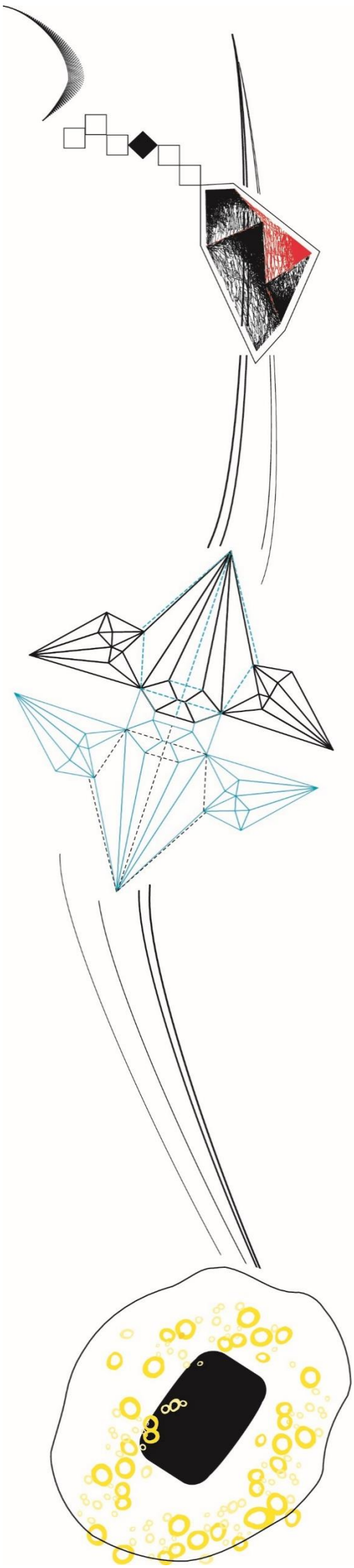

VALIDATION OF THE BRIEF QUESTIONNAIRE ON OCCUPATIONAL SITTING

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ABSTRACT

The present research aimed at validating the Brief Questionnaire on Occupational Sitting (BQOS) developed by Van de Lagemaat (2018). It is a self-report questionnaire that chronologically splits up the day in shorter parts and intends to measure average and domain-specific sitting time on regular days. A correlational longitudinal study was conducted to assess the feasibility, test-retest reliability, and the construct validity of the BQOS. Therefore, an ecological momentary assessment (EMA) form of the BQOS was created and used as a validation tool. The major difference between the original one and this version lies in the measurement level – instead of average sitting times on a regular day, the EMA form measured daily sitting times. The sample consisted of 30 full-time students who participated in the study over the course of one week. They filled in the BQOS twice and, within seven consecutive days, the participants completed one EMA version of the BQOS each day.

The psychometric assessment showed that first, the test appears to be feasible since not many students expressed their concern, but some reported to have experienced difficulties to complete the original form due to a large variability in their schedule. Second, the outcomes of the correlation analysis assessing the test-retest reliability suggest that overall, the results are consistent over one week. Third, addressing the construct validity of the BQOS, average total and domain-specific sitting time on a regular day were only measured partly because there are no regular days for full-time students. Full-time students vary in their domain-specific sitting time from day to day and correspondingly, it is not possible to speak of a regular day. However, this does not imply that the BQOS is not valid per se since the results reveal that, on average, the BQOS demonstrates appropriate psychometric properties. In line with previous studies, for example, the gathered data indicates that students' sitting time on a university day equals eleven hours as opposed to nine hours on a day off. Conclusively, the BQOS might indeed be valid, but only for populations with a low variation in their sitting time.

INTRODUCTION

Frequent prolonged sitting has one powerful, however mostly unknown implication: Against intuition, its adverse health consequences cannot be compensated by doing sports (Owen, Healy, Matthews, & Dunstan, 2010). Even though some might meet the criteria for being healthy according to physical activity guidelines, they could still suffer from serious illnesses because of prolonged sitting times. Persons who are physically active but nevertheless sit for too long are called ‘Active Couch Potatoes’. This is a huge problem because prolonged sitting is associated with diabetes 2, cardiovascular diseases, and even premature mortality (de Rezende et al., 2014). According to Chau et al. (2013), the average sitting time of adults is remarkably high: People spend around nine to eleven hours a day of their waking hours in a sedentary position.

Sedentary behaviours are currently defined in either of the two following ways: First, sedentary behaviours are all behaviours that do not exceed the metabolic equivalent (MET) of 1.5 implying that it also includes behaviours that are not sedentary per se (Pate, O'neill, & Lobelo, 2008). Second, sedentary behaviours are all behaviours that do not exceed the metabolic equivalent rate of 1.5 and the behaviour in question has to be either sitting or reclining (Tremblay et al., 2017). According to the latter, behaviour is not classified as sedentary as long as people stand upright even though the MET is smaller than 1.5. A recent study showed that, while standing, the activation of the muscles is approximately 2-fold the activation of the muscles while sitting which points towards the second of the two provided definitions (Tikkanen et al., 2013). However, there currently is no consensus on one or the other (Gibbs, Hergenroeder, Katzmarzyk, Lee, & Jakicic, 2015).

Apart from the struggle to find agreement on one single definition, it is undeniable that there is a link between prolonged sitting and bad health consequences. Therefore, it is crucial to create comprehensive models, to design interventions tailored to the issue of reducing sitting time, and to identify populations which are at risk of suffering from the mentioned consequences. The fundament of all these efforts lies in the existence of valid questionnaires screening for unhealthy behavioural patterns. Being in line with this consecutive nature, the rationale of behavioural epidemiology is to provide empirical guidelines that aid in dealing with common health-related issues (Sallis, Owen, & Fotheringham, 2000).

Agenda of Sedentary Behaviour Research

Behavioural Epidemiology is a branch of research that targets and tries to promote health behaviours using empirically obtained insights to design effective interventions (Sallis et al., 2000). Relating this to sedentary behaviour research, the subordinate goal of

interventions is to reduce sitting time to eventually decrease the number of people who are affected by the mentioned health consequences (Jochem, Schmid, & Leitzmann, 2018). Sallis and colleagues (2000) developed a framework that aids in accomplishing that goal: It consists of five interrelated steps that, if researched and addressed sufficiently, could lead to an improvement of the general population's health. The phases read as follows: 1) Establish links between behaviours and health; 2) Develop measures of the behaviour; 3) Identify influences on the behaviour (determinants); 4) Evaluate interventions to change the behaviour; 5) Translate research into practice. Owen et al. (2011) argued that, up to then, phases three and four received the least attention in research and that empirical evidence concerning the second and fifth phase is only limited.

Research in the field of sedentary behaviours, be it measuring sitting time, assessing prevalence rates, or identifying the magnitude of an issue, always starts with some kind of measurement. Without the existence of a reliable and valid measurement instrument, the subsequent steps would most likely suffer from the lack of accuracy that invades the envisaged research. Well-tested measurement instruments are, therefore, essential in guiding research and formulating statements about populations who are at risk.

Objective and Subjective Measurements of Sedentary Behaviours

When developing a questionnaire, there is always the question of what actually should be measured, the construct of interest. However, this is a difficult one within an area of research where it is not even completely agreed on what sedentary behaviour actually is. Keeping this in mind, a concise summary of the contemporary measures used in the field of sedentary behaviour research is given. Measurement methods are generally divided into two categories (Atkin et al., 2012): Subjective measurements (Self-report questionnaires, proxy-report questionnaires, and diaries) and objective measurements (Accelerometry, posture monitors, HR/Combined sensing, and multi-unit monitors). Each of the branches is presented briefly with some major advantages and disadvantages.

Objective measurements are by design more reliable than subjective measurements in tracking both, a person's activity level (e.g. accelerometer) and a person's posture (e.g. posture monitor) (Ainsworth, Riviere, & Florez-Pregonero, 2018). The greatest advantage of accelerometers is the avoidance of reporting bias since its data collection does not need human reporting at all (Reilly et al., 2008). However, most often the burden to use such instruments is fairly high and currently, there is no consensus on how to analyse the obtained data (Atkin et al., 2012). For example, it is difficult to get participants to wear monitoring devices for a long period of time so that it is difficult to recruit representative samples.

There still is the need for subjective measurement methods because objective methods cannot distinguish between domains (university, transporting, occupation etc.), also referred to as nondiscretionary behaviours, and modes (reading, TV viewing, gaming etc.), known as discretionary behaviours (Prince, LeBlanc, Colley, & Saunders, 2017). Without information on where the behaviour of interest occurs (domain-specific information), no appropriate determinants can be identified and no effective intervention can be designed. It furthermore appears that some discretionary behaviours are more associated with adverse health risk than others. Exactly these pieces of information cannot be obtained by objective methods (de Rezende, Lopes, Rey-López, Matsudo, & do Carmo Luiz, 2014) contrary to subjective ones which have the major advantage of providing such crucial data (Ainsworth et al., 2018; Healy et al., 2011).

