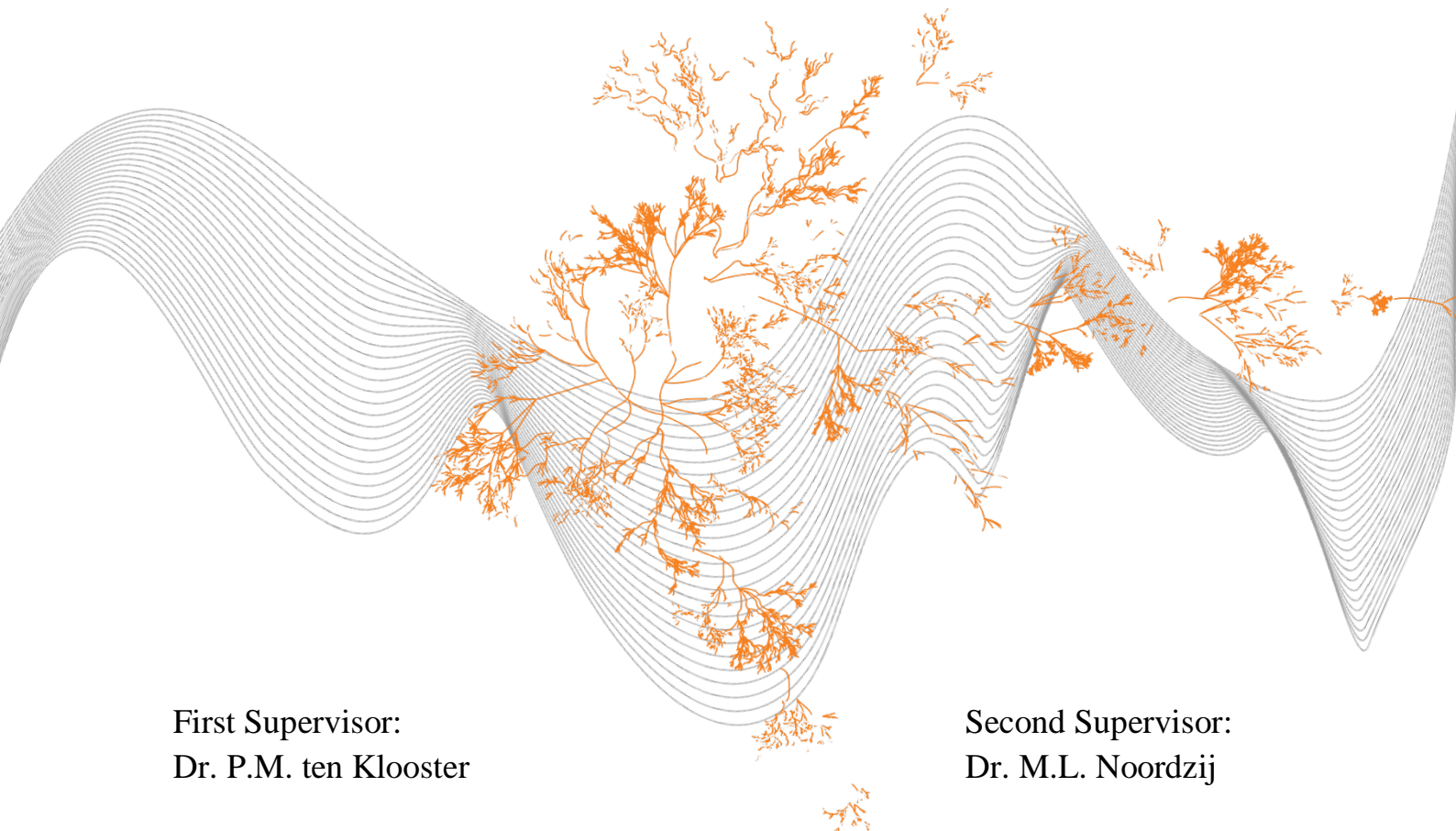# Measuring Feelings of Anxiety and Depression in Daily Life – An Experience Sampling Study

Bachelor's Thesis
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28th June 2019

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Abstract

Feelings of anxiety and depression have been measured as trait variables in most studies so far. However, several indications point towards measuring them as state variables as being more appropriate. Recently, the experience sampling method (ESM) has gained popularity in measuring affect as a momentary state and might be a method capable of giving a more complete picture of the dynamics of emotional experience over time. The current study aims to explore the convergent validity of state measures of anxiety and depression obtained by means of ESM with the Hospital Anxiety and Depression Scale (HADS), representing a trait measure of the two feelings. In addition, the relationship between anxiety and depression is investigated, as there is an ongoing debate on how strongly the two constructs are related. In a sample of a non-clinical population, state anxiety and depression were measured four times a day over the course of one week via the TIIM application for smartphones. Subsequently, the retrospective HADS was administered on the eighth day of the study. Means of state anxiety and depression per person over all measurement points were calculated, as well as the mean state anxiety and depression level of the whole group per measurement point. The results suggested strong correlations between the state and trait variables. Visual analyses and correlation analyses indicated a strong association between the means of state anxiety and of state depression per person, but not between the means of the whole group per measurement point, suggesting that state anxiety and depression are strongly associated within persons, but not over time. Further, there seems to be a high degree of fluctuation in momentary anxiety and depression. Interpretation of the results indicates that the state measures of anxiety and depression are related to their trait measures and that there is substantial overlap, but that there are differences between what the two kinds of measurements capture. It is concluded that anxiety and depression appear to be distinguishable from each other to such an extent that it seems relevant to measure them as separate concepts. Last but not least, state measures can be a relevant addition next to traditional trait measures of feelings and the combination of both may provide a more complete picture of people's affective experience.

Introduction

Anxiety and depression are the most prevalent mental health problems people are dealing with today. According to the World Health Organization (2012), 25% of the European population suffer from anxiety or depression each year, while up to 50% of all chronic sick leaves can be attributed to depression or anxiety. Lifetime prevalence rates for the Dutch population amount to 19.6% for anxiety disorders and 20.1% for depressive disorders (de Graaf, ten Have & van Dorsselaer, 2010). Many cases of anxiety or depressive disorders also stay unrecognised as such. As a result, about 50% of all cases of major depressive disorder in Europe are estimated to not receive any treatment (World Health Organization, 2012). It is of societal interest and of high importance to enhance our understanding of feelings of anxiety and depression and to develop valid and reliable measurement instruments for them. Regarding anxiety and depression in particular, there is an ongoing debate among researchers and clinicians concerning the way the two constructs should be measured and whether they are distinguishable. The current study aims to contribute to this debate by taking a closer look at anxiety and depression as feelings experienced by people on a daily basis.

Anxiety and depression are negatively valenced feelings that, when taken to their extremes, can become or be a symptom of mental disorders, for example generalised anxiety disorder or major depressive disorder. In its *APA Dictionary of Psychology,* the American Psychological Association (APA) defines anxiety as "an emotion characterized by apprehension and somatic symptoms of tension in which an individual anticipates impending danger, catastrophe, or misfortune" (APA, n.d.a, "anxiety"). A person experiences anxiety because of worry about a perceived nonspecific threat that the person may encounter in the future, while this anxious response is not necessarily appropriate (APA, n.d.a). Nevertheless, the body is activated and provided with energy to be able to fight or take flight of this threat and usually shows a variety of physical responses typical of sympathetic nervous system activation.

Depression, on the other hand, is defined by the APA (n.d.b, "depression") as "a negative affective state, ranging from unhappiness and discontent to an extreme feeling of sadness, pessimism, and despondency, that interferes with daily life". A state of depression is often characterised by a low perceived energy level as well as other changes that can relate to bodily factors, cognitions, or social behaviour (APA, n.d.b): A person who is feeling depressed might for example sleep much more or much less than usually, cannot concentrate or motivate him- or herself to do certain activities, and might withdraw from social situations.

