

Mental fortitude in everyday life: Associations between beneficial and harmful sisu, sisu-related states and affects, measured by ESM

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Abstract: This study explores how the Finnish concept of "sisu," denoting perseverance and inner strength in the face of adversity, manifests in the daily states. Moreover, the associations between beneficial and harmful sisu and positive and negative affectivity, which have implications for well-being and personality, were examined. Data was collected from 82 knowledge workers in four Finnish organizations, utilizing the Sisu Scale to assess beneficial and harmful sisu. Participants evaluated their sisu-related states and affectivity daily for three weeks using a mobile application. Multilevel modeling was employed to analyze the associations between sisu traits, sisu-related states, and affects, controlling for age and sex. Results indicate that high beneficial sisu is associated with increased determination, feelings of control, and positive affect. On the other hand, harmful sisu is linked to accepting overly challenging tasks, getting stuck on unproductive activities, and persisting in mundane tasks. High harmful sisu is also associated with decreased satisfaction and feelings of control. The findings illustrate how sisu manifests in everyday life, and indicate the significance of affective states in the expression of mental fortitude. It also seems that sisu plays a role in facing everyday challenges despite its traditional association with major adversities in the Finnish language. Further research is required to explore sisu-situation interactions and the role of negative affectivity in sisu.

Keywords: Sisu, perseverance, mental fortitude, affective states, positive affect, negative affect, ESM, EMA

1. Introduction

There are individual differences in how people cope with misfortunes and obstacles: some seem to bounce back better than others, and some even experience personal growth after traumatic events (Ramos & Leal, 2013; Tedeschi & Calhoun, 2004). These discoveries have led to research on the non-cognitive individual qualities that could assist people in coping with the inevitable unfairness of life and thriving as well as possible. Constructs that strengthen one's mental fortitude are not only related to decreased hindrances from adversities but also increased psychological well-being (Hu et al., 2015; Lin et al., 2017). This study was set up to uncover the important dynamics of positive and negative mental fortitude traits and regular, every-day challenges.

Adversity is usually referred to as unfavourable life events or conditions that pose significant challenges to an individual's adaptive functioning (e.g. Tedeschi & Calhoun, 2004). Additionally, even smaller everyday challenges can cause stress in individuals and, especially when accumulated, lead to outcomes that are detrimental to well-being in the long term (DeLongis et al., 1988; O'Connor et al., 2021). However, less is known how mental fortitude traits manifest in everyday behavior of an individual, although contemporary research is emerging on mental fortitude traits and related short-time states (Arjomand, 2020; Jiang et al., 2023). Moreover, so far, the research on the inherent and environmental factors that help succeed beyond expectations has been focused mainly on North American culture and lexicon, which might not capture the complete nuances of human existence (Bermant et al., 2011; Lomas, 2016). Therefore, a more in-depth understanding of the power of the mind could be acquired by exploring the concepts found in other languages.

Sisu is a traditional Finnish cultural construct, and it describes the ability to survive and overcome challenges even in adverse situations. One consistently appearing feature of *sisu* seems to be the difficulty of defining it accurately or translating the word to other languages (Lahti, 2019, 2022; Lomas, 2016). Despite the massive emphasis *sisu* has on Finnish cultural heritage or the interest it has evoked worldwide (Chase, 2013; Länsimäki, 2003), only in recent years have the psychological characteristics of *sisu* begun to be studied empirically. E. Lahti has diligently examined *sisu* from qualitative and experimental points of view (Lahti, 2019, 2022), and Vuori & Määttänen (2023) have explored the manifestation of *sisu* in management through interviews. This study takes a more quantitative approach and examines the measurable properties of *sisu* and aims to deepen the understanding of *sisu* in everyday, real-life contexts. Research is needed on how mental fortitude manifests in the everyday affects and experiences of an individual.

1.1 Sisu as a psychological construct

Sisu was systematically examined as a psychological construct not until in 2019 (Lahti, 2019). Based on the answers from 1208 respondents on questions "How would you define *sisu*?" and "What consequences may there be of having too much *sisu*?" two dimensions of *sisu* were found. Beneficial *sisu* consists of extraordinary perseverance, action mindset, and latent power. Extraordinary perseverance involves withstanding adversities, having integrity, and exceeding oneself mentally and physically, whereas action mindset refers to a bold attitude towards challenges. Latent power, in turn, is the elusive core of *sisu*. It is something almost magical and can be accessed in the most challenging situations. However, even though *sisu* enables favorable outcomes, there seem to be potential downsides of having too much or the wrong kind of *sisu*. Exceeding one's mental and physical resources can lead to disadvantageous outcomes such as burnout, injury, or even death. Harmful *sisu* can also disturb reasoning and result in prolonging unsuccessful behavior while it would be wiser to quit. Additionally, it can lead to overlooking others on one's way to success.