Van de Lagemaat (2018) developed the *Brief Questionnaire on Occupational Sitting (BQOS)* which aims to assess people's average sitting time and furthermore, connecting to the previous objection against objective measures, identifies for how long people sit in a specific domain. In the questionnaire, it is clearly stated which behaviours count and which behaviours do not count as sedentary (e.g. riding a bicycle is excluded). Collected information, in turn, could be used to determine in which domain health behaviours can be promoted and moreover, support the frequency of sedentary interruptions (stand up more often). It is clear that Van de Lagemaat (2018) tried to integrate both, sitting times as well as domain-specific information to get a coherent picture of a person's sitting habits. The BQOS was developed because most of the available questionnaires that aim to assess sedentary behaviour focus on different populations (e.g. children). And those which do cover occupational sitting are inappropriate due to too long administration times. Van de Lagemaat (2018) found that within an occupational setting, people who completed the BQOS sit eleven hours in total of which six and a half hours can be ascribed to work-related sitting. This finding is in line with the average sitting time of the population estimated by Chau et al. (2013), already suggesting that the instrument might be accurate in assessing average sitting times.

An accurate measurement instrument incorporating information of specific domains could help to track one's sitting habits and eventually replace them for the better (Atkin et al., 2012). The present study, therefore, aimed at validating the BQOS using ecological momentary assessment principles.

Ecological Momentary Assessment (EMA) - The Golden Standard

This particular form of assessments is not a single measurement technique but rather entails a range of techniques to address a specific topic. It is defined as "methods using repeated collection of real-time data on subjects' behavior and experience in their natural environments" (p. 3, Shiffman, Stone, & Hufford, 2008). EMAs produce data that generally is more reliable in comparison to alternative measures using retrospective recall assessments (Shiffman et al., 2008).

The BQOS is such a retrospective measurement instrument since it is a self-report questionnaire asking for average sitting times. Adopting an EMA approach would yield in more reliable data since the time span in repeated measures is shortened so that recall is easier and less biased (Romanzini et al., 2019). However, merely applying EMA methods is too time-consuming, costly, and survey compliance is not always guaranteed (Hufford, 2007). Here, it is used as an aid to investigate whether or not the BQOS produces reliable and valid results.

Classical EMA techniques, as highlighted in the definition, focus on real-life data collection that occurs timely after a specific event. In the present case, such instantaneous recordings are not possible because it would be a highly demanding task for participants to write down the time they sat in a particular setting (e.g. a diary of sedentary behaviour). Since this would break the scope of the research, the BQOS was adjusted in a way that people could complete one survey each day. Consequently, reporting bias was not completely eliminated but reported sitting time should be more accurate compared to the original BQOS where no exact time frame of remembrance is given.

Feasibility, Reliability, and Validity of Questionnaires

A subjective measurement instrument has to meet certain criteria to be recognised as suitable for measuring what it claims to measure. This is not demonstrated by one single study but by a body of research examining the feasibility, reliability, and validity of a particular test (de Yébenes Prous, Salvanés, & Ortells, 2009).

Feasibility

Feasibility, like reliability, is a prerequisite of validity. Without a standardised way of interpreting the gathered data, a short completion time, and without clear instructions for test takers how to complete a particular questionnaire, no meaningful results can be expected (de Yébenes Prous, Salvanés, & Ortells, 2009).

Test-Retest Reliability

The establishment of reliability, referring to the consistency of a measurement instrument, indirectly contributes to the establishment of validity (Heale & Twycross, 2015): A valid instrument is always reliable but a reliable one is not necessarily valid. Rather, it is a prerequisite for validity. This aspect alone made it worth to assess the reliability of the BQOS in the form of a test-retest analysis, which gives an indication of the consistency of a test over time. An appropriate level of reliability and feasibility have to be given to also demonstrate an adequate degree of validity (de Yébenes Prous, Salvanés, & Ortells, 2009). These qualities have to be ensured to be able to speak of a good test and to eventually use it for research or practical purposes.

Construct Validity

Validity is at the heart of each measurement instrument but most difficult to demonstrate because establishing the validity of an instrument is a constant process and demands continuous research rather than a one-time assessment. Scholtes and colleagues (2010) state that three types of validity are crucial in the validation process of a questionnaire: content validity, construct validity, and criterion validity. In demonstrating the construct validity of the BQOS, which is the main focus of this research, it was assessed whether the results of the questionnaire actually reflect what it claims to measure. More precisely, the extent to which the BQOS really measures total and domain-specific average sitting time on a regular day was examined.

Consensus Taxonomy of Sedentary Behaviour

Whereas these characteristics of a good test hold true for each test, whatever it intends to measure, there are also some concrete aspects special to questionnaires assessing sedentary behaviours postulated by Chastin, Schwarz, and Skelton (2013). They developed a consensus taxonomy of categories that might comprehensively account for sedentary behaviours and identified nine broad dimensions: purpose, environment, type, posture, social, time, state, associated behaviours (eating, drinking, smoking), and measurement. It is appealing to incorporate such factors into a questionnaire to cover many variables that, otherwise, might invade the results. However, note that one single questionnaire least likely includes all of these dimensions (Ainsworth et al., 2018).

Research Questions

Following the agenda of Owen et al. (2010), contemporary research on this topic has to be focused on the development and validation of a proper questionnaire, the identification of determinants, and the design of applicable interventions because evidence is only limited. The present study focused on the former (point two on the agenda) and aimed at validating the BQOS by means of ecological momentary assessments. There were five research questions in total of which one assessed the feasibility, one the test-retest reliability, and three which target the construct validity of the BQOS:

1. *How feasible is the original BQOS in its administration? (Feasibility)*
2. *How consistent are the results of the BQOS over a time span of one week as measured by two administrations being seven days apart from each other? (Test-Retest Reliability)*

Other than the previous questions, the emphasis of the following ones was on the construct validity of the BQOS. The third research question starts at the most basic level of the measurement instrument: Sitting time. Since the main purpose of the questionnaire is to provide test users with a proper indication of the test-taker's average total and domain-specific sitting time, it is important that the test yields meaningful numbers.

3. *How large is the average total and domain-specific sitting time of full-time students as measured by the original BQOS and EMAs? (Construct Validity)*

Whereas the third question assesses the content level of the research, the fourth one investigated whether the premise of the test held true: If there is such a high level of consistency across university days that it is possible to request students to enter average time spans and points in time on a regular university day. The within-subject sitting time variation was analysed to answer this question.

4. *How large is the daily total and domain-specific sitting time variance in a full-time student sample as measured by EMA versions of the BQOS? (Construct Validity)*

The last research question examined to what extent values of the representative BQOS converge with matched, definitely more reliable values of the EMAs. Since it could have been the case that, although there might be a rather large variance in total and domain-specific sitting times, the BQOS produces valuable numbers that are accurate on a general but not on an individual level.

5. *How much do the results of the BQOS and the averaged EMA measures converge in terms of full-time students' average total and domain-specific sitting time? (Construct Validity)*

METHODS

Study Design

The research took the form of a *correlational longitudinal survey*. Five pieces of evidence, one on the feasibility, one on the test-retest reliability, and three on the construct validity of the BQOS provided a proper indication of whether the measurement instrument in question is appropriate for measuring average and domain-specific sitting time on a regular day in a full-time student sample. Therefore, participants' sedentary behaviour was monitored for one week tracked by ecological momentary assessments.

Participants

The sample, with a mean age of 19.73 (SD=1.33), initially consisted of 36 participants of which 30 (28 women and two men) completed the whole research. To be allowed to participate, they had to be present at university at least four of the next seven days and comprehend English to a sufficient degree. It can be assumed that all of them were Psychology Bachelor students since the study was hosted by the SONA system of the University of Twente and, as a reward for being a participant, they received credit points they need to pass their studies.

Materials

Two questionnaires, namely, *the Brief Questionnaire on Occupational Sitting – Translated and Adapted to the University Setting* and the *Brief Questionnaire on Occupational Sitting – EMA Version (Form A and B)* were used as instruments to validate the original *Brief Questionnaire on Occupational Sitting*. The major differences of the questionnaires are comprehensively displayed in table 1. See Appendix A for the original BQOS as developed by Van de Lagemaat (2018) and Appendix B for the questionnaires that have been used in this research.

Table 1

Major Characteristics of the Individual Questionnaires.

