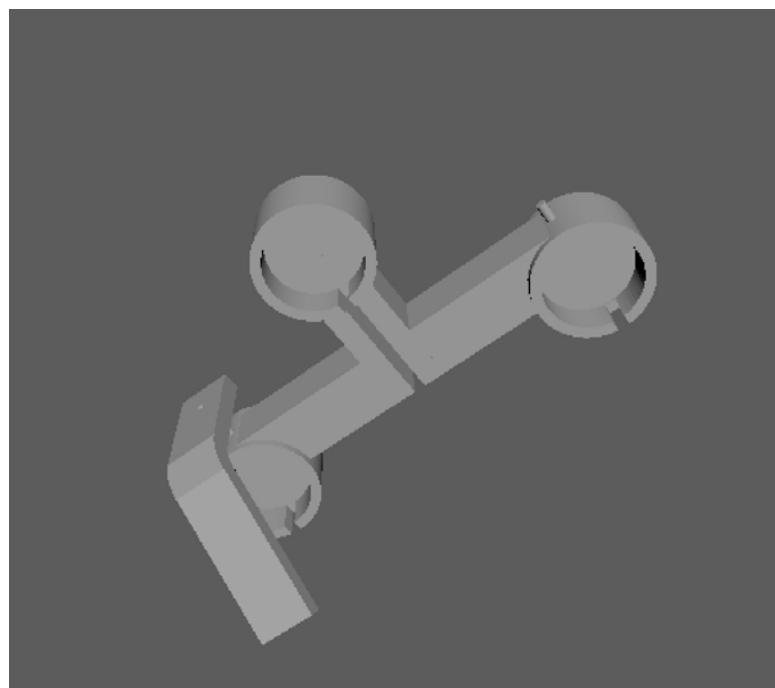


Figure 3.24 3D modeling — second prototype components



Figure 3.25 Frist and Second prototype — System

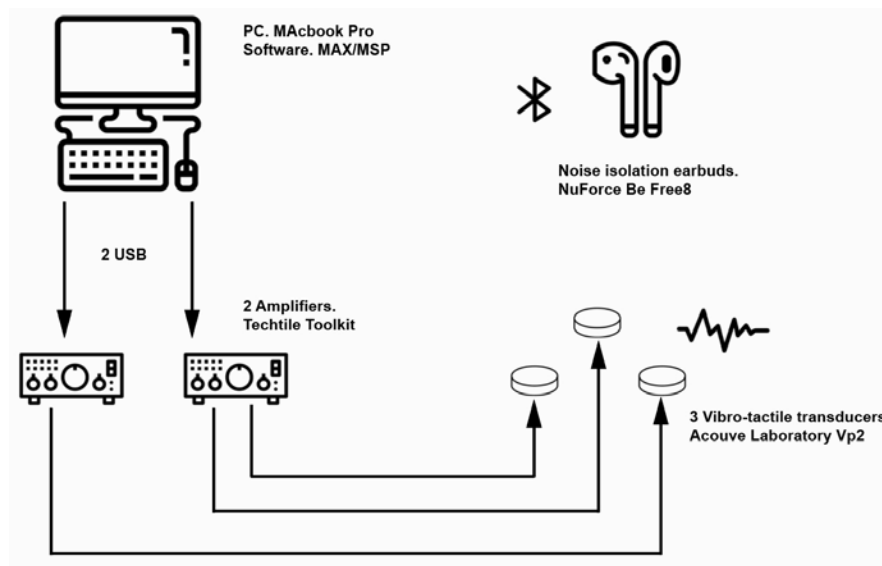


Figure 3.26 System overview of "HESS"

3.9. Design Summary

In this chapter, first, the concept behind "HESS" was defined. Ethnographic research helped shape and underline the needs of target users. Then, the design process and the making of the prototypes was conducted. In summary, "HESS" was designed to cater to users dealing with stress and in the search of new sensory experiences that lead to mental well-being.

The user engages with the "HESS" system by wearing the haptic device on their shoulders and putting on headphones or earbuds. Expected experiences are;

- Listening to the ASMR audio track.
- Feeling the synchronized vibration haptic feedback on the upper region of the back.
- ASMR triggered tingles.

Through the implementation of "HESS" users can expect the following results:

- Stress recovery.
- Establishment of relaxation and calmness.
- Enhanced ASMR sensory experience.
- Self-awareness.

The next chapter holds the experiments and evaluation results of the prototype.

Chapter 4

Evaluation

”HESS” is a system that aims at providing an immersive sensory experience that allows the users to feel the ASMR audio triggers in their body to relax. ”HESS” consists of a binaural ASMR audio track and a wearable device that provides haptic feedback in the form of synchronized vibration. Users wear either wireless headphones or earbuds on, for fewer restraints and more mobility.

”HESS” aims at recreating and enhancing the ASMR experience and is to be used in various case scenarios, in other words, whenever the individual feels stressed, anxious, unable to focus or sleep, and is looking forward to experience a moment of calmness and relaxation. ”HESS” fulfills the goals of this study by;

1. Exploring the emotional response of the ASMR audio-haptic feedback cross-modality.
2. Exploring the ASMR phenomenon and the feasibility of enhancing the feeling of the ASMR audio in the body for ASMR users and non-ASMR users.
3. Applying accumulative research of physiological responses to stress and stress coping behaviors.
4. Exploring the feasibility of ASMR audio-haptic feedback cross-modality for stress management.

Users who experience the ”HESS” system are expected to feel an improvement in their emotional state in other words, feel calmer and less stressed and therefore respond positively. It should also correlate directly with heart rate (HR) data supporting their psychological response. The experiment was conducted at the Keio University Graduate School of Media Design under controlled conditions in a research lab environment with permission granted from all participants.

4.1. Participants

The participants recruited for the study are masters students from Keio University Graduate School of Media Design (KMD), (N=20; M=7; ages between 22 and 30). Notably, only (8/20) participants reported experiencing the ASMR phenomenon. When it comes to stress coping mechanisms, the majority of the participants (15/20) preferred to listen to music. Others reported various other behaviors.

4.2. Methodology

To test the feasibility of ASMR audio-haptic feedback cross-modality for stress management and ASMR experience enhancement, two experiments were designed; **Cross-modality study** and **ASMR audio only study**. The cross-modality study is the user testing of the "HESS" prototype experience. It is focused on the testing of the ASMR audio-haptic cross-modality and its effects on the user. Whereas, the ASMR audio only study is designed to test the ASMR audio listening experience and its effects on the user. Both studies have been counterbalanced using Latin square. Every participant will test both studies with an alternation of the studies' order for every next participant. Surveys and scale tests were conducted before and after each study. As well as a post testing interview to assess their affect change with and without "HESS".

