Testing the Effectiveness of Strength-based Interventions in Increasing Motivation and Decreasing Mental Fatigue of Students

Master's Thesis (400997-M-24)

Final Version

Word Count: 9384

Research Master in Psychology: Individual Differences and Assessment

Tilburg University

Manon Enting

SNR: 2001921

Supervisor: dr. G. H. van Roekel

Date: 02-07-2021

Abstract

In the present study, we aimed to examine whether a strength-based intervention was effective in decreasing mental fatigue levels and increasing adaptive motivation levels of university students (N = 104, M_{age} = 20.152 years, SD_{age} = 3.118, 75.24% female). Participants completed daily diary questionnaires on their smartphones for five weeks and were randomly assigned to either a signature strengths intervention condition (n = 52) or an ideal strengths intervention condition (n = 52). Two-level random time-series analyses within the Dynamic Structural Equation Modeling framework were performed to examine the mean level changes of mental fatigue and adaptive motivation from pre-intervention phase (T = 14 days) to the intervention phase (T = 21 days). Moreover, we tested whether mean level changes differed between the intervention conditions. As expected, we found a significant increase in mean levels of adaptive motivation in the intervention phase compared to the pre-intervention phase (p < .001). Contrary to our predictions, there was no decrease in mean levels of mental fatigue in the intervention phase compared to the pre-intervention phase (p = .208). Also, no significant differences between the two intervention conditions were found in mean level changes of adaptive motivation (p = .478) and mental fatigue (p = .798). Altogether, this study shows the potential of both signature strengths interventions and ideal strengths interventions for increasing adaptive motivation levels of students.

Keywords: daily diary questionnaires, students, strength-based intervention, adaptive motivation, mental fatigue

Testing the Effectiveness of Strength-Based Interventions in Increasing Motivation and Decreasing Mental Fatigue of Students

High work pressure, emotional exhaustion, and a high risk of burnout are common problems for students of Dutch universities (LSVb, 2017). Even though a high risk of burnout is a frequent and increasing problem in most modern societies, previous research shows that this risk is especially prevalent in the student population, with 34.6% of the students having a high risk of burnout compared to 14.6% in the healthy working population (LSVb, 2017). Mental health problems have even further increased during the COVID-19 pandemic, with students from Dutch universities reporting higher levels of depression, anxiety, loneliness, and gloom than before the pandemic (Caring Universities, 2020; van der Velden et al., 2020). One way to overcome this high prevalence of mental health problems is to focus on student's strengths rather than their deficits. Strengths are defined by Linley and Harrington (2006) as "the natural capacity for behaving, thinking, or feeling in a way that allows optimal functioning and performance in the pursuit of valued outcomes" (p. 88). Using and developing strengths is related to optimal functioning, such that individuals who use their strengths wisely are more likely to work efficiently and effectively. If students are better aware of their strengths and use them more wisely, this might help them to work more efficiently and effectively, resulting in less work pressure and subsequently an improved mental health.

Researchers have come up with classifications of strengths to better facilitate strength identification (Quinlan et al., 2011). An influential classification in the field of positive psychology is the Character Strengths and Virtues classification by Peterson and Seligman (2004). This framework classifies 24 character strengths that can be distinguished in the following virtues: wisdom, courage, humanity, justice, temperance, and transcendence. The classification of character strengths is frequently used in strength-based interventions aimed at increasing well-being, in which individuals are encouraged to use their signature strengths, usually operationalized as the top five most prominent character strengths (Quinlan et al., 2011). Strength-based interventions focus on three processes, namely the identification, development, and usage of character strengths (Meyers & van Woerkom, 2016). In these

interventions, participants reflect on their signature strengths, cultivate and refine these strengths, and use them more often or in a new way in their daily life (Seligman et al., 2005). A literature review by Ghielen et al. (2017) found that strength-based interventions have multiple benefits, such as increased well-being, higher work-engagement, and increased personal growth initiative. Furthermore, a recent meta-analysis by Schutte and Malouff (2018) showed that signature strengths interventions had a significant impact on positive affect or happiness, depression, life satisfaction, and an increase in the use of signature strengths. Altogether, these studies suggest that signature strength-based interventions are promising tools with beneficial effects for several life outcomes (Schutte & Malouff, 2018).

To date, most strength-based interventions focus on increasing well-being, personal growth, engagement, and on decreasing depression and anxiety (Ghielen et al., 2017; Schutte & Malouff, 2018). Less is known about other constructs related to students' wellbeing, such as mental fatigue. As mentioned before, many students suffer from emotional exhaustion, experience high work pressure, and have a high risk of burnout (LSVb, 2017). These problems are closely related to mental fatigue, which can be operationalized as the cognitive aspects of fatigue (Vercoulen et al., 1994). Previous research shows that using and developing strengths is related to optimal functioning, such that individuals who use their strengths wisely are more likely to work efficiently and effectively (Linley & Harrington, 2006), potentially resulting in lower work pressure and consequently lower mental fatigue levels. Furthermore, some studies have suggested that focusing on human strengths might counteract exhaustion (Schaufeli et al., 2002). Hence, it is relevant to examine if using strengths reduces mental fatigue levels of students.

Besides examining mental fatigue levels, it is also relevant to examine whether using signature strengths can increase motivation levels of students, given that the motivation of students plays an important role in achievements in school and the enjoyment of studying (Schunk et al., 2008). Martin et al. (2015) found that motivation can be both adaptive and maladaptive, with adaptive motivation reflecting positive cognitions such as self-efficacy, valuing, and mastery orientation (Liem & Martin, 2020). Specifically, adaptive motivation was

defined by Martin et al. (2015) as “the individuals’ inclination, energy and drive to learn, work effectively and achieve their potential” (p. 28). Working on signature strengths might result in increased adaptive motivation of students because using character strengths allows for optimal functioning and thus achieving one’s potential. Owens et al. (2021) found that strengths use positively predicted academic meaning in university students, which is not the same as adaptive motivation, but closely related as it is defined as the “academic/educational goals and pursuit that are personally valuable and significant, foster personal growth, and can potentially help others” (p. 5). Based on these studies, the question arises whether signature strengths can also be used to increase adaptive motivation of students, which might increase their energy and drive to learn and help them in achieving their potential (Martin et al., 2015).

Types of Strength-based Interventions

In addition to signature strengths interventions that were described before, recent studies have also tested strength-based interventions in which the lesser strengths were used (Proyer et al., 2015). Lesser strengths were defined by Proyer et al. (2015) as the character strengths that participants possessed at the lowest degree. Overall, the lesser strengths intervention was equally effective as the signature strengths intervention in terms of happiness, decreasing depressive symptoms, enjoyment, and benefits (Proyer et al., 2015). Remarkably, the effectiveness of the lesser strengths intervention compared to the signature strengths intervention was dependent on how much strengths participants reported to possess. Participants who reported to have many strengths benefitted most from the lesser strengths intervention, while participants who reported to have only few strengths benefitted more from the signature strengths intervention. Furthermore, Proyer et al. (2015) suggested that the effectiveness of signature strengths interventions versus lesser strengths interventions might also depend on the individual character strengths-profile of the participants. To summarize, Proyer et al. (2015) show that there are individual differences in the effectiveness of signature strengths interventions and lesser strengths interventions. It is

therefore relevant to take individual differences into account when testing the effectiveness of strength-based interventions.

Up till now, it remains unclear to what extent individual differences in the effectiveness of strength-based interventions exist, although it is known that strengths are dynamic constructs that highly depend on contextual situations (Biswas-Diener et al., 2011). One way to take the dynamic nature of strengths into account is to use ambulatory assessment measures, in which short questionnaires are repeatedly released to participants' smartphones (van Roekel et al., 2019). Using this approach has several advantages because assessing participants in their natural environment results in ecologically valid measurements and less retrospective bias (Himmelstein et al., 2019). In addition, the multilevel structure of the ambulatory assessments data allows for examining both within- and between-person changes. To our knowledge, there are only few studies that used ambulatory assessments to examine strength use at both the within-person and the between-person level (Merritt et al., 2018; van Woerkom et al., 2015). One of these studies found daily variations in opportunities to apply signature strengths in daily life (Merritt et al., 2018), which shows that the application of strength use in daily life is not fixed, but rather different across days. Hence, we can imply that having assessments of multiple days is beneficial because using strengths might be more effective on some days than on others. Altogether, this emphasizes the need for measuring the effectiveness of strength-based interventions with ambulatory assessments to take both individual differences and the dynamic nature of strengths into account.