Widely accepted scales for measuring anxiety and/or depression include, for example, the Beck Depression Inventory (BDI; Beck, Ward, Mendelsohn, Mock & Erbaugh, 1961), the Beck Anxiety Inventory (BAI; Beck, Epstein, Brown & Steer, 1988), the Symptom Check List-90 (SCL-90; Derogatis, Lipman & Covi, 1973) with its depression and anxiety subscales, and the Hospital Anxiety and Depression Scale (HADS; Zigmond & Snaith, 1983). What all of these scales have in common is that they measure depression and/or anxiety as a type of *trait variables,* e.g. by asking about the level of anxiety and depression experienced in the past week as in the case of the HADS (Zigmond & Snaith, 1983). This means that the assumption is made that anxiety and depression are relatively stable over time. A trait is defined as "an enduring personality characteristic that describes or determines an individual's behavior across a range of situations" (APA, n.d.c, "trait"). Short-time fluctuations in intensity of anxiety and depression are neglected in these kinds of assessments that conceptualise them as traits.

However, it is questionable if this assumption of stability over time is actually valid. Emotions are generally considered to be changing frequently over the course of time, presumably because of their adaptive function. Emotional responses act as a means to alert the person of important changes in the environment and as a motivation to either approach or avoid the stimuli (Kuppens, Allen & Sheeber, 2010). Therefore, variability in emotional states can be expected. Accordingly, instead of measuring anxiety and depression as trait variables, emotional experience of depression and anxiety might better be considered as a *state variable* that can change from moment to moment. Likewise, as stated before, the APA defines depression as an "affective state" (n.d.b, "depression"). In contrast, by its definition, anxiety is considered to be a "long-acting response" (APA, n.d.a, "anxiety"), indicating the possibility that anxiety is more stable over time.

There is also the option of considering the state and trait form of anxiety and depression, respectively, as two different concepts. For example, according to Bradley (2016, as cited in Weeks, Hayley & Stough, 2019), while state anxiety is a momentary experience of threat in a stressful situation that varies over time, trait anxiety can be defined as a person's general tendency for perceiving threats and reacting to them with a physical fight-or-flight response. These two concepts might also differ in how well they predict symptoms like sleep difficulties, as has been suggested by the study conducted by Weeks et al. (2019). *The State-Trait Anxiety Inventory (STAI)* by Spielberger and Gorsuch (1983, as cited in Weeks et al., 2019) treats state and trait anxiety as separate constructs as well, pointing at a difference between the two. Weeks et al. (2019), however, found a strong positive correlation between state and trait anxiety, which indicates that they might be more strongly related than conceptualised. For depression,

seemingly, such a distinction between state and trait has not yet been made. Hence, it seems to be unclear whether the same or different constructs are measured with state and trait measures of anxiety and potentially also depression. In addition, there is the question whether measuring anxiety and depression as either state or as trait variables is to be preferred over the other.

On the one hand, trait measures are convenient and can be administered with little time required because one self-report measure can account for a person's experience over a long time period such as a week or a month. On the other hand, an aspect in disfavour of the usage of measurement instruments conceptualising depression and anxiety as traits is their inclination towards neglecting retrospective memory biases people may show. As especially patients with an anxiety or depressive disorder tend to remember and report their past experience in an overly negative way (e.g. Girz, Driver-Linn, Miller & Deldin, 2017) or according to the mood state they are in while reporting from their past (Dalgleish & Watts, 1990), retrospective self-reports of anxiety and depressive symptomatology are likely to be biased. Moreover, as explained before, they do not take into account short-term fluctuations that might present a different picture of a person's emotional experience over the course of a certain time period than an average estimated for the whole time period.

A methodology that has been developed to measure momentary experiences as they occur is the *experience sampling method (ESM)*. This technique attempts to overcome memory biases typical of other types of self-report studies by measuring state variables on several occasions over the course of a certain time period (Kuppens et al., 2010). Due to this quality as well as the fact that the measurements take place within the context of everyday life, it has been suggested that experience sampling is especially ecologically valid (Versluis, Verkuil, Lane, Hagemann, Thayer & Brosschot, 2018). In addition, this technique makes it possible to study the temporal variability of the state variable under investigation and therefore offers a more complete picture of the emotional experience, which is important because the extent of fluctuation has been suggested to be predictive of e.g. certain mental disorders (Stone, 2007, as cited in Palmier-Claus et al., 2010). ESM might, therefore, be a more appropriate method for studying experiences such as depression and anxiety in a natural setting.

The experience sampling methodology sounds promising, but so far there have been only few studies investigating its validity and comparing it to the existing trait measures for anxiety and depression. Moreover, while various types of ESM measures have been introduced which, for example, measure general affect, such as the Affect Grid developed by Russell and Mendelsohn (1989), ESM measures that specifically measure the constructs state anxiety and depression are rare and have not been validated extensively. As an example, in an ESM study

by Cox, Sterba, Cole, Upender, and Olatunji (2018), a single-item measure was used for momentary anxiety, but neither indications about its validity were given, nor was a comparison to a trait measure made.

The objective of the current study is, therefore, to assess the convergent validity of measuring anxiety and depression as state variables by means of the experience sampling methodology in a sample of a non-clinical population of young adults. The state measures will be compared to a trait measure of depression and anxiety. It is expected that the two would have shared variance because both will assess people's emotional experience reported in a given time period. However, as ESM is expected to capture more variability of the variables over time, which in turn creates a difference between the state and trait measures, a perfect correlation between the two is not anticipated. Instead, like it was found in the study conducted by Weeks et al. (2019), a strong – but not perfect – correlation is expected. A moderate to strong correlation would indicate convergent validity of the state measures in relation to the trait measures, which would suggest that in both cases, an aspect of anxiety or depression, respectively, is measured. It would, on the other hand, also signal that the state measures capture something that is different from what the trait measures report, such as more variability of the emotional experience over time.

A further question that is being widely discussed is whether the current practice of considering depression and anxiety as separate concepts is actually accurate. This is especially relevant when it comes to the diagnosis and treatment of the respective disorders representing the extremes of the emotions under consideration. According to McLean, Asnaani, Litz and Hofmann (2011), anxiety disorders are highly comorbid with mood disorders, including major depressive disorder. The two might thus have certain components in common. Also Bakish (1999) states that people suffering from anxiety and/or depression might generally share a variety of negative emotions which could be indicators of a factor that underlies both types of disorders. Clark and Watson (1991), for example, suggested that anxiety and depressive disorders might share a factor they call *general distress* and even argue in favour of a mixed anxiety-depression diagnosis. Such a *mixed depressive and anxiety disorder* has already been implemented in the diagnostic tool developed by the World Health Organization (2019), the *International Classification of Diseases (ICD-11).*

The results of studies that measured both anxiety and depression tend to converge in having found strong associations between the two constructs, especially when using self-report measures (Frances et al., 1992). Therefore, Frances et al. (1992) also suggest that a distress factor might account for the overlap measured between anxiety and depression. However, the

authors recognise that there is also a difference between the two that should not be neglected, as the associations are strong but far from perfect. Discriminating features of anxiety and depression have been explored in a study by Watson, Clark and Carey (1988): Their results indicated that the absence of positive affect is a distinctive characteristic of depression, while the presence of negative affect relates to both anxiety and depression.

In their paper, Frances et al. (1992) conclude: "Anxiety and depression often go together but are not entirely equivalent" (p. 86). If anxiety and depression are really this closely related, their patterns over time should also show similarities. Hence, one way to shed light on the relationship between anxiety and depression is to look at the manner in which the two fluctuate and go together, or behave independently from each other, by examining the results of the experience sampling data obtained. Further, their correlations over time and within persons can be analysed to investigate whether anxiety and depression are associated. In accordance with previous studies (Frances et al., 1992), it is expected that an association will be found. Despite shared variance of these two feelings, however, it is also expected that anxiety and depression will show some distinct features, like Watson et al. (1988) suggested. The nature and strength of the possible association, however, still needs to be explored and might suggest whether anxiety and depression can actually be distinguished from each other. In conclusion, besides assessing convergent validity between state and trait measures of anxiety and depression, the aim of the current study is to further investigate the relationship between anxiety and depression.

Method

Study Design and Participants

The current study made use of the intensive longitudinal experience sampling method (ESM) for measuring state anxiety and state depression. A questionnaire survey design was used for obtaining measurements of the corresponding trait variables, as well as demographic data.