It is important to hide the real goal of the experiment from the participants. By doing so, the participants could naturally behave and respond to every design factors of the experiment similarly to their own behaviors. Conducting the user study without participant's awareness, as with any non-universal phenomenon, will avoid the possibility that the findings (particularly those related to tingle frequency and affective states) reflect a demand characteristic or expectation effect. Therefore, at the beginning of the experiment, the participants were deceived to believe that the user study examines and evaluates the ASMR audio track and the haptic feedback wearable device. The real goal of the experiment was revealed at the end. Which is to examine the participant's physiological and psychological signals as a response to "HESS". Nonetheless, participants were informed to

expect ASMR sounds and harmless vibration.

4.2.1 Data Collection

To have a solid understanding of the evaluation and analysis methods to assess the physiological and psychological responses instigated during the user study by "HESS", these materials were used; Depression Anxiety Stress Scales(DASS-21), the self-assessment manikin (SAM), self-created surveys to gather demographic data, perceived current stress levels, ASMR related knowledge and post experimentation interview.

For the artifact design evaluation, participants will complete the UX evaluation survey, and the Heart rate (HR) physiological signal data will be collected. The materials will be presented below;

Pre Testing

The survey included demographic questions and inquiry about ASMR knowledge, as well as a 1point-5point scale for assessing stress level and current mental and physical conditions.

Physiological data collection

For the experiment, the apple watch series 3 was used to collect physiological signals data of the Heart rate (HR) for mental stress monitoring.

Psychological Data Analysis

The DASS-21 and the self-assessment manikin (SAM) scale will be used to measure emotion.

- **Depression Anxiety Stress Scale (DASS)**, a psychometric stress Scale Self-evaluation, the assessment will be conducted as part of the "HESS" evaluation for measuring participant's psychological state changes. The DASS is a 42-item self-administered questionnaire designed to measure the magnitude of three negative emotional states: depression, anxiety, and stress.

The Depression part focuses on reports of low mood, motivation, and self-esteem, the Anxiety part, focuses on physiological arousal, perceived panic, and fear, and the Stress part, focuses on tension and irritability. Previous research refers to The DASS as having few limitations. But Instead of using the 42-item questionnaire, DASS-42, designed for clinical sampling, "HESS" used the 21-item questionnaire, DASS-21, for non-clinical sampling. Previous research tested the construct validity of the DASS-21 and showed that it possesses adequate construct validity. Furthermore, the advantage of using DASS-21 instead of the DASS-42 is that it is shorter and takes less time to take and possesses adequate reliability [63, 64].

- **The self-assessment manikin (SAM)**, is a non-verbal 5 point scale pictorial assessment technique that directly measures three features that have been identified as central to emotion; valence/pleasure of the response (from positive to negative), perceived arousal (from high to low levels), and perceptions of dominance/control (from low to high levels) associated with a person 's affective reaction to a wide variety of stimuli [65].

Post Testing

- The survey included a 1point-5point scale for assessing stress level and current mental and physical conditions.
- **Heart metrics survey to measure the user experience (UX)**, it is an approach to define user experience measures for a system, product, or feature, originally developed by Google [66]. HEART: **H**appiness, **E**ngagement, **A**doption, **R**etention, and **T**ask success. These are categories, from which teams can then define the specific metrics that they will use to track progress towards goals. The Happiness and Task Success categories are generalized from existing user experience metrics: Happiness incorporates satisfaction, and Task Success incorporates both effectiveness and efficiency. Engagement, Adoption, and Retention are new categories, made possible by large-scale behavioral data.
- **Post experimentation Interview**, the questions and its highlights can be found in the appendix section of the thesis.

4.3. Experiment Setting

"HESS" was tested in a controlled environment within an isolated room to reduce the number of error variables, the users were seated at a table, (Figure 4.2). The experiment was conducted at the Keio University Graduate School of Media Design with permission granted from all participants. Lighting, room temperature and positioning of the furniture were maintained at similar levels throughout the tests. The room consisted of the following items; single meeting table, the "HESS" prototype, one personal computer for recording data and running software, the Apple watch series 3 as the heart rate monitor, surveys and chairs for the administrator and the participants, (Figure 4.1). HR data was monitored in real time. In total, 4 variables were measured: (1) heart rate (apple watch series 3), (2) emotional response (SAM), (3) the psychometric measures of psychological functioning (DASS-21), (4) UX review (HEART Metrics survey).

The designed experiments aimed to assess and evaluate:

1. The usability of "HESS" prototype in managing stress and providing calmness.
2. Whether or not "HESS" prototype was a source of distraction and or arousal.
3. The physiological changes after the utilization of "HESS" prototype.
4. Whether or not the participant found the experience positive and beneficial.
5. Whether or not "HESS" prototype induced the ASMR tingles.
6. The overall user experience of "HESS".



Figure 4.1 Pre-user testing setup

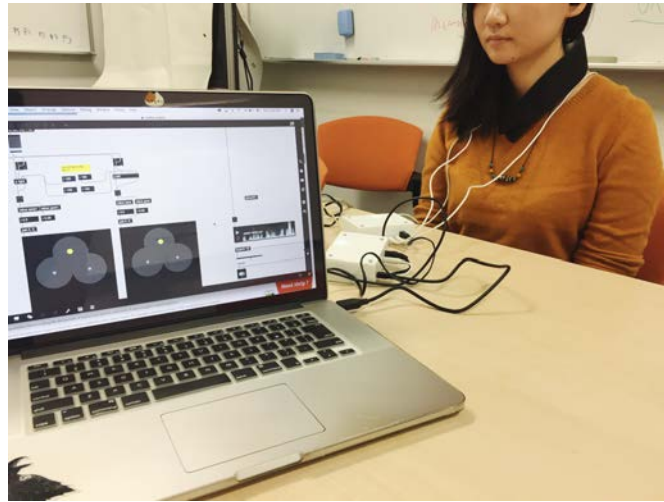
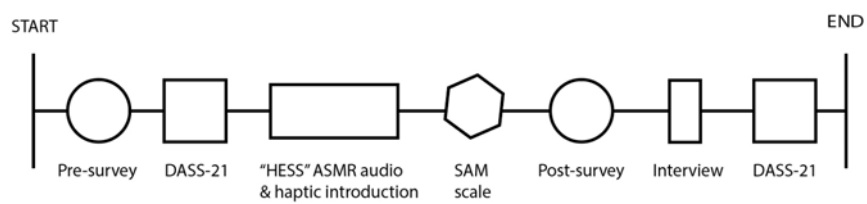


