The Association between daily affect and trait anxiety, depression, and alexithymia within individuals

Faculty of Behavioural, Management and Social Sciences (BMS)

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Elena Zorc (s1794442)

Examination Committee

Dr. P. M. ten Klooster

J. T. Kraiss, MSc.

Abstract

Recently a shift in research appeared from studying emotions as a stable trait, to research of emotions as a state, given that emotions are inherently dynamic in nature. The Affect Grid is an effective measurement tool for momentary emotional states, analyzing affect on two dimensions, pleasure and energy. Using the Experience Sampling Method, the current study was designed to further examine the dynamics of daily affect, as well as the association of core affect with trait anxiety, depression, and alexithymia on a daily basis within individuals. This study draws on previously collected data among 26 non-clinical participants who were asked to score their momentary emotional states four times a day over a period of seven days using the Affect Grid via the TiiM application. On the eighth day the HADS and TAS-20 were administered to retrospectively measure trait anxiety and depression as well as alexithymia. Linear Mixed Modelling (LMM) and visual analyses were used to explore the associations between state core affect and the trait-like variables. A marginal association was found between core affect and trait anxiety and depression. Only a weak significant association was found between pleasure and trait anxiety (β = -.268, p < .05) as well as trait depression (β = -.242, p < .05). Moreover, a non-significant association was found between energy and trait anxiety (β = .014, p = .775) and depression (β = -.054, p = .260). No significant association was found between daily core affect and total alexithymia (pleasure: β = -.095, p = .110; energy: β = .027, p = .568). However, an association was found between signs of alexithymia and energy (β = -.640, SE = .190, t = -3.368, p = .002). Moreover, the visual analysis suggested that participants with signs of alexithymia did tend to score lower on pleasure and higher on energy over all measurements then participants with no signs of alexithymia. The current study concludes that trait and state measurements of emotions do differ from one another and are at most weakly correlated. Trait measurements are able to analyze the basic characteristics of a trait, while state measurements can be used to analyze the daily dynamic affect. Researchers are recommended to measure both trait and state measures to provide a more coherent picture of individuals' affective tendencies over time and their trait characteristics, as well as further include the TAS-20 as a control variable.

Content

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Introduction

In the field of psychology, a distinction is made between trait and state in the study of emotions. A trait is considered to a person's more permanent, stable level of emotions. Furthermore, a trait refers to being consistent and to the enduring mood, which includes the temperament and emotional reactions of an individual (Zelenski & Larsen, 2000; Watson, 2000). Next to emotions as a trait, emotions as a state also have to be considered. A state is defined as a temporary and situational response of emotions. The emotional response an individual experiences is affected by internal and/or external triggers in the moment, including environmental changes (Gray, Watson, Payne, & Cooper, 2001). These responses can be physical, behavioral, psychological, or cognitive. Given that feelings can change within a moment, feelings as a state are not stable (Zelenski & Larsen, 2000). State emotions can fluctuate whereas trait emotions are habitual tendencies and more stable personality characteristics (Bieg, 2013).

In the past, most researchers focused on emotions and moods as a trait and thus assume that they are stable over time. However, when studying individuals' emotions, measurements addressing them as a state require more attention, given that the dynamic processes within individuals can be analyzed that way (Watson & Tellegen, 1985). According to the circumplex model of affect cognitive interpretations of core neural sensations are the origin for all affective states, whereas older approaches argue that every individual has a set of basic emotions which are discrete and therefore distinguishable by facial expression and biological processes (Colombetti, 2009). Those cognitive interpretations are a result of two independent systems, valence and arousal (Posner, Russell, & Peterson, 2005; Russell, 1980). According to Russell (1980) this circumplex model represents core affect, which is composed of the most fundamental feelings that do not necessarily have to be directed towards something. Thus, it represents an individual's feelings at a specific point in time. However, core affect can also be described as an emotional experience when it is directed at an object through attributions or appraisals (Schutz, Quijada, De Vries & Lynde, 2010). The two fundamental feelings or dimensions of core affect can be described as two continuums. The first continuum valence on the horizontal axis ranges from pleasant to unpleasant. Valence encompasses how negative or positive the experience is perceived. The second continuum arousal (later replaced with the

term energy), on the vertical axis, ranges from low to high arousal. Arousal describes how energized or enervated the experience is perceived (Russell, 1980). Even though core affect is a combination of those two dimensions, it can be integrated in one unified state. Thus, it is possible to experience a low energy and at the same time high displeasure and thus someone would feel tired, or low energy and high pleasure in which case the individual would feel calm (Barrett & Bliss-Moreau, 2009; Russell, 2009). In contrast to emotional states like fear, grief, joy and anger, core affect is accessible by self-report, changing over time and continuously present (Zelenski and Larsen, 2000; Russell, 2003; Kuppens, Van Mechelen, Nezlek, Dossche, & Timmermans, 2007; Kuppens & Tong, 2010).

To assess the two dimensions valence (pleasure – displeasure) and 'energy' (arousal – sleepiness) of core affect, Russell (1980) designed the Affect Grid (Figure 1). This single-item scale can be used to collect emotion ratings from stress and tension to calm, relaxation or serenity, and from ecstasy, excitement and joy to depression, melancholy, sadness, and gloom. The Affect Grid has proven to be an effective measurement tool when measuring within moment emotions and can be used to measure core affect over time within individuals. Therefore, it would be interesting to use the Affect Grid as a tool to measure the state emotions of individuals within the moment over a period of time, to see how it changes and how it is affected by various trait variables.

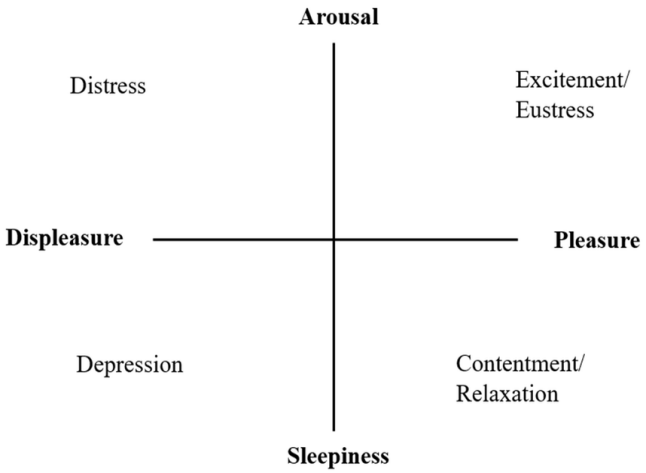

Figure 1. The Affect grid (adapted from Russell, 1980; and Russell et al., 1989)

Core affect is known to play an important role in several psychological functions, including perception, decision making, and memory. However, until now, little research has been conducted on what impacts changes in core affect (Russell, 2009). Anxiety and depression

are two traits that might influence core affect from moment to moment to a large degree. They are characterized by experiences of emotional distortions and thus might impact core affect experienced by an individual over time (Bowen, Clark, & Baetz, 2004). Given that core affect is a state variable representing the feelings of an individual at a specific point in time, it could be expected that trait anxiety and trait depression are strongly associated with state core affect.

According to Gellman and Turner (2013), trait anxiety can be defined as a stable tendency of an individual to perceive negative emotions throughout several different situations. Moreover, trait-anxious individuals often report bodily symptoms and are overly concerned about them. The individuals experience the environment as threatening, including situations that other people would not describe as threatening. This experience is called cognitive-perceptual bias. Trait anxiety encompasses biases on three different levels. First, anxious individuals experience an over-attentional bias, which means that they tend to focus more than others on threatening stimuli. Moreover, individuals have a distorted negative interpretation of information which increases their anxious responses and individuals tend to over-recall threatening information (Gellman & Turner, 2013). Furthermore, individuals who suffer from an anxiety disorder often display emotion regulation difficulties in daily life (Farmer, & Kashdan, 2012). Therefore, it can be assumed that individuals with high trait levels of anxiety score lower on state pleasure over time, than individuals with low levels of trait anxiety. It is less clear how high trait anxiety would be associated with the second aspect of core affect, energy.

High levels of trait depression are also often associated with rapid mood changes within the moment. Given that disturbed feelings are an important feature of depression, it is also referred to as an affective disorder. Depression can be defined as a negative affective state, which ranges from unhappiness to severe feelings of sadness, pessimism, and despondency interfering with daily life functioning. Next to the negative affective states, also a variety of physical, cognitive, and social symptoms occur. Those include lack of energy and displaying difficulties to concentrate or make decisions, often with the result of avoiding social activities. Sufferers often experience an inability to function normally and there is an increased risk of self-injuring or self-destructive behavior (VandenBos, & American Psychological Association, 2007, American Psychiatric Association, 2015). As such, it could be assumed that individuals with high trait depression also score low on pleasure and low on energy, compared to individuals with low levels of trait depression.