Present Study

In the present study, an online strength-based intervention was proposed with a signature strengths intervention condition and a newly proposed ideal strengths intervention condition. The ideal strengths intervention condition was closely related to the lesser strengths intervention condition by Proyer et al. (2015), although the ideal strength is a strength that participants would like to develop to become more in line with their ideal self, rather than a strength that is possessed at the lowest degree. An advantage of using ideal

strengths is that participants actively choose to work on this strength. Therefore, it is prevented that participants work on lesser strengths they do not find important.

Effectiveness of the Intervention

The effectiveness of the intervention was assessed in multiple ways. First, the effectiveness of the intervention was examined with descriptive analyses regarding the compliance rates, drop-out rates, and self-reported participant burden. The aim of these analyses was to find out whether participants became less compliant over time, if and after how long they dropped out, and if they experienced higher participant burden in the intervention phase than in the pre-intervention phase. The results from these analyses can be used to assess the effectiveness of the intervention in terms of adherence to the intervention.

Secondly, we aimed to investigate whether mean levels of mental fatigue changed in the intervention phase compared to the pre-intervention phase. Specifically, were there mean level changes in mental fatigue levels in the intervention phase compared to the pre-intervention phase? Given previous research on strength use (Linley & Harrington, 2006; Schaufeli et al., 2002), we expected that mental fatigue levels would decrease more in the intervention phase compared to the pre-intervention phase. In addition, we examined whether mean level changes in mental fatigue levels differed between types of interventions. Studies from the field of personality psychology found that well-being interventions are more tiring for participants who have to act in a way that is not in line with their personality (Jacques-Hamilton et al., 2019). In the present study, we wanted to investigate whether this also holds for character strengths. Character strengths are very similar to personality in that they are also relatively stable personal characteristics that can be developed to some extent through psychological activities and experiences (Linley & Harrington, 2006). We expected a discrepancy between the ideal strengths and actual strengths, but no discrepancy between signature strengths and actual strengths, meaning that participants in the signature strengths intervention condition used strengths that were more in line with their actual strengths.

Therefore, we expected that decreases in mental fatigue would be highest in the signature strengths intervention condition.

Thirdly, we aimed to examine whether the mean levels of adaptive motivation changed in the intervention phase compared to the pre-intervention phase. Given previous research suggesting that strength use positively predicts academic meaning (Owens et al., 2021), we expected that adaptive motivation would increase in the intervention phase compared to the pre-intervention phase. In addition, we examined whether mean level changes in adaptive motivation levels differed between types of interventions. Specifically, did participating in a signature strengths versus an ideal strengths intervention result in different changes in levels of adaptive motivation from pre-intervention to intervention phase? Participants in the ideal strengths intervention condition are possibly more focused on personal growth and reaching their potential because they work on improving a strength they would like to use more in daily life rather than focusing on an already prominent strength. Therefore, we expected that increases in levels of adaptive motivation in the intervention phase compared to the pre-intervention phase would be higher in the ideal strengths intervention condition than in the signature strengths intervention condition.

All in all, the present study contributes to the scientific literature in several ways. First, the present study proposed a new type of intervention based on ideal strengths and compares it to the frequently used signature strengths intervention. Secondly, this study examined the effectiveness of strength-based interventions at both the between-person and within-person level. In a previous study on strengths use in college students it was suggested that longitudinal studies on strengths use are needed (Owens et al., 2021). Using ambulatory assessments, it is possible to investigate the effectiveness of strength-based interventions in students' natural settings, but also to make inferences about the effectiveness of the intervention at the individual level. It is conceivable that the intervention was very effective for some individuals, but not so effective for others. If there are large individual differences in the effectiveness of this intervention, this might indicate that no one size fits all and that individually tailored strength-based interventions are needed in the future. For instance, it is

conceivable that working on signature strengths is more effective for some participants, while working on ideal strengths is more effective for others. Altogether, the results from this study can provide useful insights for improving strength-based interventions in the future.

Method

This study was preregistered before data analysis (https://osf.io/z65ew/).

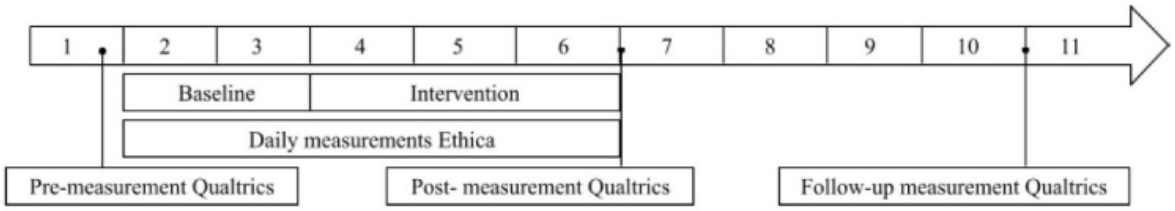
Participants

Participants were undergraduate students from a Dutch university (M_{age} = 20.152 years, SD_{age} = 3.118, 75.24% female). Eight students were excluded from the initial sample because they did not participate in the intervention, resulting in a final sample of 104 participants. Due to time constraints, we were unable to perform power analyses with Monte Carlo simulations before data collection. Therefore, power analyses were performed for a more basic model, to have an indication of the sample size needed for the study. Power analyses for a repeated-measures ANOVA with a within-between factors interaction were performed in G*Power 3.1 for the smallest effect size of interest (Cohen's F = .1). In a simpler model with less measurement occasions (T = 10) than in the present study only 80 participants were needed. This gives some indication that there is enough power to detect small effects in the present study with 104 participants and more measurement occasions (T = 35).

Participants were recruited via announcements shared in courses of undergraduate students. The data collection of the pre-measurements started a few days before the start of the daily diary questionnaires. Given the short time frame of the study, we continued with participant recruitment during the data collection of the pre-measurements. We only included participants that completed the pre-measurement before the data collection of the daily diary questionnaires had started, since the informed consent form of the study was included at the beginning of this questionnaire. See Figure 1 for a visual representation of the timeline of the study.

Figure 1

Visual Representation of Study Timeline



Measures

Pre-measurement

The gender, age, field of study, and highest completed education of participants were collected in the pre-measurement. The pre-measurement also included the VIA-IS-P survey (McGrath, 2019) to assess the signature strengths of participants. This 96-item questionnaire measures the 24 character strengths as classified by Peterson and Seligman (2004) on a 5-point Likert scale.

Daily Diary Questionnaires

All other measures were time-variant and collected via the daily diary questionnaires. The daily diary questionnaires consisted of a minimum of 33 items and a maximum of 56 items (see Appendix A). Three items (*Time spend alone*, *Which strength did you use today: choose one or more VIA character strengths*, and *How often did you use this strength*) were presented depending on previous answers, namely if a participant indicated to have been alone during the day or if they had used one or more VIA character strengths during the day. Based on a small pilot study amongst students we suspected that the average responding time for these questions is approximately six to eight minutes. A more detailed description of the daily diary items used for this study are given below.

Mental fatigue. Mental fatigue was measured with 5 items from the subscale Concentration in the Checklist Individual Strength (Vercoulen et al., 1994) on a VAS scale. Example items are "*Today, I had difficulties with thinking*" and the reversed item "*Today, if I was working on something I could keep track of my thoughts*". The composite score of mental fatigue was computed by averaging the 5 items. As suggested by Lai (2021), we

calculated the composite reliability (ω^{2l} = 0.405), within-level reliability (ω^{w} = 0.338), and between-level reliability (ω^{b} = 0.575) of mental fatigue (see Appendix B for formulae). These estimates indicated low reliability of the mental fatigue items at the composite level, between-level, and within-level.

Adaptive Motivation. Adaptive motivation was measured with 3 items from the adaptive motivation scale of the of the Motivation and Engagement Wheel (Martin et al., 2015) on a VAS scale. The composite score of adaptive motivation was computed by averaging the scores on the following items: "*I believe I did good work*", *"I learnt something important and useful"*, and "*I was focused on learning and improving more than competing and being the best*". Again, we calculated the composite reliability (ω^{2l} = 0.824), within-level reliability (ω^{w} = 0.783), and between-level reliability (ω^{b} = 0.848) of adaptive motivation. These estimates indicated that the reliability of the items was good at the composite level, between-level, and within-level.

