Sitting with your thoughts:
Investigating rumination as a moderator between sedentary behaviour and mood using experience sampling

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Abstract

Purpose: Sedentary behaviour has been shown to negatively affect mental health and mood specifically. Students are particularly prone for both high levels of sitting and emotional problems. Risk factors for mood disorders like depression in students are rumination and one of its facets, brooding. One of the ways in which rumination affects mood is by leading negative mood states to be more pronounced. Rumination and its facet brooding were thus proposed to moderate or strengthen the negative effect sitting has on mood states.

Method: An experience sampling method (ESM) design was used to capture trait and state rumination, brooding, mood and sedentary time in the real-life context of a student population. In a total of nine days, a baseline questionnaire as well as repeated measurements twice a day were taken by students (N = 34, M_{age} = 22.38, SD_{age} = 2.20, 76.47% females, 23.53% males, 97.06% university students, 2.94% higher education students, 88.24% German, 8.82% Dutch, 2.94% other) using a mobile application called Ethica. Linear mixed models were used for analysing the nested data.

Results: Rumination and brooding did not moderate the relationship between sitting time and mood. Instead, both had significant main effects on mood (B = -0.07, t = -2.69, p = .01; B = -0.08, t = -3.33, p < .01) and have been found to exert their effects on both the between-subjects (B = -0.05, t = -3.16, p < .01; B = -0.04, t = -3.04, p < .01) and within-subjects level (B = -0.09, t = -6.62, p < .01; B = -0.08, t = -6.57, p < .01). Trait and state rumination (B = 1.96, t = 5.00, p < .01), as well as state rumination and brooding (B = 0.83, t = 20.81, p < .01) were significantly associated.

Conclusion: Rumination and brooding predict the experience of negative mood and do so more on the within-subjects level. Studying predictors of positive affect as moderators between sitting time and mood is recommended to identify factors that enable the experience of positive mood in students in the face of high sitting time.

Keywords: sedentary behaviour, mood, rumination, experience sampling

Introduction

The negative impact sedentary behaviour has on physical health is well-established. Possible adverse outcomes include greater risk for diabetes, cancer, cardiovascular disease and premature mortality, among others (Biwas et al., 2015; Patterson et al., 2018; Wilmot et al., 2012). The relationship between sedentary behaviour and mental health has been less clear. As a consequence, this link recently became an area of interest (Hamer & Smith, 2018).

Sedentary behaviour can be defined as "… any waking behaviour characterised by an energy expenditure of ≤ 1.5 metabolic equivalents (METs) while in a sitting, reclining or lying posture" (Tremblay et al., 2017). In general, one metabolic equivalent can be equated with the resting metabolic rate of a population, given that no chronic disease or mobility impairment is present (Tremblay et al., 2017). Sedentary behaviour is not to be equated with physical inactivity as research repeatedly demonstrated those two to be distinct and largely independent concepts (Jochem, Schmid, & Leitzmann, 2018; Tremblay et al., 2017). The adverse outcomes associated with sedentary behaviour are independent from those attributable to a lack of physical activity (Biddle et al., 2019; Biwas et al., 2015; Patterson et al., 2018). However, these outcomes tend to be less pronounced with higher levels of physical activity (Biddle et al., 2019; Biwas et al., 2015). All in all, it is possible to engage in both a sufficient amount of physical activity and too much sitting (Owen, Healy, Matthews, & Dunstan, 2010). The health risks associated with sedentary behaviour would still be present in this case (Biddle et al., 2019; Biwas et al., 2015; Patterson et al., 2018). Hence, sedentary behaviour has to be investigated and targeted irrespective of physical activity.

Current state of research: Sedentary behaviour and mood outcomes

The increasing attention on sedentary behaviour and its influence on mental health comes along with an increasing number of studies associating sitting with mental disorders like depression, anxiety and poor well-being in general (Borojevic, 2016; Hallgren et al., 2020; Edwards & Loprinzi, 2016). A link between increased sitting and negative mood has also been established (Edwards & Loprinzi, 2016; Endrighi, Steptoe, & Hamer, 2016; Giurgiu et al., 2019). Experimentally inducing sedentary behaviour resulted in negative mood, even after controlling for changes in physical activity levels (Endrighi et al., 2016). In a randomised controlled study, the pronounced effect of sedentary behaviour on mood manifested itself in as little as one week. Mood levels went back to baseline one week after the intervention has ended (Edwards & Loprinzi, 2016). The immediate nature of this effect underlines the importance and strength of this relationship.

Borojevic (2016) suggested a threshold of 5.6 or more hours of sitting time at which mental well-being tends to decrease and psychological distress to increase. In general, people spend between 4.9 and 11.9 hours a day sitting, with a median of 8.2 hours (Bauman, Petersen, Blond, Rangul, & Hardy, 2018). These rates have since increased due to the emergence of the novel corona virus (Stockwell et al., 2021). Restrictions, lockdown regulations and the loss of resources, be it social or financial, have been contributing factors (Diamond & Byrd, 2020). The emergence of Covid-19 has not only affected sedentary behaviour levels, it also resulted in negative mood states, putting more people at risk for developing mood-related disorders like depression (Terry, Parsons-Smith, & Terry, 2020). This study is thus embedded in the broader context of a global pandemic where major increases in sedentary behaviour and negative mood facilitate the emergence of a variety of mental disorders, including mood disorders.

Rumination: a precursor, indicator, and mediator of mood problems

Central to mood disorders is often a thinking pattern called rumination (Nolen-Hoeksema, Wisco, & Lyubomirsky, 2008; Watkins & Roberts, 2020). Rumination can be defined as repetitive, persistent and negative thoughts about one's self, emotions, and problems (Watkins & Roberts, 2020). Watkins and Roberts (2020) suggested its effect on mental health is threefold. First, it leads negative moods to endure and to be more pronounced. Secondly, it serves as a mental health vulnerability factor over and beyond any specific diagnostic labels, as it is involved in, for instance, depression, insomnia, psychosis and impulsive actions. Lastly, it hinders therapy and psychological interventions in their efficacy (Watkins & Roberts, 2020).

Rumination has been found to have the strongest and most consistent relationship with depression, a mood disorder (Nolen-Hoeksema et al., 2008; Papageorgiou & Siegle, 2003; Smith & Alloy, 2009; Thomsen, 2006). In relation to depression specifically, it is often characterised by repetitive thoughts about the causes and consequences of one's symptoms and referred to as depressive rumination (Nolen-Hoeksema et al., 2008). Rumination acts as a precursor and maintenance factor in depression and is thus crucial for understanding depressive symptoms (Nolen-Hoeksema et al., 2008; Smith & Alloy, 2009). The influence on depressive symptoms is both of independent nature as well as in interaction with other variables like emotional inertia (Koval, Kuppens, Allen, & Sheeber, 2012). Rumination partially or fully mediates the relationship between depression and a variety of related concepts such as neuroticism, negative inferential styles, and self-criticism (Nolen-Hoeksema et al., 2008). In general, rumination is a relevant concept that acts as a precursor, indicator, and mediator of mood disturbances and is thus specifically attended to in the course of this study.