Anxiety and depression are usually measured with questionnaires that treat them as a trait. A well-known measurement tool for both trait anxiety and depression is the Hospital Anxiety and Depression Scale (HADS). It is a self-assessment scale that is based on the assumption that depression and anxiety are somewhat stable over time, by using recall periods of the past week. The scale is short with only 14 items and therefore can be filled out in a reasonable amount of time. The anxiety and depressive subscales of the HADS can be used to assess the presence of depression and anxiety within an individual (Snaith & Zigmond, 1986).

Research has shown that many people who suffer from mood disorders like anxiety and depression also often display rather high levels of alexithymia (Marchesi, Brusamonti, & Maggini, 2000; Hamaideh, 2018; Bagby, Taylor, & Parker, 1994; Li, Zhang, Guo, & Zhang, 2015). An early study of Sashin (1985) on affect tolerance has shown that individuals who score low on affect tolerance show little or no reaction to emotions and feelings. He defined affect tolerance as "the ability to respond to a stimulus which would ordinarily be expected to evoke affects by the subjective experiencing of feeling" (Sashin, 1985). Those findings are closely related to the phenomenon nowadays known as alexithymia. Alexithymia is characterized by a dysfunction in emotional awareness, social attachment as well as interpersonal relating. Sufferers display an impairment in recognizing, differentiating, and communicating their emotions as well as distinguishing between their own and others' emotions which often results in un-empathic and ineffective emotion (Parker, Taylor, & Bagby, 2001; Taylor, Ryan, & Bagby, 1985). Since people with high levels of alexithymia display difficulties in recognizing their own emotions, it is interesting to examine if individuals with high levels of trait alexithymia display less variability in core affect over time.

In order to be able to assess whether an individual displays alexithymia, Taylor, Rayan and Bagby (1985) developed the Toronto Alexithymia Scale (TAS). Based on the characteristics of alexithymia the TAS determines an individual's ability to identify his/her feelings and distinguish them from physical sensations. Next to that, the scale assesses the ability to communicate feelings and an individual's tendency to express externally oriented thinking (Bagby, Parker, & Taylor, 1994). The scale helps to assess alexithymia dimensionally and categorically, therefore the degree of severity can be determined and whether an individual displays low, intermediate, or high levels of alexithymia (Taylor & Bagby, 1988).

The symptom severity of depression could lead back to difficulties individuals with higher levels of alexithymia experience, especially their problems with recognizing and

describing their emotions (Bamonti, Heisel, Topciu, Franus, Talbot, & Duberstein, 2010). In that sense it is important to take into account levels of alexithymia when measuring mood and emotions. Mattila, Salminen, Nummi and Joukamaa (2006) found out that 18% of the general population displays difficulties verbalizing and or expressing their emotions or having problems distinguishing them from the emotions of others. In her studies on the multifaceted nature of alexithymia, Goerlich (2018) recommended to control for closely related constructs to alexithymia in order to get a better picture of the different facets and dimensions of alexithymia. Related constructs include negative affectivity, depression, and anxiety. Thus, this study will focus more closely on the associations between those four constructs over time.

Due to the need of a study design that is able to intensively measure dynamic affects of individuals over time the experience sampling method (ESM) has been developed (Larson, & Csikszentmihalyi, 2014). The origin of the experience sampling method lies in diary studies in which participants report their experiences, feelings, and behaviors daily (Ohly, Sonnentag, Niessen, & Zapf, 2010). Compared to the diary studies the experience sampling method attempts to overcome even more the memory biases individuals often display when self-reporting by measuring state variables at multiple points in time over a certain period of time (Kuppens Oravecz, & Tuerlinckx, 2010). In an ESM study, participants are asked to answer the same set of questions multiple times per day during a certain period, which usually lasts a few weeks to months (Hektner, Schmidt, & Csikszentmihalyi, 2007). Therefore, ESM can be used to gather detailed information about the feelings and emotions as well as the changes of the feelings of an individual in a natural setting (Van Berkel, Ferreira, & Kostas, 2018). The ESM has already been used in several studies measuring state emotions. For example, Versluis, Verkuil, Lane, Hagemann, Thayer, and Brosschot (2018) used ESM to study emotional awareness. They found out that emotional awareness fluctuates over time and, therefore, is not as stable as assumed before. In an ESM study by Zelenski and Larsen (2000) the results showed that trait emotions are perceived in two dimensions, positive and negative affect, confirming the assumption of a dimensional model (Watson & Tellegen, 1985). Moreover, ESM measures have been proven to be a sufficient measurement tool for measuring general affect of an individual. The Affect Grid in specific has shown to be reliable for the use of the experience sampling method (Russell, Weiss, & Mendelsohn, 1989; Müller, 2019). A study by Kuppens, Champagne, and Tuerlinckx (2012) used the ESM to examine the bidirectional relationship of core affect and appraisals with the use of the Affect Grid. The findings affirmed patterns of the continuous interplay of appraisal and core affect.

In the past, most researchers focused on emotions and moods as a trait. Measurement addressing them as state requires more attention (Watson & Tellegen, 1985; Kuppens, Stouten, & Mesquita, 2009; Scherer, 2000). The Affect Grid in combination with the ESM might give a better picture of how individuals experience core affect throughout the day and how it changes over time. Furthermore, past studies have suggested that there is an association between trait anxiety and depression and daily mood states. This study aims to further investigate the relationship of these two traits with the core affect states over time. Next to that, investigates the association between levels of alexithymia and core affect. Additionally, it is examined whether individuals who display higher levels of alexithymia experience less variability in daily core affect.

Methods

Design and Procedure

The current study is a secondary analysis based on data collected by Hassanabadi (2019) and Hoppe (2019). Their study was approved by the BMS Ethics Committee of the University of Twente (#190452) and was a quantitative study which was conducted with a longitudinal experience sampling method (ESM) to measure state variables. The experience sampling method was used to collect data multiple times a day via self-reports. Next to that, a one-time survey was conducted and placed after the ESM period to obtain demographic data as well as measurements of the corresponding trait variables from the participants.

To obtain the data, the *The Incredible Intervention Machine (TiiM)* application designed by the BMS Lab at the University of Twente was used (BMS Lab, 2020). In order to be able to use the application, the participants had to own and be able to use an Android or iOS smartphone. Before the study was conducted, a pilot study with two participants was carried out over a period of three days to optimize the procedure. Moreover, before starting to collect data, the researchers informed their participants about the purpose of their study as well as provided a handout. The handout included a step-by-step description carrying the participant through the whole procedure and an explanation of how the TiiM app should be used.

In total, the duration of the study was eight days, given that according to Hektner, Schmidt, & Csikszentmihaly (2007) at least one week is necessary to obtain representative data of individuals' feelings. In the first seven days, starting on Tuesday morning at 10:00 a.m., the

participants were asked to score the Affect Grid to determine their current feelings. Signal-contingent sampling was used to obtain data four times a day at a random time within a specific time slot. That kind of sampling prevents participants from structuring their days according to the measurement schedule and therefore the data is expected to be more valid. The number of daily measurements were limited to four, given that more are considered to be too demanding for the participants of an ESM (Hektner, Schmidt, & Csikszentmihaly, 2007). Thus, the participants received a notification on their phone every day in the morning between 10:00 and 11:00 a.m., during lunchtime between 12:00 and 2:00 p.m., in the afternoon between 4:00 and 6:00 p.m., and in the evening between 8:00 and 10:00 p.m. in which they were asked to fill out the Affect Grid (Figure 2). On the eighth day the survey was conducted, and every participant was asked to answer several demographic questions, including age, gender, nationality, and occupational status. Next to that, they were asked to fill out the Hospital Anxiety and Depression Scale (HADS) and the Toronto Alexithymia Scale (TAS-20) to measure the trait variables depression and anxiety as well as alexithymia over the past week.

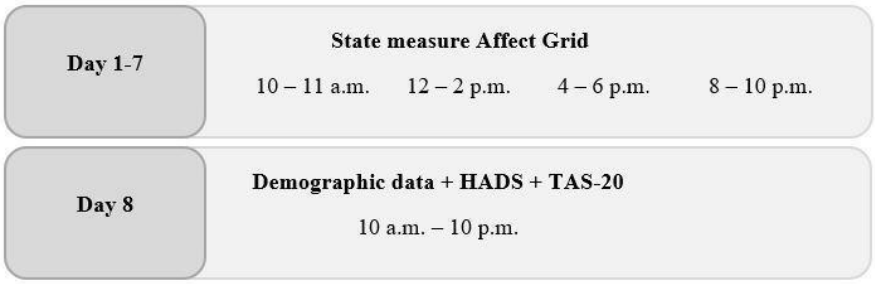

Figure 2. Overview of the study´s timeline.

Participants

In their study, Hassanabadi (2019) and Hoppe (2019) recruited 26 participants. The convenience sampling method was used to recruit participants from the general population via Social Media channels. In ESM studies a median number of 19 participants has shown to be representative for insight into individuals' experiences and feelings (Van Berkel, Ferreira, & Kostakos, 2017). In order to be included in the study the participants had to be 18 years or older, they had to have access to an iOS or Android-capable smartphone, they had to be students and/or employed and they had to be able to understand and comprehend the English language.