Subsequently, Lahti (2022) has deepened the understanding of *sisu* by experientially studying its manifestation during challenging experiences, such as ultramarathon, as well as its connection to systemic intelligence. Lahti (2022) also introduces the concept of gentle power as the ultimate expression of healthy or beneficial *sisu*, and links positive attitude with *sisu* and resilience. Vuori & Määttänen (2023), for their part, explored the manifestation of *sisu* in management during the covid-19 pandemic. Their findings align with beneficial *sisu* aiding in overcoming adversity, whereas harmful *sisu* led to distorted thinking that negatively affected the well-being of the managers themselves. Additionally, a phenomenon of collective *sisu* emerged when a group coped together with exceptional circumstances.

1.2 Sisu and related constructs

Whereas the research on *sisu* is relatively young, other widely studied concepts also point to the strength of the human mind. These *mental fortitude* traits are worth regarding since they can help with understanding *sisu* and separating it from other constructs (Henttonen et al., 2022). Concepts such as *grit*, *resilience*, *mental toughness*, and *hardiness* have been consistently linked with outcomes such as general and psychological well-being (Hu et al., 2015; Salles et al., 2014; Stamp et al., 2015), protection from harmful stress (Blalock et al., 2015), better mental health of trauma survivors (Heckman & Clay, 2005), and better physical health (Yi et al., 2008). Perhaps the most researched mental fortitude concept is *resilience* (for a historical review, see Tusaie & Dyer, 2004), which is currently often described as a context and time-dependent interactive dynamic process between an individual and their environment (Herrman et al., 2011; Luthar et al., 2000). Lahti (2019) suggests *sisu* as one path to resilience. *Hardiness* has been researched mostly in military contexts, and it is defined as the ability to turn a stressful life event into a personal growth experience (Kobasa, 1979). *Mental toughness* is an umbrella term that refers to the capability to cope with demands, believe in oneself, and remain determined and focused under pressure, usually in the domains of sports and education (Jones et al., 2002; Lin et al., 2017). Beneficial *sisu* might help strengthen hardiness or mental toughness during the last endeavor (Lahti, 2019). *Grit*, for its part, is a passionate, goal-oriented trait that consists of perseverance and consistency of interests (Duckworth et al., 2007). Even though *sisu* is sometimes translated as *grit*, *sisu* does not require passion or specific interest in a particular topic (Lahti, 2019; Määttänen & Henttonen, 2021).

Besides the beneficial aspects, there have been findings of potential downsides of some mental fortitude concepts (Alaoui & Fons-Rosen, 2021; Khan et al., 2021; G.M Lucas et al., 2015; Mahoney et al., 2014; Sabouri et al., 2016). However, it is notable that whereas the harmful *sisu* seems to be a specific type of *sisu*, to our knowledge separate domains of other mental fortitude constructs have not been proposed. Therefore, harmful *sisu* seems to be a unique construct.

1.3 The *sisu* scale

In addition to the qualitative studies, the psychometric properties of *sisu* have been examined. Henttonen, Määttänen and colleagues (2022) presented questionnaires for the measurement of beneficial and the harmful sides of *sisu*. Additionally, the similarity of *sisu* with existing mental fortitude and personality traits were examined. The structure of the scale is equivalent to the conceptualization of Lahti (2019). The beneficial and harmful *sisu* are slightly positively correlated. About one-third of the variation in beneficial *sisu* was explained by personality, whereas harmful *sisu* was not associated with any of the studied personality variables (Henttonen et al., 2022). The findings support treating *sisu* as an independent construct.

Additionally, the Sisu Scale enabled studying the associations between *sisu* traits and well-being and therefore detecting if *sisu* is likely to have practical significance in the field of health psychology. Henttonen and colleagues (2022) studied the sample of 82 working adults during the Sisu at Work project. They found that beneficial *sisu* correlates positively with higher life satisfaction and perception of health, and negatively with depression symptoms. Harmful *sisu*, in turn, is positively associated with depressive symptoms and work stress measured by effort-reward imbalance, and negatively associated with life satisfaction and perception of health. Moreover, including beneficial and harmful *sisu* in a model with existing mental fortitude constructs significantly increased the explained variance in predicting well-being, depressive symptoms, and work stress. These results emphasize the importance of including *sisu* in the research on non-cognitive characteristics that contribute to well-being.

1.4 The manifestation of *sisu*: *Sisu states*

In the qualitative studies, *sisu* is described as a hidden energy reserve that can be accessed when needed (Lahti, 2019, 2022; Vuori & Määttä, 2023). The *Sisu Scale*, for its part, conceptualizes this inner reserve of *sisu* as a measurable *trait* of an individual. The respondents assess their general tendencies to deal with challenges, take risks, be determined, exceed one's capabilities, or neglect others while pursuing goals. Research on multiple other personality constructs has pointed out that the trait scores are often quite robust between individuals over time and predict important life outcomes, such as well-being. However, there is usually significant variability in trait-related behavior, cognitions, and affects across situations within individuals (Bem & Allen, 1974; Fleeson, 2001; Mischel, 2004). Personality traits might successfully describe differences in the general tendencies or long-term outcomes between individuals, but their predictive power on specific behavior at the level of an individual is often less clear. This phenomenon is often referred to as the personality paradox (Mischel, 2004; Mischel & Shoda, 1995). There is yet no research about the associations between the general *sisu* traits and *sisu*-related situational manifestation, that is, the *sisu states*. States refer to short-term, situational occurrences of feelings, thoughts, and behavior (Fleeson, 2001; Fridhandler, 1986). If *sisu* traits are directly related to *sisu* states, people who score high on the *Sisu Scale* would also frequently and consistently express *sisu*-relevant behavior, cognitions, or affects across various situations. If the two are inconsistently related, then the *sisu* traits manifest themselves through processes other than robust everyday experiences, for example by interacting with situational variables.