The two facets of rumination

Rumination's primary characteristic lies in its preservative nature rather than the specific content of the thoughts (Nolen-Hoeksema et al., 2008). Shifting the focus to what one ruminates about led to some debate on whether both adaptive and maladaptive forms of rumination exist (Treynor, Gonzalez, & Nolen-Hoeksema, 2003). The distinction has been made between two facets of rumination: brooding and pondering, of which the former is considered maladaptive and the latter more adaptive (Treynor et al., 2003). Brooding is described as a negative form of self-reflection in which a person engages in abstract questions on why particularly they face certain circumstances while focusing on factors that might hinder effective problem-solving (Treynor et al., 2003). Pondering, in turn, is described as a more neutral way of self-reflection, in an attempt to solve any problems at hand (Treynor et al., 2003). Brooding positively related to depression severity both in the short- and in the long run (Treynor et al., 2003). Further research supported the notion that the brooding facet particularly is more strongly involved in depression (Joormann, Dkane, & Gotlib, 2006; Schoofs, Hermans, & Raes, 2010). When comparing currently depressed, formerly depressed, socially anxious, and healthy control participants, brooding levels were highest for those currently suffering from depression, lower in those who suffered from depression in the past and in socially anxious participants, and lowest for the control group (Joormann et al., 2006). These findings suggest that although brooding is not exclusive to depression, it is highly characteristic of it (Joormann et al., 2006). People who have formerly been diagnosed with depression as well as those currently being diagnosed with social anxiety engage in more brooding than people without a history in mental disorders would (Joormann et al., 2006). From this follows that brooding seems to be heavily involved in disturbances of mood.

The research on pondering, however, has been mixed. According to Treynor et al. (2003), pondering related positively to depression in the short-term but was negatively correlated with depression when assessed longitudinally, suggesting that despite its initial detriment, it might have adaptive properties in the long-term. This differs from the findings of Joormann et al. (2006) which suggest that pondering might only be adaptive in non-clinical populations. When paired with brooding and depressive symptoms, the line between adaptive and maladaptive rumination becomes blurrier (Joormann et al., 2006; Whitmer & Gotlib, 2011).

In general, this differentiation between the two subcomponents of rumination has been supported by an increasing number of studies (Joormann et al., 2006; Schoofs et al., 2010; Whitmer & Gotlib, 2011). As a consequence, the two facets seem to not only differ in their nature but also in their effect on mood, with brooding playing a more decisive role.

Students as an at-risk population subgroup

In studying both sedentary behaviour and mood outcomes, it is important which group is under study. Certain population subgroups are more at-risk for increased sedentary behaviour and for worse mood outcomes (Borojevic, 2016; Castro, Bennie, Vergeer, Bosselut, & Biddle, 2020; Moulin, Truelove, Burke, & Irwin, 2019; Storrie, Ahern, & Tuckett, 2010).

Students engage in higher levels of sedentary behaviour compared to the general young adult population (Castro et al., 2020). Estimates of average sitting time range from 7.29 hours a day when self-reporting, to 9.82 hours a day when objective measures were used (Castro et al., 2020). Moulin et al. (2019) observed even higher numbers of around 11 hours that students spend sitting daily. Those levels could be due to activities such as studying, attending lectures or writing assignments (Castro et al., 2020). The time spent sitting can vary substantially across countries (Moulin et al., 2019). Students' average daily sitting time exceeds the threshold of 5.6 hours previously proposed by Borojevic (2016), at which psychological distress begins to increase and mental well-being to decrease.

In line with this, students were found to experience higher levels of mental health problems than the general population (Storrie et al., 2010). Their emotional health seems to be particularly problematic: when studying at university, depression, anxiety and heightened stress levels were common in students (Storrie et al., 2010). Certain cognitive functioning and response styles have been identified as risk factors for mood disorders like depression in students (Sheldon et al., 2011). Among them were rumination and brooding as significant risk factors for this group (Sheldon et al., 2011).

Based on these findings, students seem to emerge as a subgroup of the population that is particularly affected by increased levels of sedentary behaviour, mood problems and rumination, making them of special interest in the course of this study. Both sedentary behaviour and rumination negatively affect mood levels in students. According to Watkins and Roberts (2020), one of the ways rumination affects mood is in leading negative mood states to be more pronounced. As a consequence, the negative mood states associated with these high rates of sitting might be more pronounced when also introducing rumination and brooding, the facet particularly relevant in negative mood outcomes. Rumination and brooding might thus act as moderators for the relationship between sedentary behaviour and mood (see Figure 1). This study attempts to shed light on the existence and nature of this relationship.

Figure 1

Conceptual model of potential moderation effects of rumination and brooding
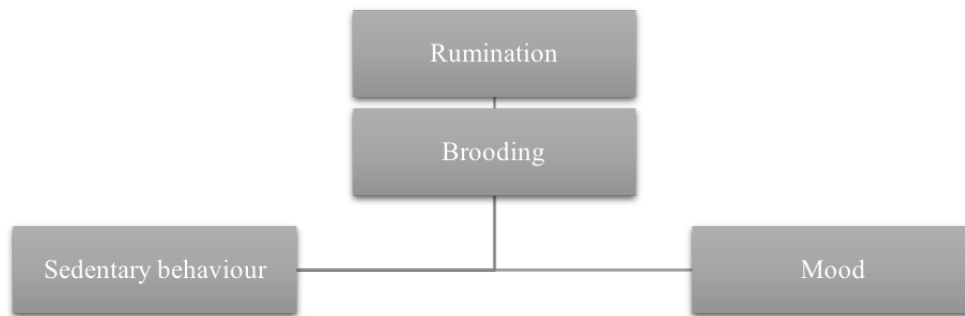
Experience sampling: capturing sedentary behaviour, mood, and rumination dynamically

Sedentary behaviour, mood, and rumination are no concepts that demonstrate complete stability. Instead, they have been studied as dynamic concepts that display fluctuation over time (Giurgiu et al., 2019; Huffziger, Ebner-Priemer, Koudela, Reinhard, & Kuehner, 2012; Moberly & Watkins, 2008). The immediate nature of the effect both sedentary behaviour and rumination have on mood further supports this point (Edwards & Loprinzi, 2016; Huffziger et al., 2012). Especially for rumination, trait and state measures seem to be distinct. Nolen-Hoeksema et al. (2008) have conceptualised rumination as a trait-like tendency whereas Moberly and Watkins (2008) observed variation in rumination that trait rumination was not able to explain. As a result, trait measures alone might not be sufficient to capture the variability occurring in everyday life (Myin-Germeys et al., 2018).

A way to measure these nuances is experience sampling. Experience sampling can be defined as a method in which peoples' behaviour, emotions and thoughts are repeatedly assessed in the context of everyday life (Larson & Csikszentmijalyi, 2014; van Berkel et al., 2017). This method comes along with a unique set of features that make it fitting to the current study. First, it is capable of grasping the intrapersonal variability that was previously observed in sedentary behaviour, mood, and rumination (Giurgiu et al., 2019; Huffziger et al., 2012; Moberly & Watkins, 2008; Myin-Germeys et al., 2018; van Berkel et al., 2017). Next, it allows the study of both state and trait measures. The relevance of experience sampling lies in offering a way to understand the relations between sedentary behaviour, mood, rumination, and brooding throughout students' daily life.

The current study

The main rationale for this study is in investigating rumination as a moderator on a relation whose importance has been repeatedly demonstrated, namely that between sedentary behaviour and mood. One of the facets of rumination, brooding, might be of particular importance in that regard. Rumination and brooding might act to make the negative mood states associated with sedentary behaviour more pronounced by strengthening the relationship between sitting and mood. The variables involved seem to be particularly relevant for students who exhibit heightened vulnerability compared to the general population (Borojevic, 2016; Castro et al., 2020; Moulin et al., 2019; Sheldon et al., 2011; Storrie et al., 2010).

Given the variability present in the concepts under study and in rumination particularly, the following first research question is proposed: *RQ1: How do rumination and brooding vary over time in students?* Based on the literature at hand, the following hypotheses are formulated: *H1: Rumination fluctuates over time* and *H2: Brooding fluctuates over time*. Since the two are conceptually related, their dependency is expected to be reflected in their fluctuations over time. This gives rise to the next hypothesis which is as follows: *H3: Brooding and rumination fluctuate in accordance with each other*.