Figure 4.2 User testing — Cross-modality Study

4.3.1 Experiment Flow

Cross-Modality Study



Audio only Study

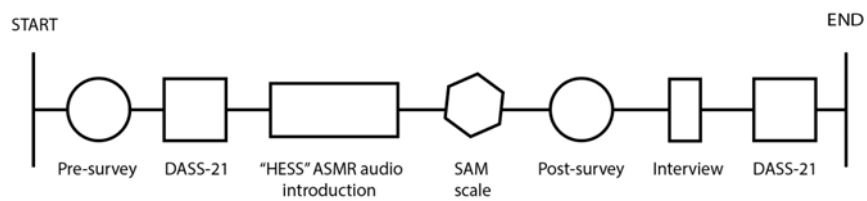


Figure 4.3 Experiment Flow

4.3.2 "HESS" Feasibility Study

The participants were brought to the study room individually. They were asked to wear the heart rate monitor, (apple watch series 3), on their left hand. They were given a brief explanation of the procedure of the user study and what to expect from the experiment (ASMR audio track or vibration on their neck and shoulders). Once their baseline heart rate was calculated, (Table ??), the testing starts. The first part of the user testing is the cross-modality study by implementing the "HESS" prototype. After 8 minutes the cross-modality study was over, and the participant's end heart rate was collected. Then they were asked to fill out the post-testing survey, the SAM scale, and the DASS-21. When done, they got interviewed and then took a break. Later, the second part of the user study started, participants' baseline heart rate has been calculated, (Table ??) shows the accumulated baseline heart rate), the audio only study started by implementing the ASMR audio track. After 8 minutes, the cross-modality study was over and the participant's heart rate was collected. They were then asked to fill out the post-testing survey, the SAM scale, and the DASS-21. When done, they got interviewed about the following topics:

- The way they feel after experiencing ASMR with and without "HESS"
- Experiencing ASMR (tingles) with and without "HESS"
- The "HESS" experience review
- The psychological and physiological state after "HESS"
- The cognitive state after experiencing ASMR with and without "HESS"
- Comparing the ASMR experience with and without "HESS"
- Prototype related preferences and alterations

Participant	Baseline Heart Rate
P1	85
P2	96
P3	78
P4	100
P5	80
P6	91
P7	64
P8	51
P9	60
P10	74
P11	65
P12	67
P13	69
P14	89
P15	73
P16	88
P17	83
P18	97
P19	93
P20	77

Table 4.1 Baseline Heart Rate — Cross-modality study

Participant	Baseline Heart Rate
P1	81
P2	69
P3	78
P4	113
P5	78
P6	92
P7	98
P8	61
P9	79
P10	79
P11	67
P12	68
P13	61
P14	77
P15	76
P16	71
P17	97
P18	79
P19	101
P20	74

Table 4.2 Baseline Heart Rate — ASMR audio only study

4.3.3 "HESS" Feasibility Study Results

Two studies were designed and tested on 20 users to test the feasibility of ASMR audio-haptic feedback cross-modality for stress management and ASMR phenomenon enhancement. **Cross-modality study** and **ASMR audio only study**.

The Depression Anxiety Stress Scale Results

(DASS) is a psychometric stress scale for self-evaluation results. The Table 4.3 shows the average difference decrease between the before and after average [Depression, Anxiety, Stress] scores of the ASMR experience without "HESS". The Table 4.4 shows the average difference decrease between the before and after average [Depression, Anxiety, Stress] scores of the ASMR experience with "HESS". The Table ?? is for the average difference decrease comparison score between both ASMR experiences, with and without "HESS". Also, (Figure 4.4) showing before and after the study results and their average difference decrease comparison score.

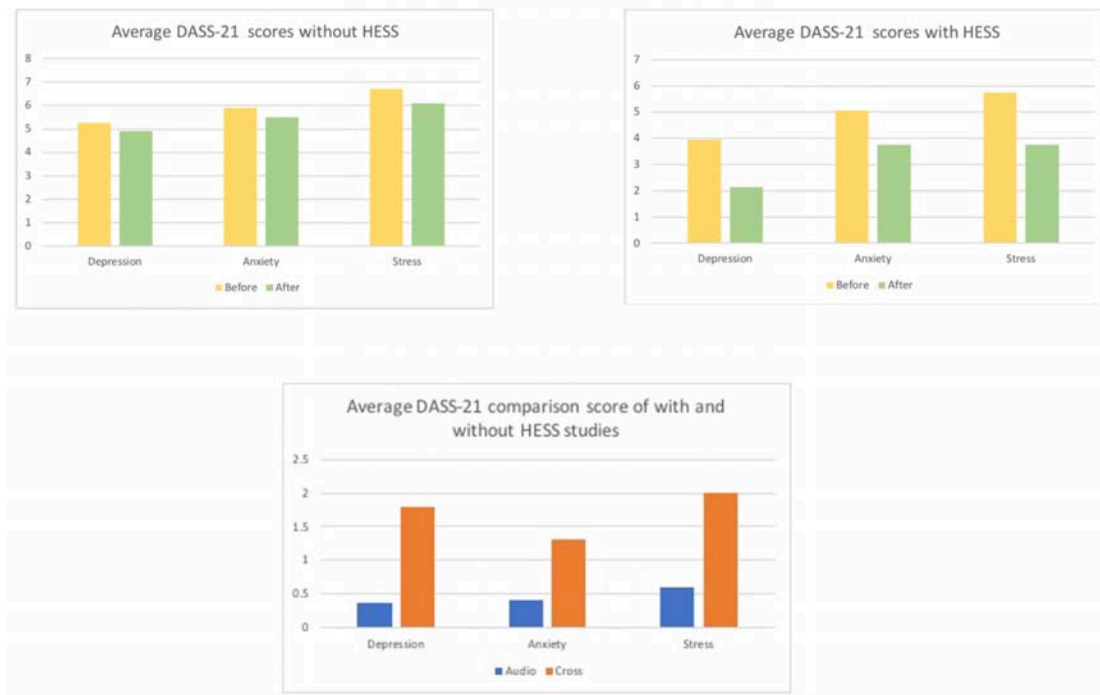


Figure 4.4 DASS-21 results with and without "HESS"

	Depression	Anxiety	Stress
Before	5.25	5.9	6.7
After	4.9	5.5	6.1

Table 4.3 Average ASMR Audio only influenced scores — DASS-21

	Depression	Anxiety	Stress
Before	3.95	5.05	5.75
After	2.15	3.75	3.75

Table 4.4 Average "HESS" influenced scores — DASS-21

Study	Average of the decreased score		
	Depression	Anxiety	Stress
ASMR Audio	0.35	0.4	0.6
HESS	1.8	1.3	2

Table 4.5 DASS-21 Average of the decreased difference score

The physiological signals of stress **Heart Rate**

To explore the physiological signals of stress, the heart rate (**HR**) was collected before and after both studies of the ASMR experience with and without "HESS" (ASMR audio only), See (Table 4.6) for the Heart Rate average comparison scores of the ASMR experiences with and without "HESS" and (Figure 4.5).