Self-reported Participant Burden. One item was included to measure the self-reported participant burden. In this VAS scale item participants were asked to indicate how easy it was for them to participate in the study during the day. In other words, this implies that the self-reported participant burden was lowest if the participants scored high on this item.

Attention Check. Previous studies suggested that it is important to identify and screen out careless responders in ambulatory assessment studies to ensure the quality of the self-report data, reduce bias, and decrease measurement error (Eisele et al., 2020; Schneider et al., 2018). One item was included in the daily questionnaires to flag observations in which participants did not respond attentively. This momentary attention measure was assessed with the following item: "*I filled in the questionnaires attentively*" (Eisele et al., 2020). There were no clear guidelines for using this item to exclude inattentive observations, therefore we only used this item to explore how attentiveness in the observations fluctuated over time and whether it differed much between participants.

Procedure

Intervention

The strength-based intervention consisted of four character strength exercises per week. Participants were asked to complete these exercises in which they either reflected on or used their character strengths in a new way in their daily life. The intervention duration was three weeks, in which participants focused on a different strength every week while completing the weekly exercises. The exercises were released in Ethica Data (2021) at the start of every intervention week. Participants were randomly assigned to the signature strengths intervention condition (n_{sig} = 52) or the ideal strengths intervention condition (n_{ideal} = 52) with the random number generator function in SPSS. The only difference between these conditions was the usage of signature strengths versus ideal strengths when completing the weekly exercises.

Ethical Considerations

Ethical approval for the study was provided by the Ethical Review Board of the affiliated university (Project RP370). We did not expect any negative consequences for the mental health of participants, still we did inform participants about whom they could contact if they experienced such problems. Also, we reminded participants of their rights to withdraw from the study at any time without further explanation. Other ethical considerations in this study concern the time investment for participants, which can be high in ambulatory assessments. To decrease time burden, we decided to keep the length of the daily questionnaires short and the number of daily assessments low. We used a fixed time schedule and let participants chose a time in the evening they found most convenient for receiving reminders to complete the questionnaires.

Data Collection

Figure 1 shows the chronological order of data collection. First of all, participants completed the pre-measures, which also included the informed consent form. The data collection of the daily diary questionnaires started a few days after the start of the pre-measures and lasted for five weeks. The daily diary questionnaires were released to

participants' smartphones using the Ethica Data software (Ethica Data, 2021). The first two weeks of the daily diary data were collected in the pre-intervention phase. In the second week of the pre-intervention phase, participants were randomly assigned to either a signature strengths intervention condition or ideal strengths intervention condition. Participants assigned to the ideal strength condition completed an additional survey before the start of the intervention phase, in which they indicated their ideal strengths by checking six strengths from a list of 24 VIA Character Strengths. The three ideal strengths were selected for every participant by randomly choosing three of the six selected ideal strengths. To make sure that the three randomly chosen ideal strengths were not similar to the three signature strengths, we controlled for the top three signature strengths when randomly selecting the ideal strengths. Ideal strengths were defined in the ideal strengths questionnaire as follows: "*The ideal self may be defined as the person you would like to be, but have not yet become. In other words, your true self refers to characteristics that you ideally would like to possess, according to your personal hopes and aspirations. Please take a moment to reflect on your ideal self and specifically think about which strengths would characterize your ideal self.*".

After the pre-intervention phase, there were three more weeks of daily diary data collection in the intervention phase. The post-measure took place directly after the intervention phase ended and the follow-up measurement took place four weeks after the intervention ended. Participants that completed at least 80% of the daily diary questionnaires and all pre-, post-, and follow-up measurements were rewarded with course credits at the end of the study.

Analyses

Compliance Rates, Participant Burden, and Drop-out Rates

The calculations for compliance rates, participant burden, and drop-out rates were performed in R version 4.0.1.

Estimation Procedure Dynamic Structural Equation Models

Two-level random time-series analyses within the DSEM framework were performed in Mplus version 8.3 (Muthén & Muthén, 1998-2017) to examine differences between the pre-intervention phase and the intervention phase and to examine the effect of intervention condition on the differences between the pre-intervention and intervention phase. All models were estimated with Bayesian Estimation and a Markov chain Monte Carlo (MCMC) algorithm that allowed for estimating a large number of random effects (Hamaker et al., 2018). We specified a minimum number of 2000 iterations and set the Potential Scale Reduction (PSR) criterion to < 1.01. Trace plots were inspected to check if convergence of the models was reached. Bayesian estimation with the MCMC algorithm makes use of the conditional posterior to sample missing data. Within this approach, the neighboring observations from an individual, the individuals' autoregressive parameter at the current iteration, and the uncertainty explained by the residual variance are used to sample the missing values (Hamaker et al., 2018).

Model Specification Dynamic Structural Equation Models

To answer the research questions, we specified two-level time-series models with random intercepts, random slopes, and random residual variances. Firstly, the dummy variable phase (0 = pre-intervention, 1 = intervention) was modeled on adaptive motivation at the within-level. The results from this model were used to answer the first research question, namely whether the mean levels of adaptive motivation differed between the pre-intervention and intervention phase. Second, the dummy variable condition (0 = signature strengths intervention condition, 1 = ideal strengths intervention condition) and a cross-level interaction between phase and condition was added, to investigate whether the effect of phase on mean levels of adaptive motivation differed per condition. Thirdly, time trends were added to the model, to check whether an increase/decrease in adaptive motivation was already present in the pre-intervention phase. Time trends were specified as the slope in the entire study period and the change in the slope in the intervention phase. When the slope change was significant and in an opposite direction as the slope, we also calculated the slope in the

intervention phase by summing the slope in the pre-intervention phase and the slope change, as suggested by Huitema and McKean (2000). Finally, an interaction between time trends and condition was modeled to examine whether time trends differed between conditions. The models described above were also estimated for mental fatigue, resulting in a final number of eight estimated models.

Exploratory Analyses: Standardized Person Specific Effect Sizes

As suggested by Grice et al. (2020) we performed additional non-preregistered analyses for the person specific effect sizes. Group-based inferences might not give a comprehensive picture of the effectiveness of the intervention, therefore person specific effect sizes are useful for calculating the percentage of participants that behaved in line with theoretical expectations. We used the cluster option in Mplus to estimate the effect of intervention separately for every participant. The estimated standardized person specific effect sizes from Mplus were loaded into R (version 4.0.1) with the MplusAutomation package (version 0.8) to visually display the effect sizes in histograms.

Deviations from the Preregistration

Some deviations from our preregistration were made. First of all, we excluded participants who did not participate in the intervention, which was not specified in the preregistration. The reason for excluding these participants was that participants who did not participate in one of the intervention conditions were not of interest for testing the hypotheses of the present study. Secondly, we specified in the preregistration that the time-varying variables mental fatigue and adaptive motivation would be centered, however we later realized that this was not needed because the default options for centering in DSEM were sufficient. Thirdly, we did not perform sensitivity analyses for drop-outs because Mplus did not allow missing values on the condition variable. It was thus impossible to check the results for participants who did not specify a condition in Ethica. Estimating if the effect of the intervention differed for drop-outs did not make sense anyways, since they did not participate in the intervention. However, we did check if the personal characteristics (age, gender) of drop-outs differed from the rest of the participants, which was not the case. Lastly, we

deviated from an initial (but not preregistered) plan to include an additional control condition. During the data collection of the pre-measurements it was decided that too little participants signed up to test three conditions.

Results

Compliance Rates, Participant Burden, and Drop-out Rates

First of all, the effectiveness of the intervention in terms of compliance rates, drop-out rates, and self-reported participant burden was examined to answer the descriptive research questions. The descriptive statistics can be found in Table 1. The overall compliance rate across all observations in the final sample was 92.38%. The compliance rates in the final sample differed from the compliance rates in the initial sample because excluded participants were less compliant in the daily diary questionnaires than participants in the final sample. Furthermore, the self-reported participant burden of participants was rather low, with an average score of 80.203 on a scale from 0 (*high participant burden*) to 100 (*low participant burden*). Finally, the overall drop-out rate of the intervention was 8.93%. Our preregistered definition of drop-outs were participants who did not complete the daily diary questionnaires during the final eight days of the study (n = 2), participants who dropped out as a participant in Ethica software (n = 0) or participants who communicated to the researchers that they dropped out of the study (n = 0). However, we later decided to also count participants who did not participate in the intervention (n = 5) and participants who were non-compliant in the intervention (n = 3) as drop-outs because these participants can also be considered as not completely participating in the study until the end.

