Dynamics of state feelings

State Affect: A longitudinal study with the use of experience sampling

Bachelor Thesis

Negar Sadeghi Hassanabadi (1761188)

27.06.2019, Enschede

University of Twente
Department of Positive Psychology & Technology
First supervisor: Dr. P.M ten Klooster
Second supervisor: Dr. M.L Noordzij

Abstract

Background: Feelings vary over time, they are not stable but are often measures as trait-like concepts. Recently, researchers have raised their interest in finding ways to measure state feelings and moods of people. Experience Sampling Method (ESM) is a method that is often used for momentary assessments of feelings or behaviors. In contrast to cross-sectional designs, it allows us to measure feelings, the moment they occur and therefore allows for a broader understanding of participants emotional life. Russel and Watson & Tellegen (1985) suggested that feelings are not discrete entities rather they are dimensional. Alexithymia refers to people who have difficulties to define or differentiate between their feelings. Surprisingly 1/5 of the general population shows signs of alexithymia. **Objective:** The aim of this study was to get an impression of the dynamic of state feelings with the use of experience sampling. Another aim was to assess whether ESM is suitable for measuring state feelings. A different aim was to investigate whether there are differences in state and trait feelings of people who show or not show signs of alexithymia. **Method:** The sample was derived from a non-clinical young population, with the age between 18 and 30 years. Either being students or full-time employees. In a longitudinal ESM study, the relationship between state and trait feelings was measured. The participants were asked to fill out the affect grid via the TiiM application for seven days four times a day at specific time points. At the eight-day participants were asked to fill out the Positive and Negative Affect Scale (PANAS) and Toronto-Alexithymia Scale 20 (TAS20). **Results**: A series of Linear mixed model (LMM) analyses were conducted. State pleasure significantly covariates with the positive affect of the PANAS. A significant main effect for the negative affect of the PANAS and state pleasure was found. A strong significant negative correlation between the level of pleasure of participants and the negative affect of participants was found with a post-hoc analysis. For the TAS20, it was shown that pleasure and energy scores of participants with signs of alexithymia are strongly positively correlated, in contrast to the scores of pleasure and energy of participants without signs of alexithymia. Scores of PA and NA affect of the PANAS and their state pleasure strongly positively correlate as well. Scores of NA affect of the PANAS and pleasure scores of the affect grid of participant's without sings of alexithymia do significantly and strongly correlate. **Conclusion:** It was found out that state feelings do vary over time and that ESM is a valid method to measure state feelings because, in this study, trait and state feelings do correlate but not too strong, suggesting that both measure something similar but state feelings account for more dynamics. Besides it was

found that participants who have signs of alexithymia have difficulties differentiate between pleasure and energy, as well as positive and negative affect.

Introduction

Feelings and Mood differ. They differ not just within populations but also within persons themselves. There are a spectrum of feelings and moods people can feel and the dynamics make it possible for them to change not only within the day but also within seconds (Watson & Clark, 1984; Kuppens, Stouten, & Mesquita,2009). Research in psychology regarding mood has a long tradition. It is not only interesting to investigate them because it underlies a variety of psychological disorders or corresponds to a part to personality characteristics but also because humans experience them in a wide spectrum within a day (Tellegen, 1985; Watson & Clark, 1984); Kuppens, Stouten, & Mesquita,2009; Ebner-Priemer, Eid, Kleindienst, Stabenow, & Trull, 2009). It is a highly discussed topic, and therefore, there are many opinions and theories, aimed to explain underlying mechanisms (Tellegen, 1985; Watson & Clark, 1984; Russel, Weiss, & Mendelsohn, 1989; Kuppens, Oravecz, & Tuerlinckx, 2010).

There are several frameworks by which psychologists classify emotions, feelings, and moods. These can be classified into two fundamental viewpoints. The first one proposes that emotions are discrete and fundamentally different constructs. It is originated from Darwin (1872) and based on this Tomkins (1962), proposed that emotions and moods are products of evolution and genetically determined. Tomkins argues that they are distinguishable not only on the basis of their neural features but also on behavioral and expressive features. His views influenced the work and ideas of Paul Ekman and Carrol Izard, who are known for their theory of discrete emotions (Colombetti, 2009). It has to be acknowledged that the limitations of this approach progressively became apparent. Researchers found out that measures of different affects are not as discrete as supposed, rather they are strongly and systematically interrelated (Watson & Clark, 1997).

Thus, researchers started to assume that affects are not discrete, rather they are dimensions, thus creating the second viewpoint. The dimensional models of emotions underlie the hypothesis that a common and interconnected neurophysiological system is responsible for all affective states (Russel, 2009). Many of the commonly used frameworks of affect belong to the second viewpoint (Russel, 2009). In 1897, Wilhelm Wundt proposed that emotions can be described in three

dimensions, pleasurable versus un-pleasurable, arousing or subduing, and strain or relaxation. In order to conceptualize human emotions, dimensional models of emotions define where they lie in two or three dimensions. Since then deprived of evidence, a general consensus has been made that two broad factors are incorporated in the dimensions of affect. Thus, nowadays most models incorporate valence and arousal or intensity dimensions (Watson & Clark, 1997). The most commonly used models are the circumplex model (Russel, 1980), and the Positive Activation – Negative Activation (PANA) model by Watson and Tellegen (1985) (Rubin & Talarico, 2009).

The circumplex model, developed by Russel (1980), suggests that emotions are operationalized in a two-dimensional circular space, containing arousal and valence dimensions. The horizontal axis represents valence while the vertical axis represents arousal. The center of the circle presents a neutral valence and a medium level of arousal (see Figure 2). Russel (1980) describes his model as representative of core affect, which consists of the most elementary feelings that are not necessarily directed toward anything. Essentially, it is how we feel at a particular point in time. Researchers have suggested that core affect is fundamentally a combination of two types of feelings continuums; Valence (pleasant to unpleasant) and arousal (low to high arousal) (Russel, 1980). Within the years the term arousal has been replaced by energy (low to high energy) (Schutz, Quijada, De Vries, & Lynde, 2010). Accordingly, Russel (2009) describes core affect as a "pre-conceptual primitive process, a neurophysiological state, accessible to consciousness as a simple non-reflective feeling: feeling good or bad, feeling lethargic or energized". He further elaborates on the continuum which incorporates two types of feelings, stating that core affects although being two dimensional, is subjectively perceived as a single feeling. This means that when combining the two dimensions with each other, the result is a unified feeling. For example, being high in energy while experiencing high unpleasantness results in being tense. Core affect, although it can account for a broad range of emotional states and provides a solid basis for discussing similarities and differences among affective states, is not the same as emotions, and is more similar to moods (Russel, 2009). Different types and intensities of feelings and moods can be experienced, depending on the quality, intensity, and content of the individual's experience on the above-mentioned dimensions (Plass & Kaplan, 2016). In order to test his circumplex model theory Russel (1980) introduced the affect grid which was designed to assess two dimensions of affect, pleasure-displeasure, and arousal-sleepiness. It is suitable for any study that requires judgments of affect of either descriptive or subjective kind. It has been developed to supply researchers with an instrument

that is short and easy to fill out and, therefore could be used rapidly and repeatedly. It has been proven to be a valid instrument to assess mood (Russel, 1980).

The PANA model, invented by Watson and Tellegen (1985), does not specifically incorporate arousal. Instead, it suggests that positive and negative affect are two separate systems. This is due to the fact that the PANAS is based on an orthogonal rotated variant of the pleasure-arousal scale, which has shown that positive and negative moods are largely independent of another (Watson & Tellegen, 1985). States of higher arousal tend to be defined by their valence and states of lower arousal tend to be more neutral in terms of valence. Positive affect (PA) reflects the extent to which a person feels enthusiastic, active and alert. Thus, high PA is a state of high energy, full concentration and pleasurable engagement whereas low PA is characterized by sadness and lethargy (Watson & Tellegen, 1985). Contrasting to this, negative affect (NA) is a general dimension of subjectively perceived stress and un-pleasurable engagement with a variety of aversive mood states, with low NA being a state of calmness and serenity (Watson & Tellegen, 1985). It has to be highlighted, that the model of Watson and Tellegen (1985) has been the more prominent scale for measuring mood and has been used far more often than the circumplex model of Russel (1980). Hence, it has been far more often validated and there are different reliable and valid versions of the PANAS. In contrast to that, the affect grid has not been used that often although it provides a valid and reliable measurement for mood.

Particularly, but not exclusively, researchers have raised their interest towards moods because many psychological disorders express themselves with a variety of moods and fluctuations, called mood disorders (Solomon, Leon, Coryell, Endicott, Fiedorowicz, & Keller, 2010; Kessler, Avenevoli, & Merikangas, 2001; Ebner-Priemer, Eid, Kleindienst, Stabenow, & Trull, 2009). Until now, most of the research concerning moods or feelings have focused on it as a trait-like concept (Watson & Tellegen, 1985; Kuppens, Stouten, & Mesquita, 2009; Scherer, 2000).

A trait is defined as a more permanent presence and a stable level of emotion. It refers to the stable, consistent and enduring disposition of the individual, including emotional reactions and temperament, rather than situational, variable and temporary factors. On the opposite, a State refers to a temporary emotional fluctuation, which is a momentary emotional reaction to internal and/or external triggers. It evolves physical, behavioral, cognitive and psychological reactions (Zelenski & Larsen, 2000). Feelings as a state are not stable, they can change from moment to moment (Davidson, 1998; Zelenski & Larsen, 2000). Especially in a variety of mood disorders,

this is typically the case, such as bipolar disorders and depressive disorders. This is due to the fact that people with those disorders most of the time have a general emotional state or mood which is distorted or inconsistent with the circumstances that they are in. Thus, interfering with their ability to function (emotions (Taylor, Ryan, & Bagby, 1985; Munoz 1995).

Moreover, many people who suffer from mood disorders display alexithymia. Alexithymia refers to difficulties in perceiving and describing the emotions of others and themselves (Taylor, Ryan, & Bagby,1985; Gross & Munoz, 1995; Linehan, 1993). The core characteristics of alexithymia are marked dysfunction in emotional awareness, social attachment, and interpersonal relating. Furthermore, individuals suffering from alexithymia also have difficulty in distinguishing and appreciating the emotions of others, which is thought to lead to un-empathic and ineffective emotions (Taylor, Ryan, & Bagby, 1985). One aspect to consider is that 18% of the general population have difficulties in verbalizing and expressing their emotions or the emotions of others (Mattila et al. 2006). Thus, it is important to check if participants display symptoms of alexithymia while measuring mood or feelings. In this study, it is hypothesized that participants who have signs of alexithymia have difficulties differentiating or maybe even confuse their daily mood and thus their levels of pleasure and energy, should either be the same or totally different. Likewise, it is assumed that they have difficulties differentiating between positive and negative affect as measured by the PANAS.

Changes and fluctuations in feelings do occur in non-clinical populations as well, although in the past not well acknowledged (Davidson, 1998; Scherer, 2000; Kuppens, Stouten, & Mesquita, 2009). People are capable of experiencing a variety of feelings throughout the day and their dynamic nature makes it possible to switch within a day or even within hours (Davidson, 1998). Past research in psychology concerning emotions and feelings has been mostly focused on emotions or moods as a trait (Watson & Tellegen, 1985; Kuppens, Stouten, & Mesquita, 2009; Scherer, 2000). Therefore, there are various tests and scales that measure feelings as a trait, as mentioned above yet, questionnaires and measurements for feelings as a state have been considered too little (Watson & Tellegen, 1985). Although this led to meaningful outcomes and important information like questionnaires that measure the trait of mood (e.g; PANAS), it does not account for the situational dynamics and variety of moods (Watson & Tellegen, 1985). The currently used tests regarding moods are not sensitive enough to catch the variations and different moods people feel throughout the day. This is partially due to tests not

accounting for the dynamics of moods because they are applied in cross-sectional designs thus, only once and retrospectively.

Another aspect that may have affected this, is the fact that in the past, research in psychology was more interested in differences within populations and not within the individual itself (Watson & Tellegn, 1985, Russel, 1980). For example, Smallwood, Fitzgerald, Miles & Phillips (2009) conducted a study in which they examined the effect of mood states on mind wandering, with the use of PANAS. Although they applied the PANAS before and after the mood induction, they did not take into account that moods change far more often. Another Study by Kennedy-Moore, Greenberg, Newman, & Stone (1992) examined the relationship between daily events and mood by applying the PANAS and another mood scale. Here again, they asked the participants retrospectively to fill out the PANAS asking about their mood of today. Yet they did not consider that moods differ throughout the day and in order to get a better view on the relationship between daily events and moods it might have been better to apply the PANAS throughout various time points within the day to be able to catch which events accounted for which moods.

Nowadays, a paradigm shift can be seen, researchers are more and more interested in the differences within an individual (Palmier-Claus, Myin-Germeys, Barkus, Bentley, Udachina, Delespaul, & Dunn, 2011). In this way, in-depth information about the individual can be gained, which then provides the means to target the needs of the individual even more (Palmier-Claus et al., 2011). Thus, there is a need for a study design, which is able to catch the dynamic affect within a person and uncovers how emotions or specifically moods unfold themselves in daily life. In order to acquire such measurements about a person's state feelings and moods, the experience sampling method (ESM) can be used. In the last years, it has become an increasingly popular tool for measuring feelings but since this is a rather new method, it has not often been used yet. It originates from dairy studies, which is a popular research method in which participants are asked to fill out behaviors, activities or feelings each day (Van Berkel, Ferreira, & Kostas, 2018). Csikszentmihalyi et al. (1977) were one of the first researchers who conducted an ESM study. They analyzed adolescent activity and experience in the late 1970s, instructing them to complete a paper self-report form upon each incoming paper signal which they received from a pager. The Introduction and the emerging usage of Smartphones have made it easier to make use of experience sampling as a method of acquiring self-reported data from participants. Using smartphone applications as a means for self-reported data about experience or emotions has gained immense popularity.