Materials

To measure the state variable feelings and moods, the Affect Grid was used. The Affect Grid is a single-item scale of pleasure and arousal which measures the current emotional state of individuals. The emotional state can then be mapped in a two-dimensional grid, where the y-axis (-100 to 100) represents the low/high energy continuum and the x-axis (-100 to 100) the pleasure-unpleasure continuum (Russell, Weiss, & Mendelsohn, 1989). The participants were asked to place a dot anywhere within the Affect Grid by moving the dot on their touchscreen of their mobile phone, regarding their current feeling at the specific timepoint (Figure 3).

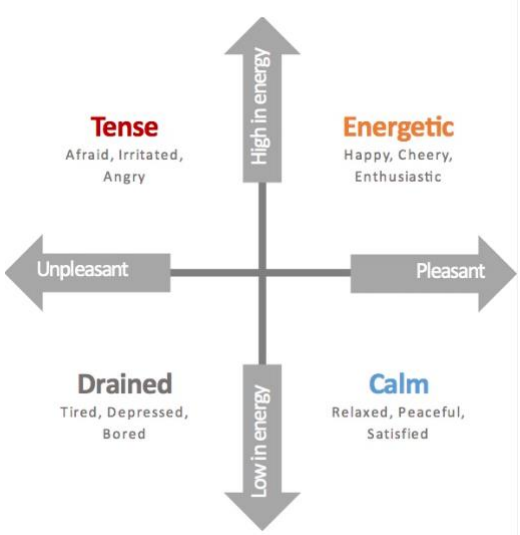

Figure 3. Affect Grid used in the study.

To measure trait depression and anxiety and alexithymia, the Hospital Anxiety and Depression Scale (HADS; Zigmond & Snaith, 1983) and the Toronto Alexithymia Scale were used (TAS-20; Bagby, Parker & Taylor, 1994). The HADS is a 14-item scale divided in two subscales, the anxiety and the depression subscale, with seven items each. Participants had to indicate how they felt on a response scale from 1 to 4 during the past week (Zigmond & Snaith, 1983). Zigmond and Snaith (1983) used the following cut-off scores as an orientation for further diagnostic examination. Scores of ≤7 of each subscale HADS anxiety and depression are seen as clinically inapparent, scores between 8 to 10 are considered mild and those ≥11 as clinically apparent.The total HADS score can be used as a global measure of psychological distress (Roberts, Bonnici, Mackinnon, & Worcester, 2001; Johnson, Burvill, Anderson, Jamrozik, Stewart-Wynne, & Chakera, 1995). In their study Hassanabadi (2019) and Hoppe (2019)

showed a good internal consistency of the HADS, with the Anxiety subscale having a Lambda 2 of .81 and the Depression scale a Lambda 2 of .83.

The second scale that was used is the Toronto Alexithymia Scale (TAS-20). This 20-item scale was designed to measure alexithymia in individuals. The items are statements describing alexithymia traits and are rated from 1 (strongly disagree) to 5 (strongly agree) on a five-point Likert scale. Levels of alexithymia were determined by using cutoff scores. A score of equal to or less than 51 indicates no signs of alexithymia, whereas a score equal to or greater than 61 indicates signs of alexithymia and a score between 52 to 60 possible signs of alexithymia. Signs, Possible signs, and No Signs of alexithymia were identified by the degree to which participants were able to identify their own emotions (Bagby, Parker, & Taylor, 1994). In the study by Hassanabadi (2019) and Hoppe (2019) the TAS-20 demonstrated good internal consistency with a Cronbach's alpha of .89.

Data analysis

After the study was conducted the data was stored and retrieved from TiiM. The data analysis was conducted using *IBM SPSS Statistics 25*. First of all, the demographics of all participants were analyzed, in terms of age distribution, gender, nationality, profession and response rates. Furthermore, a total Affect Grid of all measurement data was displayed for visualization of within-person and between-person variability in the two dimensions pleasure and energy of core affect of all participants throughout the study.

Next, Linear Mixed Modelling (LMM) analysis with an autoregressive covariance structure was used to calculate the Estimated Marginal means for the state measurements pleasure and energy over time and across participants. LMM analysis is especially useful for this type of study, given that it can effectively deal with missing values and the nested structure of the data. The autoregressive covariance structure (AR1) is commonly used in studies of psychopathology and emotion dynamics. It is proven to be useful for modeling the dependency between sequential measures in a multivariate time series, like it is the case in an ESM study (Kincaid, 2005; Hamilton, 1994). The AR1 considers the correlation to decrease with increasing distance between the time points (Jongerling, & Hoijtink, 2017). Estimated Marginal means were calculated for pleasure and energy for all participants per timepoints, as well as per participant. State pleasure or state energy were added as the dependent variable and either the

timepoints or the participants were added as fixed independent factors. For better visualization *Microsoft Excel 2019* was used to create graphs including the Estimated Marginal means of state pleasure and energy over the 28 timepoints for all participants. To statistically test the association between time and state pleasure and energy, as well as participants and state pleasure and energy, timepoints and participants were subsequently added as a fixed covariate in separate models. For checking for an association, the non-standardized regression estimates were used.

In order to analyze whether trait depression and anxiety were significantly associated with state pleasure and energy over time the sum scores of all participants on the HADS scale were entered as a fixed covariate in a new series of LMMs. Standardized regression estimates were used for analyzing the association between the continuous trait-like variables and core affect, and interpreted as weak (< .30), moderate (.30 to .50) and strong correlation (> .50) as suggested by Cohen (1988). Next, the participants were divided into three groups based on their results on the TAS-20 for further exploration of the effect of alexithymia on state pleasure and energy. Participants were either categorized as no signs of alexithymia, possible signs of alexithymia, or signs of alexithymia. Moreover, to analyze changes in core affect in the three groups, the average pleasure and energy for each group was illustrated and the Estimated Marginal means of pleasure and energy per group were calculated over the 28 timepoints. For this, state pleasure or energy were added as the dependent variable, either the participants with no signs, possible signs or signs of alexithymia, as well as the timepoints were added as a fixed factor. Afterwards, the continuous sum scores of the TAS-20 scale were added to the state variables as a fixed covariate to analyze whether trait alexithymia in general is associated with state pleasure and energy.

After the group-level analysis, several participants were selected based on notable features, including very high/low HADS or TAS-20 scores or high/low core affect, for further case-wise exploration on the individual level. Separate Affect Grids were created for selected participants as well as their trait measurements were compared.

Results

Demographics

In total, 26 participants took part in the study of which 11 were male and 15 were female. Their age ranged from 18 to 32 and the majority was German (88.46%), while the rest was Dutch or British. Most participants were students, whereas some of them had a job next to their study. The remaining participants indicated to have a full-time occupation. On average, the participants responded to most of the 28 measurements, two participants responded to the minimum number of 13 measurements and two participants to all 28 measurements. In total, the response rate of all participants was 78.71 %. All responses were considered in the analysis.

Table 1

Demographic variables of the participants

Variables		*M* (*SD*) or *n* (%)
Age, *M* (*SD*)		23.91 (3.61)
Gender	Male, *n* (%)	11 (42.31)
	Female, *n* (%)	15 (57.69)
Nationality	German, *n* (%)	23 (88.46)
	Dutch, *n* (%)	2 (7.69)
	Other, *n* (%)	1 (3.85)
Profession	Student, *n* (%)	16 (61.54)
	Job next to studies, *n* (%)	11 (42.31)
	Full-time occupation, *n* (%)	10 (38.46)
Number of Responses to state measurements, *M* (*SD*)		22.04 (4.01)

N=26

Daily affect

In Figure 3 the distribution of the two dimensions, pleasure and energy, of the 26 participants over the seven days of the study can be seen. Large inter-individual variations were observed. However, the intra-individual scores did not seem to vary from each other that drastically. Most participants scored in the right quadrants, which means that they mostly scored high on pleasure (*M* = 19.09, *SD* = 43.71). The participants' mean energy score was negative, which means that they mostly scored low on energy (*M* = -6.74, *SD* = 44.36).