To ensure data quality, we also explored whether the attentiveness in the daily diary questionnaires fluctuated over time and differed between participants. Descriptive statistics showed that the average score of attention across all participants did not fluctuate much over time. The mean composite score of attention was 90.288 across all observations, 90.820 during the pre-intervention phase, and 90.132 during the intervention phase. We flagged some inattentive observations (0.58%) with a score lower than 30 on the attention item, although most of the observations (75.19%) included scores of at least 80. Finally, we found

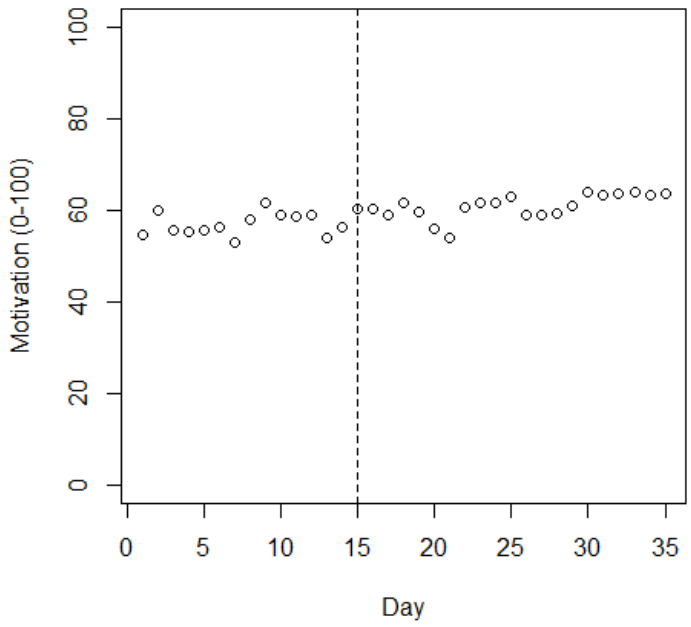
individual differences in attentiveness, with individual mean scores of attention ranging from 55.969 to 100. Altogether, this suggests that most participants filled in the questionnaires attentively.

Descriptive Statistics

Mean levels of adaptive motivation and mental fatigue were inspected to get an idea of the mean level changes in the study. The mean composite score of adaptive motivation was 56.884 (*SD* = 23.002) during the pre-intervention phase and 60.860 (*SD* = 21.656) during the intervention phase. The mean composite score of mental fatigue was 43.078 (*SD* = 22.288) during the pre-intervention phase and 41.517 (*SD* = 21.969) during the intervention phase. The mean levels of adaptive motivation and mental fatigue aggregated by day are displayed in Figure 2 and 3.

Figure 2

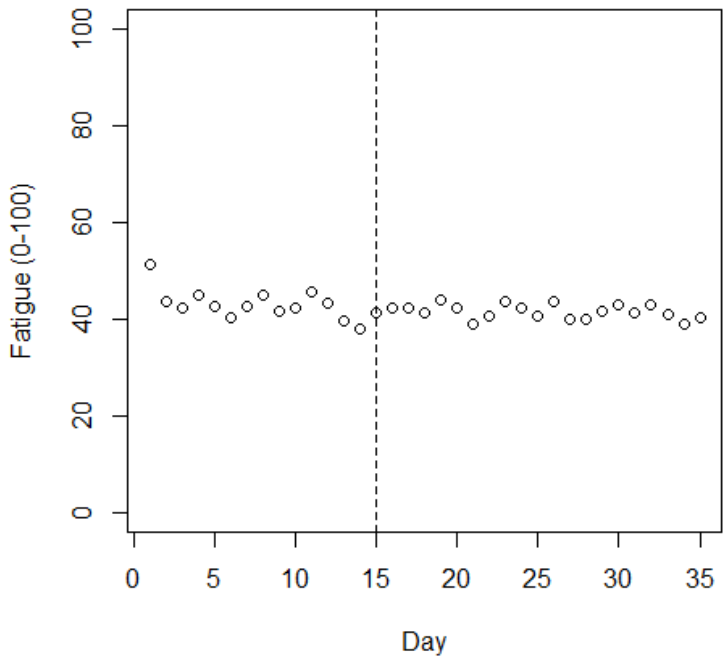
Mean Levels of Adaptive Motivation Aggregated by Day



Note. The vertical striped line represents the start of the intervention phase for most of the participants.

Figure 3

Mean Levels of Mental Fatigue Aggregated by Day



Note. The vertical striped line represents the start of the intervention phase for most of the participants.

Randomization Checks

Randomization checks were performed to check if the mean levels of adaptive motivation, mental fatigue, self-reported participant burden, and attention were significantly different between conditions in the pre-intervention phase. Independent samples t-tests showed no significant differences between the signature strengths intervention condition and ideal strengths intervention condition in the pre-intervention phase for mental fatigue (M_{sig} = 42.707, M_{ideal} = 43.456; t(1348) = -0.617, p = .537), adaptive motivation (M_{sig} = 57.325, M_{ideal} = 56.434; t(1348) = 0.711, p = .477), self-reported participant burden (M_{sig} = 81.032, M_{ideal} = 81.351; t(1349) = -0.251, p = .802), and attention (M_{sig} = 90.295, M_{ideal} = 91.356; t(1349) = -1.385, p = .166).

Mean Level Changes in Adaptive Motivation

Two-level random time series analyses within the DSEM framework were performed to examine mean level changes in adaptive motivation in the intervention phase compared to the pre-intervention phase. The unstandardized parameter estimates of these DSEM models

are shown in Table 2. First of all, the effect of phase on adaptive motivation was significant, indicating a significant increase in mean levels of adaptive motivation in the intervention phase compared to the pre-intervention phase. These findings support our hypothesis that adaptive motivation levels would increase in the intervention phase compared to the pre-intervention phase. There was no effect of condition on adaptive motivation levels and the effect of phase on adaptive motivation did not differ between conditions as indicated by a non-significant cross-level interaction between phase and condition. Hence, we found no support for the hypothesis that increases in adaptive motivation were higher in the ideal strengths intervention condition than in the signature strengths intervention condition.

Time Trends

Time trends were added to the model to investigate whether the mean level change in adaptive motivation was gradual or abrupt and to test if increase in adaptive motivation was already present in the pre-intervention phase. Adding time trends to the DSEM model showed a non-significant slope, but a significant positive slope change. These findings illustrate a gradual increase in adaptive motivation that was not present in the pre-intervention phase. It should be noted that adding time trends to the model changed the interpretation of the phase variable because in the time trends model it represents the level change in mean levels of adaptive motivation immediately after the start of the intervention rather than at the end of the intervention. The phase variable was not significant anymore in the time trends model, suggesting no significant level changes in adaptive motivation immediately after the start of the intervention. Lastly, the cross-level interaction between time trends and condition was not significant, meaning that the time trends were similar for both the signature strengths intervention condition and the ideal strengths intervention condition.

Mean Level Changes in Mental Fatigue

Two-level random time series analyses within the DSEM framework were conducted to examine mean level changes in mental fatigue in the intervention phase compared to the pre-intervention phase. The unstandardized parameter estimates of these DSEM models are shown in Table 3. The effect of phase on mental fatigue was not significant, indicating no

significant mean level changes in mental fatigue in the intervention phase compared to the pre-intervention phase. Moreover, there was no significant effect of condition on mean levels of mental fatigue and the effect of phase on mental fatigue did not differ between conditions as indicated by a non-significant cross-level interaction between phase and condition. These results were not in line with our expectations because we expected a significant negative effect of phase on mental fatigue levels and a significant cross-level interaction between phase and condition.

Time Trends

Even though no significant mean level changes in mental fatigue were found, we still added time trends to check the change patterns over time. As before, adding time trends to the model changed the interpretation of the phase variable because in the time trends model it represents the level change in mean levels of mental fatigue immediately after the start of the intervention rather than at the end of the intervention. Table 3 displays the unstandardized parameter estimates of the time trends models. The phase variable was significant, indicating a significant level change in mean levels of mental fatigue immediately after the start of the intervention. Furthermore, we found a significant negative slope of mental fatigue, implying a significant decrease in mental fatigue levels that already started in the pre-intervention phase. Lastly, there was a significant positive slope change. Summing the slope and slope change estimates resulted in an unstandardized estimate for the slope in the intervention phase of -0.088.