ESM requires participants to answer an identical set of short questions, multiple times per day, within a certain amount of time. This can be done for weeks or even months. Nowadays with the rise of smartphones, it allows researchers to send out notifications when they need to fill out the questionnaire occur (Van Berkel, Ferreira, & Kostas, 2018). This method allows researchers to get detailed information about an individual's feelings and changes in feelings at the moment they occur (Van Berkel, Ferreira, & Kostas, 2018). Correspondingly, the change in feelings can be monitored and associated with existing or assumed psychopathologies, personality differences, and gender (e.g. Ebner-Priemer et al., 2009; Ebner-Priemer, Eid, Kleindienst, Stabenow, & Trull, 2009). ESM is helpful in order to measure state emotions and to assess to what extent or if they differ from participants' trait emotions (Versluis, Verkuil, Lane, Hagemann, Thayer, & Brosschot, 2018.

For example, Kuppens, Allen, and Sheeber (2010) conducted a study on Emotional Inertia and Psychological Maladjustment by using the method of experience sampling. They found out that emotional fluctuations of individuals who have depression and low self-esteem as expected were characterized by higher levels of inertia in both positive and negative emotions, as opposed to people who did not exhibit low self-esteem or depression. Also, Versluis, Verkuil, Lane, Hagemann, Thayer, and Brosschot (2018) conducted a small study about emotional awareness with the use of experience sampling, they found out that indeed Emotional Awareness varies over time and is not as stable as often assumed. Zelenski and Larsen (2000) were one of the first researchers studying the distribution of basic emotions from a state and trait perspective using experience sampling. They asked undergraduate university students to fill in a daily report form, three times a day (around noon; in the early evening; and in the late evening). Zelenski and Larsen (2000), found out that positive emotions were rated higher than negative emotions. Also, negative emotions, in the total sample were rated lower. Besides, their study showed that happiness was rated more intensively compared to the other emotions. An interesting finding was that overall positive emotions seemed to be much more blended than the negative ones. Hence, negative emotions were experienced much more distinctly. Another interesting finding was, that their study, support the assumption of Watson and Tellegen (1985), that trait emotions are perceived in, two dimensions, positive and negative affect. Their study resulted in the conclusion that when emotions were assessed within-subject states, these states conform much more to discrete emotions model, in contrast, they found out that when emotions as traits are measured, they conform to a dimensional model.

In the current study, the aim is to get an impression of the different states of feelings with the use of experience sampling and to evaluate whether ESM is a suitable way of measuring emotional states over time. Another aim is to explore the convergent validity of state measures with trait measures, this is done in order to check whether ESM data is a valid way to measure feelings. A different aim is to see whether participants display signs of alexithymia and if participants who display signs of alexithymia are able to differentiate between their feelings. The target group a non-clinical young population of people from the age of 18 till 30, as people in that age period, are more prone to displaying fluctuations throughout the day in their emotions and feelings (Klerman, 1988).

Methods

Design

This quantitative study was conducted with the experience sampling method (ESM). ESM is an approach in which data is collected via self-reports multiple times per day at the moment they occur, in order to sample experiences and feelings of an individual in their natural setting (Van Berkel, Ferreira, & Kostakos, 2018). Participants get notified when they are required to answer a short, identical set of questions. An ESM study usually has a duration of at least three days to three weeks, involving multiple reports, usually four to ten times (Van Berkel, Ferreira, & Kostakos, 2018). It is very different from cross-sectional study designs, in which data is only retrieved once, retrospectively or beforehand. The experience sampling design was chosen due to the fact that data can be collected repeatedly over the day for each participant and measurements of feelings can be retrieved within the moment. This allows studying both the variability of levels of pleasure and energy over time.

The Duration of the study was set to be eight days which is aligned to Hektner, Schmidt, & Csikszentmihaly (2007), who advised that a minimum of one week is necessary to have a representative sample of people's activities or feelings. At day eight participants were required to fill out the Positive and Negative Affect Scale (PANAS), which asks about participants feelings or moods regarding last week and the Toronto-Alexithymia Scale 20 (TAS20, once. This study was conducted with the use of TiiM, created by the BMS lab of the University of Twente (Appendix 3), therefore it was chosen to use signal contingent sampling, in which participants are required to make a response to a signal delivered at unpredicted times (Van Berkel, Ferreira, & Kostas, 2018). Hence, participants got a notification on their smartphone when they were required to answer

questions. In the first seven days starting from a Tuesday morning at 10:00 am, the participants were asked to fill out the Affect Grid four times a day, in a specific time slot, determined by the researcher. It was chosen to assess feelings, four times a day in order to assess the variability of moods participants felt throughout the day. The times of measurement were chosen randomly within the 4-time intervals by rolling a dice. The first time slot was between 10:00 a.m. to 11:00 a.m., the second time slot was between 12:00 p.m. to 2:00 p.m., the third time slot was between 4:00 p.m. to 6:00 p.m. and the last time slot was between 8:00 p.m. to 10:00 p.m. Participants had the opportunity to delay the measurement for one time and were reminded to fill in the Affect Grid half an hour later, within the specific time slot.

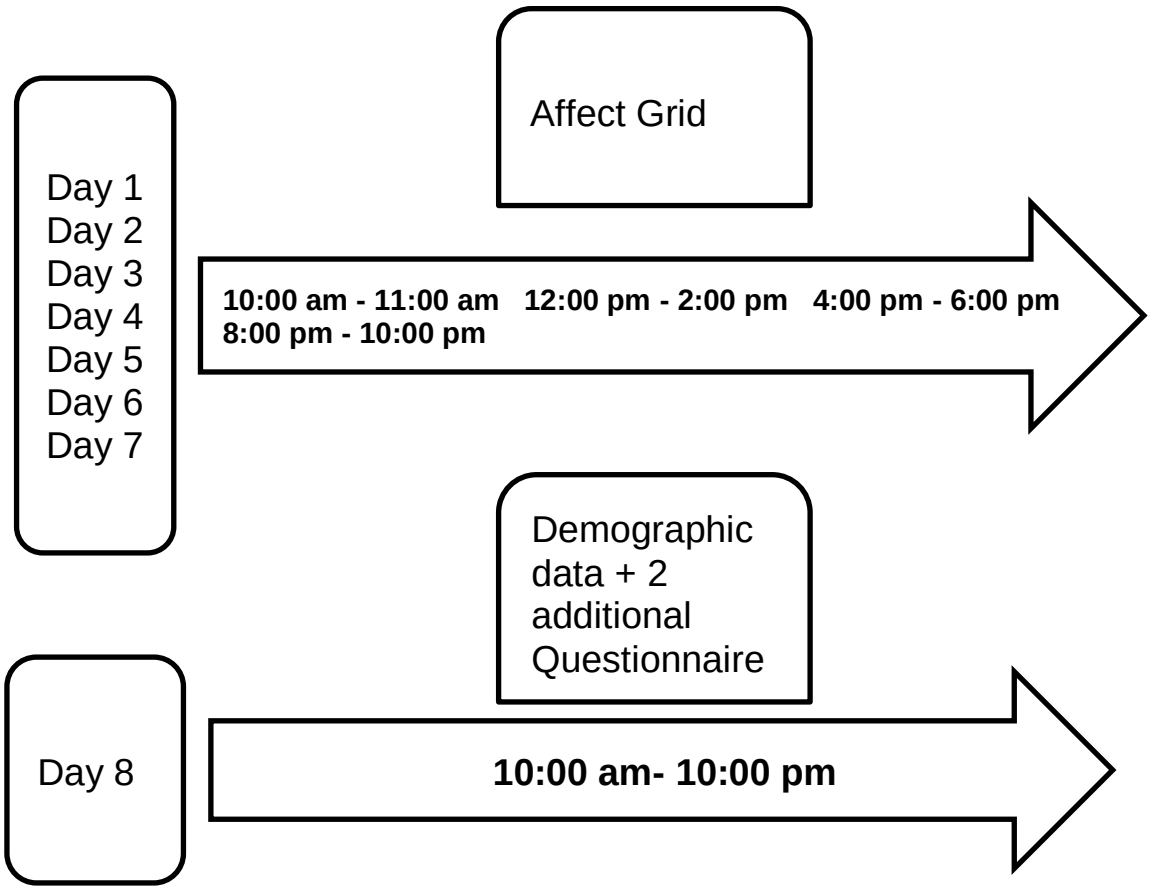


Figure 1. Study Layout of ESM Study

Participants

Twenty-six participants were recruited through convenience sampling out of the general population, this is aligned with previous studies. Traditionally, in order to estimate how many participants are needed, a power analysis is done. This is different in an ESM design because reliability is achieved with many measurements instead of many respondents. In this study, it was chosen to have at least 25 participants because Van Berkel and his colleagues (2018) provided in their research article that a median number of 19 participants provides representative insight into experiences or feelings. In ESM Studies the sample size is most of the time small because ESM studies tend to employ analyses with substantially larger power such as linear mixed models that adequately deal with the nested structure of the data. Participants were approached through various social media channels or through family, friends or other acquaintances.

The inclusion criteria were (1) the participants had to be over 18 years old, (2) they had to be studying at a university or university of applied science and/or be employed, (3) they had to have an iOS or Android-capable smartphone, (4) they were able to properly understand and comprehend the English language. Participants were excluded from this study by the following exclusion criteria; (1) did not agree with the informed consent, or (2) did fill in the affect grid less than 13 times.

Materials

TiiM (The incredible intervention machine)

In order to take part in the study, participants had to download the TIM application. This is an application that was developed by researchers from the University of Twente and functions as a means of conducting research online. Participants received a registration link with which they were able to register for the study and create an account in TiiM. With the start of the study, participants received notifications regarding the questions they needed to fill out each day (Appendix 3).

Affect Grid

The Affect Grid is a single item scale that was developed to measure a person's emotional state. It is based on the circumplex model of affect, in which a person’s emotional state can be mapped onto a two-dimensional Cartesian plane where the x-axis represents a pleasure-displeasure continuum and the y-axis represents an arousal-sleepiness continuum (Russel,1980). The original

version of the affect grid had the form of a 9x9 grid and participants had to mark an X in the square, to indicate how he or she is feeling at the moment. Since the original affect grid was a pen and paper version, it resulted in participants only making use of the space within the square, not being aware that they also could mark their X everywhere within the grid. Thus, the outcome tended to be skewed (Russel, Weiß, & Mendelsohn, 1989). Over time, the Affect Grid and the wordings of the x and y-axis were altered. Nowadays, the most common wordings are a pleasure for the x-axis and energy for the y-axis (Russel, Weiß & Mendelsohn, 1989). The Affect Grid was chosen due to the fact that it is quickly filled out and consequently can be used rapidly and repeatedly. In this study, the Affect Grid is used to measure state feelings and moods of participants throughout the study. The original Affect Grid was altered in order to be used in this study, in a digital form and also to undermine the probability of getting skewed data. Participants in this study could mark their emotional state with a dot, anywhere within the Affect Grid, which they moved with the touchscreen of their mobile phone. In figure 2, the original version as well as the altered version, used in this study, are depicted.

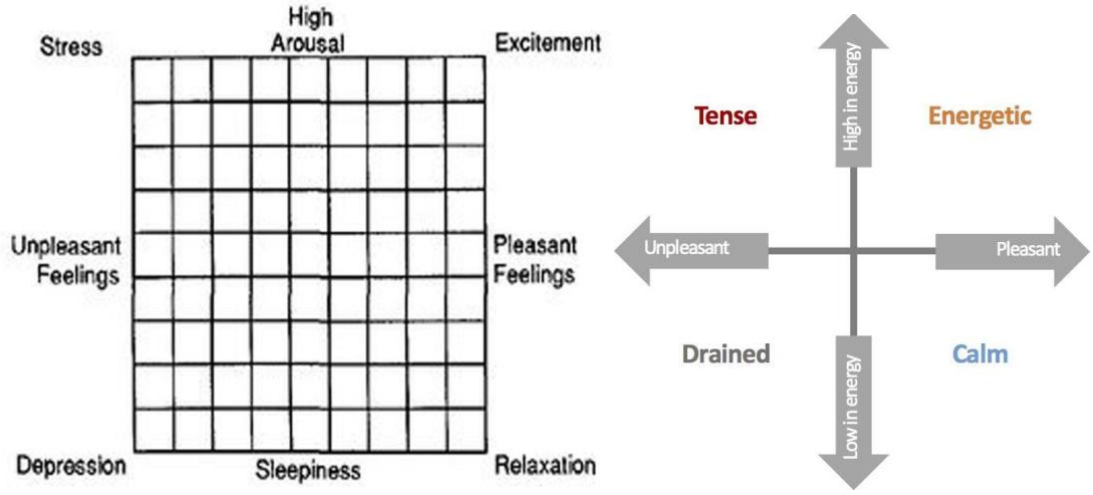


Figure 2. Original Affect Grid (left) and altered Version of the Affect Grid used in this study (right).

Positive and Negative Affect Scale (PANAS)

The Positive and Negative Affect Scale (PANAS) was developed to measure mood or emotion and is the most widely used questionnaire for that (Watson, Clark, & Tellegen, 1988). The

PANAS is a self-report scale and consists of 20 items, with 10 measuring positive affect (PA) and 10 measurings negative affect (NA). Items are rated on a five-point Likert Scale ranging from 1 being very slightly not at all to 5 being extremely. It was designed to measure affect in various contexts such as; the present day, past day, week, or year, or in general (Watson, Clark, & Tellegen, 1988). Since for this study the PANAS is used for a trait measure, the questions were asked with the intonation on "the past week". The final score is measured by taking the sum of the 10 terms on the positive scale and the sum of the 10 terms on the negative scale. Scores on each scale can range between 10 to 50 with higher scores on the PA scale representing higher levels of positive affect and vice versa for the NA scale. Values assigned are positive for answers on the positive scale and negative for answers on the negative scale (Watson, Clark, & Tellegen, 1988). In a sample of international students, with 9 females and 9 males (the average age was 28) Thompson (2007) found high reliability for the NA scale with Cronbach's alpha being 0.82 and for the PA scale, Cronbach's alpha being 0.85. The PANAS has a strong convergent validity with such measures as general distress, depression and state anxiety (Thompson, 2007). In this study, the Positive affect scale of the PANAS also showed high reliability with Cronbach's alpha being 0.74. Likewise, the negative affect scale has shown high reliability with a Cronbach's alpha of 0.87.

