Investigating the Dynamics of Symptoms of Anxiety and Depression and Optimism in Young Adults: An Experience Sampling Study

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Abstract

Introduction. Recently, anxiety and depressive symptoms in young adults increased steadily, which presents a risk for their mental well-being. Since the assumption of positive emotions and attitudes, among them optimism, may have protective functions, these variables are explored between and within young adults. First, the study shows to what extent momentary symptoms of anxiety and depression and state optimism in young adults vary over two weeks. Second, the study examines how momentary anxiety symptoms and state optimism, and momentary depressive symptoms and state optimism are associated.

Method. The variables were examined with the experience sampling method (ESM). The study's sample constituted 25 participants (M_{age} = 23.52; SD_{age} = 2.82; age range 19 to 32 years; 44% male, 56% female). They answered three brief questionnaires daily via the mobile application Ethica reporting their feelings, and behaviours for two weeks in April 2020. Momentary anxiety and depressive symptoms were assessed by a one-item visual analogue scale (VAS) per variable. State optimism was measured by the first item of the Short-Warwick-Edinburgh-Mental-Wellbeing-Scale (SWEMWBS). Linear Mixed Model analyses and the person-mean centring method were used to explore the extensive data.

Results. All three state measures varied on the group and the individual level. The association between anxiety symptoms and optimism was a more a between-person effect (β = -.41; SE = .11; p < .001) and less a within-person effect (β = -.29; SE = .03; p < .001). The association between depressive symptoms and optimism was both a between (β = -.37; SE = .07; p < .001) and within-person effect (β = -.49; SE = .03; p < .001).

Conclusion. This study provided additional insights into momentary anxiety and depressive symptoms and state optimism occurring in students' daily lives. First, analyses revealed that the state measures often co-exist. Second, the variability of the participants' states encourages the notion to consider every individual as unique. Third, between- and within-person effects were equal in direction and similar in strength, supporting and adding to previous research. These findings stress the need to conduct further research and develop individually tailored interventions to increase the level of optimism in people's everyday lives.

Investigating the Dynamics of Symptoms of Anxiety and Depression and Optimism in Young Adults: An Experience Sampling Study

In recent years, symptoms of anxiety and depression in young adults, especially students, tended to rise (Bluhm et al., 2014; Derntl & Svaldi, n.d.; Son et al., 2020). Lifetime prevalence rates of anxiety and depressive disorders among young adults range from 13% to 21% (Bruffaerts et al., 2019; Eisenberg et al., 2007). According to the Center for Collegiate Mental Health (2020) and Pereira et al. (2020), anxiety and depression are the most common mental health problems students have to deal with due to several stressors regarding finances, transitional life events, or job matters. Both disorders are, among other things, characterised by a diminished ability to experience positive emotions and states, such as happiness, hope or optimism (Seligman & Csikszentmihalyi, 2014), which allow for more flexible and helpful psychological responses, for example, an optimistic outlook on one's own personal control when facing stressful events (Alloy & Clements, 1992; Chang & Sanna, 2001).

Moreover, the COVID-19 pandemic contributed and still contributes to a deterioration of symptoms of anxiety and depression in young adults (Redden, 2020; Son et al., 2020). Despite the high demand for professional support, many affected young adults decide to discontinue treatment or do not seek help at all (Bluhm et al., 2014; Son et al., 2020). This calls for techniques to motivate affected young adults to disclose themselves by consulting professionals. Also, it calls for more in-depth investigations in young adults' mental health to detect resources that may prevent severe problems (Mathur et al., 2018; Seligman & Csikszentmihalyi, 2014). Given the facts that optimism is considered a valuable personal resource, is linked with well-being and might help in the management of stressors in life such as anxiety and depressive symptoms (Carver et al., 2010; Millstein et al., 2019; Scheier & Carver, 1992), the present study explores the dynamic states of anxiety, depression, and optimism in a non-clinical young adult sample aged between 19 and 32 years.

Trait and State Anxiety and Depression

Momentary symptoms of anxiety and depression should neither be confused with full-blown anxiety and depressive disorders nor with trait anxiety and depression. Anxiety disorders are generally marked by feelings of worry and anxiety that are out of proportion, and cannot be controlled by the person affected (Park & Kim, 2020; Reynolds & Kamphaus, 2013). A general low mood and impairment in daily functioning characterise depressive disorders (Uher et al., 2013). Both disorders restrict people's daily lives on a psychological

level but also in the form of physical symptoms such as dizziness, increased heart rate or sweating. Moreover, they are often comorbid (Eisenberg et al., 2007; Kessler et al., 2005). Trait anxiety and depression, however, describe a person's predisposition regarding those disorders and refer to their general personality characteristics (Reidy, 2004). Momentary symptoms of anxiety and depression are people's potentially varying emotional states that depend on the situation they are in (Endler & Kocovski, 2001; Krohne et al., 2002). Both traits and states of anxiety and depression do not necessarily have to have clinical relevance.

Therefore, not every person who experiences momentary symptoms of anxiety or/and depression is also diagnosed with a mental disorder. Every person can experience them to a different extent because moods and emotions are not always stable but rather fluctuate over time (de Vries et al., 2020; Kuppens et al., 2010; Wenze et al., 2007). Thus, momentary symptoms of anxiety or/and depression do not necessarily have a tremendous negative effect on daily functioning but can solely be a snapshot of one's current emotional state. This leads to the assumption that many people seem to be able to deal with momentary anxiety and depressive symptoms adaptively (Cabral & Patel, 2020) by using their personal capacities. A caveat, however, is that the mere existence of these symptoms increases the likelihood of exacerbation because they count among the various risk factors of the onset of an anxiety and depressive disorder (Cabral & Patel, 2020; Dyrbye et al., 2006). Therefore, it is essential to investigate the presence and relationship of those momentary symptoms and other potentially protective resources, such as optimism early on in young adults.

Trait and State Optimism

Potential opportunities to improve mental well-being can be found in the field of positive psychology. This area shifts the focus from an illness-oriented perspective to a strengths- and resource-oriented view. Positive psychology concerns valued personal experiences such as mental health, contentedness, hope, flow, joy, and optimism (Seligman & Csikszentmihalyi, 2014). Optimism counts among human resources and strengths that can function as a beneficial personal characteristic in adapting to stressful events more efficiently in daily life (Banerjee, 2012; Luthans & Youssef, 2007; Peterson, 2000; Scheier & Carver, 1992). Generally, optimists tend to attribute positive happenings to themselves and negative ones to external circumstances (Kluemper et al., 2009). Additionally, optimism seems to boost resilience which buffers against the onset and relapse of mental health issues (Carver et

al., 2010; Ellicott et al., 1990; Finlay-Jones & Brown, 1981; Seligman & Csikszentmihalyi, 2014). Hence, there is ample evidence that optimism is advantageous in different areas of life.

Further, Scheier and Carver (1985) postulated that optimistic persons tend to view their future prospects positively, which is usually maintained over time. In a more recent study, Carver et al. (2010) adjust and broaden their perspective in that they assume that optimism is not always a stable dispositional trait. During specific life circumstances, for example, transitional phases in life in young adulthood, optimism may vary and fluctuate more like a state due to unforeseeable developments in the future (Carver et al., 2010). Thus, trait optimism is relatively stable over time and refers to the generally optimistic outlook on life, whereas state optimism is alterable and concerns context-related optimistic expectancies (Kluemper et al., 2009; Peterson, 2000).

If people have optimistic and favourable expectancies of an outcome, they work actively towards this goal despite potentially occurring adversities. This supposition is rooted in expectancy-value theories that concern people's motivation to execute a specific action depending on their expectation (i.e., the probability of the occurrence of the desired outcome through one's action) and value (i.e., how much importance is placed on the wanted outcome) (Feather, 1988; Eccles & Wigfield, 2002; Scheier et al., 1994). The changeable nature of state optimism enables people to train and develop their optimistic outlook on situations (Kluemper et al., 2009; Luthans & Youssef, 2007; Seligman, 2011). Learning and training optimism can support people in striving and coping actively with experienced issues (Kluemper et al., 2009; Malouff & Schutte, 2016; Scheier & Carver, 1985). Hence, state optimism seems not to be merely innate and fixed, which could offer promising opportunities to enhance well-being.

There are several ways to cope with controllable and uncontrollable situations. Alongside many other coping responses, Skinner et al. (2003) distinguished between approach coping – the tendency to tackle the problematic situation or feelings – and avoidance coping – the tendency to circumvent the problematic situation or feeling. In their meta-analytic review about dispositional optimism and coping, Nes and Segerstrom (2006) found that optimism is positively related to approach coping strategies and negatively related to avoidance coping strategies. Moreover, optimistic people seem to be more likely to react adaptively due to their willingness to change the stressful situation by further activating their personal resource capacities to build strength and stamina in the face of an arduous event (Luthans & Youssef, 2007; Scheier & Carver, 1985). If training in optimism could increase

more adaptive coping responses in dealing with stressors, further research in the state-like nature of optimism is needed.

The Relationship Between Anxiety and Optimism, and Depression and Optimism

Although a considerable amount of cross-sectional research has been conducted regarding the relationship between optimism and mental and physiological health (e.g., Banerjee, 2012; Giltay et al., 2006; Rao et al., 2021), there is still a dearth of within-person effect analyses in the variability of well-being and psychopathologies (Affleck et al., 2001; de Vries et al., 2020). Within-person analyses aim to explain how one or more variables are expressed within an individual over different time points. Between-person analyses aim to examine potential differences between individuals concerning the variable(s) under investigation at a single point in time (Curran & Bauer, 2011). Symister and Friend (2003) confirmed cross-sectionally that increased optimism was associated with decreased depressive symptoms in a clinical population suffering from a chronic renal disease. Further cross-sectional studies discerned that higher levels of trait optimism were related to lower levels of depression (Banerjee, 2012) and lower anxiety levels (Schweizer et al., 1999). In a longitudinal study among urogenital cancer patients, optimism was significantly and negatively associated with anxiety and depression (Zenger et al., 2009). Similarly, optimism has been found to still predict future depressive symptoms in college students when controlling for negative and positive affect, daily hassles, and prior depressive symptoms (Vickers & Vogeltanz, 2000).