Previous studies in conceptualizing *sisu* have clarified its essence, and addressed its manifestation in adverse circumstances. This study aims to gain understanding about the *sisu* state manifestation and therefore clarify how *sisu* operates and influences coping and well-being. It is also unclear whether *sisu* is available also for the daily hindrances or reserved only for major adversities. Moreover, studying the state manifestations of *sisu* also contributes to mental fortitude research by helping to understand how these traits manifest in behavior and inner experiences.

1.5 *Sisu* and affective states

In addition to the short-time states directly corresponding to *sisu*, it is feasible to study associations between *sisu* traits and affects that arise during daily activities. Lahti (2022) proposes that positive attitude is a core element of *sisu*, since it improves the quality of thinking and can increase effort. Moreover, it has been suggested that personality traits operate partly through positive and negative affectivity and self-regulation (Hampson, 2012). Positive affect has been consistently attributed as a central dimension of subjective well-being, and it is also negatively associated with adverse outcomes, such as rumination and depression (Diener et al., 1999; Lyubomirsky et al., 2005; Määttä et al., 2021). When it comes to stress regulation, positive affect allows more flexible information processing and broader cognitive capacity than negative affect (for reviews, see: Isen, 1999; Lyubomirsky et al., 2005). Thus, it has been suggested that positive affect facilitates the implementation of advanced cognitive strategies that help cope with adverse situations (Aspinwall, 1998). Additionally, positive affect might engage people in beneficial behavior by increasing approach motivation and persistence (Fredrickson, 2004). Therefore, positive affectivity plays a distinct role in the psychological processes that advance resilient outcomes. Beneficial *sisu* is characterized by facing one's fears and taking risks when needed, which require approaching discomfort. Since positive affect facilitates approach motivation and coping abilities, it can be hypothesized that beneficial *sisu* enables cultivating positive affect while facing challenges. Moreover, positive affect has been positively associated

with resilience (Hu et al., 2015; Tugade & Fredrickson, 2004), grit (Hill et al., 2016; Jiang et al., 2020; Singh & Jha, 2008; Sung et al., 2020), and mental toughness (Gucciardi et al., 2015; Mahoney et al., 2014). However, the previous studies are mainly cross-sectional and thus rely on memory about the general affectivity levels. An exception to this is the study of Jiang and colleagues (2020) where an association was observed between grit and daily positive affect. There is also little information about specific affects and their relations with mental fortitude since most studies measure only positive or negative affectivity overall (Sung et al., 2020).

Negative affect, for its part, can be conceptualized as a part of an avoidance/conflict-resolving system that creates an adaptive response in threatening situations (Gray, 1987). However, the system also links frequent negative affect to psychopathology, mainly mood and anxiety disorders (Watson et al., 1994). Negative affect has been observed to have inverse correlations with mental fortitude concepts (Gucciardi et al., 2015; Mahoney et al., 2014; Singh & Jha, 2008), which implies similar associations with beneficial *sisu*. When it comes to associations with harmful *sisu*, negative affect fosters externalized behavior such as aggression, which resembles the harm to others -dimension. It also narrows an individual's "thought-action palette" in the moments of distress to promote survival (Fredrickson, 2004). If this narrowing is prolonged, it might impair an individual's problem-solving abilities and complicate coping with distress, which are characteristics of harm to reasoning. Therefore, there are indications that something, perhaps negative affectivity, prevents people with high harmful *sisu* from reacting adaptively to challenges. On the other hand, it has been suggested that positive affect might encourage gritty people to persist in a task even though it would be wiser to quit (G. M. Lucas et al., 2015). Therefore, it is worth examining if the adverse persistence of harmful *sisu* is also related to positive affect. The examination of affectivity in harmful *sisu* might shed light on its core nature.

1.6 Measuring sisu-related and affective states

The most distinct trait-related states have the same content as trait scales but as short-term versions (Ching et al., 2014; Fleeson, 2001). As follows, *sisu* states would be directly correspondent to *sisu* traits measured with the *Sisu Scale*, but as short-term versions. In affect research, however, the most common approach is the two-factor model, where positive and negative affect are measured separately. The assessment tool is often adapted from the Positive and Negative Affect Schedule (PANAS; Watson et al., 1988). In PANAS, positive affect refers to the extent to which an individual is or has been excited, enthusiastic, satisfied, and alert. In contrast, negative affect describes the levels of distress and aversive mood states such as anger or anxiety. Positive and negative affect are not opposite sides of a continuum but two independent dimensions. The short-term correlations of positive and negative affective states are distinctively inverse, but in the long run, the correlation between positive and negative affectivity levels diminishes (Diener & Emmons, 1984; Zelenski & Larsen, 2000). In PANAS the affects are measured as the overall score of positive or negative affect. However, the discrete positive and negative affective states, such as joy and anger, can have differing functions, thus warranting their separate study (Fredrickson, 2004; Lench et al., 2011).