Rumination has demonstrated and is expected to demonstrate variability over time, a variability that trait rumination was not able to explain in previous research (Moberly & Watkins, 2008). Nonetheless, trait rumination was a predictor of state rumination, suggesting that although distinct, trait rumination is an important concept in relation to state rumination (Moberly & Watkins, 2008). This relation will be the topic of the second research question, being: *RQ2: How are trait rumination and state rumination associated within students?* Given the findings of Moberly and Watkins (2008), it is plausible to assume that in this study, similar outcomes will be reported. From this follows the next hypothesis, namely: *H4: Trait rumination and state rumination are positively associated within students*.

Lastly, the proposed moderation effect of each rumination and brooding on the relation between sedentary behaviour and mood will be investigated. The third and last research question is formulated as follows: *RQ3: Do a) rumination and b) brooding moderate the relationship between sitting time and mood in students?* On the basis of the previously discussed findings, both are expected to act as moderators. This results in the following hypotheses: *H5: Rumination moderates the relationship between sitting time and mood* and *H6: Brooding moderates the relationship between sitting time and mood*. These relations will be subject of the current study.

Methods

Study Design

In this research, an experience sampling method (ESM) design, also called intensive longitudinal design was utilised. Hereby, differences between and fluctuation or variation within individuals could be studied. In a time period of nine days, sedentary behaviour, mood, rumination, and brooding were generally assessed twice a day. Overall, seven days were planned for repeated measurements, plus the first day being for the baseline questionnaire and the last day for a retrospective questionnaire, making a total of nine days. Two measurements a day seemed reasonable for measuring fluctuations during the day while minimising the burden for participating subjects. In terms of sampling strategy, a variable time-based protocol was used to approximate a representation of students' experience over the course of their day (Connor & Lehman, 2012; Larson & Csikszentmihalyi, 2014).

As part of a joint research project, data for the current study was collected together with related studies that measured different moderators. The rest of this paper will focus exclusively on the variables of interest for this current study. Data collection started on 9 April 2021 and ended on 9 May 2021. The ethical approval was granted by the Ethical Committee of the Faculty of Behavioural Sciences of the University of Twente on 6 April 2021 (Case number 210263).

Participants

Prior to participation, five inclusion criteria had to be met. These were being at least 18 years old, proficiency in English, as well as being a university or higher education student. Participants were also required to possess an Android or Apple mobile phone and be able to stand for at least 15 minutes without interruptions (see Appendix A). Recruitment took place in the form of convenience sampling in which the researchers contacted people personally. The study was also accessible via SONA systems, where students from the University of Twente could acquire one credit point for participation.

After deleting four participants with insufficient compliance, namely less than 50% (Connor & Lehman, 2012), a total of 34 participants completed the study. According to Connor and Lehman (2012), for this study design, a sample size of 30 would ensure sufficient reliability. Participant mean age was 22.38 (*SD = 2.20*), ranging between 19 and 29 years of age. All subjects were students, with 33 being associated with university (97.06%) and one with higher education (2.94%). The sample consisted of 26 females (76.47%) and 8 males (23.53%). In terms of nationality, frequencies differed with 'German' being reported 30 times (88.24%),

'Dutch' three times (8.82%) and 'other' one time (2.94%). These sample characteristics were in line with the proposed inclusion criteria.

Materials

One central instrument for conducting this ESM study was the mobile application Ethica through which the participants completed the surveys. Ethica is an application that offers the possibility to set up and perform highly individualised studies and was thus compatible with the intensive longitudinal nature of the current study. To capture the variables of interest, seven different questionnaires were entered into Ethica (for the complete list of items for the baseline and repeated measurements see Appendix B).

Baseline survey

The baseline survey was comprised of a demographic questionnaire as well as a trait measure for rumination. Demographical data was assessed with four items. First, one's age was entered as an integer. Next, occupation was specified by choosing one of three options, namely 'student (university), 'student (higher education)' and 'other'. Any participants that happened to select 'other' would be excluded from the analyses given the target group of students. For gender, four options were given to select from which were 'female', 'male', 'other' and 'prefer not to say'. Lastly, the item measuring nationality allowed for a choice between 'Dutch', 'German' and 'other'.

Trait rumination was measured with the Ruminative Response Scale Short Form (RRS-SF) which consists of 10 items on a 4-point Likert scale ranging from 'almost never' to 'almost always' (Treynor et al., 2003). Two subgroups of five items measure the two facets of rumination, namely brooding and reflection (Treynor et al., 2003). In comparison to the initial RRS, the short form is less confounded with depression, a frequent critique point expressed with regard to the original RRS (Treynor et al., 2003). For each of the subscales, acceptable internal reliability scores of .71 and .73 were found for brooding and reflection, respectively (Thanoi & Klainin-Yobas, 2015). The overall scale demonstrated good reliability with an α value of .80 (Thanoi & Klainin-Yobas, 2015). Thanoi and Klainin-Yobas (2015) also argued for sufficient construct as well as concurrent validity of the RRS-SF.

Repeated measurements

Given the repeated measurements and the length of study coming along with the experience sampling method, the state measures had to be kept as short as possible while still capturing the variables of interest adequately. For that, items were derived from validated questionnaires, combined or reformulated to fit the needs of the current study (see Table 1).

Table 1

Overview of measurement instruments in this study

Measured variable	Demographical data	Trait rumination	State mood	State rumination	State brooding	Sedentary behaviour
Item length	4	10	6	2	1	6
Creation (derived, reformulated or combined)	Created	RRS-SF	Derived from I-PANAS-SF	Derived and partly combined from BSRI	Derived from BSRI	Derived and partly combined from PAST-U

Note. RRS-SF = Rumination Response Scale Short Form. I-PANAS-SF = International Positive and Negative Affect Scale Short Form. BSRI = Brief State Rumination Inventory. PAST-U = Past Day Sedentary Time – University.

State mood was measured with a selected number of items from the International Positive and Negative Affect Scale Short Form (I-PANAS-SF) (Thompson, 2007). The scale is a short form of the regular PANAS and consists of 10 items, five of which measure positive and negative affect as experienced generally on a 5-point Likert scale ranging from 'very slightly or not at all' to 'extremely' (Thompson, 2007). The positive and negative affect scales both had adequate reliability with Cronbach's alphas of .75 and .76 when validated with a different sample (Thompson, 2007). The test-retest reliability was acceptable at 8-week follow-up with a value of .84 for both scales (Thompson, 2007). Convergent as well as cross-cultural validity was also demonstrated (Thompson, 2007).

The items used were selected on the basis of their factor loadings. In total, three items per scale were extracted because they had the highest factor loadings in the developmental sample as well as in the validation sample (Thompson, 2007). For positive affect, the items active, attentive and determined were selected. For negative affect, the items upset, afraid and nervous were selected. Lastly, the items were reformulated from general statements to asking for participants' mood in the current moment. For example, the item 'To what extent do you

generally feel determined?' was reformulated into 'Right now, to what extent do you feel determined?'.

State rumination was captured by selected items from the Brief State Rumination Inventory (BSRI) (Marchetti, Mor, Chiorri, & Koster, 2018). The original BSRI consists of 8 items that are scored on a VAS scale from 0-100 (Marchetti et al., 2018). It showed moderate and positive correlations with the brooding and reflection subscale of the RRS-SF (Marchetti et al., 2018). Additionally, the BSRI has been shown to have adequate construct validity, as well as good convergent and discriminant validity (Marchetti et al., 2018). Further, internal reliability scores ranging from .89 to .91 were found (Marchetti et al., 2018).