While symptoms of anxiety and depression count among factors that decrease people's mental well-being, optimism is considered an essential part of maintaining or increasing mental health (Millstein et al., 2019; Rand, 2009). Although previous research might create the impression that those variables stand in contrast, the two continua model of mental health suggests a different approach. It holds that psychopathologies (i.e., symptoms of anxiety and depression) and mental well-being (i.e., optimism) are connected but are not situated on the same continuum to give information about the overall health (Keyes et al., 2020; Renshaw & Cohen, 2013; Westerhof & Keyes, 2009). A person does not necessarily experience increased mental health when not suffering from a mental illness and vice versa. According to this model, symptoms of anxiety and depression are situated on one continuum (i.e. presence/absence of mental illness), and optimism is found on the other continuum (i.e. presence/absence of mental health), which could support their co-existence. While previous

studies all have made an important contribution to mental well-being research, no studies examine the relationship between state optimism and fluctuations in mental health, such as momentary anxiety and depressive symptoms between and within young adults.

The Present Study

In the light of the changeable nature of optimism over time and its hypothesised positive influence on mental health, the investigation of changes in optimism, how these changes are connected to other psychological variables and optimism's possible protective effects is necessary. However, researchers mainly investigated between-person effects by utilising the trait measures of optimism, anxiety and/or depression instead of their state counterparts (Huffman et al., 2019), with optimism often being used as a moderator variable (e.g., Boileau et al., 2020). Thus, the investigation of the state measures over multiple time points, including within-person analyses, would shed light on the dynamics of optimism and symptoms of anxiety and depression within young adults and disclose potential differences between within- and between-person effects. This exploration of the state variables is done by the experience sampling method (ESM).

The extensive data may contribute to a better understanding of young adults' internal processes. This study is relevant because especially the young adult population often has to deal with a considerable amount of developmental processes and unsettledness, which can be accompanied by varying anxiety and depressive symptoms (Ibrahim et al., 2013; Kokou-Kpolou et al., 2020) as well as changes in their levels of optimism (Carver et al., 2010). Thus, it is of particular interest to examine the variability of those variables over time and their association with each other in this population. No study so far has compared the between- and within-person effects and the relationship between those variables in an ESM study design. Therefore, this study aims to answer the following research questions:

(1) How do momentary symptoms of anxiety and depression vary between and within young adults over two weeks?

(2) How does state optimism vary between and within young adults over two weeks?

It is anticipated that this study replicates the scientific consensus among fluctuations of momentary symptoms of anxiety and depression between and within individuals throughout the study period (e.g., Helbig-Lang et al., 2012; Verhagen et al., 2016; Walz et al., 2014). Similarly, it is expected that state optimism also varies throughout the days between and within persons (e.g., Carver et al., 2010). The following two research questions focus on

assessing the relationship between current symptoms of anxiety and optimism and state depression and state optimism:

(3) How are momentary symptoms of anxiety and state optimism associated between and within young adults over two weeks?

(4) How are momentary symptoms of depression and state optimism associated between and within young adults over two weeks?

On a between-person level, both questions investigate whether people who are on average more or less optimistic than others present on average more or less anxiety or/and depressive symptoms. Given the findings from previous research (e.g., Banerjee, 2012; Schweizer et al., 1999), a (strong) negative between-person association is predicted. On a within-person level, both questions aim to answer whether a person who has a higher or lower level of state optimism than their own average experiences a higher or lower level of momentary anxiety and depressive symptoms at that time point. Considering prior studies (e.g., Scheier & Carver, 1985), it is assumed that a person who has high levels of momentary anxiety and/or depressive symptoms simultaneously experiences high levels of optimism at that moment. Thus, a positive within-person association is predicted.

Method

Design

This ESM study was conducted as a joint research project of two bachelor psychology students in April 2020 (April 6 to April 19). The Ethics Committee of the Faculty of Behavioural Sciences (ECBMS) at the University of Twente approved this research (#191314). The ESM offers the possibility to assess the variability in emotions, moods, thoughts, and behaviours in respondents' familiar environments over time (Hektner et al., 2007; Myin-Germeys et al., 2009; Trull & Ebner-Priemer, 2009; Verhagen et al., 2016). Therefore, the ESM is used to capture the variability of momentary symptoms of anxiety and depression and levels of state optimism over time. This method deals with longitudinal data that includes repeated measurements interleaved within individuals. It facilitates within-person analyses but simultaneously enables researchers to conduct between-person analyses and, thus, to compare both effects with each other (Curran & Bauer, 2011; Hoffman & Stawski, 2009). The collection of momentary self-report data averts potential recall biases because those reports do not rely on memories that can be easily distorted (Barrett & Barrett, 2001; Trull & Ebner-Priemer, 2009). Such a study is characterised by smaller sample sizes
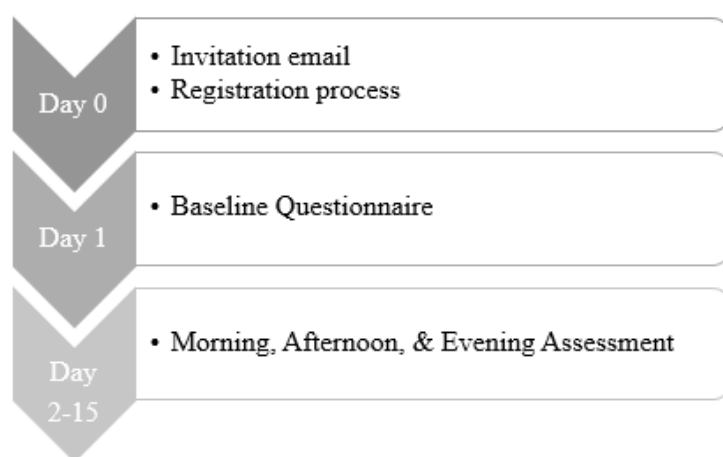
compared to survey studies in which a questionnaire is usually completed once (Bolger et al., 2003; Conner & Lehman, 2012; van Berkel et al., 2017) because the repeated daily self-reports account for the meaningfulness of the data.

For this study, Ethica was utilised, which is a platform that enables researchers to construct and conduct an ESM study via a mobile application ("Ethica…", n.d.; "Features", n.d.). The different types of questions could be added and timed in Ethica. Thus, only a mobile device with an internet connection was needed to download the mobile application and participate. The download instructions were explained in a self-generated email by Ethica before the study (Appendix A). The informed consent form, the contact information of the researchers, and further information about the study were displayed in the app (Appendix B). The study lasted two weeks, which is seen as a standard length in ESM research (Conner & Lehman, 2012; van Berkel et al., 2017). Furthermore, the daily assessments were kept relatively short to reduce participant burden (Conner & Lehman, 2012; Myin-Germeys et al., 2018). An interval contingent sampling design was used for those assessments meaning that the participants received the questionnaires at fixed time points, which enabled repeated measurements throughout the day (Conner & Lehman, 2012; Palmier-Claus et al., 2019; Figure 1). Reminders were sent via the notification option of the app to support participant engagement (Conner & Lehman, 2012).

Figure 1

Flow-chart of the Study and Measurement Design

Day 0
- Invitation email
- Registration process

Day 1
- Baseline Questionnaire

Day 2-15
- Morning, Afternoon, & Evening Assessment

Participants

Initially, 35 young adults were recruited through convenience sampling to take part in this study. Convenience sampling facilitated the recruitment procedure because the

participants were selected from the researcher's social environments and were thus, more accessible (Naderifar et al., 2017). This sampling procedure ensured higher study adherence and participation rates, which is of vital importance for ESM studies (Conner & Lehman, 2012). Inclusion criteria for the present study consisted of English proficiency and possessing a mobile device. Participation in this study was voluntary, and it was possible to withdraw from it whenever desired.

Materials

This study was part of a more extensive study examining traits and states of well-being, stress, anxiety, and depression. From the baseline questionnaire, only the demographics regarding the participants' age, gender, nationality, the highest degree of education, and field of study were used. Further measures utilised in the current study are explained below.

Momentary Symptoms of Anxiety and Depression

Momentary anxiety and depressive symptoms were measured by two single-item visual analogue scales (VAS). The exact questions asked were: "How anxious do you feel right now?" and "To what extent do you feel down right now?". The VASs' brevity and simplicity are well-suitable for repeated assessments among different populations to measure subjective experiences (Bijur et al., 2001; Facco et al., 2011; McGrath et al., 1996; van Duinen et al., 2008). The anxiety and depressive symptoms scales could be rated with a slider from 0 ("no anxiety at all" or "not feeling down at all") to 100 ("extreme anxiety" or "feeling extremely down"). In this study, scores were rated as follows: 0 to 33.3 = low, 33.4 to 66.6 = moderate, 66.7 to 100 = high. Previous studies already used a similar VAS of anxiety as a valid measure for momentary anxiety symptoms (e.g., Cox et al., 2018; van Duinen et al., 2008). Similarly, the VAS of depressive symptoms also seems to be a valid tool because it correlated strongly ($r_s = .61$) with other frequently used depression scales (Huang et al., 2019). Split half correlations were significant, strong and positive between the odd and even-numbered time points of state anxiety ($r_s = .94$, $p < .001$) and state depression ($r_s = .92$, $p < .001$) indicating excellent reliability for both scales.

State Optimism

To measure state optimism, the first item of the Short Warwick-Edinburgh Mental Wellbeing Scale (SWEMWBS) was used: "I've been feeling optimistic about the future."

(Koushede et al., 2019). In the present study, scores were counted as follows: 0 to 1.50 = low, 1.51 to 3.50 = moderate, 3.51 to 5.00 = high. Although this item referred to the respondents' feelings in the past two hours, it seemed to be an acceptable measurement to capture the potential variability of optimism over time because it was assessed multiple times a day. Moreover, it concerned the participants' positive attitude regarding their future which was another reason to consider it a suitable measure. The answer options ranged from "none of the time" to "all of the time" on a five-point Likert scale, which represents a typically used scale in ESM research (Myin-Germeys et al., 2009). For state optimism, the split-half correlation was significant, strong and positive ($r_s = .89$, $p < .001$), indicating excellent reliability.

