INVESTIGATING THE ROLE OF ELEMENTS OF NATURAL ENVIRONMENT RECREATED IN THE CLINICAL SETTING FOR STRESS REDUCTION

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Tiivistelmä – Abstract

It has been shown in environmental psychology research that a natural environment can promote stress reduction which could be used for relaxation purposes in music therapy. However, therapy is normally conducted in clinical settings, and therapists do not always have the option to take patients outdoors. In this study, the elements of the natural environment were recreated in the clinical setting to investigate their role in stress reduction during the relaxation music listening session. The presence of natural elements were expected to lead to greater stress reduction. Stress levels were evaluated subjectively with visual analogue scales and objectively via the heart rate variability. Results revealed that in presence of the natural elements participants reported feeling less stressed, but HRV data does not fully support this finding. Also, a trend of improved night sleep quality after the "Nature" intervention was found. Overall, more stressed participants benefited more from the "Nature" condition, but due to the small sample size the results cannot be generalized and further investigation is needed. Finally, a mismatch between the subjective and objective data was pointed out, and its meaning was discussed.

Asiasanat – Keywords	
Natural environment, stress, relaxation music, heart rate variability	

Säilytyspaikka – Depository	

Muita tietoja – Additional information

CONTENTS

1   INTRODUCTION

Initial decision to investigate the role of nature elements recreated in the clinical setting for stress reduction comes from interest to the environmental aspect and its role in therapy. The standard clinical setting environment is usually considered to be neutral and is left outside the frames of the therapeutic equation. However, the surroundings are always present, and altering the environment may have an effect on the therapeutic process and its outcomes. Therefore, originally, my interest was focused on the role of the environment in therapy setting and how music therapy process benefit from a natural, outdoor environment. However, I found the music therapy process to be too broad of a phenomenon to evaluate this effect, and therefore I decided to concentrate on a concrete aspect of human health: stress. Moreover, in order to diminish the number of uncontrollable variables, a listening experiment was chosen as a method. Therefore the current study does not investigate a therapy process.

The first section of the current work is the literature review, where the theoretical background is provided. First subsection deals with environmental psychology: a field of study, which subject is the interplay between the environment and individuals. The focus is put on the possible link between the nature and human health. Second and third subsections concentrate on stress, especially on the issue of chronic stress, and its physiological indicator: heart rate variability. The third and fourth subsections describe the relationship between stress and nature and stress and music, based on the results of previous research. The place of relaxation techniques among music therapy methods is discussed in the following subsection.

The research aims and rationales are discussed in the next section, which is followed by the method section, where the stimuli selection process, population and the experimental design are discussed.

The results are presented in the fourth section and discussed in the fifth section. Finally, the conclusion is drawn in the last section.

2 LITERATURE REVIEW

2.1 Look around you: environmental psychology

It is often hard, and sometimes even impossible to consider certain phenomena without taking the environment into consideration. The environment not only plays the role of the "background", but also represents a complex phenomenon in and of itself. It can be defined as "the surroundings or conditions in which a person, animal, or plant lives or operates" (Oxford Dictionary, 2017). The interplay between individual and the environment is studied in the framework of environmental psychology. In other words, it studies the influence of the environment on human experiences, behavior and well-being as well as the influence of human on the environment (Steg et al, 2013). It focuses on the human-environment interaction and takes into consideration different kinds of environment including natural environment.

Environmental music therapy is a branch of music therapy, which concentrates on the environmental aspect of the therapy process. It is defined as "a noninvasive mind–body intervention that considers the physical, psychological, and cultural needs of patients, caregivers, and staff" (Canga, 2012, p. 221). However, research in this area is more concentrated on hospital environment. The effort to bring music therapy outdoors was first made by Eric Pfeifer (Pfeifer, 2016 in Kopytin, 2016). Although some companies (e.g. Percussion play) offer outdoor music therapy sessions ("Percussion play", 2013), this area remains under-researched.

Natural environment can be defined as "any kind of environment, place or setting where vegetation and other natural elements are dominantly present" (Steg et al, 2013, p. 50). Possible connection between natural environment and human health has been a topic of speculation for a long time. One of the first researchers who provided reliable evidence of the positive effects of nature to human health was Ulrich (1984). In his study, he found that patients in the hospital recovered more quickly after a surgery if they could see natural areas with trees from their windows. Large-scale population studies were used by public health

research to investigate possible relationships between natural environments and health and well-being. De Vries and colleagues found that respondents who lived nearby green areas (1-3 km) reported better general and mental health and fewer health related complaints than those with lower percentage of green space near their homes (De Vries, Verhej, Groenewegen, & Spreeuwenberg, 2003). However, according to Steg et al (2013), epidemiological studies have shown that relationships between green space and health are more evident for people who spend more time in or near their homes such as the elderly. However, this relationship has yet to be observed with other populations, and no relationships between these variables have been clearly observed as of yet. This was one of the reasons why the current study used young adults as a sample population.

An attempt to explain a positive relationship between nature and health has been made by De Vries (2008), who proposed four possible mechanisms: improvement in air quality, stimulation of physical activity, facilitation of social cohesion and restoration from (or reduction in) stress. However, with respect to the first three mechanism, studies provide somewhat ambiguous and questionable results, for example: air quality can actually decrease if trees "trap" the industrial dust; motivation for physical activity is mostly intrinsic and the presence of nature does not make people more active (Steg et al, 2013). Maas, van Dillen, Verheij and Groenewegen (2009) suggested, green environment might increase the sense of social cohesion without increasing the actual number of social contacts. At the same time, the fourth mechanism (stress reduction) is supported by a number of studies known as restorative environment research, which will be discussed in greater detail later in this report. The term "restorative environment" refers to particular environments which have the potential to trigger psychological and/or physiological recovery processes (Steg et al, 2013).

As a theoretical basis, two main theories are used in restorative environment research: stress recovery theory and attention restoration theory. Ulrich explained stress recovery theory as people's initial reaction to the environment occurs without conscious cognitive analysis. If certain features (like vegetation) are present in the environment, they cause immediate positive affective response, which initiate the restorative processes and leads to stress recovery (Ulrich, 1983).

In contrast to this quick response mechanism, slower, cognitive mechanisms are emphasized in attention restoration theory. It is based on the assumption that people have only the limited capacity to voluntary concentrate their attention to some objects which would not attract their attention otherwise. Prolonged use of central executive mechanisms, which allow people to focus their attention by inhibiting competitive stimuli, can lead to a phenomenon called directed attention fatigue. According to the attention restoration theory, following features of human-environment relationship can counter directed attention fatigue in subjects through: fascination (if the environment automatically draws attention), a sense of being connected, and a compatibility between the person and the environment (Kaplan, 1995).

Restorative environment research was chosen as the theoretical basis for the current study. Furthermore, it also draws on both stress recovery and attention restoration theories.

These effects are not nature-specific and occur in other kinds of environment. Also, it is important to remember, that the term "environment" embraces all possible types of environment, and does not necessarily refer to the natural environment. In the current study two types of environment were be taken into consideration: clinical environment and natural environment (recreated in the clinical setting).

2.2   Stress

Over the past decades, the word "stress" has became a normal part of our everyday vocabulary. The first definition of stress was proposed by Hans Selye. He defined stress as "the non-specific response of the body to any demand for change" (Selye, 1936 in Szabo, 2012, p. 472). According to Selye, there are two general types of stress: eustress and distress. Eustress, as Selye stated, is a "good" stress which may be beneficial to individual. This term was used by Lazarus in his model for a positive cognitive response to stress, which motivates individuals towards action, and contrasts negative stress or "distress" (Lazarus, 1966). This term was frequently used in medicine to describe "the degree of discomfort reported by patients in relation to their perceptions of the symptoms being experienced" (McCorkle & Young, 1978 in Ridner, 2004, p. 538). The term "psychological distress" is frequently used in medicine and nursing literature to refer to "the general concept of maladaptive psychological functioning in the face of stressful life events" (Abeloff et al. 2000 in Rinder, 2004, p. 539).

A concept of stress continued developing, and new viewpoints on stress along with new definitions emerged. According to Butler (1993), during the history of stress research, stress was defined at least three ways from differing viewpoints: stimulus-based, response-based and as a dynamic process. Stimulus-based definition focused on the external factor which causes stress and emphasized that stress occurs as a results of pressure. In contrast, response-based definition focused on internal factors at work when responding to stress. This aspect of stress was emphasized the most by Selye. Finally, stress can be defined as a dynamic process reflecting both external and internal factors. A definition of stress by Lazarus and Folkman reflects this view. According to them, "stress is a particular relationship between the person and the environment that is appraised by the person as taxing or exceeding his or her resource and endangering his or her well-being" (Lazarus & Folkman, 1984). Another definition of stress also includes other related emotions; Steg et al (2013, p. 56) define stress as: "a real or perceived threat or challenge to the integrity of the organism, which is often accompanied by fear or anxiety".

In common language the word "stress" is mostly used in a negative sense, when actually stress as a phenomenon is *not* necessarily "bad". Changes in the environment activate a set of responses that Selye called a general adaptation syndrome, which is presently referred to as a stress-response. These responses have evolved in order to keep humans and their ancestors alive in case of physical threat. Short-term stress can boost the immune system, while chronic stress results in it's suppression. This may eventually may lead to the manifestation and development of a stress-related illness such as diabetes mellitus, peptic ulcers, atherosclerosis (Salleh, 2008). However, in present-day life humans more often get involved with stressful social situations that do not pose a direct threat of any physical danger and often cannot be resolved in a short time period. At the same time, the human body responds to physical and social stressful situations in a similar way (Sapolsky, 2004). As a result, emergency stress-response systems stay turned on for a long time, leading to an unbalanced endocrine system which may lead to certain stress-related diseases. Moreover, research has found an association between psychological distress and mortality (Russ, 2012). Thus, the current study is focused on the long-term stress and the possible long-term effects of the interventions.

2.3   Heart rate variability as a stress indicator

Now, that we have discussed the definitions of stress and its impact on human life, the question remains: how do we measure stress objectively? Heart rate variability can be considered as a physiological indicator of stress; it is closely linked to stress and is often used for stress assessment (Laborde, 2017). The link between them lies in the functioning mechanisms of the human nervous system.

The human nervous system consists of two main branches: central and peripheral. The autonomic nervous system is a part of the peripheral nervous system, which is responsible for enabling internal organs to function, and consists of both the sympathetic and parasympathetic branches. The main task of the sympathetic branch is to activate the body and prepare it to the fight or flight responses, whereas the main task of the parasympathetic nervous system is to put the body into rest and recovery mode. Sympathetic activity is associated with stress responses and parasympathetic activity is associated with stress reduction and recovery. Typically these divisions of the autonomic nervous system function in opposition to each other, providing the balance of stress and recovery states in the organism. Studies show, that night sleep quantity and quality are especially important for physiological recovery (Rusko et al, 2006., Myllymäki, 2006).

Heart rate variability (HRV) refers to the variability of the intervals between heart beats, or beat-to-beat variability. It can index the vagal tone, an internal biological process, that reflects the activity of the vagus nerve, which is strongly associated with parasympathetic activity in general and, thus, with recovery processes. Therefore, HRV is often used in stress related studies. A study was conducted to investigate the relationship between mental stress, heart rate and heart rate variability; results showed, that HR and HRV were affected by a mental task, and for this reason the authors suggested, that HRV can be used for stress levels measurements (Taelman, Vandeput, Spaepen, Van Huffel, 2009). Moreover, meta-analysis showed, that HRV is affected by stressful stimuli, suggesting that it can be used for stress measurement (Kim, 2018). When it comes to HRV analysis, there is a vast number of possible

parameters, which can be classified into the following groups: time-domain parameters, frequency-domain parameters and non-linear indices.

The Root Mean Square of Successive Differences (RMSSD) is a time-domain parameter, which reflects vagal tone and is a frequently used in HRV research (Laborde, 2017). RMSSD is positively associated with recovery and negatively associated with stress reactions. In other words: the higher is RMSSD, the lower is the stress level.

2.4   Nature and stress: previous studies and perspectives

There is a large body of research, both inside and outside of the environmental psychology research, which has investigated the possible association (or absence of) between the natural environment and stress levels. Japanese researchers tested the effects of shinrin-yoku, a common form of relaxation in Japan, which involves walking or staying in the forest to promote health, to identify factors related these effects (Morita, 2007). Results revealed a decrease in both depression and hostility scores, and the increase in liveliness score; stress levels were also decreased, and, interestingly, the higher stress level was, the greater the effect. The researchers concluded that forest environments are advantageous in respect to acute emotions, especially among those experiencing chronic stress. They state that shinrin-yoku may be employed as a stress reduction method, and that forest environments may be useful for therapeutic purposes.

Finnish researchers also take part in restorative environment research. A study conducted by Dr. Liisa Tyrväinen showed that even short time spent in nature areas have positive effects on perceived stress relief compared to built-up environment (Tyrväinen, 2014). Tyrväinen suggested that a visit to the a green area, such as a park, which is located in the city, can promote stress reduction. In other words, it is not necessary to go to the forest to enjoy the benefits of the natural environment.

These findings concerning the relationship between the natural environment and human health uncovered a practical application in different areas, including outdoor education and outdoor psychotherapy (Jordan, 2015). However, in most cases, therapists, especially those who work in institutions, have to follow certain regulations, and are not allowed to take therapy

outdoors. In this case, certain elements of natural environment, such as nature sounds, images and plants, can be used for recreating a natural environment in clinical setting. The results of original Ulrich's study were supported by the results of another study conducted by Korean researchers with hospital patients recovering after surgery in room with or without potted plants (Park, 2006). Their findings showed that patients in the room with plants had shorter recovery times and used fewer painkillers than those in rooms without plants.

How can music therapists to bring the nature to the clinic? First of all, it seems to be impossible to bring "nature" as such inside, but rather certain elements. So then, which elements do we choose and how many? The suggested criteria would be the following: it is at least relatively easy to bring natural outdoor elements to the clinical setting in order to be included in the clinical context and it should have positive effect on health in respect to stress recovery.

Nature sounds could be quite easily brought to the clinical setting and naturally included in the context of therapy, but would the patient benefit from them? A study conducted by a team of Swedish researchers investigated the role of nature sounds in stress recovery using a virtual reality forest with nature sounds, without nature sounds, and a control condition (Annerstedt et al, 2013). Physiological data such as cardiovascular data and saliva cortisol were measured to assess the differences between stress recovery processes in given conditions. Repeated ANOVA revealed the activation of the parasympathetic nervous system in participants from the first group (virtual reality forest with natural sounds), whereas participants from the group that recovered in the virtual forest without natural sounds and the control group did not show any activation or deactivation in autonomic nervous system. These results suggest that the sounds of nature can enhance the processes of stress recovery.

A study conducted by Ratcliffe, Gatersleben and Sowden (2013) looked at the restorative perceptions of bird sounds and its role in stress recovery. The authors used semi-structured interviews and found out that bird songs were associated with attention restoration and stress recovery in natural environments (Ratcliffe et al, 2013). In contrast to the study conducted by Sweden, where researchers used physiological data and quantitative analysis, this study used qualitative interviews to provide information about subjective perceptions of birdsong and their role in recovery processes.

2.4　Music and stress

Music is known to be a powerful tool for self-regulation (Juslin & Laukka, 2004) and music-induced psychophysiological states and emotions are as real as the states and emotions of other origins (Koelsch, 2010). Several studies have been conducted in order to investigate the relationship between music and stress levels. The results of a study conducted in collaboration between French and Canadian researchers revealed that salivary cortisol level stopped increasing after the stress stimulation when music was present. Other the other hand, the cortisol levels of participants in the silence condition continued to increase. (Khalfa, 2003). It suggests that the presence of music prevents the stress response from building up after the initial stress stimulation.

Another example is the research conducted by a team of Australian researchers from Monash University, who looked in their study at stress-induced effects on heart rate, subjective anxiety and systolic blood pressure and their possible relation to music. Results showed that increases in the characteristics mentioned above were each prevented by exposure to music (Knight, 2001).

But is any music equally good for this purpose? Another study looked at whether music can improve cardiovascular recovery after stress and whether or not it depends on the genre. Their findings showed that participants who listened to classical music after a stressful stimulation had significantly lower levels of systolic blood pressure than those who listened to silence, pop, or jazz music (Chafin, 2004).

Another musical phenomenon connected to stress reduction is relaxation music. Relaxation music is widely used in music therapy, psychology and cognitive sciences research (Khalfa, 2003; Knight, 2001; Kukielczynska-Krawczyk, 2016), but the phenomenon itself still requires clarification. The first attempts to define relaxation music were made by Gaston (1951). Relaxation music which he referred to as sedative music: "has sustained melodic lines, non-percussive, quiet, even and simple rhythms with lots of repetition". However, as noticed by other researchers (see Tan, 2012), responses to relaxation music differ from person to person and depends highly on such factors as musical background, personal associations and past experiences, cultural background, familiarity and the listener's current psychological state.

The role of preference for relaxation effect seems to be ambiguous. On the one hand, a study has shown, that even though music listening had an effect on cardiovascular and respiratory systems, these effects were dependent on musical properties rather than the listeners' preference, repetition or habituation (Bernardi, Porta, & Sleight, 2006). However, on the other hand, according to Tan (2012), listener's preference can increase a relaxation effect: preference was significantly correlated with perceived degree of relaxation in both professional music therapists and adults with no musical training.

A set of studies were conducted to define relaxation music (Tan, 2012). First of all, 30 pieces of relaxation music were selected by music therapists. Then, selected pieces were listened to and evaluated by another group of therapists. The parameters for evaluation were the following: personal preference, perceived degree of relaxation and familiarity. Also, psychophysical properties associated with relaxation music were identified and rated. The analysis revealed that most of the 30 selected pieces of relaxation music had the following features:

- tempo is approximately 60 bmp;

- pitches around C5;

- small dynamic changes;

- moderately complex melody (able to repeat approximately 65% of the melody);

- relatively low rhythmic complexity (able to repeat approximately 80% of rhythm);

- diatonic, with tonic center;

- small ensemble or chamber ensemble;

- no lyrics (mostly);

- no vocalization;

- major mode;

- ascending and descending contour;

- timbrel structure: synthesizers (46.7%), string instruments (40.0%), others (13.3%) (e.g., percussion, dulcimer, voice).

These results also suggested that both preference and familiarity increased the salience of the relaxation effect (Tan, 2012).

There are various music-assisted and music based relaxation techniques. A study conducted by Robb (2000) compared different relaxation techniques and conditions: music assisted progressive muscle relaxation, progressive muscle relaxation, music listening, and silence. However, results revealed that all conditions led to significant decrease in anxiety and increase in perceived relaxation, but the mean difference between pre- and post-experiment measurements of anxiety and perceived relaxation was larger for participants who received music assisted progressive muscle relaxation.

2.6   Practical implication: receptive methods in music therapy

In music therapy, music listening mostly represented as a part of receptive techniques. According to Grocke and Wingram (2007) receptive music therapy is the technique by which *the client is the recipient of the music experience*. This contrasts other techniques, where the client is the music maker. In contrast to active methods of music therapy, receptive methods are focused on music listening. Relaxation procedures also belong to the larger group of receptive music therapy methods. A broader explanation of receptive music therapy was given by Bruscia (1998, pp. 120-121):

"In receptive experiences, the client listens to music and responds to the experience silently, verbally or in another modality. The music used may be live or recorded improvisations, performances or compositions by the client or therapist, or commercial recordings of music

literature in various styles (e.g. classical, rock, jazz, country, spiritual, new age). The listening experience may be focused on physical, emotional, intellectual, aesthetic or spiritual aspects of the music and the client's responses are designed according to the therapeutic purpose of the experience".

2.7   Summary

A number of different stress studies have shown the negative effects of long-term and chronic stress. Environmental psychology research has also shown a long-existing viewpoint that the natural environment has a positive effect on human health. Different mechanisms behind this phenomenon were discussed, including stress recovery, which was found to be the most supported in the literature on the topic. Results of a number of studies in the framework of restoration environment research revealed, that natural environments could facilitate stress reduction. These results found practical implications in such branches of psychotherapy such as outdoors psychotherapy. These studies have demonstrated the positive effects of music listening on stress reduction. Music for relaxation most often possess certain features such as slow tempo, clear structure, the absence of sudden rhythmic and dynamic changes. In respect to music therapy, music listening is the core of receptive music therapy techniques, and findings from these studies can be used by clinicians in order to facilitate stress reduction in patients.

3   RESEARCH AIM, RATIONALES AND HYPOTHESES

Research findings in the field of environmental psychology have suggested that a natural environment is beneficial for the human health. Therapy, however, is normally conducted in the clinical setting and therapists do not usually have the ability to take patients outdoors. In this research, elements from the natural environment were recreated in the clinical setting using nature sounds, forest images and potted plants. The main research question is: will the relaxation music listening in presence of the elements of natural environment lead to greater stress reduction than relaxation music listening in a normal clinical setting? This question is of importance because, first of all, there is a risk of developing chronic stress for those individuals who experience long-term stress on a daily basis, which may lead to the development of certain stress-related diseases. Long-term stress increases the chances of developing cardiovascular disease, bronchial diseases, skin conditions, ulcers, diabetes mellitus, atherosclerosis and certain psychiatric disorders such as neurosis and depression (Salleh, 2008).

Secondly, even though the positive effects of natural environment were shown in several studies, it is not easy and often not possible at all to take patients outdoors due to the restrictions and regulations that therapists have to follow, as well as patients' conditions and several safety reasons. In this study, nature was "taken to the clinic", and the purpose was to investigate how nature elements combined with relaxation music can be used in clinical settings for stress reduction. Thus, even though the current study is not a therapy process, the results of this study can find wider practical implication in everyday use among clinicians.

Finally, I believe that this question is important also because of the cultural aspect. This study was conducted in Finland, and nature and forests have been playing an important role for Finnish people throughout their history. Nowadays, Finnish people still consider their nature as an important part of their lives and use natural environment for restoration. The significance of nature for Finnish people makes the question especially relevant for their unique cultural setting.

Certain characteristics of Finnish nature make taking the process outdoors an even more challenging task: weather conditions (long winters) and potentially dangerous natural inhabitants of forests such as ticks, may interrupt therapy processes or even make it practically impossible. Therefore, bringing the elements of a natural environment to the clinical setting would allow to combine the benefits of a natural environment with the safety of an indoor clinical setting. Of course, using only certain elements of natural environment indoors is not equal to being outdoors: elements such as specific nature smells, air and light quality are difficult to recreate indoors. Nevertheless, it makes it easier to control all variables and attain more reliable results. According to Ulrich (1984), having certain natural elements indoors, such as potted plants, also enhances recovery processes and helps to diminish stress levels.

There are 2 main hypotheses in this study:

1. Both Nature and Clinic interventions will lead to the decrease in stress levels.

2. Nature intervention will lead to the greater decrease in stress levels.

To test the hypotheses, an experiment with Clinic and Nature conditions was conducted. The elements of natural environment were recreated by using sound and visual stimuli, such as nature sounds, video clips with forest images and potted plants. Visual stimuli were included because in the original Ulrich's study (1984) the view from the window was used as a stimulus, and in the study conducted by Annerstedt et al (2013) virtual reality forest (including forest images) was used. These elements are relatively easy to bring indoors;, they can be naturally included in the clinical context and some of them were proven to have positive effects on the human health regarding stress issues and recovery processes.

Young adults were chosen as a target group because individuals from this age group often experience stress in their work or school life due to the busy lifestyle, and because at this age it is still possible to prevent stress-related issues. Also, most previous studies investigating the relationship between natural environments and stress levels were concentrated on less mobile groups of people such as elderly.

4   METHOD

In the current study, the role of the environment for stress reduction was investigated by alternating between a usual, non-environmental, clinical setting and a setting with elements from a natural environment recreated in clinic. These conditions will be further referred as "Nature" and "Clinic".

4.1   Participants

Nine (*N*= 9) healthy young adults (2 male, 7 female, 22 to 29 year old, Mean age 26) of different nationalities (Finland, Russia, Great Britain, France, India, Mexico, Lithuania) were recruited for participation in the experiment. Participants were recruited through mailing lists and social media. The sampling method was convenience sampling. Most participants reported stress related issues during the recruitment stage. Each participant provided information about their age, height, weight and general health.