Sensitivity Analyses

Sensitivity analyses for missing data were planned if the difference in drop-out rates between conditions was equal to or higher than fifty percent. Since the difference in drop-out rates was only 3.58%, we did not perform these analyses.

Exploratory Analyses: Standardized Person Specific Effect Sizes

In addition to the preregistered analyses, we also estimated the person specific effect sizes to examine the percentage of participants for which the theoretical expectations held. Specifically, we estimated the effect size of phase on adaptive motivation and mental fatigue

for every participant separately. It should be noted that we had less power for these person specific effect sizes that only used individual observations, restricting the number of data points per effect size to a maximum of 35.

The exploratory analyses revealed that the standardized person specific effect size of phase on adaptive motivation was only significant for six out of 104 participants (5.77%). A histogram including the standardized person specific effect sizes of all participants is displayed in Figure 4. From this figure can be implied that standardized person specific effect sizes ranged from -0.126 to 0.786, with a positive effect for most of the participants. Moreover, the standardized person specific effect of phase on mental fatigue was significant for only one of the 104 participants (0.96%). The standardized person specific effect sizes for all participants are displayed in Figure 5.

Figure 4

Histogram of Standardized Person Specific Effect Sizes of Phase on Adaptive Motivation

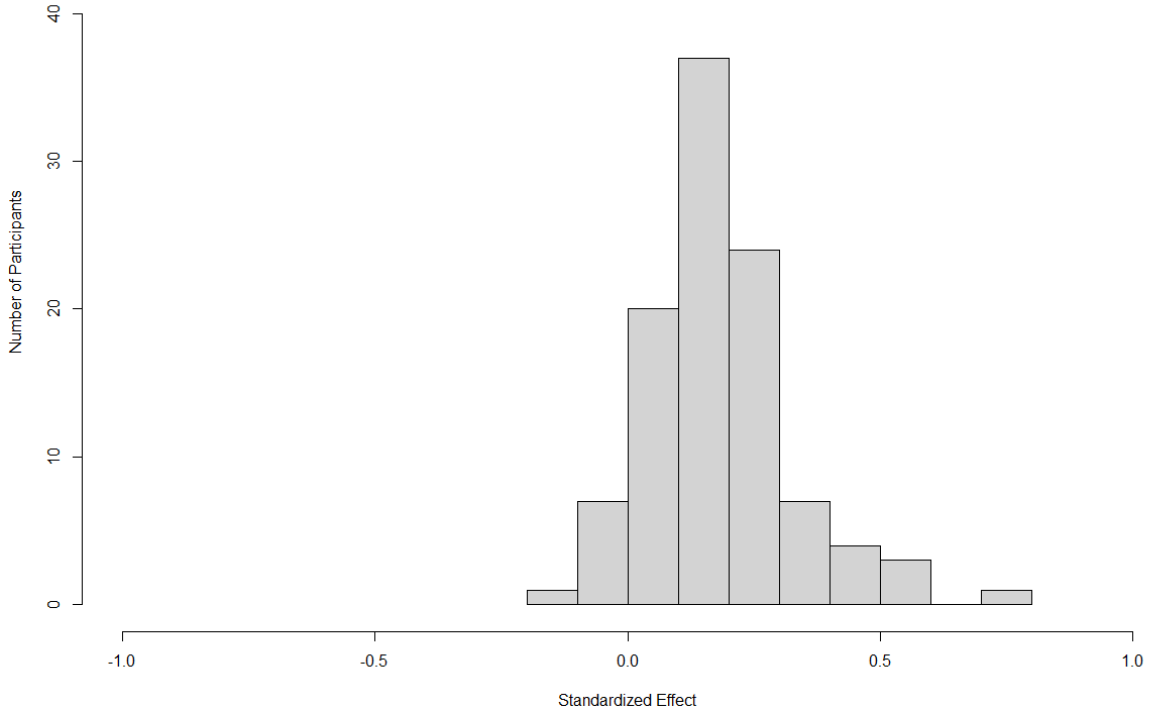


Figure 5

Histogram of Standardized Person Specific Effect Sizes of Phase on Mental Fatigue

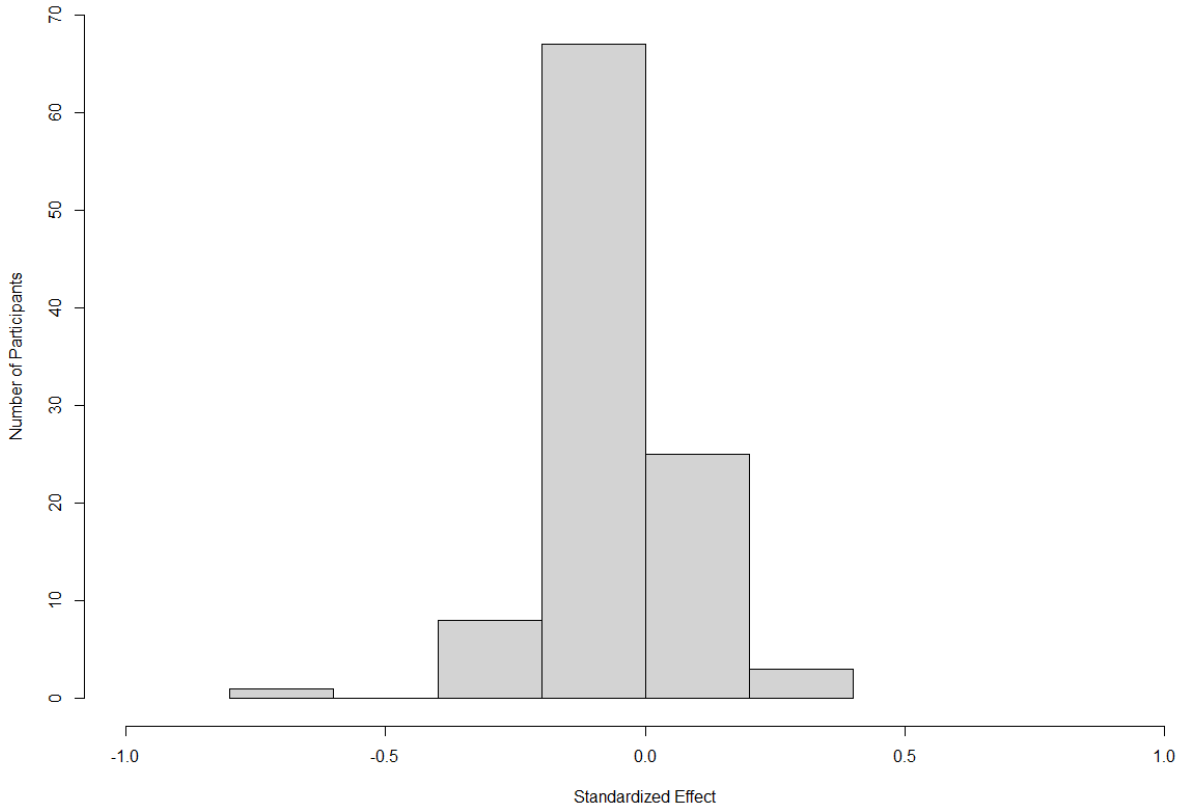


Table 1

Descriptive Statistics for Compliance Rates, Drop-outs, and Self-reported Participant Burden

	Final sample (*N* = 104)			Signature Strengths Condition (*n* = 52)			Ideal Strengths Condition (*n* = 52)		
	Pre-intervention	Intervention	Total	Pre-intervention	Intervention	Total	Pre-intervention	Intervention	Total
Compliance daily diary questionnaires	93.04%	91.93%	92.38%	92.53%	91.44%	92.88%	93.55%	92.42%	91.88%
Compliance intervention	-	-	96.15%	-	-	96.15%	-	-	100%
Self-reported participant burden	81.190	80.036	80.203	81.351	80.581	80.127	81.032	79.494	80.900
Drop-out rates[a]	4.46%	4.46%	8.93%	-	3.85%	3.85%	-	0.00%	0.00%

[a] Eight participants dropped out the study because they did not participate in the intervention. These participants are not included in the calculation of the drop-out rates for the conditions separately.