Procedure

After the administrative procedures, including ethical approval, invitation emails, information provision, app download and agreement with the consent form, the participants started the study with the 10-minute baseline questionnaire. All three daily measurements followed a fixed sampling schedule to comprehensively assess the different conceptions of interest (Myin-Germeys et al., 2018). Furthermore, the measurement points were chosen according to the interval contingent sampling method (Figure 2).

Figure 2

Overview of the Daily Assessments at Fixed Time Points
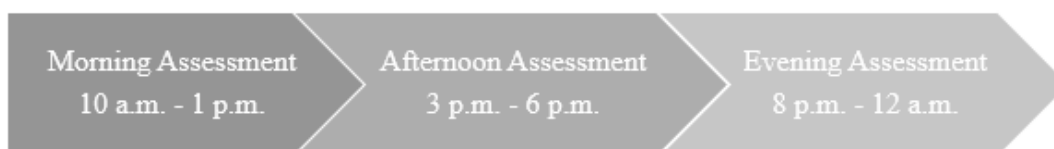
It is common practice in ESM research to spread the assessments throughout the day to capture the variability of moods, emotions and behaviours (Bolger & Laurenceau, 2013; Conner & Lehman, 2012). Each assessment required about three minutes of time investment. All assessments were announced by notification via the app to remind the participants to fill them in. If a questionnaire has not been answered 90 minutes after the first notification, another reminder was sent. In total, the participants had three hours to fill in the morning and afternoon assessments and four hours to fill in the evening assessment before the measurement occasion was closed.

Data Analysis

In total, 35 young adults commenced the study, of whom 10 participants were excluded from the analyses because they did not fulfil the completion rate of at least 50% of assessments. Conner and Lehman (2012) recommended such a cut-off score to allow for some missing data on the part of the respondents for which the statistical method can account. Microsoft Office Excel (2016) was used for visualisation purposes of the results in the form of line graphs, and the IBM SPSS Statistics version 25.0 was used for visualisations of boxplots and data analyses ("IBM Support", n.d.).

First, the demographics were analysed utilising descriptive statistics to present the participants' age, gender, nationality, the highest degree of education, and field of study in a structured way, including means, standard deviations, percentages, minima, and maxima. Second, state optimism, anxiety and depression were evaluated. Third, the Shapiro-Wilk test tested normality of all variables with a p-value higher than .05 indicating a normal distribution and a p-value lower than .05 indicating a non-normal distribution of the data (Ghasemi & Zahediasl, 2012). Subsequently, the split-half reliability was calculated for the daily one-item measures. Good reliability was confirmed if a reliability coefficient of .7 or higher was calculated (Taber, 2018). The average of the state measures per person was calculated, and the data was then split into halves based on even and odd time points. For each of the halves, the average was calculated with which correlational analyses (either a Pearson correlation or a Spearman's rho correlation depending on normality) were conducted to obtain a statement regarding the scales' split-half reliability (Horstmann & Ziegler, 2020).

For longitudinal data analyses, linear mixed models (LMMs) were used. LMMs are commonly used to analyse longitudinal data because they can deal with nested data (Ariyo et al., 2019). For every LMM, the participant IDs were specified as the subject variable, and the measurement points were specified as the repeated measurement. Moreover, a first-order autoregressive covariance structure (AR1) with homogeneous variances was used, which accounts for repeated measures and regards time adjacent time points as highly correlated. It assumes that this correlation decreases when the intervals between time points increase (Field & Wright, 2011). Missing values were accounted for using the restricted maximum likelihood method that rebalances the data ("Restricted Maximum Likelihood Method", n.d.). In the following paragraphs, momentary symptoms of anxiety and depression are referred to as state anxiety and state depression, respectively.

To answer the first and the second research questions, which intended to explore the variability of state anxiety, state depression, and state optimism over time on a between- and within-person level, different LMMs were run. First, state anxiety, state depression and state optimism were set as the dependent variable and measurement points, days and participant IDs were set as the fixed independent factor. These analyses resulted in an estimated marginal (EM) mean for every dependent variable per time point or day of all participants and per participant during the whole study period. Second, three participants were selected who had high or low EM mean scores in either of the three state variables to get more insight into individual variabilities at all measurement points. Therefore, line graphs of their individual scores in every assessment were created. Third, one boxplot for each state measure was created representing every participant's raw scores throughout the study period and, thus, variability within-person.

The third and fourth research questions concerned the relationship between state anxiety and state optimism and the association between state depression and state optimism on a between- and within-person level. Person-mean centring was applied, which can be used to separate between- and within-person effects in LMM analyses (Curran & Bauer, 2011). For this, the person-mean (PM) score, which describes the mean score across all measurement points for every participant, was calculated for every state measure by aggregating the data accordingly. This score is relevant for the between-person effects. After that, the person-mean centred (PMC) score was calculated by subtracting the PM score from each individual and time-specific time-varying covariate measure. The PMC score was thus relevant for within-person associations (Curran & Bauer, 2011). PM and PMC scores were transformed to standardised z-scores to make results across different scales comparable.

Next, two LMMs were run with those standardised variables. First, the standardised state anxiety variable was set as the dependent variable, and standardised state optimism PM and PMC variables were set as covariates. Second, the standardised state depression variable was set as the dependent variable. The standardised state optimism PM and PMC variables remained as covariates. These analyses disaggregated the between- and within-person associations. The magnitude of the associations was determined according to Cohen (1988; 1992): small = -/+ $0.1 \leq \beta < $ -/+ 0.3, medium = -/+ $0.3 \leq \beta < $ -/+ 0.5, large = $\beta \geq $ -/+ 0.5. Additionally, line graphs with standardised scores were created to illustrate potential associations between state measures.

Results

Characteristics of the Sample Population

The participants' overall response rate amounted to 86%, meaning they answered 36 out of 42 assessments. Table 1 provides an overview of the participants' demographic information, means, standard deviations, and observed minima and maxima.

Table 1

Characteristics of the Sample (N = 25)

Characteristics		n (%)	M (SD)	Observed min. | max.
Age in years	19-32	25 (100)	23.52 (2.82)	19 | 32
	19-24	19 (76)		
	25-32	6 (24)		
Gender	Male	11 (44)		
	Female	14 (56)		
Nationality	German	22 (88)		
	Australian	1 (4)		
	Other	2 (8)		
Highest degree	High School	15 (60)		
	Bachelor	10 (40)		
Field of study	Social sciences	18 (72)		
	Natural sciences	1 (4)		
	Arts	1 (4)		
	Other	4 (16)		
	Not applicable	1 (4)		
State Measures	State Anxiety	25 (100)	17.16 (21.22)	0 | 100
	State Depression	25 (100)	16.53 (20.02)	0 | 100
	State Optimism	25 (100)	3.48 (0.85)	1 | 5

On average, the participants reported low state anxiety and depressive symptoms levels every day resulting in estimated marginal (EM) means in the bottom quarter (0 to 25) of the scale ranging from 0 to 100. The levels of state optimism found a daily level of EM means between 3.28 and 3.62, indicating moderate to high daily average levels of state optimism. Figure 3 illustrates the daily average state levels for all participants. Notably, there was a pattern between anxiety symptoms and optimism as well as between depressive symptoms and optimism visible. Anxiety and depressive symptoms seemed to decrease or increase when optimism increases or decreases, respectively. Although the effects of measurement days per state variable were non-significant ($p > .001$), the visualisation in Figure 3 indeed shows fluctuations between days.

Figure 3

*EM Means of State Anxiety, State Depression and State Optimism per Day (N = 14)*
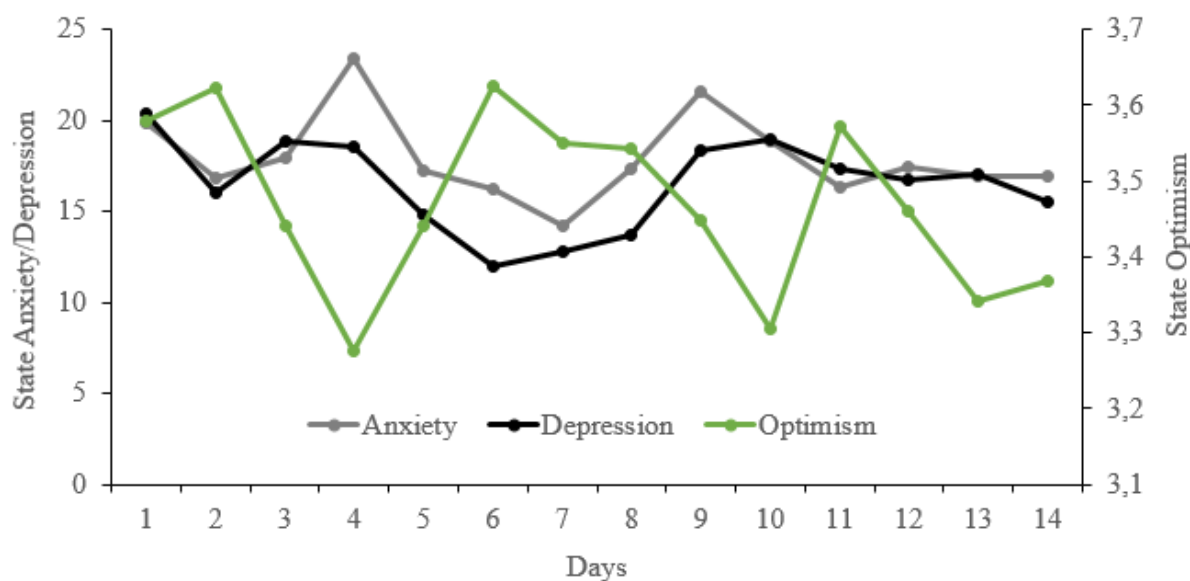
Characteristics of Two Example Participants

Two participants' data were selected based on their similar means in the lower half of the scales of state anxiety and state depression. They were visualised in two separate line graphs to demonstrate inter- and intraindividual differences. First, Figure 4 shows that participant 25808 experienced fluctuations of momentary anxiety and depressive symptoms ranging from low to high levels throughout the study period despite the moderate mean values ($M_{anx} = 34.60$; $M_{dep} = 35.39$). Their state optimism levels ($M_{opt} = 3.70$), however, varied to a

lesser extent. The scores ranged from 2 to 5 on the scale over the two weeks. Thus, there was no consistent pattern visible, but indeed variability between measurement points.