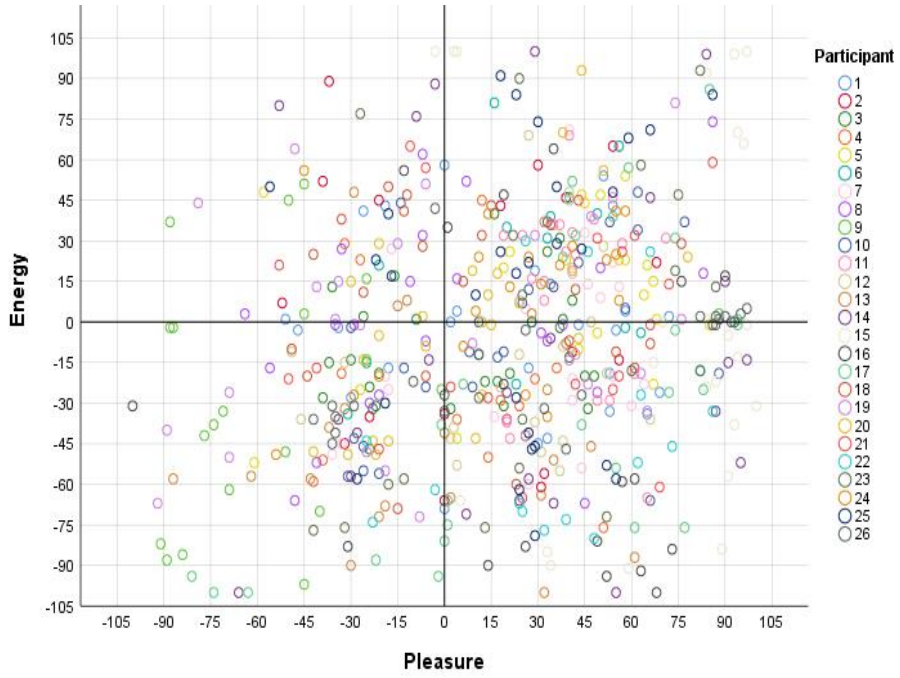

Figure 3. Affect Grid of all participants over time.

In order to analyze the state pleasure and energy scores of all participants over the 28 timepoints a Linear mixed model (LMM) analysis was used. The average amount of pleasure estimated over all measuring points was 19.47 (*SE* = 2.65) and the average amount of energy was -6.96 (*SE* = 2.12). In Figure 4, the Estimated Marginal means of all participants over all 28 timepoints can be seen. On timepoint 17, which was a Saturday morning (8.00 – 10.00 a.m.), the participants indicated the highest pleasure (*M* = 33.66, *SD* = 10.30), while on the 21st timepoint, which was a Sunday morning (8.00 – 10.00 a.m.), the lowest pleasure was indicated (*M* = 2.85, *SD* = 11.86). On the other hand, the highest energy (*M* = 12.22, *SD* = 9.86) of all participants was measured at the sixth timepoint, which was a Wednesday noon (12.00 – 2.00 p.m.) and the lowest energy (*M* = -26.34, *SD* = 10.13) of all participants at a Saturday evening between 8:00 and 10:00 p.m. (timepoint 20). Figure 4 also suggests that the participants showed more variety in energy during the weekend compared to weekdays and their pleasure was higher than their energy during the week.

When time was added as a fixed covariate to the model, a non-significant effect of time on pleasure was found (*B* = .010, *SE* = .007, *t* = 1.43, *p* = .155). Moreover, a non-significant negative association was found between time and state energy (*B* = -.007, *SE* = .006, *t* = -1.272, *p* = .205).

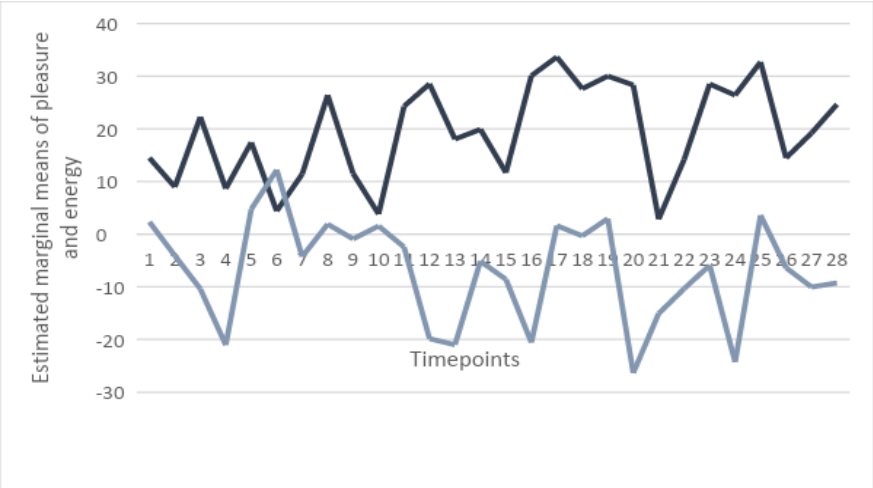

Figure 4. Estimated Marginal means of pleasure (dark blue) and energy (light blue) over the 28 timepoints.

In order to analyze the average pleasure and energy of all 26 participants over the seven days a new LMM analysis was done (see Figure 5). Of all participants the average pleasure over time was 18.7 (*SE* = 2.03) and the average energy of all participants over time was -7.2 (*SE* = 1.99). The highest average pleasure over the seven days was measured in participant 15 (*M* = 68.07, *SD* = 9.87). Nevertheless, five of the 26 participants, namely 4, 8, 13, 19, and 20, on average scored lower on pleasure compared to the other participants, and especially participant 9 scored markedly low (*M* = -59.46, *SD* = 10.61). The energy of all participants, also visible in figure 5, was low for most of the participants. Participants 4, 9, 13, 16, 17, and 22 had a mean energy of under -20, whereas participant 13 on average had the lowest energy (*M* = -39.43, *SD* = 9.98).

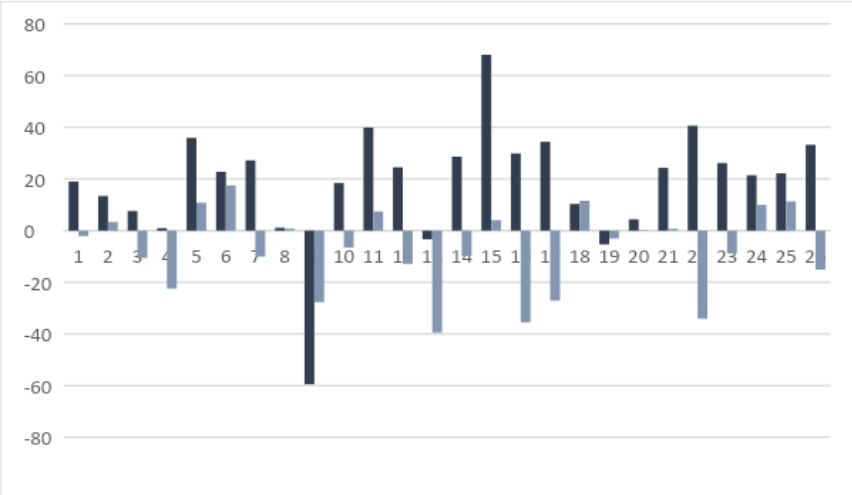

Figure 5. Estimated Marginal means for pleasure (dark) and energy (light) of all 26 participants.

Trait anxiety and depression

Overall, the 26 participants obtained a mean score of 13.67 (*SD* = 6.60) on the total HADS scale that was completed on the eighth day of the study, while the mean score for the anxiety subscale was 8.90 (*SD* = 3.86) and 4.77 (*SD* = 3.60) for the depression subscale. The mean total scores of the HADS of each participant can be seen in Figure 6. Participant 13 displayed the highest mean total score and participant 26 the lowest mean score. The lowest trait anxiety was measured in participant 26 and participant 21 had the highest trait anxiety. Next to that, on the depression scale the lowest score was measured for the participants 3, 15, 23, and 26, while the highest trait depression was measured in participant 13.

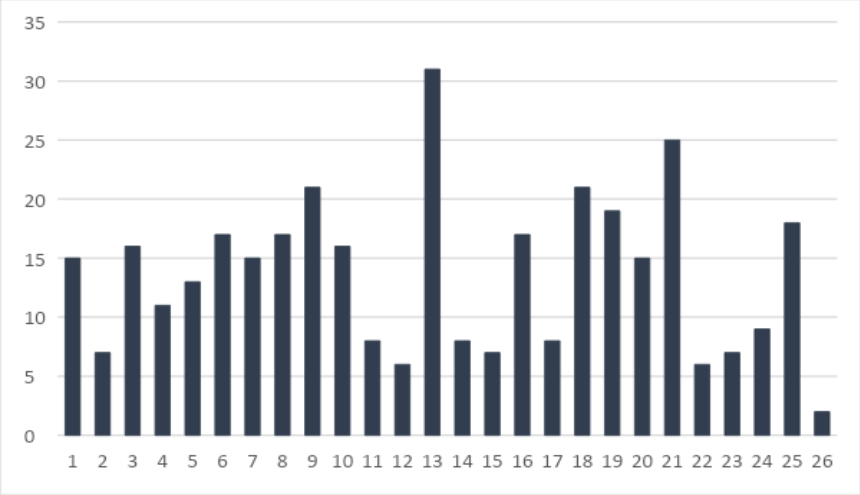

Figure 6. Sum scores of HADS of all 26 participants.