Characteristics	Original BQOS (Van de Lagemaat, 2018)	BQOS – Translated and Adapted	BQOS – EMA Version	
Division	-	-	Form A – University Day	Form B – Day Off
Language	Dutch	English	English	English
Measurement Level	Average Total and Domain-Specific Sitting Time on a Regular Working Day/Day Off	Average Total and Domain-Specific Sitting Time on a Regular University Day/Day Off	Daily Total and Domain-Specific Sitting Time on a University Day	Daily Total and Domain-Specific Sitting Time on a Day Off
Questions	15 Questions	15 Questions	12 Questions	5 Questions
Population	Office Workers	Full-time Students	Full-time Students	Full-time Students
Administration	Self-report	Self-report	Self-report	Self-report
Rationale	-	Represents the Original BQOS	Ecological Momentary Assessment	Ecological Momentary Assessment

BQOS – Translated and Adapted to the University Setting (Represents the original BQOS)

The original questionnaire was developed by Van de Lagemaat (2018) to gain insight into Dutch office worker's average total and domain-specific sitting time on regular days. It consists of two major sections including one that asks for respondent's sitting time on a regular working day and another one asking for sitting time but on a regular day off.

At the heart of the questionnaire are the eleven questions that give the test user a sense of the participants' domain-specific sitting time. There are two types of questions, green ones asking for a specific point in time (e.g. 7:15), and blue questions asking for time periods (e.g. 30 minutes). The combination of alternately using green and blue questions might result in a comprehensive picture of respondents' sitting time on a regular working day. Obtaining information on the sitting time on a regular day off is the main aim of the second section. It is basically structured in the same way as the previous one but only consists of three questions, two green ones and one blue question.

Since the drawn sample consisted of various nationalities, however, all of them advanced at comprehending English, the original BQOS was translated to English via a back-and-forth translation (see table C1 for the exact Dutch-English translation). Full-time students find themselves in a completely different environment (university instead of office environment) than office workers and correspondingly, terms that are special to the day to day labour of office workers were exchanged with words that fit the university setting. To give one example, "university" is the substitute for "office". The translated and adapted version of the BQOS thus is the representative of the original BQOS and differs in term of domain and language. The researcher added one question asking whether participants experienced difficulties completing the questionnaire to be able to assess the feasibility of the BQOS as well (see Appendix B for the exact wording of the question).

BQOS – EMA Version (Form A and B)

The EMA version requests average and domain-specific sitting time only for one particular day, instead of asking for average and domain-specific sitting time on a regular day as the previous one does. Note the distinction between form A and B: Form A consists of the first part of the questionnaire with its emphasis on the days where students are present at university. Form B is analogous to the last part of the representative BQOS with four questions that have to be answered when participants have a day off. Similar to form A, the posed questions address the day of completion.

Procedure

After the questionnaires have been compiled by means of the online research tool Qualtrics, it was distributed via the SONA system of the University of Twente. The data was gathered within two weeks. Full-time who wanted to take the survey simply registered themselves and, after they agreed to the informed consent (see Appendix B), they filled in the initial survey. The informed consent briefed the participants on the purpose and course of the research and the right to quit at any time without further consequences. By finishing the whole study, students granted 1 SONA credit point. This aided as a motivational factor since undergraduate Psychology students have to get 15 of these to successfully complete their studies.

A flowchart of data collection is illustrated in figure 1 and highlights the consecutive nature of the study. The numbers within the circles correspond to the days at which particular questionnaires had to be taken. First of all, respondents completed the initial questionnaire, namely the *BQOS – Translated and Adapted to the University Setting*. On the same day they also filled in the *BQOS – EMA Version* and within the next six days, students had to take the *BQOS –EMA Version* each day. However, the seventh day constituted an exception since the students not only completed the last *BQOS –EMA Version* but also filled in the *BQOS – Translated and Adapted to the University Setting* a second time. Whether respondents attended university or not determined which form they had to take, either form A or form B of the *BQOS –EMA Version.* Thus, there were nine questionnaires in total that were completed in seven consecutive days. Aside from filling in the first survey, respondents also had to provide their e-mail address to be able to contact them if problems would have been arisen and to be able to send the hyperlinks to the participants via which the students accessed the questionnaires (see Appendix B for the wording of the message). The BMS Ethics Committee of the University of Twente approved this study (File nr. 190194).

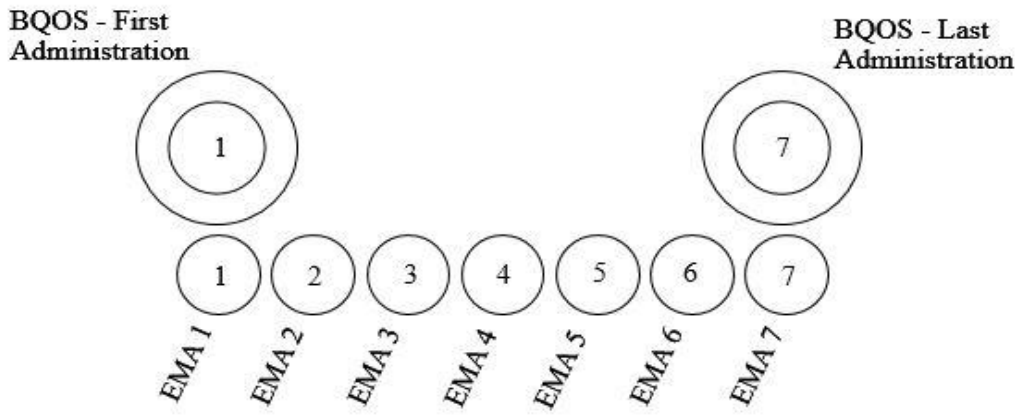

Figure 1. Flowchart for data collection.

Data Analysis

Data Adjustments

There were two major sets of variables, variables that contain information about points in time [hh:mm] and variables that contain information about time spans [mm]. Primarily, the analyses focused on the latter ones since these entail the kind of information that is most interesting: The time spent sitting within a particular domain. In each data set the cases were sorted according to an identifier and after the data was made coherent, the nine data sets (2x BQOS; 7x EMA) were merged into a single one. Moreover, several new variables had to be computed: The total sitting time was calculated for each of the nine questionnaires (9 variables), individual standard deviations of the repeated EMA measures including total sitting time and the domain-specific time spans for each case individually (7 variables), and averaged EMA variables were computed by calculating the mean of all variables for each of the participants (15 variables). Table D1 (see Appendix D) displays a comprehensive overview of all newly computed variables.

RQ 1: How feasible is the original BQOS in its administration? (Feasibility)

The degree to which the BQOS is feasible and easy in its completion was assessed by the evaluation of an incorporated question that asked whether participants experienced any difficulties. If yes, they stated for what reason they had these difficulties. Additionally, relevant comments were taken into account.

RQ 2: How consistent are the results the BQOS produces over a time span of one week as measured by two administrations being seven days apart from each other? (Test-Retest Reliability)

The reliability of the BQOS was estimated using Pearson's r to see whether the test produces consistent results. For each question individually, it was examined whether the degree of consistency was appropriate. Therefore, each variable of the first administration was correlated with the variables of the last administration of the BQOS to assess the test-retest reliability of the questionnaire.

RQ 3: How large is the average total and domain-specific sitting time of full-time students as measured by the original BQOS and EMAs? (Construct Validity)

Means and standard deviations of time points, domain-specific time spans, as well as the total sitting time of each questionnaire provided the first overall impression of the gathered data.

RQ 4: How large is the daily total and domain-specific sitting time variance in a full-time student sample as measured by EMA versions of the BQOS? (Construct Validity)

Since the EMA – version was completed on seven consecutive days, there is data for each day of the week. Hence, the data entails the variation of sitting time of a whole week. This variation, be it large or be it small, indicates how well the BQOS is suited to measure people's average sitting time on a regular day. Therefore, the individual standard deviation for all time span variables of the EMA was computed. For each of the seven variables containing the individual standard deviation, a mean was calculated indicating the average individual standard deviation.

RQ 5: How much do the results of the BQOS and the averaged EMA measures converge in terms of full-time students' average total and domain-specific sitting time? (Construct Validity)

Using the averaged EMA time span variables (7 variables), as well as the appropriate values obtained from the representative BQOS (7 variables for each BQOS), correlation analyses were performed to analyse if, on average, the BQOS provides accurate results. If there is a high correlation between the matched questions – averaged EMA values and the ones of the representative BQOS – the BQOS might really be a proper measurement instrument in assessing average total and domain-specific sitting time. The results were put in a comprehensive correlation matrix.

RESULTS

RQ 1: Feasibility

Only in nine instances, participants reported having experienced difficulties filling in the original BQOS suggesting that filling in the BQOS was feasible to a fairly high degree. Table E1 (see Appendix E) is a coding scheme which includes the exact quotes, where these were retrieved from and to which particular codes they were allocated. There are three out of five codes in total that are relevant in evaluating the feasibility of the BQOS: Day-to-Day Variability (5), Technical Criticism (3), and Invitation Trigger Criticism (3). The numbers within the brackets indicate how many quotes were ascribed to that code.