Daily personality-related or affective states can be detected with the Experience Sampling Method (ESM, sometimes used interchangeably with Ecological Momentary Assessment, EMA). ESM collects individual fluctuations in daily self-reported behavior, affects, and cognition. Therefore, the variation over time within and between individuals is considered. The strength of the method lies in its ecological validity: the measurements are provided in real-time, in naturalistic settings (Scollon et al., 2003; Shiffman et al., 2008). Since people tend to be unreliable with their assessment of past behavior, affects, and thoughts, the short time interval between

measurement and event enhances the reliability of the assessment. The measurements can be assigned randomly during the day, or with predetermined time intervals, for instance every hour.

1.7 Research questions and hypotheses

This study examines the associations between beneficial and harmful sisu traits and sisu-related daily states to better understand the essence and manifestation of sisu. Moreover, the associations between sisu traits and positive and negative affect are investigated to clarify the connections between sisu, stress regulation, and well-being. Associations between harmful sisu and affects are reported as exploratory findings due to lack of existing research as basis of formulating explicit hypotheses.

Research question 1: Are sisu traits associated with corresponding short-time states?

Hypothesis 1.1: Beneficial sisu is positively associated with being determined, persisting in a dull task, executing something that was uncertain to succeed, and experiencing being in control.

Hypothesis 1.2: Harmful sisu is positively associated with becoming stuck, accepting overly challenging tasks, and thinking critically of others.

Research question 2: Is beneficial sisu associated with positive or negative affects?

Hypothesis 2.1: Beneficial sisu is positively associated with positively nuanced affects.

Hypothesis 2.2: Beneficial sisu is negatively associated with negatively nuanced affects.

Research question 3: Is harmful sisu associated with positive or negative affects?

2. Method

2.1 Participants

The participants of this study were from the *Sisu at Work* project of the University of Helsinki and VTT. The VTT ethical committee (27.5.2019) approved the procedures to gather the data used in this study. Eighty-two participants took part in the study, 52 (63 %) women and 30 (37 %) men. Their age varied from 24 to 58 ($M = 41.03$, $MD = 42.5$, $SD = 8.51$). The participants were knowledge workers from four Finnish organizations, and therefore their jobs rely on intellectual skills, critical thinking, and problem-solving rather than manual labour. Their positions varied from expert roles to managers. They were recruited via the organizations' e-mail lists. The participants signed a written form of consent before participating. All participants were Android phone users due to the requirements of the mobile application used in the study. As compensation, the participants received movie tickets, and personalized reports of their sleep quality and mental resources during the experimental period.

2.2 Study procedure

The data collection was conducted in stages in 2019. Henttonen, Määttä and colleagues have already examined parts of the same data in their study (2022). The subjects participated in the study for three consecutive weeks, the exact timing depending on the organization. At the beginning of the study, the participants answered a broad survey, including demographic information and the sisu questionnaires. Then, they installed a mobile application through which they provided the ESM assessments. They also wore devices that measured their heart rate and skin conductance. At the end of the study, the participants filled a survey about their activity routines during the experimental period and rated their user experiences of the study devices.

All measures were conducted in Finnish. During the subsequent three-week data collection, the participants answered daily surveys about their sisu states and affects, as well as about their social company, sleep, rumination, stress, and activities. Some of the surveys had to be answered three times a day, whereas others were answered only once each day. Answering took about one minute. The participants received a reminder from the application in the morning (at 9 or 10 am), in the afternoon (at 4 pm) and in the evening (at 9 pm), and the questionnaires were open for two hours from the reminder. In this article, the associations between the sisu traits and the ESM responses regarding sisu-related states and positive and negative affects are discussed.

2.3 Measures

2.3.1 Sisu traits

Beneficial and harmful sisu traits were assessed prior to the experimental period with the Sisu Scale. The beneficial sisu consists of *latent power*, *extraordinary perseverance*, and *action mindset*. Harmful sisu, for its part, involves *harm to self*, *harm to reasoning*, and *harm to others*. Each subscale consists of three claims and thus, there are 18 claims in total. The claims, such as “I am willing to take risks to reach important goals” or “My determination often results in conflicts with other people”, are answered on a 7-point Likert scale. In the current study, the internal consistencies (Cronbach’s alphas α) for the subscales were sufficient ($.73 > \alpha > .65$) apart from the *harm to others* -subscale with Cronbach’s alpha of .45. The overall scales for beneficial and harmful sisu showed good ($\alpha = .82$) and satisfactory ($\alpha = .69$) internal consistencies. See Appendix 1 for more detail on the Sisu Scale.