Association between core affect and trait anxiety and depression

In order to test whether trait anxiety and depression are associated with pleasure over time an LMM analysis was used in which the HADS scores of all participants were added as a covariate to state pleasure and state energy. The separate HADS scores of the two subscales anxiety and depressions were used. The analysis showed that trait anxiety was significantly, but only weakly negatively associated with pleasure (β = -.268, *SE* = .055, *t* = -4.893, $p < .05$) and non-significantly associated with energy (β = .014, *SE* = .048, *t* = .287, *p* = .775). Trait depression was also significantly, but weakly negatively associated with pleasure (β = -.242, *SE* = .056, *t* = -4.314, $p < .05$). Similar to anxiety, the analysis of the association between trait depression and energy showed a non-significant negative association (β = -.054, *SE* = .047, *t* = -1.130, *p* = .260).

Trait Alexithymia

The average TAS-20 score of all participants was 52.41 (*SD* = 11.30). According to the cut-off scores of the TAS-20 from the 26 participants 13 showed no signs of alexithymia, 6 showed signs of alexithymia, and the remaining 7 participants showed possible signs of alexithymia. The highest score was reported by the 13th participant with 76 and the lowest from the participant 26 with 21 (Figure 7).

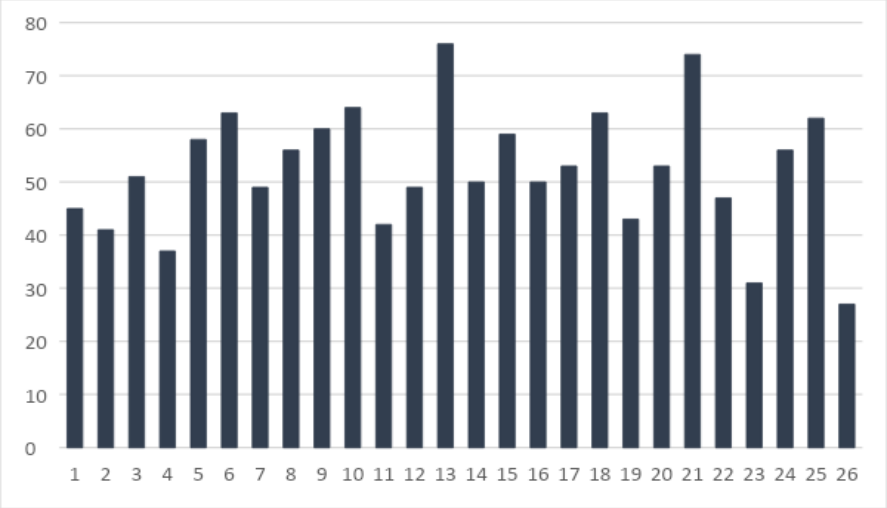

Figure 7. Sum scores of TAS-20 of all 26 participants

Figure 8 shows that after dividing the participants in three groups based on their signs of alexithymia, lower average scores of pleasure and energy can be seen in the group with signs of alexithymia. In the group with no signs of alexithymia the average pleasure was visibly higher than in the group with possible signs as well as the group with signs of alexithymia. The energy level, however, was the lowest in the group with no signs of alexithymia. When comparing the energy level of the group with signs to the other two groups it visibly increased. Thus, the group with signs of alexithymia displayed less pleasure but more energy, although overall the energy level was still negative.

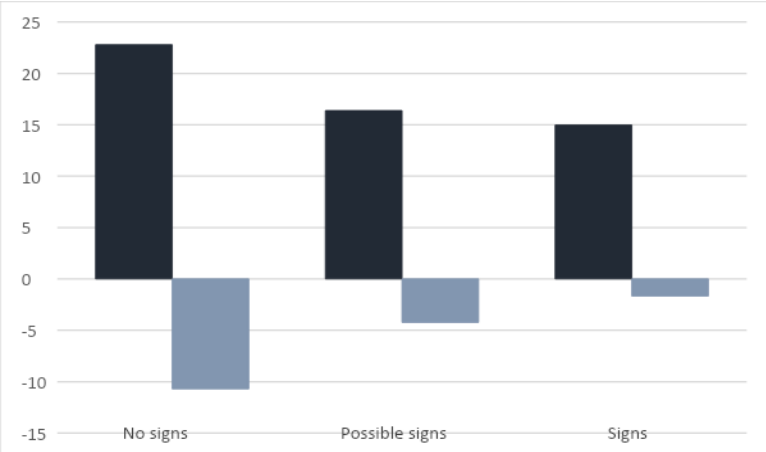

Figure 8. Average pleasure (dark) and energy (light) over time for the separate groups with different levels of alexithymia

When looking at the scores throughout the 28 timepoints within the three groups it is visible that in all groups the pleasure and energy levels did fluctuate strongly over the week. In the group with no signs of alexithymia the fluctuation of pleasure can mainly be seen in the positive range, between 0 and 60 and the energy mostly in the negative range (Figure 9). Figure 10 shows that in the group with possible signs of alexithymia the participants appear to fluctuate somewhat stronger over the 28 timepoints. The pleasure scores are spreading in the negative direction more frequently and the energy scores in the positive direction. Especially on Sunday morning (timepoint 21) the participants scored very low on pleasure and energy. In none of the other groups with or without signs of alexithymia does the pleasure get that low. In the group with signs of alexithymia the fluctuation of energy appeared to be stronger within a day, but over the week the fluctuations were similarly strong (Figure 11).

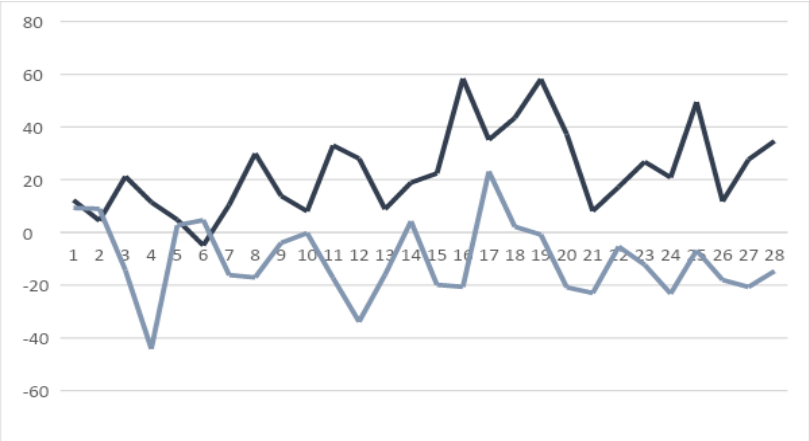

Figure 9. Estimated Marginal means of pleasure (dark) and energy (light) of all participants with no signs of alexithymia over the 28 timepoints.

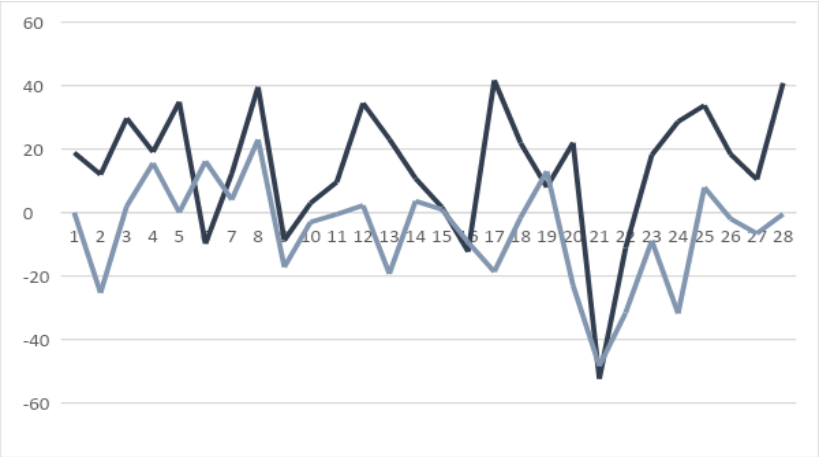

Figure 10. Estimated Marginal means of pleasure (dark) and energy (light) of all participants with possible signs of alexithymia over the 28 timepoints.

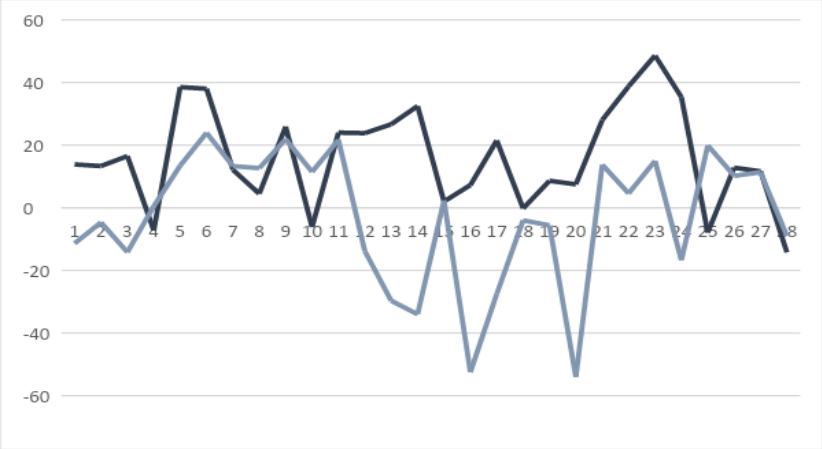

Figure 11. Estimated Marginal means of pleasure (dark) and energy (light) of all participants with signs of alexithymia over the 28 timepoints.