For this scale, no factor analyses were present or accessible, meaning that items could not be selected on the basis of their factor loadings. Instead, items were then selected on the basis of their content with an attempt to capture them as well as possible. For rumination, the definition proposed earlier by Watkins and Roberts (2020) functioned as the basis for that. Items 2 'Right now, I wonder why I react the way I do', and 3 'Right now, I wonder why I always feel the way I do' were combined to one item formulated as 'Right now, I wonder why I always feel and react the way I do' (Marchetti et al., 2018). This combined item is intended to capture the thoughts concerning oneself and one's feelings (Marchetti et al., 2018; Watkins & Roberts, 2020). Item 7 'Right now, I wonder why I have problems other people don't have', is taken to capture the thoughts concerning one's own circumstances (Marchetti et al., 2018; Watkins & Roberts, 2020). Together, these two items were intended to capture state rumination. For state brooding, one item of the BSRI was derived, namely item 7: 'Right now, it is hard for me to shut off negative thoughts about myself' (Marchetti et al., 2018). This was used because it differentiated brooding from rumination as such by its negative valence, especially in regard to oneself (Treynor et al., 2003).

Sedentary behaviour was assessed in the form of total sedentary time of the previous day. For this, the Past Day Sedentary Time – University (PAST-U) was utilised (Clark, Pavey, Lim, Gomersall, & Brown, 2016). The PAST-U consists of 9 items (Clark et al., 2016). Each of the items describe different contexts and activities in which sedentary behaviour could take place, thereby guiding the respondents towards realistically estimating one's sedentary time (Clark et al., 2016). It was considered especially fitting because it was adapted to university students and thus included contexts that are considered specific to students, for instance, studying (Clark et al., 2016). An adequate internal reliability value of .64 was established. Further, adequate validity has been found to be .63 (Prince, LeBlanc, Colley, & Saunders, 2017).

The PAST-U was slightly altered to fit the requirements of the repeated measurements. The items 2 and 3, which were related to work and transport were deleted as they were not deemed as important in the context of Covid-19. The items 4 and 5, covering tv and gaming were combined into one item because of their similarity. As a consequence, six items were ultimately used. Any other sedentary time that was not assessed by the previous items was then assessed using the last item.

Procedure

Participants were provided with a link and a registration code with which they could join and partake in the study on the Ethica mobile application. Participation started upon giving active, informed consent (see Appendix A). On the first day, respondents were then asked to fill out the baseline questionnaire in which demographics and trait rumination were assessed.

For the repeated measurements, the surveys were randomly triggered within fixed time intervals. In general, the variables under study were measured twice a day. Morning assessments were triggered between 10:00 and 13:00, and evening assessments between 17:00 and 20:00. Once the surveys were triggered, participants received a notification, informing them that the questionnaire was available for the next 60 minutes. After 30 minutes, a reminder was sent. After 60 minutes have passed, the survey expired and could no longer be completed, in which case this would be handled as missing data.

Starting from day two until day eight, two short, daily questionnaires captured state measures of mood, rumination and brooding. From day three until day eight, sedentary time of the day before was assessed in the morning together with the state measures. On day nine, solely the sedentary time of yesterday was measured in the morning. The complete schedule for the nine-day participation period is illustrated in Table 2.

Table 2

Schedule overview of the nine-day participation period

	Day 1	Day 2	Day 3 – 8	Day 9
11:00 – 13:00	Demographics + Trait rumination	State measures	State measures + Sedentary behaviour	Sedentary behaviour
17:00 – 20:00		State measures	State measures	

Note. State measures = State mood, rumination and brooding

Data analysis

To analyse the gathered data, SPSS was used in its 27th version. First, the data set was downloaded from Ethica in csv format. After importing it into SPSS, the data had to be cleaned and datasets had to be merged in preparation for the analyses. String variables were recoded into numeric scale variables. In some cases, sedentary time was reported in hours instead of minutes, in which case the values were recoded into minutes.

Trait rumination and sedentary behaviour were computed by summing up their items. For overall state mood, the positive and negative affect scales were created first by adding together the respective items. Then, the negative scale was subtracted from the positive scale to obtain state mood generally. State rumination was determined by averaging its two items whereas state brooding remained unchanged because it consisted of one item only.

In total, assessment took place at 16 measurement points per participant, with the first one assessing overall trait rumination and the last capturing the sitting time of the day prior. Those measurements were time-lagged and were practically intended to capture 14 repeated measurements per participant. Trait rumination was considered consistent at all 14 measurement points. The respective adjustments were made in SPSS. For an overview of the demographical data, descriptive statistics were run for the age, occupation, gender, and nationality of participants. In order to be able to put the findings into context, descriptive statistics for the variables under study were run.

In general, the method of choice for the current study were linear mixed models or hierarchical linear models. This type of analysis can account for the nested nature of intensive longitudinal data (Garson, 2013). It is also compatible with randomly occurring missing data which could be observed in the present dataset (Garson, 2013). First, the sample fluctuation of rumination and brooding over the course of a week was explored. For that, the estimated marginal means of both variables for time points were created via linear mixed models with rumination and brooding as dependent variables separately and time point as the factor. The extracted estimated marginal means could then be imported into and illustrated using Excel.

To see whether their potential dependency is statistically significant, a linear mixed model was run with brooding as the dependent and rumination as the independent variable or fixed covariate. A random intercept model was run to assess individual variation. This means that for each individual, a regression line with a different intercept, but an unchanging, fixed slope, in this case for state rumination, was created. Further, three salient individual cases were studied to look into whether the sample fluctuation is observable in the fluctuation on an individual level. Three participants with a compliance of 100% were selected for closer

examination. Their values for rumination and brooding for the 14 measurement points were derived and visualised using Excel.

Next, the association between trait rumination as fixed covariate and state rumination as dependent variable was examined. A random intercept model was employed again to assess individual variation. Further, rumination and brooding were investigated as potential moderators of the relationship between sedentary behaviour and mood. For that, two linear mixed models were run for each of the two moderators with mood as the dependent variable. As independent variables, sedentary behaviour, the respective moderator, and the interaction effect between sedentary behaviour and rumination or brooding were included. A random intercepts model was realised again. Here, the independent variables were set as unchanging, fixed effects.

Given the central role of rumination and brooding for mood outcomes, potential ad hoc explorative analyses were considered. The effect of both variables has been established before, however, whether their effect mainly takes place on the between- or within-subjects level has not been studied. Person mean (PM) and person mean centred (PMC) values were computed for rumination and brooding (Curran & Bauer, 2011). The PM scores were created by taking the mean of rumination and brooding for each individual across all time points. The PMC scores were generated by subtracting the PM from each individual rumination or brooding scale. This was done to enable potential explorative analyses of the effects of rumination and brooding on mood.

Results

Descriptive statistics of rumination, brooding, sedentary time and mood

To place the findings into context, the variables under study were examined in terms of descriptive statistics over the sample ($N = 34$; see Table 3). Mean trait rumination generally was 9.36 ($SD = 4.95$) and was thus on the lower end of the scale, as values from 0 to 30 are possible. State rumination and state brooding were also rather low with means of 13.16 ($SD = 18.15$) and 14.16 ($SD = 20.38$) respectively. The standard deviations for these means were high, suggesting that rumination and brooding varied greatly in the sample. For these scales, values between 0 and 100 were possible. Mean sedentary time was high with 9 hours and 26 minutes ($SD = 3.31$). Given the possibility of values between -12 and 12, mean mood was medium-high with a value of 4.21 ($SD = 3.31$). Overall, the sample was characterised by rather low means in trait rumination, state rumination, and state brooding. In contrast, the sample displayed high mean levels of sedentary behaviour and medium or slightly elevated levels of mood.