Toronto Alexithymia Scale (TAS-20)

Besides the PANAS, the Toronto Alexithymia Scale (TAS-20) was used. It was developed to measure alexithymia and is one of the most commonly used tests for that. The TAS-20 is a self-report scale and consists of 20 items with three different subscales. The Items are rated by using a five-point Likert scale whereby 1 is "strongly disagree" and 5 is "strongly agree". In order to get a total alexithymia sore, responses are summed over all 20 items. For the subscales, each subscale factor is the sum of the responses to that subscale. The TAS-20 uses cutoff scoring which means that a score of equal to or less than 51 means non-alexithymia, a score equal or greater than 61 means alexithymia and scores between 52 to 60 mean possible alexithymia (Bagby, Parker, & Taylor, 1994).

In a sample of 389 male and 576 female students from a Canadian university with 21.8 (SD=5.6) being the mean age, Bagby, Parker, and Taylor (1994) found high reliability, with Cronbach's alpha being 0.81. In this study, the TAS20 has shown high reliability with Cronbach's alpha being 0.89.

Pilot Study

In order to check the usability of the application and the understanding of the questions, before the final study, a pilot was conducted. Two people were asked to take part in the pilot test which took place for three days. Also, both researchers and the supervisor of this bachelor's project took part. Both participants understood the questions asked but for the use of the application it was decided to provide future participants with a handout, in which it was explained step by step how to download the application and set up an account. Likewise, for the final study, instructions were added in the application on how to deal with the tools such as the Affect Grid and the Likert scales.

Procedure

This study was approved by the BMS Ethics Committee of the University of Twente (#190452). Participants were recruited via convenience sampling through various Social Media channels. First participants were informed about the purpose of the study, confidentiality regarding their data, and agreed on the terms and conditions of the study (Appendix 1). A handout was offered, in which it was explained which steps have to be done in order to participate and how the application TIIM application works (Appendix 2). All questionnaires and scales mentioned above were merged into one "intervention" in TiiM. In the first seven days starting from a Tuesday morning at 10:00 am, the participants were asked to fill out the Affect Grid and two additional questions regarding anxiety and depression four times a day, in a specific time slot, determined by the researcher. On the last day of the study, participants had to fill out the PANAS and the TAS-20 and the HADS. The two questions regarding anxiety and depression and the HADS were used by another researcher. Also, they had to fill in socio-demographics including age, occupation or study, study program, nationality, and gender. After the study, the obtained data was stored and retrieved from TiiM.

Data analysis

The statistical program SPSS (version 25) and Microsoft Excel (16.14.1) were used for the data analysis. Since on the last day of the study the application did not work for some participants, it was required to make use of Qualtrics and send the baseline questionnaires PANAS, TAS20, and questions about the demographics to five participants who were not able to fill out these questionnaires via TiiM. First of all, the data from TiiM and from Qualtrics were transformed into SPSS-datasets. In the wide format rows with missing input were deleted. All participants were

included in the analysis, due to the fact that all completed the questionnaire in TiiM frequently, (all participants completed the questionnaires at least 13 times). In order to get information about the demographic variables such as age, gender, nationality and student and/or job, descriptive statistics such as means, standard deviations, frequencies, were used. For the reliability of the questionnaires, a reliability analysis was conducted, to get the score of Cronbach's alpha. For PANAS and TAS20, the sum scores of participants and means and standard deviations were calculated.

In order to make use of Linear Mixed Modeling (LMM), the data set was changed into a long format. Linear Mixed Modeling was used to analyze the data of this study because it accounts for the nested structure and missing data and therefore is especially useful for ESM data. Thus, a series of LMM analyses with an autoregressive covariance structure was conducted to analyze the hierarchical structure of the repeated measurements per participants and/or time. All mean values gathered by LMM take missing data into account and are as a consequence estimated and referred to as marginal means. In each LMM analysis, the subjects were the participants, the measuring point was repeated and the repeated covariance type was AR(1). The dependent variable was either x (pleasure) or y (energy), of the Affect Grid. The measuring point was set as a fixed factor and was added to the model. This was done in order to get the estimated marginal means for each measurement point to be able to compare the data over the different time points and to see how participants feelings changed or varied throughout the study. In order to get information about each participant, the fixed factor participant was added to the model. In this way estimated marginal means for each participant were estimated, to be able to compare participants. The output of the analysis mentioned above provided a mean estimation of the dependent variables pleasure and energy, of the affect grid. Next, PA and NA of the PANAS and the grouped TAS20 scores were added as a fixed factor into a series of separate LMM analyses, in order to get an estimation of F-values. In the same analysis, either PA or NA affect of the PANAS were added as covariates in order to estimate their correlation to the dependent variables pleasure or energy of the affect grid. To be able to estimate the correlation of the grouped TAS20 scores to the dependent variables was added as a covariate but measurement point was not added as a fixed factor because otherwise, SPSS did not provide an output. To be able to compare the estimated means of the variables and to create graphs to visualize how the various variables were related to each other, Excel was used. Graphs were created for measurement points over time and between participants.

In order to confirm the outcome of the LMM analyses, a series of post-hoc bivariate Pearson's correlation analyses were used. This was done to confirm the relationship between the

participant's overall mean state of pleasure or energy on the different time points of measurement. Likewise, a post-hoc bivariate correlation analysis was used to examine the relationship between the overall mean state of pleasure and energy of participants, with the overall positive and negative affect of the PANAS of the participants.

Based on the outcomes of the TAS20 questionnaire, participants were divided into two groups. Participants without alexithymia (0) and Participants with alexithymia (1). This questionnaire is used to see in what degree participants are able to identify their emotions and whether people who have no signs of alexithymia have a different level of state emotions throughout the day. It was decided that participants with a sum score of 55 or higher, have alexithymia and participants below that score do not. It was decided because 55 is approximately the middle score. Thus, 15 participants showed no signs of alexithymia whereas 11 participants did. This allows evaluating differences between individuals showing signs or no signs of alexithymia. Furthermore, these groups' pleasure and energy levels were analyzed with bivariate correlation analysis. A bivariate correlation for the groups' pleasure/energy and their positive or negative affect was as well analyzed, to get information regarding their trait and state measures, and to check whether the participants who have alexithymia differ in that aspect as well from the participants who do not. The effect sizes of the analyses were interpreted on the basis of Cohen's conventions (1988), in which a coefficient of .10 is considered as a weak correlation, a coefficient of.30 a moderate and a coefficient of 0.50 a strong correlation.

For the purpose of getting in-depth information about participants with extreme scores, 2 individuals were picked. Their scores of pleasure and energy of the affect grid were visualized in graphs, likewise, their affect grid was replicated.

Results

Demographic variables

In total, there were 26 participants who downloaded the TiiM application and completed the study. The mean age of the participants was 23.7 (SD= 3.71), with 15 being female and 11 male. There were 16 students, of which 11 had a student job, the rest of the sample consisted of people who have a full-time occupation (Table 1). All 26 participants were included in the analysis. The response rate was 78.71 % (M=22.04, SD=4.01).

Table 1. Demographic variables of participants.

Item	Category	Frequency	%
Gender	Male	11	42.3
	Female	15	57.7
Nationality	German	23	88.4
	Dutch	2	7.7
	Other (British)	1	3.8
Job	Yes	21	80.8
	No	5	19.2
Student	Yes	16	61.5
	No	10	38.5

Descriptive statistics

State pleasure and energy over the time of 7 days

By running a Linear mixed model analysis, the participants' pleasure and energy throughout the study were analyzed. The estimated marginal means of all 28 measuring points of all participants can be seen in Figure 2. The average amount of pleasure was estimated being 19.50 (SD=9.30), over the 28 measuring points. The average level of energy was -7.16 (SD=10.1). Overall there was a wide variation in mean scores across the measurement points. Participants scored the highest pleasure, with the mean being 33.66 (SD=10.30), on the 17th measurement, which equals to Saturday morning (Time of measurement 8:00 - 10:00 a.m.). Their lowest pleasure level was on the 21st measurement with a mean of 2.85 (11.86), this measurement was taken Sunday morning (8.00 - 10:00 a.m.) (Figure 2). The participants all together had the highest energy on the sixth

measurement with a mean of 12.2 (SD=9.86), which was taken Wednesday (12:00 - 2:00 p.m.). On the contrary, their lowest energy was on the 20th measurement, with a mean of -26.34 (SD=10.13), which equals to Saturday evening (8:00 - 10:00 p.m.) (Figure 2). Having a look at the graph, suggested that higher pleasure levels do not indicate higher energy levels.

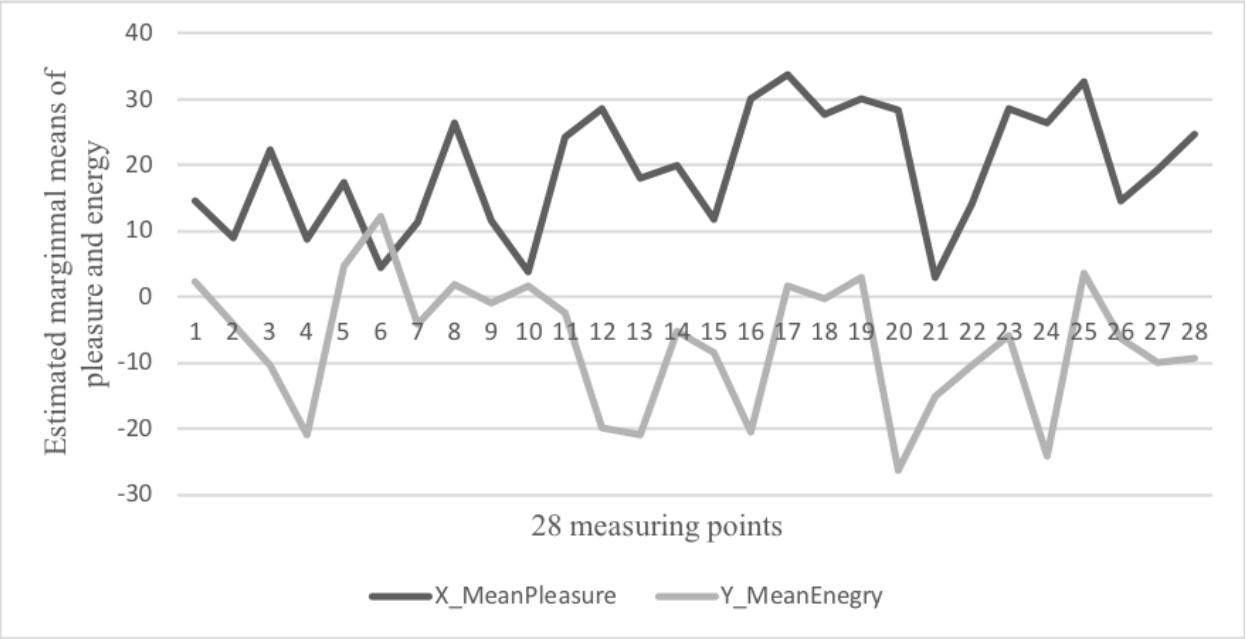


Figure 2. Estimated marginal means of pleasure and energy for all 28 measuring points, of all participants

State Pleasure and Energy per Person

Analyzing the data for each participant, overall it shows that there were great variations between participants and their feelings. Participant 9 scored the lowest overall pleasure with a mean of -60.24 (SD=10.74) and participant 15 having the highest pleasure overall with a mean of 67.70 (SD=9.96) (Figure 3). Regarding the energy scale, it resulted in participant 6 having the highest overall energy with a mean of 16.20 (SD=12.98) and participant 13 having the lowest overall energy with -38.94 (SD=9.94) (Figure 3).