Association between core affect and trait alexithymia

By adding the TAS-20 sum score as a covariate to the state pleasure of all participants over time a non-significant negative association between pleasure and alexithymia was found (β = -.095, *SE* = .059, *t* = -1.609, *p* = .110). Next, by adding the TAS-20 sum score as a covariate to state energy also a non-significant positive association between energy and alexithymia was found (β = .027, *SE* = .048, *t* = .573, *p* = .568). Additional LMM analyses showed that having no signs of alexithymia was also non-significantly negatively associated with pleasure (β = -.038, *SE* = .111, *t* = -.339, *p* = .735) and non-significantly negatively associated with energy (β

= -.0560, *SE* = .092, *t* = -.605, *p* = .546). When checking for an association between possible signs of alexithymia and pleasure a non-significant negative association was found (β = -.701, *SE* = .798, *t* = -.878, *p* = .390). Similarly, a non-significant positive association was found between possible signs of alexithymia and energy (β = .189, *SE* = .452, *t* = .418, *p* = .678). Signs of alexithymia were non-significantly negatively associated with pleasure (β = -.193, *SE* = .157, *t*= -1.234, *p* = .224), but significantly negatively associated with energy (β = -.640, *SE* = .190, *t* = -3.368, *p* = .002).

Individual case analyses

To obtain a more detailed picture of the individual differences in state pleasure and energy over time during the study four participants were selected for analysis on the individual level. The first participant that was selected, participant 9 showed, compared to the other participants, lower pleasure and energy over time. Figure 12 shows that the participant never experienced positive pleasure throughout the whole study and also his/her energy was predominantly low. Therefore, the participant felt drained most of the time with some tense periods. On the eighth day participant 9 scored 12 on the subscale anxiety of the HADS and 3 on the subscale depression of the HADS and 60 on the TAS-20. Which means that in regard to the cut-off scores of the HADS, the participant is considered to be clinically apparent when it comes to anxiety and clinically inapparent when it comes to depression. With regards to the cut-off scores of the TAS-20 the participant displayed possible signs of alexithymia

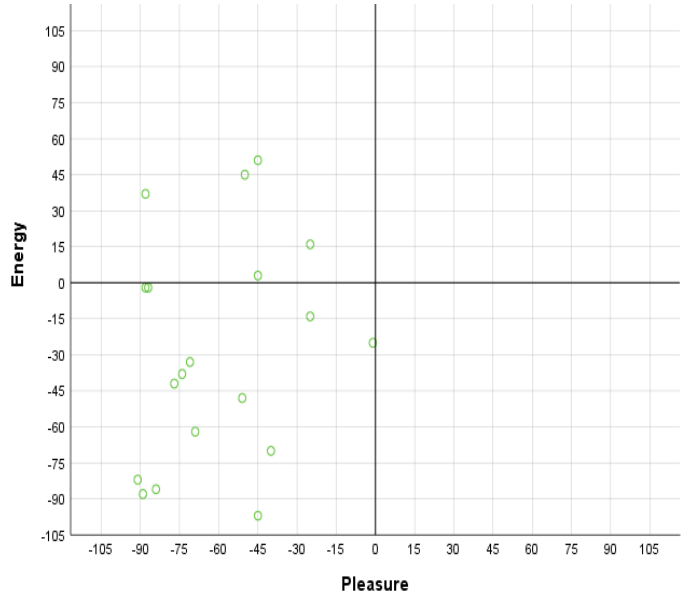

Figure 12. Affect Grid of participant 9.

On the other hand, participant 15 scored the highest on pleasure over time which can be seen in Figure 13. The participant only had one point during the study when he/she experienced unpleasantness, however, the energy was low most of the time with some situations in which the energy was high. In those cases, the energy was always above 60, the high energy level with high pleasure indicates that the participant was energetic during these times. In the times the participant indicated low energy levels but rather high pleasure levels he was calm and relaxed. This participant scored 6 on anxiety and 1 on depression on the HADS and 59 on the TAS-20. This suggests that the participant is clinically inapparent when it comes to both anxiety and depression. However, the TAS-20 score showed that the participants had possible signs of alexithymia.

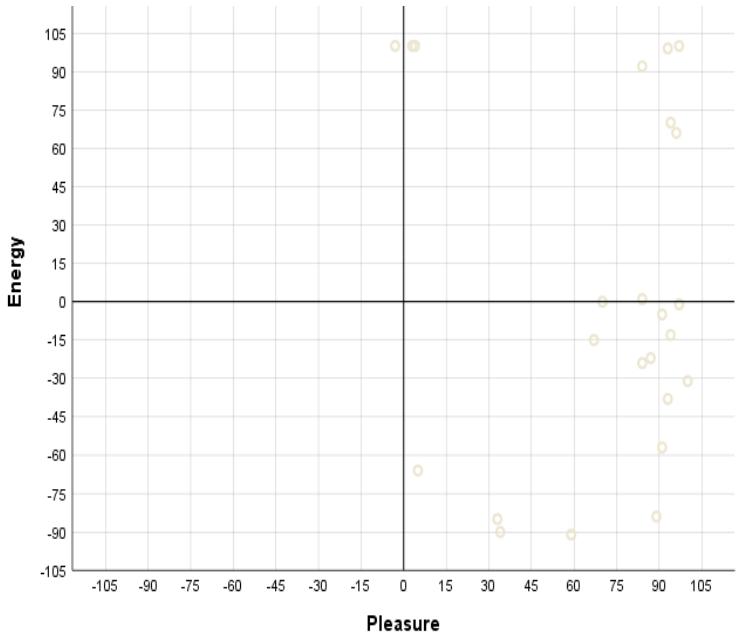

Figure 13. Affect Grid of participant 15.

Participant 6 displayed the highest energy over time visible in Figure 14. Next to his generally high energy levels the participants' pleasure was also positive most of the time, which indicates that he/she was energetic most of the time throughout the study. The HADS score of participant 6 was 10 on anxiety and 7 on depression, which means that this participant scored considerably mild on anxiety and clinically inapparent on depression. On the TAS-20 the participant score was 63 which means with regards to the cut-off scores he shows signs of alexithymia.

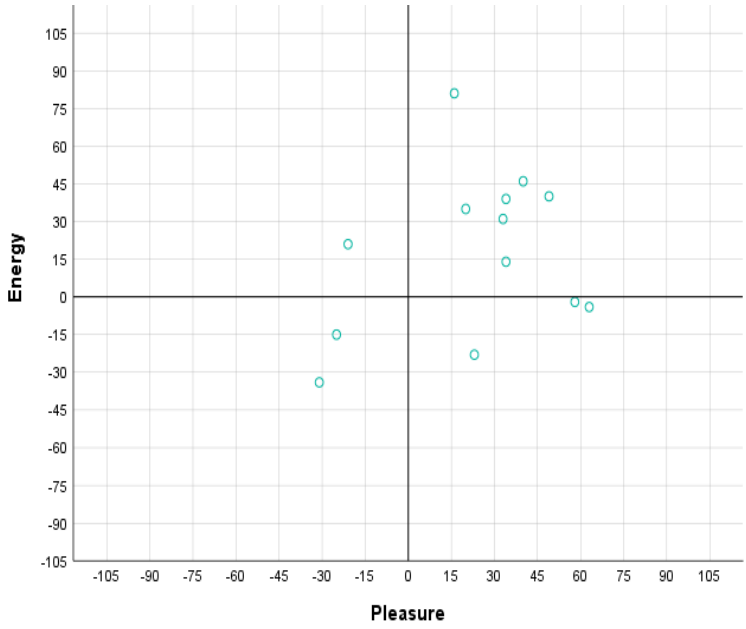

Figure 14. Affect Grid of participant 6.

The last participant, participant 22, similar to participants 16 and 17, showed a nearly evenly distributed average score of pleasure, in the positive direction, and energy, in the negative direction. Figure 15 shows that the participant indicated to be calm most of the time, which means that the energy level was low, while the pleasure was high. This participant scored 4 on anxiety 2 on depression on the HADS scale and 47 on the TAS-20. Thus, neither shows signs of alexithymia nor does he show clinical clues for having anxiety or depression.