Figure 4

Individual Scores of State Anxiety, Depression and Optimism per Time Point (N = 42)
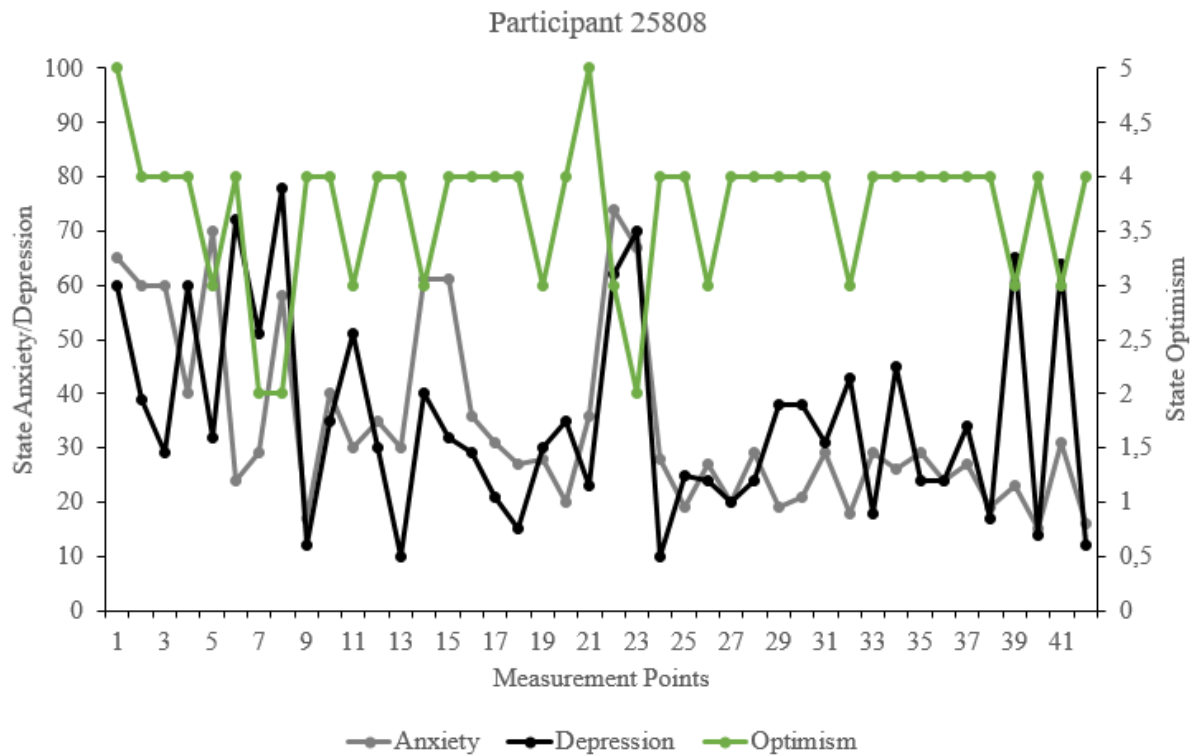

Second, participant 25831 had constant moderate levels of state optimism (M_{opt} = 2.0) and varying levels of momentary symptoms of anxiety (M_{anx} = 35.45) and depression (M_{dep} = 35.41). Although the respondent answered solely on thirty measurement points, Figure 5 shows a stable trend throughout the study period in their optimism levels. In contrast, the state anxiety and state depression levels changed from measurement point to measurement point, indicating variability in those two state measures. Although participant 25808 and participant 25831 had similar mean values on momentary symptoms of anxiety and depression, their individual scores varied differently.

Figure 5

*Individual Scores of State Anxiety, Depression and Optimism per Time Point (N = 42)*

Participant 25831
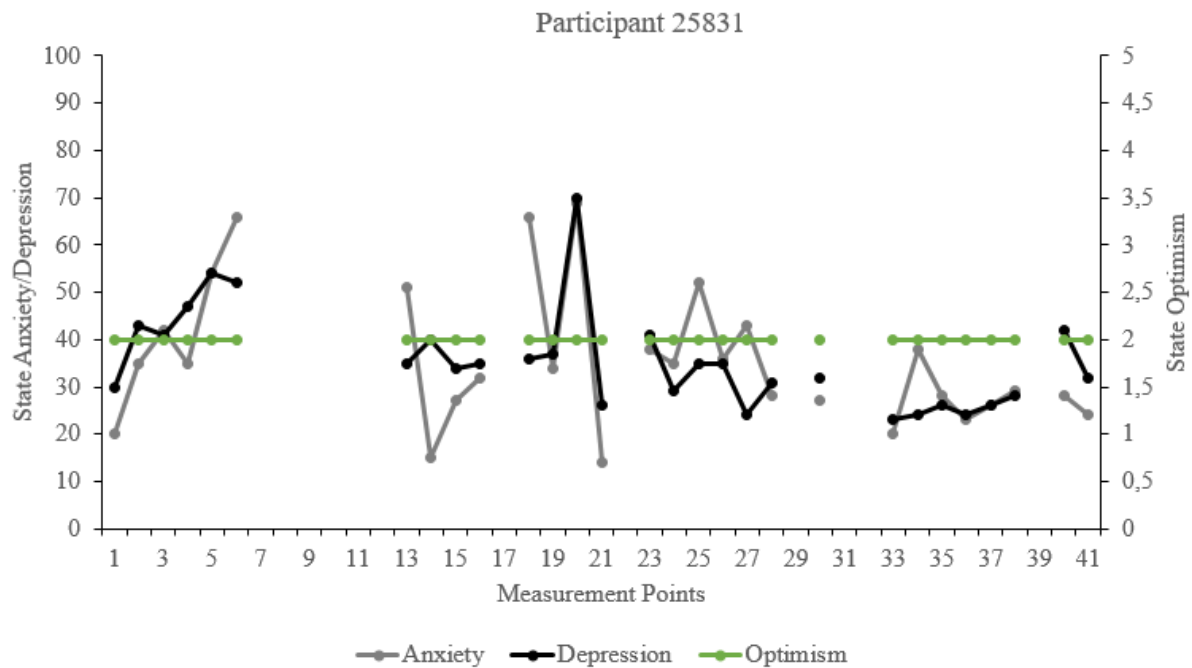
Research Question 1: How Do Momentary Symptoms of Anxiety and Depression Vary Between and Within Young Adults Over Two Weeks?

The first research question concerned the variability of momentary anxiety and depressive symptoms in young adults. In the following, the variability in those state measures is explained by first discussing the variability on the between-person level and second dealing with it on the within-person level. Figure 6 illustrates how the EM means in state anxiety, and state depression varied between participants and clearly shows differences between persons. The EM means of state anxiety and state depression remained predominantly in the lower half (0 to 50) of the scale (0 to 100) except for the average anxiety level of participant 25818, which was higher (M_{anx} = 80.51). Thus, EM means of momentary symptoms of anxiety and depression were mainly low to moderate, differed from participant to participant, and showed a similar trend.
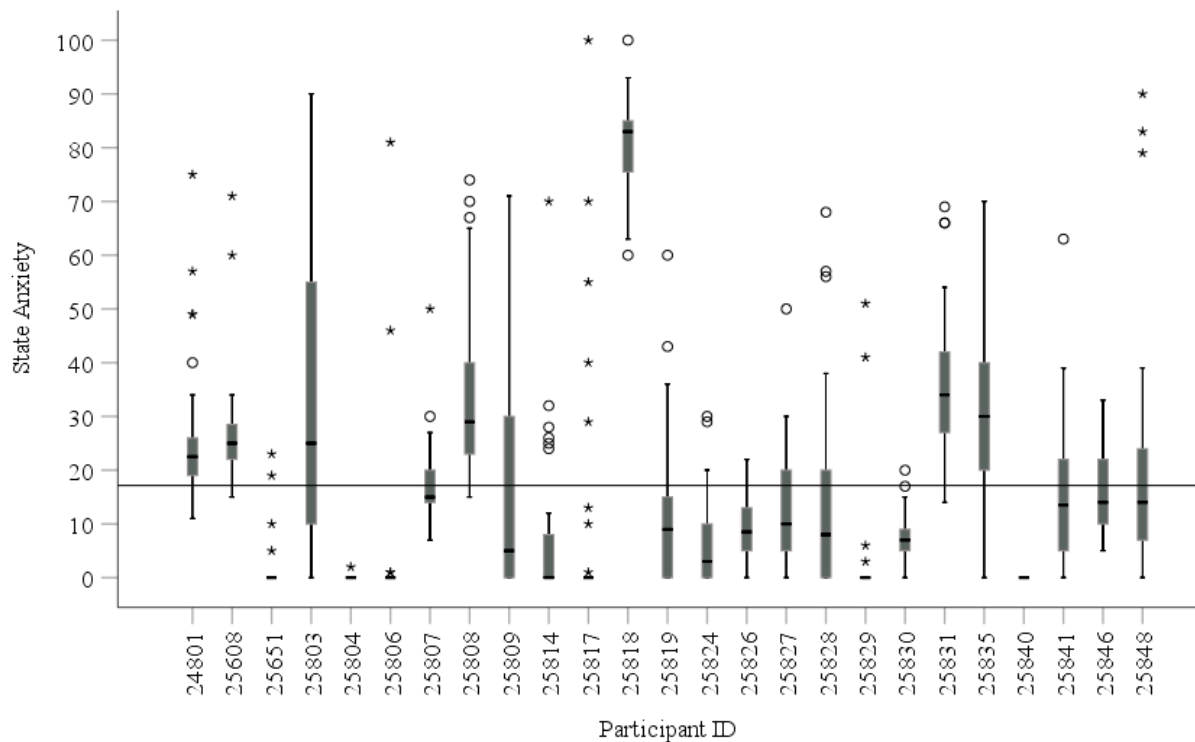
Figure 6