Table 3

Number of observations, Minimum, maximum, mean and standard deviation for trait rumination, state rumination, brooding, sedentary time and mood

|	*n*	Minimum	Maximum	Mean	Std. Deviation
Trait rumination	34	0.00	23.00	9.36	4.95
State rumination	388	0.00	92.50	13.16	18.15
State brooding	388	0.00	95.00	14.16	20.38
Sedentary time	384	1.58	19.50	9.43	3.57
State mood	388	-7.00	12.00	4.21	3.31

Variation of rumination and brooding over time

Sample variation

In the entire sample, rumination and brooding displayed slight variance over time (see Figure 2). Hence, *H1* and *H2* are accepted. It is clearly visible that rumination and brooding vary in accordance with each other, making it plausible to assume that the two are dependent. As a consequence, *H3* is also accepted. This observation is supported by the fact that the linear mixed model found a significant association between rumination and brooding ($F = 433.11$, $p < .01$). More specifically, rumination is positively related to brooding, meaning that higher rumination was a predictor of higher brooding ($B = 0.83$, $t = 20.81$, $p < .01$; see Table 4). Further, there was significant variance due to different individuals (*Wald Z* $= 2.43$, $p = .02$). In general, the scores remain rather low given the range of the scale.

Figure 2

*Variation of mean state rumination and state brooding across time points*
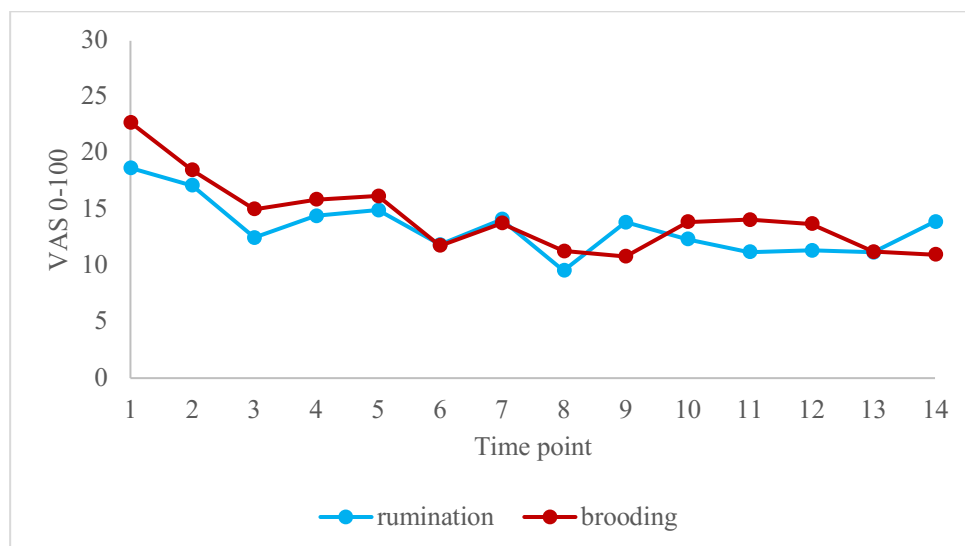
Individual variation

In the course of studying individual cases, different patterns of fluctuation emerged. For the first selected individual, more pronounced fluctuation can be observed compared to the sample fluctuation (see Figure 3). In the middle of the participation period, a visible spike in both rumination and brooding is present. Despite the stronger variation, rumination and brooding still vary in accordance with each other which could be said to demonstrate their dependency. Overall, a bigger range of scores is observable compared to the entire sample, with values ranging from 16 to 67. The scores for this participant gather around the middle of the VAS scale, meaning that generally, medium levels of rumination and brooding were experienced.
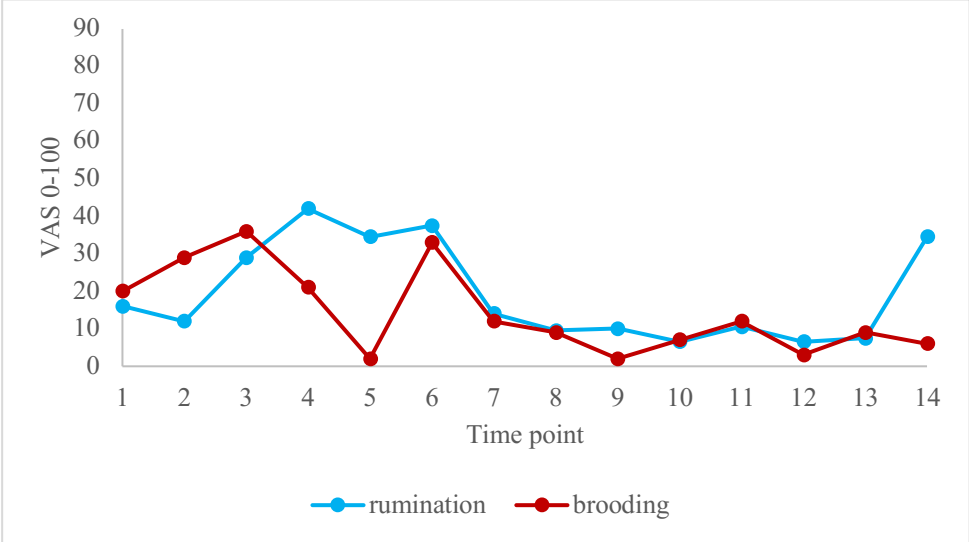
Figure 3

Individual variation of state rumination and state brooding across time points for individual 1
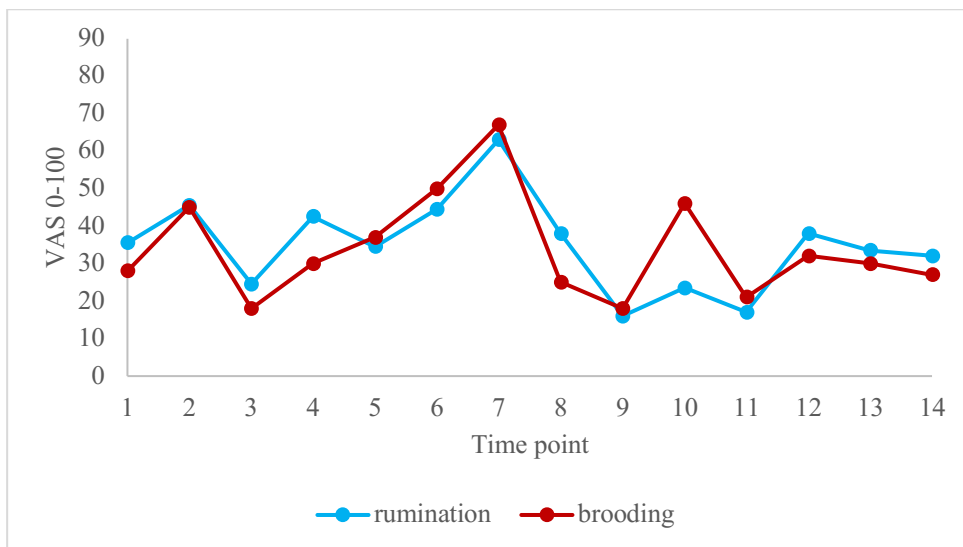
The second selected individual demonstrates greater fluctuation in the beginning of and greater stability towards the end of the participation period (see Figure 4). Independent of whether more variation or consistency is present, rumination and brooding fluctuate in accordance with each other. However, there are points of divergence, for instance, at the fifth time point there is substantial difference between the levels of experienced rumination and brooding. Generally, this participant exhibits relatively small scores that do not exceed the lower half of the VAS scale, indicating a rather low level of rumination and brooding overall.

Figure 4

Individual variation of state rumination and state brooding across time points for individual 2

The last individual case under study displayed rather pronounced variation in the beginning as well as towards the end of the participation period where large spikes are apparent (see Figure 5). In the middle of this period, more stability can be observed. Similar to the previous cases, variation of rumination and brooding occurs in accordance with each other. In this participant, broader ranges in scores are clearly visible, with values from around 20 to around 80, indicating the experience of both low and high levels of rumination and brooding.