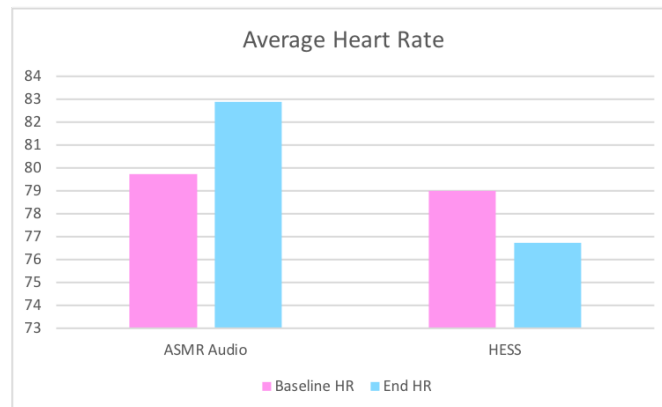


Figure 4.5 Heart Rate average comparison scores with and without "HESS"

Study	Average HR	
	Baseline HR	End HR
ASMR Audio	79.75	82.9
HESS	79	76.75

Table 4.6 Heart Rate average decrease difference scores

Induced Emotion Assessment

The study investigates the users' affective reaction to the ASMR experience with and without "HESS" using **the self-assessment manikin (SAM)**. It is an assessment technique that directly measures three features that have been identified as central to emotion. For the study of the ASMR experience results will focus on the two first features; valence/pleasure of the response (from positive (1) to negative (5)), perceived arousal (from high (5) to low levels (1)). **Valence/pleasure** for an insight on the user's feeling triggered by the experience and **perceived arousal** for an insight on the user's emotional and cognitive state. See (Table 4.7) for the Average of the induced emotion scores of each ASMR experiment. (Figure 4.6) for the distribution of the induced emotion of 20 users who tested the ASMR experience without "HESS". (Figure 4.7) shows the distribution of the average induced emotion of 20 users who tested the ASMR audio-only experience. (Figure 4.8) for the distribution of the induced emotion of 20 users who tested the ASMR experience with "HESS". (Figure 4.9) shows the distribution of the average induced emotion of 20 users who tested the ASMR experience with "HESS".

Study	Average SAM score	
	Valence	Arousal
ASMR Audio	2.55	3.6
HESS	2	4.25

Table 4.7 Average of the induced emotion of both experiment

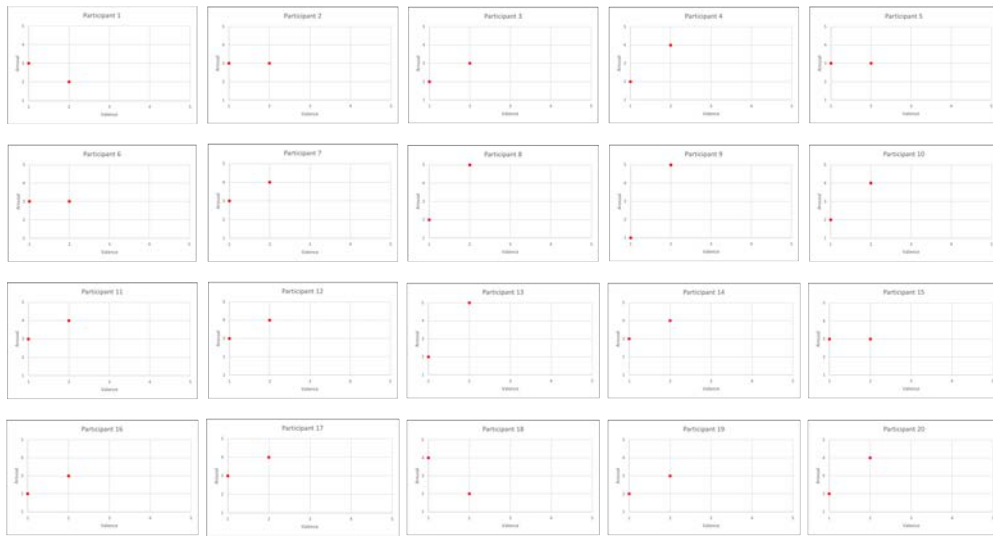


Figure 4.6 The distribution of the induced emotion of 20 users — ASMR Audio only

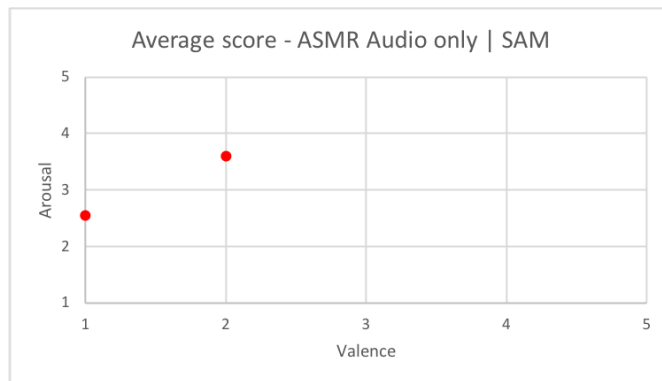


Figure 4.7 The distribution of the average induced emotion of 20 users — ASMR Audio only

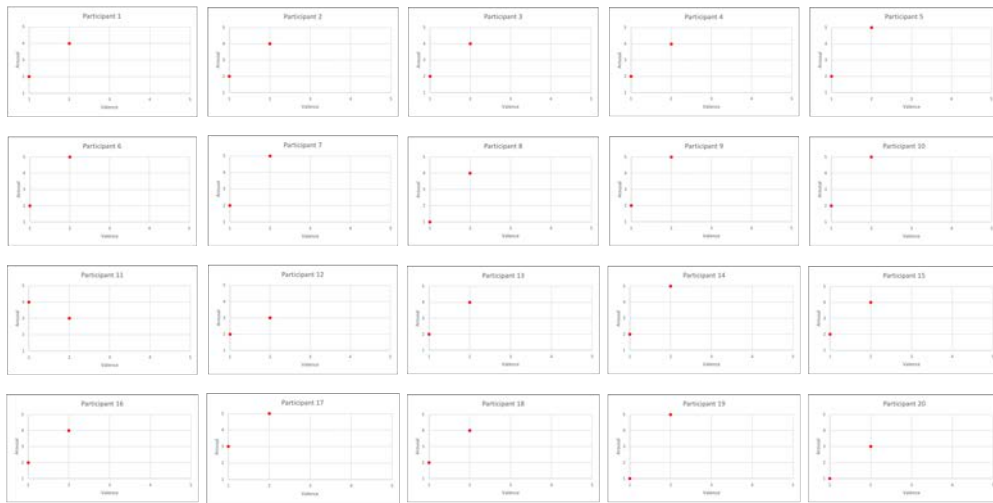


Figure 4.8 The distribution of the induced emotion of 20 users by "Hess"

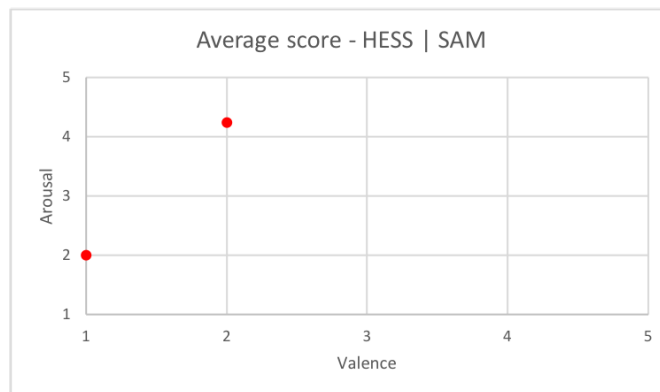


Figure 4.9 The distribution of the average induced emotion of 20 users — "Hess"

ASMR experience review

We have (Figure 4.10) that shows the users capacity to experience ASMR tingling sensations as well as the results collected after both studies. **Surveys** for both studies of the ASMR experience with and without "Hess"; show valuable self-perceived physiological and psychological changes and user experience related reviews, compared results of both studies in criteria such as; experience rating Figure 4.11, satisfaction rating Figure 4.12, improvement after both ASMR experiences Figure 4.13, sleepiness level rating Figure 4.14, calmness level rating

Figure 4.17, stress level rating Figure 4.16, engagement level rating Figure 4.15).