A convenience sampling strategy was used for sampling the study's participants from the general population. The a-priori specified inclusion criteria included that participants had to be students or having a job, as well as be above the age of 18. Participants had to own and be able to use a smartphone with either an iOS or Android operating system because of the compatibility requirements of the *The Incredible Intervention Machine (TIIM)* application (The BMS Lab, n.d.) used in the study.

The study was conducted in April 2019 over the course of eight days. It was chosen to use seven days for the ESM measurements of the variables state anxiety and state depression because in this way, all days of the week could be covered. There is a possibility that participants' feelings are depending on the day of the week. People might, for example, feel less anxious on the weekend than on a weekday because they do not have to face potential stressors at their workplace. To rule out skewed results by cause of such a tendency, the ESM study was conducted over a full week. Moreover, it was decided to not carry out the study for longer than seven days. The demands of the study, e.g. to look at the smartphone regularly and fill in questions four times a day even in moments in which it might feel inappropriate or uncomfortable for participants to respond to the questions, put a strain on the participants. Therefore, it was considered important to minimise the burden for the participants, and thus the duration of the study, in order to keep them motivated to respond to the measurements conscientiously. On the eighth day of the study, the measures of demographic data, as well as of the trait variables of anxiety and depression were taken.

A total of 26 people voluntarily participated in the study. Beforehand, it was aimed for a sample size of at least 25 participants. Participant numbers in ESM studies differ to a great extent, however, Van Berkel, Ferreira and Kostakos (2017) report that the median number of participants is 19. A number of participants close to this median was considered appropriate for this study as well, with a few more participants to account for potential missing data.

Procedure

The study took place over the course of eight days in total, of which the first seven days were used for the ESM measurements of the variables state anxiety and state depression. For obtaining the data, it was made use of signal-contingent sampling. This type of sampling allowed collecting measures of momentary levels of anxiety and depression at time points that were not anticipated by the participants. Thus, it was avoided that participants structure their days according to the measurement schedule of the study and the data were, hence, expected to be more valid. On each day, four time windows were specified within which, at a random time point, the participants received the instruction to respond to the questionnaire items right away. Four measurements per day were considered to be appropriate because it was intended to collect data of the participants' feelings at time points as representative of the different parts of the day as possible. More than four measurements were considered to be too demanding for the participants though. Therefore, the measurements were scheduled in the morning between 10 and 11 a.m., around lunchtime between 12 and 2 p.m., in the afternoon between 4 and 6 p.m., and in the evening between 8 and 10 p.m. It was decided to begin the measurements no earlier than 10 a.m. in the morning because of the high percentage of students in the sample. Students could generally be expected to get up quite late in the morning because their classes often do not begin that early. If the participant did not respond immediately, he or she received a reminder 30 minutes later. If he or she would not respond until the end of the respective time window, the items were then no longer available to the participant and it was counted as missing data.

Before the start of the actual study, a pilot study was conducted with two participants over the course of three days. As a consequence of the information obtained through the pilot study, a few details concerning the study were changed: As it turned out that participants sometimes had too little time to respond to the items, it was decided that the first notification asking the participants to answer the questions needed to occur no later than 30 minutes before the end of the time window, so the participants had at least 30 minutes to respond until the items were made unavailable. Furthermore, a handout with information and instructions for taking part in the study was created to give to participants before the beginning of the study (see Appendix A). Besides that, some images used in the application were replaced to support consistency and clarity, and errors in the response categories were corrected.

As a first step, the participants had to register for the study via a URL provided in the handout. Then, the participants downloaded and installed the TIIM application on their smartphones. All further instructions and questionnaires were then provided in this application.

Before the data collection started, the participants received information about the study's procedure and were asked to provide their informed consent in the app. Then, at each measurement point, the participants indicated their current feelings by means of the Affect Grid, which was included for the aim of another study. Subsequently, they were instructed to answer one question measuring the state anxiety and state depression, respectively. The order of these three items were determined randomly for each measurement to avoid ordering effects.

On the eighth day of the study, the participants received a longer questionnaire, which took them approximately 20 minutes to fill in. Due to a technical problem with the TIIM application, four participants were unable to fill in the long questionnaire on the eighth day. For these participants, the long questionnaire was provided through the online survey tool *Qualtrics* two days later. After completion of the study, the participants were thanked for their participation. If the participants had any further questions about the study and its results, they were invited to contact the researchers at any time.

Day 1–7

State Measures Anxiety + Depression

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

Day 8

Demographic Data + HADS

10 a.m. – 10 p.m.

Figure 1. Overview of the study's timeline.

Measures

For measuring the state variable anxiety with the ESM, the single-item measure "How anxious do you feel right now?" was used. This item was derived from a study by Cox et al. (2018). Participants were instructed to indicate their level of momentary anxiety on a continuous scale from 0 ("not anxious at all") to 100 ("extremely anxious") with the help of a slider. In addition, the item measuring the state variable of depression was formulated in a similar way: "To what extent do you feel down right now?". The extent to which the participants felt down was to be indicated on the continuous scale from 0 ("not down at all") to 100 ("extremely down").

On the last day of the study, the participants filled in a self-report measure consisting of questions about the participants' demographical data, including their age, gender, nationality, and occupational status. Furthermore, it comprised the *Hospital Anxiety and Depression Scale*

(HADS; Zigmond & Snaith, 1983), the *PANAS* (Watson, Clark & Tellegen, 1988), as well as the *Toronto Alexithymia Scale* (Bagby, Parker & Taylor, 1994). The PANAS and the Toronto Alexithymia Scale were included for the aim of another study. The HADS was chosen for the purpose of measuring the trait anxiety and trait depression within the context of the current study.

The HADS consists of 14 items, with seven belonging to an Anxiety subscale and the other seven to a Depression subscale. Respondents needed to indicate how they have been feeling in the past week by choosing one out of four possible answers, which were later scored on a scale from 0 to 3 (Zigmond & Snaith, 1983). In the current study, the measurement instrument showed to have a Lambda 2 of .81 for the Anxiety subscale, and a Lambda 2 of .83 for the Depression subscale, indicating good internal consistency.

The Incredible Intervention Machine (TIIM)

All measurement instruments were administered via the TIIM application. The Incredible Intervention Machine is a survey tool developed by the BMS Lab of the University of Twente (The BMS Lab, n.d.). It is an application for iOS and Android operating systems and can be used to provide participants with interventions or let them respond to questionnaires on their smartphones. Push notifications are sent as soon as a new module is available to the participant, and as a means to remind the participants to respond. TIIM allows to time each notification specifically and also to determine how long a module is supposed to be accessible to the participant. When the application is opened, the module is shown, but after the response has been recorded, the home screen of the application shows only the note that the participant is asked to patiently wait for the next module to become available. The two questions asked in the course of the current ESM study were to be responded to by using a slider that could be adjusted with the help of the touchscreen on a scale from 0 to 100. For every item, additional instructions as well as images were provided. See the Appendix B for screenshots of the application.

Data Analysis

For the analysis of the data obtained within the current study, the programme *IBM SPSS Statistics* (Version 24) was used. First, the datasets were exported from TIIM and Qualtrics to SPSS and then combined. Subsequently, the dataset was split into two datasets, one containing the data of the ESM measurements (state measures), and one containing the demographic data and the data collected by means of the HADS (trait measures). Sum scores for the complete HADS, as well as for its Anxiety and Depression subscale were calculated, respectively, for

each participant. The sum scores were then merged with the ESM dataset. Descriptive statistics were analysed in terms of the information provided about demographics, such as the distribution of age, gender, nationality, and occupational status.

Multiple Linear Mixed Modelling analyses were conducted with an autoregressive covariance structure in order to obtain Estimated Marginal means (EM means) for the repeated measurements of state anxiety and state depression per participant and per measurement point, thereby taking into account missing data. Accordingly, in the Linear Mixed Modelling analyses, either state anxiety or state depression were set as the dependent variable. The fixed independent factor was specified to be either the measurement points or the participant IDs. Moreover, it was investigated whether trait anxiety and trait depression covaried with state anxiety and state depression, respectively, in the Linear Mixed Model. For that purpose, trait anxiety and trait depression were each entered as a fixed covariate.