Figure 5

Individual variation of state rumination and state brooding across time points for individual 3
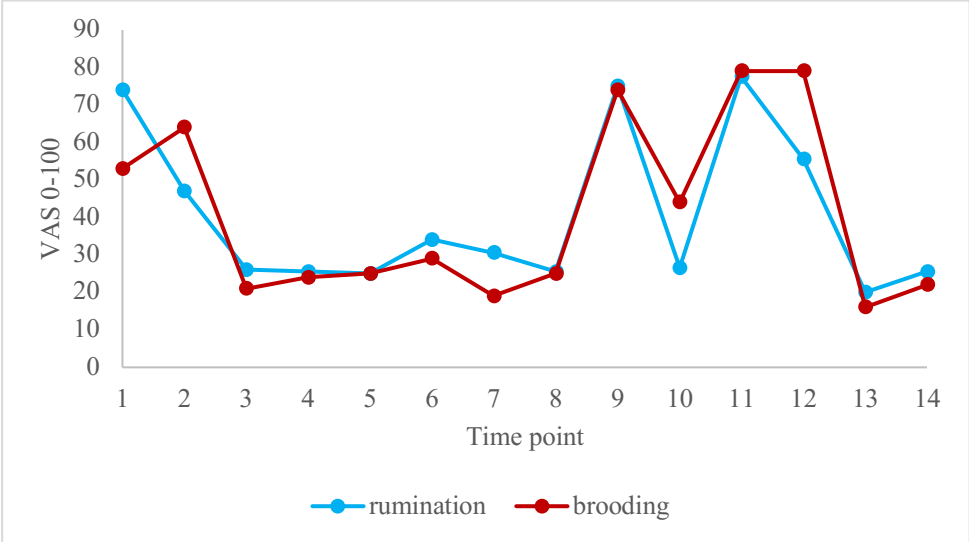
Trait and state rumination

Trait rumination has been found to be a significant predictor of state rumination (F = 25.00, p < .01). More specifically, trait rumination was positively associated with state rumination (B = 1.96, t = 5.00, p < .01; see Table 4). Higher trait rumination was thus linked to higher state rumination, meaning that *H4* is accepted. The relation between the two is illustrated in Figure 6. In terms of random effects, there was significant variance due to the presence of different individuals (*Wald Z* = 3.44, p = .01).

Figure 6

Z-scores for trait rumination and state rumination for each participant
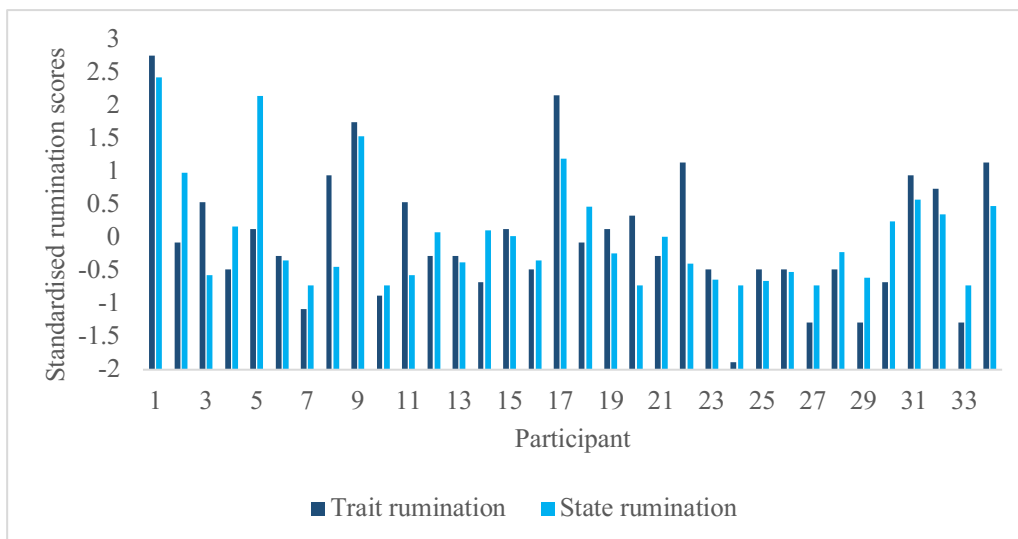
Rumination and brooding as moderators between sedentary behaviour and mood

Rumination as moderator

With rumination as a moderator, there was a significant main effect of rumination on mood (F = 7.21, p = .01) and a marginally significant main effect of sedentary behaviour (F = 3.80, p = .05), while the interaction effect was nonsignificant (F = 0.15, p = .70). Consequently, *H5* is rejected. Rumination was negatively associated with mood, meaning that higher levels of rumination would contribute to the occurrence of negative mood (B = -0.07, t = -2.69, p = .01; see Table 4). Further, there was significant variance resulting from different individuals being present, thereby providing support for the inclusion of the random intercept (*Wald Z* = 2.73, p = .01).

Brooding as moderator

The introduction of brooding as a moderator has generated slightly different findings. The main effects of brooding ($F = 11.12$, $p < .01$) and sedentary time ($F = 6.40$, $p = .01$) were significant. The interaction effect between brooding and sedentary behaviour remains nonsignificant ($F = 0.45$, $p = .50$). Hence, *H6* is rejected. Both brooding ($B = -0.08$, $t = -3.33$, $p < .01$) and sedentary time ($B < -0.01$, $t = -2.5$, $p = .01$) exert a negative influence on mood, with the estimate of sedentary time being nearly zero (see Table 4). This means that higher brooding and higher sedentary time would be predictors of negative mood. Similar to the preceding moderation analysis, a significant amount of variance due to the presence of different individuals was demonstrated (*Wald Z* $= 2.83$, $p = .01$). This in turn justifies the inclusion of the random intercept.

Table 4

Summary of general results of associations and moderation analyses

Dependent variable	Independent variable(s)	F	SE	Estimate	t	*Sig.*	95% Confidence Intervals	
							Lower bound	Upper bound
Brooding	Rumination	433.11	0.04	0.83	20.81	< .01**	0.75	0.91
State rumination	Trait rumination	25.00	0.39	1.96	5.00	< .01**	1.16	2.76
	Rumination	7.21	0.03	-0.07	-2.69	< .01**	-0.16	- 0.02
Mood	Sedentary behaviour	3.80	<0.01	< -0.01	-1.95	.05	< -0.01	< 0.01
	Rumination*Sedentary behaviour	0.15	< 0.01	< -0.01	-0.39	.70	< -0.01	< 0.01
	Brooding	11.12	0.02	-0.08	-3.34	< .01**	-0.13	-0.03
Mood	Sedentary behaviour	6.40	< 0.01	< 0.01	-2.53	.01*	< -0.01	< -0.01
	Brooding*Sedentary behaviour	0.45	< 0.01	< 0.01	0.67	.50	< -0.01	< 0.01

Note. * indicates $p < .05$. ** indicates $p < .01$.

Ad hoc explorative analyses

In order to gain a deeper understanding of two emerging predictors of mood, namely rumination and brooding, further explorative analyses were conducted. More specifically, it was looked into whether their effects take place mainly on the between-subjects or on the within-subjects level.

Two additional linear mixed models were run with mood as the dependent variable. The PM and PMC variables for rumination and brooding were separately included as fixed effect covariates. For rumination, both PM ($F = 9.99$, $p < .01$) and PMC ($F = 43.84$, $p < .01$) were significant predictors of mood. Similar findings emerged in relation to brooding. For brooding, PM ($F = 9.24$, $p < .01$) and PMC ($F = 43.11$, $p < .01$) were significant predictors of mood as well (see Table 5). This means that the effects of rumination and brooding were present on both a between-subjects and within-subjects level. The slope estimates provide the possibility to gain a more nuanced understanding of the magnitude of these effects. In terms of rumination, the slope estimates for the PMC score ($B = -0.09$, $t = -6.62$, $p < .01$) was higher than that for the PM score ($B = -0.05$, $t = -3.16$, $p < .01$). The same held true for the brooding scores were the estimated slope for the PMC score ($B = -0.08$, $t = -6.57$, $p < .01$) was higher than that of the PM score ($B = -0.04$, $t = -3.04$, $p < .01$). From this follows that their effects seem to take place more so on a within-subjects level. This means that if rumination or brooding are generally high in one person, their mood levels would tend to be lower than in a person who engages in little rumination or brooding. In the same sense, if one person experiences high rumination or brooding at one point in time, their mood would be lower than if that same individual experienced low rumination or brooding at a different time.