EM Means of State Anxiety and State Depression per Participant (N = 25)
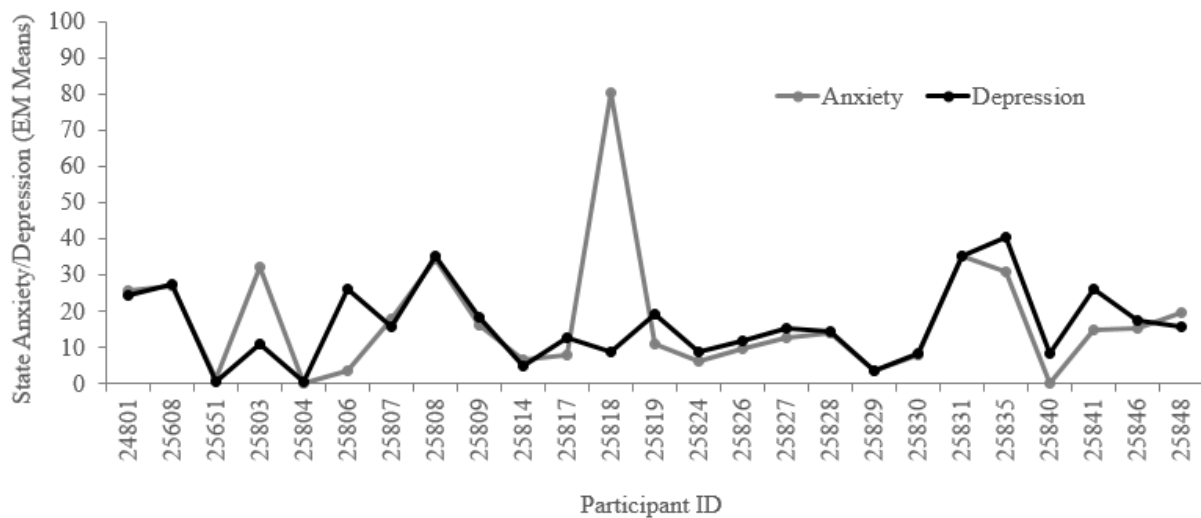
On the within-person level, the data also indicated variability. Figure 7 represents every participant's minimum, first quartile, median, third quartile, maximum, mild outliers and extreme outliers of their experienced anxiety symptoms over the study period. The depiction shows that some participants experienced more variability within their anxiety levels (larger boxplots), and other participants experienced less variation (smaller boxplots). Participant 25803 had the most extensive variability ranging from 0 to 90, whereas participants 25804 and 25840 had the most stable and lowest scores ranging from 0 to 2. In total, six participants had no outliers in their data. Although the group mean (M_{anx} = 17.16) was low, many respondents experienced higher or lower levels of momentary anxiety symptoms than the group mean.

Figure 7

Boxplot Illustrating State Anxiety Scores in Every Participant (N = 25) Over the Study Period
*With a Reference Line at the Group Mean (M_{anx} = 17.16)*

Note. The stars (*) indicate extreme outliers and circles (°) represent mild outliers.

The participants' state depression scores also varied within participants (Figure 8).
Respondents 25806 and 25835 presented themselves with the most enormous variation
ranging from 0 to 100. Thus, their scores of momentary depressive symptoms varied between
low, moderate and high scores. In contrast, participants 25651 and 25804 experienced the
tiniest fluctuations in momentary depressive symptoms ranging from 0 to 10. In total, again,
six participants had no outliers in their data. Despite the group mean (M_{dep} = 16.53) was low,
many respondents experienced higher or lower levels throughout the study period.
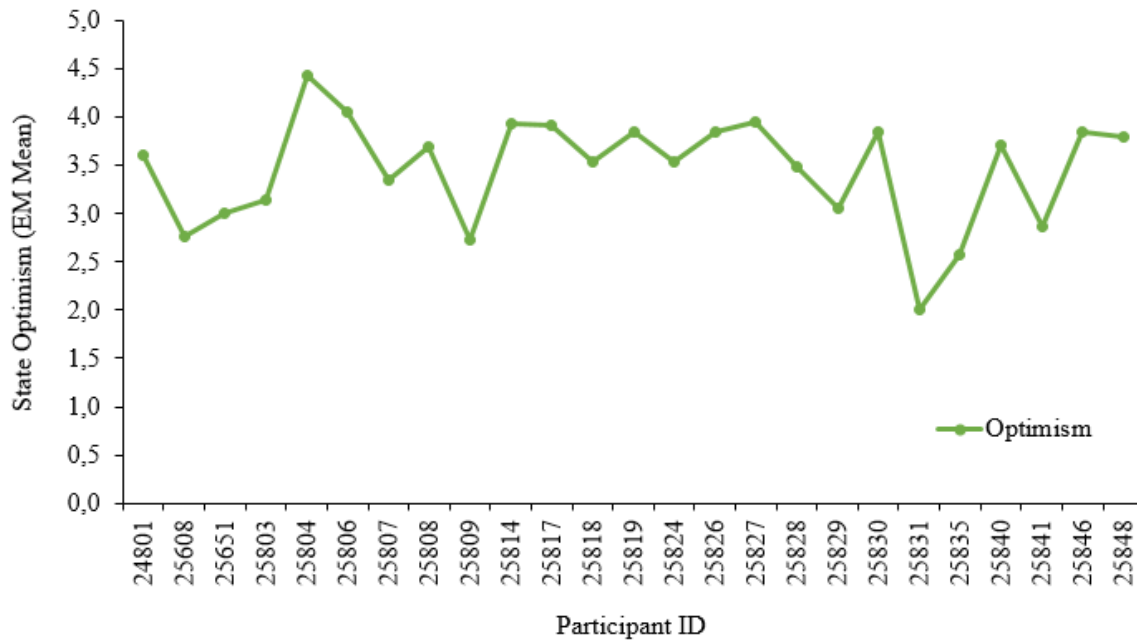
Figure 8

Boxplot Illustrating State Depression Scores in Every Participant (N = 25) Over the Study Period With a Reference Line at the Group Mean (M_{dep} = 16.53)
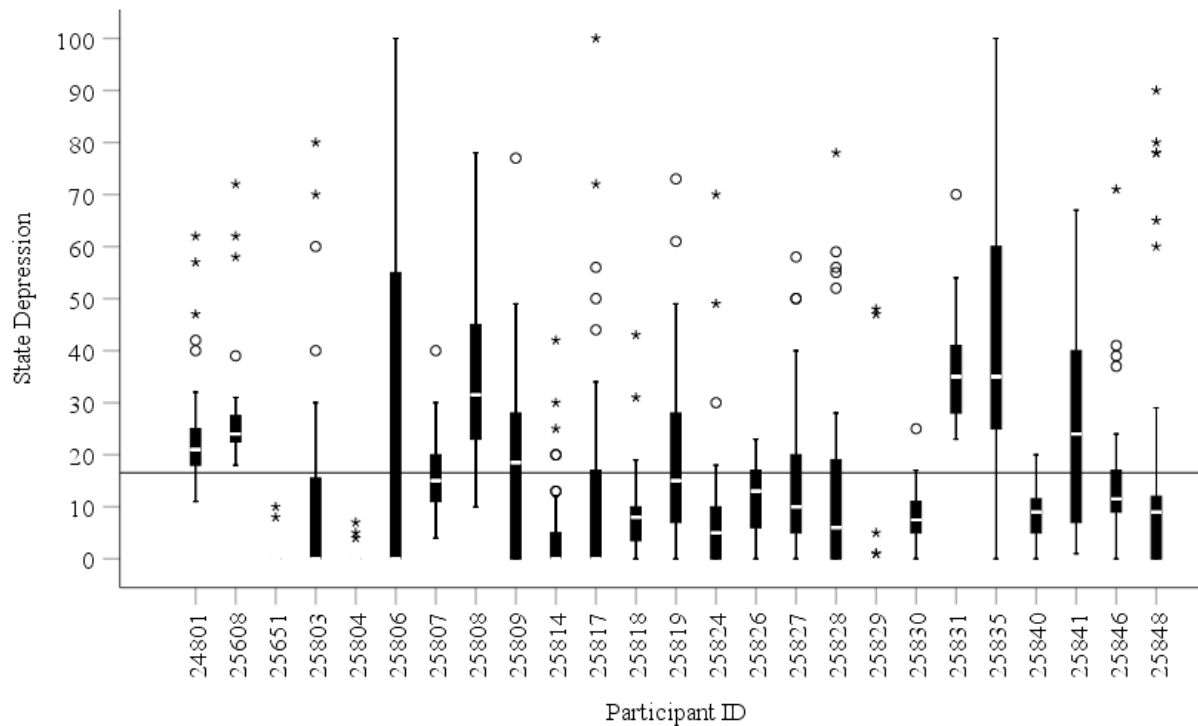
Note. The stars (*) indicate extreme outliers and circles (°) represent mild outliers.

Research Question 2: How Does State Optimism Vary Between and Within Young Adults Over Two Weeks?

The respondents' EM means of state optimism also differed from person to person. Figure 9 illustrates this variation on the between-person level. EM means of state optimism were principally in the upper half (2,5 to 5) of the scale (0 to 5) except the level of participant 25831, who scored in the bottom half of the scale.

Figure 9

EM Means of State Optimism per Participant (N = 25)

On the within-person level, every participant had their own variation in the state levels of optimism (Figure 10). Some respondents again showed more or less variability in their daily optimism scores. Participants 25817 and 25829 showed the largest variation ranging from 0 to 5, whereas respondents 25608, 25651, 25814, 25826, 25830, 25831, 25846, and 25848 showed the least variability.