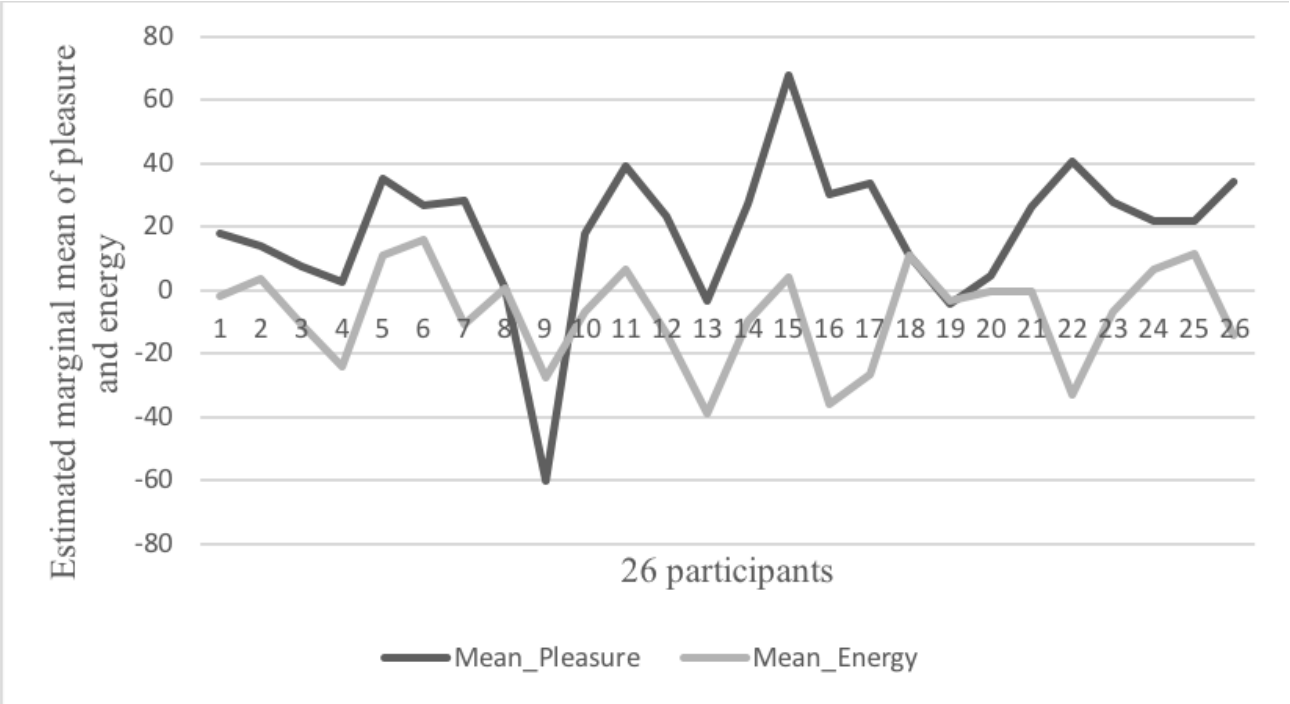


Figure 3. Estimated marginal means for pleasure and energy of all 26 participants

Comparing both the overall means of time point and participants or overall emotions in participants showed that there was substantial variation in both. Specifically, in the pleasure scale participants scores varied strongly. Furthermore, there was more variation and outbreaks in energy levels throughout the weekend than on weekdays, which can be seen in Figures 2 and 3. Additionally, the participants had higher levels of pleasure than energy throughout the week compared to weekends.

PANAS

On the eight day of the study, participants were asked to fill out questionnaires such as the PANAS and the TAS20. The PANAS is used, in order to check how their trait affect is associated with their state affect. The participants' overall positive affect was 33.10 (SD=5.60) and the overall negative affect was 25.41 (SD=11.79). Meaning that the participants all together perceived more positive than negative affect. Overall, in Figure 6, it can be seen that in most participants the levels of positive affect are much higher than the negative affect. But for example, in 9 participants, the scores of negative affect are higher than the positive affect. Participant 9, also as can be seen in figure 4, had very low pleasure levels, this suggests that state feelings, do reflect themselves in the trait emotions of a person. For the positive affect, the highest score was 46, for participant 15 and

the lowest was 26, for participant 7. The highest score for negative affect 42, for participant 21 and the lowest score was a 13, for 26.

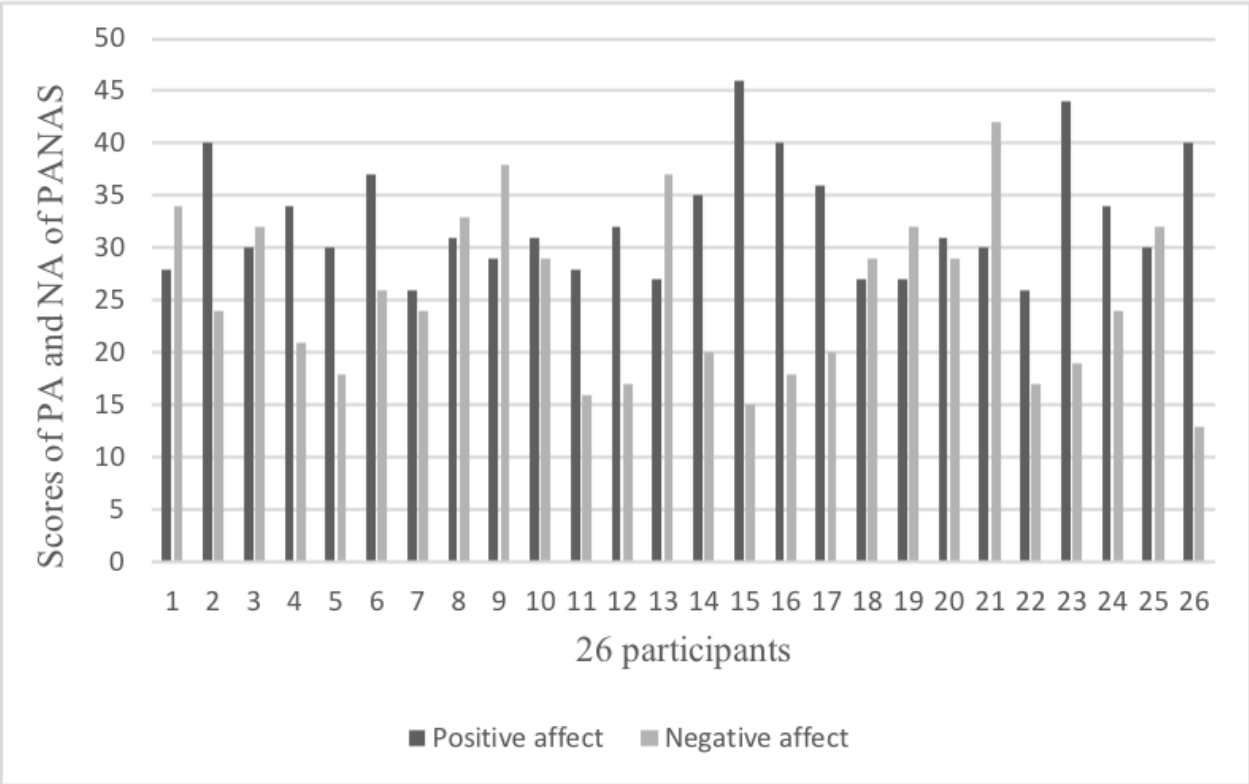


Figure 6. Sum scores of the positive and negative affect of the PANAS for all 26 participants

TAS20

The participants average of the scores of the TAS20 was 52.27 (SD=11.70). Meaning overall participants possible show signs of alexithymia. From the 26 participants, 11 show no signs of alexithymia, 6 showed signs of it and 9 showed possible signs of alexithymia (Figure 7). Participant 13, had the highest score with 76 and participant 23, the lowest score with 31.

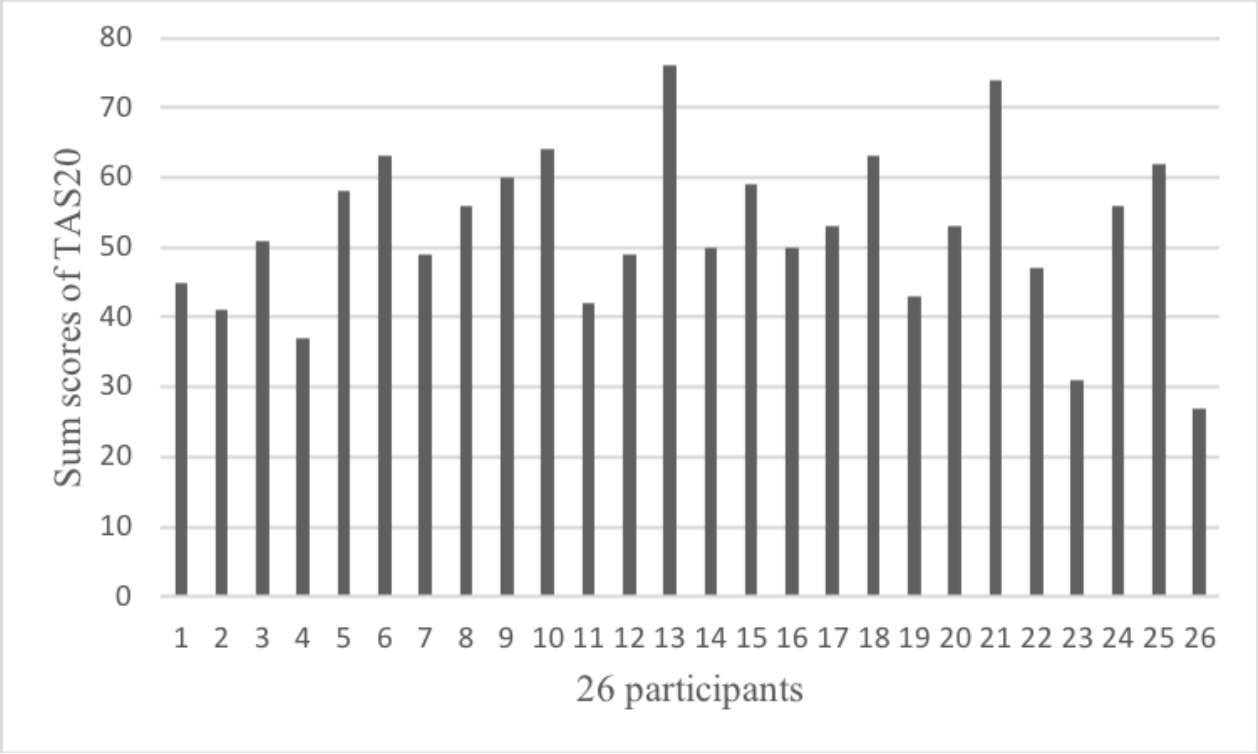


Figure 7. Sum scores of TAS20 of all 26 participants

After changing the cut-off score to 55, in order to divide participants into two groups, no signs of alexithymia and signs of alexithymia the following was found out. After this grouping, fifteen participants had no signs of alexithymia and eleven had signs of alexithymia. In figure 8, it can be seen that there appear to be less variation in the scores of pleasure and energy from people with signs of alexithymia. The mean pleasure of participants with alexithymia was 15.1 (SD=31.3), their mean energy was -1.1 (SD=17.3). The highest score of pleasure was 67.7, which belongs to participant 7, the lowest score of pleasure was measured of participant 4, with a value of -60.2. Participant 2, had the highest overall energy with a score of 16.2, in contrast, participant 6 had the lowest energy with a score of -38.9.

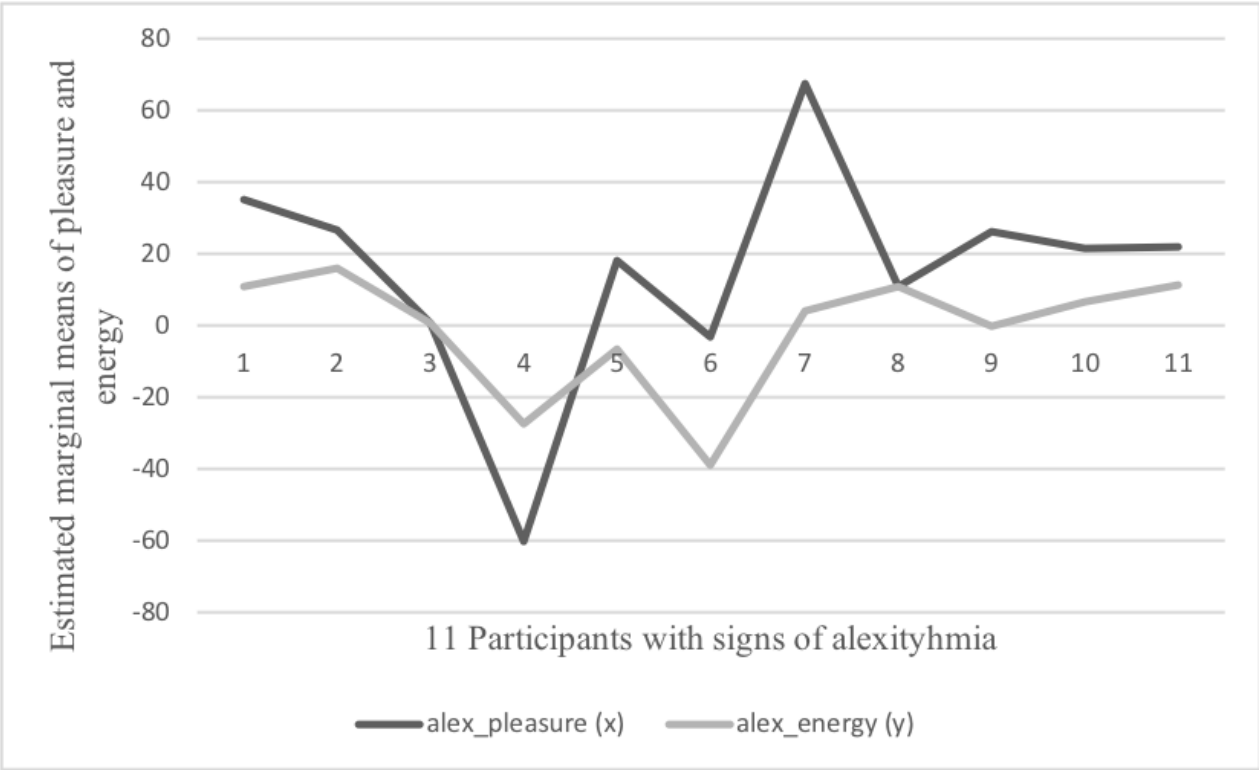


Figure 8. Estimated marginal means of pleasure (x) and energy (y) of the 11 participants with alexithymia

As opposed to what was mentioned before, in figure 9 it can be seen that scores of pleasure and energy of people without signs of alexithymia have huge variations. The mean pleasure of participants without signs of alexithymia was 21.87 (SD=14.01), their mean energy was -11.98 (SD=12.87). Overall, participant 13 had the highest pleasure with a score of 40.82 and participant 11, the lowest with a score of -4.51. The highest energy was measured in participant 6, with a score of 6.84, in contrast, participant 9 had the lowest energy with a score of -35. Considering both and comparing figures 8 and 9, it can be seen that there are differences in levels of pleasure and energy with regard to participants with and without signs of alexithymia.