Table 5

Summary of ad hoc explorative analyses of between- and within-subject effects of rumination and brooding

Independent variable(s)	F	SE	Estimate	t	Sig.	95% Confidence Intervals	
						Lower bound	Upper bound
Rumination PM	9.99	0.02	-0.05	-3.16	< .01**	-0.08	-0.02
Rumination PMC	43.84	0.01	-0.09	-6.62	< .01**	-0.12	-0.06
Brooding PM	9.24	0.01	-0.04	-3.04	< .01**	-0.07	-0.01
Brooding PMC	43.11	0.01	-0.08	-6.57	< .01**	-0.10	-0.05

Note. Dependent variable = mood. * indicates $p < .05$. ** indicates $p < .01$.

Discussion

This study focused on shedding light on the potential existence and nature of a moderation effect of rumination and brooding on the relation between sitting time and mood. It also studied fluctuations in rumination and brooding on the sample and individual level, as well as examined the relation between trait and state rumination. The findings revealed that neither rumination nor brooding moderated the relation. Instead, they had significant main effects on mood, whereupon explorative analyses revealed that their effects take place on both the between- and within-subjects level, but more so on the within-subjects level.

Main findings and implications

Rumination and brooding did not moderate the relationship between sitting time and mood. They did, however, influence mood directly. This is in line with previous research. In general, rumination and brooding have been repeatedly associated with negative affect (Thomsen, 2006; Treynor et al., 2003). In terms of experience sampling studies, Moberly and Watkins (2008) established state rumination as a direct predictor of negative mood. In a study by Huffziger et al. (2012), inducing rumination resulted in an immediate decrease in positive mood levels. The results of this study thus correspond with previous studies that proposed rumination and brooding as predictors of negative affect. It has to be noted that in the current study, their estimates were rather small, meaning that they only slightly affected mood.

The ad hoc explorative analyses revealed that the effects of rumination and brooding were present on both the between- and the within-subjects level. In line with this are findings of the current study. Rumination and brooding varied over time. Still, trait rumination predicted state rumination, meaning that considering between and within person effects is relevant. Similar findings have been reported in previous research (Moberly & Watkins, 2008). Despite the significance of both levels, rumination and brooding exerted their effects more so on the within-subjects level. This means that rumination and brooding levels were determined more by situational factors than by those related to a person as such. These findings correspond to the study by Moberly and Watkins (2008) that has found the variability within subjects to be greater than that between subjects, meaning that situational or contextual factors are likely more decisive.

A situational factor that has been found to promote rumination is the experience of stress (Valenas & Szentagotai-Tatar, 2015). This would be in line with the fact that students generally tend to experience high levels of stress (Storrie et al., 2010). Moreover, being confronted with negative emotional experiences has been shown to contribute to rumination

levels as well (Curci, Lanciano, Soleti, & Rimé, 2013). In terms of factors related to the person as such, difficulties with cognitive control were found to influence a person's general tendency to ruminate (Mor & Daches, 2015). Specifically, not being able to inhibit thinking about irrelevant information as well as not being able to flexibly shift attention towards relevant information contributes to persistent rumination (Mor & Daches, 2015). Once ruminative thoughts arise, these cognitive control problems make it harder to stop ruminating (Mor & Daches, 2015). Overall, this implies that rumination and brooding can be altered on both levels, either by altering factors like cognitive control or by altering something in a given situation like stress, both of which would, in turn, likely affect mood. It also implies that since it is more of a within-subjects effect, altering the situation might be enough to positively affect mood levels in students.

The relationship that was initially assumed to be moderated was not established in this sample. The effect of sedentary time on mood was marginally significant in one moderation analysis, and significant in the other. However, the estimates for sedentary time were nearly zero, which means that it had almost no effect on mood levels. This in in contrast to previous studies which repeatedly demonstrated the negative and immediate effect of sedentary behaviour on mood (Edwards & Loprinzi, 2016; Endrighi et al., 2016). The students in this sample spent a large number of hours sitting. Their levels were higher than that of the general population, a finding that could be expected in students (Bauman et al., 2018; Castro et al., 2020; Moulin et al., 2019).

Still, they experienced medium-high mood, meaning that sitting for many hours does not necessarily relate to negative mood. Given that the effect of sitting time on mood is so well-established, other moderations might have been at play that lessened the impact sitting had on mood. First, a factor that exerts a positive effect on mood is mindfulness (Gotink et al., 2016; Tschacher & Lienhard, 2021). In particular, awareness and acceptance, two facets of mindfulness, were associated with positive affect (Tschacher & Lienhard, 2021). In another study by Gotink et al. (2016), mindfulness and positive mood were related in the form of an upward spiral where increases in mindfulness where accompanied by increases in positive mood and vice versa. Secondly, a similar upward spiral has been reported with gratitude, in which gratitude and positive affect enhance each other (Jans-Beken et al., 2018).

Hence, being mindful, aware and accepting, as well as being grateful promotes the experience of positive mood. Factors like these might have weakened the impact of sedentary behaviour on mood in this sample. Their presence as moderators thus possibly enabled the students to engage in many hours of sitting while still experiencing medium-high mood.

Strengths and limitations of the current study

This study was the first study to study rumination and brooding as potential moderators of the relationship between sitting time and mood in students. The use of experience sampling made possible the study of between- and within-subjects effects, of capturing variation over time and of assessing both state and trait measures in relation to rumination and its facet brooding. Studying students enabled identifying rumination and brooding as predictors of mood for an important group whose vulnerability for high levels of sitting and negative mood is higher than that of the general population. In that, this study demonstrated the importance of studying factors that influence student mood levels in the face of high sedentary time, be it as moderators or as direct predictors.

In the course of this study, certain limitations were identified. First, in order to measure the state variables, items from validated questionnaires had to be extracted, combined or altered in order to fit the needs of this study. As a consequence, the psychometric qualities of the created surveys are unknown. This was the case because one or two-item questionnaires for these variables were either not existent or not accessible. Instead, the items were mainly chosen based on their factor loadings in order to ensure that the variables are captured as well as possible. For the BSRI, from which the state rumination and brooding items were extracted, no factor analyses were accessible. The items could thus not be chosen based on their factor loadings and were alternatively chosen based on their content. Also, the brooding item was derived from a rumination instead of a brooding questionnaire.

Second, sedentary time was measured at different time points without taking into account whether these measurements took place on a weekday or on the weekend. Previous studies have found there to be a difference in sedentary levels for different parts of the week (Kantomaa et al., 2016). More specifically, higher education was associated with higher sedentary time during the week than on the weekends (Kantomaa et al., 2016). The current study did not consider this, meaning that some of the fluctuation might have been due to either being part of the working week or the weekend.

Recommendations for future research

The possibility of engaging in high levels of sitting and still experiencing medium-high mood in this student population might mean that other moderators potentially decreased the effect sitting had on mood. Future research should study mindfulness and gratitude as moderators between sitting time and mood in students. For sitting time, the differentiation between weekday and weekend should be made since sedentary levels tend to differ greatly in

that sense. In terms of study design, ESM should be used to be able to study these moderators as trait and state measures, and to differentiate between within- and between-subjects effects. These positive influences on mood could then be promoted in a person more generally or in any specific situation, and thereby positively affect mood levels in students. This is especially important since students are required to sit for a substantial period of time due to activities such as attending lectures or studying. Identifying and targeting these moderators would enable students to experience positive mood even in the face of high levels of sitting.

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Appendices

Appendix A

Informed Consent

_____

Dear participant,

Thank you for taking part in our study!