Microsoft Excel 2019 was used for creating graphs of the computed EM means of the trait anxiety and depression levels per participant, as well as of state anxiety and depression levels per participant and per measurement point. Moreover, some graphs were created of the state anxiety and depression scores over time for a selection of four individual participants that had a high response rate for the ESM items. Based on these graphs, a visual analysis of the differences in state and trait anxiety and depression levels within and between participants, as well as of the patterns of the state anxiety and depression levels over the course of the week was used to investigate the relationship between anxiety and depression.

Next, Pearson correlations were calculated to analyse the associations between the Estimated Marginal means of the state and trait variables, i.e. between the state anxiety data gathered by the ESM measurements and the person's trait anxiety obtained through the sum score of the Anxiety subscale of the HADS, as well as between state depression and trait depression, between state anxiety and trait depression and state depression and trait anxiety. The interpretation of the effect sizes was based on Cohen (1988), according to whom a correlation coefficient (*r*) greater than .5 suggests a large or strong correlation, *r* greater than .3 a moderate correlation, and *r* greater than .1 a small correlation.

Results

Descriptives

A number of 26 participants from age 18 to 32 (mean= 23.62, SD= 3.67) took part in the study. The sample consisted of 11 men and 15 women, with 23 participants being of German, two of Dutch, and one of British nationality. 16 of the participants were students, of which 11 also had a job next to their studies. From day one to seven, at a total of 28 timepoints, the participants were asked to respond to the state measurements of anxiety and depression. On average, participants responded to 22.04 (78.71%) out of the 28 measurements (SD= 4.01), the minimum being 13 measurements (46.43%) for two participants and the maximum being all of the 28 measurements for two participants as well. No participants were excluded from the dataset. See Table 1 for an overview of the descriptives.

Table 1

Means (M) and Standard Deviations (SD), Frequencies (n) and Percentages (%)

Variables	M or n	SD or %
Age, M (SD)	23.62	3.67
Gender: Male, n (%)	11.00	42.31
Female, n (%)	15.00	57.69
Nationality: German, n (%)	23.00	88.46
Dutch, n (%)	2.00	7.69
British, n (%)	1.00	3.85
Students, n (%)	16.00	61.54
Job, n (%)	21.00	80.77
Number of responses to state measurements, M (SD)	22.04	4.01
HADS: Sum score, M (SD)	13.65	6.77
Anxiety score, M (SD)	8.85	3.92
Depression score, M (SD)	4.81	3.66

N=26

Trait Anxiety and Depression

As a final step of the study, all 26 participants filled in a self-report measure for trait anxiety and depression, the HADS. For each participant, sum scores were calculated for the entire questionnaire as well as separately for its two subscales (Table 1). Figure 2 illustrates the subscale scores for trait anxiety and depression for each participant. On average, participants obtained a score of 13.65 (SD= 6.77) for the HADS, with a mean of 8.85 (SD= 3.92) for the Anxiety subscale, and a mean of 4.81 (SD= 3.66) for the Depression subscale. Most participants, except for five, had a higher trait anxiety than depression score. Within participants, the differences between the two variables tended to be large in many cases.

Participant 3, for example, had a difference of 12 units between the anxiety and depression scores.

As can be seen in the figure, differences between the participants were large as well. Participant 26 had the lowest trait anxiety with a score of 1, while participant 21 had the highest trait anxiety with a score of 16. The lowest trait depression with a score of 1 was measured for the participants 3, 15, 23, and 26. Participant 13 had the highest trait depression with a score of 17.
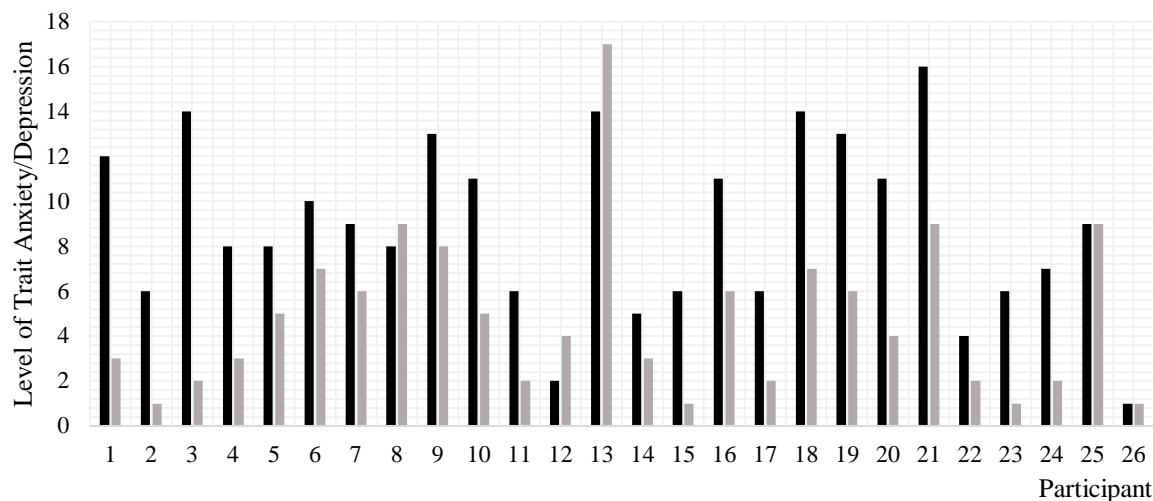

Figure 2. Trait anxiety (in black) and trait depression (in grey) as measured by the subscale sum scores of the HADS per participant.

State Anxiety and Depression

A Linear Mixed Modelling analysis was conducted in order to obtain Estimated Marginal means (EM means) for all measurement points per person for the state measurements of anxiety and depression. The factor 'participant' was found to have a significant fixed effect (anxiety: $F= 13.82$, $p < .001$; depression: $F= 12.68$, $p <.001$). Figure 3 illustrates the computed means for state anxiety and state depression per participant over all measurement points. Large differences between participants were found. Participant 17 had the lowest mean state anxiety with a score of 3.03, while Participant 25 had the highest mean state anxiety with a score of 49.11. The means over all measurement points for state depression ranged from 2.00 (Participant 1) to 57.70 (Participant 9).

As opposed to the trait anxiety and depression levels, the means per person of state anxiety with an average of 16.80 (SD= 13.86) were lower than of state depression with an average of 22.87 (SD= 15.95). Further, Figure 2 shows that within most persons, the difference between the mean of state anxiety and the one of state depression was large. Only in a few

cases, for example Participant 2, 3, 11, or 25, their means of state anxiety and state depression seemed to be on a similar level.
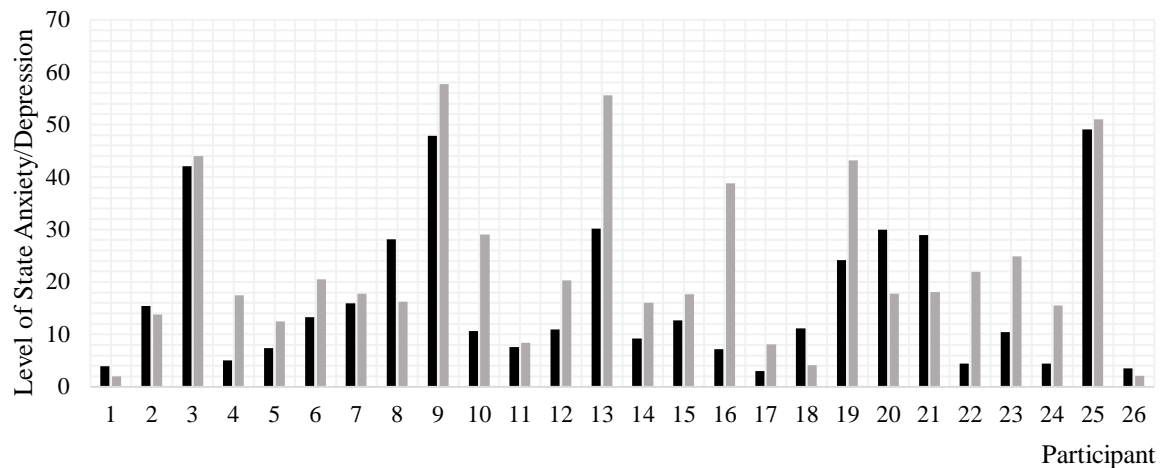

Figure 3. Mean state anxiety (in black) and mean state depression (in grey) per participant.