The main finding is that quotes that have been allocated to the code "Day-to-Day Variability" refer to complaints about the feasibility of the BQOS, in particular because it was difficult to enter averaged time points and spans due to highly variable days. For example, one respondent stressed that *"No day is like the other, it really depends. Thus, it is hard to say those things on average"*. Whereas this code criticises the BQOS on a content level, the two latter codes criticise the implementation and are not primarily complaints about the BQOS.

RQ 2: Test-Retest Reliability

All of the displayed correlations (see table 2) reached significance with a significance level of $p \leq .001$. The correlation of the most interesting variable, "Total Sitting Time" on a university day, is above .7 and, according to Cohen (1988), can be classified as large. This implies that there is a positive relationship between the total sitting time of the first administration and the last administration of the BQOS. Generally, the correlations of the time point variables are greater than the correlations of the time span variables meaning that respondents were consistent in their responses but apparently, they were more consistent with regard to time points than for time spans.

Table 2

Pearson's Correlations of the Matched Variables of the First and Second Administration of the BQOS.

Variables (BQOS 1- BQOS 2)	Pearson's r
University Day	
Time Point: Awakening	.88**
Time Point: Leaving for Uni	.68**
Time Span: Awakening to Leaving	.54**
Time Point: Arriving at Uni	.82**
Time Span: Way to Uni	.85**
Time Point: Leaving Uni	.82**
Time Span: In Uni (removal of two extreme cases)	.58**
Time Point: Arriving at Home	.75**
Time Span: Way Back Home	.85**
Time Point: Sleeping	.77**
Time Span: Home to Sleep	.56**
Time Span: Total Sitting Time (removal of two extreme cases)	.77**
Day Off	
Time Point: Awakening	.83**
Time Point: Sleeping	.78**
Time Span: Total Sitting Time	.63**

Note. * correlation significant at the 0.05 level (two-tailed), ** correlation significant at the 0.01 level (two-tailed).

RQ 3: Construct Validity – Descriptive Statistics

Table 3 displays the descriptive statistics including mean and standard deviation for each variable for the first (BQOS 1) and second (BQOS2) administration of the BQOS and for the averaged EMA variables. Since the study was most interested in the accuracy of sitting time measurements in specific domains as well as the total sitting time, the focus lies on the time span variables which are labelled with "[min]". The mean sitting time of the former only differs marginally across questionnaires: 674.47 minutes (BOQS 1), 660.60 minutes (EMA Average), and 668.23 minutes (BQOS 2). This roughly equals 11 hours of sitting on a day spent at university. On a day off, students only sit 9 hours of their total waking time, meaning a difference of 2 hours in mean total sitting time. It is also worth to mention that the standard deviations of the means indicating total sitting time of a university day are smaller compared to the ones of a day off suggesting that, in terms of sitting time, lives of students are more similar at university days.

Taking a closer look at the domain-specific time span variables, it is remarkable that the mean sitting times of the BOQS 1 and the BQOS 2 are very similar. Comparing these very similar means to the ones of the EMA measures, it is apparent that they are considerably different: For example, the mean of the variable "Awakening to Leaving [min]" is about 18 minutes and the mean of "Home to Sleep [min]" is 20 minutes larger. Putting this into perspective, the mean difference between the means of the two BQOS administrations is only one minute. However, the mean total sitting time, at least for a university day, is nearly the same.

Table 3

Means and Standard Deviations of all Variables as Measured by the First (BQOS 1) and Second (BQOS 2) Administration of the BQOS and the Averaged EMA Measures.

Variables	Mean (SD)		
University Day	BQOS 1	BQOS 2	EMA Measures
Awakening [hh:mm]	7:04 (0:51)	7:04 (0:45)	7:30 (0:52)
Leaving for Uni [hh:mm]	8:37 (1:12)	8:23 (0:53)	9:18 (0:55)
Awakening to Leaving [min]	45.73 (41.33)	46.17 (36.90)	63.72 (29.51)
Arriving at Uni [hh:mm]	8:57 (0:49)	8:51 (0:44)	9:51 (0:50)
Way to Uni [min]	13.70 (20.50)	11.03 (15.28)	13.99 (15.34)
Leaving Uni [hh:mm]	13:55 (1:40)	14:00 (1:42)	14:33 (1:26)
In Uni [min]	245.83 (77.88)	244.50 (81.80)	231.13 (64.87)
Arriving at Home [hh:mm]	14:26 (1:49)	14:42 (1:51)	15:22 (1:39)
Way Back Home [min]	13.70 (20.50)	11.03 (15.39)	16.75 (22.36)
Sleeping [hh:mm]	22:48 (0:56)	23:05 (0:55)	23:26 (1:02)
Home to Sleep [min]	355.50 (98.33)	355.50 (110.66)	335.00 (91.47)
Total Sitting Time [min]	674.47 (97.78)	668.23 (123.22)	660.60 (91.07)
Day Off			
Awakening [hh:mm]	8:38 (1:11)	8:45 (1:05)	8:26 (0:56)
Sleeping [hh:mm]	23:41 (1:14)	23:43 (0:57)	23:29 (0:53)
Total Sitting Time [min]	498.00 (142.16)	557.00 (177.51)	547.08 (145.97)

RQ 4: Construct Validity – Individual Standard Deviations

Whereas the table of the previous section displays standard deviations between-subjects, table 4 includes the means of the within-subjects standard deviation. It is easily visible that not only the between-subject variability is rather high (see Table 3, SDs of the Averaged EMA variables) but also the within-subject variability (see Table 4). For "Awakening to Leaving" (49.84), "In Uni" (87.28), and "Home to Sleep" (97.80), the within-subject variability even exceeds the between-subject variability, yet after removing some outliers. This alone suggests a high variability of sitting time in these specific domains for individuals.

Table 4

Within-Subjects Sitting Time Variability as Indicated by the Means of Individual Standard Deviations for all EMA Time Span Variables.

Variables	Mean of individual SDs [min] (Number of Cases Excluded)	Mean of averaged EMA Measures [min]	Standardised Coefficient of Variation
University Day			
Awakening to Leaving	49.84 (1)	63.72	.78
Way to Uni	8.27 (2)	13.99	.59
Way Back Home	7.10 (3)	16.75	.42
In Uni	87.28 (1)	231.13	.38
Home to Sleep	97.80 (0)	335.00	.29
Total Sitting Time	97.66 (1)	660.60	.15
Day Off			
Total Sitting Time	92.44 (1)	547.08	.17

Generally, a standard deviation that is large suggests that the data is far spread, whereas a small standard deviation indicates that the data is centred around the mean. This statement is, however, relative meaning that the SDs always have to be interpreted with regard to the mean, otherwise, the numbers are meaningless. Thus, the means of the averaged EMA presented in the previous section had to be taken into account too. The coefficient of variation, which is displayed in the last column, is best for this particular purpose because it makes consistent comparison possible. High values indicate a large whereas low values indicate a small variation within a particular domain. The means of the individual standard deviation and the rather larger coefficients of variation point towards a high within-subject sitting time variation in full-time students.

RQ 5: Construct Validity – Correlation Matrix

Table 5 displays the Pearson's correlation between the time span variables of the BQOS 1/BQOS 2 and the averaged EMA. The Pearson's correlations within the brackets are basically a replication to add validity to the findings already presented. They show the correlation of the BQOS 2 time span variables with the averaged EMA variables. Only the correlations of interest, the correlations of the matched variables and each correlation that reached significance, are presented to avoid distraction by too many values.

Table 5

Pearson's Correlations of the BQOS 1/BQOS 2 Time Span Variables and the Averaged EMA Time Span Variables.

Averaged EMAs / BQOS 1 (BQOS 2 in brackets)	1	2	3	4	5	6	7
1. Awakening to Leaving	.29 (.31)	-	-	-	-	-	-
2. Way to Uni	-	.61** (.70**)	-	.48** (.59**)	-	-	-
3. In Uni	-	.36* (-)	.22 (.42*)	-	-.50** (-.43*)	-	-
4. Way Back Home	-	.61** (.69**)	-	.48** (.57**)	-	-	-
5. Home to Sleep	-	-.39* (-)	-	-	.62** (.82**)	-	-
6. Total Sitting Time – Uni Day	-	-	-	-	-	.58** (.63**)	-
7. Total Sitting Time – Day Off	-	-	-	-	-	-	.39* (.70**)

Note. * correlation significant at the 0.05 level (two-tailed), ** correlation significant at the 0.01 level (two-tailed).