4.2   Data sources

Data were collected through several different sources, including subjective reports and objective measurements. To assess the general stress levels of participants, a Depression, Anxiety and Stress Scale (DASS-21) was used. DASS-21 is a self-report psychometric tool for measuring the levels of depression, anxiety and stress, which consists of 21 items. It is a shorter version of the original DASS scale, which includes 42 items. DASS-21 has been shown to be a valid tool for measuring depression, anxiety and stress in men and women (Henry, 2005; Gomez, 2014). The visual analogue scale (VAS) for measuring subjective perception of the stress levels was given to participants before and after each intervention.

Heart rate variability (HRV) was measured continuously during the experimental time: starting from the day before the intervention, during the day of intervention and ending on the following day. The heart rate monitors "Bodyguard 2" were used for this study. The heart rate

monitors and the software are produced by Firstbeat Technologies Oy ("Firstbeat", 2018). The soft skin-friendly electrodes were used to minimize the discomfort. One electrode was attached on the right, under the collar bone, and the other one was attached on the left, under the rib cage. Figure 1 in the Appendix illustrates the procedure. These monitors were chosen because they are compact, user-friendly, comfortable to wear and suitable for long-term measurements.

Participants were encouraged to live their normal lives and engage in their usual everyday activities while wearing the heart rate monitors. They also filled in measurement diaries which provided the data about their everyday activities, especially those that were stressful, straining or recreational. Also, a sleep inquiry was provided to participants. Each participant was given detailed instructions and demonstration of the monitor before the experiment. Special skin-friendly electrodes for long-term measurements were used to avoid skin irritation and/or evoke any additional stress in participants.

Finally, a questionnaire about the listening experiences was offered to the participants after each intervention. The questionnaire consisted of the following statements which participants evaluated using a 5-point Likert scale: I found the music relaxing; I found the music pleasurable; I paid attention to the surroundings; I closed my eyes during the experiment; I have experience in relaxation procedures; Overall, I enjoy relaxation music.

4.3 Stimuli selection and a pilot study

The selection of stimuli was conducted in several steps. A great number of relaxation tracks and tapes can be found today through streaming services online. A pilot was first conducted in order to select suitable relaxation tracks. This step was taken in order to exclude from the actual study any tracks which might evoke negative feelings and reactions in participants, or were found too activating by the participants of the pilot study.

Five relaxation tracks composed and performed by different artists were selected using the parameters presented by Tan et al (2012) and offered to a group of participants ($N = 10$, 9 females, 1 male), who then reported their relaxation levels before and after listening, and their opinion about whether they considered the tracks to be annoying or pleasurable, activating or

relaxing. Participants were given visual analogue scales to report their experiences. Participants listened to the excerpt of each piece, then had time to evaluate it. Silent pauses were kept between the pieces. The table 1 below illustrates the participant' ratings of the songs by the parameter "Relaxing".

TABLE 1. Participant' ratings of the songs by the parameter "Relaxing".

	N	Minimum	Maximum	Mean	Std. Deviation
Track 1	10	56,00	100,00	83,4000	14,47757
Track 2	10	32,00	100,00	67,1000	23,77417
Track 3	10	36,00	86,00	57,0000	17,49286
Track 4	10	28,00	100,00	68,8000	23,07861
Track 5	10	33,00	100,00	70,2000	23,69154

As the table 1 shows, the first track was the most relaxing for these participants. The fifth track was the second most relaxing, but the difference with the first track was quite noticeable. The table 2 below illustrates the participant' ratings of the songs by the parameter "Pleasurable".

TABLE 2. Participant' ratings of the songs by the parameter "Pleasurable".

	N	Minimum	Maximum	Mean	Std. Deviation
Track 1	10	31,00	100,00	74,3000	24,27642
Track 2	10	37,00	100,00	75,3000	19,79366
Track 3	10	40,00	100,00	68,0000	22,10581
Track 4	10	22,00	100,00	64,6000	23,43881
Track 5	10	37,00	100,00	70,3000	23,70677

The most pleasurable tracks were the second and the first (see Table 2). The fifth track was the third most pleasurable. However, the relaxation effects of track are of more importance for the purpose of the study, and the "Pleasure" parameter was included in order to avoid "annoying" tracks in the actual experiment. The final choice was made in favour of the first and fifth tracks.

The table 3 below illustrates the participant's perceived relaxation levels before and after the listening.

TABLE 3. Participant's perceived relaxation levels before and after the listening.

	N	Minimum	Maximum	Mean	Std. Deviation
Before	10	3,00	9,00	5,0000	1,82574
After	10	7,00	10,00	8,1000	1,28668
Valid N (listwise)	10				

As the table 3 shows, the subjective stress levels were decreased in all participants.

Those tracks found to be the most relaxing and pleasurable were eventually chosen as experimental stimuli. All participants listened to the same tracks by Brian Eno and Deuter during the experiment.

Nature stimuli consisted of several elements: nature sounds with an emphasis on birdsongs, visual stimuli featuring nature and potted plants. The soundscapes typical of Finnish forests and rivers were used for the nature sound stimulus. The sounds were recorded near Jyväskylä and carefully selected in order to avoid those sounds which naturally evoke stress responses, such as unexpected changes in the soundscape. Even though they are also a part of natural soundscape, such sounds have the potential trigger stress responses and therefore are not deemed suitable for stress reduction purposes. Also, a video of a green forest was projected to the screen as a visual stimuli, and a potted plant was placed in the room.

4.4   Experimental design

Even though we are talking about the clinical setting, the study itself is not a therapeutic process, but an experiment. However, findings that may arise from the results of the study might find their practical implication in receptive music therapy.

There were two conditions in the experiment: clinical setting with relaxation music without nature sounds (Clinic) and "nature" setting with relaxation music with nature sounds (Nature). Each session took around 30 minutes. The study follows within-subject design, so each participant took part in both conditions. A within-subject experimental design was chosen due to the nature of HRV data: the norms are very individual and vary a lot from person to person. The design of experimental procedure:

a. HRV Measure 1 begins – VAS Measure 1 – Clinic – VAS Measure 2 – HRV Measure 1 ends – Break of a week – HRV Measure 2 begins – VAS Measure 3 – Nature – VAS Measure 4 – HRV Measure 2 ends

or

b. HRV Measure 1 begins – VAS Measure 1 – Nature – VAS Measure 2 – HRV Measure 1 ends – Break of a week – HRV Measure 2 begins – VAS Measure 3 – Clinic – VAS Measure 4 – HRV Measure 2 ends

The design is quite similar to the Alternating treatments design: baseline measure, intervention 1, measure, intervention 2, measure (Byiers, 2012), with a break of a week between interventions. Order of the interventions was pseudo-random: 5 participants received Clinic condition first, 4 participant received Nature condition first. This was done to prevent the order effect.

5   RESULTS

The collected data were analyzed on two levels: general and individual. General analysis was conducted by comparing mean results of the whole sample. Its purpose was to find possible patterns and see if they were statistically significant. However, the nature of the data allowed also more detailed analysis of each individual case. Heart rate variability data is highly individual, and the results could be affected by individual differences of physiological nature, lifestyle, current situation, etc. Thus it was decided to analyse each participant's results individually as well as generally.

5.1   General analysis

5.1.1   General analysis of RMSSD

The time periods of two hours before, during and two hours after each intervention were used as the first set of the points of analysis based on the "Three Rs principle": Resting, Reactivity, Recovery (Laborde, 2017). This allowed for the assessment of the dynamics of RMSSD for this time period and see if the intervention had any immediate or long-term effects.

Nights before and after each intervention were chosen as another point of analysis. This was done in order to see if the intervention had a long-term effect: if it affected sleep quality, it was believed to have promoted recovery. This is important since long-term and chronic stress can cause different stress-related health issues. Short-term stress, however, is a normal part of everyday life and it is normally not a health threat as long as there are recovery periods between stress reactions. Night sleep is an important recovery point, so it was chosen as the second point of analysis.

As was mentioned earlier, the heart rate variability was used as physiological indicator of stress, and RMSSD was used, as it is a time-domain parameter, thus is suitable for the long-term measurements (Laborde, 2017). Due to the individual differences in the heart rate data,

the logarithm transformation was used to normalize it (Stanley et al., 2013). It is indicated as lnRMSSD. For individual analysis was used the original data.

Figure 2 illustrates the estimated marginal means of lnRMSSD for two hours before, during and two hours after each intervention. The Table 4 shows the means and standard deviation for each time period. As was explained earlier, the higher RMSSD is the lower the participant's stress levels.

TABLE 4. Descriptive statistics for lnRMSSD 2 hours before, during and after each intervention

Time	Mean	Std. Deviation	N
2 hours before the Nature condition	3,4185	,33076	9
2 hours before the Clinic condition	3,4825	,34815	9
Nature condition	3,4642	,49285	9
Clinic condition	3,6154	,33406	9
2 hours after the Nature condition	3,4031	,50146	9
2 hours after the Clinic condition	3,4828	,32777	9
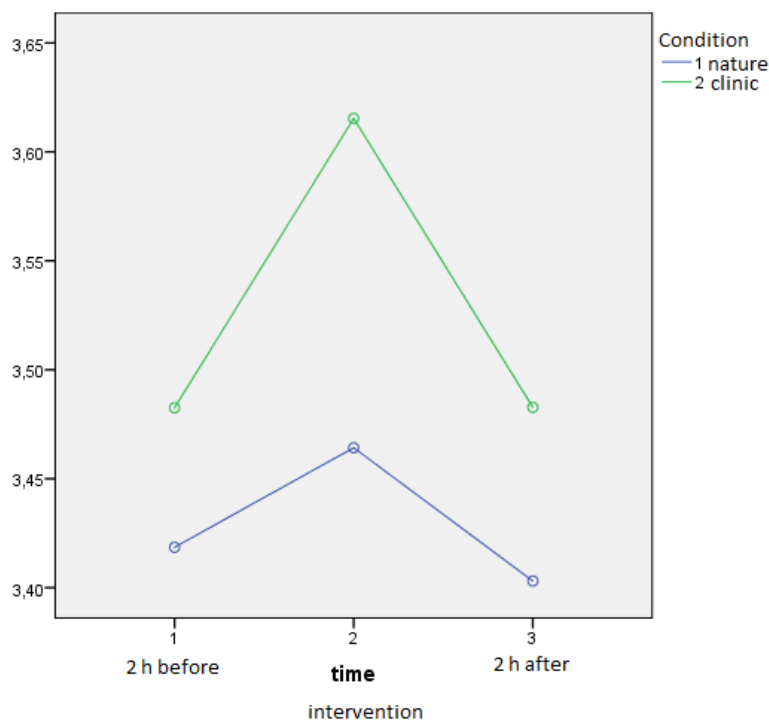
FIGURE 2. Estimated marginal means of lnRMSSD for 2 hours before, during and 2 hours after each intervention.

A two-way repeated measures ANOVA was conducted in order to see if there was a significant difference in RMSSD between the given time periods (before, during and after) in the Clinic and Nature condition. The main effect for the condition type yielded an F ratio of $F(1,8) = 1.02$, $p > .05$, indicating that there was no significant difference between the Nature and Clinic conditions. The main effect for the time periods (before, during, after) yielded an F ratio of $F(2,16) = 1.00$, $p > .05$, indicating that there was no significant differences in RMSSD between the given periods of time. The interaction effect was not significant ($F(2,16) = 0.17$, $p > 0.05$).

Figure 3 below illustrates the estimated marginal means of lnRMSSD for the night before and after each intervention. Table 5 shows the means and standard deviation for each time period.

TABLE 5. Descriptive Statistics for lnRMSSD the nights before and after both conditions

Time	Mean	Std. Deviation	N
Night before the Nature condition	3,9872	,38426	9
Night before the Clinic condition	4,0895	,36335	9
Night after the Nature condition	4,0600	,31710	9
Night after the Clinic condition	4,1380	,34031	9
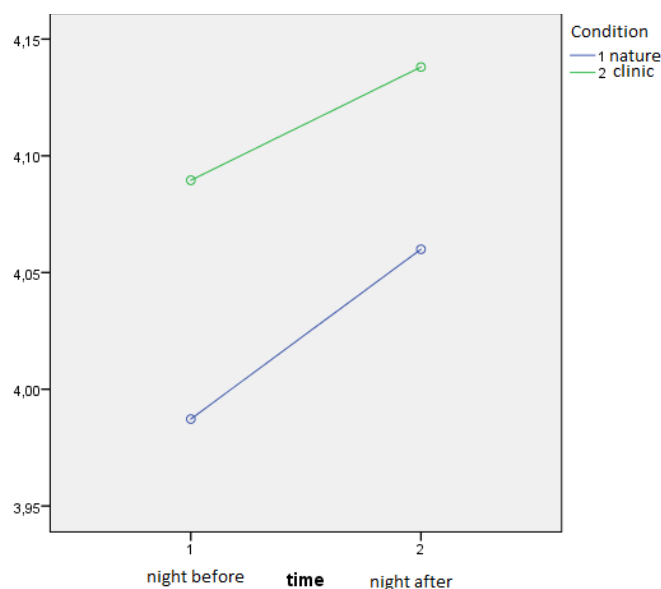
FIGURE 3. Estimated marginal means of lnRMSSD for the night before and after each intervention.

A two-way repeated measures ANOVA was conducted to see if there was a significant difference in RMSSD between the nights before and after Clinic and Nature condition. The main effect for the condition type yielded an F ratio of $F(1,8) = 2.59$, $p > .05$, indicating that

there was no significant difference between the Nature and Clinic conditions. The main effect for the time periods yielded an F ratio if $F(1,8) = 1.54$, $p > .05$, indicating that there was no significant differences in RMSSD between the nights before and after. The interaction effect was not significant ($F(1,8) = 0.08$, $p > .05$).

5.1.2 General analysis of Visual Analogue Scale

Visual analogue scale (VAS) was used to assess the subjective stress levels of participants before and after each intervention. The collected data were not normally distributed, so a Wilcoxon matched-pairs test was used. Results indicated that post-measurements of subjective stress level were significantly lower than pre-measurements for both the clinic and nature settings, and that difference was higher for the Nature condition ($Z = -2.52$, $p=.012$ for clinic and $Z= -2.67$, $p=.008$ for nature).

5.1.3 Stress

Another parameter of interest was the participants' general stress level. The questionnaire DASS-21 was used to measure Depression, Anxiety and Stress. The Table 6 below illustrates the results (the levels are colour-coded, see the test key in the Appendix, Table 7).

TABLE 6. Results of DASS questionnaire

	DASS	normal	mild
	moderate	severe	extremely severe
Participant	Depression	Anxiety	Stress
1	24	22	28
2	6	4	10
3	18	20	20
4	8	4	10
5	4	16	30
6	18	24	20
7	6	6	8
8	0	8	6
9	18	18	28

Both those, who have "Normal" stress levels and those, whose stress levels vary from "Moderate" to "Severe" are present in the sample (ratio of stressed and non-stressed is 5:4).

The tables 8 and 9 below illustrate the descriptive statistics for lnRMSSD of Stressed and Non-stressed groups of participants.

TABLE 8. Descriptive statistics for lnRMSSD Stressed participants

Stressed participants	N	Minimum	Maximum	Mean	Std. Deviation
Night before the Nature condition	5	3,45	4,82	3,9694	,51504
2 hours before the Nature condition	5	3,14	4,05	3,5269	,33248
Nature condition	5	2,81	4,14	3,6024	,56074
2 hours after the Nature condition	5	2,69	4,15	3,5047	,68237
Night after the Nature contion	5	3,85	4,74	4,1571	,35958
Night before the Clinic condition	5	3,63	4,79	4,1064	,42514
2 hours before the Clinic condition	5	3,22	4,12	3,6184	,36101
Clinic condition	5	3,23	4,28	3,6285	,42915
2 hours after the Clinic condition	5	2,95	4,04	3,4435	,41668
Night after the Clinic condition	5	3,58	4,83	4,1657	,44689
Valid N (listwise)	5				

TABLE 9. Descriptive statistics for lnRMSSD for Non-stressed participants

Non-stressed participants	N	Minimum	Maximum	Mean	Std. Deviation
Night before the Nature condition	4	3,78	4,26	4,0095	,19714
2 hours before the Nature condition	4	2,84	3,57	3,2831	,31670
Nature condition	4	2,81	3,73	3,2916	,39619
2 hours after the Nature condition	4	3,19	3,43	3,2760	,10477
Night after the Nature contion	4	3,66	4,25	3,9385	,24561
Night before the Clinic condition	4	3,75	4,41	4,0685	,33167
2 hours before the Clinic condition	4	2,96	3,57	3,3127	,28318
Clinic condition	4	3,37	3,80	3,5990	,22666
2 hours after the Clinic condition	4	3,22	3,72	3,5319	,22185
Night after the Clinic condition	4	3,96	4,38	4,1034	,19918
Valid N (listwise)	4				

The Figures 4 and 5 below illustrate the changes in lnRMSSD in stressed and non-stressed participants during the nights before and after both interventions and 2 hours before, during and 2 hours after each intervention. As Figure 4 shows, night recovery of the stressed participants increased after both interventions, but especially after the Nature intervention. Contrary, night recovery of the non-stressed participants decreased after the Nature intervention. However, after the Clinic intervention, night recovery of the non-stressed

participants increased. As Figure 5 illustrates, there were no changes in the HRV of non-stressed participants during and after the Nature intervention, but during the Clinic intervention their lnRMSSD increased significantly. At the same time, heart rate variability of stressed participants increased more during the Nature intervention.
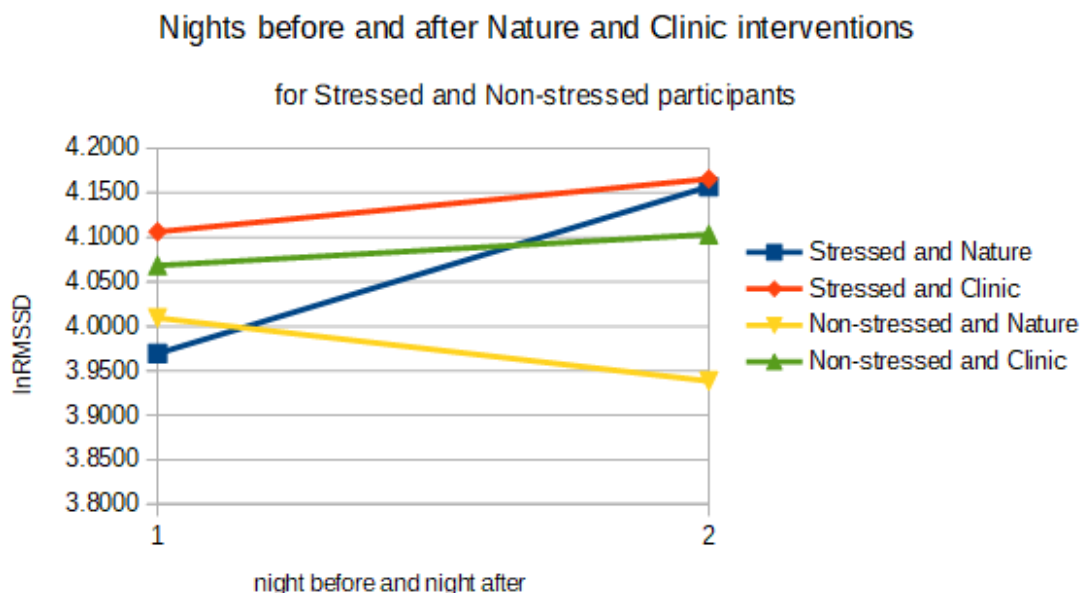
FIGURE 4. Nights before and after Nature and Clinic interventions for Stressed and Non-stressed participants
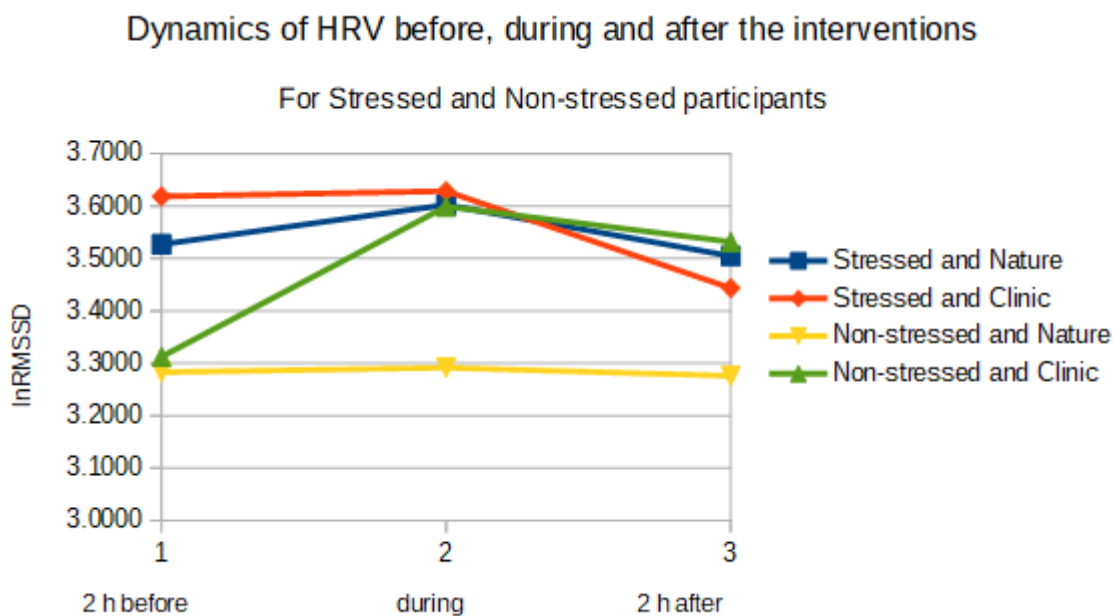
FIGURE 5. Dynamics of HRV before, during and after the interventions for stressed and non-stressed participants.

5.2   Individual analysis

Individual analysis was conducted using visual methods. The Figures show the changes in participants' RMSSD during the following time periods: 2 hours before, during and 2 hours after each intervention, and night before and after each intervention. Furthermore, information about everyday activities of participants was included in the individual analysis, which gave a chance to see how intervention related to other activities and the lifestyle of each participant. Information about participants' activities was taken from their measurement diaries, marked at the Figures and colour coded: light-green colour means an intervention, red – psychological stress, blue – physical activity, dark green – recreational activities and gray – other. All colours, apart from the colours for "intervention" and "other" were suggested by the FirstBeat software.

Participant 1

Participant 1 found the music relaxing and pleasurable, kept eyes closed and did not pay attention to the surroundings. Participant 1 had some experience in relaxation techniques and a neutral attitude towards relaxation music in general. The first condition for this participant was the Clinic condition.
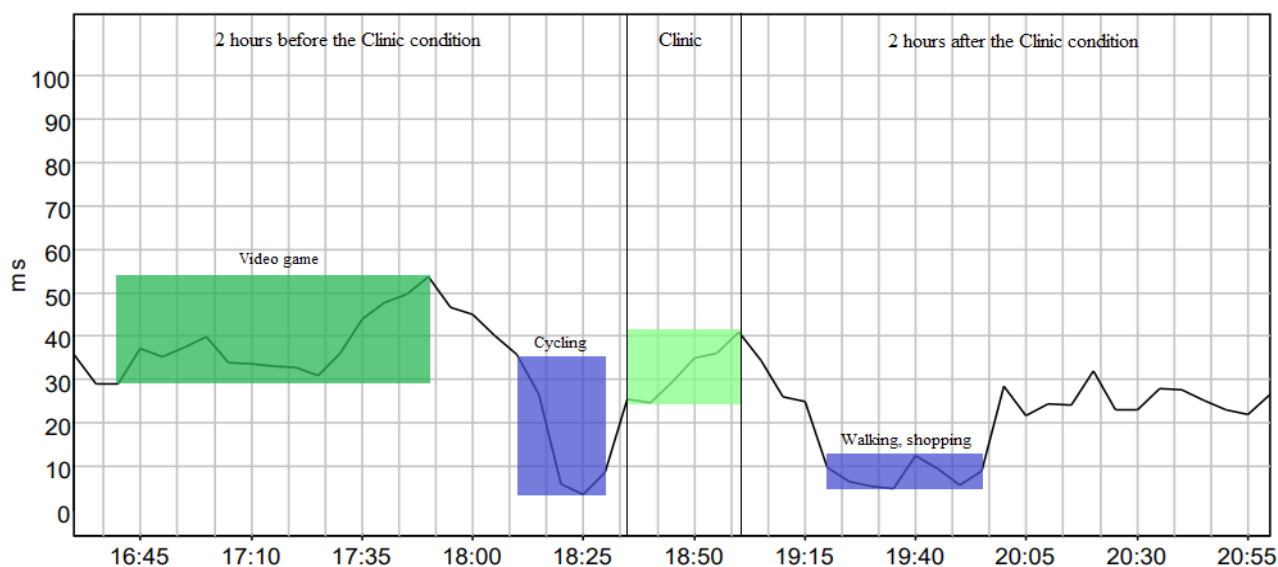
FIGURE 6. 2 hour before, during and 2 hours after the Clinic condition, Participant 1

Figure 6 above illustrates the dynamics of the heart rate variability in RMSSD from 2 hours before the Clinic condition to 2 hours after the Clinic condition. The highest point of RMSSD (≈54 ms) occurs at 17.50, while the participant was engaging with a recreational activity (video game), the lowest point (≈ 8 ms) occurs at 18.25, while the participant was cycling to the experiment. Both occur within 2 hours before the Clinic condition (Mean = 29.07). During the intervention, a steady increase in RMSSD up to ≈ 41 ms can be noticed (Mean = 33.28), followed by a decrease during the following 2 hours (Mean = 23.63).