Table 2

Model Convergence, Model Fit, and Unstandardized Parameter Estimates for Adaptive Motivation in DSEM Models

	Model 1	Model 2	Model 3	Model 4
PSR (iterations)	1.005 (2,500)	1.002 (2,800)	1.005 (6,700)	1.008 (18,200)
Deviance (pD[a])	29635.427 (487.531)	29646.937 (493.219)	29593.521 (517.106)	29582.426 (507.099)
Intercept	57.146*** [54.209; 60.015]	57.649*** [53.378; 61.725]	56.923*** [53.825; 60.058]	57.642 *** [52.800; 62.413]
AR Mot[b]	0.162*** [0.120; 0.203]	0.160*** [0.119; 0.199]	0.137*** [0.098; 0.176]	0.136*** [0.096; 0.176]
Phase	2.845*** [1.639; 4.051]	3.303*** [1.476; 5.117]	0.433 [-0.939; 2.057]	1.970 [-0.903; 4.853]
Condition		-0.849 [-6.797; 4.984]		-1.409 [-7.902; 5.183]
Phase*Condition		-0.934 [-3.345; 1.653]		-2.137 [-5.406; 1.064]
Slope			0.016 [-0.109; 0.137]	-0.002 [-0.263; 0.262]
Slope Change			0.227* [0.055; 0.411]	0.144 [-0.188; 0.473]
Slope*Condition				0.018 [-0.284; 0.321]

Slope	0.136 [-0.256; 0.545]
Change*Condition	

[a] pD is the estimated number of parameters. [b] AR Mot is the autoregressive effect of adaptive motivation. *p <.05. **p <.01. ***p < .001

Table 3

Model Convergence, Model Fit, and Unstandardized Parameter Estimates for Mental Fatigue in DSEM Models

	Model 1	Model 2	Model 3	Model 4
PSR (iterations)	1.007 (2,100)	1.006 (4,500)	1.008 (24,300)	1.008 (21,400)
Deviance (pD[a])	30272.477 (496.123)	30271.536 (493.970)	30230.783 (488.498)	30234.093 (492.739)
Intercept	42.743*** [40.019; 45.519]	42.691*** [38.828; 46.674]	46.257*** [43.235; 49.384]	46.211*** [41.666; 50.963]
AR Fat[b]	0.168*** [0.130; 0.210]	0.170*** [0.130; 0.209]	0.156*** [0.117; 0.195]	0.157*** [0.116; 0.196]
Phase	-0.820 [-2.177; 0.434]	-1.120 [-3.086; 0.979]	2.751** [0.075; 0.278]	2.205 [-1.326; 5.667]
Condition		0.324 [-5.083; 5.517]		0.031 [-6.272; 6.366]
Phase*Condition		0.356 [-2.211; 3.112]		0.927 [-3.619; 5.701]
Slope			-0.378*** [-0.577; -0.197]	-0.394** [-0.717; -0.103]
Slope Change			0.290*** [0.080; 0.526]	0.375* [0.053; 0.743]
Slope*Condition				0.050 [-0.361; 0.450]

Slope change*Condition	-0.161 [-0.618; 0.280]

[a] pD is the number of estimated parameters. [b] AR Fat is the autoregressive effect of mental fatigue.*p <.05. **p <.01. ***p < .001

Discussion

This study aimed to test the effectiveness of a strength-based intervention in multiple ways. First of all, the compliance rates, self-reported participant burden, and the drop-out rates were examined to investigate how well participants adhered to the intervention and how much effort it took them to participate. Secondly, we tested the effectiveness of the strength-based intervention by examining mean level changes in adaptive motivation and mental fatigue. Finally, we estimated person specific effect sizes to explore whether effects on the group-level were similar to effects on the individual level.

Descriptive analyses illustrated that compliance in the daily questionnaires and the intervention was high, while the self-reported participant burden and drop-out was low. The drop-out rate was lower than most of the drop-out rates documented in previous strength-based intervention studies (Ghielen et al., 2017). This was the first study to examine the compliance in the intervention and participant burden on a daily level. We did not find much fluctuations in compliance rates and participant burden over time. Even though we only calculated average compliance rates and average participant burden rates, our results already give some indication that participants did not lose much interest to participate in the intervention over time. Also, the results give some indication that self-reported participant burden did not change much in the intervention phase.

Next, two-level time series were performed to test the effectiveness of the intervention in increasing adaptive motivation levels and decreasing mental fatigue levels. In line with our expectations, we found a significant increase in mean levels of adaptive motivation in the intervention phase compared to the pre-intervention phase. Adding time trends to the model showed that the increase in adaptive motivation was gradual and did not start in the pre-intervention phase. This finding adds to the existing literature that strength-based interventions not only have a positive impact on happiness or positive affect, academic meaning, well-being, life satisfaction, and personal growth initiative (Ghielen et al., 2017; Owens et al., 2021; Schutte & Malouff, 2018), but also on adaptive motivation. Interestingly, exploratory analyses showed that the standardized person specific effect size of the

intervention on adaptive motivation was positive for most of the participants, but only significant for 5.77% of the participants. This could mean that the intervention was effective on the group level, but most often not on the individual level. However, it is more likely that there was not sufficient power to estimate the standardized person specific effect sizes, since only 35 observations per participant were used to estimate these effect sizes.

The mean levels of mental fatigue did not differ significantly between the pre-intervention phase and the intervention phase. Interestingly, the direction of the slope and slope change for mental fatigue were reversed. The negative slope indicated a decrease in mental fatigue that already started in the pre-intervention phase, while the positive slope change and the small negative slope in the intervention phase indicated that decreases in mental fatigue leveled off during the intervention phase. These results suggest that the strength-based intervention was presumably not effective in decreasing mental fatigue levels. A possible explanation for these results might be the presence of external study-related factors during the study period. In the pre-intervention phase, participants were less busy than in the final weeks of the study because the exam period of students started immediately after the intervention ended. These external study-related factors might have influenced mental fatigue levels in addition to any effects of the intervention. Previous research indeed found that exam stress is one of the most important stressors for university students (Abouserie, 1994; LSVb, 2017). The onset of exam stress differs between persons, with some persons experiencing stress already more than a week before the exams start, while others only experience stress the day before the exams (LSVb, 2017). This suggests that the extent to which external study-related factors might have affected our results differs between participants. Another possible explanation for the absence of an effect is that the within-level, between-level, and composite reliability of the mental fatigue items were low. This might have been due to the heterogeneity of the mental fatigue items. Given the low reliability, our results regarding mental fatigue levels should be interpreted with caution because it remains unclear if the items accurately measured mental fatigue levels.

Finally, the effect of intervention did not differ between conditions, not for adaptive motivation and not for mental fatigue. These findings suggest that the intervention was equally effective when using signature strengths versus ideal strengths. This was not in line with our hypotheses because we expected the signature strengths intervention to be more effective for decreasing mental fatigue. Even though previous research from the field of personality psychology has shown that working on personality traits that are not in line with one's actual personality is more tiring (Jacques-Hamilton et al., 2019), we found no evidence that working on ideal strengths was more tiring for participants than working on signature strengths. Furthermore, we did not find differences between the ideal strengths intervention condition and the signature strengths intervention condition in mean level changes of adaptive motivation. Even though we expected a higher increase in adaptive motivation in the ideal strengths intervention, this hypothesis was not supported in the present study.

Strengths and Limitations

The present study had some strengths and limitations. An important strength was the usage of daily ambulatory assessments to examine the effectiveness of the intervention. This method is highly ecologically valid because it allows for examining the effectiveness of the strength-based intervention in students' natural settings. Furthermore, having multiple assessments for every participant enabled us to examine both within- and between-person changes. Moreover, the strength-based interventions were individually tailored based on the top three signature strengths or ideal strengths of participants. Finally, the daily assessments provided rich information on the dynamics of adaptive motivation and mental fatigue before and during the intervention phase, making it possible to check for time trends and see whether increases/decreases were already present before the intervention phase.

Nevertheless, there were some limitations that should be considered when interpreting the results. First of all, there was no control group, making it difficult to examine whether external factors might have affected the mean levels of adaptive motivation and mental fatigue regardless of intervention effects. An example of an external factor that might have affected the results was the exam period that was already mentioned before. This event

might have resulted in increases in adaptive motivation and increases in mental fatigue in addition to any effects of the intervention. Even though it is likely that motivation increases in the weeks before the exam period, this does not necessarily mean that adaptive motivation increases. As mentioned earlier, adaptive motivation concerns positive cognitions regarding motivation, which is not per se the same as motivation to study for exams. Hence, it is not self-evident that the increase in adaptive motivation was only due to the exam period. Furthermore, a control group would have allowed us to examine whether mental fatigue levels increased due to the upcoming exam period. In the intervention conditions it remains a possibility that the mental fatigue levels of students increased in addition to any decreases in mental fatigue due to the intervention, canceling out the effect of the intervention and resulting in only a small decrease in mental fatigue in the intervention phase.