The observed pattern implies that, on a general level, participants reported their average sitting time accurately meaning that people who filled in the BQOS and indicated to rather sit a lot, in fact really sit a lot, at least on an average but not necessarily on a daily level. Apart from "Awakening to Leaving", there is at least a moderate positive correlation between the matched variables (≥ .39) taking into account both, the BQOS 1 – averaged EMA correlations and the BQOS 2 – averaged EMA correlations. Not only is there a high domain-specific accuracy in predicting average sitting time but also the variables "Total Sitting Time – Uni Day" and "Total Sitting Time – Day Off" correlate significantly.

Summary of the Results

The BQOS is sufficiently feasible but the code "Day-to-Day Variability" highlights that some students experienced difficulties entering an average value because there was such a high variability between days. Furthermore, the Pearson's correlations between the matched variables of the BQOS 1 and the BQOS 2 show that the consistency of the results over the period of seven days was rather high suggesting an appropriate degree of test-retest reliability.

All of these correlations are significant at the 0.001 level and are at least moderately positive. The descriptive statistics revealed that, on a university day, students sit approximately eleven hours and, on a day off, they sit around nine hours of their total waking time. It appears that, although the within-subject sitting time variation within particular domains was large, full-time students estimated their domain-specific sitting time rather well.

DISCUSSION

The rationale of this study was to validate the Brief Questionnaire on Occupational Sitting developed by Van de Lagemaat (2018) thereby closely adhering to the postulated agenda of Owen et al. (2011) focusing on the development of valuable measurement instruments. The results revealed that the BQOS demonstrates appropriate psychometric properties and, on a content level, provided insights into students' sitting behaviour.

Psychometric Assessment – How valid is the BQOS?

Feasibility

When it came to data analysis, the researcher had to spend some time making the data coherent implying that the instructions might have been too vague. This is in line with Van de Lagemaat (2018) who pointed out that there is no test handbook that prescribes how to treat errors. For example, some people did not enter anything in a particular field where they were meant to enter a "0" or when they went to bed at midnight, there were three different ways of communicating it ("12", "0", or "24"). To enhance its feasibility, the BQOS has to be standardized even more with a clear handbook for the test taker and additionally, clear guidelines that tell the test user how to manage inconsistencies or when to exclude cases.

Test-Retest Reliability

The positive correlations of the variables of the first and second BQOS administration are rather strong implying that the BQOS provides rather consistent results over the time span of one week. Students were more consistent with time points than with time spans. The total sitting time, which might be of most interest for researchers, appears to be very consistent. Specific domains, such as "Awakening to Leaving" and "In Uni" are less consistent. Where students had to enter rather long time spans, as in the case for the mentioned domains, the reliability was compromised. Splitting up the chronological day even more would probably enhance the reliability but simultaneously increase the burden for participants who, in turn, had to spend more time filling in the questionnaire. According to this trade-off, the BQOS succeeds in finding an appropriate length-reliability balance.

Construct Validity

Since the prerequirements of validity, a proper degree of feasibility and reliability were confirmed, the question remains whether the BQOS measures what it claims to measure (de Yébenes Prous et al., 2009): Total and domain-specific sitting time on a regular day. Van de Lagemaat (2018), although not explicitly stated, developed the BQOS on the basis of the definition given by the Sedentary Behaviour Research Network because the questionnaire prescribes that only behaviours that are sedentarily and equal to or below a MET of 1.5 should be considered when entering sitting times although an agreed on definition of sedentary behaviour still is missing (Gibbs et al., 2015; Tremblay et al., 2017). The rationale for developing the BQOS was to have a brief questionnaire that screens for domain-specific sitting times in offices workers because existing ones mostly focus on different populations, mostly children or elderly, or are too long in their administration (Van de Lagemaat, 2018).

Within the drawn sample of full-time students, however, the BQOS does not measure the intended construct, average total and domain-specific sitting time on a regular day, in full-time students because there is no such thing as a regular day. This does not imply, however, that the BQOS is not valid in general but that it is not a suitable measurement instrument to assess full-time students' average sitting time on a regular day due to their high day-to-day sitting time variability. As the data shows, the BQOS still is valid in the sense that it allows for discrimination and comparison between students and that it produces reliable results on an average level. This shows that the questionnaire cannot be simply generalised to other populations other than the one it was intended for (office workers) without any doubts. More precisely, it raises the question whether the BQOS might be population-restricted meaning that it is only an appropriate measurement instrument for populations who fulfil the criterion of having regular days.

Content Analysis – How long do students sit?

On average, students spend approximately eleven hours of their waking time in a sedentary position when attending the university as opposed to only nine hours when absent from university. This converges with the findings of Chau and colleagues (2013) who reported that adults in Western cultures spend nine to eleven hours sitting. Van de Lagemaat (2018) got similar results for office workers who, on average, sit eleven hours on a regular working day. One might understandably wonder why full-time students sit equally long as office workers because evidently, students have to be present at university far less than office workers have to be present at the office. Contrasting to office workers whose presence time at work equals 8.3 hours on a regular working day, students are at university for approximately

4.6 hours. Unfortunately, the gathered data only contains information about the domain itself but not about modes (e.g. eating, watching television, studying, etc.) so that it was not possible to formulate a valid statement about how much of the total study time was spent sitting. Within an office environment, one can assume that, of the time that was spent sitting, all of it is directly related to work. Such an assumption cannot be made for students because many students study at home for several hours as well but the BQOS does not provide the test user with such mode-specific information.

According to Prince et al. (2017), mode-specific questionnaires screening for sitting time might even be more appealing than domain-specific ones. So instead of putting emphasis on the environment, such questionnaires would screen for information on other relevant categories such as the type (in front of a screen/not in front of a screen), the social aspect (alone/with other people), and associated behaviours (e.g. snacking, smoking). According to Chastin et al. (2013), such categories are relevant in the assessment of sedentary behaviour as well. Even though in full-time students, there is great day-to-day variability and little consistency in sitting times within one particular domain, there could still be a low variability with regard to mode-specific sitting times.

Strengths and Limitations

There were two issues of technical nature that had a negative impact on the quality of the results. First, a minor flaw was that the questionnaires did not allow for going back when participants wanted to alter their response, for example, when they made a mistake. Where there was a mistake, participants still had the chance to clarify this in the form of a comment at the end of each questionnaire. Second, the students received the invitation to the next survey 24 hours after the completion of a questionnaire which resulted in an increasing delay of the time point of finishing an EMA as the study went on. For example, for some students, the delay was so large that they had to fill in the EMA for a particular day in the morning of the next one which enlarged the recall bias and, in turn, invaded the quality of the results. As both of these are implementation issues, it would be easy to avoid them in future validation studies by implementing a back button and by a distribution of following questionnaires that occurs immediately after completing one.

Another major limitation that deteriorated the results, especially the test-retest reliability, was the reactive nature of the EMA measurements meaning that the process of filling in one questionnaire each day altered the participants' sensitivity towards their sedentary behaviour (Shiffman et al., 2008). In turn, this had an effect on their responses to the questions of the second BQOS administration. This phenomenon is also reflected in the

relationship of the BQOS 2 variables and the matched variables of the averaged EMA are higher than the ones of the BQOS 1 and the averaged EMA. Participants might have become more aware of how much time they usually spend sitting, but, as you will see in the following paragraph, this is a success in itself.

People whose days vary to a great extent, as in the case of full-time students, could definitely track their sitting time more accurately by means of objective measurements, such as accelerometers (Reilly et al., 2008). It would not demand them to monitor their own sedentary behaviour as precisely as they had to do with the EMA measurements. However, this advantage of objective measurements likewise is an argument for subjective measurements: People do not monitor their sitting behaviour and thus, there is no awareness of one's own sitting habits. In contrast, the EMA measurements encourage people to think about exactly these, as highlighted by a comment of one participant: *"I just realised how much time I am spending with sitting at the moment. Just studying all day long and only riding a bike as time spent with exercise. Glad I did the survey, I really need to something about that"*. Not only was the usage of EMAs helpful in validating the BQOS but also beneficial to students since it has the potential to induce change which connects to the following section.

Implications for Health Psychology and Technology

A measurement instrument which shifts the test taker's attention towards an unhealthy sedentary lifestyle and simultaneously leads to a positive behavioural adjustment is of great value. Regarding the practical value of the BQOS, it could be used an EMA form so that it would satisfy step 2 – the development of measures of the behaviour in question – as well as step 4 – the development of interventions to change behaviour – of the postulated sequences in behavioural epidemiology (Sallis et al., 2000). According to Ainsworth and colleagues (2018), it is now more feasible than ever to implement EMA methods due to technological developments. For example, a wrist band screening tracking one's sitting behaviour connected to an app asking for domain-specific information is one possible option. The gathered data could first be analysed and then be used to provide people with feedback and proposals on how to improve one's sitting habits. Such an approach would be in line with the notion of Gibbs et al. (2015) that data obtained from objective methods (wrist band) and subjective methods (app) is complementary.