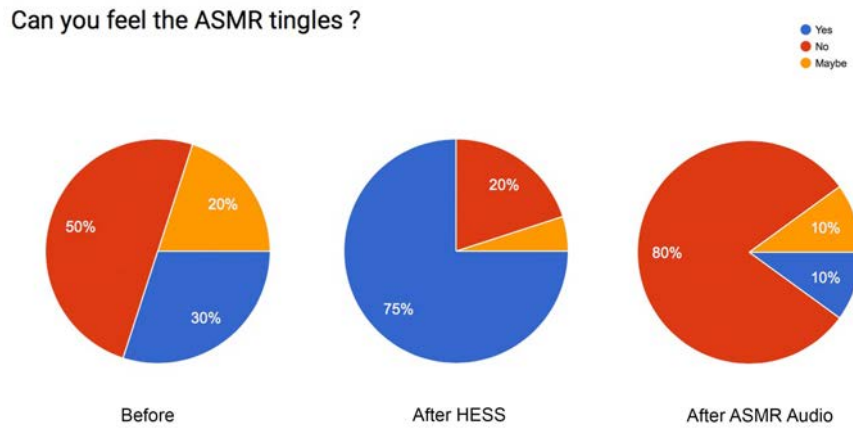


Figure 4.10 ASMR Tingles

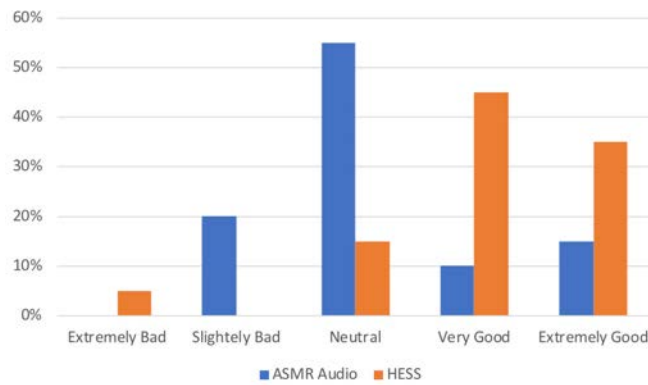
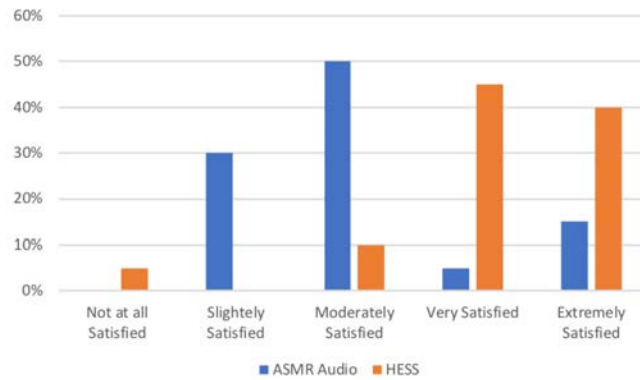
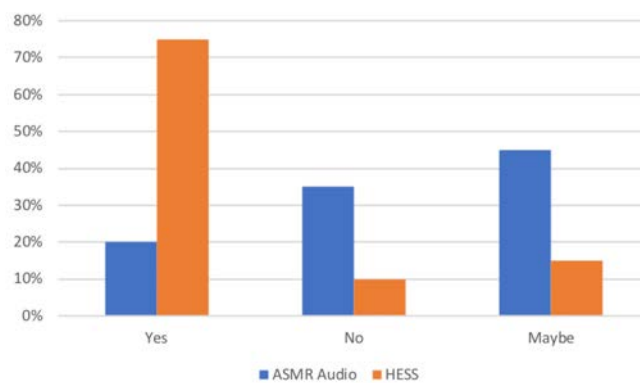


Figure 4.11 Comparison of ASMR experience rates with and without "HESS"



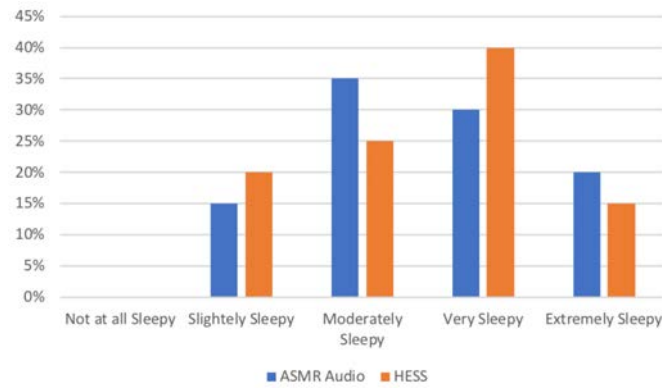
Comparison of Satisfaction Rates

Figure 4.12 Comparison of satisfaction rates of the ASMR experience with and without "HESS"



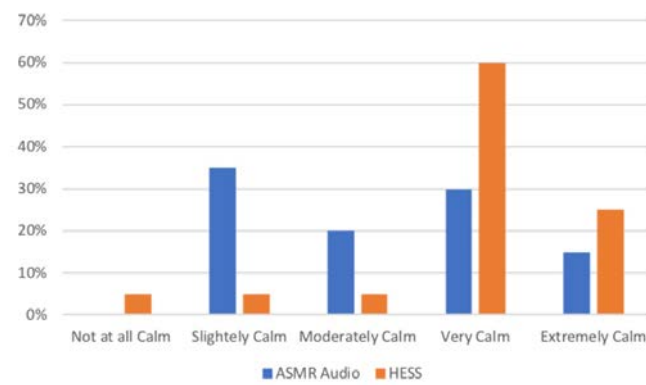
Comparison of Improvement Rates

Figure 4.13 Comparison of improvement rates of the ASMR experience with and without "HESS"