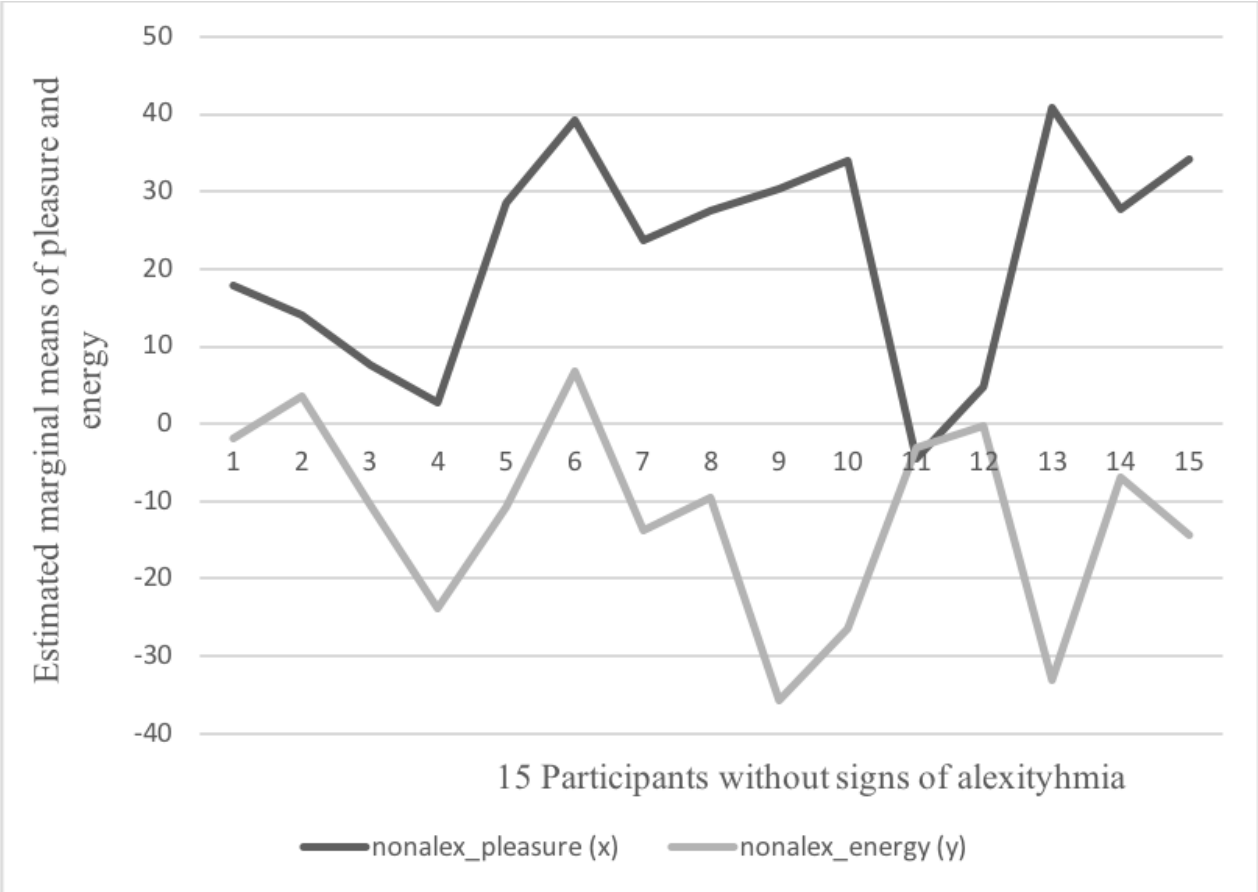


Figure 9. Estimated marginal means of pleasure (x) and energy (y) of the 15 participants without alexithymia

Linear Mixed model

Table 2. Using different variables as covariates in the Linear mixed model

Dependent	Fixed factors	Covariates	F-value (df1, df2)	p-values
Pleasure (x)	Measurement point	Energy (y)	1.060 (27, 309.0289)	**p=.387**
		PA (PANAS)*	14.539 (1, 126.076)	**p=.000**
		NA (PANAS)*	42.546 (1, 137.351)	**p=.000**
		No_Yes Alexithymia*	2.068 (1, 123.210)	**p=.153**
Energy (y)	Measurement point	PA (PANAS)*	0.000 (1, 174.080)	p=.978
		NA (PANAS)*	0.105 (1, 175.426)	p= .746
		No_Yes Alexithymia*	5.976 (1, 178.873)	**p=.015**

*Measurement point was not added as a fixed factor to the model otherwise the model would not provide an output

State and Trait Measures

By running a bivariate correlation analysis, Pearson's correlation revealed a weak non-significant negative correlation between state pleasure and state energy throughout the 28 measuring points (r= -0.128, p =.516). This implies that pleasure and energy levels did not correlate with each other over the 28 measuring points. Another Pearson's correlation revealed a strong significant negative correlation for the trait positive affect and trait negative affect of the PANAS (r=-.520, n=26, p=.007). This indicates that when Positive affect increases in a person, then negative affect decreases (Appendix 5).

Association between dependent and independent variables

By adding trait positive affect as a covariate, in the LMM analysis, it showed that positive affect did significantly covariate with state pleasure F (1, 126.076) =14.539, p=.000. The post-hoc bivariate correlation analysis confirmed the effect because a moderately significant positive correlation (r=.409, n=26, p=.038) between the overall mean of participants of state pleasure and

their trait positive affect was found. Indicating that when participants' pleasure increased, their overall positive affect increased as well. Trait negative affect was added to the LMM analysis as a covariate of state pleasure of participants, it revealed a significant main effect F (1, 137.351) =42.546, p=.000. Afterwards a post-hoc bivariate analysis was conducted. A strong significant negative correlation was found between the estimated mean pleasure of participants and the negative affect of participants (r=-.664, n=26, p=.000). This suggests that when levels of pleasure of participants increased, their overall negative affect tended to decrease.

In separate LMM analysis, each positive and negative affect were added as covariates, but both did not have a significant effect on energy levels (Table 2). A post-hoc analysis for the level of energy and positive affect of persons, there was a weak non-significant positive correlation found (r=.048, n=26, p=.814). For the level of energy and negative affect, there was also a weak non-significant positive correlation found (r=.057, n=26, p=.781). Both suggesting that state energy does not influence the individual's overall positive or negative affect (Appendix 5).

Association of TAS20 scores with the Affect Grid and PANAS

Adding the overall score of the TAS20 of the participants as a covariate to the state pleasure of participants, in the LMM, resulted in a strong significant main effect F (1, 123.210.) =2.068, p=.153. As well adding the overall TAS20 score as a covariate to state energy of participants resulted in a strong significant main effect F(1,178.873)=5.976,p=.015. Indicating that TAS20 scores correlate with both pleasure and energy scores, thus when TAS20 scores are higher, both state pleasure and energy are higher as well.

Two bivariate correlation analyses were conducted for the participants who showed signs of alexithymia and the participants who did not show signs of it. The bivariate correlation analysis of the pleasure and energy scores of the 11 participants with signs of alexithymia revealed a strong significant positive correlation (r=.643, n=11, p=.034). It indicated that when pleasure levels increased, energy levels of participants with signs of alexithymia increased as well. On the contrary, after conducting a bivariate correlation analysis for the scores of pleasure and energy of the 15 participants with no signs of alexithymia revealed a moderate non-significant negative correlation (r=-.321, n=15, p=.243). Suggesting that, levels of pleasure and energy did not increase or decreased, when one of them increased or decreased, in participants without signs of alexithymia (Appendix 6).

Lastly, to check whether there are different associations of scores of the affect grid and the PANAS of participants with and without signs of alexithymia several bivariate correlation analyses were conducted. For PA and pleasure levels of participants with alexithymia, it revealed a strong significant positive correlation (r=.633, n=11, p=.037). Implying that when pleasure levels increased, positive affect increased as well, similar to what was found with the bivariate correlation analysis of all 26 participants levels of pleasure and PA. For the participant's levels of pleasure and their negative affect, the analysis revealed a strong negative significant correlation as well (r=-.672, n=11, p=.024). This is likewise similar to what was found when doing the analysis with all 26 participants. For participants with signs of alexithymia with regard to their overall PA and their energy levels, the Pearson correlation indicated a moderate positive non-significant correlation (r=.357, n=11, p=.281). This suggests that when their energy levels increased, their overall PA did not increase. On the contrary, with regards to their overall NA and their energy levels, it indicated a strong negative significant correlation (r=-.544, n=11, p=.084). Indicating that when levels of energy increased, their NA decreased (Appendix 6).

For participants without signs of alexithymia, there was only one significant finding. Correlating their overall NA with their pleasure levels revealed a strong negative significant correlation (r=-.745, n=15, p=.0013). Suggesting that when their pleasure levels increased, their NA decreased. These findings, implicate that participants with alexithymia and participants without alexithymia do differ in how they perceive their feelings (Appendix 6).

Individual analysis

Having a closer look at participant 9, resulted in the findings of figure 4. It can be seen that throughout the study, the participants' levels of pleasure are very low most of the time, on the contrary, the energy levels of the participants vary a lot throughout the study. Considering the affect grid, the participant most of the time feels drained, with a few times feeling calm. This can also be seen in the Graph which differentiates between pleasure and energy level (Appendix 4)

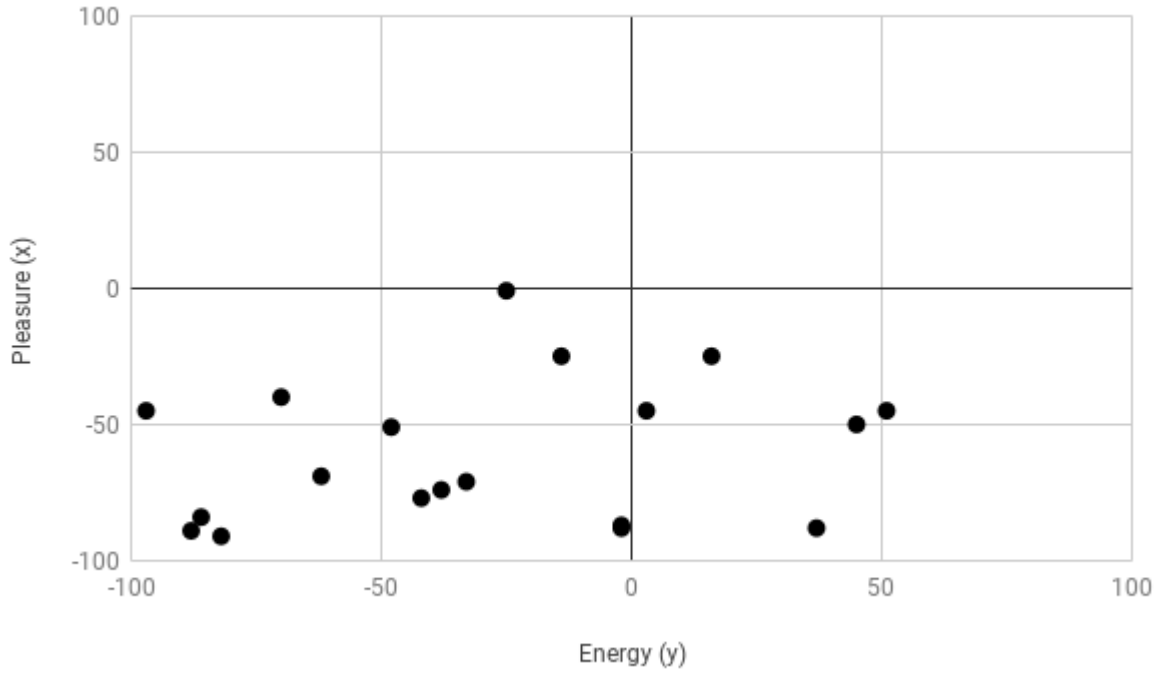


Figure 4. Scores of the Affect Grid of Participant 9 throughout the study

In figure 5, the scores of pleasure and energy of participant 15 have been put into a graph. It can be seen that the pleasure levels are mostly stable and high throughout the study. Opposed to that, are the energy levels. They vary a lot throughout the study. Especially in the measuring points 9 to 11, which equals to Thursday noon, afternoon and evening. Here it can be seen that the participants experience the lowest levels of energy on Wednesday afternoon but in the evening, the energy is very high with a score of 99. The same results can be seen for the measuring points 12 through15, which equal to Friday morning to evening. In the mornings, the level of energy is the lowest, with a score of -91 but in the evenings the scores increase to a 100.