Conclusion and Recommendation for Future Research

Van de Lagemaat (2018) already pointed out some of the advantages and flaws of the BQOS: One the one hand, it is relatively brief in its administration and splits up the day chronologically in different domains and parts which provides a comprehensive insight into the test taker's day (from waking up to going to bed). On the other hand, the produced data cannot reveal if a person's sitting pattern is healthy or not because the BOOS does not record interruptions of prolonged sitting.

The present study contributes to the body of research several new aspects that are relevant when considering to use the BQOS for either research or practical health purposes: First, due to the large within-subject sitting time variability of full-time students, there was no regular university day and hence, it cannot be claimed to have measured average total and domain-specific sitting time on a regular day. This crucial finding indicates that the BQOS only provides limited information when used for populations with a large variation in their daily sitting time and cannot be generalised to such populations. Second, although it is not an appropriate measurement instrument for identifying unhealthy sedentary behavioural patterns, it could be used as a brief initial screening tool to get a proper sense of individuals' days and furthermore to discriminate and compare between people. Third, the BQOS demonstrates good psychometric properties: It is feasible, consistent over time, and measures total and domain-specific sitting time, at least on an average level.

Further validation studies are nevertheless necessary to demonstrate the appropriateness of this domain-specific questionnaire. Therefore, similar research should be conducted with a low day-to-day variability sample to contribute to the body of research that validates the BQOS. A study showing that, in such a sample, the BQOS really measures the construct it claims to measure would add a lot of credibility to this questionnaire. Using accelerometers, which are more precise in measuring daily sitting time, as a different kind of validation tool could be of great advantage (Ainsworth et al., 2018). However, only if they were supplemented by a diary to keep track of the domains.

Content related, a similar study setup, substituting the BQOS with another mode-specific questionnaire, could reveal whether or not students also have a high day-to-day sitting time variability when considering modes instead of domains. It might be the case that mode-specific questionnaires are a better tool to use for populations that are high in their sitting time variability (e.g. full-time students) and domain-specific questionnaires such as the BQOS more appropriate for low variability populations (e.g. office workers).

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APPENDIX A - ORIGINAL BQOS

Brief Questionnaire on Occupational Sitting (BQOS – original version)

Vragenlijst Zitgedrag
Het doel van dit onderzoek is onder andere om erachter te komen hoeveel tijd u zittend doorbrengt op een gemiddelde werkdag en vrije dag. De korte, anonieme vragenlijst neemt maximaal 5 minuten in beslag. Het onderzoek wordt uitgevoerd door [naam]. Aan het einde van de vragenlijst wordt gevraagd of u deel zou willen nemen aan één interview van maximaal 20 minuten over uw zitgedrag. Meer uitleg over het interview vindt u bij die vraag. Voordat u begint aan de vragenlijst, vragen we om uw toestemming voor deelname aan het onderzoek (volgende pagina).

Informed Consent: Toestemmingsverklaring voor deelname aan onderzoek over zitgedrag.
Verantwoordelijke onderzoeker:
Afstudeerbegeleider:

Ik verklaar op een voor mij duidelijke wijze te zijn ingelicht over de aard, methode en doel van het onderzoek. Ik weet dat de gegevens en resultaten van het onderzoek alleen anoniem en vertrouwelijk aan derden bekend gemaakt zullen worden. Ik stem geheel vrijwillig in met deelname aan dit onderzoek. Ik behoud me daarbij het recht voor om op elk moment zonder opgaaf van redenen mijn deelname aan dit onderzoek te beëindigen.

Geef aan of u akkoord gaat (gaat u niet akkoord dan kunt u dit scherm afsluiten).

- o Ik ga hiermee akkoord

Wat is uw geslacht?

- o Man
- o Vrouw
- o Anders / wil ik niet zeggen

Wat is uw leeftijd?

Opleidingsniveau (afgeronde opleiding)

- o Basisschool
- o Middelbare school
- o MBO
- o HBO
- o Universiteit
- o Anders, namelijk:

Burgerlijke staat

- o Getrouwd
- o Ongetrouwd

Hoeveel uur werkt u gemiddeld per week voor deze werkgever?

Ga bij deze vraag uit van een **gemiddelde werkdag.**
Bij de groene vragen gaat het om tijdstippen.
Bij de blauwe vragen gaat het om tijdsperiodes.

Voorbeeld van antwoorden op de groene vragen:
7.15 uur vult u zo in: Uren '7' en Minuten '15'.
22.00 uur vult u zo in: Uren '22' en Minuten '00'

Voorbeeld van antwoorden op de blauwe vragen:
Heeft u 20 minuten gezeten, vul dan in: Uren '0' en Minuten '20'.
Heeft u 4.5 uur gezeten, vul dan in: Uren '4' en Minuten '30'

Vul altijd iets in.

	Uren	Minuten
Tijdstip: Hoe laat staat u meestal op voor uw werk?		
Tijdstip: Hoe laat vertrekt u meestal naar uw werk?		
Hoeveel tijd zit u gemiddeld in bovenstaande periode, vanaf opstaan tot vertrek naar uw werk? (Denk aan het ontbijt, voor de televisie, etc.)		
Tijdstip: Hoe laat komt u meestal aan op uw werk?		
Hoeveel tijd zit u gemiddeld in uw reistijd naar werk? (Denk aan de auto, openbaar vervoer, maar tel fietsen niet mee).		
Tijdstip: Hoe laat vertrekt u meestal van uw werk?		
Hoeveel tijd zit u gemiddeld tussen aankomst op uw werk en het verlaten van uw werk? (Denk aan werken aan uw bureau, in pauzes, vergaderingen, etc.)		
Tijdstip: Hoe laat komt u meestal thuis van uw werk?		
Hoeveel tijd zit u gemiddeld in uw reistijd naar huis? (Denk aan de auto, openbaar vervoer, maar tel fietsen niet mee).		
Tijdstip: Hoe laat gaat u meestal slapen na uw werkdag?		
Hoeveel tijd zit u gemiddeld tussen thuiskomst van uw werk en het slapengaan? (Denk aan diner, televisie, computer, op de bank, etc.)		

Ga bij deze vraag uit van een **gemiddelde vrije dag.**
(Zoals het weekend, maar ook doordeweeks als u in het weekend meestal werkt).
Bij de groene vragen gaat het om tijdstippen.
Bij de blauwe vragen gaat het om tijdsperiodes.

Voorbeeld van antwoorden op de groene vragen:
7.15 uur vult u zo in: Uren '7' en Minuten '15'.
22.00 uur vult u zo in: Uren '22' en Minuten '00'

Voorbeeld van antwoorden op de blauwe vraag:
Heeft u 2 uur gezeten, vul dan in: Uren '2' en Minuten '00'
Heeft u 12,5 uur gezeten, vul dan in: Uren '12' en Minuten '30'|
Vul altijd iets in.

	Uren	Minuten
Tijdstip: Hoe laat staat u op een vrije dag meestal op?		
Tijdstip: Hoe laat gaat u meestal slapen op een vrije dag?		
Hoeveel tijd zit u gemiddeld op een vrije dag, in totaal? (Denk aan ontbijt, televisiekijken, dineren, bioscoop, reizen, etc.)		

Maakt u op uw werk wel eens gebruik van middelen om **anders of minder** te zitten?
Denk aan hoge vergadertafels, zit-sta bureaus, zitballen, een kniestoel, bureaufiets, etc.

- ○ Ja, dagelijks of bijna dagelijks
- ○ Ja, elke week wel eens
- ○ Maandelijks
- ○ Misschien een aantal keer per jaar / nooit
- ○ Nee, nooit
- ○ Anders, namelijk:

Heeft u vragen of opmerkingen over het onderzoek? Zo niet, klik op volgende.

Bedankt voor uw deelname aan dit onderzoek. Als u interesse heeft opgegeven voor het interview krijgt u vanzelf bericht van de onderzoeker. Mocht u geïnteresseerd zijn in de uitkomsten van het onderzoek dan kunt u deze opvragen bij [naam, contactgegevens].

APPENDIX B – QUESTIONNAIRES USED

Brief Questionnaire on Occupational Sitting - Translated and Adapted to the University Setting (BQOS 1 and BQOS 2)

Welcome to the research study!

We are interested in the validation of a questionnaire that intends to measure domain-specific sitting time. You will be presented with information relevant to the course of the study and asked to fill in 9 brief surveys over the course of one week. Please be assured that your responses will be kept completely confidential.

The study should take you around one hour to complete (Estimated time for finishing the whole study) and you will receive 1 credit point for your participation. Your participation in this research is voluntary. You have the right to withdraw at any point during the study, for any reason, and without any prejudice. If you would like to contact the principal investigator in the study to discuss this research, please e-mail f.wissmann@student.utwente.nl.