2.3.2 Sisu states

The sisu states were created to correspond to the sisu traits measured with the Sisu Scale, but as short-term versions. The sisu states were assessed via the mobile application during the afternoon survey (at 4 pm). The answers were provided on a seven-point Likert scale (1 meaning *not true at all* and 7 meaning *completely true*). The subjects assessed the claims based on the past day. The state claims (translated from Finnish) were the following:

1. I did something laborious or tedious, even though I would not have wanted to (Latent power, from now on referred to as persistence)
2. I did something that was uncertain to succeed (Action mindset, from now on referred to as uncertainty)
3. I was determined (Extraordinary perseverance, from now on referred to as determination)
4. I felt that things were under my control (from now on referred to as control, see explanation below)
5. I became stuck on something (Harm to reasoning, from now on referred to as stuck)
6. I accepted a task that was too challenging (Harm to self, from now on referred to as overchallenge)
7. It felt that others had foolish opinions or ideas (Harm to others, from now on referred to as criticism)

The state claims persistence, uncertainty, determination and control refer to the features of beneficial sisu. More precisely, control -state comes from the control over fate-factor of beneficial sisu that was found in the original factor solution during explorative factor analysis but not included in the confirmatory stage and further versions of the scale. Stuck, overchallenge, and criticism are related to harmful sisu.

2.3.3 Positive and negative affects

The participants assessed their affective states on a seven-point Likert scale three times a day via the mobile application. In the assessments the affects from the past 30 minutes were evaluated. The positive and negative affect claims were inspired by PANAS (Watson et al., 1988). Overall *positive affect* was calculated as the mean of *happiness, enthusiasm, satisfaction, focus, and vigor* ($\alpha = .85$). Overall *negative affect* was calculated as a mean of *sadness, anxiety, and anger* ($\alpha = .83$). Missing responses were excluded in the formation of the overall variables and the means were calculated with the remaining responses, which enabled more data for analysing negative affective states and did not influence the results with positive affective states. In addition to the positive and negative compound variables, the affects were examined separately to gain a more comprehensive understanding of the specific functions of affective states.

2.4 Statistical analyses

R software (R Core Team, 2020) was used for all the statistical analyses in this study. The research questions were investigated with multilevel linear modelling (MLM). MLM can be used for data organized on more than one level. For longitudinal datasets, the measurement point is treated as the lowest level of data, and the participants are treated as the second level. MLM is often a better choice for repeated measures than a repeated-measures ANOVA since MLMs can deal with missing values and the violation of the assumption of independence of errors (Tabachnick & Fidell, 2013). Moreover, compared to linear regression or ANCOVA, MLMs allow random intercepts and random slopes.

The multilevel models were created with the *lme4* -package of the R program (Bates et al., 2015). The restricted maximum likelihood (REML) method was applied in the analyses. *LmerTest* package was used for significance estimates (Kuznetsova et al., 2017). The package applies Satterwaite's method for approximating the degrees of freedom and calculating p-values for the models. Since the fixed effects of *sisu* traits were in the center of interest in this study instead of the random effects, the standard unstructured covariance matrix structure was assumed to function adequately (Roback & Legler, 2021). Thus, additional covariance structures were not modelled.

Before the analysis, the data were checked for outliers, such as impossible values, and none were detected. No participants were excluded from further analyses based on their response rate, since tentative analyses did not show differences in results compared to analyses with all the participants. In the first phase of the analysis, "null models", or unconditional means models, were created for each dependent state variable. In the null models, the only predictor is the intercept, which allows calculating the intraclass correlation (ICC). The ICCs were 18–39 % which supports using multilevel models since the variance is notable both between and within subjects (Kish & Frankel, 1974).

In this study, the point of measure (the *time* variable) was used as the lowest level predictor and the *sisu traits* as the second level fixed predictors. The point of measurement was calculated as hours from the first measure of each participant which enabled considering both the order and the exact timing of the assessment. All continuous variables were standardized to allow the comparison between the coefficients. Moreover, the models were adjusted for sex and age. In the final full multilevel models, each dependent variable (each *sisu* state variable, individual affect variable, and the aggregated positive and negative affects) was combined with *beneficial sisu* and *harmful sisu* as predictors. Both predictors could be added to the models simultaneously since they were unrelated in the data ($r = -.01, p = .94$). Additionally, an interaction term for beneficial and harmful *sisu* was added if both main effects were significant. The *sisu* trait predictors and

the covariates were fixed, but the intercept and the slope of the time variable were specified as random effects. Thus, the trend of sisu-related or affective states could vary between participants over time, but the effects of sisu traits were assumed to be invariant across subjects.

The models were evaluated with Bayesian information criterion (BIC), Akaike information criterion (AIC), and chi-square tests. Most of the models with both random slope and random intercept performed better compared to models with only the random intercept. Exceptions to this were the models with the sisu-related states *persistence* and *uncertainty*, and therefore a random slope was not eventually allowed in the two models. Correlation between the intercept and random slope was allowed in all the models with a random slope, since restricting the correlation did not improve model fit. The final models satisfied the assumptions of linearity, and the residuals were approximately normally distributed and homoscedastic. Nevertheless, due to slightly skewed diagnostic plots, logarithmic transformations were performed to the sisu state *overchallenge* and all negative affect variables. The transformations did not influence the results and thus were not used in the final models.

The data included missing responses that were analysed and treated when necessary. The detailed explanation of the missing values analysis can be found in Appendix 2 at the end of this paper.