Association between State and Trait Anxiety and Depression

Furthermore, a second Linear Mixed Modelling analysis was conducted in order to obtain EM means of the scores of all participants per measurement point for state anxiety and state depression. A significant fixed effect of the factor 'measurement point' was not found. Trait anxiety showed to be a significant covariate of state anxiety ($F= 32.24$, $p < .001$). Likewise, trait depression was found to be a significant covariate of state depression ($F= 41.12$, $p < .001$).

Figure 4 illustrates the computed means for state anxiety and state depression per measurement point and thus the development of state anxiety and depression over the course of one week. It starts with measurement point 1 being the first measurement on Tuesday morning and point 28 being the last measurement on Monday evening. According to the two curves, momentary anxiety and depression seemed to fluctuate relatively independently from each other over time. The different patterns suggest that state depression tended to be higher overall and fluctuated more strongly than state anxiety. Even though increases and decreases of state anxiety and depression seemed to be occurring in an analogous fashion, the magnitude of the in- or decrease differed greatly between the two curves and tended to be greater in the case of state depression.

State anxiety was highest on Wednesday morning (point 5; mean= 23.92, SD= 3.77) and its trend suggested a slight decline from this timepoint on until the end of the study. The lowest group mean of state anxiety was measured on Thursday afternoon (point 11; mean= 12.19, SD= 3.69). In contrast, state depression showed no clear trend, but high variability over the course of these seven days. Two peaks of high state depression were identifiable on

Wednesday at lunchtime (point 6; mean= 31.04, SD= 5.06), as well as on Sunday in the morning (point 21; mean= 32.04, SD= 6.27) and at lunchtime (point 22; mean= 31.75, SD= 4.93). At the latter mentioned timepoint, the discrepancy between state anxiety and state depression was the clearest: On Sunday at lunchtime, state anxiety had a mean of only 17.06 (SD= 3.77). State depression was especially low on Friday at lunchtime (point 14; mean= 15.25, SD= 4.96) and on Saturday morning (point 17; mean= 14.94, SD= 5.45).
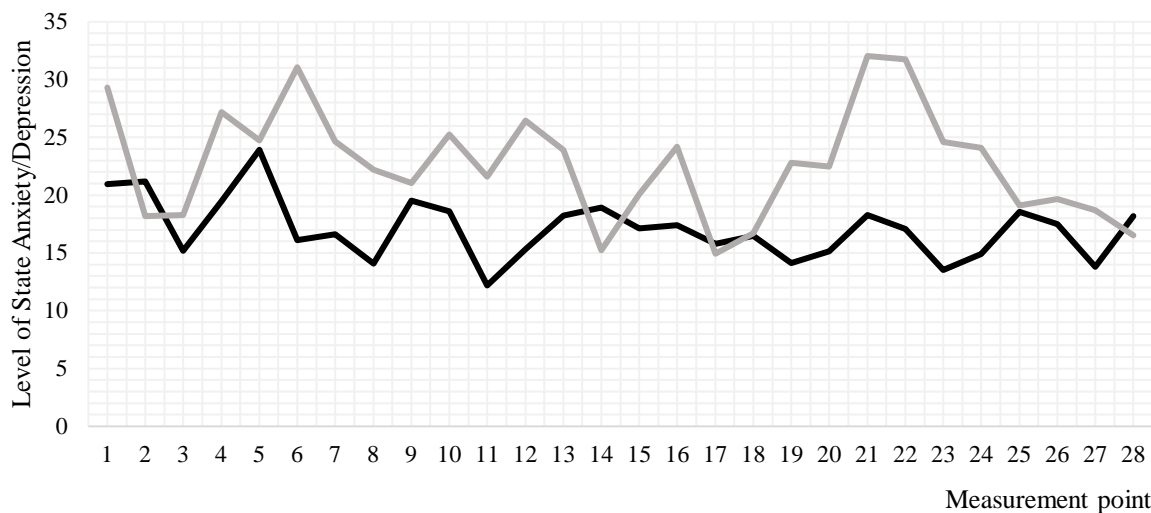
Figure 4. Mean state anxiety (in black) and mean state depression (in grey) per measurement point over time.

Correlations

Next, a number of Bivariate Pearson Correlation analyses was conducted with the variables under investigation (see Table 2). A Pearson Correlation analysis between the EM means per measurement point of state anxiety and of state depression resulted in only an insignificant and small positive correlation (r= .10, p= .62), confirming the observation made on the basis of Figure 4 that state anxiety and depression fluctuated relatively independently from each other over time.

In contrast, the EM means per person of state anxiety and state depression were shown to be strongly positively correlated (r= .74, $p < .01$), as were the trait anxiety and trait depression scores (r= .60, $p < .01$), which is different from the impressions gained from the visual analyses of Figure 2 and 3. The EM means per person of state anxiety correlated just as strongly with trait anxiety (r= .54, $p < .01$) as with trait depression (r= .54, $p < .01$). Likewise, a strong positive correlation was found between the EM means per person of state depression and the trait depression scores (r= .56, $p < .01$). Between the EM means per person of state depression and the trait anxiety scores, however, only a moderate correlation was found (r= .46, $p < .05$).

Table 2

Pearson Correlations between the EM Means per Person of the Anxiety and Depression Variables

Variables	1	2	3
1. State anxiety			
2. State depression	.74**		
3. Trait anxiety	.54**	.46*	
4. Trait depression	.54**	.56**	.60**

** $p < .01$; * $p < .05$
N=26

Visual Analyses on Individual Level

In order to gain a more detailed picture of participants' state anxiety and depression over time during the course of the study, four participants with high response rates to the ESM items were selected as examples for a further analysis on the individual level. The first of these, Participant 25, had a very high level of both state anxiety and depression and a difference between the two EM Means per person was only slight (see Figure 3). The pattern of the participant's state anxiety and depression over time can be seen in Figure 5. The two curves show great amplitudes with strong variations over the course of the study, anxiety ranging from a score of 31 to 82, and depression from 7 to 92. As in case of the EM Means per measurement point for the whole group, Participant 25's level of depression per measurement point varied more greatly than the level of anxiety. Likewise, the patterns of depression and anxiety were not similar and the curves did not shift in parallel. A clear relationship between the two variables cannot be easily detected from looking at the graphs in Figure 5.
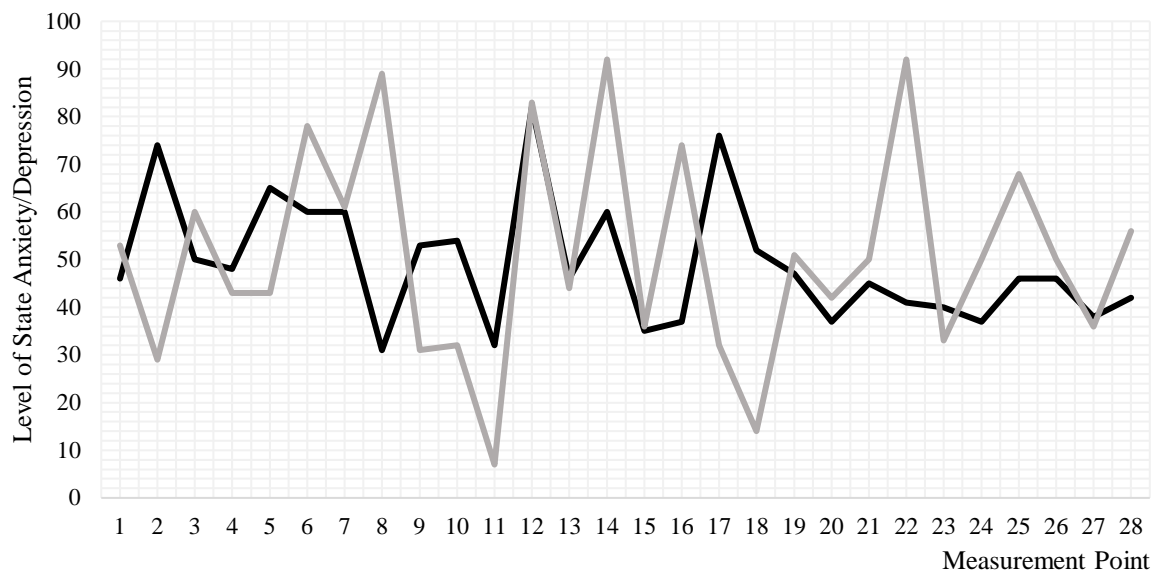
Figure 5. State anxiety (in black) and state depression (in grey) of Participant 25 per measurement point.