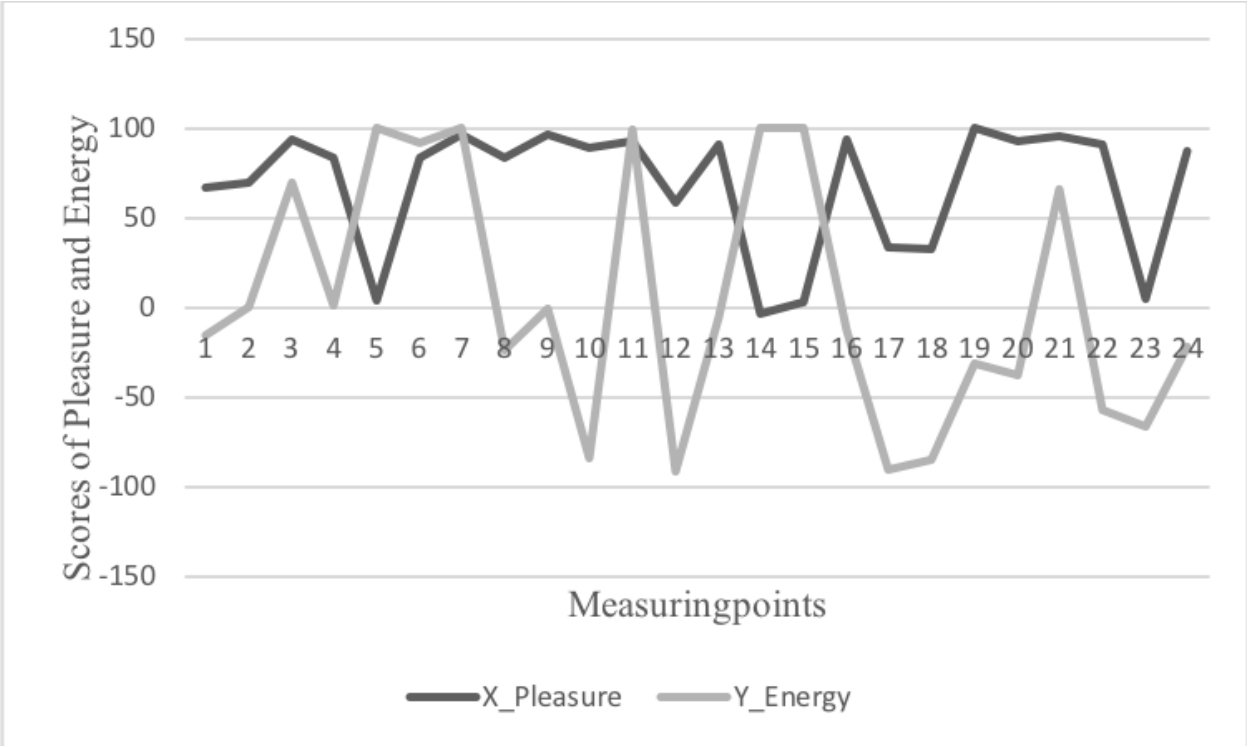


Figure 5. Scores of Pleasure and Energy of Participant 15 throughout the study

In Figure 6, the scores of the affect grid of participant 15 are displayed. Here it can be seen that the participant felt tense most of the time but a few times, the participant felt energetic. This is similar to what can be seen in Figure 6, where it is displayed that the participants' levels of energy vary more than his pleasure levels.

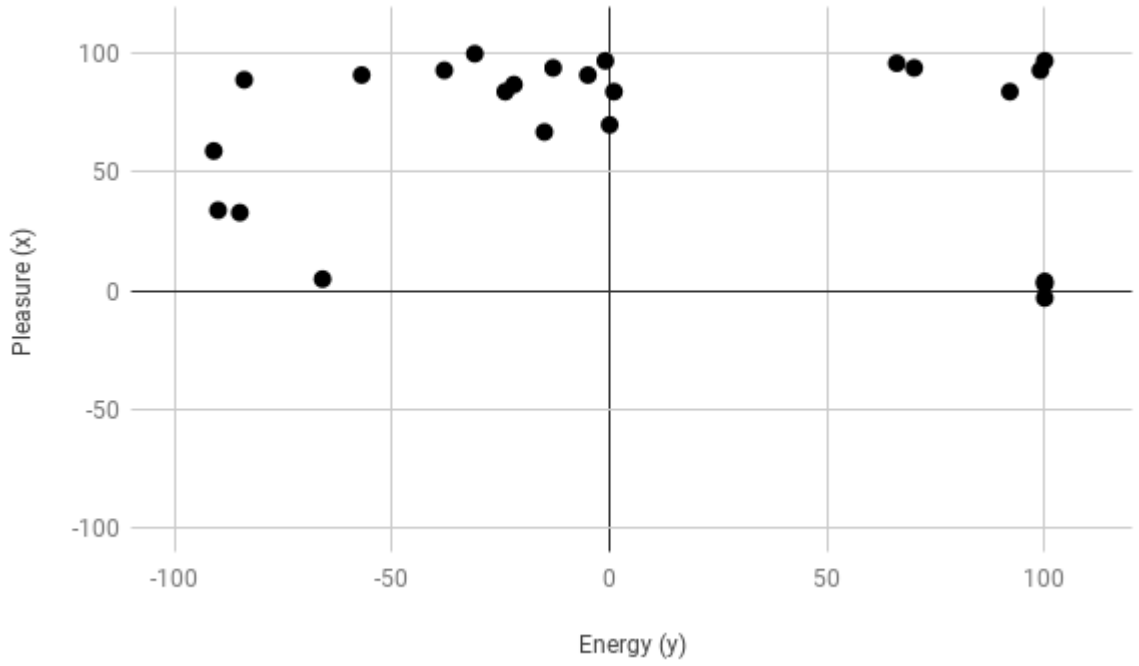


Figure 6. Scores of Affect Grid of Participant 15.

Discussion

This study's objective was to gain an impression of the variety of momentary emotional states and how they differ throughout the day and within persons themselves. One of the main findings of this study was that when comparing the trait feelings and the state feelings of participants, there are indeed variations. Feelings as already mentioned in the introduction, are not stable, but change, considerable also within a day. This study indicated that experience sampling appears to be a suitable method to catch the dynamic of feelings because it provided information about the variations of feelings, participants had throughout the study. It showed that state feelings and trait feelings do correlate but not too strong, indicating that state measures do give insight into the dynamics of feelings in a way that trait measures cannot. Thus, ESM in this study was a valid way of measuring feelings.

Another result showed that, in this sample, pleasure and energy levels differ a lot as well, meaning that they are not associated with each other. A person can feel energized without having pleasure or vice versa. Accordingly, this confirms the independence of the two axes in the Affect Grid (Russel, 1980). Another finding was that pleasure and energy, within the time measurements

are not correlated, this again confirms the independence of the different axis of the affect grid. Nevertheless, it has to be mentioned that a person perceives higher levels of energy/pleasure when she or he already feels higher levels of pleasure/energy (Russel, 1980). Based on this, it can be concluded that an effective way of measuring state emotions are scales which treat emotions as dimensions and not as discrete entities. This is in accordance with Russel (2009), who found out that it is more effective to measure emotions in a dimensional way since in dynamic models of emotions, emotions are not treated as discrete entities but rather are dimensional.

Overall, the participants scored higher on pleasure than energy. This is in accordance with the study of Zelenski and Larsen (2000), in which they found out that their participants overall perceived much more positive emotions than negative ones. Logically, they perceived more pleasure on Saturday morning. This can be assumed since the sample consisted of people with a job or students, meaning that they had free time and were able to choose which activities to do. Likewise, great variations among participants were found. this was expected due to the fact that in a sample derived from a normal population, people differ in their feelings. Again, this is similar to what Zelenski and Larsen (2000) found out when comparing undergraduate students with each other. An interesting finding was when looking at the participant which scored the lowest overall pleasure over the duration of the study, the participant's levels of pleasure throughout the study were very low and did not vary much. In contrast to that, the energy levels varied a great amount.

Also, the trait negative affect was lower than his/her positive affect, implicating that state levels indeed give information about the trait behavior of emotions of the person. This is in concordance to what Watson and Tellgen (1985) found out. The PANAS is orthogonally rotated to the pleasure-arousal dimensions, indicating that pleasure measures do provide the same information as positive affect measures. This again, indicates that an ESM study is able to capture detailed information about a person's emotional life, which trait-like tests such as the PANAS, which are applied only on one-time point, cannot capture or account for. Another finding which supports this indication was illustrated by the case study of pleasure and energy levels throughout the study of participant 15. The pleasure levels were high and stable, but the energy level varied much. When looking at specific days and time periods of dates, it showed that the participant experienced lower energy levels in the morning and much higher energy levels in the evenings. This detailed information cannot be provided with traditional ways of studying feelings and moods, like Watson and Tellegen (1985) or Kuppens, Stouten, and Mesquita (2009) did. Likewise, this

result is similar to what Klerman (1988) had found, people perceive higher energy levels in the evenings and perceive depressive-like symptoms in the mornings.

Versluis and her colleagues (2018) did an ESM study, in which they checked whether emotional awareness varies over time or is stable. Their results have shown that indeed, emotional awareness varies over time. Thus, this provides evidence that emotions are not stable rather they vary. This study found similar results in that respect as well. The results have shown that emotions vary over time. Compared to the PANAS, which is only applied once and retrospectively, the ESM with the use of the affect grid provides evidence that feelings vary and change, even within days. Both the Versluis study (2018) and this study did not determine what these variations are due to, meaning that they did not measure the context, thus there is no clear explanation for the variations. Another aspect they are similar is that the real-life variations in emotions meaningfully capture the variability within subjects in the complexity of emotional experience over time.

Comparing the findings of this study, to one of the first studies which studied trait and state emotions while using ESM, showed interesting findings (Zelenski & Larsen, 2000). First of all, similar to what Zelenski and Larsen (2000) have found, is that feelings do vary over time and there are a variety of feelings, people experience throughout the day. Their results with regards to positive and negative emotions were similar, indicating that in a non-clinical population, positive emotions are much more prominent. This study, similar to what Zelenski and Larsen (2000) found out, supported the assumption of Watson and Tellegen (1985) that trait emotions are perceived in a dimension of positive and negative affect. Since this study did not check for the intensity of feelings, no comparison with regards to the results of Zelenski & Larsen can be made. Likewise, no comparison of the amount of blend within the categories of negative and positive emotions can be made. Surprisingly, their results concluded that state emotions conform more to discrete emotions model rather than dimensional ones, in contrast, trait emotions did conform to the dimensional model. The current study cannot come to such a conclusion since for both state and trait measurements, dimensional models of emotions were used.

Participants on average had a higher trait positive affect than negative affect, this implies that participants generally have more positive emotions than negative ones. Again, this is in concordance to what Zelenski & Larsen (2000) found out when comparing state and trait feelings. Besides this study confirms what Zelenski & Larsen (2000) found out, negative emotions were rated lower than positive ones. Comparing the state levels of pleasure of people with their trait positive affect, an interesting finding was revealed. The state levels of pleasure

account for 16% variance of positive affect, indicating that there is a difference and thus measuring state is important. They correlate with each other, indicating that the more pleasure they perceived throughout the week of measuring, the higher their trait score of positive affect was. This is in accordance with what was expected because the PANAS asks about the emotions the participants experienced in the last week. Thus, higher scores of pleasure throughout the week indicate higher positive affect scores. Also comparing the state levels of pleasure of people with their trait negative affect, provided an interesting finding. The more pleasure they perceived throughout the week, the lesser their negative affect score was.

Surprisingly, state pleasure did account for 44% of the variance for negative affect, this indicates that state feelings are associated with trait feelings but catch dynamics in feelings which trait measurement of feelings cannot. As already mentioned above, since the PANAS asks for emotions participants experienced last week, this result is aligned with the one mentioned beforehand. Meaning that higher scores of pleasure indicate lesser negative affect in persons. Once more, this is in accordance with the Zelenski and Larsen study (2000), the more positive emotions participants perceived, the lesser were the negative emotions they perceived. On the contrary, when comparing the state energy of people with either the trait positive or negative affect, there were no associations. The state energy of people did not affect their trait positive affect, this means that regardless of how high or low their energy was in the week, their positive affect score did not change. This is also an interesting outcome since energy is one of the axes of the affect grid which measures mood. This is aligned with Russel, Weiss, & Mendelsohn (1989) had found out when they studied the relationship between PA and NA affect of the PANAS with pleasure-arousal of the Affect grid. Neither PA nor NA were correlated with arousal (or energy in this case), indicating that the PANAS does not measure the same thing as arousal (energy), when orthogonally rotated, although it measures pleasure, when rotated.

With regards to the TAS20, it has been shown that this sample, in general, using the validated cut-off scores, shows no signs or some signs of alexithymia, which means most participants do not have difficulties to identify or describe their feelings. After categorizing the sample into two different groups with different cutoff scores, one having no signs of alexithymia and, one having signs of alexithymia, almost half of the sample does show signs of alexithymia. Findings have shown that participants with signs of alexithymia do not differ too much in their pleasure and energy levels. This implicated that in this sample, people with signs of alexithymia may have more difficulties identifying and differentiating between their feelings of pleasure and

energy. As hypothesized, on the contrary participants without signs of alexithymia showed a lot of variation, suggesting that these participants had no difficulties differentiating or identifying their emotions throughout the week. Furthermore, it has been revealed that the higher the alexithymia scores, the lower the pleasure and energy levels of the participants have been. This is in accordance with the literature, stating that people who show signs of alexithymia have difficulties differentiating between various emotions (Taylor, Ryan, & Bagby, 1985).

Comparing the scores of pleasure and energy of participants with and without signs of alexithymia, showed that overall, participants with signs of alexithymia score lower in both pleasure and energy. Previous studies about alexithymia and mood disorders such as the one from Ebner-Priemer, Eid, Kleindienst, Stabenow, and Trull (2009), had found out that people with alexithymia show more negative emotions than positive ones. This is due to the fact that people who show signs of alexithymia are much more prone to psychopathological symptoms such as depressive episodes and mood swings (Ebner-Priemer, Eid, Kleindienst, Stabenow, & Trull 2009). Interestingly, when participants with alexithymia levels of pleasure increased, their energy levels increased as well, indicating that they do not differentiate between those dimensions, again confirming what Taylor, Ryan, and Bagby (1985) had found out. In contrast to that, it has been revealed that increases in the level of pleasure do not indicate increased levels of energy for participants without signs of alexithymia. Indicating that participants without signs of alexithymia differentiate between the different dimensions of the affect grid.

Interpreting the results of the study, a few limitations have become prominent. First of all, the study was done via an application that showed to have some malfunctions. Participants complained that the app did occasionally not save their answers, or even when choosing an answer, the application still indicated that no answer was chosen which raise difficulties continuing with the surveys. Thus, participants sometimes needed much more time to fill out the questionnaires, which left them annoyed and frustrated. This could have influenced their levels of pleasure and energy throughout the study and hence altering the results. Another limitation is the fact that this study was compiled with another researcher, which made use of other questionnaires for the ESM and for the trait questionnaires. The fellow researcher studies depression and anxiety, therefore maybe the participants were biased with negative wordings before filling out the Affect Grid, meaning an ordering effect could have been possible. This could have led to declines in pleasure and energy levels as well. Still, in order to prevent this bias, the order in which the Affect Grid, the

question regarding depression, the question regarding anxiety were organized was randomized throughout the day.