3. Results

3.1. Descriptive statistics

The average beneficial sisu score was 41.09 (SD = 7.91, range 23–60). For harmful sisu, the average score was 26.88 (SD = 7.26, range 12–47). There were no sex or age differences in the sisu traits. The sisu trait scores were approximately normally distributed based on Shapiro-Wilk's test ($W = 0.99$, $p = .69$ for beneficial sisu and $W = 0.99$, $p = .56$ for harmful sisu). Descriptive statistics for the state variables are presented in Table 1 (below).

3.2 Associations between sisu traits and sisu-related states

The standardized beta coefficients of the multilevel models and the random effects are presented in Table 2. The variance between subjects explained 18–31 % of the variance in the sisu-related state variables. Thus, even though most of the variation was time-dependent, the variation was also notable between individuals. Beneficial sisu was significantly positively associated with *determination* ($t(73.17) = 4.84$, $p < .001$) and *control* ($t(67.82) = 2.44$, $p = .02$). The association between beneficial sisu and *persistence* did not reach significance, but the trend was positive ($t(69.08) = 1.92$, $p = .06$). Harmful sisu, for its part, was significantly positively associated with *persistence* ($t(73.62) = 2.72$, $p = .008$), logarithmic *overchallenge* ($t(52.87) = 5.50$, $p < .001$), and *stuck* ($t(68.37) = 3.98$, $p < .001$), and significantly negatively associated with *control* ($t(71.60) = -2.92$, $p = .005$). Moreover, men scored significantly lower in *criticism* compared to women ($t(59.88) = -2.33$, $p = .02$). Additionally, *uncertainty* seemed to decrease over time ($t(828.85) = -2.59$, $p = .01$) and it was positively, but not significantly, associated with harmful sisu ($t(74.57) = 1.67$, $p = .09$). Interaction terms were added only if both harmful and beneficial sisu had a significant main effect, which was true only for the model with *control*. However, the interaction between beneficial and harmful sisu on *control* was not significant ($t(72.23) = 1.81$, $p = .08$) and adding the interaction term did not improve model fit ($\chi^2 = 3.4$, $p = .07$).

Table 1. Descriptive statistics for the *sisu* state and affect variables

	Mean	SD	Median	Skewness	Kurtosis
<i>Affective states</i>					
Positive affect	4.70	1.08	4.8	-0.05	-0.34
Happiness	4.81	1.30	5.0	-0.24	-0.48
Enthusiasm	4.43	1.35	4.0	0.00	-0.63
Satisfaction	5.04	1.25	5.0	-0.42	-0.28
Focus	4.56	1.36	5.0	-0.08	-0.64
Vigour	4.79	1.38	5.0	-0.30	-0.63
Negative affect	2.61	1.04	2.0	1.22	1.5
Sadness	2.56	1.20	2.0	1.41	1.75
Anxiety	2.81	1.13	2.0	1.19	0.97
Anger	2.47	1.19	2.0	1.34	1.49
<i>Sisu-related states</i>					
Determination	5.08	1.33	5.0	-0.48	-0.30
Perseverance	4.59	1.72	5.0	-0.22	-1.11
Control	5.21	1.28	5.0	-0.59	-0.11
Uncertainty	4.06	1.72	4.0	0.13	-1.20
Overchallenge	2.73	1.17	2.0	1.26	1.60
Stuck	3.47	1.58	3.0	0.51	-0.89
Criticism	3.20	1.51	3.0	0.84	-0.31

Note. The variables have a score range from 1 to 7.

Table 2. The standardized beta coefficients of the fixed effects (standard error in parenthesis) and the random effects of the multilevel models with the sisu-related states

	Determination	Persistence	Control	Uncertainty	Overchallenge	Stuck	Criticism
<i>Fixed effects</i>							
Beneficial sisu	0.30*** (0.06)	0.11+ (0.06)	0.13* (0.05)	0.00 (0.07)	-0.05 (0.06)	-0.09 (0.06)	0.09 (0.08)
Harmful sisu	-0.06 (0.06)	0.16** (0.06)	-0.16** (0.05)	0.11+ (0.07)	0.33*** (0.06)	0.23*** (0.06)	0.11 (0.08)
Sex ^a	0.03 (0.13)	-0.19 (0.12)	0.14 (0.11)	-0.09 (0.14)	-0.02 (0.12)	-0.06 (0.12)	-0.37* (0.16)
Age	0.03 (0.06)	-0.04 (0.06)	0.02 (0.05)	-0.07 (0.07)	0.05 (0.06)	-0.06 (0.06)	-0.06 (0.08)
Time	0.01 (0.03)	-0.05+ (0.03)	0.05 (0.04)	-0.08** (0.03)	0.05 (0.04)	-0.08+ (0.04)	0.04 (0.04)
<i>Random effects</i>							
Intraclass correlation	0.31	0.27	0.18	0.26	0.22	0.18	0.29
Residual	0.66	0.79	0.79	0.75	0.77	0.76	0.72
Intercept	0.24	0.18	0.15	0.26	0.12	0.14	0.25
Slope ^b	0.03		0.04		0.03	0.06	0.01
Correlation ^c	0.16		-0.15		-0.58	0.07	0.02

Note. *** $p < .001$ ** $p < 0.01$ * $p < .05$ + $p < .1$ (trend)