Figure 7 illustrates the dynamics of RMSSD for the same participant from 2 hours before the Nature condition (Mean = 30.51) until 2 hours after the Nature condition (Mean = 17.27). The highest point of RMSSD (≈ 32 ms) occurs at 17.42, and the lowest point (≈ 4 ms) occurs at 19.21 while the participant was cycling after the experiment. During the intervention there was an increase of up to ≈ 31 with occasional decreases in RMSSD (Mean = 25.58).
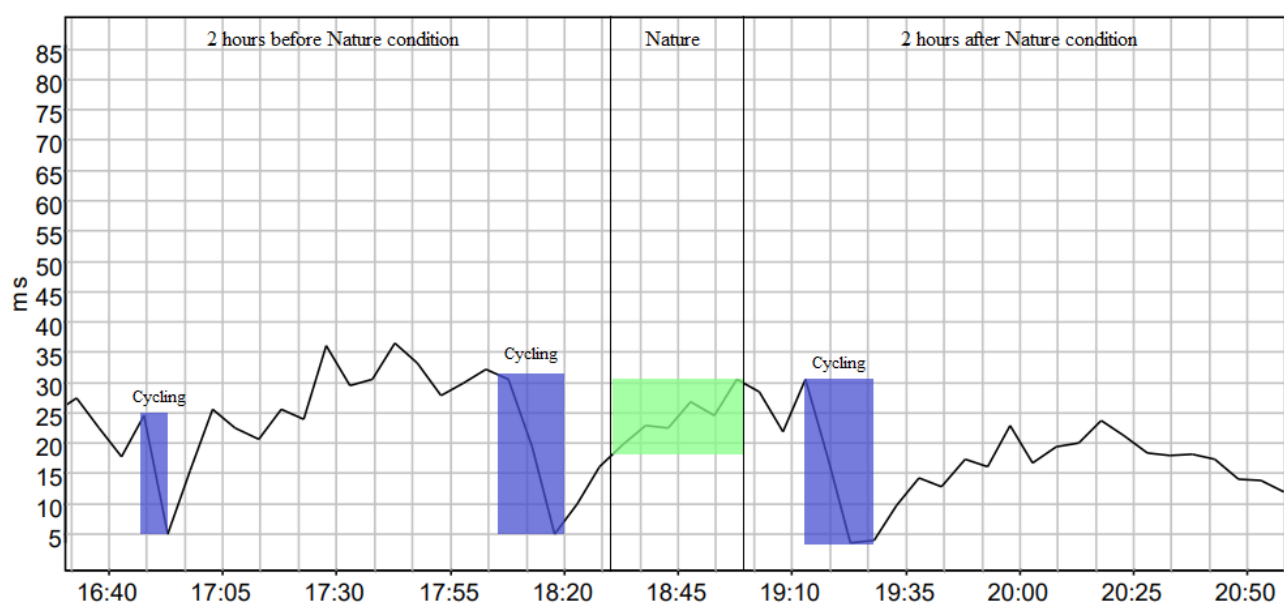
FIGURE 7. 2 hour before, during and 2 hours after the Nature condition, Participant 1

There was a minor increase in sleep quality on the night after the Clinic condition. During the first night the highest point of RMSSD was ≈ 97 ms, and the lowest point was ≈ 22 ms (Mean

= 57.04). During the night after the Clinic intervention the highest point was ≈ 97 ms, and the lowest was ≈ 35 ms (Mean = 58.03) (see the Figures 8 and 9 in Appendix).

The nights before (highest point ≈ 62, lowest point ≈ 15, Mean = 31.44) and after the Nature intervention (highest point ≈ 81, lowest point ≈ 31, Mean = 52,75) were compared too. It has to be noticed that during these days the participant was feeling tired and had a psychologically stressful event on the day before the experiment, which could have affected the sleep quality. Participant reported that on the night before the Nature intervention they did not sleep well, woke up several times during the night and eventually woke up tired in the morning. See the Figures 10 and 11 for details in the Appendix.

Participant 2

Participant 2 found the music relaxing and pleasurable, kept eyes open but did not pay much attention to the surroundings. They had little experience in relaxation procedures and a neutral attitude towards relaxation music in general. The first condition for this participant was the Nature condition.

The Figure 12 illustrates the changes in RMSSD from 2 hours before the Clinic condition (Mean = 33.29), during the Clinic condition and 2 hours after (Mean = 34.65). The highest peak (≈ 63 ms) was at 20.04, and the lowest drop (≈ 6 ms) was at at 18.25 while the participant was cycling and immediately after that. There was a drastic increase in RMSSD in the beginning of the Clinic intervention with the top point of 35 and Mean of 31.32. Figure 13 shows the dynamics of RMSSD in the period of time from 2 hours before the Nature condition (Mean = 17.17) to 2 hours after (Mean = 26.28). The highest peak (≈ 44 ms) was achieved at 20.05, while the participant was engaged in a recreational activity, and the lowest drop (≈ 4 ms) occurred at 18.20, while the participant was cycling. There was an increase of RMSSD followed by a decrease during the Nature intervention with the top point of 28 and Mean of 23.89.

RMSSD
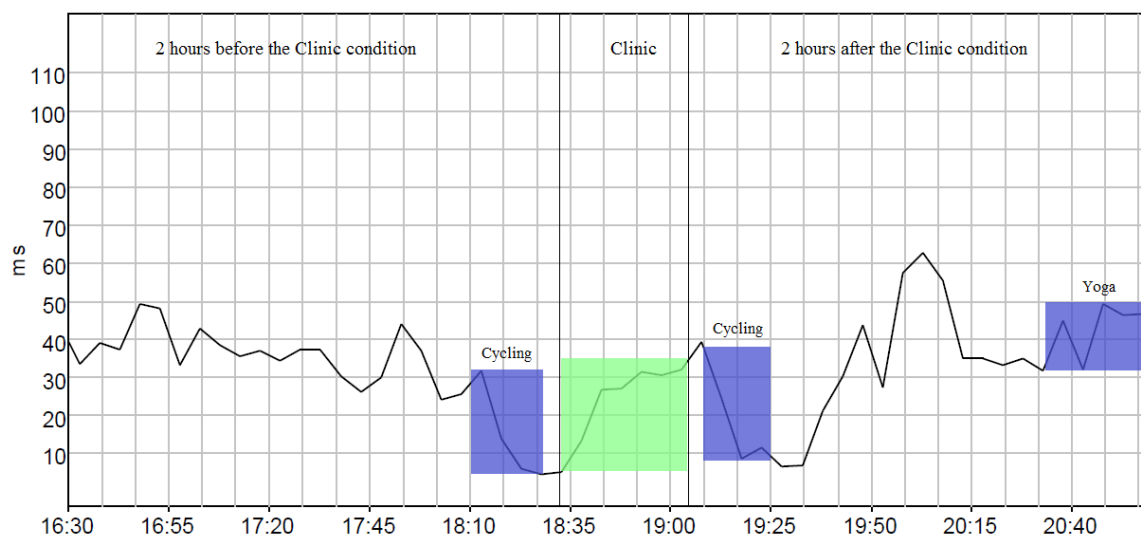
FIGURE 12. 2 hours before, during and 2 hours after the Clinic condition, Participant 2
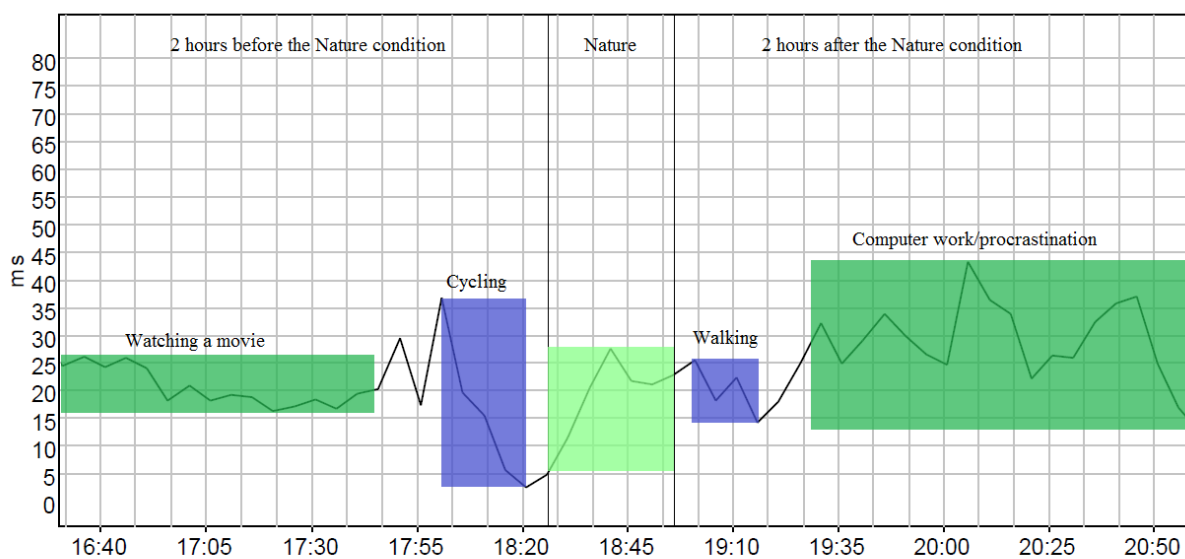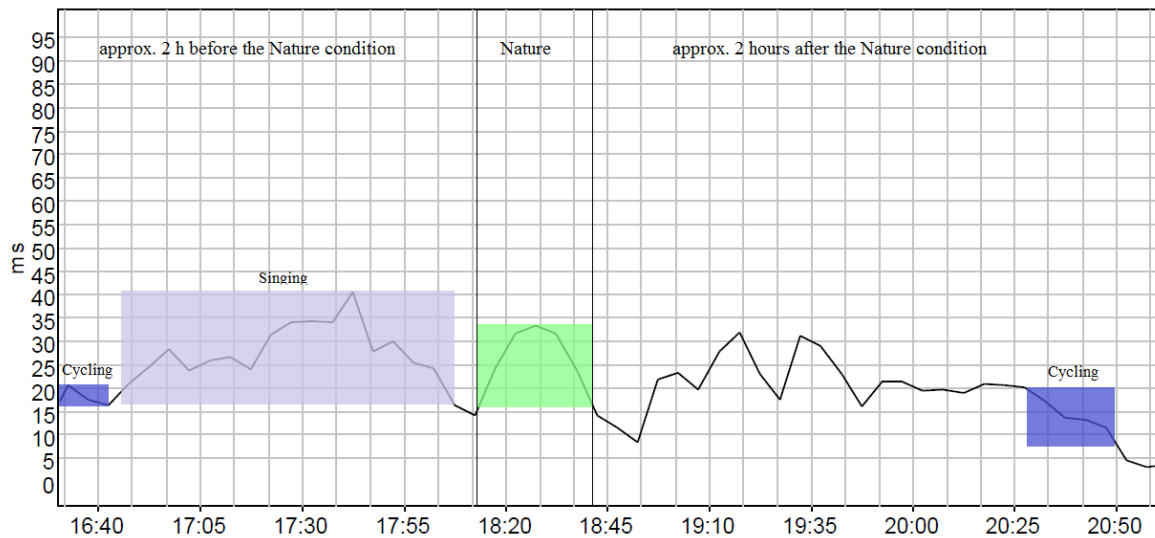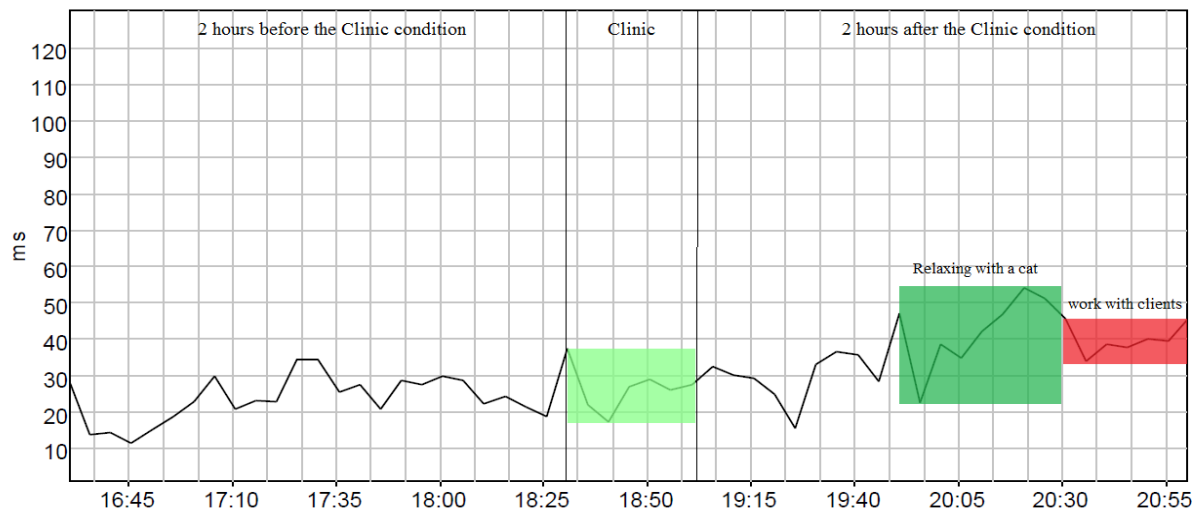
RMSSD

FIGURE 13. 2 hours before, during and 2 hours after the Nature intervention, Participant 2.

During the night before the Clinic intervention the highest point of RMSSD was ≈ 109 ms, and the lowest point was ≈ 30 ms (Mean = 72.91). During the night after the Clinic intervention the highest point was ≈ 95 ms, and the lowest was ≈ 30 ms (Mean = 60.96). The quality of sleep decreased. For more details see Figures 14 and 15 in the Appendix.

The night sleep of the participant 2 during the night before and after the Nature condition were also compared. There was a measurement break between 1.45 and 4.20 am. During the first night the highest point of RMSSD was ≈ 82 ms, and the lowest point was ≈ 21 ms (Mean = 56.93, without a measurement break). During the night after the Nature intervention the highest point was ≈ 77 ms, and the lowest was ≈ 26 ms (Mean = 48.62). The quality of sleep decreased, however, it is hard to draw any conclusions due to the measurement break. For more details see Figures 16 and 17 in the Appendix.

Participant 3

Participant 3 found the music pleasurable, kept eyes mostly closed and did not pay attention to the surroundings. The participant had little experience in relaxation procedures and did not find relaxation music enjoyable in general. The first condition for this participant was the Nature condition. A Figure 18 below shows the changes in RMSSD in the period of time from 2 hours before the Clinic condition (Mean = 25.08) to 2 hours after (Mean = 19.06). The highest point (≈ 68 ms) was achieved 20.18, however, it might have been an artifact, as the number is so much higher than the mean, and the lowest point (≈ 4 ms) was at 20.13. There was an increase of RMSSD followed by a slight decrease during the Clinic intervention with the top point of 24 and Mean of 20.02.
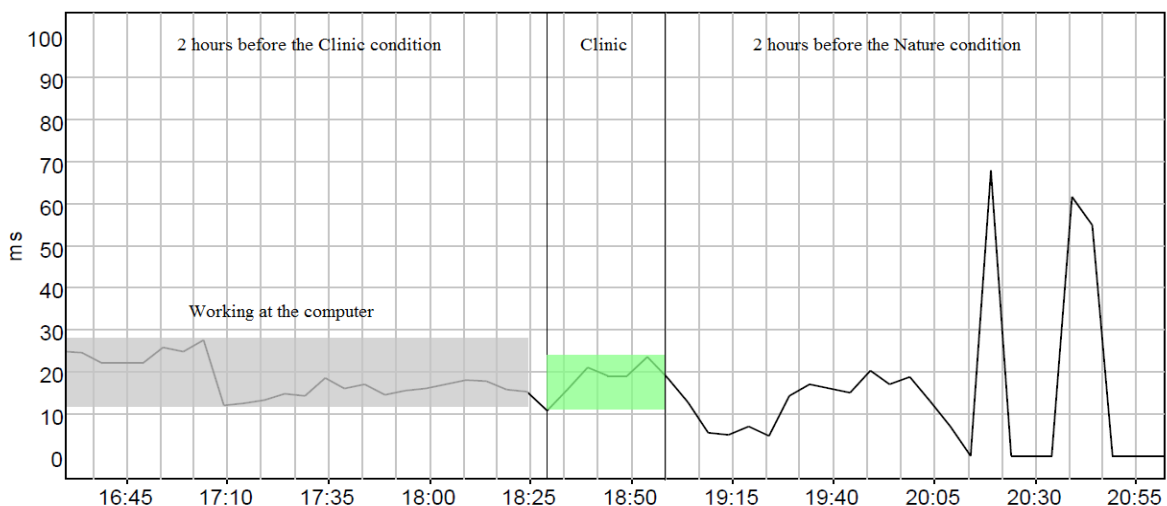
FIGURE 18. 2 hours before, during and 2 hours after the Clinic intervention, Participant 3.

Figure 19 illustrates the changes in RMSSD from 2 hours before the Nature condition (Mean = 23.19) to 2 hours after (Mean = 14.66). The highest peak ($\approx$ 40 ms) was achieved at 17.44, while the participant was singing in a choir, and the lowest drop ($\approx$ 4 ms) was at 20.58, after cycling. There was a steady increase of RMSSD followed by a similarly steady decrease during the Nature intervention with the top point of 34 and Mean of 16.62.
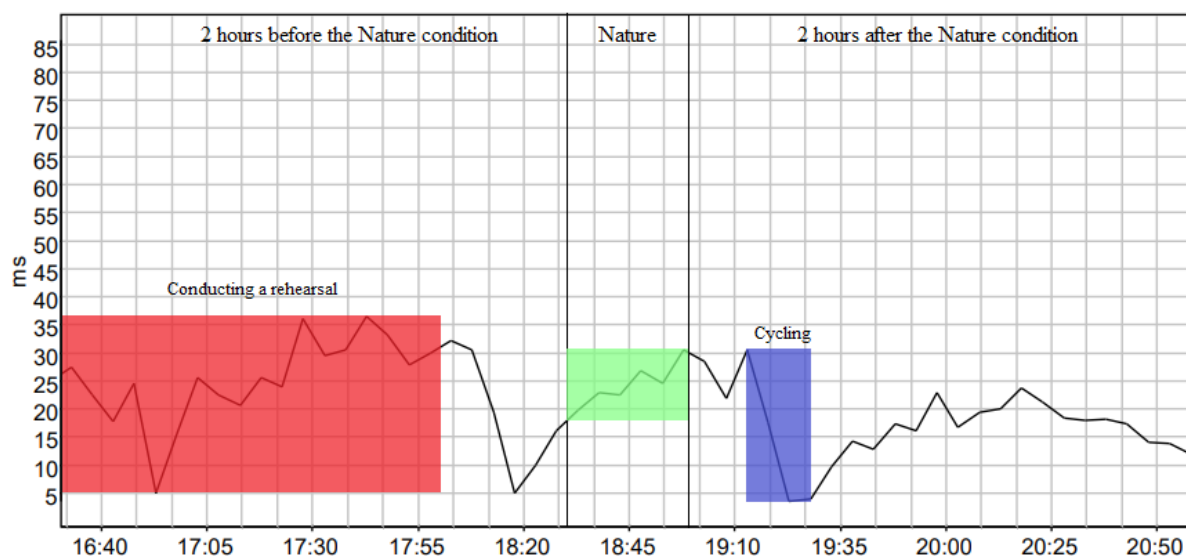
RMSSD

FIGURE 19. 2 hours before, during and 2 hours after the Nature intervention, Participant 3.

During the night before the Clinic condition the highest point of RMSSD was $\approx$ 90 ms, and the lowest point was $\approx$ 25 ms (Mean = 53.09). During the night after the Clinic intervention the highest point was $\approx$ 97 ms, and the lowest was $\approx$ 29 ms (Mean = 65.56). The quality of sleep increased. See Figures 20 and 21 for more details.

During the night before the Nature intervention the highest point of RMSSD was $\approx$ 79 ms, and the lowest point was $\approx$ 26 ms (Mean = 53.71). During the night after the Nature intervention the highest point was $\approx$ 96 ms, and the lowest was $\approx$ 28 ms (Mean = 54.42). The quality of sleep slightly increased. See Figures 22 and 23 in Appendix.

Participant 4

Participant 4 found the music very relaxing and pleasurable, kept eyes open and paid a lot of attention to the surroundings. They had little experience in relaxation techniques and enjoyed relaxation music a lot. The first condition for this participant was the Clinic condition.

The Figure 24 below illustrates the dynamics of RMSSD for participant 4 from 2 hours before the Clinic condition (Mean = 24.92) to 2 hours after the Clinic condition (Mean = 38.18). The highest point of RMSSD ($\approx$ 54 ms) occurred at 20.20, while the participant was relaxing, and the lowest point ($\approx$ 11 ms) occurred at 16.46. During the intervention there was a drastic decrease at the beginning, followed by a slow increase in RMSSD (Mean = 28.94).

FIGURE 24. 2 hours before, during and 2 hours after the Clinic condition, Participant 4.

RMSSD

*background stress during the whole day due to visitors
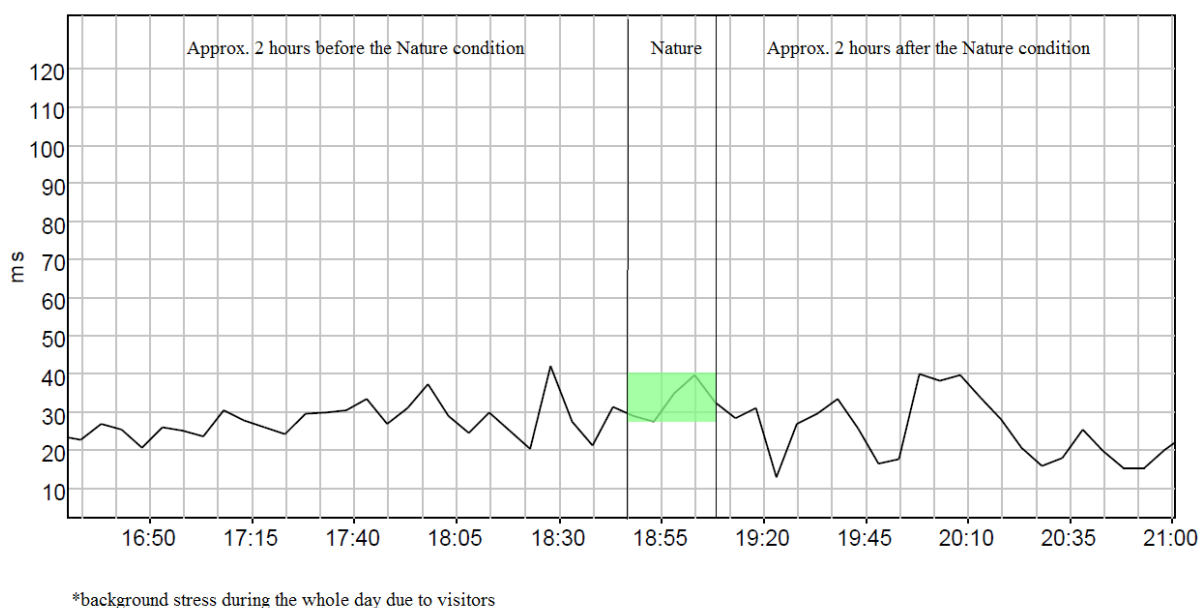
FIGURE 25. 2 hours before, during and 2 hours after the Nature condition, Participant 4.