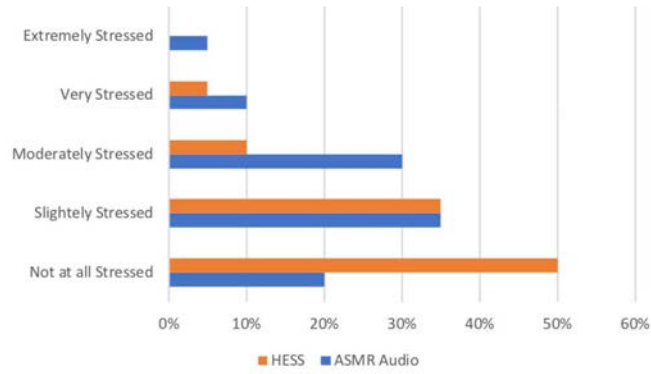
Comparison of Sleepiness Rates

Figure 4.14 Comparison of sleepiness rates of the ASMR experience with and without "HESS"



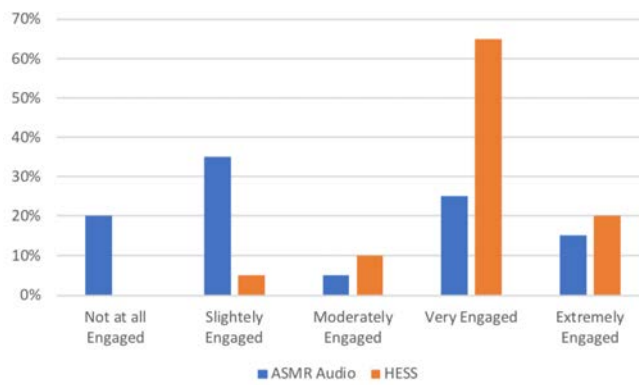
Comparison of Calmness Rates

Figure 4.15 Comparison of calmness rates of the ASMR experience with and without "HESS"



Comparison of Stress Rates

Figure 4.16 Comparison of stress level rates of the ASMR experience with and without "HESS"



Comparison of Engagement Rates

Figure 4.17 Comparison of engagement rates of the ASMR experience with and without "HESS"

Chapter 5

Discussion

5.1. Evaluation of the Feasibility and Effectiveness of "HESS"

5.1.1 Feasibility of "HESS" Cross-modal ASMR Experience in Managing Stress

In the interview and survey, P9, P16, P6, P20, P14, P15, P12, P11, P13, P10, P5 are some of the participants that shared that the "HESS" ASMR experiment got them calm, as shown in Figure 4.15, the highest percentage of rate is of 60% on the "very calm" compared to 30% for the ASMR audio only experiment, which highest percentage rate is of 35% on the "slightly calm" compared to 5% for the "HESS" ASMR experience. This comparison shows that the "HESS" ASMR experiment get users to feel calmer than with ASMR audio only experiment. Furthermore, as shown on the bar chart, Figure 4.14, the highest percentage rate for sleepiness is of 35% on the "moderately sleepy" with a percentage of 25% with "HESS", on the other hand, the highest percentage of sleepiness using "HESS" is the "very sleepy" rate with 40% and 30% for audio only ASMR. Making "HESS" the better alternative to getting sleepy. As for the perceived stress level after both ASMR experiments, Figure 4.16, we have a rate of 50% of "not stressed at all" with "HESS" and 20% for audio only ASMR, as for the "extremely stressed" we can see that audio only has a rate of 5% compared to 0% for "HESS" ASMR experiment. Therefore "HESS" is more efficient than ASMR audio only for managing stress, establishing calmness and coping with insomnia. To solidify these findings, let's look at the Heart rate data. As shown in both (Table ??) and (Figure 4.5), the ASMR audio-only experiment has an average baseline HR of 79.75 and an average

end HR of 82.9. This shows an increase in the HR average, For "HESS" ASMR experiment to be more efficient in managing stress, it should show a decrease in the end HR average, baseline HR average is 79 and the end HR average is 76.75 a decrease of 3.25 that proves that the "HESS" cross-modal ASMR experiment does manage stress.

we will refer to DASS-21 for psychometric evaluation and normative data for the Depression, Anxiety, and Stress. Check if the "HESS" cross-modal ASMR experiment is more or less effective in decreasing levels of Depression, Anxiety, and Stress. As shown in the (Figure 4.4) and (Table 4.3), the average before and after in the case of the ASMR audio-only experiment is; Depression (5.25 before and 4.9 after), Anxiety (5.9 before and 5.5) and Stress (6.7 before and 6.1 after). And as in (Table ??), the average before and after in the case of the "HESS" ASMR experiment is; Depression (3.95 before and 2.15 after), Anxiety (5.05 before and 3.75) and Stress (5.75 before and 3.75 after). In (Table ??), the difference between the before average and the after average shows the decreasing average of (Depression;0.35), (Anxiety;0.4), (Stress;0.6) for eh Audio only as for the "HESS" ASMR experiment, the decrease average is as follows (Depression;1.8), (Anxiety;1.3), (Stress;2). The Depression, Anxiety, and Stress decrease are more important than with ASMR audio-only.

Based on the post-testing interview, before and after surveys, Heart rate and DASS-21 results, and compared to ASMR audio experience, "HESS" is suitable to manage stress.

5.1.2 The Emotional Response to "HESS"

The SAM Scale assesses the emotional response induced by stimuli in our case both ASMR experiments. Let's focus on the valence, pleasure section where the rating goes from 1 to 5 corresponding to very pleasant to very unpleasant. Means that, for a positive emotional response, we need the average score to fall in between **(1-3) for valence** and **(3-5) for Arousal**. Since 1 means aroused and 5 means calm. See (Table 4.7) for the Average of the induced emotion scores of each ASMR experiment, the average emotional response of "HESS" ASMR experiments falls in, Valence (2) means that it is positive since it is in the (1-3) positive part of the scale and an average arousal score of (4.25), a positive response indicating that it

is perceived as very calming. Compared to "HESS" only audio's average rating is (2.55) in valence and (3.6) in arousal.

Valence/pleasure for an insight on the user's feeling triggered by the experience and **perceived arousal** for an insight on the user's emotional and cognitive state. The cognitive state is the thought processes and state of mind. Backed with qualitative data, participant (P9, P12, P6, P20) indicated feeling very calm yet refreshed, focused and with a clear mind, referring to that situation/feeling as *"a reset, blank mind, not thinking but focused"*.

"HESS" provides users with a complex salubrious experience, it is both an activating experience and a calming one.

5.1.3 Feasibility and Effectiveness of "HESS" in Enhancing and Re-creating the ASMR Experience

Re-creating the ASMR Experience for Non-ASMR Users

As we can see in the pie chart (Figure 4.10), 30% of the participants are able to experience tingles and 20% are not sure they did or if they are able to. After the ASMR experiment using "HESS" the percentage of participants who experienced tingles induced by ASMR audio-haptic cross-modality increased by 45%, so that after the "HESS" introduction in the user study, 75% were able to feel the tingles and 5% were still not sure. As for the ASMR experiment using only audio, it showed an increase in the percentage of the participants who were not able to experience the tingles, 80% of didn't experience tingles and only 10% did. Being able to experience the tingles is the essence of the ASMR experience. And these findings indicate that the concept of "HESS" is capable of providing a higher possibility of tingly sensation by utilizing ASMR audio-haptic cross-modality. Therefore achieving an enhanced ASMR experience as well as re-creating the ASMR feeling in users who can not experience ASMR, since that the percentage of the participants who couldn't experience ASMR decreased from 50% by the time the experiment to 20% of the participants who were still unable to feel the ASMR tingles. Besides, further information from the participants was obtained through interview sessions which were conducted right after the ASMR experiments. Participants indicated feeling tingles for the first time, induced by "HESS", P15 was

surprised to get the tingly feeling in her chest and thighs, P11 was surprised by the tingles around her neck.