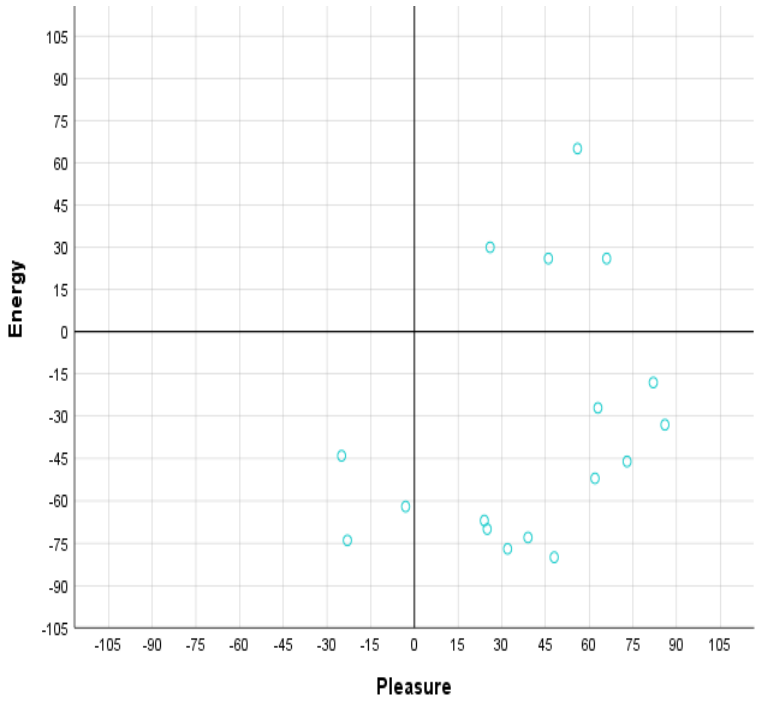

Figure 15. Affect Grid of participant 22.

Next to the four participants, two participants were further analyzed due to the fact that they scored either the highest or the lowest on both trait measurement scales, the HADS and the TAS-20. First, participant 13 scored the highest on the HADS with anxiety 14 and depression 17, regarding the cut-off scores this means that the participant was clinically apparent on both anxiety and depression. Second, this participant scored the highest on the TAS-20 with 76 which indicated signs for alexithymia. On the daily affect grid, the participant mostly indicated to experience low energy during the time of the study and evenly distributed levels of pleasure. This indicates that the participant was either calm or drained during the seven days of the study.

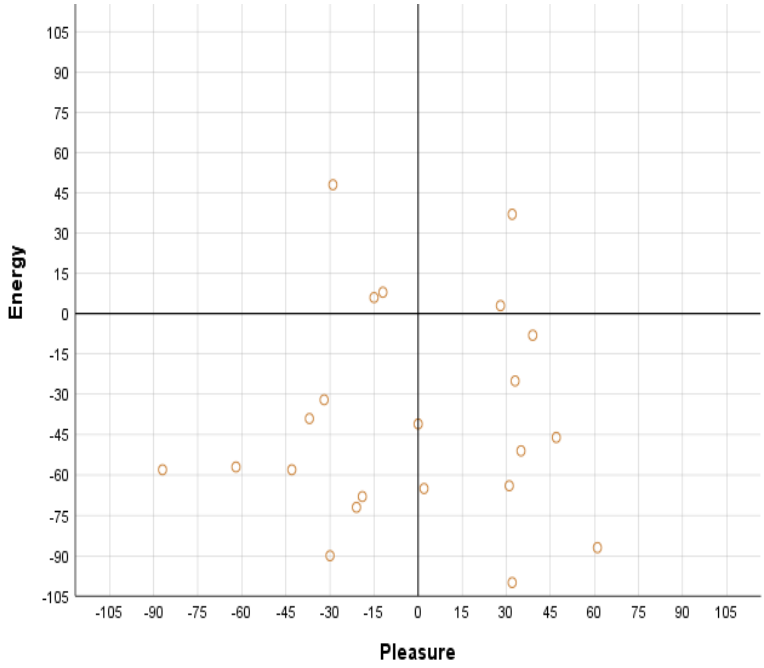

Figure 16. Affect Grid of participant 13.

Moreover, participant 26 obtained the lowest scores on the HADS with 1 on anxiety and 1 on depression, and the TAS-20 with 27. Thus, the participant was clinically inapparent on anxiety, depression and shows no signs of alexithymia. The pleasure of this participant was generally high (M = 32, SD = 52.9) with scores above 90, compared to the other participants (M = 19.09, SD = 43.71). Moreover, the participant displayed rather low energy (M = -15.35, SD = 21.97). In Figure 17, it becomes visible that the participant indicated that he/she was either calm or drained throughout the week. However, the participant indicated nearly the same feelings throughout a few measuring points. Over the timepoints 19 to 23, which equals Saturday afternoon and evening, and Sunday morning, noon, and afternoon, the participant´s

energy and pleasure did not change substantially. This might suggest that the patient had a relatively stable mood during the weekend. During this period of time the participant was rather energetic and calm.

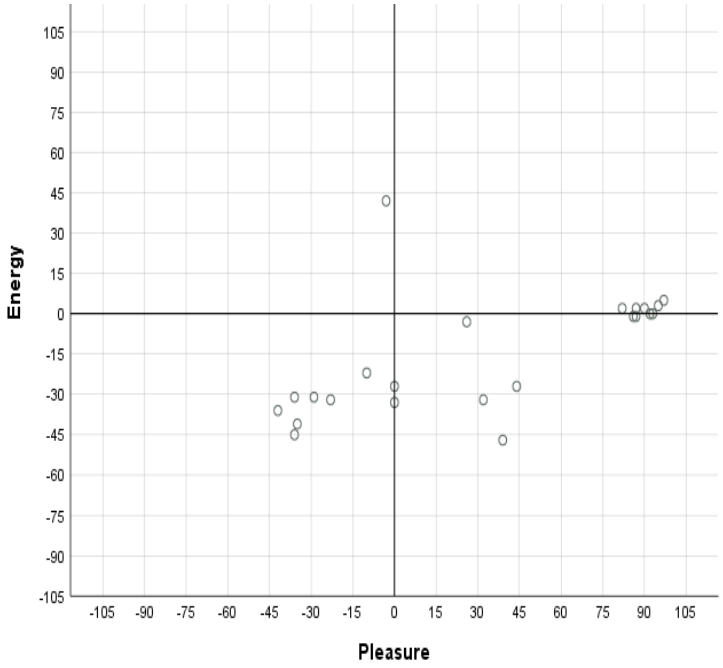

Figure 17. Affect Grid of participant 26.

Discussion

The current study was designed to examine the pattern of momentary emotional states throughout a week within individuals and their association with trait-like variables, including anxiety, depression and alexithymia. Daily levels of core affect were only marginally associated with trait level assessments of mood. Trait anxiety and depression were weakly associated with pleasure, but not energy, over time, indicating that trait anxiety and depression measures can only marginally explain daily levels of core affect. Overall, alexithymia was not significantly associated with core affect over time, still signs of alexithymia was significantly associated with energy. Moreover, participants with signs of alexithymia showed less variability in core affect then those without or possible signs of alexithymia. The findings suggest that trait measures of emotions and state measures of emotions assess relatively distinct aspects of mood. State measurements do seem to be able to measure the actual variations in emotions within an individual within the moment, while the trait measurements may measure mainly the memory of emotions over a period of time.

The data analysis showed that core affect and trait anxiety and depression are associated only to a limited degree. Trait anxiety and trait depression were only weakly associated with one aspect of core affect, namely pleasure. Regardless of the weak association, the results are in line with previous research showing for instance that trait anxiety is significantly associated with displeasure (Weger, & Sandi, 2018). The other aspect of core affect, energy, was not associated with trait anxiety and depression. However, when it comes to analyzing the association between trait-like-variables and energy a distinction has to be made between negative and positive levels of energy within the Affect Grid. Low energy in combination with moderate to high pleasure can also be associated with relaxation and feeling calm and not only physical and psychological exhaustion, in the sense of anxiety and depression (Russell, Weiss, & Mendelsohn, 1989; Lieberman, 2007; VandenBos, & American Psychological Association, 2007; Barton, Karner, Salih, Baldwin, & Edwards, 2014). Therefore, when looking for an association between trait anxiety/trait depression and core affect, measured with the Affect Grid, it has to be considered that in most constructs measuring trait-like low energy is associated with negative aspects. Transforming the continuous features of the Affect Grid into categorical once might help better analyzing them (Meyer, 2020). Still the mixed concept of energy within the Affect Grid might explain why no association was found between trait measures and energy.