Figure 10

Boxplot Illustrating State Optimism Scores in Every Participant (N = 25) Over the Study Period With a Reference Line at the Group Mean (M_{opt} = 3.48)
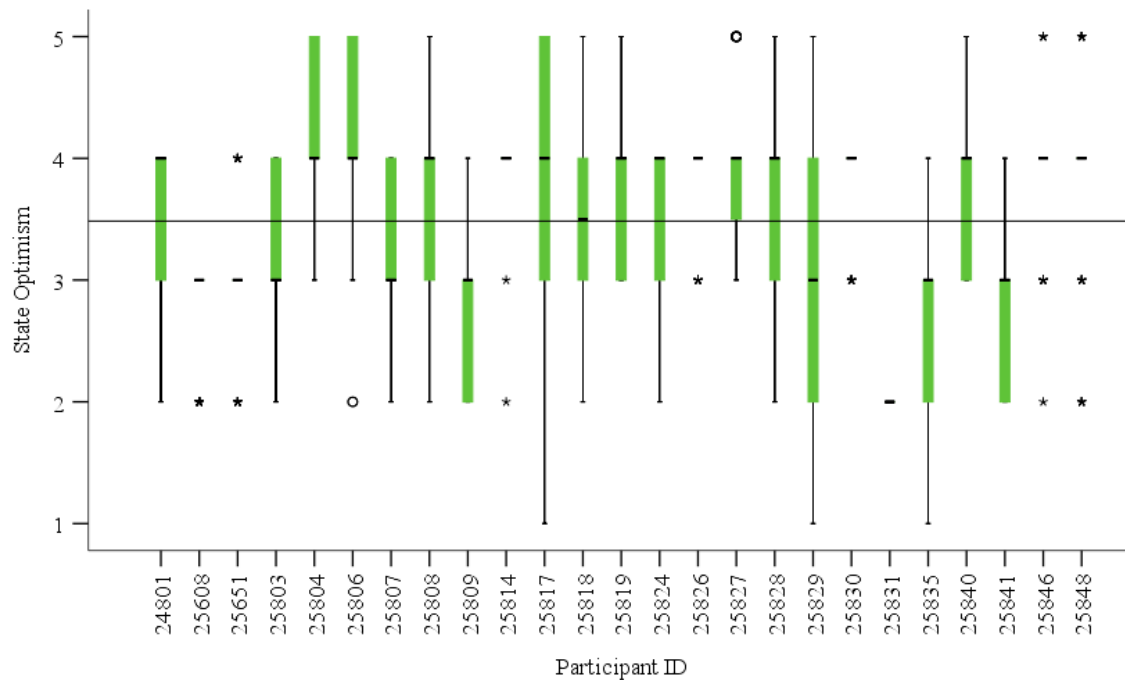

Note. The stars (*) indicate extreme outliers and circles (°) represent mild outliers.

Research Question 3: How Are Momentary Symptoms of Anxiety and State Optimism Associated Between and Within Young Adults Over Two Weeks?

Figure 11 represents the participants' EM means in a standardised way, which allows for comparison across the state anxiety and state optimism scales to answer the third research question. The EM means of state anxiety and state optimism seemed to be negatively associated on the between-person level because many participants had higher or lower average optimism levels when simultaneously having lower or higher average momentary symptoms of anxiety, respectively. However, this association was not visible in all participants. Therefore, there might also be a positive association between average momentary anxiety and state optimism in some respondents (e.g., participant 24801), who experienced simultaneously low, moderate or high levels of anxiety and optimism on average.

Figure 11

Standardised EM Mean Scores of State Anxiety and State Optimism per Participant (N = 25)
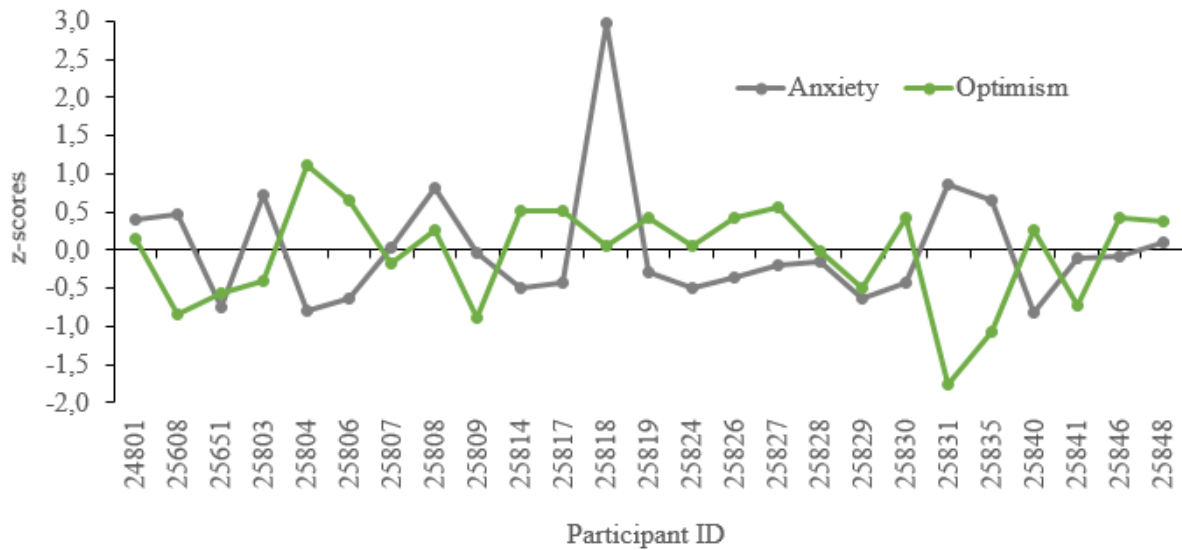
Participant 25818 experienced the highest anxiety levels (M_{anx} = 80.51) throughout the study period and was thus chosen for a visual example of the within-person association between state anxiety and state optimism. Figure 12 depicts that the participant scored below the average level of optimism on 16 assessment occasions and that they scored above the average on the other 16 measurement occasions. In total, the participant responded to 32 out of 42 assessments. Thus, the interrupted lines in the graph represent the participant's missed replies to measurements. The respondent experienced extremely high levels of anxiety symptoms (absolute score range of the scale from 0 to 100: 63 to 100) and low to high levels of optimism (absolute score range of the scale from 0 to 5: 2 to 5). In this participant, the associations between anxiety and optimism were not consistent but somewhat mixed, predominantly indicating a negative one.

Figure 12

Individual Standardised Scores of State Anxiety and State Optimism of One Participant per Measurement Point (N = 42)
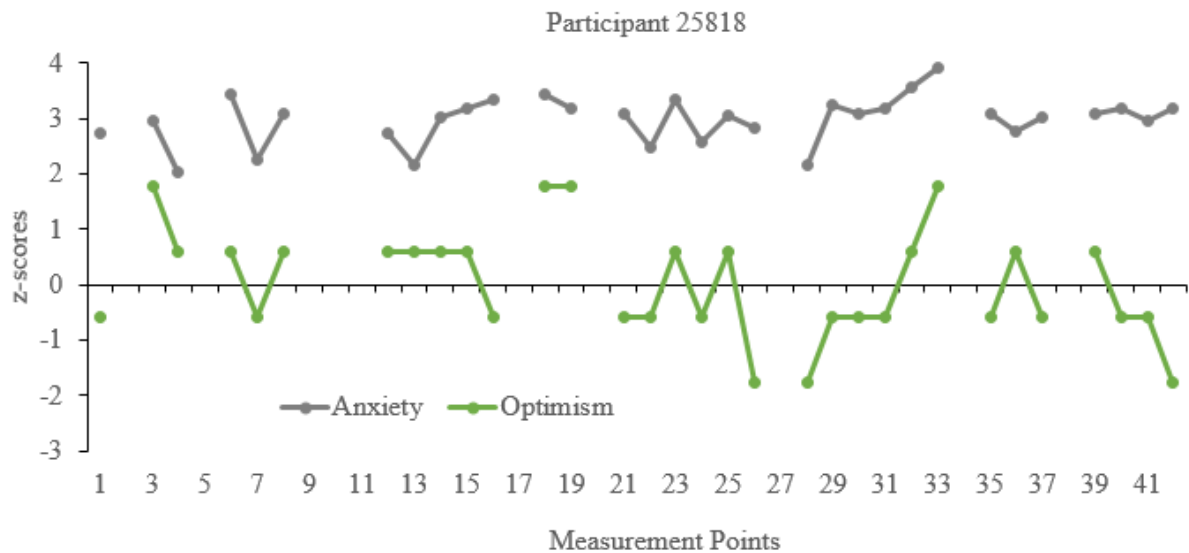
In order to test the association more in-depth, LMM analyses with the standardised variable of state anxiety and the standardised PM and PMC variables of state optimism were conducted (Table 2). They indicated that state anxiety and state optimism were negatively associated on both the between- and within-person level and that the effect was slightly more substantial on the between-person level.

Table 2

Between- and Within-Person Associations Between State Anxiety and State Optimism

Dependent Variable	Fixed Covariate	β (SE)	95% CI [LB, UB]	*t (df)*	*p*
standardised state anxiety	standardised state optimism PM	-.41 (.11)	[-.64, -.19]	-3.63 (84.34)	< .001
	standardised state optimism PMC	-.29 (.03)	[-.35, -.24]	-11.42 (754.57)	< .001

Note. SE represents the standard error, CI indicates the confidence interval, and LB and UB indicate lower bound and upper bound. PM and PMC represent the person-mean variables (between-person) and the person-mean centred (within-person) variables, respectively.

Research Question 4: How Are Momentary Symptoms of Depression and State Optimism Associated Between and Within Young Adults Over Two Weeks?

To answer the last research question, standardised EM mean scores of state depression and state optimism per participant were illustrated in a further line graph (Figure 13). In some participants, a negative association between depression and optimism could be assumed (e.g., participant 25831), whereas in others, no or a positive association could be apparent (e.g., participant 25803).