Participant 10's state anxiety and depression per measurement point presented a different picture. As can be seen in Figure 6, changes in state anxiety and depression over time seemed to appear in parallel, with anxiety going up at the same time as depression went up, but the magnitude of the change was much greater in case of depression. Once again, the level of depression had a greater amplitude, ranging from 1 to 75, and stronger fluctuations. On average, like in case of the group average, this participant's level of state depression was substantially higher than the level of state anxiety (see Figure 3).
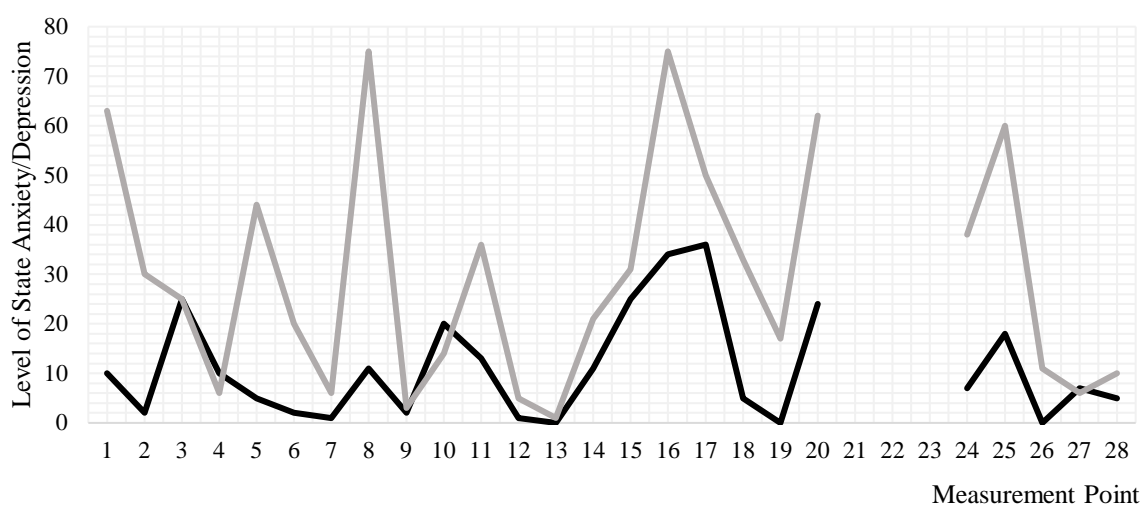

Figure 6. State anxiety (in black) and state depression (in grey) of Participant 10 per measurement point.

In case of Participant 20, as can be seen in Figure 7, there seemed to be a great amount of overlap between the experience of state anxiety and depression. For the most part, the two variables' patterns were highly similar and the curves ran in parallel, without presenting a big difference between them, which is a different finding than in case of the whole group. Moreover, in contrast to the group averages, the participant's level of state anxiety was higher than the level of state depression (see Figure 3), which especially showed from measurement point 16 to 27. But still, state anxiety developed over time in a parallel fashion to state depression.
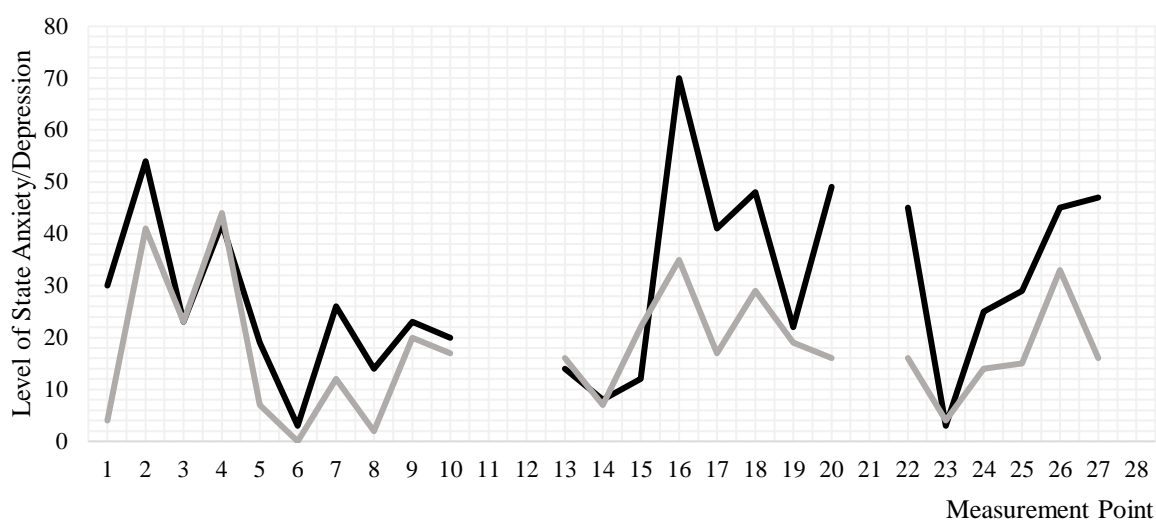

Figure 7. State anxiety (in black) and state depression (in grey) of Participant 20 per measurement point.

The patterns of Participant 13's state anxiety and depression, on the other hand, seemed to be very different from each other, as can be seen in Figure 8. The participant had especially high levels of state depression, which also varied to a great extent over the course of the study. Like in the case of Participant 25 and 10 and as was suggested by the EM Means per measurement point for the whole group, the participant's level of state depression varied to a greater extent than the level of state anxiety. The two curves were not similar and no clear relationship between the two variables could be detected in Figure 8 for the case of Participant 13.
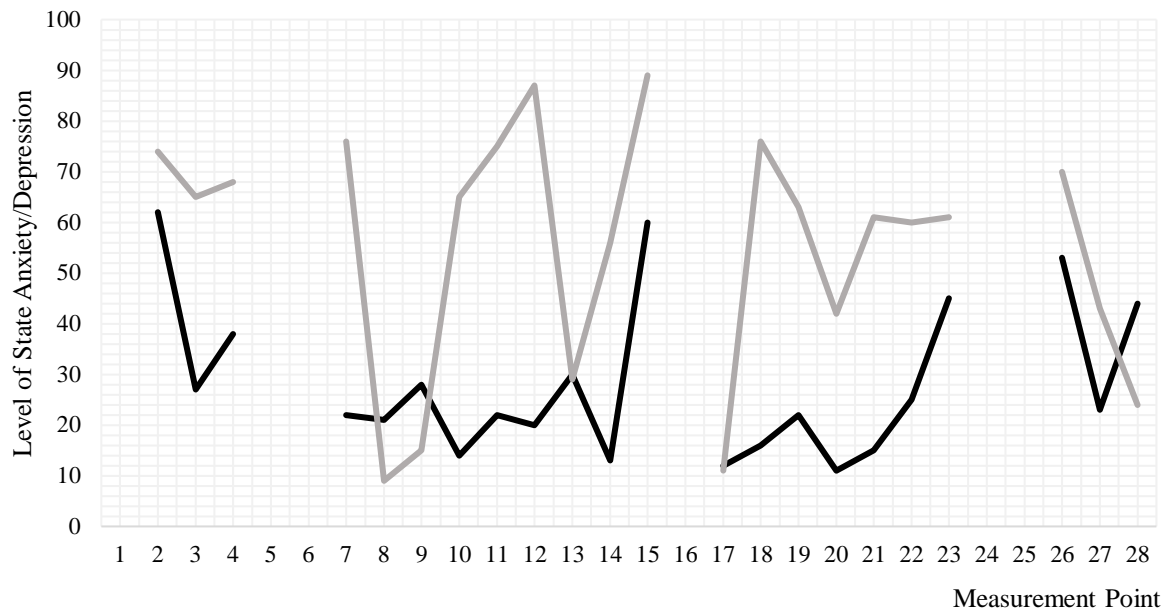
Figure 8. State anxiety (in black) and state depression (in grey) of Participant 13 per measurement point.