Nonetheless, a major strength of this study was the use of Linear Mixed models, which accounted for the missing data and since it was much data that was acquired, the missing data was no burden. A linear mixed model is a powerful analysis but when using bivariate correlation analysis as a post-hoc analysis, the study was underpowered. Another major advantage of this study is the use of ESM, in this way current feelings and mood states of the participants in their natural environment have been acquired. This gives in-depth inside about the emotional state's participants perceives not just throughout the week but also throughout the day. In line with this advantage is the fact that ESM is a rather new approach to studying emotions and therefore has not been often used. ESM makes it possible to study emotional states of participants throughout the day in their natural life. Particularly in the way this study is designed, it has not been used yet. Although there are already a few studies that make use of ESM in order to get in-depth information about emotional states, none of them validates them with a trait questionnaire in order to see whether ESM data is valid. Likewise, the use of the TAS20 to screen for persons with signs of alexithymia has not been acknowledged even though one study uses the emotional awareness scale, which has a subscale for alexithymia. The fact that this study, made use of the affect grid, which can be filled out in a few seconds, made it more bearable to conduct a longitudinal study and thus made it more applicable for the use with students or full-time employees. Another aspect to consider is the fact that this study did not ask in particular what the individuals did during the time slots where they had to fill out the questionnaires. Hence, no detailed information can be given, why in specific time points, participants scored high or low in pleasure and energy dimensions of the affect grid.

With regard to this study, it has become more certain, that feelings and moods vary a lot, not just within a person but also through different time points. The use of ESM provides a good and valid way to assess state feelings as well it enriches our understanding of emotions. Likewise, it has become evident that Alexithymia does not only appears in clinical but also in non-clinical populations. Alexithymia needs to get further acknowledged in studies conducting research about feelings or emotions in general. Concluding this, the study provides evidence for the fact that state feelings differ from trait feelings and that there are variations within feelings and moods, not just within populations but within persons and days as well.

In order to raise awareness of this aspect of emotions and to go from differences within people to differences within a person, ESM studies need to be further conducted, in order to find

out which is the most suitable way to measure feelings as states. Future studies should increase the study duration as well specifically ask what participants did when they filled out the ESM questionnaires, in this way, more data is retrieved which seemingly provides more insight about state emotions and likewise accounts for explanations of the variations of state emotions. Likewise, future studies are advised to use the TAS20 as a control variable because as this study has shown, alexithymia does account for skewed data. Emotions, in general, are a highly discussed topic and further research needs to be done in order to gain in depth knowledge in this complex theme because feelings do account and can explain a variety of behaviors.

References

Bagby, R. M., Parker, J. D., & Taylor, G. J. (1994). The twenty-item Toronto Alexithymia Scale—I. Item selection and cross-validation of the factor structure. *Journal of psychosomatic research*, *38*(1), 23-32.

Colombetti, G. (2009). From affect programs to dynamical discrete emotions. *Philosophical Psychology*, *22*(4), 407-425.

Csikszentmihalyi, M., Larson, R., & Prescott, S. (1977). The ecology of adolescent activity and experience. *Journal of youth and adolescence*, *6*(3), 281-294.

Darwin, C. (1872). *The Origin of Species: By Means of Natural Selection Or the Preservation of Favored Races in the Struggle for Life* (Vol. 1). Modern library.

Davidson, R. J. (1998). Affective style and affective disorders: Perspectives from affective neuroscience. *Cognition & Emotion, 12,* 307–330. doi:10.1080/026999398379628

Ebner-Priemer, U. W., Eid, M., Kleindienst, N., Stabenow, S., & Trull, T. J. (2009). Analytic strategies for understanding affective (in) stability and other dynamic processes in psychopathology.*Journal of abnormal psychology*, *118*(1), 195.

Gross, J. J., & Muñoz, R. F. (1995). Emotion regulation and mental health. *Clinical psychology: Science and practice*, *2*(2), 151-164.

Kennedy-Moore, E., Greenberg, M. A., Newman, M. G., & Stone, A. A. (1992). The relationship between daily events and mood: The mood measure may matter. *Motivation and Emotion*, *16*(2), 143-155.

Kessler, R. C., Avenevoli, S., & Merikangas, K. R. (2001). Mood disorders in children and adolescents: an epidemiologic perspective. *Biological psychiatry*, *49*(12), 1002-1014.

Klerman, G. L. (1988). The current age of youthful melancholia: evidence for increase in depression among adolescents and young adults. *The British Journal of Psychiatry*, *152*(1), 4-14. Linehan, M. M. (1993) *Cognitive–behavioral treatment of borderline personality disorder.* New York: The Guilford Press.

Kuppens, P., Allen, N. B., & Sheeber, L. B. (2010). Emotional inertia and psychological maladjustment. *Psychological science*, *21*(7), 984-991.

Kuppens, P., Oravecz, Z., & Tuerlinckx, F. (2010). Feelings Change: Accounting for Individual Differences in the Temporal Dynamics of Affect. Journal of Personality and Social Psychology, 99(6), 1042–1060. https://doi.org/10.1037/a0020962

Kuppens, P., Stouten, J., & Mesquita, B. (2009). Individual differences in emotion components and dynamics: Introduction to the special issue. *Cognition & Emotion, 23,* 1249–1258. doi:10.1080/02699930902985605

Linehan, M. M. (1993) *Cognitive–behavioral treatment of borderline personality disorder.* New York: The Guilford Press.

Mattila, A. K., Salminen, J. K., Nummi, T., & Joukamaa, M. (2006). Age is strongly associated with alexithymia in the general population. Journal of Psychosomatic Research, 61(5), 629–635.

Palmier-Claus, J. E., Myin-Germeys, I., Barkus, E., Bentley, L., Udachina, A., Delespaul, P. A. E. G., … Dunn, G. (2011). Experience sampling research in individuals with mental illness: reflections and guidance. Acta Psychiatrica Scandinavica, 123(1), 12–20. https://doi.org/10.1111/j.1600-0447.2010.01596.x

Plass, J. L., & Kaplan, U. (2016). Emotional design in digital media for learning. In *Emotions, technology, design, and learning* (pp. 131-161). Academic Press.

Rubin, D. C., & Talarico, J. M. (2009). A comparison of dimensional models of emotion: Evidence from emotions, prototypical events, autobiographical memories, and words. *Memory*, *17*(8), 802-808.

Russell, J. A. (1980). A circumplex model of affect. *Journal of personality and social psychology*, *39*(6),1161.

Russell, J. A. (2009). Emotion, core affect, and psychological construction. *Cognition and emotion*, *23*(7), 1259-1283.

Russell, J. A., Weiss, A., & Mendelsohn, G. A. (1989). Affect grid: a single-item scale of pleasure and arousal. *Journal of personality and social psychology*, *57*(3), 493.

Scherer, K. R. (2000b). Emotions as episodes of subsystem synchronization driven by nonlinear appraisal processes. In M. D. Lewis & I. Granic (Eds.), *Emotion, development, and self organization: Dynamic systems approaches to emotional development* (pp. 70–99). New York, NY: Cambridge University Press. doi:10.1017/CBO9780511527883.005

Schutz, P. A., Quijada, P. D., De Vries, S., & Lynde, M. (2010). Emotion in educational contexts. Shifting moods, wandering minds: negative moods lead the mind to wander. *Emotion*, *9*(2), 271.

Smallwood, J., Fitzgerald, A., Miles, L. K., & Phillips, L. H. 2009.

Solomon, D. A., Leon, A. C., Coryell, W. H., Endicott, J., Li, C., Fiedorowicz, J. G., ... & Keller, M. B. (2010). Longitudinal course of bipolar I disorder: duration of mood episodes. *Archives of general psychiatry*, *67*(4), 339-347.

Taylor, G. J., Ryan, D., & Bagby, M. (1985). Toward the development of a new self-report alexithymia scale. Psychotherapy and psychosomatics, 44(4), 191-199.

Tellegen, A. (1985). Structures of mood and personality and their relevance to assessing anxiety, with an emphasis on self-report. In A. H. Tuma *& J. D.* Maser (Eds.), *Anxiety and the anxiety disorders* (pp. 681-706). Hillsdale, NJ: Erlbaum.

Thompson, E. R. (2007). Development and validation of an internationally reliable short-form of the positive and negative affect schedule (PANAS). *Journal of cross-cultural psychology*, *38*(2), 227-242.

Tomkins, S. (1962). *Affect imagery consciousness: Volume I: The positive affects*. Springer publishing company.

Trull, T. J., & Ebner-Priemer, U. W. (2009). Using experience sampling methods/ecological momentary assessment (ESM/EMA) in clinical assessment and clinical research: introduction to the special section.

Van Berkel, N., Ferreira, D., & Kostakos, V. (2018). The experience sampling method on mobile devices. *ACM Computing Surveys (CSUR)*, *50*(6), 93.

Versluis, A., Verkuil, B., Lane, R. D., Hagemann, D., Thayer, J. F., & Brosschot, J. F. (2018). Ecological momentary assessment of emotional awareness: Preliminary evaluation of psychometric properties. *Current Psychology*, 1-9.

Watson, D., & Clark, L. A. (1997). Measurement and mismeasurement of mood: Recurrent and emergent issues. *Journal of personality assessment*, *68*(2), 267-296.

Watson, D., Clark, L. A., & Tellegen, A. (1984). Cross-cultural conver- gence in the structure of mood: A Japanese replication and a compar- ison with U.S. findings. *Journal of Personality and Social Psychology, 47.* 127-144.

Watson, D., Clark, L. A., & Tellegen, A. (1988). Development and validation of brief measures of positive and negative affect: the PANAS scales. *Journal of personality and social ´ psychology*, *54*(6), 1063.

Wundt, W. M., & Judd, C. H. (1897). *Outlines of psychology* (Vol. 1). Scholarly Press.

Zelenski, J. M., & Larsen, R. J. (2000). The distribution of basic emotions in everyday life: A state and trait perspective from experience sampling data. *Journal of Research in Personality*, *34*(2), 178-197.

Appendix

Digital informed Consent (Appendix 1)

You are being invited to participate in a research study titled *Feelings change: A study of daily variability of affect.* This study is being done by Wiebke Hoppe and Negar Sadeghi from the Faculty of Behavioural, Management and Social Sciences at the University of Twente.
The purpose of this research study is the validation of measurement instruments for daily fluctuations in feelings. For seven days, you will be asked to respond to short questions about your current feelings at four times a day. These questions will take you approximately 2 minutes to answer. On the eigth day of the study, you will be asked to fill in a longer questionnaire, which will take you approximately 30 minutes. The data will be acquired within the means of the Bachelor's theses of both researchers.
Your participation in this study is entirely voluntary and you can withdraw at any time. You are free to omit any question.
We believe there are no known risks associated with this research study; however, as with any online related activity the risk of a breach is always possible. To the best of our ability your answers in this study will remain confidential. We will minimize any risks by anonymisation of your data. Only the two researchers and their supervisor Peter ten Klooster will have access to the data and they will *not* be forwarded to any third party.
If you have any questions about the research or are interested in the results of the study, please contact:
Wiebke Hoppe, w.hoppe@student.utwente.nl
Negar Sadeghi, n.sadeghihassanabadi@student.utwente.nl

If you have any complaints about this research, please direct them to the secretary of the Ethics Committee of the Faculty of Behavioural Sciences at the University of Twente, Drs. L. Kamphuis-Blikman P.O. Box 217, 7500 AE Enschede (NL), telephone: +31 (0)53 489 3399; email: l.j.m.blikman@utwente.nl).

Handout (Appendix 2)

"Feelings change: A study of daily variability of affect" – Handout

Dear participant,

thank you very much for taking part in our study. Before we can get started, here are some important information that you need to keep in mind:

To be able to participate, you need a smartphone with iOS or Android and have a good understanding of the English language.

Steps to complete before the study starts:

1. To **sign up** for the study, please follow this link: **https://app.tech4people-apps.bms.utwente.nl/enrol/IHsxP**
2. On the website that opens up, please read the information provided carefully. Click on 'Continue' and fill in your email address, your name, and select a password which you will later use to log in to the app.
   → Your data will be anonymized. We will not be able to see your email address. In the data set, your name will not be visible. However, in the data set, each participant will be identified with a participant ID, i.e. a number that only we (that means: Wiebke, Negi, and our supervisor Dr. Peter ten Klooster) and no third party can match with your real name. In case that we recognize any problems you seem to be having (e.g. missing many questions), we would then be able to contact you personally. If you wish to stay fully anonymous, you can simply choose to insert a fake name. Remember that you need the name and the password to be able to log in to the app.
3. Please **download the application "TiiM"** (The incredible intervention machine) created by the BMS Lab of the University of Twente from your Appstore.
   a. Google Play: https://play.google.com/store/apps/details?id=nl.bmslab.utwente.tiimapp
   b. App Store: https://itunes.apple.com/de/app/tiim/id1229896853?mt=8
4. Make sure that you **enable TiiM to send you notifications:** In the app, go to "Settings", set a checkmark next to "Push notifications" and then tap on "Save". It might also be necessary to allow TiiM to send you notifications in the settings of your smartphone.
5. If you do not yet see our study on the TiiM dashboard, please wait until we accept your registration. When you are accepted, you will receive an email as a confirmation for your enrolment. After that, you will be able to access our study in TiiM.
6. To be able to begin with the study, please read and accept the informed consent.
7. The study will be conducted **from 10 a.m. on Tuesday, the 23rd of April until 10 p.m. on Tuesday, the 30th of April 2019.** So please make sure to have completed all the previous steps before the study starts. If you are not sure whether everything is in good order, please contact us so that we can check it before the study starts.