Figure 13

Standardised EM Mean Scores of State Depression and State Optimism per Participant (N = 25)
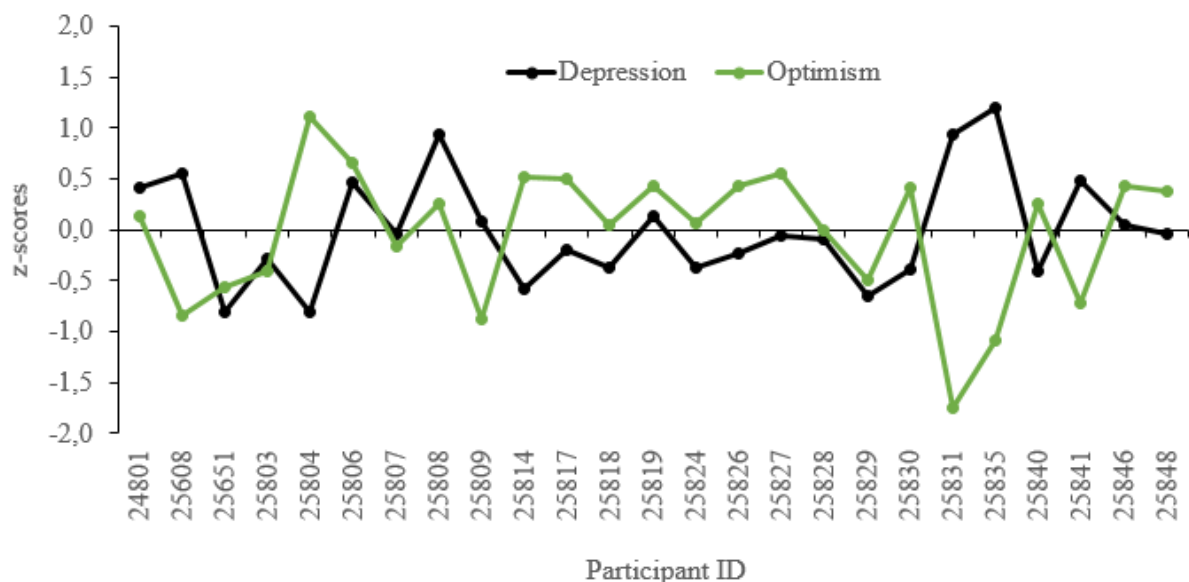
On a within-person level, again, participant 25818 was chosen because of their low average state depression score (M_{dep} = 9.03). Figure 14 illustrates state depression and state optimism levels in a standardised way. Between those two variables in this participant, no clear pattern in terms of a potential direction of an association became apparent. Thus, this participant's data provided a mixed picture and fluctuations in both variables from measurement point to measurement point.

Figure 14

Individual Standardised Scores of State Depression and State Optimism of One Participant per Measurement Point (N = 42)
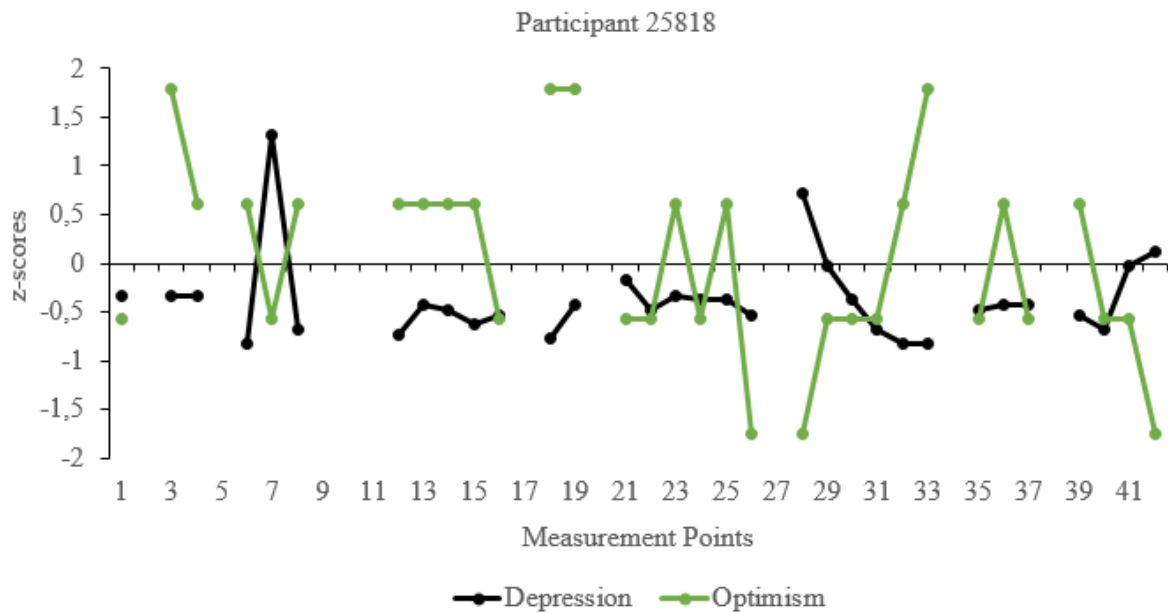
In order to analyse the associations more clearly, LMM analyses with the standardised variable of state depression and the PM and PMC variables of state optimism were conducted (Table 3). The association between state depression and state optimism was negative and both a between- and within-person effect.

Table 3

Between- and Within-person Associations Between State Depression and State Optimism

Dependent Variable	Fixed Covariate	β (SE)	95% CI [LB, UB]	*t (df)*	*p*
standardised state depression	standardised state optimism PM	-.37 (.07)	[-.50, -.24]	-5.60 (202.36)	< .001
	standardised state optimism PMC	-.49 (.03)	[-.56, -.43]	-14.41 (850.41)	< .001

Note. SE represents the standard error, CI indicates the confidence interval, and LB and UB indicate lower bound and upper bound. PM and PMC represent the person-mean variables (between-person) and the person-mean centred (within-person) variables, respectively.

Discussion

This study aimed to investigate the dynamics of the state measures of anxiety, depression and optimism within and between young adults over two weeks. First, we examined how momentary symptoms of anxiety and depression varied between and within young adults. The results demonstrated minor to major fluctuations over the study period regarding the state measures. The participants' average of their experienced symptoms of anxiety and depression varied from person to person. No respondent had the same average of anxious and depressed feelings at the same time as another person of the sample, which mirrors differences between individuals, albeit being minor sometimes. Even if participants had similar means in state anxiety and state depression, which could have created the impression that those respondents did not experience higher levels of anxiety and depressive symptoms, their individual scores provided different pictures. Their scores of the state measures either remained relatively stable over the study period or their momentary anxious and depressed feelings fluctuated from smaller to larger extents and thus had their individual pattern of variation. These findings illustrate that every human is unique in experiencing their feelings. Moreover, they stress that an average score does not represent this uniqueness and support previous literature on the importance of separating between- and within-person analyses (Curran & Bauer, 2011; Hoffman & Stawski, 2009).

Second, we investigated how state optimism varied between and within young adults. A similar picture could be detected: state optimism varied both between and within young adults, even though not always to a great extent. Also, participants with similar or the same average state optimism score did not necessarily show the same individual optimistic states distributed over different time points. Although some participants had completely stable and equal levels of state optimism over the study period, more participants showed some variation here supporting Carver et al.'s (2010) supposition that optimism may fluctuate. The individual expressions of state optimism levels again stress the uniqueness of every individual. Furthermore, this finding is also consistent with Kluemper et al.'s research (2009), who assumed that levels of state optimism might vary between different contexts. Since the participants took part in this study from their natural environment, they could have changed their optimistic attitude from context to context.

Third, we examined the relationship between momentary anxiety symptoms and state optimism on both the between- and within-person level. State anxiety and state optimism were negatively associated with each other between and within persons. There was a slight

difference in the effects. The finding indicated that individuals with higher (or lower) state optimism scores on average than others have moderately lower (or higher) state anxiety scores at different time points than others. When an individual had a higher (or lower) state optimism score than their own average, this was only weakly associated with a lower (or higher) state anxiety score at that time point. Fourth, the association between state depression and state optimism was tested. Here, the variables were also negatively related, but no difference between the effects was apparent. Individuals with higher (or lower) state optimism scores on average than others have moderately lower (or higher) state depression scores at different time points than others. When a person had a higher (or lower) state optimism score than their own average, this was moderately associated with a lower (or higher) state depression score at that same time point.

These findings only partly accord with our expectations and prior research. The negative between-person associations were in line with our expectations and prior studies. For instance, Barnerjee (2012) found that optimism was related to lower levels of depression and Schweizer et al. (1999) discovered the same association for optimism and anxiety. However, it was expected that the between-person effects would have been strong instead of being only moderate. Regarding the between-person effects, we assumed positive effects because Carver et al. (2010) postulated that optimism might function as a buffer in the view of adversity. That is, an optimistic person at one point in time was expected to experience high levels of momentary anxiety and depressive symptoms at that same time point. Further, it was supposed that the optimistic person could use their high-level optimism to buffer against those negative emotions.

However, the second part of this hypothesis was beyond the scope of this study. It only included the first part of testing the data for a positive association, which could not be detected. Instead, negative within-person effects were found, which were weak (anxiety-optimism) and moderate (depression-optimism). One explanation for this could be that optimistic people are more likely to engage in active coping strategies in order to deal with challenging situations or feelings (Nes & Segerstrom, 2006; Skinner et al., 2003) and thus could have prevented and protected themselves from strong experiences of anxiety and depressive symptoms. Conversely, people with higher anxiety and/or depressive symptoms are characterised by low mood and restricted behavioural and cognitive flexibility (Park & Kim, 2020; Uher et al., 2013), making it more difficult to assume an optimistic attitude for those people.

Theoretical Reflection and Implications of the Main Findings

Prior research revealed that states such as feelings, emotions and behaviours might change weekly, daily, or hourly depending on the context and environment the people concerned are in (Kluemper et al., 2009; de Vries et al., 2020). Although the present study did not replicate this finding in that it could not find a statistically significant effect of time on the group level regarding momentary symptoms of anxiety and depression and state optimism, there were indeed fluctuations detectable. These findings support the two-continua model of mental health, stating that mental illness and mental health are situated on two different continua instead of being opposing constructs on one single continuum (Westerhof & Keyes, 2009). The current study explains that individuals can experience heightened anxiety and/or depressive symptoms and simultaneously increased levels of optimism and also vice versa. Moreover, state-like experiences in anxiety, depression and optimism may change between close time intervals, and thus, they can even change within the same day. Such quick changes could be detected and revealed in this study. Thus, the state constructs of anxiety, depression, and optimism are not mutually exclusive but can co-exist and are indeed malleable.