By clicking the 'I consent' button below, you acknowledge that your participation in the study is voluntary, you are 18 years of age, and that you are aware that you may choose to terminate your participation in the study at any time and for any reason.

Please note that this survey will be best displayed on a laptop or desktop computer. Some features may be less compatible for use on a mobile device.

- o I consent
- o I do not consent

Will you attend University at least 4 times in the upcoming 7 days?

- o Yes
- o No

What is you gender?

- o Man
- o Woman
- o Other
- o Do not want to report

What is your age?

What is your highest level of education?

- o Middle School
- o High School
- o Bachelor

- Master
- Other, namely:

On average, how many hours a day do you spend at the university?

Average Day at the University

For the next questions, imagine a regular day at your university.
The green questions ask for points in time.
The blue questions ask for time spans.

Example of answers to the green questions:
7:15 is entered as follows: Hours '7' and Minutes '15'.
You enter 22.00 as: Hours '22' and Minutes '00'

Example of answers to the blue question:
If you sat for 2 hours, enter: Hours '2' and Minutes '00'
If you sat 12.5 hours, enter: Hours '12' and Minutes '30'

Please always enter something.

	Hours	Minutes
When do you usually wake up on a regular day at the university?		
When do you usually leave for university?		
How much time do you spend sitting in the abovementioned period, from waking up to leaving for university? (Think of breakfast, watching television, etc.)		
When do you usually arrive at your university?		
How much time do you spend sitting on your travel to the university? (Think of the car, public transport, but do not count riding a bicycle)		
When do you usually leave your university?		
How much time do you spend sitting while you are in the university environment, between arriving and leaving your university? (Think of lectures, breaks, meetings, etc.)		
When do you usually get home from university?		
How much time do you spend sitting on your way back home? (Think of the car, public transport, but do not count riding a bicycle)		
When do you usually go to bed after a regular day in the university?		
How much time do you spend sitting on average between coming home from university and bedtime? (Think of dinner, television, computer, on the couch, etc.)		

Average Day Off

For the next questions, imagine a regular day off (e.g. the weekend).
The green questions ask for points in time.
The blue questions ask for time spans.

Example of answers to the green questions:
7:15 is entered as follows: Hours '7' and Minutes '15'.
You enter 22.00 as: Hours '22' and Minutes '00'

Example of answers to the blue question:
If you sat for 2 hours, enter: Hours '2' and Minutes '00'
If you sat 12.5 hours, enter: Hours '12' and Minutes '30'

Please, always enter something.

	Hours	Minutes
What time do you usually get up on a day off?		
What time do you usually sleep on a day off?		
How much time do you spend sitting in total on an average day off? (Think of breakfast, watching television, dining, cinema, traveling, etc.)		

How often do you use facilities that reduce sitting time or are alternatives to casual chairs? Think of high conference tables, sit-stand desks, sitting balls, a knee-chair, desk bike, etc.

- Daily, almost daily
- Once or twice a week
- Monthly
- A few times in a year
- Never
- Other, namely:

Did you experience any difficulties while filling in this questionnaire?*

- Yes, namely:
- No

*Not in the actual BQOS; Researcher incorporated this question to assess the feasibility of the BQOS

You have answered many questions and might now have questions you want to ask or comments you would like to share with the researcher. Please use the open space below to do this.

Do you want to continue participating in the study?

- Yes
- No

What is your email address? Please type in the email you check most frequently. Please also make sure that this email address is correct. The hyperlinks will be emailed to this address each day.

Thank you for taking the time to take this survey! Including today, you will receive X more hyperlinks with brief surveys (each of them takes max. 5 minutes to complete) in the next Y days.

Brief Questionnaire on Occupational Sitting - EMA Version

Welcome back research participant!

This brief questionnaire asks you about your sitting time for this particular day, not in general. Please keep this in mind while giving you responses.

Did you attend university today?

- Yes → guides participants to form A), and skips form B)
- No → guides participants to form B), and skips form A)

A) Questionnaire participants receive on days spent at university

Day at the University

The next questions address your sitting time of this particular day.
The green questions ask for points in time.
The blue questions ask for time spans.

Example of answers to the green questions:
7:15 is entered as follows: Hours '7' and Minutes '15'.
You enter 22.00 as: Hours '22' and Minutes '00'

Example of answers to the blue question:
If you sat for 2 hours, enter: Hours '2' and Minutes '00'
If you sat 12.5 hours, enter: Hours '12' and Minutes '30'

Please, always enter something.

	Hours	Minutes
When did you wake up today?		
When did you leave for university today?		
How much time did you spend sitting in the abovementioned period, from waking up to leaving for university? (Think of breakfast, watching television, etc.)		
When did you arrive at your university?		
How much time did you spend sitting on your travel to the university? (Think of the car, public transport, but do not count riding a bicycle).		
When have you left your university today?		
How much time did you spend sitting while you were in the university environment, between arriving and leaving your university? (Think of lectures, breaks, meetings, etc.)		
When did you get home from university?		
How much time did you spend sitting on your way back home? (Think of the car, public transport, but do not count riding a bicycle)		
When will you go to bed today?		
How much time will you spend sitting between coming home from university and bedtime? (Think of dinner, television, computer, on the couch, etc.)		

Did you use a facility that diminishes sitting time or is an alternative to casual chairs today? Think of high conference tables, sit-stand desks, sitting balls, a knee-chair, desk bike, etc.

- Yes
- No

Did you experience any difficulties while filling in this questionnaire?

- Yes, namely:
- No

*Not in the actual BQOS; Researcher incorporated this question to assess the feasibility of the BQOS

You have answered many questions and might now have questions you want to ask or comments you would like to share with the researcher. Please use the open space below to do this.

Do you want to continue participating in the study?

- Yes
- No

What is your email address? Please type in the email you check most frequently. Please also make sure that this email address is correct. The hyperlinks will be emailed to this address each day.

Thank you for taking the time to take this survey! Including today, you will receive X more hyperlinks with brief surveys (each of them takes max. 5 minutes to complete) in the next Y days.

B) Questionnaire participants receive on days they did not attend university

The next questions address your sitting time for this particular day.
The green questions ask for points in time.
The blue questions ask for time spans.

Example of answers to the green questions:
7:15 is entered as follows: Hours '7' and Minutes '15'.
You enter 22.00 as: Hours '22' and Minutes '00'

Example of answers to the blue question:
If you sat for 2 hours, enter: Hours '2' and Minutes '00'
If you sat 12.5 hours, enter: Hours '12' and Minutes '30'

Please, always enter something.

	Hours	Minutes
What time did you get up today?		
What time will you go to sleep today?		
How much time do you think you spend sitting today? (Think of breakfast, watching television, dining, cinema, travelling, etc.)		
*Of the abovementioned time span, how much time was dedicated to university-related activities? (Think of self-study, group meetings, writing assignments etc.)		

*This is no question of the original BQOS and was incorporated to screen for sitting dedicated to studying on a day off

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Did you use a facility that diminishes sitting time or is alternatives to casual chairs today? Think of high conference tables, sit-stand desks, sitting balls, a knee-chair, desk bike, etc.

- o Yes
- o No

Did you experience any difficulties while filling in this questionnaire?

- o Yes, namely:
- o No

*Not in the actual BQOS; Researcher incorporated this question to assess the feasibility of the BQOS

You have answered many questions and might now have questions you want to ask or comments you would like to share with the researcher. Please use the open space below to do this.

Do you want to continue participating in the study?

- Yes
- No

What is your email address? Please type in the email you check most frequently. Please also make sure that this email address is correct. The hyperlinks will be emailed to this address each day.

Thank you for taking the time to take this survey! Including today, you will receive X more hyperlinks with brief surveys (each of them takes max. 5 minutes to complete) in the next Y days.

Informed Consent

Welcome to the research study!

We are interested in the validation of a questionnaire that intends to measure domain-specific sitting time. You will be presented with information relevant to the course of the study and asked to fill in 9 brief surveys over the course of one week. Please be assured that your responses will be kept completely confidential.

The study should take you around one hour to complete (Estimated time for finishing the whole study) and you will receive 1 credit point for your participation. Your participation in this research is voluntary. You have the right to withdraw at any point during the study, for any reason, and without any prejudice. If you would like to contact the Principal Investigator in the study to discuss this research, please e-mail f.wissmann@student.utwente.nl.

By clicking the 'I consent' button below, you acknowledge that your participation in the study is voluntary, you are 18 years of age, and that you are aware that you may choose to terminate your participation in the study at any time and for any reason. Please note that this survey will be best displayed on a laptop or desktop computer. Some features may be less compatible for use on a mobile device.