" with "HESS" I felt the tingles in my head neck and on my lower back, but compared to the "HESS" experiment, audio only didn't do anything for me. No changes."-P12

P12: can experience the ASMR tingles. After the "HESS" ASMR experiment P12 was able to feel the tingles in their head, neck and lower back, however, P12 couldn't feel the tingles after the audio only ASMR experiment.

"Better than with ASMR audio-only. I feel calm and want to sleep but I don't feel tired. I was focused on the sound and the comfortable vibration. I didn't think about anything else. My mind was clear and blank. Will definitely use it when tired and want to sleep."-P14

P14: can't experience the ASMR tingles. After the "HESS" ASMR experiment P14 was able to feel the tingles in their neck, however, P14 couldn't feel the tingles after the audio only ASMR experiment.

Enhancing the ASMR Experience

As seen in the pie chart (Figure 4.10), 30% of the participants are able to feel the tingles. We notice a decrease in the percentage of participants who got to feel the tingles with the audio-only ASMR experiment. Only 10% compared to 75% who felt the tingles with "HESS" ASMR experiment. Furthermore, (Figure 4.11) shows that 10% of the users rated the audio-only experiment as "very good" compared to 45% with "HESS" and 15% rated the audio only experiment "extremely good" compared to 35% with "HESS". The chart in (Figure 4.12) shows that the highest satisfaction rates for the audio only experiment are, "slightly satisfied" and "moderately satisfied" with a combined percentage of 80% compared to a combined percentage of 10% for the "HESS" ASMR experiment. Whereas the "HESS" ASMR experiment's highest satisfaction rates, (Figure 4.12) are "extremely satisfied" and "very satisfied" with a combined percentage of 95% compared to 20% for the audio only experiment.

ASMR is proven to establish an improvement in emotional states and induce relaxation. 20% of the users indicated feeling an improvement in the affective and mental state after the audio-only experiment. Compared to an improvement

of 75% of the users after the "HESS" ASMR experiment,(Figure 4.13). Furthermore, after the audio-only experiment, 20% of the users indicated not feeling stressed at all and 30% indicated feeling "very calm". Compared respectively to 50% not feeling stressed at all and 60% indicated feeling "very calm" after the "HESS" ASMR experiment, (Figure 4.17). The collected data is in favor of the hypothesis claiming that "HESS" is capable of enhancing the ASMR experience. Furthermore, P20, P9, P12, P6 have shared interesting insight on how the "HESS" ASMR experiment was more intense and rewarding in terms of emotional states and perceived relaxation and focus.

"Very comfortable. This is different from the YouTube ASMR videos. My whole body and ears feel like one. Tingles everywhere. I feel very comfortable and I really loved the experience."-P20

"it's a strange feeling hard to describe, tingles on my body that feel good. A very positive experience I feel an increase in energy and way less stressed than when I started. the most interesting part was how my mind went blank, I was finally able to experience a quiet head."-P12

"amazing sensation, I even at one point stopped feeling people's presence in the room, I was in a quiet place in my head, so calm and peaceful. Amazing experience, feeling the music in my body made me focus more on every sensation I could ever feel. I was part of the audio, one with the tingles, floating somewhere peaceful in my head and feeling so very focus and refreshed."-P9

"Felt completely different and way better than with the audio-only. This is how ASMR experiences should be! I feel like I rebooted my mind. Both focused and relaxed. I might even sleep right here right now or just do some math at 4 am. What is this? I love it."-P6

The Audio only ASMR Experience

Participants got bored and indicated unwillingness to experience it again. *"no thank you!"*-P12. Users in this test didn't show much enthusiasm or change, other than getting sleepy mostly. With the highest percentage of sleepiness being 35% "moderately sleepy" and 25% compared to the "HESS" ASMR Experience, which has the highest percentage of sleepiness of 40% "very sleepy" compared to 30% for the audio only ASMR experiment, Figure 4.14, furthermore, participants

with "HESS" experienced mixed states of calmness and arousal simultaneously, feeling sleepy yet focused and energized.

"So calm and sleepy, it was good not like just with ASMR sounds. The vibration felt like an acoustic massage that made me give meaning and purpose to the sounds that I hated when it was just ASMR audio. I feel refreshed like if I just woke up from a nice sleep. It's like I am in a sweet spot between waking up refreshed and still being sleepy but not tired. I would use it to help me sleep, no doubt. My mind was wandering I don't know where."-P15 *"Better than with ASMR audio-only. I feel calm and want to sleep but I don't feel tired. I was focused on the sound and the comfortable vibration. I didn't think about anything else. My mind was clear and blank. Will definitely use it when tired and want to sleep."-P14*

Feedback about the ASMR experience with just the ASMR audio;

- Boring
- No perceived changes
- calmness
- sounds are annoying
- hard to keep the focus

"Quietness" of the Haptic feedback

based on the interview, the tactile score was influenced by individual differences; 12 participants indicated preferring strong vibration explaining that it gives them more pleasure and stronger sensory experience of the audio in their bodies. Some subjects wished they could selectively amplify, select or silence the three haptic channels individually. P14, P6, P19, P3, P5 indicated that they preferred the neck vibration most, P10, P8, P7 preferred the shoulders vibration. But the "HESS" ASMR experience's goal is to create an enhanced cross-modal sensory experience that provides a pleasant state to the user. There isn't a single formula that pleases all users in terms of vibration intensity, I noticed though that the participants that can feel ASMR commented that the haptic 'volume' of the haptic feedback was not high enough. P9, P12, P19, P6, P20, P3 indicated

that stronger vibration provides them with interesting sensations of focus, intense tingles, a floating sensation and refreshed kind of energy, *"it felt nice but I prefer the stronger vibration, the tingles are stronger and I feel more excited but the soft vibrations are also nice, they make me feel sleepy and relaxed."*-P9 Whereas the participants who can not experience ASMR indicated that the strong vibration were too much for their bodies to handle, providing that it was a new sensory experience and that they were provided with intense representation of the audio in their bodies which gave them tingles, a new hence perceived as scary sensation for some; for example, *"I felt like I was the main character in a horror movie, every sound was felt in my body and I slipped in an other dimension where my mind and imagination took over. Too much for me, I am not ready for such a strong sensory experience."*-P10 To establish a calming "HESS" sensory experience for both users who can and can not experience ASMR, I modified the initial haptic feedback setting of the second prototype. Then tested it again. Provided by the current haptic feedback settings; *"I was pleasantly surprised, extremely relaxant and calming, no more horror stories in my head, the vibration is gentle but just the right setting to get me to feel sleepy and happy."*-P10 *"I felt the tingles! Amazing, this never happened before and the sounds aren't as annoying anymore, thanks to the haptic feedback."*-P2 *"I loved how the strong vibration made me fell, but this is also good. The gentle vibration lolled to sleep and I felt like I was floating, this is an other aspect of the possibilities and ray of sensations "HESS" can provide. How exciting."*-P9

Constructive feedback about the system of "HESS";

- More soundtrack with different themes.
- Freedom and choice to modify the audio volume and the intensity of the vibration.
- waterproof wearable device.
- Pleasant feeling on the body, stronger vibration might be suited for more intense sounds, that would be an interesting experience.
- The synchronization is well done.