Generally, the associations between state anxiety and optimism and between state depression and optimism did not appear to be distinctly a trait-like or state-like effect. Most associations were moderate except for the within-person effect between state anxiety and state optimism, which was only weak. The weak to moderate associations could be explained by the individuality of feelings and states and the possibility of negative and positive emotions and attitudes co-occurring (Gadosey et al., 2021). Given that the sample's state measures turned out to be fluctuating between and within individuals, it is understandable that no strong associations were found. Moreover, the study design, which was as unobtrusive as possible and only intervened in the participants' environment to a minimal extent, probably contributed to the heterogeneity of emotions and attitudes because respondents could fill in the assessments in different situations and contexts via their mobile device. Hence, participants' context differences could have furthered state variability when they answered the daily assessments.

These findings could militate against the co-existence of high (low) state anxiety, depression, and optimism levels. The negative associations indicate, for example, an increase in state anxiety while state optimism decreases, which makes a co-existence of high (low) levels in both variables complicated. However, the strengths of the associations were only weak to moderate, indicating that there were exceptions. These exceptions were visible in

some participants who had simultaneously high (low) state of anxiety, depression and optimism levels. Moreover, the results reinforce the dual-continua model of mental health. Anxiety and depression are on the same continuum (Keyes et al., 2020) and, thus, are more likely to be positively and strongly correlated (e.g., Kessler et al., 2005). Optimism is situated on the other continuum, which partly explains its negative association with anxiety and depression. Additionally, the study's findings regarding the participants' fluctuations in state measures represent a further explanation for the strengths of the associations because the less consistent the variables are out of all proportion to one another, the weaker the associations become. This is why it is crucial to keep the individual distinctness of states in mind when analysing moods, feelings and attitudes.

The detected negative and weak to moderate associations contribute to existing research in that they show that between- and within-person effects were not that different as previously expected. Moreover, the discovered changes in optimism levels are promising regarding the notion that it is possible to change and train optimism (Kluemper et al., 2009; Malouff & Schutte, 2016). Considering individual differences from longitudinal measurement techniques is essential to tailor interventions aiming to increase optimism levels optimally. This could also be relevant for clinical practice since it is vital to view every human being as a unique person with individual character traits, behaviours, moods, and feelings.

Limitations and Strengths of the Study

Three limitations are most relevant to the results reported herein. First, the lockdown regulations due to the COVID-19 pandemic during which the data collection took place could have contorted the data by influencing the participants' behaviours, moods, and feelings. Although it was expected that the participants were more stressed than usual (Redden, 2020), the opposite seemed to be the case when looking at the low average momentary symptoms of anxiety and depression and moderate average levels of state optimism. This finding accords with de Quervain et al. (2020), who found that some people experienced fewer stressors during the restriction period, most probably because of a reduction of stress-inducing factors. Since this study's sample predominantly contained students, they could likely have experienced less distress than usual because most universities switched to online education that reduced their time investment.

Second, the participants were recruited by means of convenience sampling. Therefore, the participants belonged to the researchers' social environment, which could have led to

social desirability biases (Schwarz, 2012). Lastly, the one-item measure of state optimism constituted a weakness because it was strictly speaking no momentary measure and did not represent all dimensions of optimism. The participants were only asked to report their optimistic outlook on the future for the last two hours. Although this is not a long period, it indeed is a retrospective measure. Thus, this measure could have been distorted by recall biases. However, because optimism was assessed three times a day in every participant and referred to a recent time frame, it is still likely that this measure had good convergence to reports in the current moment (Schwarz, 2012).

Despite its limitations, the study certainly had several strengths. First, the usage of the ESM is a strength in itself. The longitudinal nature of this method enabled the researchers to investigate momentary states in the participants' natural environment, which contributed to its ecological validity (Trull & Ebner-Priemer, 2009). Therefore, the method's unobtrusiveness due to the possibility to implement it via a mobile application into the respondents' daily lives was an advantage over former longitudinal methods. The large amount of momentary data constitutes another strength of this method because they represented the participants' states thoroughly, and their momentary nature prevented recall biases (Trull & Ebner-Priemer, 2009). Furthermore, the extensive data enabled the researchers to investigate within-person effects. Although the study did not reveal substantially differing between- and within-person effects, utilising person-mean centring bypassed the ecological fallacy. That is, to make inferences from between-person effects on within-person effects and thus to assume that results on the group-level also hold for the individual-level (Curran & Bauer, 2011).

Lastly, the relevance of the study is another strength. Young adults, especially students, provably experience many stressors in their lives and are thus prone to experience higher levels of anxiety and depressive symptoms (Hoying et al., 2020; Kokou-Kpolou et al., 2020). According to Redden (2020) and Son et al. (2020), the COVID-19 pandemic further increased their risk. Thus, a more in-depth investigation into the nature of such symptomatology and its connection to inherent resources, such as optimism, was seen as necessary. The fact that most research on those variables was conducted cross-sectionally so far (e.g., Banerjee, 2012; Symister & Friend, 2003) supported the decision to investigate those variables within an ESM study.

Future Research Directions

Future research could investigate the variables addressed in this study with an adapted approach concerning the questionnaires but within a similar population and the same research method. Hereby, the use of more accurate state measures of optimism that reflect its multi-dimensionality similar to the Life Orientation Test-Revised (LOT-R) is recommended (Huffman et al., 2019). For example, Millstein et al. (2019) developed a multidimensional and psychometrically-sound questionnaire of state optimism consisting of seven short items, which could be suitable for an ESM study. Furthermore, the LOT-R could be implemented as a baseline questionnaire to reliably and validly determine optimists within a sample population. This would enable researchers to divide the sample into optimistic and non-optimistic people before conducting further in-depth analyses, and it would allow for comparisons between those groups. Next to those recommendations for future research, it could be fruitful to include participants' coping behaviours. Since coping strategies play an important role in emotion regulation (Nes & Segerstrom, 2006; Skinner et al., 2003), their relationship to anxiety and depressive symptoms and optimism could shed light on people's resource capacities. Building on those recommendations, tailored interventions could be created based on study results.

Due to the increasing number of young adults suffering from either depressive or anxiety symptoms or both (Kujawa et al., 2020), there is an urgent need for tailored interventions and preventive strategies. When getting more insight into the state measures and their relationships, such interventions will probably be more feasible to construct to tackle students' mental well-being. One example could be an ecological momentary intervention (EMI), which could build on previous ESM studies. EMIs are interventions presented within a mobile application that can be accessed by participants whenever and wherever desired. Due to their real-life implementation, EMIs proved to effectively impart skills and knowledge (Heron & Smyth, 2011). Hence, they represent a possibility to improve young adults' optimism and related coping skills by implementing positive psychological interventions. In their meta-analysis, Malouff and Schutte (2016) found that psychological interventions can increase optimism and called for further testing of these interventions utilising innovative methods.

Conclusion

The study's results revealed a mixed picture in that the findings were partly unexpected. On the one hand, the present study supported existing research regarding the negative between-person association between symptoms of anxiety/depression and optimism. On the other hand, it contributed to current research in that the researchers also found negative within-person associations between symptoms of anxiety/depression and optimism. However, those associations should be interpreted with caution because they were weak to moderate, and do not say anything about causation. Thus, we do not know whether, for example, increased anxiety and depressive symptoms decrease a person's level of optimism or vice versa. Due to the weak to moderate associations, the individual data also showed that momentary symptoms of anxiety/depression and state optimism were not mutually exclusive but rather co-existed in many participants and were not always expressed in opposite directions. This finding stresses the importance of considering the individuality of every person. Furthermore, it encourages further research on this topic in the form of longitudinal studies to find individual factors and behaviours that enable young adults to develop and maintain high levels of optimism and individual qualities, which make them responsive to optimism interventions to generate greater well-being.

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Appendices

Appendix A: Invitation email generated by Ethica

Hi *participant's name*,

Name of the person who sent the invitation from University of Twente has invited you to join "*study name*" research study. Please click on the link below to open the Ethica app and join the study:

https://ethicadata.com/study/*studynumber/*

If you don't have the Ethica app installed, the above link will ask you to download it first. If you have any problem with the link, you can also download the Ethica app from Google Play or App Store, and after you log in, join the study using registration code 1144. Also, don't forget that your username is *participant's email*.

Thanks for helping advance the science,

The Ethica Data team

Appendix B: Informed consent form

Dear participant,

Thank you for your participation in this study. Before you participate, it is important that you understand the goal of this research and what the study will ask from you. The purpose of this study is to find out how different components of mental health are related to each other. To explore this relationship, we want to measure fluctuations in mental health in daily life to gather a more detailed picture of the dynamics of mental health.

For this study, we will ask you to fill in several questionnaires on your mobile phone. All questionnaires will be completed in the Ethica app. The study will start with a questionnaire concerning your demographics and general mental health. This initial questionnaire will take about 10 minutes to complete. After that, you will receive three daily (short) questionnaires each day for a period of two weeks. Notifications will remind you about the next questionnaire. The questionnaires will be provided in the morning, afternoon and evening. One daily questionnaire takes approximately 2 minutes to complete.

For the purpose of this study, it is important that you answer the questionnaires as soon as possible after the notification. Make sure that you have switched on your notifications for the Ethica app on your mobile device, as you will receive a notification on your mobile device when to fill in the questions. We would also like to ask you to regularly check the Ethica application to see whether new questionnaires to answer are ready.

The information that we collect from this research project will be kept confidential. This means that only the researchers have insight into your answers. All personal data (such as age, gender etc.) will be anonymized and will not be published and/or given to a third party. Also, for the researchers it will not be possible to determine which data belongs to which participant. Your participation in this study is voluntary. You are free to withdraw from this study at any time and without giving a reason.

Contact information

If you have any questions regarding this study, you can contact the principal investigators of this project Sina Völker (s.volker@student.utwente.nl) and Jonas Möller (j.moller@student.utwente.nl).

Consent

I have read and understood the information provided and had the opportunity to ask questions. I understand that my participation is voluntary and that I am able to withdraw at any time, without a reason or cost. I hereby voluntarily agree to take part in this study.