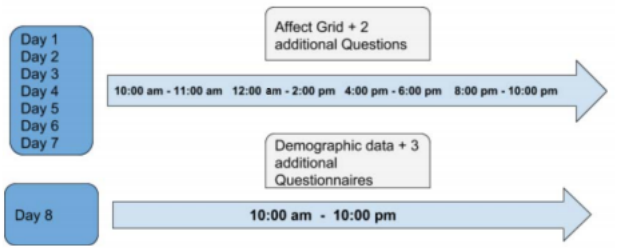
During the course of the study:

1. Over the course of seven days (23.–29.04.), you will be asked to fill in an "Affect Grid" and two additional short questions four times a day. Further instructions concerning these items will be provided in TiiM.
2. The four measurements on each day will take place at a random time point within certain time windows:

a. 10 a.m. – 11 a.m.
b. 12 a.m. – 2 p.m.
c. 4 p.m. – 6 p.m.
d. 8 p.m. – 10 p.m.

You will receive a notification when the next set of questions is available to you and, if you don't respond, a reminder. It is important to answer these questions **as soon as possible**. The questions will no longer be available to you after the time window is over. Therefore, **please look at your phone from time to time**. Each measurement, i.e. each set of three questions, takes about 1 minute to complete, so it's only 4 to 5 minutes that you spend with our study per day!

3. Missed a measurement? Don't worry, but try to be consistent and finish the study ☺
4. On the eighth day of the study (30.04.), you will be asked to fill in a somewhat longer questionnaire in TiiM consisting of four parts, which in total takes about 20 minutes to complete.
5. When you are done with filling in all the available questionnaires, you have finished your participation in our study and you can deinstall TiiM. If you want to make sure that all your responses have been received by us in good order, you can contact us and let us check before you deinstall the app.
6. If you experience problems with TiiM, you can try to log out and log in again, close the app, or restart your phone. If it still doesn't work, please feel free to contact us.

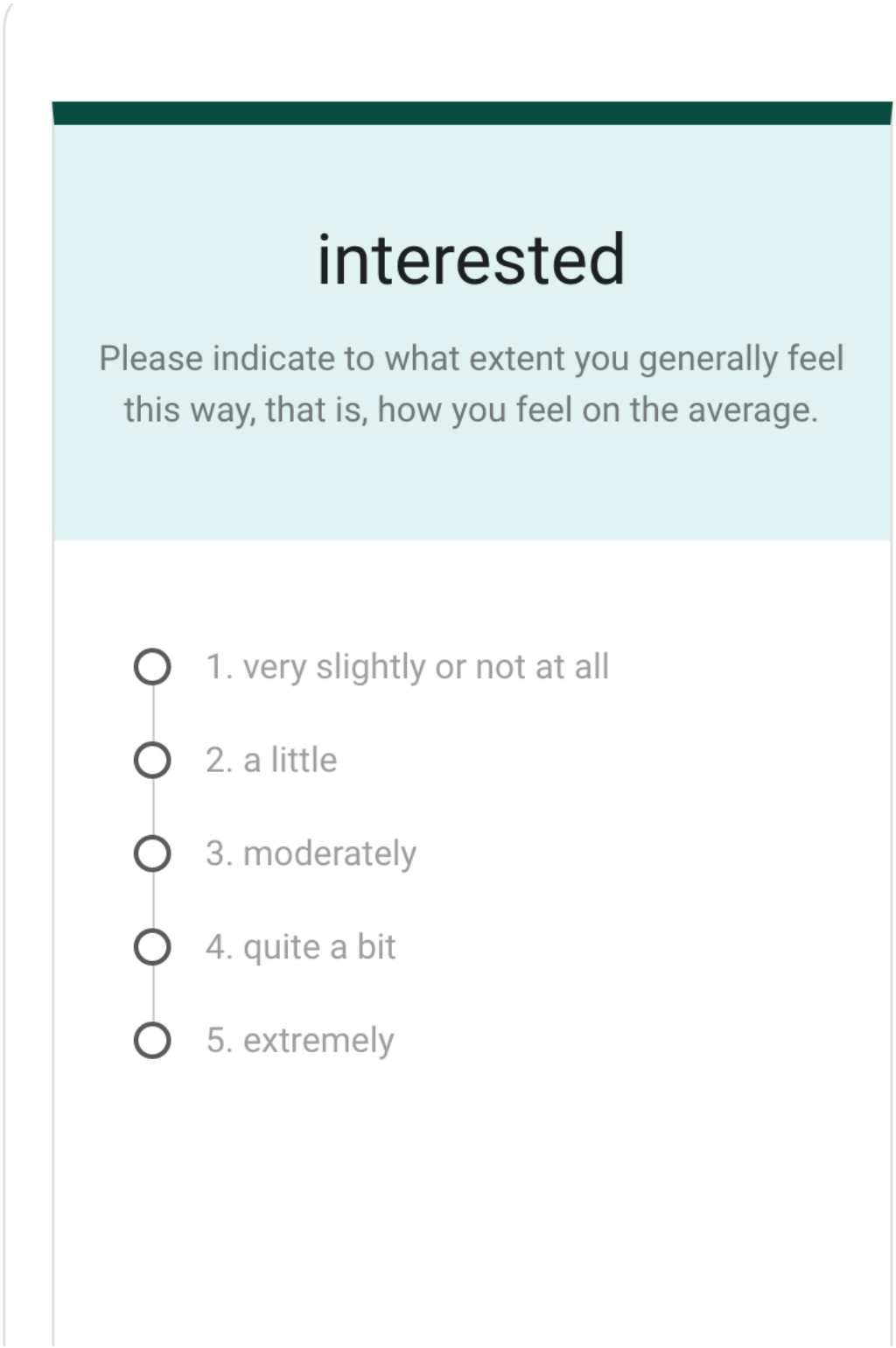


If you still have any questions or experience problems during the study, do not hesitate to contact us!
Negi: n.sadeghihassanabadi@student.utwente.nl
Wiebke : w.hoppe@student.utwente.nl

Thank you for your participation! ☺

Best wishes,
Negi and Wiebke

TiiM Modules (Appendix 3)



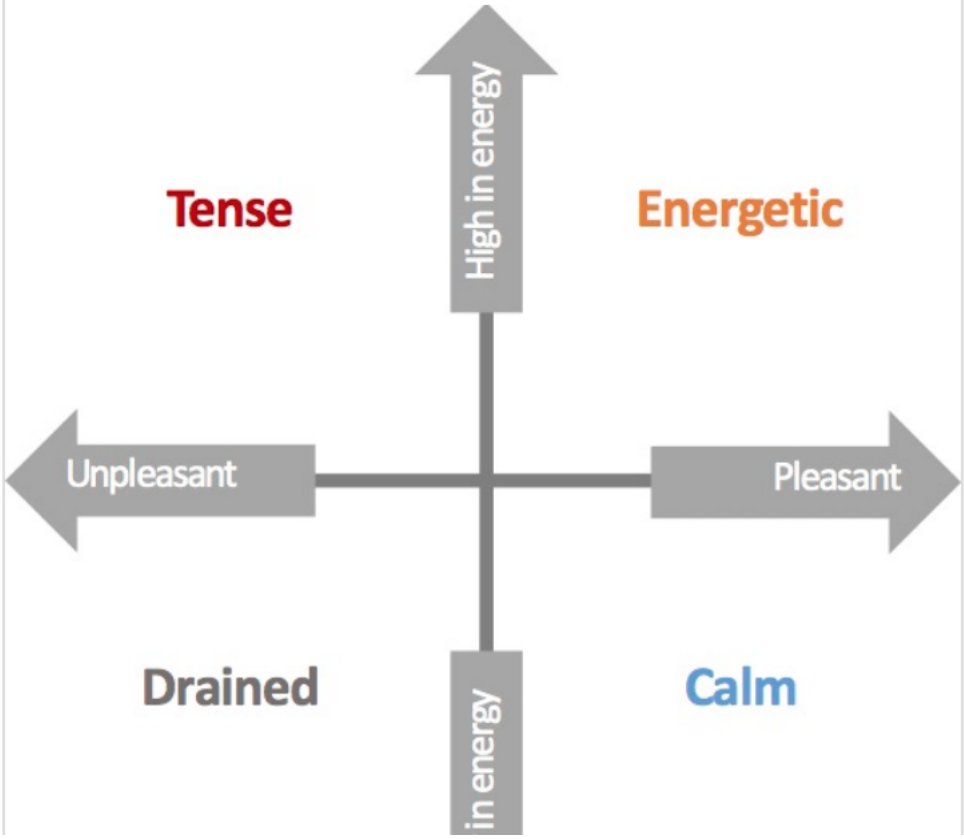
I am often confused about what emotion I am feeling.

Please indicate to what extent you agree with this statement.

- 1. Strongly disagree
- 2. Disagree
- 3. Neither agree nor disagree
- 4. Agree
- 5. Strongly agree

How do you feel right now?

With regards to your current feeling, please put the yellow dot anywhere you want in this quadrant.



Graph about Participant 9 (Appendix 4)

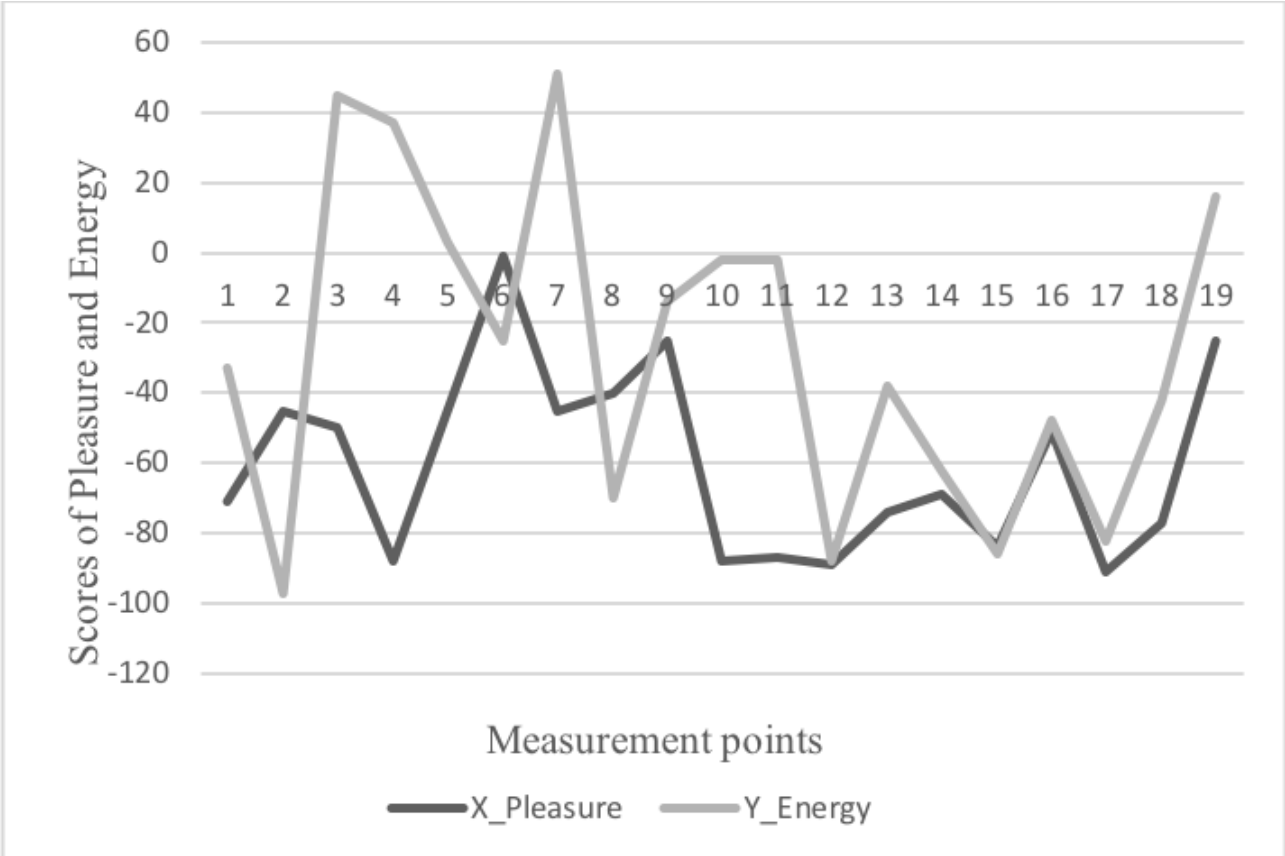


Table 3. Bivariate correlation analysis of dependent and independent variables of all participants and measurement points (Appendix 5)

	State Energy*	NA (PANAS)	PA (PANAS) *(n=26)*	NA (PANAS) *(n=26)*
State Pleasure*	-.128 (p=.516)*			
PA (PANAS)		**-.520 (p=.007)**		
State Pleasure *(n=26)*			**.409 (p=.038)**	**-0.664 (p=.000)**
State Energy *(n=26)*			.048 (p=.814)	.057 (p=.781)

*Results marked with an * are measured within the 28 measurement points

Table 4. Bivariate correlation analysis of independent and dependent variables of participants with and without signs of alexithymia (Appendix 6)

	State Energy	PA (PANAS)	NA (PANAS)
State pleasure *(n=11)*	**.643 (p=.034)**	**.633 (p=.037)**	**-.672 (p=.024)**
State energy *(n=11)*		.357 (p=.281)	**-.544 (p=.084)**
State pleasure* *(n=15)*	-.321 (p=.243)	.148 (p=.598)*	**.745 (p=.001)***
State energy* *(n=15)*		-.145 (p=.606)*	.405 (p=.134)*

*everything marked with an * are results from the 15 participants without signs of alexithymia