The Figure 25 above illustrates the changes in RMSSD for participant 4 from 2 hours before the Nature condition (Mean = 26.51) to 2 hours after the Nature condition (Mean = 24.26). The highest point ($\approx$ 41 ms) occurred at 18.28 and the lowest ($\approx$ 13 ms) occurred at 19.23. During the intervention there was a minor decrease, followed by an increase (up to 40), and another decrease in RMSSD (Mean = 31.58). Unfortunately, participant has not stated participating in any other activities during the time period, but mentioned that they were under continuous stress during those days.

The sleep quality during the night before (highest point $\approx$ 125, lowest point $\approx$ 24, Mean = 82.56) was slightly higher than the night after the Clinic intervention (highest point $\approx$ 123, lowest point $\approx$ 17, Mean = 80,06). For more details see Figures 26 and 27 in the Appendix. During the night before the Nature intervention the highest RMSSD point was 126, lowest point $\approx$ 30, Mean = 70.68. During the night after the Nature intervention the highest point was $\approx$ 161, lowest point $\approx$ 30, Mean = 70,32. No significant differences was found (see Figures 28 and 29 in the Appendix).

Participant 5

Participant 5 found the music very relaxing and pleasurable, kept eyes open and paid some attention to the surroundings. Participant had some experience in relaxation procedures and enjoyed relaxation music in general. The first condition for this participant was the Clinic condition.

The Figure 30 below illustrates the dynamics of RMSSD for participant 5 for 2 hours before the Clinic condition (Mean = 46.48), during the Clinic condition intervention and 2 hours after the Clinic condition (Mean = 34.59). The highest point of RMSSD ($\approx$ 54 ms) occurred at 17.50, even though the participant reported having stressful thoughts at that time. The lowest point ($\approx$ 8 ms) occurred at 18.25. Although the participant did not state anything in their diary, it is assumed that they were cycling. During the intervention there was an increase in RMSSD up to 40 ms (Mean = 27.2).

The Figure 31 below illustrates the changes in HRV for participant 5 for 2 hours before the Nature condition (Mean = 31.60), during the Nature condition intervention and 2 hours after it (Mean = 33.78). The highest point of RMSSD ($\approx$ 37 ms) occurred at 17.28 and 17.34, even though participant reported being engaged in a stressful activity. The lowest point ($\approx$ 5 ms) occurred at 18.18. During the intervention the RMSSD increased up to 41 ms (Mean = 24.2).
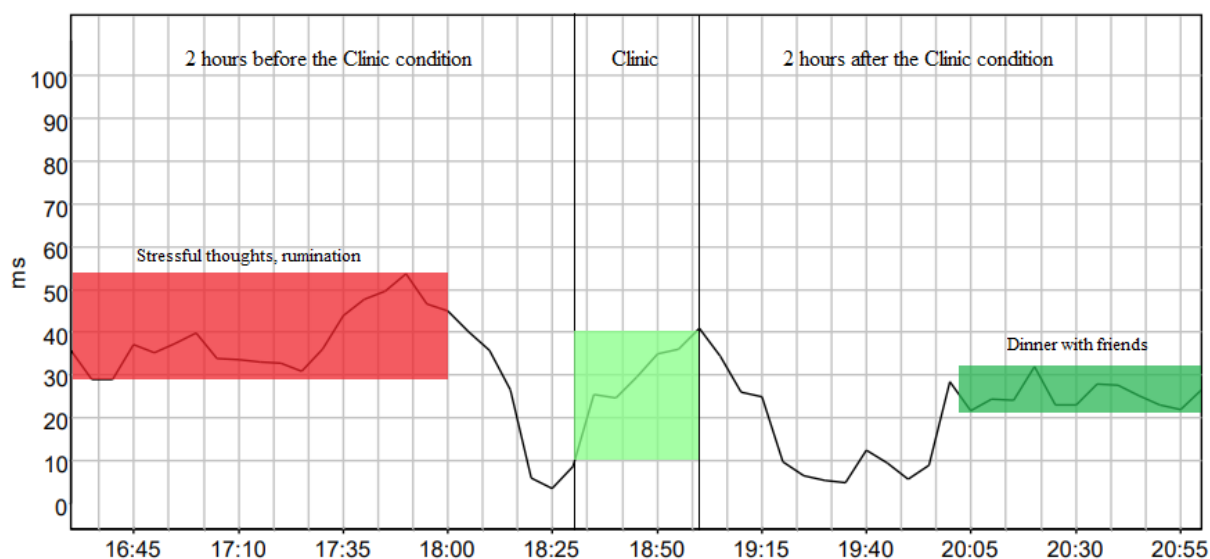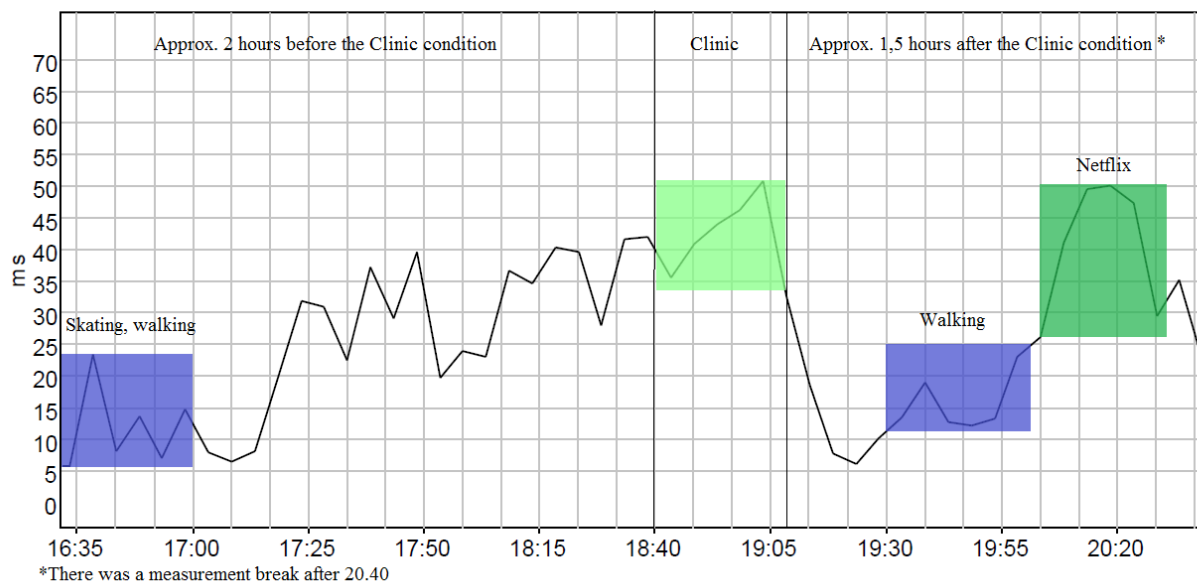

FIGURE 30. 2 hours before, during and 2 hours after the Clinic condition, Participant 5.

RMSSD

FIGURE 31. 2 hours before, during and 2 hours after the Nature condition, Participant 5.

During the night before the Clinical intervention, the highest RMSSD point was ≈ 97, lowest point ≈ 21 (Mean = 60.05). On the night after the Clinic intervention the highest point was ≈ 97, lowest point ≈ 35 (Mean = 67,32). The quality of sleep increased. For more details see Figures 32 and 33 in the Appendix. During the night before the Nature intervention the highest point was ≈ 63, lowest point ≈ 15 (Mean = 43.37), and on the night after the Nature intervention the highest point was ≈ 86, lowest point ≈ 31 (Mean = 55,40). There was a major increase in the sleep quality. See Figures 34 and 35 in the Appendix.

Participant 6

Participant 6 found the music very relaxing and pleasurable, kept eyes mostly closed and paid a little attention to the surroundings. They had some experience in relaxation procedures and some preference towards relaxation music in general. The first condition for this participant was the Clinic condition.

The Figure 36 below illustrates the changes in RMSSD for participant 6 for 2 h. before the Clinic condition (Mean = 34.63), during, and 2 hours after (Mean = 34.01). The highest point of RMSSD ($\approx$ 61 ms) occurred at 19.57, and the lowest point ($\approx$ 5 ms) was at 18.17, while the participant was cycling. During the intervention there was a drastic increase in up to 49 ms (Mean = 45.91).

RMSSD
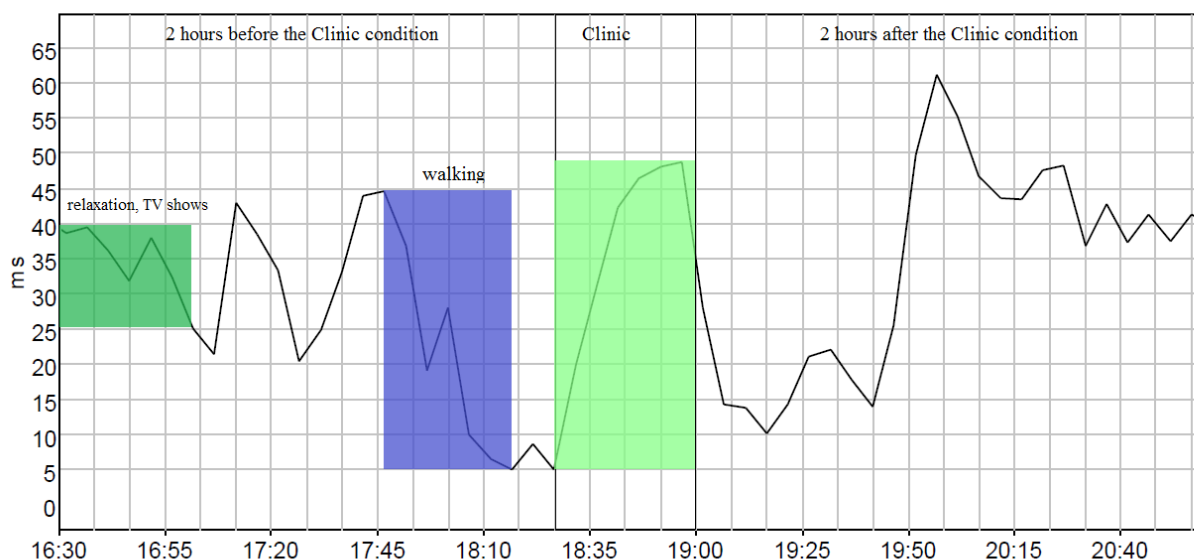
FIGURE 36. 2 hours before, during and 2 hours after the Clinic condition, Participant 6.

The Figure 37 below shows the changes in RMSSD for participant 6 for 1,5 hours before the Nature condition (Mean = 35.39), during the Nature condition intervention and 2,5 hours after the Nature condition (Mean = 52.14). The highest point of RMSSD ($\approx$ 79 ms) occurred at 17.28 during the Nature intervention, and the lowest point ($\approx$ 4 ms) occurred at 18.44, while the participant was cycling. During the intervention there was a major increase in RMSSD up to 79 ms, followed by a drastic decrease (Mean = 62.88).

RMSSD
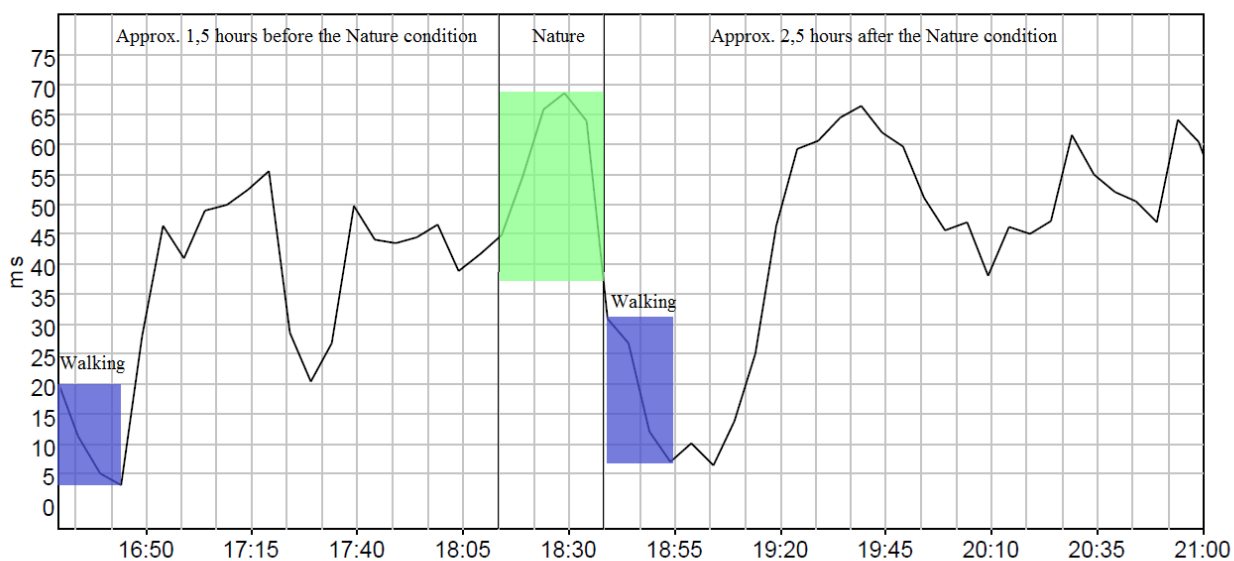
FIGURE 37. 1,5 hours before, during and 2,5 hours after the Nature condition, Participant 6.

During the night before the Clinic condition the highest RMSSD point was ≈ 66, lowest point ≈ 15 (Mean = 37.62). On the night after the Clinic intervention the highest point was ≈ 52, lowest point ≈ 11, Mean = 35,77). The quality of sleep slightly decreased. During the night before the Clinic intervention the highest RMSSD point was ≈ 64, lowest point ≈ 19 (Mean = 45.75). On the night after the Nature intervention the highest RMSSD point was ≈ 77, lowest point ≈ 30 (Mean = 46,86). There was a minor increase in the sleep quality. For more details see Figures 38-41 in the Appendix.

Participant 7

Participant 7 found the music relaxing and pleasurable, kept eyes closed during the Clinic condition and open during the Nature condition, did not pay attention to the surroundings during the Clinic, and paid attention during the Nature condition. They had a lot of experience in relaxation techniques and sometimes enjoyed relaxation music. The first condition for this participant was the Clinic condition.

The Figure 42 illustrates the dynamics of RMSSD for participant 7 for 2 hours before the Clinic condition (Mean = 19.24), during the Clinic condition intervention and 1,5 hours after the Clinic condition (Mean = 24.96). The highest point of RMSSD ($\approx$ 51 ms) occurred at 19.04 during the Clinic intervention, and the lowest point ($\approx$ 6 ms) occurred at 16.33, while the participant was skating. During the intervention there was an increase in RMSSD up to 51 ms (Mean = 44.10), followed by a decrease. There was a measurement break after 20.40.

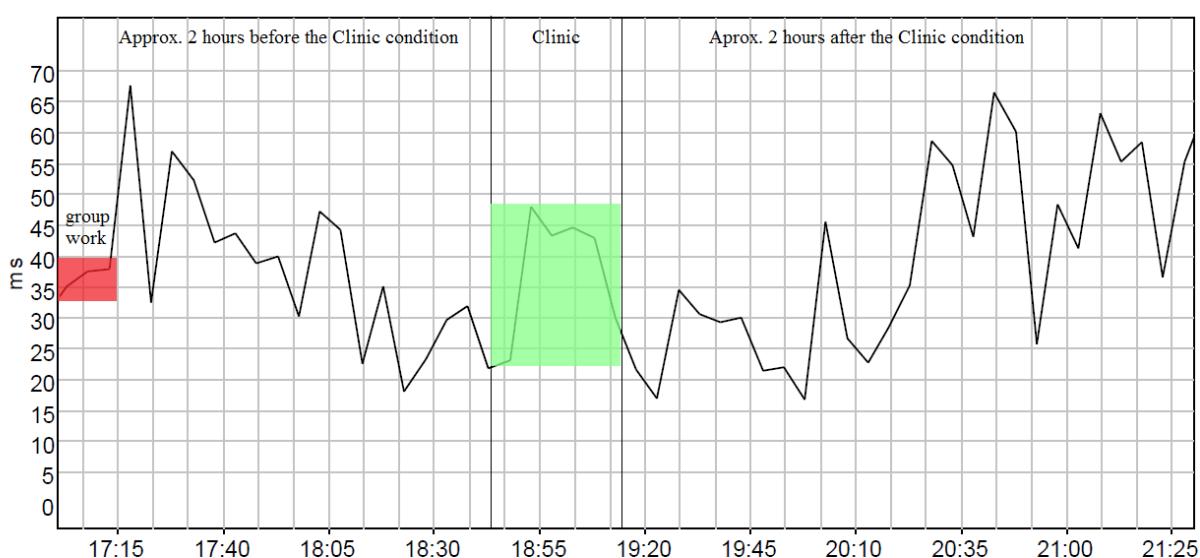FIGURE 42. 2 hours before, during and 1,5 hours after the Clinic condition, Participant 7.
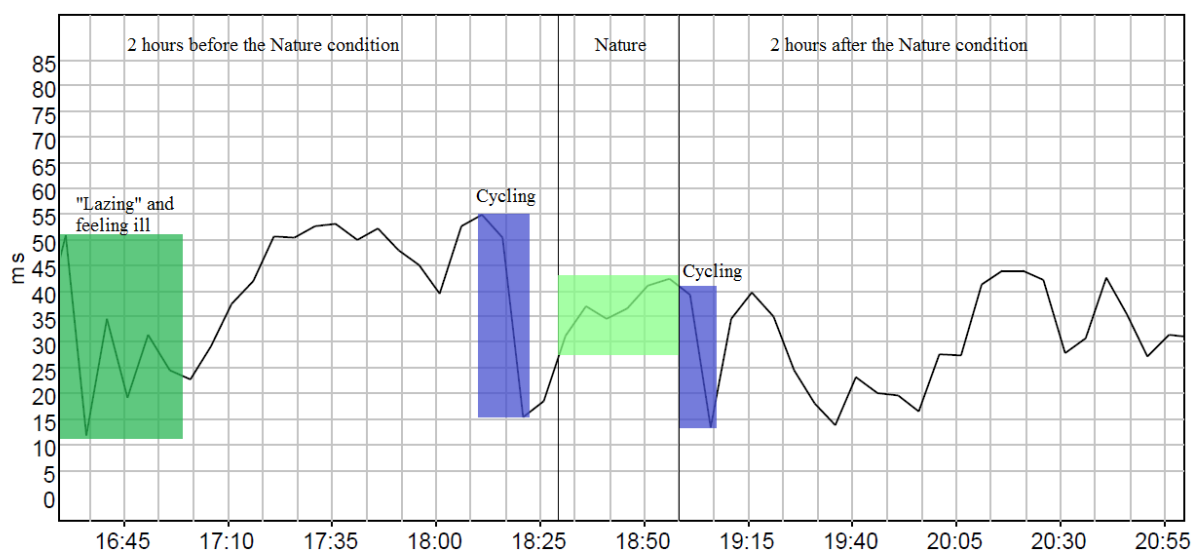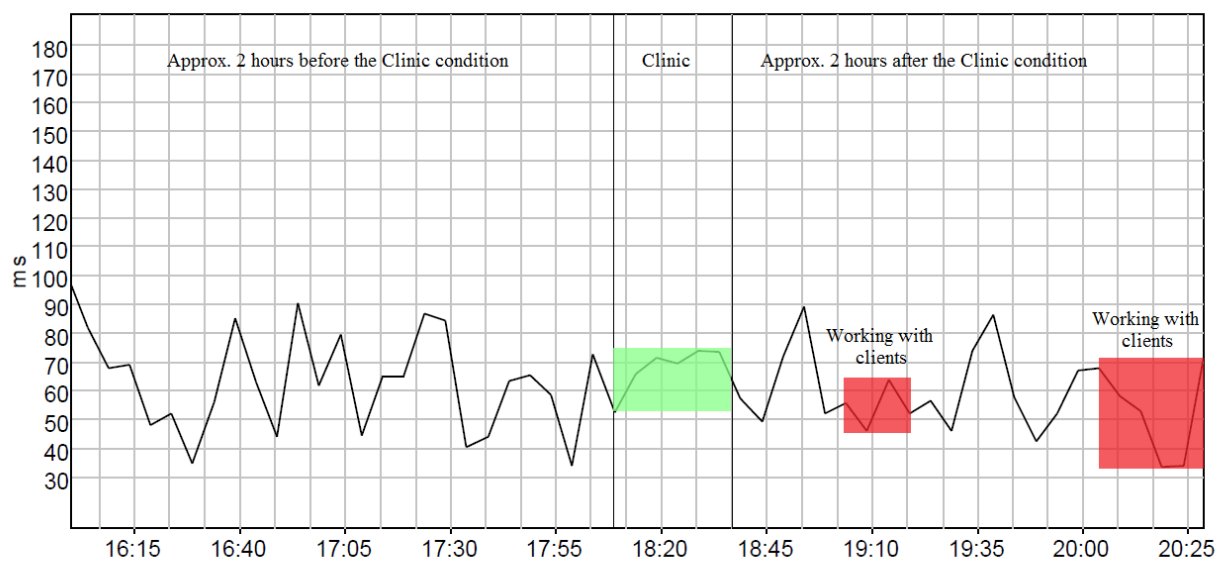

FIGURE 43. 2 hours before, during and 2 hours after the Nature condition, Participant 7.

The Figure 43 above illustrates the changes in RMSSD for participant 6 for 2 hours before the Nature condition (Mean = 35.52), during the Nature condition intervention and 2 hours after the Nature condition (Mean = 30.73). The highest point of RMSSD ($\approx$ 55 ms) occurred at 18.10, and the lowest point ($\approx$ 14 ms) occurred at 18.57, while the participant was cycling. During the intervention there was an increase in RMSSD up to 44 ms (Mean = 41.84).

On the night before the Clinic condition the highest RMSSD was point $\approx$ 74, lowest point $\approx$ 17 (Mean = 45.58). On the night after the Clinic intervention the highest RMSSD point $\approx$ 80, lowest point $\approx$ 3 (Mean = 52,72). The quality of sleep increased. On the night before the Nature condition, the highest RMSSD was point $\approx$ 80, lowest point $\approx$ 25, Mean = 52.10) and after the Nature intervention the highest point was $\approx$ 89, lowest point $\approx$ 3, Mean = 52,40). Interestingly, both during the night after Clinic and Nature conditions there was a sudden drop in RMSSD. Participant could not recall anything specific happening during these nights. See Figures 44-47 in the Appendix.

Participant 8

Participant 8 found the music very relaxing and pleasurable, kept eyes open and paid some attention to the surroundings in both conditions, they did not have any experience in relaxation techniques and enjoyed relaxation music in general. The first condition for this participant was Nature condition.

The Figure 48 below shows the changes in RMSSD for participant 8 for 2 hours before the Clinic condition (Mean = 35.61), during and 2 hours after the Clinic condition (Mean = 41.37). The highest point of RMSSD ($\approx$ 67 ms) occurred at 17.17 after the stressful event (group work), and the lowest point ($\approx$ 17 ms) occurred at 19.23. During the intervention there was an increase in RMSSD up to 48 ms (Mean = 62.88), followed by a decrease.

The Figure 49 shows the changes in RMSSD for participant 8 for 2 hours before the Nature condition (Mean = 31.23), during and 2 hours after the Nature condition (Mean = 25.06). The highest point of RMSSD ($\approx$ 50 ms) occurred at 17.37, and the lowest point ($\approx$ 10 ms) occurred

at 18.40, just before the Nature condition intervention. During the intervention there was a fast increase in RMSSD up to 30 ms, followed by a decrease (Mean = 16.55).