- I consent
- I do not consent

E-mail Instructions

Dear research participant,

hereby you receive the hyperlink to the next survey: hyperlink

This is the x$^{st/nd/th}$ out of nine surveys in total. I suggest that you answer the survey in the evening because you have to answer questions that address your sitting time on one particular day. After you completed this survey, you will receive the next link in one day. Please be aware that you will only receive your SONA credit points when you finish the whole course of the study. Thanks for your effort!

If you have any questions or comments, do not hesitate to get into touch.

Warm wishes,
Fabian Wißmann

APPENDIX C – BACK-AND-FORTH TRANSLATION

Table C1

Back-and-Forth Translation of the BQOS for Instructions, Questions, and Answer Options.

Original BQOS - Dutch	Translated Items - English
Instructions	
Ga bij deze vraag uit van een gemiddelde werkdag/vrije day.	For the next questions, imagine a regular working day/day off.
Bij de groene vragen gaat het om tijdstippen.	The green questions ask for points in time.
Bij de blauwe vragen gaat het om tijdsperiodes.	The blue questions ask for time spans.
Voorbeeld van antwoorden op de groene vragen:	Example of answers to the green questions:
7.15 uur vult u zo in: Uren '7' en Minuten '15'.	7:15 is entered as follows: Hours '7' and Minutes '15'.
22.00 uur vult u zo in: Uren '22' en Minuten '00'	You enter 22.00 as: Hours '22' and Minutes '00'
Voorbeeld van antwoorden op de blauwe vragen:	Example of answers to the blue question:
Heeft u 20 minuten gezeten, vul dan in: Uren '0' en Minuten '20'.	If you sat for 2 hours, enter: Hours '2' and Minutes '00'
Heeft u 4.5 uur gezeten, vul dan in: Uren '4' en Minuten '30'	If you sat 12.5 hours, enter: Hours '12' and Minutes '30'
Vul altijd iets in.	Please always enter something
Questions	
Hoe laat staat u meestal op voor uw werk?	When do you usually wake up on a regular working day?
Hoe laat vertrekt u meestal naar uw werk?	When do you usually leave for work?
Hoeveel tijd zit u gemiddeld in bovenstaande periode, vanaf opstaan tot vertrek naar uw werk? (Denk aan het ontbijt, voor de televisie, etc.)	How much time do you spend sitting in the abovementioned period, from waking up to leaving for work? (Think of breakfast, watching television, etc.)
Hoe laat komt u meestal aan op uw werk?	When do you usually arrive at your work?

Hoeveel tijd zit u gemiddeld in uw reistijd naar werk? (Denk aan de auto, openbaar vervoer, maar tel fietsen niet mee)	How much time do you spend sitting on your way to work? (Think of the car, public transport, but do not count riding a bicycle)
Hoe laat vertrekt u meestal van uw werk?	When do you usually leave your work?
Hoeveel tijd zit u gemiddeld tussen aankomst op uw werk en het verlaten van uw werk? (Denk aan werken aan uw bureau, in pauzes, vergaderingen, etc.)	How much time do you spend sitting while you are at work, between arriving and leaving your work? (Think of lectures, breaks, meetings, etc.)
Hoe laat komt u meestal thuis van uw werk?	When do you usually get home from work?
Hoeveel tijd zit u gemiddeld in uw reistijd naar huis? (Denk aan de auto, openbaar vervoer, maar tel fietsen niet mee)	How much time do you spend sitting on your way back home? (Think of the car, public transport, but do not count riding a bicycle)
Hoe laat gaat u meestal slapen na uw werkdag?	When do you usually go to bed after a regular working day?
Hoeveel tijd zit u gemiddeld tussen thuiskomst van uw werk en het slapengaan? (Denk aan diner, televisie, computer, op de bank, etc.)	How much time do you spend sitting on average between coming home from work and bedtime? (Think of dinner, television, computer, on the couch, etc.)
Hoe laat staat u op een vrije dag meestal op?	What time do you usually get up on a day off?
Hoe laat gaat u meestal slapen op een vrije dag?	What time do you usually go to bed on a day off?
Hoeveel tijd zit u gemiddeld op een vrije dag, in totaal? (Denk aan ontbijt, televisiekijken, dineren, bioscoop, reizen, etc.)	How much time do you spend sitting in total on an average day off? (Think of breakfast, watching television, dining, cinema, travelling, etc.)
Maakt u op uw werk wel eens gebruik van middelen om anders of minder te zitten? (Denk aan hoge vergadertafels, zit-sta bureaus, zitballen, een kniestoel, bureaufiets, etc.)	How often do you use facilities that reduce sitting time or are alternatives to casual chairs? (Think of high conference tables, sit-stand desks, sitting balls, a knee-chair, desk bike, etc.)
Hoeveel uur werkt u gemiddeld per week voor deze werkgever?	How many hours a week do you work for your employer?

Answer Options

Uren	Hours
Minuten	Minutes
Ja, dagelijks of bijna dagelijks	Yes, daily or almost daily
Ja, elke week wel eens	Yes, sometimes in each week
Maandelijks	Monthly
Misschien een aantal keer per jaar	Maybe a few times in a year
Ne, nooit	No, never
Anders, namelijk:	Other, namely:

APPENDIX D – NEWLY COMPUTED VARIABLES

Table D1

Comprehensive Overview of Newly Calculated Variables.

Total Sitting Time	Averaged EMA	Individual SDs
	Form A – University Day	Form A – University Day
BQOS 1 – Uni Day [min]	Awakening [hh:mm]	
BQOS 2 – Uni Day [min]	Leaving for Uni [hh:mm]	
EMA 1 – Form A [min]	Awakening to Leaving [min]	Awakening to Leaving [min]
EMA 2 – Form A [min]	Arriving at Uni [hh:mm]	
EMA 3 – Form A [min]	Way to Uni [min]	Way to Uni [min]
EMA 4 – Form A [min]	Leaving Uni [hh:mm]	
EMA 5 – Form A [min]	In Uni [min]	In Uni [min]
EMA 6 – Form A [min]	Arriving at Home [hh:mm]	
EMA 7 – Form A [min]	Way Back Home [min]	Way Back Home [min]
	Sleeping [hh:mm]	
	Arrival Home to Sleep [min]	Arrival Home to Sleep [min]
	Total Sitting Time [min]	Total Sitting Time [min]
	Form B – Day Off	Form B – Day Off
	Awakening [hh:mm]	
	Sleeping [hh:mm]	
	Total Sitting Time [min]	Total Sitting Time [min]

APPENDIX E – CODING SCHEME

Table E1

Coding Scheme including concrete Quotes and Final Codes.

Quote	Questionnaire	Retrieved from	Final Code
"My schedule changed a lot and the time university starts and ends differ."	BQOS 1	Feasibility	Day-to-Day Variability
"Every day is different and you have often different plans after the lectures/tutorials, e.g. going to the library afterwards. But that is not every day but sometimes."	BQOS 1	Feasibility	Day-to-Day Variability
"No day is like the other, it really depends. Thus, it is hard to say those things on average."	BQOS 1	Feasibility	Day-to-Day Variability
"It was a little difficult to enter the time I arrive and leave from university, because they always differ so I just chose to use my "morning time" and use it as an average, because sometimes I only have classes in the morning and sometimes only in the afternoon."	BQOS 1	Feasibility	Day-to-Day Variability
"There is no going back to the previous question button."	BQOS 1	Feasibility	Technical Criticism
"I just realised how much time I am spending with sitting at the moment. Just studying all day long and only riding a bike as time spend with exercise. Glad I did the survey, I really need to something about that!"	EMA 1	Qsts. & Cmts.	Benefit

“Today is my birthday, so this weekend I did nothing for university. I usually spent much time studying every weekend.”	EMA 2	Qsts. & Cmts.	Informative
“In the second survey, I made a mistake in regard to the question asking for the day. I answered that the day way a Sunday, when it actually was a Saturday. I wanted to go back and change my answer after seeing my mistake but there was no arrow to go back.”	EMA 2	Qsts. & Cmts.	Technical Criticism
“I do not like that each questionnaire is sent to you 24h after you have filled it in. It would be nice if it was sent to you every morning at 9.”	EMA 4	Qsts. & Cmts.	Invitation Trigger Criticism
“I accidentally filled out that today is Monday but I meant Tuesday.”	EMA 4	Qsts. & Cmts.	Informative
“There is no “Back” button and at first I chose the wrong day. Luckily I could open the link on my phone.”	EMA 4	Feasibility	Technical Criticism
“At the beginning I received the mails in the evening and now I receive them in the morning and I am not sure whether to fill it out according to the last day or this day.”	EMA 5	Feasibility	Invitation Trigger Criticism
“The questionnaire is sent to you 24 hours after you filled it in. Sometimes I am not able to answer the questions at the same time the next day.”	EMA 5	Feasibility	Invitation Trigger Criticism
“Each day is different.”	BQOS 2	Feasibility	Day-to-Day Variability