Secondly, we did not take the type of character strengths into account when examining the effectiveness of the strength-based intervention. The effectiveness might depend on which of the 24 different character strengths participants worked on. Some character strengths (*e.g.* love) might be easier to work on in daily life than others (*e.g.* leadership), also depending on the daily activities of the students. For instance, it might be easier for a student who works as a team leader in a grocery store to apply the leadership character strength in daily life than for a student who has no side job. Previous research indeed shows that sufficient opportunities to apply strengths are needed to make a strength-based intervention successful (Harzer & Ruch, 2012; Merritt et al., 2018). Furthermore, the effectiveness of the intervention might depend on the constellation of character strengths that participants worked on during the intervention. Allan (2015) suggested that strength-based interventions should take the interdependence of character strengths into account because a right balance between character strengths can increase the impact of the intervention. All in all, this shows that the effectiveness of strength-based interventions might also be influenced by the type of character strength. For future research it might be interesting to take the daily activities of participants and the constellation of targeted character strengths into account when examining the effectiveness of the intervention.

Thirdly, we received feedback from participants on how our study could be improved. Some participants indicated the need for more reminders during the week to apply their strengths in daily life. Some researchers indeed incorporate reminders in strength-based interventions to encourage participants to actively participate in the intervention and to contact researchers with questions or concerns if needed (Seligman et al., 2005). These reminders can be easily implemented in Ethica Data software and will help participants with getting most out of the intervention. Moreover, some participants would have liked more information on how to apply their strengths in daily life. For future intervention studies it may be considered to plan video calls with participants before the start of the intervention, so that participants can ask the researcher for examples on how to use their strengths in their daily life. Finally, some participants indicated that the pandemic restricted their opportunities to apply their strengths in daily life. Even though using strengths might increase the adaptive motivation of students in times of pandemic, this also shows that the pandemic possibly limits the effectiveness of the intervention due to restricted opportunities to apply strengths in daily life. It is thus recommended to replicate these findings after the pandemic, to check whether the intervention is more effective when there are more opportunities to apply strengths. Altogether, these experiences from participants provide useful insights in how to improve strength-based interventions in the future.

Conclusion

The present study shows that strength-based interventions positively impact adaptive motivation levels of students, but that more research is needed to test the effect of the intervention on mental fatigue levels. Furthermore, the study shows that the signature strengths intervention and ideal strengths intervention were equally effective in increasing adaptive motivation levels of students. The present study also highlights the need for well-powered studies that take individual differences into account when examining the effectiveness of strength-based interventions. The significant random effects already revealed variation in the effectiveness of the intervention, although it remains unclear whether there was enough power to explore these individual differences with person specific

effect sizes. To properly explore these individual differences with person specific effect sizes, it is recommended to look into the number of observations that is needed to make solid conclusions, while also making sure that the participant burden remains as low as possible. All in all, the present study moves the field of strength-based interventions forward by showing the potential of both signature strengths interventions and ideal strengths interventions in increasing adaptive motivation levels of students.

References

Abouserie, R. (1994, 1994/01/01). Sources and Levels of Stress in Relation to Locus of Control and Self Esteem in University Students. *Educational Psychology, 14*(3), 323-330. https://doi.org/10.1080/0144341940140306

Allan, B. A. (2015). Balance among Character Strengths. *Journal of Happiness Studies, 16*, 1247-1261.

Biswas-Diener, R., Kashdan, T. B., & Minhas, G. (2011). A dynamic approach to psychological strength development and intervention. *The Journal of Positive Psychology, 6*(2), 106-118. https://doi.org/10.1080/17439760.2010.545429

Caring Universities. (2020). *De geestelijke gezondheid van studenten tijdens de COVID-19 pandemie: De eerste voorlopige data uit het Caring Universities consortium*.

Ebesutani, C., Regan, J., Smith, A., Reise, S., Higa-McMillan, C., & Chorpita, B. F. (2012, 2012/06/01). The 10-Item Positive and Negative Affect Schedule for Children, Child and Parent Shortened Versions: Application of Item Response Theory for More Efficient Assessment. *Journal of Psychopathology and Behavioral Assessment, 34*(2), 191-203. https://doi.org/10.1007/s10862-011-9273-2

Eisele, G., Vachon, H., Lafit, G., Kuppens, P., Houben, M., Myin-Germeys, I., & Viechtbauer, W. (2020, Sep 10). The Effects of Sampling Frequency and Questionnaire Length on Perceived Burden, Compliance, and Careless Responding in Experience Sampling Data in a Student Population. *Assessment*, 1073191120957102. https://doi.org/10.1177/1073191120957102

Ethica Data. (2021). https://ethicadata.com/

Ghielen, S. T. S., van Woerkom, M., & Christina Meyers, M. (2017). Promoting positive outcomes through strengths interventions: A literature review. *The Journal of Positive Psychology*, 1-13. https://doi.org/10.1080/17439760.2017.1365164

Grice, J. W., Medellin, E., Jones, I., Horvath, S., McDaniel, H., O'lansen, C., & Baker, M. (2020). Persons as Effect Sizes. *Advances in Methods and Practices in Psychological Science, 3*(4), 443-455. https://doi.org/10.1177/2515245920922982

Hamaker, E. L., Asparouhov, T., Brose, A., Schmiedek, F., & Muthen, B. (2018, Nov-Dec). At the Frontiers of Modeling Intensive Longitudinal Data: Dynamic Structural Equation Models for the Affective Measurements from the COGITO Study. *Multivariate Behav Res, 53*(6), 820-841. https://doi.org/10.1080/00273171.2018.1446819

Harzer, C., & Ruch, W. (2012). The Application of Signature Character Strengths and Positive Experiences at Work. *Journal of Happiness Studies, 14*(3), 965-983. https://doi.org/10.1007/s10902-012-9364-0

Himmelstein, P. H., Woods, W. C., & Wright, A. G. C. (2019, Jul). A comparison of signal- and event-contingent ambulatory assessment of interpersonal behavior and affect in social situations. *Psychol Assess, 31*(7), 952-960. https://doi.org/10.1037/pas0000718

Huitema, B. E., & McKean, J. W. (2000). Design Specification Issues in Time Series Intervention Models. *Educational and Psychological Measurement, 60*(1), 38-58.

Jacques-Hamilton, R., Sun, J., & Smillie, L. D. (2019, Sep). Costs and benefits of acting extraverted: A randomized controlled trial. *J Exp Psychol Gen, 148*(9), 1538-1556. https://doi.org/10.1037/xge0000516

Lai, M. H. C. (2021, Feb). Composite reliability of multilevel data: It's about observed scores and construct meanings. *Psychol Methods, 26*(1), 90-102. https://doi.org/10.1037/met0000287

Liem, G. A. D., & Martin, A. J. (2020). The Motivation and Engagement Scale: Theoretical Framework, Psychometric Properties, and Applied Yields. *Australian Psychologist, 47*(1), 3-13. https://doi.org/10.1111/j.1742-9544.2011.00049.x

Linley, P. A., & Harrington, S. (2006). Playing to your strengths. *The Psychologist, 19*, 86-89.

LSVb. (2017). *Van succes-student naar stress-student. Hoe groot is het probleem?* https://lsvb.nl/wp-content/uploads/2017/10/LSVb-2016-Onderzoeksrapport-mentale-gezondheid-van-studenten.pdf

Martin, A. J., Papworth, B., Ginns, P., Malmberg, L.-E., Collie, R. J., & Calvo, R. A. (2015). Real-time motivation and engagement during a month at school: Every moment of every day for every student matters. *Learning and Individual Differences, 38*, 26-35. https://doi.org/10.1016/j.lindif.2015.01.014

McGrath, R. E. (2019). *Technical Report: The VIA Assessment Suite for Adults: Development and initial evaluation*. VIA Institute on Character.