On the night before the Clinic condition the highest RMSSD point was ≈ 69, lowest point ≈ 20 (Mean = 42.60). On the night after the Clinic intervention the highest RMSSD point was ≈ 67, lowest point ≈ 36 (Mean = 52,24). The quality of sleep increased. On the night before the Nature intervention, the highest RMSSD point was ≈ 60, lowest point ≈ 21 (Mean = 44.02) On the night after the Nature intervention the highest point ≈ 67, lowest point ≈ 20 (Mean = 38,79). There was a decrease in sleep quality. See Figures 50-53 in the Appendix.

FIGURE 48. 2 hours before, during and 2 hours after the Clinic condition, Participant 8.

RMSSD
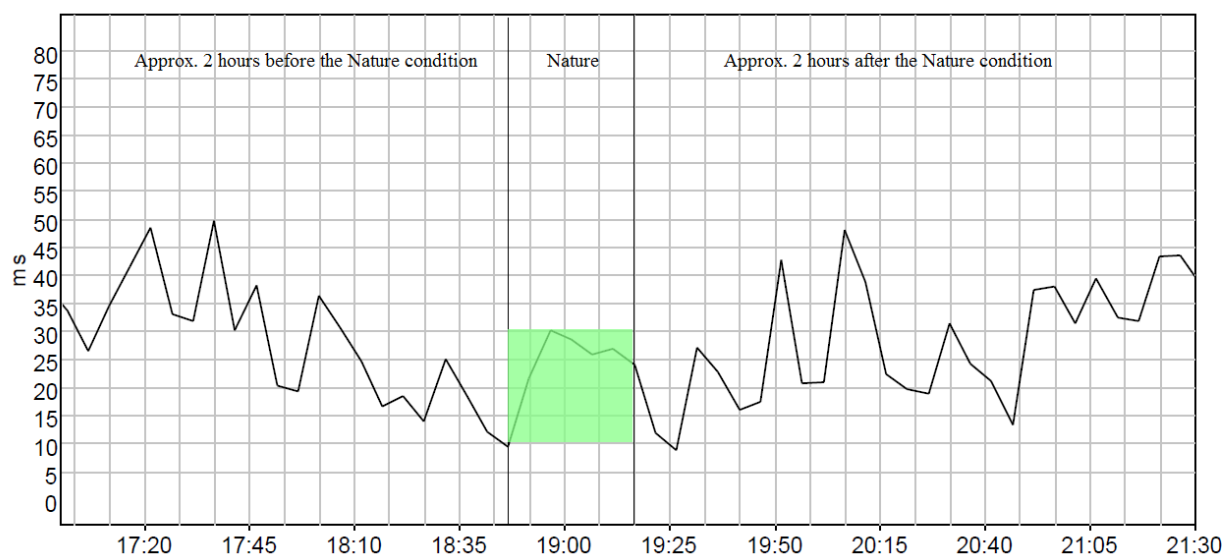
FIGURE 49. 2 hours before, during and 2 hours after the Nature condition, Participant 8.

Participant 9

Participant 9 found the music very relaxing and pleasurable, kept eyes closed and did not pay attention to the surroundings. The participant had no experience in relaxation techniques and enjoyed music in general. The first condition for this participant was the Nature condition.

The Figure 54 below shows the changes in RMSSD for participant 9 for 2 hours before the Clinic condition (Mean = 61.35), during and 2 hours after the Clinic condition (Mean = 56.67). The highest point of RMSSD ($\approx$ 88 ms) occurred at 16.30, and the lowest point ($\approx$ 41 ms) occurred at 20.19 during a psychologically stressing event. During the intervention there was an increase in RMSSD up to 75 ms (Mean = 71.93).

RMSSD

FIGURE 54. 2 hours before, during and 2 hours after the Clinic condition, Participant 9.

The Figure 55 below shows the changes in RMSSD for participant 9 for 2 hours before the Nature condition (Mean = 57.56), during and 2 hours after the Nature condition (Mean = 63.20). The highest point of RMSSD (≈ 92 ms) occurred at 19.53, and the lowest point (≈ 27 ms) occurred at 17.18. During the intervention RMSSD remained at around 82 ms (Mean = 78.33).

RMSSD
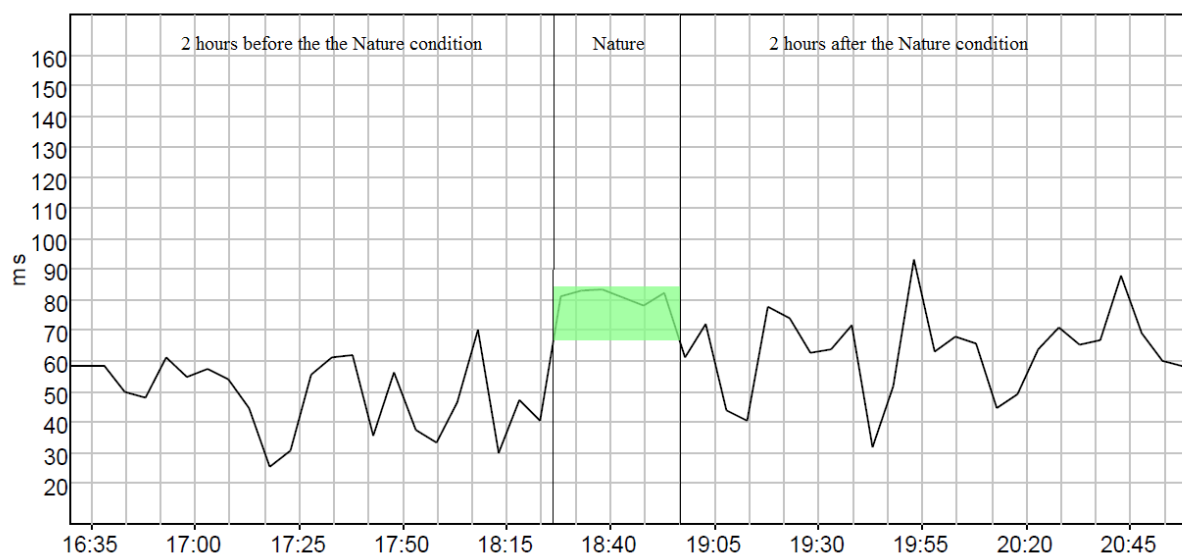
FIGURE 55. 2 hours before, during and 2 hours after the Nature condition, Participant 9.

On the night before the Clinic condition the highest RMSSD point was ≈ 180, lowest point ≈ 80 (Mean = 120.68). On the night after the highest point was ≈ 181, lowest point ≈ 69 (Mean = 125,04). The quality of sleep increased. On the night before the Nature condition the highest RMSSD point was ≈ 160, lowest point ≈ 71 (Mean = 124.28). On the night after the Nature intervention the highest point was ≈ 164, lowest point ≈ 80 (Mean = 114,81). There was a decrease in sleep quality. For more information see Figures 56-59 in the Appendix.

6   DISCUSSION

In order to answer a question "Will the relaxation music listening in presence of the elements of natural environment lead to greater stress reduction than relaxation music listening in a normal clinical setting?" an experiment with two conditions, "Clinic" and "Nature" was conducted. The HRV data and subjective reports were collected and analysed.

The results of the general analysis of means of HRV data suggested a pattern: during both the Nature and Clinic interventions the RMSSD was higher, thus the stress was lower, than 2 hours before and after the interventions. The difference was greater for the Clinic condition, however, the results of analysis of variance revealed, that there were no significant differences in the dynamics of the HRV between different conditions. This may be due to the small sample size. The lower stress levels during the Clinic intervention as opposed to the Nature intervention could be explained by possible overstimulation in the Nature condition. Perhaps, for some participants having music, bird sounds and projected images on the screen created an information overload and reduced the relaxation effect. In other words: less is more.

At the same time, the subjective evaluation of stress levels provided by the participants with VAS showed that all participants felt less stressed after both Clinic and Nature intervention and that the effect was greater for the Nature intervention. Statistical analysis with Wilcoxon test suggested that these results were significant.

The results revealed a mismatch between the objective HRV data and the subjective stress level reports. Results suggested that people seem to be more "optimistic" when it comes to self-evaluation of stress.

The changes in HRV during the night before and after each intervention were also chosen as points of analysis. Results revealed a trend suggesting that the quality of night sleep after both Nature and Clinic interventions was higher than before the interventions, and that the improvement was greater after the Nature intervention. The analysis of variance revealed, however, that the difference was not significant.

The general stress levels measured with DASS-21 were also taken into consideration. Four of the nine participants had "Normal" stress scores, while five participants had Moderate" and "Severe" stress level scores. 4 out of the five of participants who turned out to have "Moderate" or "Severe" stress levels also scored higher than "Normal" in both the Anxiety and Depression scale measures. The association between depression and anxiety scores can be explained by the possible comorbidity of these disorders (Gorman, 1997). The changes in RMSSD for both groups 2 hours before, during and 2 hours after each intervention were analysed. The greatest stress reduction was achieved by the non-stressed participants during the Clinic intervention, whereas the Nature condition did not seem beneficial for them. However, the Nature condition facilitated stress reduction better in the stressed participants than in the Clinic condition.

The dynamics of participants' RMSSD during the nights before and after each interventions were also analysed and the following pattern was discovered: RMSSD slightly increased in both stressed and non-stressed participants after the Clinic condition. In other words, the sleep quality for both groups after the Clinic condition increased. The situation with the Nature condition is the following: there was a major increase in RMSSD in those participants, who had high general stress levels, and a decrease in RMSSD in those whose stress levels were normal. The sleep quality of the more stressed participants improved after the Nature condition, whereas the non-stressed participants slept worse after the Nature condition.

These results suggest the following pattern: the Nature condition promoted stress reduction well in the stressed participants, however it was not beneficial for the non-stressed participants. On the other hand, the Clinic condition lead to minor stress reduction in the stressed participants and was more beneficial for those who were non-stressed. These results support Morita's (2007) findings, suggesting, that the more stressed participants were, the more they benefited from the walk in the forest. However, the small sample size makes it impossible to draw any general conclusions, and further investigation is needed.

A closer look at individual results of each participant revealed that most participants experienced at least a temporary increase in RMSSD (and, therefore, a reduction in stress) during the interventions. The exception was participant 4 during the Clinic, whose increase in RMSSD during the intervention was low. However, the mean score of the intervention time

was higher than the mean score of 2 hours before the intervention time in only 10 out of 18 cases for both the Clinic and Nature interventions. Also, figures suggest that only in 2 cases out of 18 the highest recovery peak was during the intervention time (Participant 6, Nature condition and Participant 7, Clinic condition). In the rest of the cases the highest point of recovery was happening outside of the intervention time.

Participants were asked to report psychologically stressing, physically straining and recreational activities in the measurement diaries. The highest point of recovery corresponded with self-reported recreational activities in only three of the cases. These activities were: watching Netflix, computer work/procrastination and relaxing with the cat. In one case (participant 3), the highest recovery point occurred while singing, but the participant did not state this activity as recovery promoting. Participant 5 represented an interesting case: during both measurements, the highest recovery point occurred during the activities, that were perceived as stressing by the participant (having stressful thoughts and conducting a rehearsal). The lowest RMSSD points occurred in most participants while they were cycling or walking, so the drop in RMSSD was due to the physical strain and not psychological stress. Five participants out of the nine participants did not recognize nor state the lowest drop of RMSSD during either one or both measurements. One participant's lowest RMSSD point occurred during the actual stressful event (working with clients), and another participant stated "feeling ill and lazy" as a recovery event, however, the lowest drop happened during this time. These results show that most participants did not seem to be successful at recognizing stressful states unless they were due to physical strain.

The results discussed above supported hypothesis 1 (both Nature and Clinic interventions will lead to the decrease in stress levels). On the subjective level both interventions led to the decrease in perceived stress levels, and the results were statistically significant. On the objective level the trend is the same; stress levels decreased during both Clinic and Nature interventions, and sleep quality increased after both interventions, however, the results were not statistically significant.

As for the second hypothesis (nature intervention will lead to the greater decrease in stress levels), it was shown to be partially true, but results are somehow controversial. On the one hand, the subjective reports showed that the Nature intervention led to greater stress

reduction. These results were statistically significant. Furthermore, night sleep quality improved more after the Nature intervention, although the result was not statistically significant. On the other hand, there was a greater reduction of stress during the Clinic intervention than during the Nature intervention, but this result is not statistically significant either.

Overall, the most clear finding was the mismatch between the objective data and subjective perception of stress levels. This could be an important finding because it suggests the lack of self-awareness in people when it comes to their own stress. It is known that chronic stress can lead to different stress-related disorders and can be considered as a health threat, so nowadays people are offered different exercises, books, sound tracks and techniques for stress reduction and self-regulation. In order to fully benefit from them people should be able to accurately recognize stress in the first place. Therefore, this finding of the current study highlights the importance of increasing the self-awareness of stress in young adults.

The main limitation of this study is the low number of participants. Also, even though the conditions were pseudo-random, some order effect might have occurred and affected the results due to the small sample size. Also, the study would have benefited from randomized sampling instead of convenience.

Suggestions for the further research would be the following: to conduct an experiment with a larger sample size and concentrate on the people, who report high stress levels.

7   CONCLUSION

A study was conducted to investigate the role of elements of natural environment recreated in the clinical setting for stress reduction. The main purpose was to see if altering the environment during the music listening would lead to a greater reduction of stress.

The results of the experiment showed, that participants felt subjectively more relaxed after listening to the music in the clinic room containing elements of a natural environment. However, objective measurements revealed a slightly higher decrease in stress during the intervention in a clinic room without these elements, but these results were not significant. Sleep quality had slightly increased on the night after the "Nature" condition, but the difference was again not significant. In addition, there was a trend suggesting that participants who were generally more stressed benefited better from the "Nature" condition. Unfortunately, due to the small sample size these findings cannot be generalized.

Overall, even though both conditions led to the decrease in stress levels, participants' own means of relaxation sometimes had a better effect than the intervention. Finally, the differences between the results of subjective and objective measurements suggested a mismatch between participants' own evaluation of their stress levels and the other objective measurements. It was shown that people are often unable to recognize stressful states. Now that, stress-related issues and disorders are recognized and discussed, different stress reduction and self-regulation techniques are being invented and tested. Self-awareness and self-evaluation, however, are the first step towards self-regulation. Thus, results from the current study illustrated the importance of developing self-awareness skills in young adults in order to avoid chronic stress and stress-related diseases. Being aware of one's own physiological and psychological states is the first step towards positive physical health, mental health and well-being.

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APPENDIX

FIRSTBEAT BODYGUARD 2 HOW TO START THE MEASUREMENT

1 Attach the electrodes to the cable and device end.

2 Remove the cover.

3 Attach the device end to the right side of the body under the collar bone. The cable end is attached to the left side of the body on the rib cage.

4 The measurement starts automatically when the device is attached. Make sure green light is flashing.
NOTE: The light is easiest to see in a dark room.
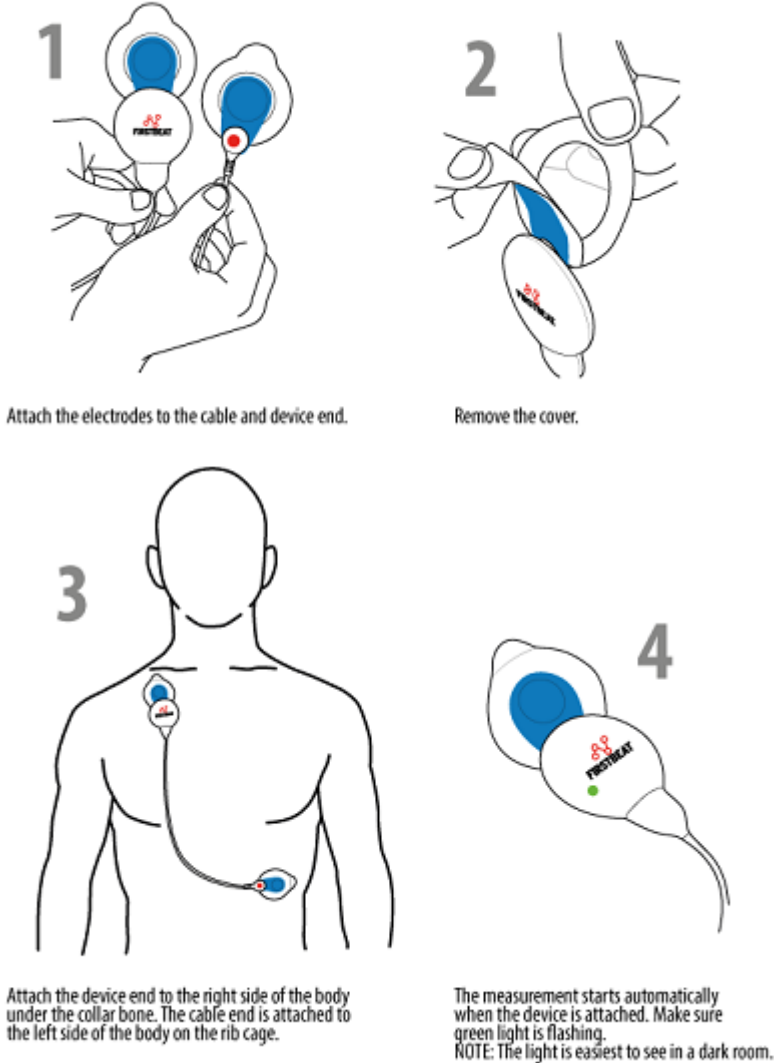
FIGURE 1. Measurement guide for the Bogyguard 2 heart rate monitors (June 2, 2018).

TABLE 7. Scoring key for DASS-21.

|	Depression	Anxiety	Stress
Normal	0-9	0-7	0-14
Mild	10-13	8-9	15-18
Moderate	14-20	10-14	19-25
Severe	21-27	15-19	26-33
Extremely Severe	28+	20+	34+

RMSSD
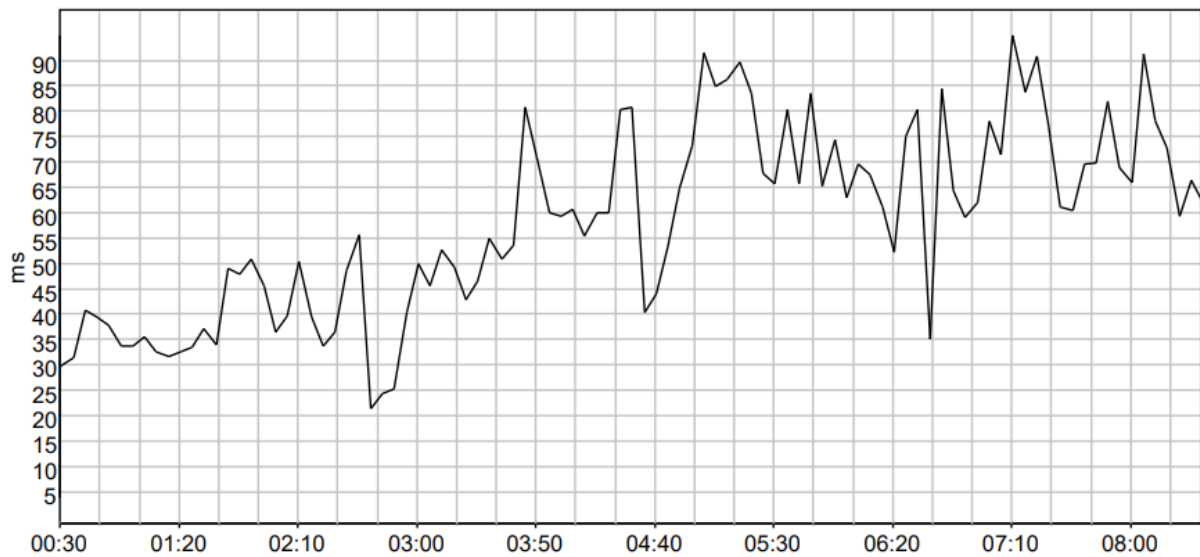
FIGURE 8. The Night before Clinic condition, Participant 1.
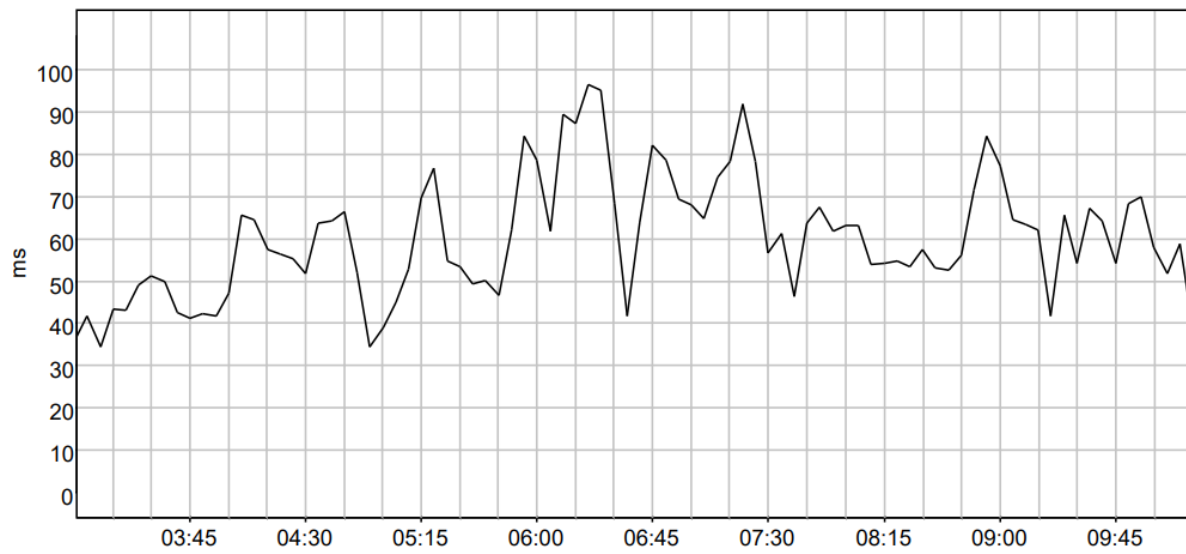
RMSSD