Here is some practical information for you to know about this study:

For you to participate, you need to be at least 18 years old, have a smartphone with Android or iOS, and a proficient understanding of the English language.

During the study:

We are interested in the relationship between sitting behaviour and mood. Also, we are going to look into possible influences on this relationship, such as your activity and thoughts at the time. For that, you will fill out multiple questionnaires.

1. On the day of signing up, so on day one, you will complete a demographic questionnaire, as well as two questionnaires, one on your mood and one on your thoughts. Together, this will take approximately 10 minutes.

2. Starting from the next day, so on day two, you will fill out two short questionnaires a day that will take about 3 minutes to complete. You will receive a notification on your phone when it is time to complete the survey. These notifications will appear randomly within the time frames of 10:00 - 13:00 and 17:00 - 20:00. You will receive a reminder after 30 minutes. One hour after receiving the prompt, the questionnaire will be no longer available. If you miss a measurement, don't worry but please continue with the study and try to be consistent :)

3. From day three to day eight, you will fill out a somewhat longer questionnaire of 8 minutes once a day together with your morning prompt that measures your sitting behaviour from the day before. On day nine in the morning, you will fill out the last questionnaire on your sitting behaviour for day eight.

We kindly ask you to complete the following steps before you can start the study:

- Please follow this link https://ethicadata.com/study/1730/ and click on 'Participate'.

- Please download the application "Ethica" from your App or Google Play Store and log in with the account you created. If the App or Google Play Store does not automatically open, use the following links:

  - o Google Play Store:
    https://play.google.com/store/apps/details?id=com.ethica.logger&hl=en&gl=US

  - o App Store:
    https://apps.apple.com/ca/app/ethica/id1137173052

- Create an account as a participant (or log in if you already have a participant account).

- Make sure to enable the notifications for Ethica as instructed.

- Read the terms and conditions carefully and agree to join the study (You can also join the study with the registration code 1730).

- Follow the instructions as provided throughout the next days.

The data gathered will be used solely for the purpose of this study. Ethica will generate participant IDs upon registering, meaning that the data will be anonymised. Your name and email address is stored on the Ethica database. You have access to your own data via your online account as well as have the right to delete your data at any time. This means that your name and email address are stored separately from your survey answers. The researchers only have access to the content of your surveys as well as your participant ID. You can withdraw from the study at any time, without providing a reason for doing so.

This study has been reviewed and approved by the Ethics Committee. No risks can be expected from taking part in this study. You may become increasingly aware of your mood, thoughts and behaviour which could potentially lead to discomfort in some people.

If you have any questions about your rights as a research participant, or wish to obtain information, ask questions or discuss any concerns about this study with someone other than the researchers, please contact the Secretary of the Ethics Committee of the Faculty of Behavioural, Management and Social Sciences at the University of Twente.

Hereby, I declare that I am 18 years or older. I have read and understood the information provided, or it has been read to me. I consent voluntarily to participate in this study and understood that I can refuse to answer questions, and I can withdraw from the study at any time, without have to give a reason.

☐ I consent.

☐ I do not consent (in this case, the study will end at this point).

Appendix B

Complete list of items for the baseline and repeated measurements surveys

Baseline Questionnaire	Question	Answer Options
Demographics		
Item 1	"*How old are you?*"	Numeric value
Item 2	"W*hat is your occupation?*"	1) Student (University) 2) Student (Higher education) 3) Other
Item 3	"*What is your gender?*"	1) Female 2) Male 3) Other 4) Prefer not to say
Item 4	"*What is your nationality?*"	1) German 2) Dutch 3) Other
Trait Rumination		
Item 1		
…		

ESM Questionnaire	Question	Answer Options
State Mood		
Item 1 (NA)	"*Right now, to what extent do you feel upset?*"	1) very slightly, or not at all 2) a little 3) moderately 4) quite a bit 5) extremely

Item 2 (NA)	*"Right now, to what extent do you feel afraid?"*	1) very slightly, or not at all 2) a little 3) moderately 4) quite a bit 5) extremely
Item 3 (NA)	*"Right now, to what extent do you feel nervous?"*	1) very slightly, or not at all 2) a little 3) moderately 4) quite a bit 5) extremely
Item 4 (PA)	*"Right now,to what extent do you feel active?"*	1) very slightly, or not at all 2) a little 3) moderately 4) quite a bit 5) extremely
Item 5 (PA)	*"Right now, to what extent do you feel attentive?"*	1) very slightly, or not at all 2) a little 3) moderately 4) quite a bit 5) extremely
Item 6 (PA)	*"Right now, to what extent do you feel determined?"*	1) very slightly, or not at all 2) a little 3) moderately 4) quite a bit 5) extremely

State Rumination

Item 1	To what extent to you agree with the following statement?	VAS (0-100)

	"Right now, I wonder why I always feel and react the way I do."	
Item 2	To what extent to you agree with the following statement? *"Right now, I am thinking 'why do I have problems other people don't have?'."*	VAS (0-100)

State Brooding

Item 1	To what extent to you agree with the following statement? *"Right now, it is hard for me to shut off negative thoughts about myself."*	VAS (0-100)

Context

Item 1	*"Right now, what context are you in?"*	1) Occupation/Study 2) Leisure 3) Transport

Type

Item 1.1 (Follow-up *"Occupation"*)	*"What were you doing right before you started answering this survey?"*	1) Sitting and using the computer for work or study purposes 2) Sitting while participating in a meeting 3) Sitting while performing other tasks that require problem solving or mental effort 4) Not sitting
Item 1.2	*"What were you doing right before you started answering this survey?"*	1) Sitting or lying while watching TV, or watching a

(Follow-up "*Leisure*")		movie, YouTube, etc. on your laptop or smartphone 2) Sitting or lying while listening to music 3) Sitting or lying for rest but not sleeping 4) Sitting or lying while reading (paper or electronic format) 5) Sitting or lying while playing a game (computer games, board games, crossword puzzles, etc.) 6) Sitting or lying while actively using social media (e.g., research purposes or writing a post) 7) Sitting or lying while talking to other people (on the phone or in person) 8) Not sitting
Item 1.3 (Follow-up "*Transport*")	"*What were you doing right before you started answering this survey?*"	1) Sitting as a passenger while commuting 2) Sitting and driving a motor vehicle 3) Sitting a reading while commuting 4) Sitting a using a computer/phone for work/study purposes while commuting

		5) Sitting and using social media or playing video games while commuting 6) Not sitting
Sitting Time		
Item 1	*"How many minutes were you sitting while studying/working yesterday? (include the time at University, during lectures, tutorials, meetings, group discussions, self-study, study from home, etc.)"*	Numerical value
Item 2	*"How many minutes were you sitting or lying down while watching TV or playing video games yesterday? (e.g., watching TV in bed, playing computer games or PlayStation, playing games on your iPhone/iPad/tablet, using the internet for activities that were not for studying or working purposes, like Facebook, Twitter, Skype, YouTube, online shopping, etc.)"*	Numerical value
Item 3	*"Thinking again of yesterday, how many minutes were you sitting or lying down while reading during your leisure time?* *(include reading in bed but do not include time spent reading for paid work or for study)"*	Numerical value

Item 4	*"How many minutes did you spend yesterday sitting down for eating and drinking?*	Numerical value
	(include meals and snack breaks)"	
Item 5	*"Please estimate the total time in minutes of yesterday that you spent sitting down to socialize with friends or family, regardless of location? (e.g., at University, at home, or in a public place. Include time on the telephone)"*	Numerical value
Item 6	*"We are interested in any other sitting or lying down that may have done that you have not already told us. (e.g., hobbies such as doing arts and crafts, playing board games, listening to music, or for religious purposes. Again, thinking of yesterday, please estimate the total time you spent sitting or lying down NOT including time that you have told us about in the previous answers)*	Numerical value