"the vibration on the shoulders felt weak."-P14 *"I want to have the "HESS" experience with more soundtracks, maybe even scary situations to help me get over my fears."*-P13 *"I also want visuals for a more intense experience."*-P10 *"A waterproof device in case I fall asleep wearing it, because I sweat a lot."*-P4 *"a little bit nervous because i didn't know what kind of sounds were coming next. I like knowing in advance."*-P20 *"some parts of the audio made me weary about expected unpleasant sounds but I was surprised with a better than expected soundtrack."*-P13

The "HESS" Immersive Cross-modal Sensory Experience

The same ASMR audio soundtrack was tested in both ASMR experiments. P12, P5, P6, P16, P20 reported getting bored and distracted. P14, P15, P10 were annoyed by the ASMR sounds while testing the audio-only ASMR experiment. 20% indicated being "not at all engaged" and 25% indicated being "very engaged". Whereas, while testing the "HESS" ASMR experiment, 0% indicated being "not at all engaged" and 65% indicated being "very engaged" with the experiment. (Figure 4.15), describing it as interesting, amazing, mind captivating, bewitching and more.

Furthermore, "HESS" established a new sensory experience. Where, it has been indicated intensely by P9, P19, P6, P16, P5, P17, P3, P4 that they drifted to another state of being. In another dimension where they could feel the sounds and feel the burst of sensations behind every abstract ASMR sound.

P15 and P13 indicated that "HESS", compared to the audio-only ASMR experiment, made them see the sounds and interpret them in their own ways. Some, like P2, got stuck in an elastic sensation. Where the sound and the intense feeling it had on their body, reminded them of an intense memory of them driving their car, fast. Not a comfortable memory, they added. But strongly insisting on being open to using "HESS" again for its impact on the imagination. P20 got taken by the cross-modal sensation to a happy memory of being on an airplane. Which made them feel relaxed and happy. It is all very subjective nonetheless, an interesting sensory and immersive experience.

"Interesting. At first, it was hard for me to stay put but it got easier for me to get used to the quiet. The vibration helped me get comfortable and I started feeling

relaxed and sleepy. Vibration made me feel the sounds, feel the rhythm and get a deeper feeling and understanding of the audio. The vibration matched the essence of the sound, like for the writing sounds, the vibration is soft because the writing is an intimate quiet experience, I like that in "HESS" and the stronger actions in sounds came with matching stronger vibrations. Even when trying to picture the sounds, my mind still felt focused on the experience. I also noticed the story hidden in the ASMR soundtrack."-P13

5.1.4 User Experience; Usability Reviews

As for the usability, the interview and surveys show that the participants expressed enthusiasm and willingness to use "HESS" as often as 6 times per day on a daily basis. Only two participants were unwilling to use "HESS" due to sensitive skin and Misophonia. Feedback about the usability of "HESS";

- Would use mostly to feel energized
- Would use mostly to help me sleep
- Would use mostly to focus
- Would use mostly to take a break and reset my mind
- Would use mostly to get some quiet and mental clarity
- Would use mostly to relax after a stressful situation
- Would use mostly to help with depression
- Would use mostly to enjoy my imagination
- Would use mostly to enjoy new sensory experiences
- Would use mostly to enjoy movies in the cinema or for attraction in theme parks

Feedback about the ASMR experience with "HESS",

- Amazing New sensation
- Interesting with big potential

Chapter 6

Conclusion

6.1. "HESS" Multi-sensory Experience

This thesis investigated ASMR audio-Haptic cross-modality and its effect on the mental and physical well being. "HESS" is a system that provides an immersive sensory experience that allows the users to feel the ASMR audio triggers in their body to relax and manage stress. "HESS" consists of a Binaural ASMR audio track and a wearable device that provides haptic feedback in the form of synchronized vibration. Users wear either wireless headphones or earbuds on, for fewer restraints and more mobility. "HESS" is an activating experience to be used in various case scenarios. Whenever the individual is feeling stressed, anxious, unable to focus or sleep, and is looking forward to experience a moment of calmness and relaxation.

"HESS" is found to be able to establish a health improving experience through ASMR audio-haptic feedback cross-modality for stress management. It successfully creates the immersive perception of the ASMR audio in the body and enhances and recreates the ASMR phenomenon for ASMR users and non-ASMR users.

6.2. Extensibility

"HESS" should also investigate the impact it has on self-awareness and mindfulness training in augmented meditation. "HESS" shows potential for applications other than therapeutic. It can be used for leisure and entertainment purposes, in the music and artistic fields, like introducing a new medium for auditory storytelling. This study had several strengths for examining ASMR audio-haptic cross-modality, that hints that "HESS" has the potential to extend its usability

into various domains; relaxation, increasing focus, sensory immersion, entertainment and storytelling, a new sensory experience and it also provides new insights into music creation by establishing an immersive storytelling experience through abstract sounds.

6.3. Future Work

The "HESS" study will undergo more investigations. On the academic side, I am planning on submitting papers to the Augmented Human Conference. Further research should take place about the "HESS" influence on the psychological and physiological changes that occur in detail, as well as investigation neurotransmitters such as GABA and Serotonin and their possible connection to ASMR audio-haptic cross-modality.

As for the art and design side; in addition to refining the prototype by applying psychological and physiological principles of human factors and ergonomics and simplifying the wiring, I am planning on exploring the storytelling possibility of "HESS" by composing more ASMR audio tracks and apply for several contests.

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Appendices

A. Interview Questions

Post Testing of "HESS" Feasibility Study Q&A

1. What was your first impression?
2. How was the experience?
3. How are you feeling right now?
4. How did the experience make you feel emotionally?
5. How did the experience make you feel physically?
6. What changed now from before you had this experience?
7. Was there anything particularly unpleasant?
8. Was there anything particularly pleasant?
9. Do you usually feel ASMR?
10. Did you feel tingles ? if yes where?
11. How is your focus during the experience?
12. What was going in your mind while having the experience?
13. Do you think you would choose to have this experience again? when and for what purpose?
14. How would you compare the ASMR experience with and without "HESS"?
15. Is there anything you want to add?