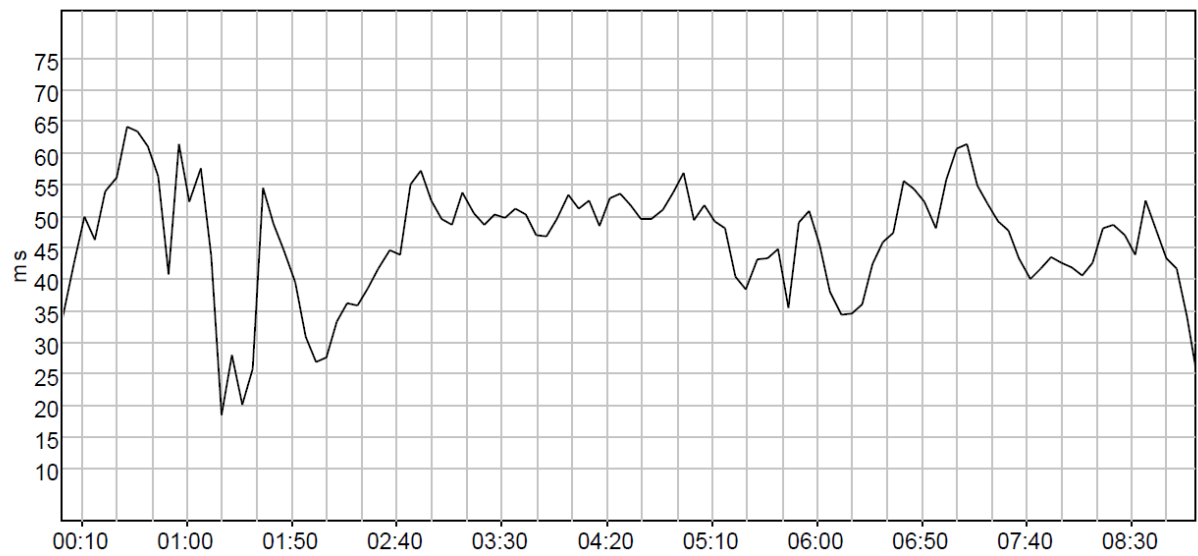
FIGURE 9. The Night after Clinic condition, Participant 1.
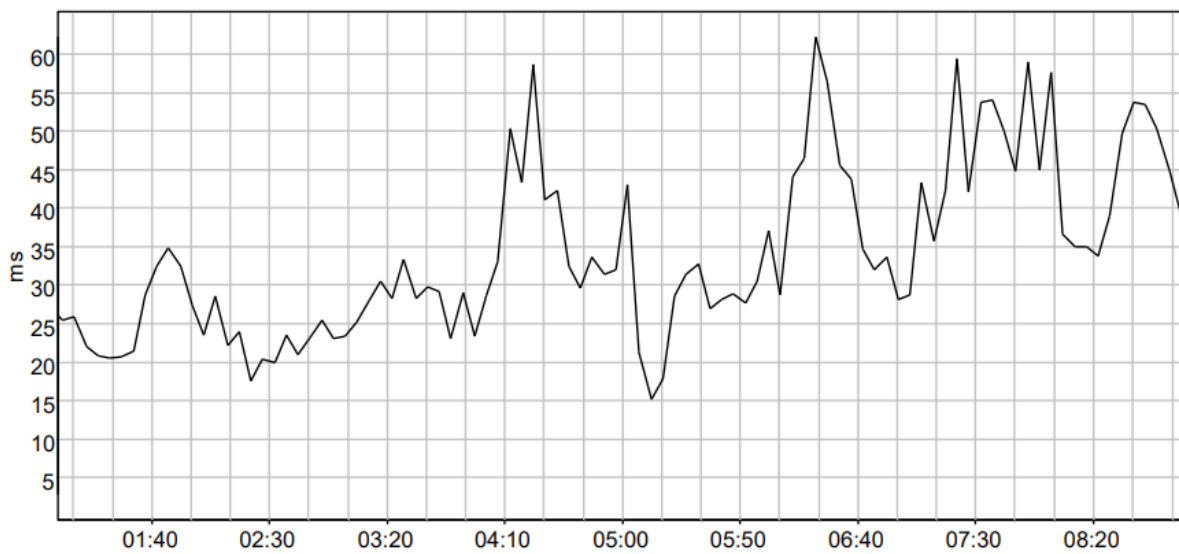
RMSSD

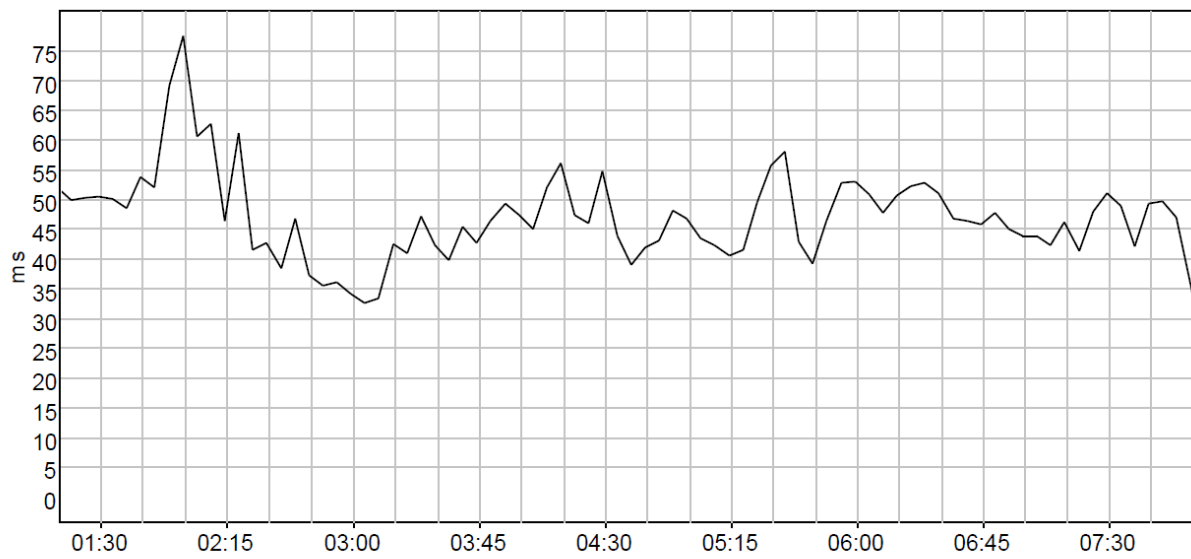FIGURE 10. The Night before Nature condition, Participant 1.
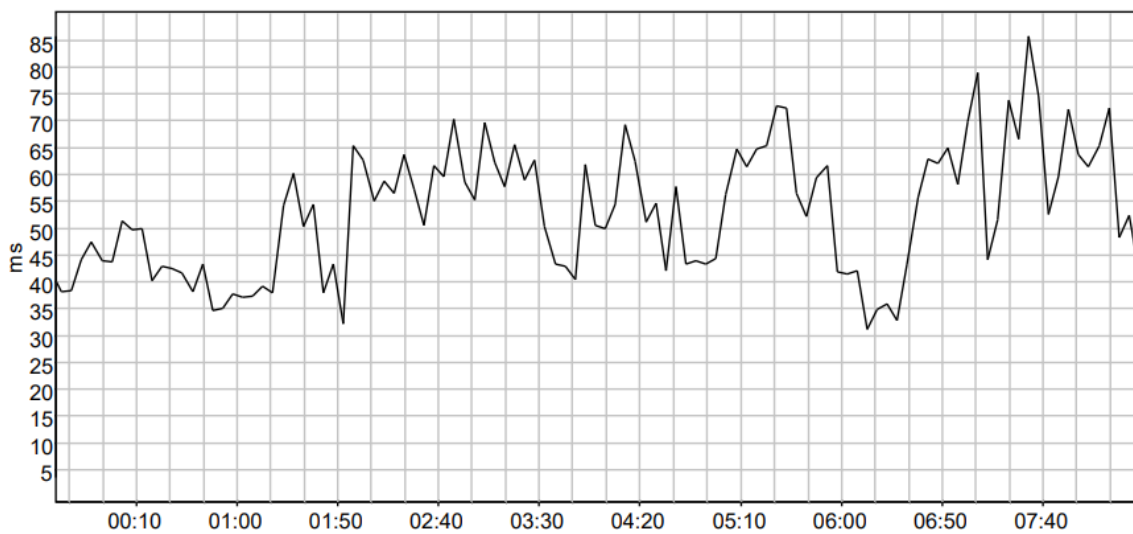
RMSSD

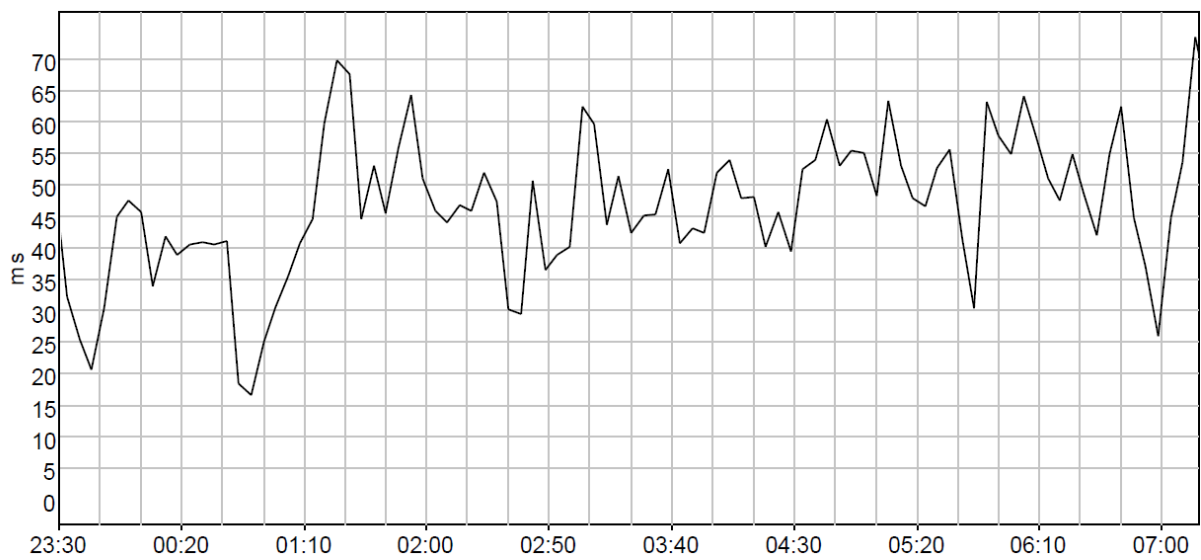FIGURE 11. The Night after Nature condition, Participant 1.
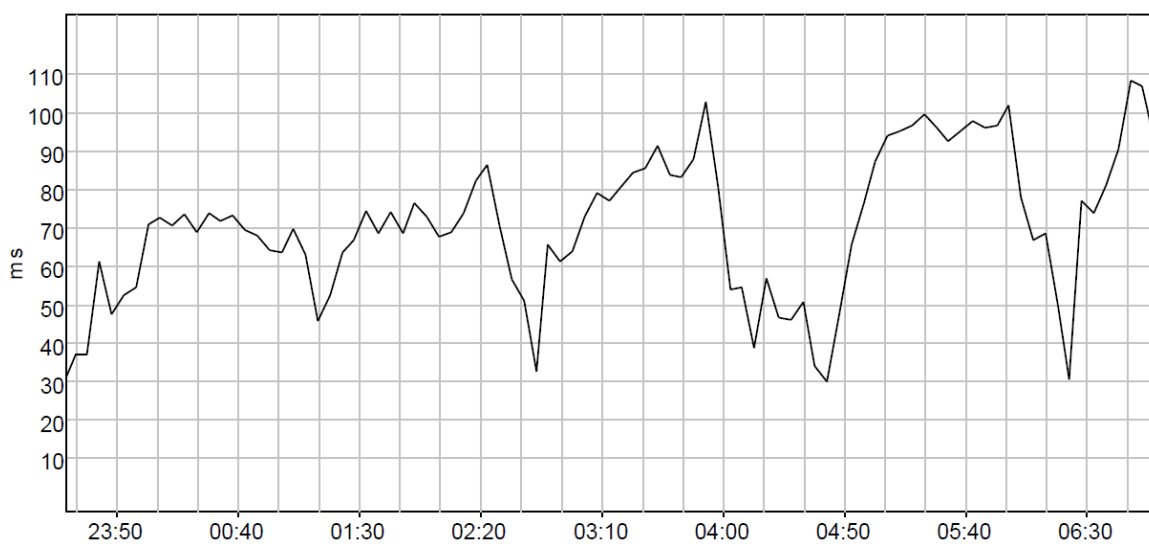
RMSSD

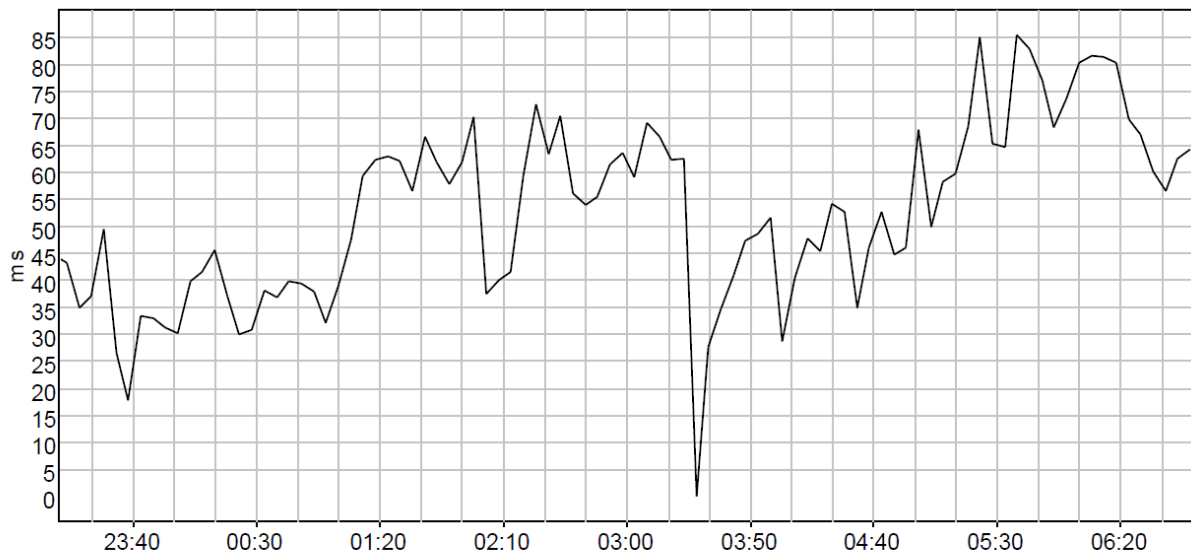FIGURE 14. The Night before the Clinic condition, Participant 2.
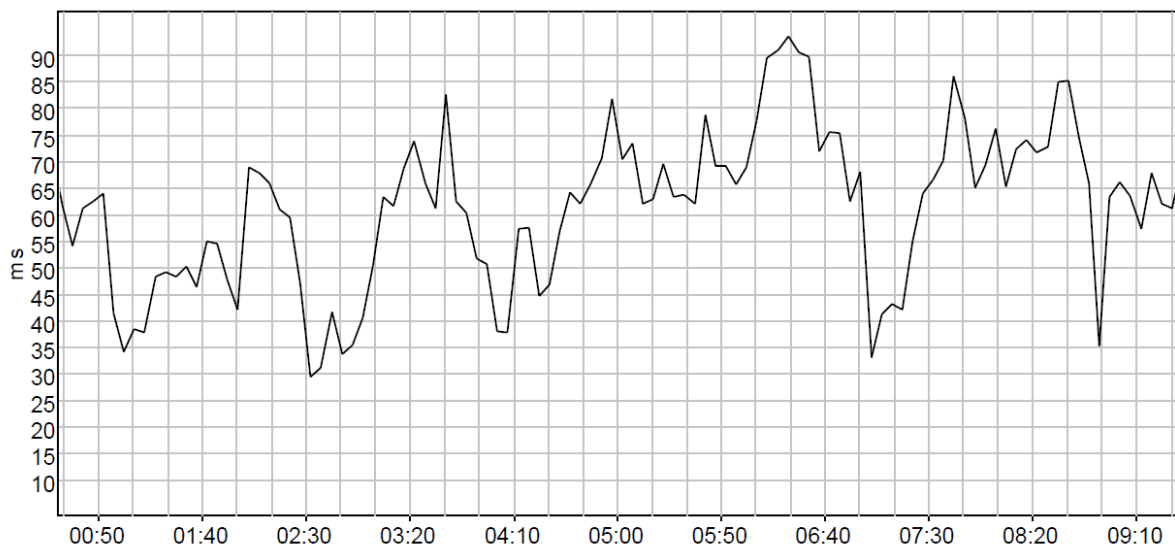
RMSSD

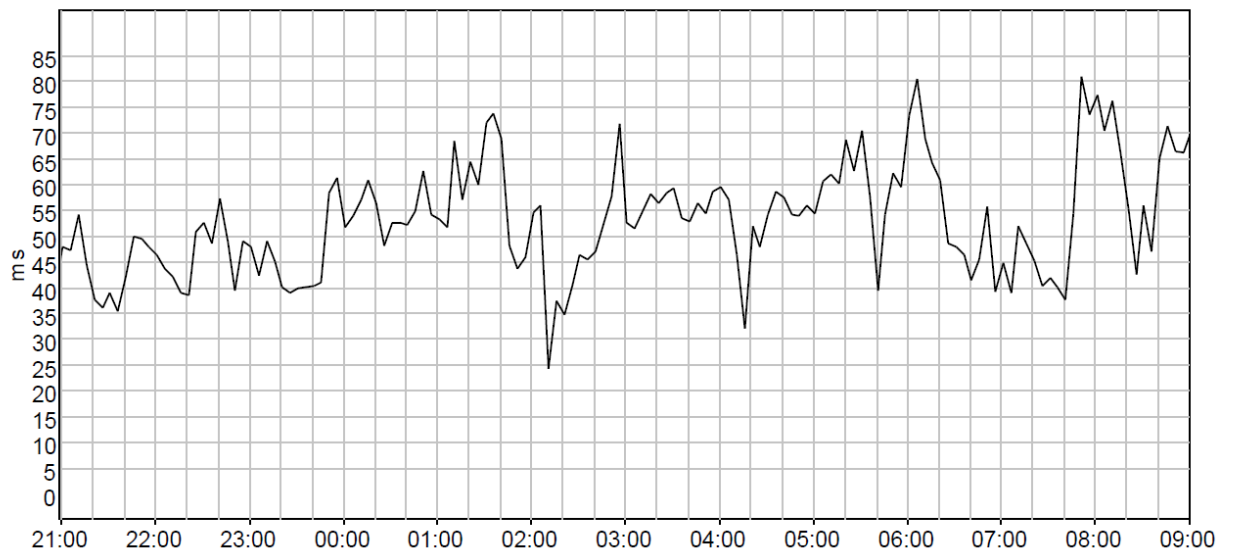FIGURE 15. The Night after the Clinic condition, Participant 2.
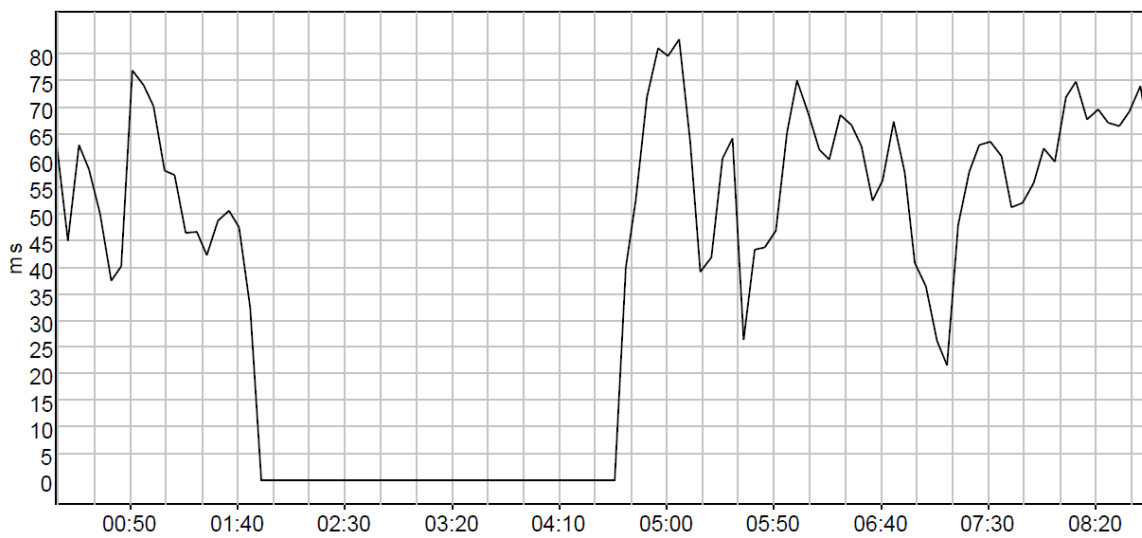
RMSSD

FIGURE 16. The Night before the Nature condition, Participant 2.
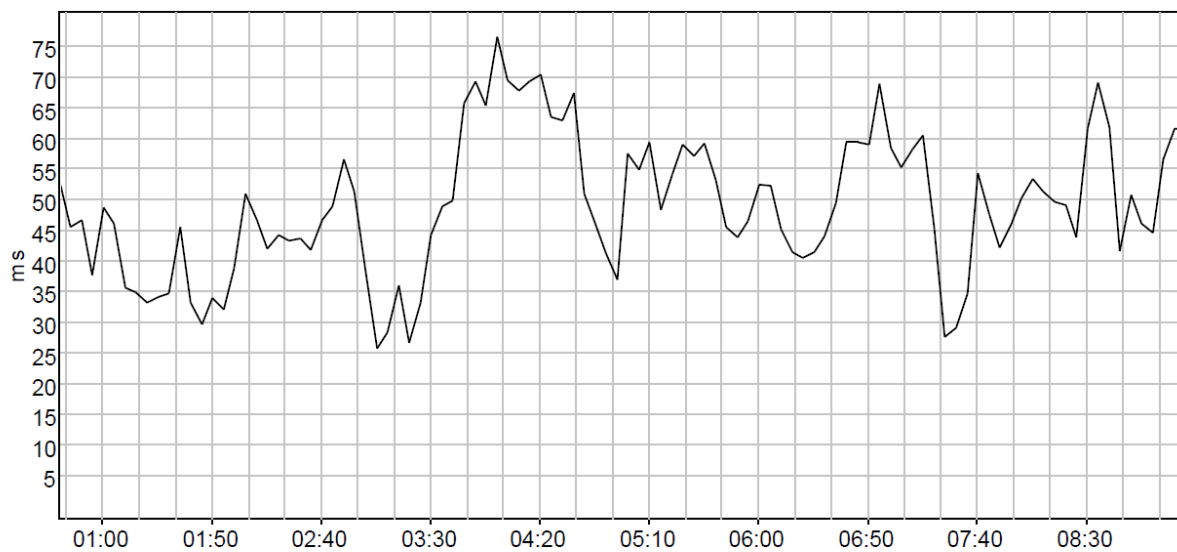
RMSSD

FIGURE 17. The Night after the Nature condition, Participant 2.
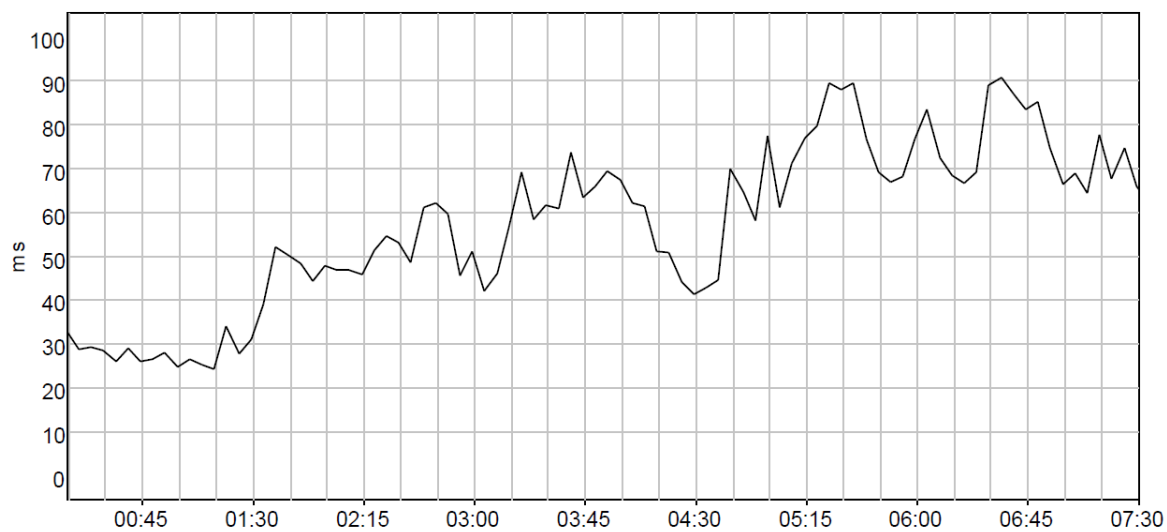
RMSSD