All in all, the four examples suggest that there were differences between persons regarding the degree of similarity of the patterns of state anxiety and depression over time. In two cases, a clear relationship between state anxiety and depression could not be detected, while in one case, parallelism of the curves could be seen. Participant 20's levels of state anxiety and depression appeared to be more strongly related. In three of the four cases, it seemed like the level of state depression had a greater extent of variability than the level of state anxiety.

Discussion

The objective of the current study was to explore the convergent validity of state measures of anxiety and depression with trait measures of these two feelings. Moreover, the relationship between anxiety and depression was examined. In line with expectations, the results of this study indicate that the state measures of anxiety and depression are strongly related to their trait measures and that there is substantial overlap, but that there are still differences between what the two kinds of measurements capture. Furthermore, there seems to be a high degree of fluctuation in momentary anxiety and depression. The results of the current study suggest that despite a detectable overlap of anxiety and depression within persons, confirming the expectation of some shared variance between the two variables, they are hardly associated over time. Overall, it can be concluded that state measures of anxiety and depression appear to have convergent validity with trait measures of these feelings, and that anxiety and depression seem to have some distinct features that make them distinguishable from each other despite their shared variance.

For the purpose of exploring the state measures' convergent validity with trait measures of anxiety and depression, correlations between the state and trait measures of the current study were analysed. It was expected that the state and trait variables would correlate strongly, but not perfectly. Perfect or very strong correlations would indicate a redundancy of measuring anxiety and depression as state variables, an implication in favour of measuring these feelings as trait variables, since making use of experience sampling methods implies a high burden for participants. Finding a nonsignificant correlation, however, would imply that the state measures of anxiety and depression measure something entirely different than the trait measures. In line with expectations, the state and trait measures seem to be related to each other between persons, as the trait variables were found to be significant covariates of the state measures. The strong association between the mean state and trait measures found indicates convergent validity. Both the state and trait measures seem to be measuring a common construct and they both assess participants' levels of anxiety and depression. This finding is in line with the research by Weeks et al. (2019), who also found a strong association between state and trait anxiety.

However, even though the correlation is strong, the respective trait measures explain only 29% of the variance of state anxiety and 31% of the variance in state depression, indicating a fairly small overlap between them. This suggests that the trait measures are not covering the same as the state measures, and there is a difference despite the strong association. This may be in line with the conceptualisation made by Spielberger and Gorsuch (1983, as cited in Weeks

et al., 2019) of state and trait anxiety being two different constructs, between which Weeks et al. also found a strong positive correlation. The variance in trait anxiety and depression that could not be explained by the respective state variables might also be due to retrospective memory biases that influence participants' response to trait measures. In the current study, the responses to the HADS, which asks for the participants' emotional experience over the past week, might have been biased. According to Girz et al. (2017), there is the possibility that people may report their past emotional experience in an overly negative way, a bias which is thought to be avoided in the EMS part of the study (Kuppens et al., 2010). The potential bias to the trait measure of anxiety and depression might underlie its indicated difference to the state measures.

Furthermore, much variability of state anxiety and depression was found over time. The two feelings do not appear to be stable across measurement points, instead they seem to be fluctuating strongly. Interestingly, the extent to which state anxiety and depression varies over time also appears to be very different between individuals, as was demonstrated by the visual analyses of four cases. Similarly, Kuppens, Oravecz and Tuerlinckx (2010) have found that there are clear differences between people in terms of how strongly their affect is changing over time. Eid and Diener (1999) even suggest that affect variability could be considered a distinct personality feature that characterises individuals, thus stressing its importance. Especially when it comes to predicting vulnerability for mental disorders such as major depressive disorder, taking into account individual differences in the way people regulate their feelings is crucial (Gross & Muñoz, 1995). Trait measures of anxiety and depression do not measure variation in the measured constructs over time and, therefore, are not able to detect such differences between individuals like ESM made possible in the current study. However, as suggested, these individual differences might be important, which provides a point for the relevance of ESM research.

On the basis of the current study, it cannot be determined whether the state measure is to be preferred over the trait measure or vice versa, but what can be noted is that apparently, depending on whether state measures or trait measures are used in a study, one may come to different results. Both outcomes might, however, be relevant: State and trait measures might cover different aspects of the construct under investigation, which are potentially equally important to consider. Clearly, more research in this area is needed in order to find a more specific answer to the question of the way in which state and trait measures measure the same or are different, and depending on that, which of them is to be preferred over the other.

Further, the current study aimed to assess the relationship between the two feelings anxiety and depression. By means of correlation analyses as well as looking at the patterns of their development over time, it was investigated how much these two concepts overlap. The answer to this question seems to be complicated. On the one hand, the strong association found between the means of anxiety and depression per person suggests that the concepts are strongly related. On the other hand, the results suggest that the means of anxiety and depression per measurement point do not correlate. In addition, the conclusion drawn from the visual analysis of the patterns of the feelings over time indicates that anxiety and depression behave differently and fluctuate independently from each other most of the time. Even though momentary anxiety and depression appeared to be changing at the same time in the same direction, the magnitude of their change was very different: Depression seems to have greater variability than anxiety. Interestingly, as indicated by the visual analyses of the four cases, the extent to which anxiety and depression go together seems to vary between individuals as well.

In essence, this suggests that it seems to depend on the perspective one takes when assessing the relationship between anxiety and depression, whether such an association can be found. When trying to make sense of the results, a closer look at what these findings mean is needed. First of all, the means of the state anxiety and depression levels experienced across all measurement points for each person were strongly associated in this study. This indicates that overall, for each person, the more anxious they felt over the course of the week, the more depressed they felt. This is in line with the strong association between trait anxiety and depression for each person suggested by the results of this study. Assuming that the state and trait measures both assessed the same underlying factors, this finding is another clue implying that a person's level of state as well as trait anxiety and depression seem to be strongly associated. Interestingly, trait anxiety and trait depression appear to be more strongly associated with each other than state anxiety with state depression, a finding that might be due to the characteristics of the measurement instruments used.

The strong association points towards the possibility of a shared underlying factor that might explain the relationship between the two feelings, which was also suggested in the current study. 55% of the variance in state anxiety is explained by state depression, and vice versa. It is in line with the argumentation in favour of a factor that might be common to anxiety and depression made by McLean et al. (2011), Bakish (1999), Clark and Watson (1991), and Frances et al. (1992), which was elaborated on before. Therefore, a general distress level might be the reason why measures of anxiety and depression are strongly correlated. If general distress is underlying both anxiety and depression or if anxiety and depression are both manifestations

of general distress, then when general distress increases, both anxiety and depression would increase. Still, anxiety and depression seem to have distinct features as well, as 45% of the variance in each of the variables could not be explained by the other. For example, Watson et al. (1988) suggested that the absence of positive affect might be a distinctive feature of depression, but also recognised that the presence of negative affect might be a shared factor of anxiety and depression, a finding that could possibly explain the results of the current study.

When taking the average of all the participants' levels of anxiety and depression at a specific time point and analysing these averages of all the measurement points, no clear association was found between anxiety and depression. This indicates that the behaviour of state anxiety is different from the behaviour of state depression over time. Looking at each measurement point, one takes into account the variables' development and variation over time, which is averaged out when computing means per person instead of per measurement point. The fluctuations over time that were indicated by the results of the current study, therefore, seem to play an important role and might make up the difference between the two variables anxiety and depression. While on the one hand, a person's overall levels of anxiety and depression were associated, the group's patterns of anxiety and depression over the course of these seven days were different as indicated by the study's results, which suggests that the concepts are not as strongly related as one might assume given the association between the means per person.