^a Women as the reference category

^b Slope of the time variable can vary between subjects

^c Correlation between random intercept and slope

3.3 Associations between sisu traits and affective states

The standardized beta coefficients of the multilevel models and the random effects are presented in Table 3 (below). Positive affect was calculated as the mean of one or more responses of *happiness, satisfaction, vigor, focus, and enthusiasm*. The same procedure was done for *anxiety, anger, and sadness* to form the negative affect variable. Variance between subjects explained 22–39 % of the variance in the positive affect variables and 12–25 % in the negative affect variables. Thus, even though most of the variation was time-dependent, the variation was also notable between individuals. Beneficial sisu was positively associated with *happiness* ($t(77.33) = 3.08, p = .003$), *satisfaction* ($t(76.85) = 3.06, p = .003$), *enthusiasm* ($t(75.33) = 2.78, p = .007$), and overall *positive affect* ($t(77.12) = 2.68, p = .01$). Harmful sisu, for its part, was negatively associated with *satisfaction* ($t(75.73) = -2.09, p = .04$). An interaction term of beneficial and harmful sisu was added to the model with *satisfaction*, but the interaction was not significant ($t(79.72) = 1.36, p = .18$) and did not improve the model fit ($\chi^2 = 1.98, p = .15$). Other significant associations between sisu traits and affective states did not emerge. However, there was a positive trend between beneficial sisu and *focus* ($t(76.80) = 1.75, p = .09$), and a negative trend between harmful sisu and *vigor* ($t(75.93) = -1.67, p = .10$).

When it comes to negative affects, based on the available data, beneficial sisu was significantly positively associated with overall *negative affect* ($t(68.23) = 2.42, p = .02$). Furthermore, both beneficial sisu ($t(68.94) = 2.33, p = .02$) and harmful sisu ($t(76.16) = 2.35, p = .02$) were significantly positively associated with *anxiety*. Interaction of harmful and beneficial sisu on *anxiety* was not significant ($t(85.47) = 0.44, p = .66$). Additionally, men scored significantly lower on *anger* ($t(58.43) = -2.24, p = .03$) and *negative affect* ($t(67.78) = -2.55, p = .01$) compared to women. There was also a positive, but not significant, association between beneficial sisu and both *anger* ($t(69.19) = 1.94, p = .06$) and *sadness* ($t(52.43) = 1.71, p = .09$), and also between harmful sisu and overall *negative affect* ($t(70.93) = 1.75, p = .08$).

4. Discussion

This study examined associations between beneficial and harmful sisu, sisu-related daily states, and positive and negative affect. The aim was to gain a more comprehensive understanding of sisu and its manifestation in everyday life.

Mainly in line with hypothesis 1.1, beneficial sisu was associated with being determined and feeling of control. Harmful sisu, for its part, was positively associated with accepting a task that was too challenging and becoming stuck on something, so hypothesis 1.2 was partly supported. Moreover, beneficial sisu was positively associated with positive affects except for vigor and focus, and thus hypothesis 2.1 was also supported. Hypotheses about the associations between harmful sisu and affects were not set. The results indicate, however, that harmful sisu is negatively associated with feeling satisfied and positively associated with anxiety.

4.1 The manifestation of sisu traits as daily states

In this study, high beneficial sisu was linked with feeling determined and in control also in everyday life. Previously the locus of control and related concepts have been associated also with mental toughness, self-efficacy, and hope (Bandura, 1977; Lin et al., 2017; Snyder, 2002). It has been suggested that persisting despite adversities is easier when a person thinks they have the power to influence their future (Anderson et al., 2016).

Table 3. The standardized beta coefficients of the fixed effects (standard error in parenthesis) and the random effects in the multilevel models with the affective states

	Happiness	Satisfaction	Enthusiasm	Focus	Vigor	Positive affect	Anxiety	Anger	Sadness	Negative affect
<i>Fixed effects</i>										
Beneficial sisu	0.21** (0.07)	0.18** (0.06)	0.17** (0.06)	0.10+ (0.05)	0.07 (0.05)	0.17** (0.06)	0.13** (0.06)	0.11+ (0.06)	0.12+ (0.07)	0.12* (0.05)
Harmful sisu	-0.09 (0.07)	-0.12* (0.06)	-0.03 (0.06)	-0.06 (0.05)	-0.09+ (0.05)	-0.09 (0.06)	0.14* (0.06)	0.03 (0.06)	0.11 (0.07)	0.09+ (0.05)
Sex ^a	0.19 (0.14)	0.11+ (0.12)	0.23+ (0.12)	0.05 (0.11)	0.19+ (0.11)	0.19 (0.13)	-0.21+ (0.12)	-0.26* (0.12)	-0.23 (0.15)	-0.28* (0.11)
Age	0.04 (0.07)	0.08 (0.06)	0.03 (0.06)	0.00 (0.05)	-0.01 (0.05)	0.02 (0.06)	-0.05 (0.06)	-0.03 (0.06)	0.07 (0.07)	-0.04 (0.05)
Time	0.01 (0.02)	0.02 (0.02)	0.00 (0.02)	0.01 (0.02)	-0.01 (0.01)	0.01 (0.02)	0.02 (0.04)	0.10 (0.04)	0.11+ (0.06)	0.06+ (0.03)
<i>Random effects</i>										
Intraclass correlation	0.39	0.31	0.29	0.22	0.23	0.35	0.22	0.12	0.25	0.22
Residual	0.60	0.69	0.70	0.76	0.77	0.64	0.75	0.85	0.70	0.76
Intercept	0.35	0.28	0.27	0.22	0.21	0.32	0.19	0.14	0.31	0.20
Slope ^b	0.01	0.01	0.01	0.02	0.01	0.02	0.04	0.03	0.12	0.03
Correlation ^c	0.22	0.33	0.28	0.55	0.51	0.33	0.44	0.63	0.72	0.59