Merritt, S., Huber, K., & Bartkoski, T. (2018). Application of signature strengths at work: A dual-level analysis. *The Journal of Positive Psychology, 14*(1), 113-124. https://doi.org/10.1080/17439760.2018.1519589

Meyers, M. C., & van Woerkom, M. (2016). Effects of a Strengths Intervention on General and Work-Related Well-Being: The Mediating Role of Positive Affect. *Journal of Happiness Studies, 18*(3), 671-689. https://doi.org/10.1007/s10902-016-9745-x

Muthén, L. K., & Muthén, B. O. (1998-2017). *Mplus User's Guide* (8th ed. ed.). Muthén & Muthén.

Owens, R. L., Allan, B. A., Maslowski, A. K., & Murphy, P. K. (2021). Strengths Use, Environmental Factors, and Academic Outcomes in Newly Matriculated College Students. *International Journal of Applied Positive Psychology*. https://doi.org/10.1007/s41042-020-00049-1

Peterson, C., & Seligman, M. E. P. (2004). *Character Strengths and Virtues : A Handbook and Classification*. Oxford University Press, Incorporated. http://ebookcentral.proquest.com/lib/uvtilburg-ebooks/detail.action?docID=279797

Proyer, R. T., Gander, F., Wellenzohn, S., & Ruch, W. (2015). Strengths-based positive psychology interventions: a randomized placebo-controlled online trial on long-term effects for a signature strengths- vs. a lesser strengths-intervention. *Front Psychol, 6*, 456. https://doi.org/10.3389/fpsyg.2015.00456

Quinlan, D., Swain, N., & Vella-Brodrick, D. A. (2011). Character Strengths Interventions: Building on What We Know for Improved Outcomes. *Journal of Happiness Studies, 13*(6), 1145-1163. https://doi.org/10.1007/s10902-011-9311-5

Schaufeli, W. B., Salanova, M., González-Romá, V., & Bakker, A. B. (2002). The Measurement of Engagement and Burnout: a Two Sample Confirmatory Factor Analytic Approach. *Journal of Happiness Studies, 3*, 71-92.

Schellekens, M., Van der Lee, M., Cramer, A. O. J., & van Woezik, R. (2019). *REFINE study*. osf.io/62qs3

Schneider, S., May, M., & Stone, A. A. (2018, Apr). Careless responding in internet-based quality of life assessments. *Qual Life Res, 27*(4), 1077-1088. https://doi.org/10.1007/s11136-017-1767-2

Schunk, D. H., Pintricht, P. R., & Meece, J. L. (2008). *Motivation in education*. Pearson Education.

Schutte, N. S., & Malouff, J. M. (2018). The Impact of Signature Character Strengths Interventions: A Meta-analysis. *Journal of Happiness Studies, 20*(4), 1179-1196. https://doi.org/10.1007/s10902-018-9990-2

Seligman, M. E., Steen, T. A., Park, N., & Peterson, C. (2005, Jul-Aug). Positive psychology progress: empirical validation of interventions. *Am Psychol, 60*(5), 410-421. https://doi.org/10.1037/0003-066X.60.5.410

van der Velden, P. G., Contino, C., Das, M., van Loon, P., & Bosmans, M. W. G. (2020, Dec 1). Anxiety and depression symptoms, and lack of emotional support among the general population before and during the COVID-19 pandemic. A prospective national study on prevalence and risk factors. *J Affect Disord, 277*, 540-548. https://doi.org/10.1016/j.jad.2020.08.026

van Roekel, E., Keijsers, L., & Chung, J. M. (2019, Sep). A Review of Current Ambulatory Assessment Studies in Adolescent Samples and Practical Recommendations. *J Res Adolesc, 29*(3), 560-577. https://doi.org/10.1111/jora.12471

van Roekel, E., Vrijen, C., Heininga, V. E., Masselink, M., Bos, E. H., & Oldehinkel, A. J. (2017). An Exploratory Randomized Controlled Trial of Personalized Lifestyle Advice and Tandem Skydives as a Means to Reduce Anhedonia. *Behavior Therapy, 48*(1), 76-96. https://doi.org/https://doi.org/10.1016/j.beth.2016.09.009

van Woerkom, M., Oerlemans, W., & Bakker, A. B. (2015). Strengths use and work engagement: a weekly diary study. *European Journal of Work and Organizational Psychology, 25*(3), 384-397. https://doi.org/10.1080/1359432x.2015.1089862

Vercoulen, J. H. M. M., Swanink, C. M. A., Fennis, J. F. M., Galama, J. M. D., van der Meer, J. W. M., & Bleijenberg, G. (1994). Dimensional assessment of fatigue. *Journal of Psychosomatic Research, 38*(5), 383-392.

Appendix A

Daily Diary Questionnaires Items

Mental fatigue (Schellekens et al., 2019)

Today, … (VAS 0-100)

1. I had difficulties with thinking
2. If I was working on something, I could keep track of my thoughts.
3. I could concentrate well
4. It was difficult to keep my attention
5. My thoughts wandered easily

Physical fatigue (Schellekens et al., 2019)

6. Physically I felt exhausted today (VAS 0 not at all – 100 very much)
7. Physically I felt in a … condition (VAS 0 very bad – 100 excellent)

Positive and Negative Affect (Ebesutani et al., 2012)

How did you feel today*?* (VAS 0-100)

8. Joyful
9. Cheerful
10. Happy
11. Lively
12. Proud
13. Miserable
14. Mad
15. Afraid
16. Scared
17. Sad

Motivation (Motivation and Engagement Scale: subscales Adaptive Motivation and Engagement by Martin et al. (2015)).

Today, … (VAS 0-100)

18. I believe I did good work
19. I learnt something important and useful
20. I was focused on learning and improve more than competing and being the best
21. I planned out my tasks and activities
22. I was organized and used my time well
23. I persisted even when things were challenging or difficult

Social Context (van Roekel et al., 2017)

24. Today, I was (multiple answers possible):
   - *a.* Alone: if checked
     - *i.* Time spend alone: VAS 0-100 (very little – very much)
   - *b.* With partner
   - *c.* With family
   - *d.* With friends
   - *e.* With classmates
   - *f.* With acquaintances
   - *g.* With strangers

25. How much have I been talking to other people

a. VAS 0-100 (not all – very much)

Activities (van Roekel et al., 2017)

26. I have been physically active today
    a. VAS 0-100 (not at all – very much)
27. I have been outside today
    a. VAS 0-100 (not at all – very much)

Authenticity

Authenticity Scale (VAS 0-100)

28. I was true to myself during this day
29. I felt authentic in the way I acted during this day
30. I felt like I was really being me during this day

Strengths usage

Strengths usage item (multiple choice: choose of 24 VIA character strengths)

31. Did you use character strengths today?
    a. Yes:
        i. Which strengths did you use? (multiple choice: choose of 24 VIA character strengths)
    b. No

Effort (developed for this study)

Effort item (VAS 0-100)

32. How easy was it for you to participate in the study today?

Careless responding (Eisele et al., 2020)

Momentary measure of careless responding (VAS 0-100)

33. I filled in the questions attentively

Appendix B

Formulae for Reliability Estimates Using the Notation from Lai (2021)

$$\omega^{2l} = \frac{\left(\sum_{k=1}^{p}\lambda_k\right)^2(\phi^w+\phi^b)}{\left(\sum_{k=1}^{p}\lambda_k\right)^2(\phi^w+\phi^b)+\mathbf{1}'\boldsymbol{\Theta}^{\boldsymbol{b}}\mathbf{1}+\mathbf{1}'\boldsymbol{\Theta}^{\boldsymbol{w}}\mathbf{1}} \quad (13)$$

$$\omega^{w} = \frac{\left(\sum_{k=1}^{p}\lambda_k\right)^2\phi^w}{\left(\sum_{k=1}^{p}\lambda_k\right)^2\phi^w+\mathbf{1}'\boldsymbol{\Theta}^{\boldsymbol{w}}\mathbf{1}} \quad (14)$$

$$\omega^{b} = \frac{\left(\sum_{k=1}^{p}\lambda_k\right)^2\phi^b}{\left(\sum_{k=1}^{p}\lambda_k\right)^2\left(\frac{\phi^b+\phi^w}{n}\right)+\mathbf{1}'\boldsymbol{\Theta}^{\boldsymbol{b}}\mathbf{1}+\mathbf{1}'\boldsymbol{\Theta}^{\boldsymbol{w}}\mathbf{1}/n} \quad (15)$$