This finding is in line with the conclusion made by Frances et al. (1992), which was cited before: "Anxiety and depression often go together, but are not entirely equivalent" (p.86). In some individual cases of participants, anxiety and depression went together more than for the whole group, and while the curves of the group means over time shifted in parallel, which somehow let anxiety and depression 'go together', the magnitude of the change differed, which indicates inequality between them. The apparent contradiction between the findings concerning the means per person (strong association between anxiety and depression) and per measurement point (no association between anxiety and depression) can, however, not be explained on the basis of the current study. Similarly, a clear answer to the question of the extent to which anxiety and depression are related cannot be given. More research is needed to shed light on the meaning of this difference and on the relationship between anxiety and depression in general.

What needs to be kept in mind is that contrary to other kinds of experience sampling studies, the current study did not take into account the situations and circumstances in which participants found themselves in while responding to the state measure items. In this way, confounding factors from the environment that might have influenced the patterns of

momentary anxiety and depression could not be ruled out. Considering the context in which the participants indicated to have a certain level of anxiety and depression would possibly provide necessary insights into the underlying factors that affect those feelings, which might explain their different patterns over time. This would be possible with a study design incorporating the *ecological momentary assessment (EMA)* methodology, in which participants, like in ESM, respond to state measures multiple times per day. In EMA, the participants are further instructed to indicate in which kind of situation, environment or context they find themselves at the moment in which they respond to the self-report measure (e.g. Versluis et al., 2018). For future studies, this methodology might be helpful to investigate environmental factors influencing state anxiety and depression levels.

The current study benefitted from a good response rate, with little missing data. The sample size of 26 participants and four assessment per day is average for ESM studies and therefore considered adequate. Still, the study's results are limited because the study was only conducted over eight days. In this way, all weekdays could be covered, but, assuming that environmental factors might have an influence on participants' affective states, one week might be not very representative. Participants might have felt especially strongly or mildly anxious or depressed during this specific week in which the study was conducted, and if it would have been conducted in another week or over the course of multiple weeks, the outcome might have been different. Future studies are recommended to extend the time window for experience sampling in order to obtain more input.

Furthermore, it should be noted that the current study is quite specific for the age group of highly educated young adults, and especially students, which dominated the sample. Affective experience in young adults might differ from how older adults feel over the day: The average level of anxiety and depression might be different, as well as the extent of variability, or the strength of the relationship between anxiety and depression. Moreover, students might be better able to recognise their own feelings, which might be even more the case for students of Psychology. Therefore, the results of this study should not be generalised to other populations, and research with other groups is needed in order to obtain a more complete picture.

It also should be kept in mind that despite a good response rate, there were missing data in the dataset. A strong point of the current study is the use of Linear Mixed Modelling, which provided the statistical analysis with more power because this method accounts for missing data. Linear Mixed Modelling, however, becomes more conservative the more missing data there are, since the estimations can be made with less confidence. Therefore, associations

between variables might be underestimated by the model, as less strong correlations are more likely to be considered insignificant. Moreover, the correlation analyses have to be interpreted with caution because of the very low statistical power due to the small sample size used.

Another potential influence on the data obtained in the current study is ordering effects. In the context of another study conducted, the Affect Grid by Russell and Mendelsohn (1989) was included to the short set of items that participants had to respond to four times per day. The order of the questions was randomised, but still, because the Affect Grid also triggers participants to think about their current feelings, the order of the items might have affected the response to the items relevant for this study.

Furthermore, the item measuring state depression has been used in this form for the first time in the current study. Its wording required some consideration before conducting the study because initially, it was intended to ask: "To what extent do you feel depressed right now?". However, the majority of the participant sample was of German nationality. The literal translation of the word "depressed" to German is "deprimiert", but the German language also has the visually and phonetically more similar word "depressiv", which is a much stronger word that only relates to clinical depression. It was intended to avoid a misinterpretation of the word "depressed" by the German participants as well as to prevent that participants would report lower levels of depression than they might actually experience. Therefore, a more mild word, "down", was chosen instead, which still might be interpreted in different ways by participants with different native languages. There is a possibility that "down" does not represent the feeling of depression as well as intended.

This word choice might also explain why in case of the state measures, depression levels were on average higher than the anxiety levels, while it was the other way around in case of the trait measures of depression and anxiety. Participants may have interpreted the word "down" as more mild than the word "anxious" and, therefore, the item might have measured more mild forms of depression than the HADS Depression scale measured. This interpretation of the question asked might have influenced the results in such a way that participants reported momentary feelings of depression with less reluctance than feelings of anxiety or the depressive symptoms asked about by the HADS. More studies using this single-item measure are, therefore, needed to test its reliability and validity.

Moreover, four of the participants filled in the HADS two days later than the rest of the participants, which might have influenced the results. This could be because the instructions of the HADS ask the participants to indicate their average level of anxiety and depression in the past week. This was a different time period in case of these four participants, which did not

completely overlap with the time period in which the state measures were obtained, than in case of the other participants. A difference between the state and trait measures of anxiety and depression might, therefore, also be due to the different time periods for which participants were reporting their anxiety and depression levels. The cause of this problem was a technical error with the TIIM application, which should be prevented in future studies. Furthermore, the current study should be replicated in order to be able to be more confident in its results.

To sum up, the current study had the objective to research the question of how feelings of anxiety and depression should be measured. It sought to contribute to the growing body of research on the relevance of applying experience sampling methods to measure state variables next to or instead of the traditional method of measuring trait variables in Psychology. In addition to that, the question whether anxiety and depression are actually distinguishable was of relevance in this study as well. What can be taken from this study is that ESM seems to enable researchers to take into account daily fluctuations in feelings that trait measures are unable to capture. With the help of ESM, a great extent of variation in momentary anxiety and depression can be detected, which made it possible in the current study to take a closer look at the peculiarities of the relationship between the two feelings. The results indicated that anxiety and depression have some shared variance, but a substantial amount of variance of one of the two feelings could not be explained by the other. In conclusion, therefore, anxiety and depression appear to be distinguishable from each other to such an extent that it seems relevant to measure them as separate concepts, despite a possible shared underlying factor. Last but not least, state measures can be a relevant addition next to traditional trait measures of feelings and the combination of both provides a more complete picture of people's affective experience.

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Appendix

Appendix A: Handout

<div style="border: 1px solid black; padding: 1em;">

"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/lHsxP
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 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.

</div>

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 p.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.
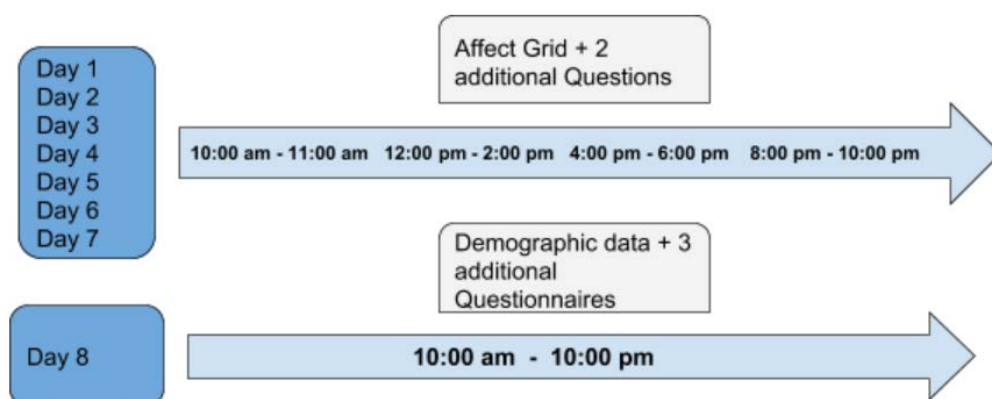
If you still have any questions or experience problems during the study, do not hesitate to contact us!

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Thank you for your participation! 😊

Best wishes,
Negi and Wiebke

Appendix B: TIIM