When researching trait variables, like trait anxiety and depression, after a period of time the (affect) recall bias should be considered. The phenomenon refers to remembering negative experiences less (underestimation) or more (overestimation) intensely (Gellman & Turner, 2013; Colombo, Suso-Ribera, Fernández-Álvarez, Cipresso, Garcia-Palacios, Riva, & Botella, 2020). Similar to that, the negativity bias might be a reason for the weak or non-significant association between the trait and state variables. The negativity bias describes the phenomenon that individuals tend to be more sensitive towards negative information than positive information and that they are more likely to be remembered later (Rozin, & Royzman, 2001; Ito, Larsen, Smith, & Cacioppo, 1998). An example of this could be participant 16 who scored high on the anxiety subscale of the HADS, which asked for the emotions of the participants during the past week after the seven days ESM. Even though the participant was apparent in trait anxiety, his actual overall pleasure was comparatively high during the week. The participant, however, had only one day where he indicated very low pleasure and energy (feeling drained). This individual case analysis suggested that the participant may have mainly referred to this specific point in time when filling out the HADS. The Experience Sampling method is able to reduce this negativity bias in emotion research by interrogating several times

a day. Only a marginal association was found which may suggest that the trait measurements measure the perception and memory of an experience while state measurements measure what actually happened over a period of time. Therefore, both might measure different aspects of mood.

Contrary to the hypothesis, that individuals with alexithymia display less changes in both aspects of core affect over time, no association between total trait alexithymia and daily core affect was found. A possible explanation for the non-significant association in the current study could be the small sample size. However, when comparing the overall core affect of the three groups (no signs, possible signs and signs of alexithymia), the participants with signs of alexithymia displayed less variability. They scored lower on pleasure and higher on energy, but the latter still in the negative plane on average. These findings are in line with studies by Taylor (1984; 1994) showing that individuals with alexithymia have a reduced ability to experience positive emotions. Another study illustrated that the absence of or limited ability to identify one's own emotions is associated with negative emotions (Rieffe, Oosterveld, & Terwogt, 2006). In fact, due to less positive and more negative emotions they are more likely to develop mental health problems, like anxiety and depression (Diener & Seligman, 2002; Watson & Clark, 1984). Given that when the pleasure level of all participants decreased while the energy level increased at the same time, the findings suggest that the participants with signs of alexithymia did not differentiate as much between the two dimensions of core affect. Thus, the analysis supports the findings by Taylor, Ryan, and Bagby (1985) that individuals with alexithymia have difficulties identifying, differentiating, noticing changes, and communicating their own emotions. The findings on alexithymia and core affect suggested that alexithymia may play an important role when researching momentary emotional states and therefore should be further integrated in state assessments.

After separating the three groups, no associations were found between possible signs, as well as no signs of alexithymia and core affect. Interestingly, an association was found between signs of alexithymia and one aspect of core affect, namely energy. Again, it could be argued that the number of participants with signs of alexithymia was very small (n=6), however, previous studies have shown that signs of alexithymia and energy are indeed associated (literature). Thus, the study by Mattila et al. (2008) showed that alexithymia is associated with poorer health-related quality of life, also including less energy. As mentioned before, individuals with signs of alexithymia are more likely to develop mental disorders. Therefore,

future research is recommended to acknowledge alexithymia given that it may negatively impact several disorders, including anxiety and depression.

More generally speaking, the current study confirmed the theory by Russel (1980) that pleasure and energy are two independent variables, given that the pleasure and energy levels showed a lot of variations and were not clearly associated with each other. Moreover, the individual as well as the group analysis showed that a person could feel energized and displeased at the same time. Furthermore, the mean scores of all participants on the Affect Grid suggest that during the study the participants displayed high pleasure and low energy and therefore they mainly indicated to be calm or relaxed. Interestingly, the highest levels of pleasure were measured during the weekend and Monday morning, apart from Sunday morning. Several studies are in line with these findings, showing that during the weekend the overall level of pleasure is higher than during the week (Ellis, Wiseman, & Jenkins, 2015; Parker, 2014). The energy level, on the other hand, was the highest during the week, from Wednesday morning till Thursday noon. At that time the pleasure levels were mostly positive, but sometimes negative, indicating that the participants were either tense or energetic. This might be the case due to the fact that most of the participants were students of which some were performing a job next to their studies or had a full-time occupation, indicating that they were either studying or working during that time.

Of all 26 participants, 13 showed no signs of alexithymia, 7 showed possible signs and 6 showed signs of alexithymia. The percentage of participants displaying signs of alexithymia therefore was 23%. When comparing this percentage to previous findings by Mattila, Salminen, Nummi and Joukamaa (2006), stating that 18% of the population display signs of alexithymia, it can be concluded that the prevalence in the current sample was roughly in the same range. These findings confirm that alexithymia does not only appear in clinical populations, but also in non-clinical samples. Again, pointing out the importance of including alexithymia as a state measurement when checking for momentary emotional states, even in non-clinical samples. Somewhat stronger fluctuations of core affect were observed during the day within the group with signs of alexithymia than the groups with possible signs or without signs. A possible explanation for these findings is that individuals with alexithymia display difficulties to distinguish between feelings and bodily sensations of emotional arousal (Nemiah, Freyberger, Sifneos, & Hill, 1976). Thus, they misinterpret bodily sensations during the day as feelings and fluctuate more during the day. After all, the pleasure and energy levels of individuals with signs

of alexithymia showed less pleasure and more energy even though they seemed to fluctuate more.

In line with previous research the Experience sampling method appeared to be a suitable method to analyze core affect with the Affect Grid (Russell, Weiss, & Mendelsohn, 1989; Müller, 2019). Thus, it was possible to illustrate the variations not only between but also within individuals with the individual case analyses. The ESM also has a potential additional strength when it comes to analyzing the data. The longitudinal data of the current study carries the ability to statistically disaggregate between-person and within-person effects. While the within-person effect represents the variability of a specific value for each participant, the between-persons effects investigate the between individual differences (Curran, & Bauer, 2011). If the distinction between the two effects is not made an Ecological fallacy can take place, meaning that only one type of data is taken into account, for example the between-person effect and the generalization is made that this is also the case for every individual, even though this is not true, since it is possible that a Simpson's paradox took place (Curran, & Bauer, 2011; Hamaker, 2012). A Simpson's paradox appears when the association on the within-individual level is opposite to or disappears on the cross-sectional level association (Wagner, 1982). In the current research no statistical disaggregation between the two effects was made, thus the reported associations are an aggregate of both types of association. Nevertheless, without a clear distinction between within- and between-person associations this shortcoming could happen easily. Therefore, in future studies that distinction would be recommended.

The Affect Grid itself has proven to be a valid measurement tool to measure the affect of individuals (Russell, Weiss, & Mendelsohn, 1989). However, it has some limitations when it comes to possible reasons for how individuals differ in reporting their mood changes during a study. Participants might misinterpret the scale and thus exaggerate shifts in their mood or perceive a pressure of social obligation to the researcher (Russell, & Gobet, 2012). The association between the state and trait measures might have been influenced by these possible influences. To diminish them the statistical procedure sinuosity transforming can be used. Russell and Gobet (2012) introduced a new equation to transform data to emasculate the social obligation and the differences in interpreting the scale while maintaining the effect of mood variability. It can be used to correct mood shift in the Affect Grid based on the “overall movement” as well as the tendency to slowly move in no particular direction and without a clear purpose. By canceling out the factors a clearer picture of an individual's actual mood can be made across a period of time (Russell, & Gobet, 2012). Thus, using the equation should be

considered when analyzing future datasets in which the Affect Grid has been used. In combination with that an ESM study over a longer period of time might be able to show trait-based tendencies (Zelenski & Larsen, 2000). Thus, a clearer picture of the individual tendencies in mood variations and their characteristic traits might be made, as well as the further investigation on the underlying mechanism of emotions. Therefore, future researchers should consider increasing the study duration.

The validity of the data may have been somewhat impacted by some malfunctions of the TiiM Application that was used for the data collection (Hassanabadi, 2019; Hoppe, 2019). A few participants indicated that the application did not save their answers and thus causing difficulties continuing the survey. As a result, the survey was sometimes more time consuming. This could be avoided by more extensively testing the Application with a pretest. During the data collection, it was not control for additional contextual factors that may have affected the results. Finally, the current findings cannot be generalized to all populations, given that a non-clinical sample was used. This was confirmed by the findings on the HADS showing that most participants were not apparent in anxiety and depression.

Emotions play an important role in explaining a variety of behaviors, thus this study intended to contribute to the growing research on emotions as a state with the use of the Experience Sampling Method instead of traditional methods using trait variables. The purpose of the current study was to examine the association between daily affect and trait variables, including anxiety, depression, and alexithymia within individuals. The analysis showed only a marginal association between momentary core affect and trait anxiety and depression. Moreover, no association was found between core affect and total alexithymia, but an association between signs of alexithymia and energy was found. In line with previous studies, the findings suggest that trait measures and state measures on emotions do measure different aspects of emotions. State measures do capture the dynamic state of emotions, while trait measures measure how people remember how they felt. Yet emotions are inherently dynamic in nature which cannot be studied by using trait measurements. State measurements on the other hand are able to analyze these dynamic processes, which could help explain the underlying mechanisms of emotions and therefore requires more attention. To further investigate affect within individuals' it would be interesting to increase the study duration of the Experience Sampling Method to investigate the tendencies of individuals state affect towards their trait characteristics. Next to that, including the TAS-20 as a control variable is recommended, given that alexithymia may impact momentary emotional states.

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