FIGURE 20. The Night before the Clinic condition, Participant 3.
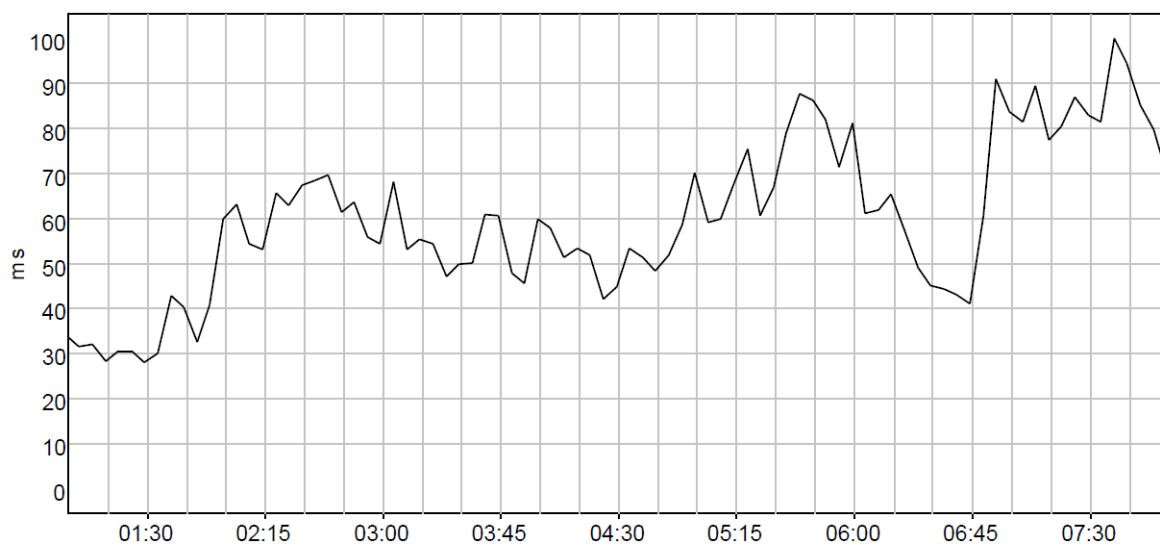
RMSSD

FIGURE 21. The Night after the Clinic condition, Participant 3.
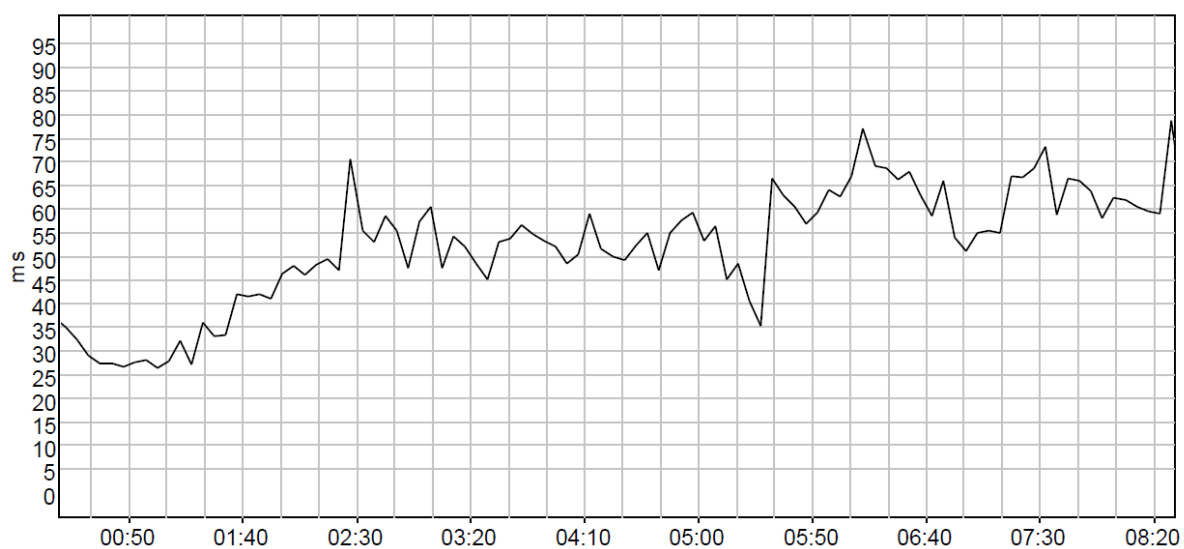
RMSSD

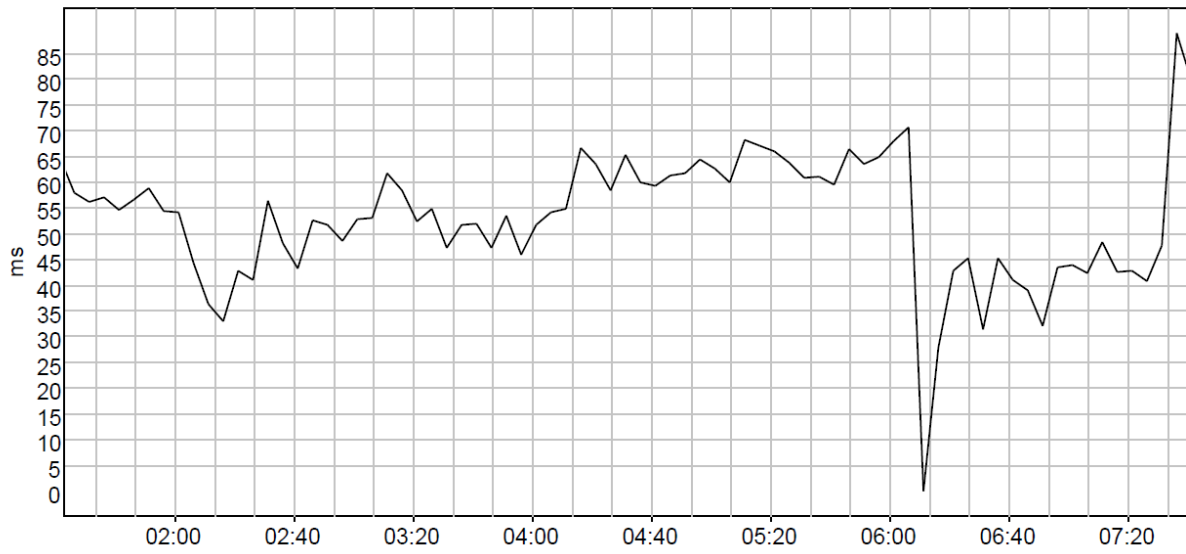FIGURE 22. The Night before the Nature condition, Participant 3.
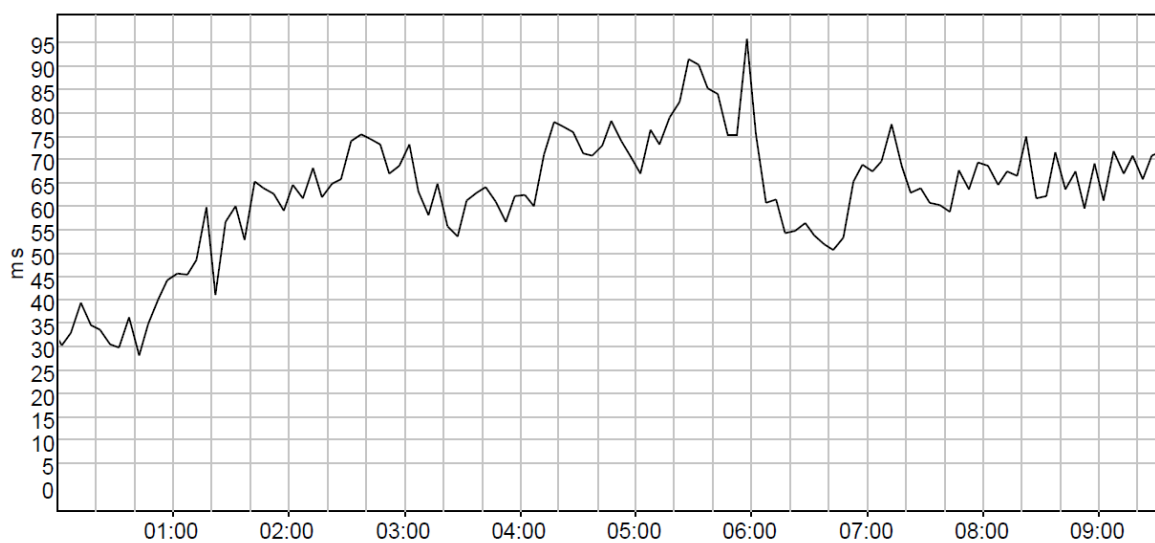
RMSSD

FIGURE 23. The Night after the Nature condition, Participant 3.
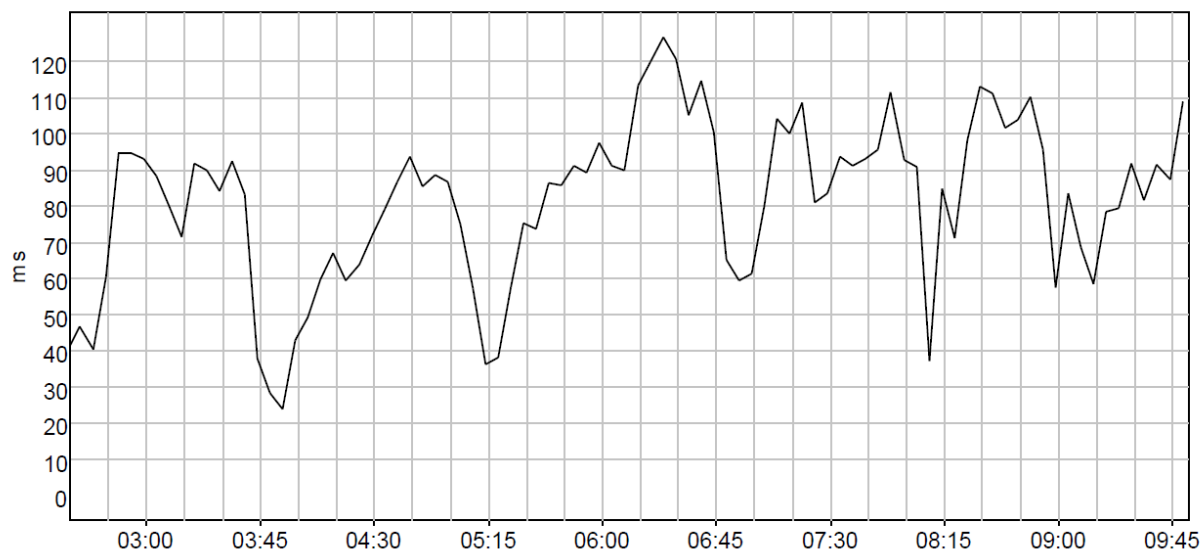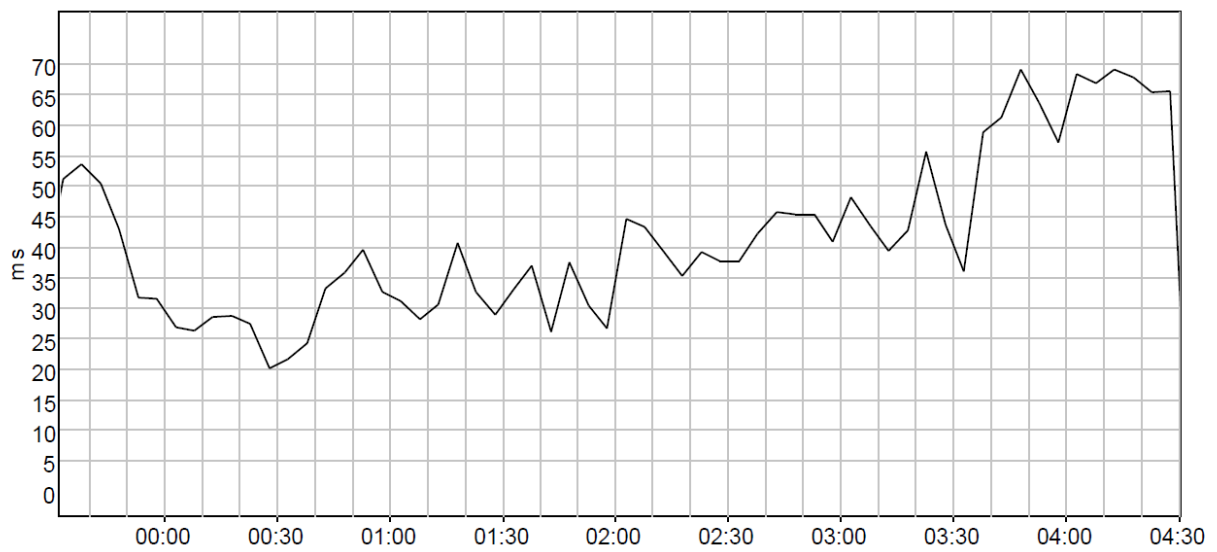
RMSSD

FIGURE 26. The Night before the Clinic condition, Participant 4.
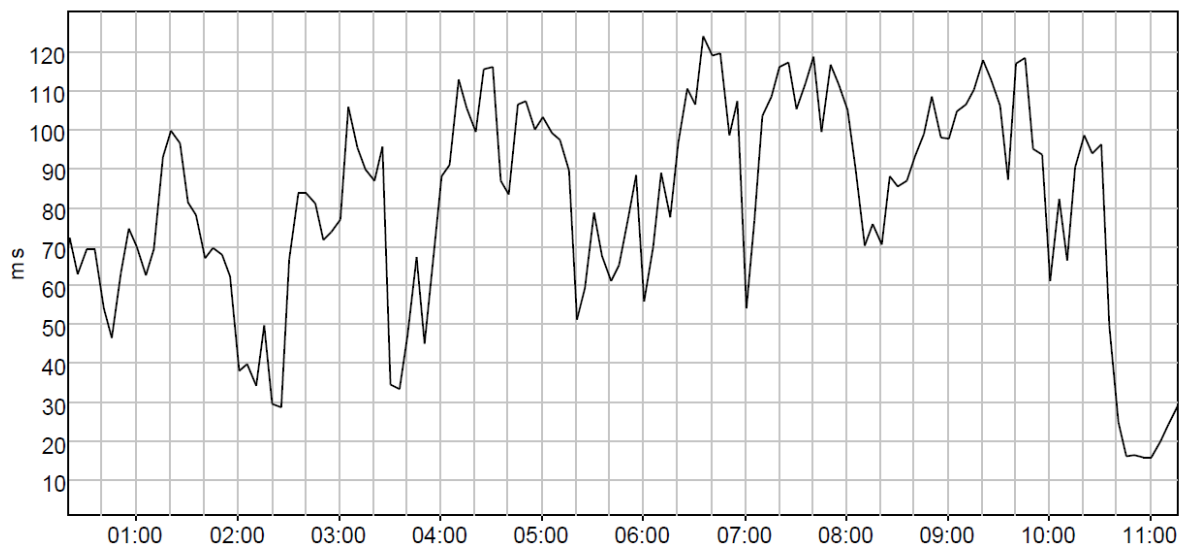
RMSSD

FIGURE 27. The Night after the Clinic condition, Participant 4.
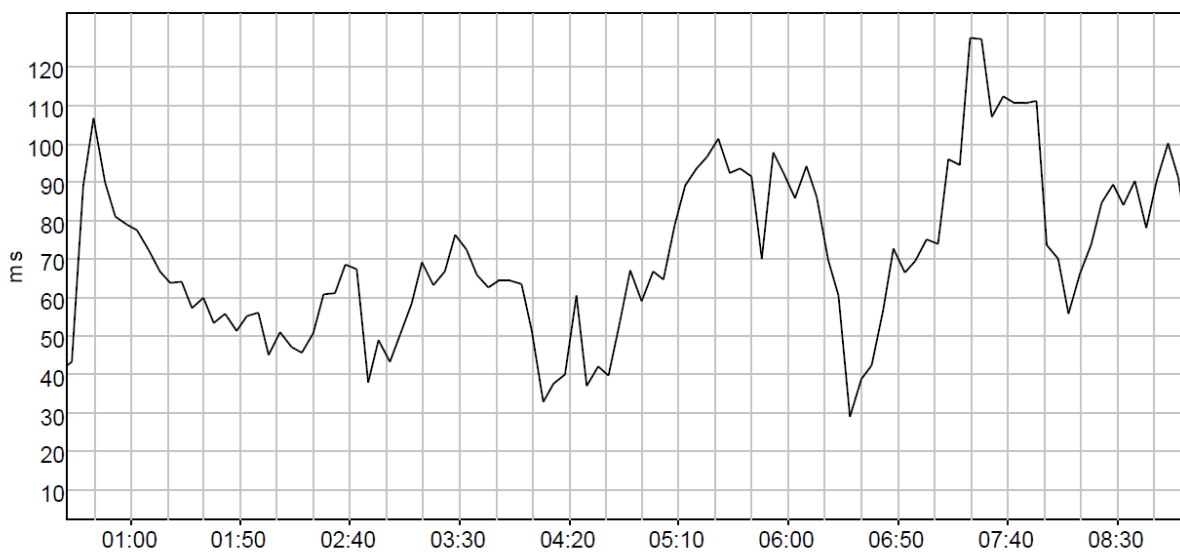
RMSSD

FIGURE 28. The Night before the Nature condition, Participant 4.
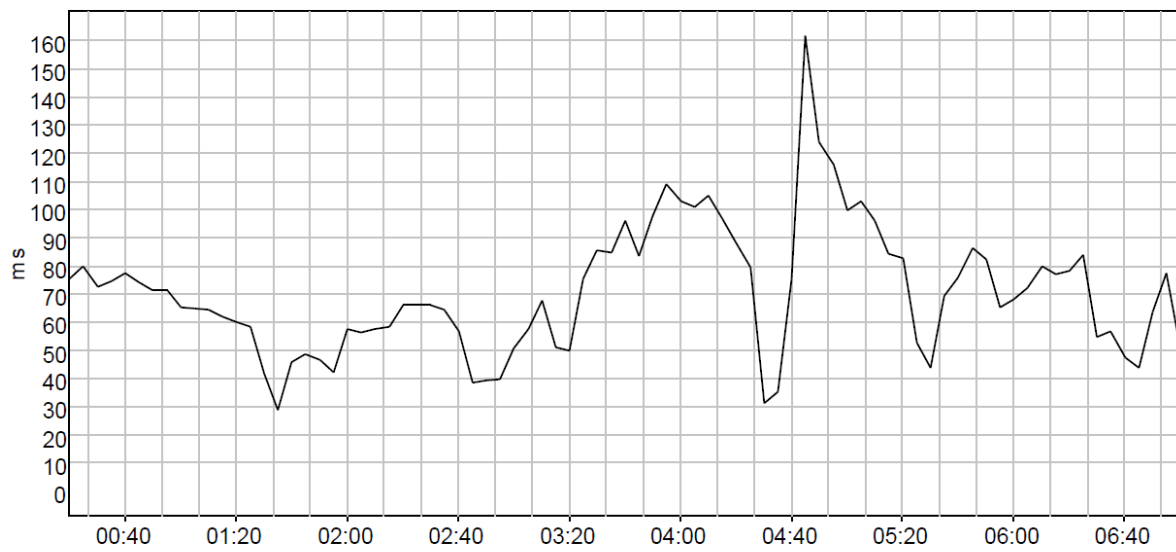
RMSSD

FIGURE 29. The Night after the Nature condition, Participant 4.
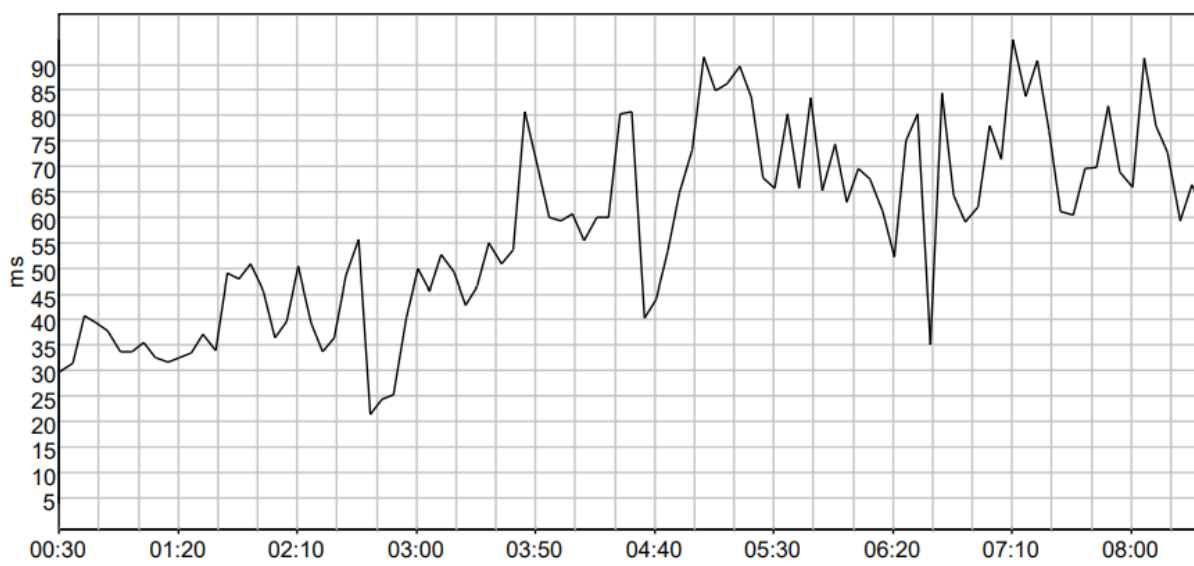
RMSSD

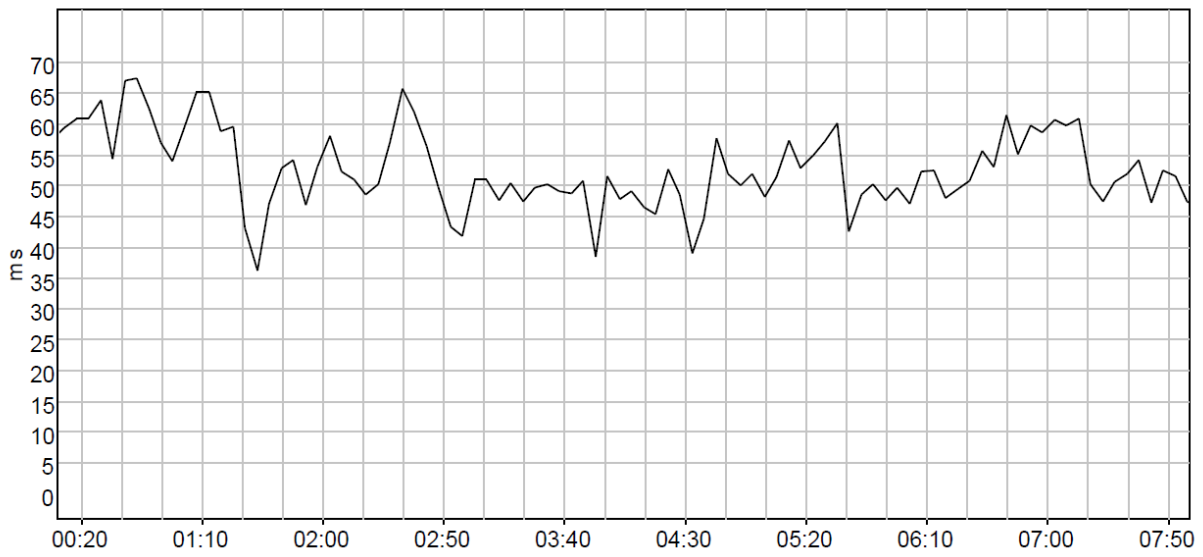FIGURE 32. The Night before the Clinic condition, Participant 5.
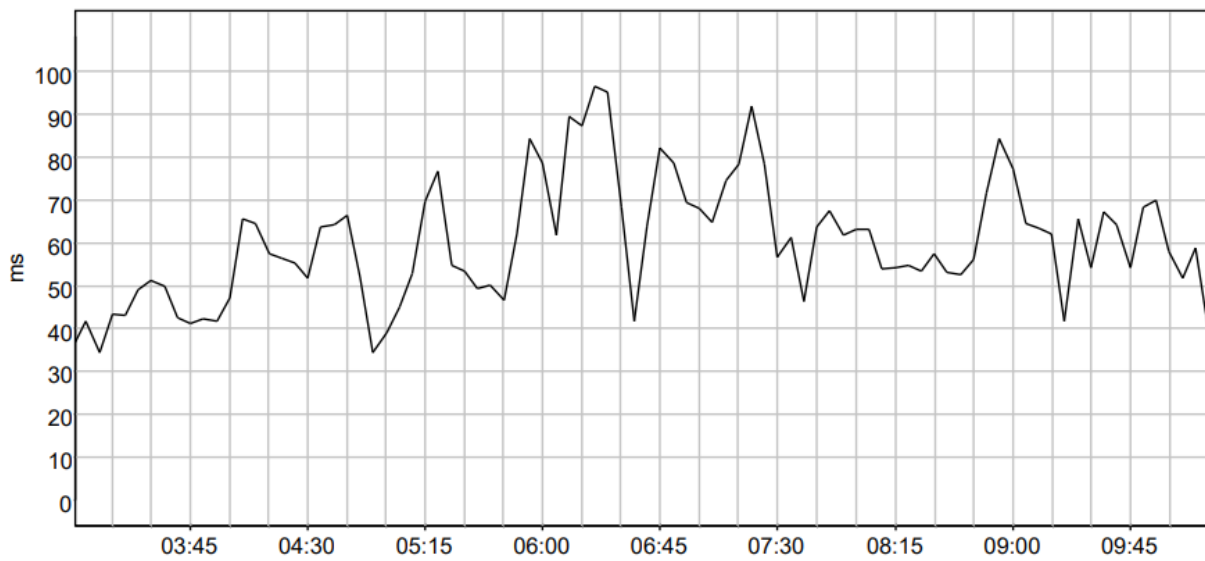
RMSSD

FIGURE 33. The Night after the Clinic condition, Participant 5.
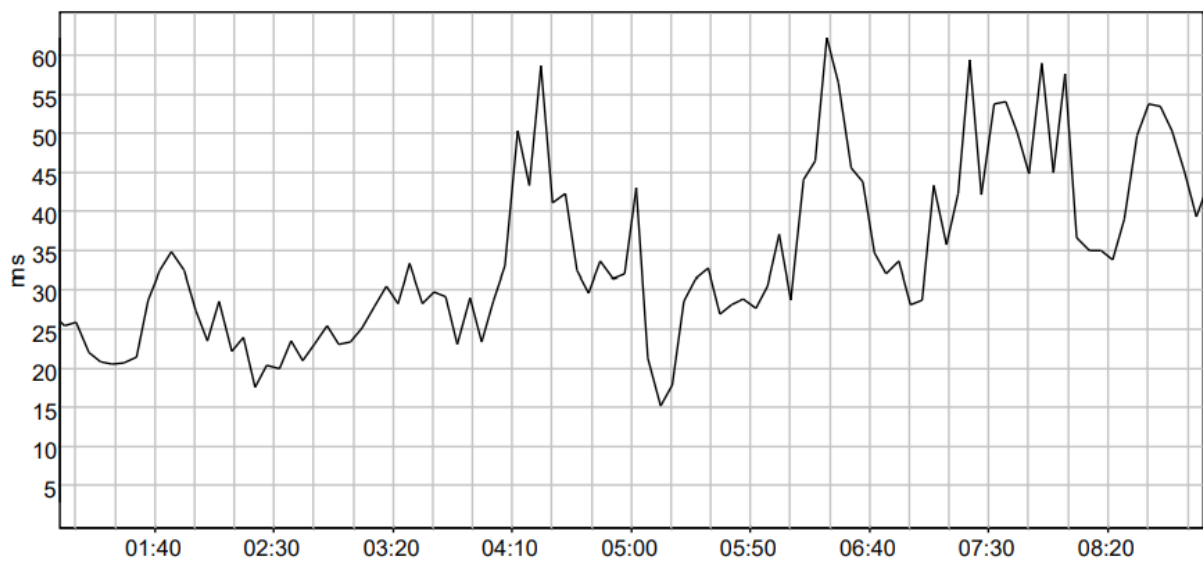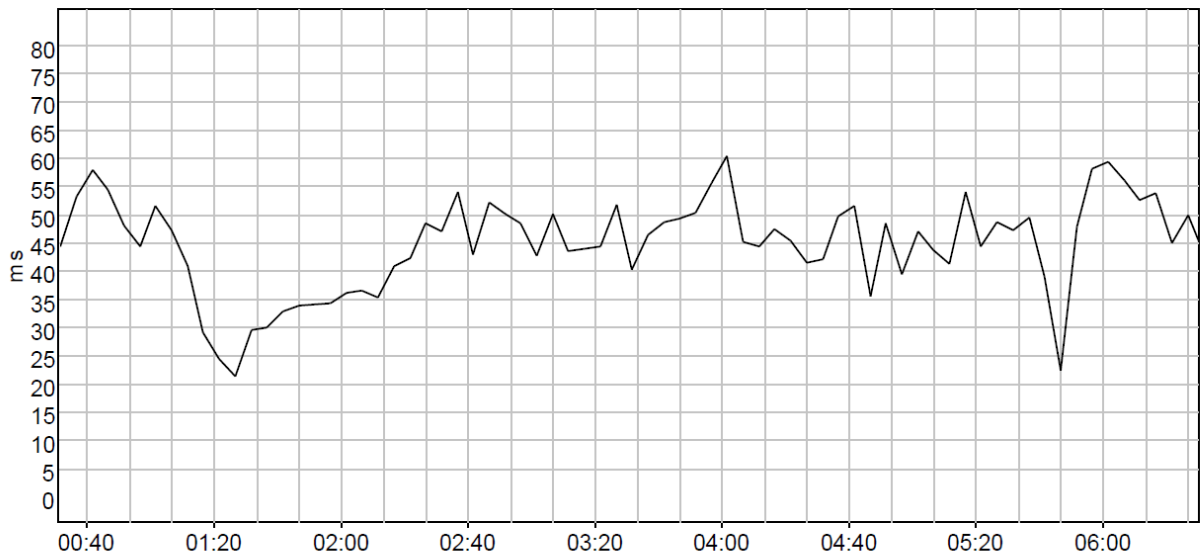
RMSSD

FIGURE 34. The Night before the Nature condition, Participant 5.
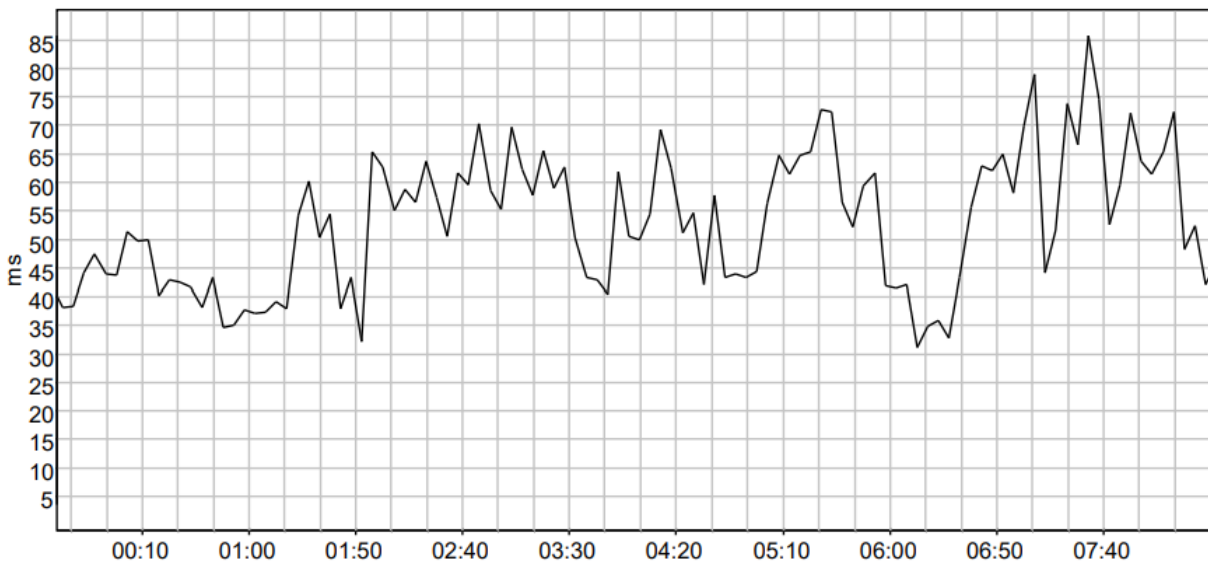
RMSSD

FIGURE 35. The Night after the Nature condition, Participant 5.
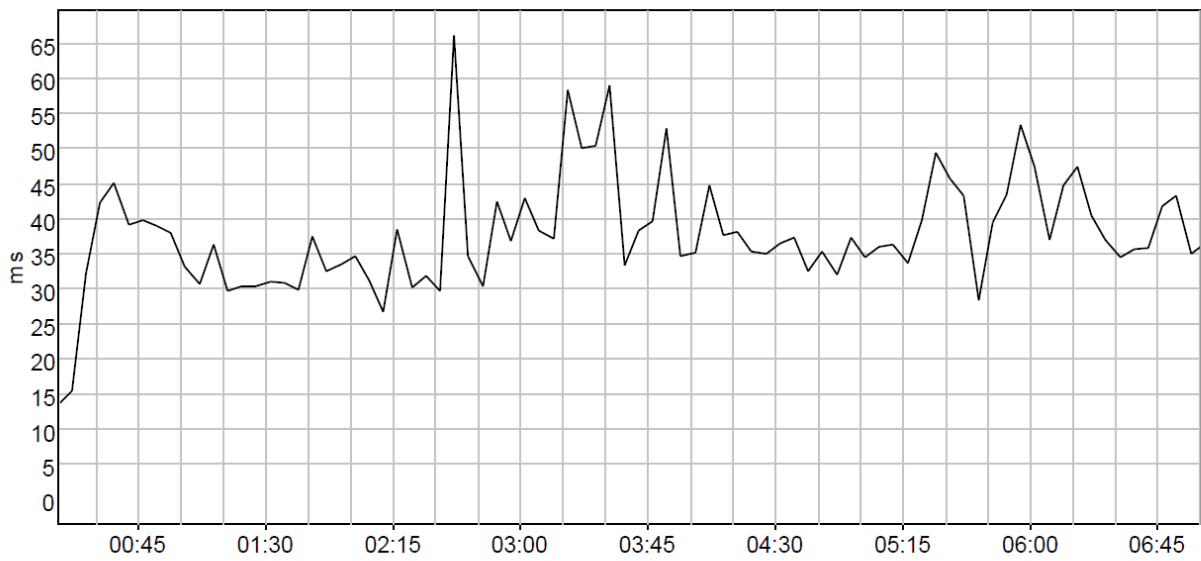
RMSSD

FIGURE 38. The Night before the Clinic condition, Participant 6.
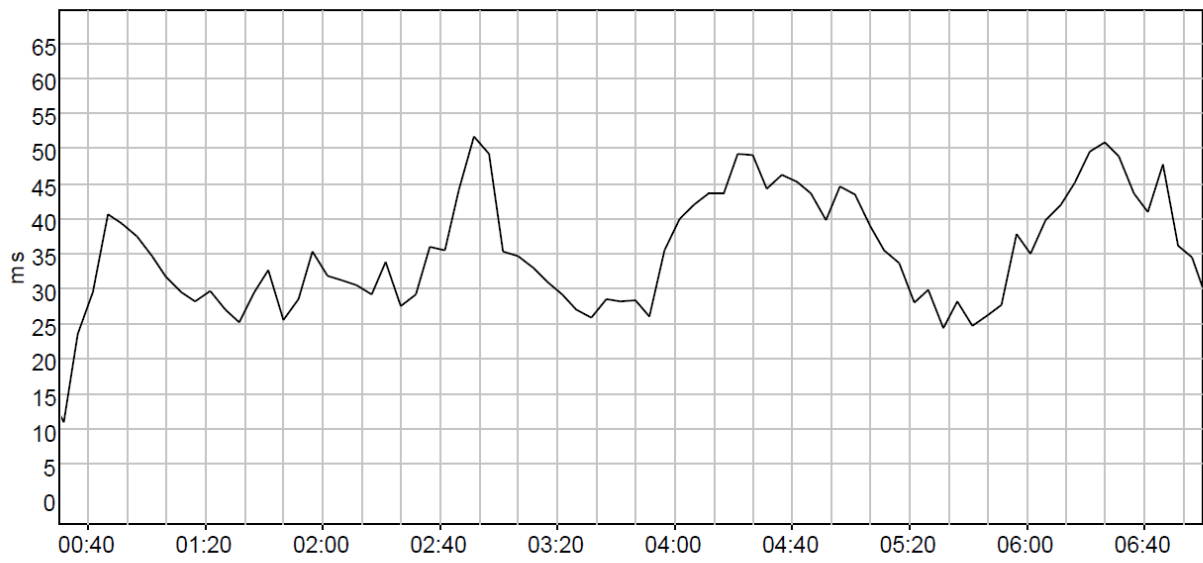
RMSSD

FIGURE 39. The Night after the Clinic condition, Participant 6.

RMSSD

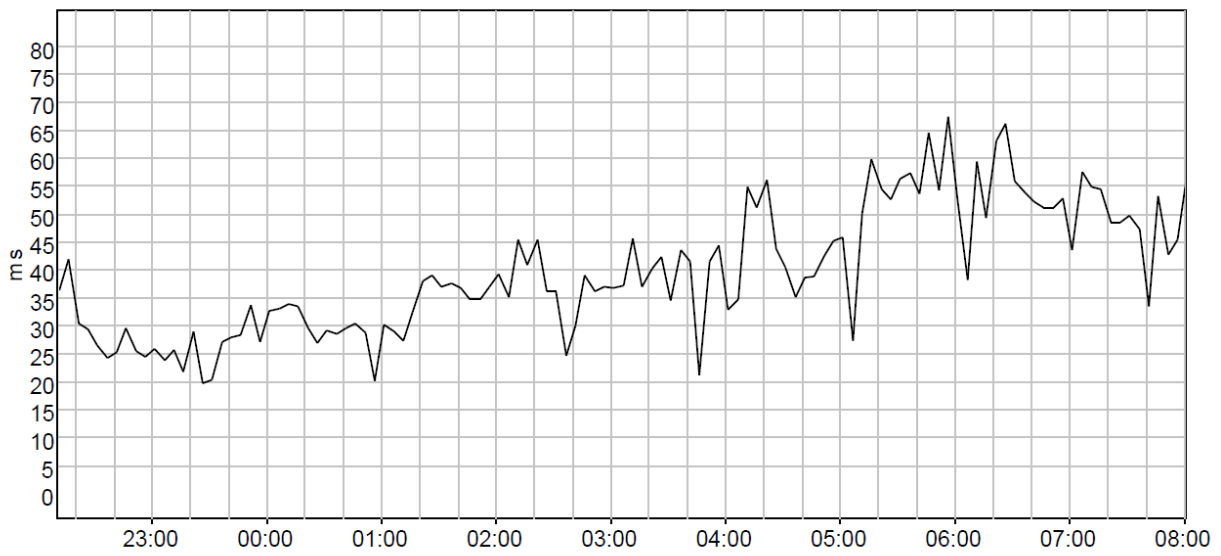FIGURE 40. The Night before the Nature condition, Participant 6.

RMSSD

FIGURE 41. The Night after the Nature condition, Participant 6.
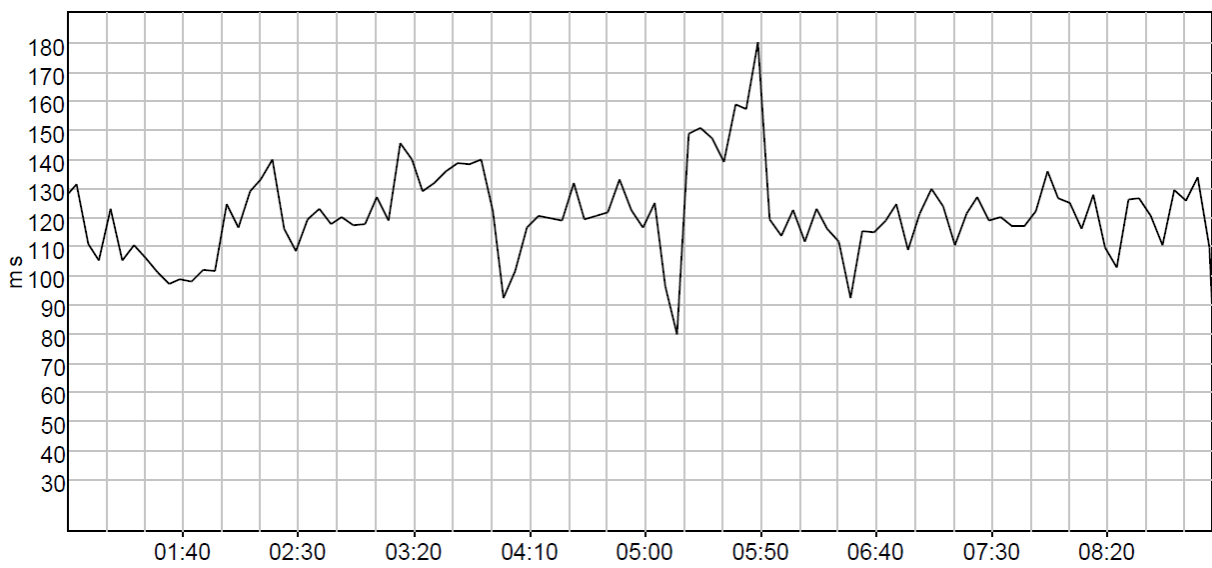
RMSSD

FIGURE 44. The Night before the Clinic condition, Participant 7.

RMSSD

FIGURE 45. The Night after the Clinic condition, Participant 7.

RMSSD

FIGURE 46. The Night before the Nature condition, Participant 7.

RMSSD

FIGURE 47. The Night after the Nature condition, Participant 7.

RMSSD

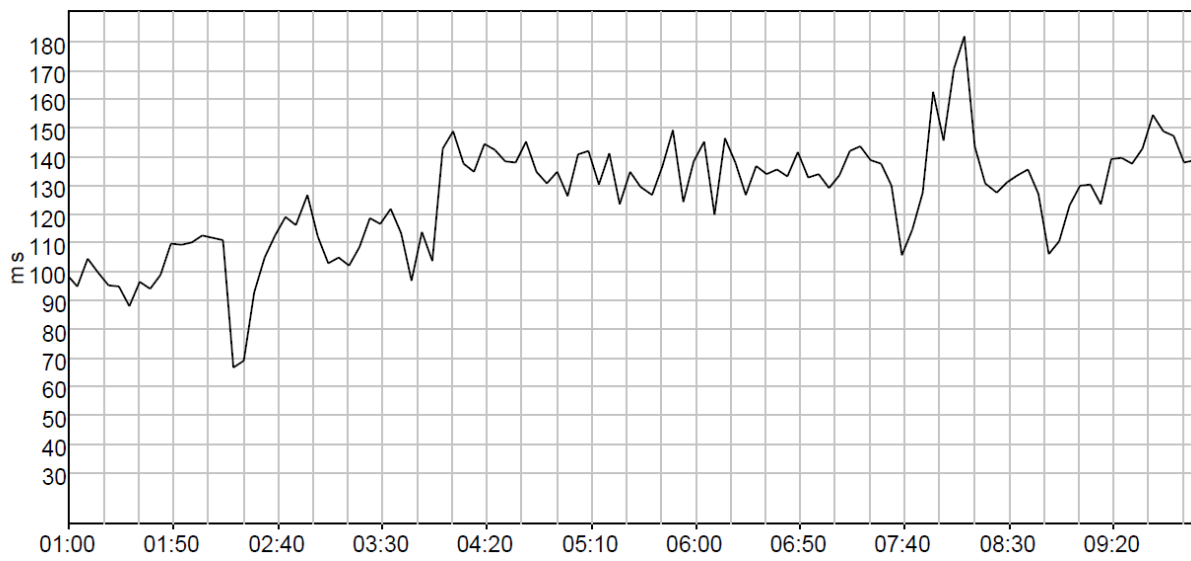FIGURE 50. The Night before the Clinic condition, Participant 8.

RMSSD

FIGURE 51. The Night after the Clinic condition, Participant 8.

RMSSD

FIGURE 52. The Night before the Nature condition, Participant 8.

RMSSD

FIGURE 53. The Night after the Nature condition, Participant 8.

RMSSD

FIGURE 56. The Night before the Clinic condition, Participant 9.

RMSSD

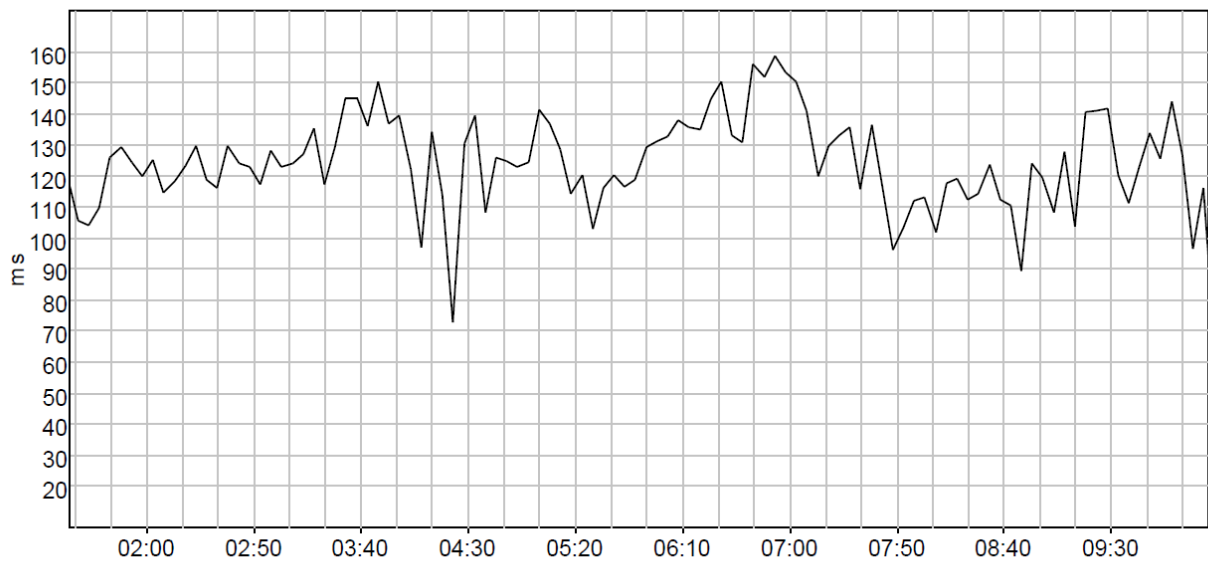FIGURE 57. The Night after the Clinic condition, Participant 9.

RMSSD

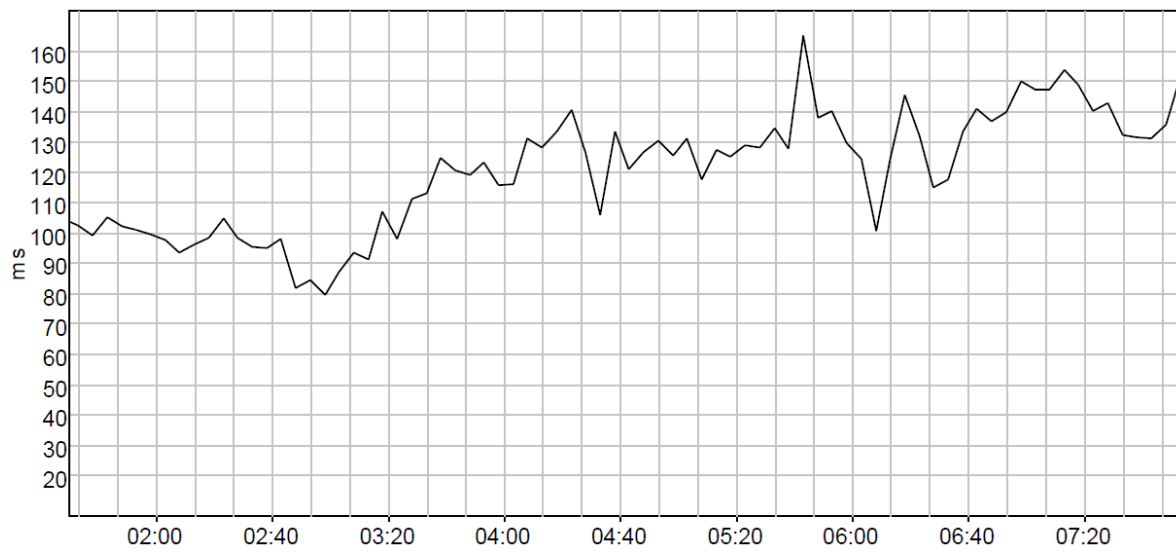FIGURE 58. The Night before the Nature condition, Participant 9.

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FIGURE 59. The Night after the Nature condition, Participant 9.