Note. *** p < .001 ** p < 0.01 * p < .05 + p < .1 (trend)

^a Women as the reference category

^b Slope of the time variable can vary between subjects

^c Correlation between random intercept and slope

Additionally, as expected, individuals with high harmful sisu scores reported executing more tasks that felt too challenging and more of getting stuck on something. There have also been earlier observations of counterproductive perseverance: grit has been associated with deteriorated performance and not being able to quit when intended (Alaoui & Fons-Rosen, 2021; G. M. Lucas et al., 2015). Furthermore, unsuccessful pursuit of goals has been linked with depression (Street, 2002), and there is also preliminary evidence of associations between harmful sisu and depressive symptoms (Henttonen et al., 2022). The findings of this study highlight the need to better understand the contribution of dogged perseverance on performance and psychopathology.

Moreover, harmful sisu was negatively associated with feelings of control in daily life. Harm to reasoning, a subfactor of harmful sisu, is about losing the sense of what one is doing, and thus almost the opposite of the feeling of control. The negative association between harmful sisu and control emphasizes the two sides of sisu, as the association is inverse compared to beneficial sisu. However, what determines which side of sisu takes over in challenging situations warrants further research.

Against expectations, high beneficial sisu individuals were not more likely to do something uncertain to succeed than the people with less beneficial sisu. It is possible that beneficial sisu is not related to a constant enduring of uncertainty but instead being able to adaptively choose the challenges that are worth fighting for. As discussed before, constant exposure to challenges that are likely to overpass an individual's competencies is a risk for increased stress (Ganster & Rosen, 2013; Siegrist, 1996; Street, 2002). Therefore, the ability to carefully evaluate when a risk is worthwhile is important for stress management. Frequently accepting a task that seems uncertain to succeed might be disruptive rather than constructive. Indeed, individuals with high harmful sisu were prone to complete a dull task regardless of their personal preferences. Therefore, harmful sisu seems to be more related to accepting and completing tasks without consideration.

Against the hypotheses, thinking that others had foolish ideas or opinions was not associated with harmful sisu. However, there were a lot of missing values in the sisu state assessing the foolishness of others' ideas. Constant criticism towards others is an adaptation from the harm to others subdimension which has had relatively low reliability both in the previous studies (Henttonen et al., 2022) and in this study. Therefore, the findings of this study add to earlier notes of the need for further examination of the social dimension of harmful sisu.

4.2 The relationship between sisu traits and positive and negative affect

It was hypothesized that beneficial sisu is positively associated with positive affect. Indeed, people with high beneficial sisu reported more overall positive affect, compared to those with less beneficial sisu. Positive affect has previously been positively associated also with other mental fortitude concepts (Hill et al., 2016; Mahoney et al., 2014; Singh & Jha, 2008; Tugade & Fredrickson, 2004; Zautra et al., 2005). It is possible that high beneficial sisu individuals can cultivate positive affect in times of distress, resulting in the ability to exceed oneself and to persist despite challenges. Cultivating positive affect can happen by using coping strategies that increase positive affectivity (Fredrickson, 2004). On the other hand, the relationship between positive affectivity and beneficial sisu might be better understood through an "upward spiral" (Aspinwall, 1998; Fredrickson, 2004). Positive affectivity facilitates beneficial sisu (e.g., perseverance and a positive approach towards challenges), which in turn supports coping with challenges, resulting in higher well-being and, therefore, positive affect. Positive affect might also explain the previously found association between extraversion and beneficial sisu (Henttonen et

al., 2022) since extraversion seems to be characterized mainly through positive affectivity (Costa & McCrae, 1980; Lucas & Fujita, 2000).

In addition to overall positive affect, beneficial *sisu* was associated with separate positive affective states, namely happiness, enthusiasm, and satisfaction. Fredrickson (1998, 2004) has reviewed the roles of specific positive emotions. Happiness, or joy, seems to be related to creativity and pushing limits, whereas enthusiasm develops the desire to act. Satisfaction (or contentment), for its part, allows an individual to pause, integrate, and reflect. These behaviors drive individuals towards resources, such as social relationships, enhanced problem-solving, and self-confidence, that help to cope during stressful times. Beneficial *sisu* is characterized by approaching challenges, not giving up, and exceeding oneself. Feeling enthusiastic may create an urge to act when needed, whereas previous satisfaction strengthens the confidence in succeeding in the future as well. Joy, for its part, helps to explore alternative solutions and creatively respond to challenges when they appear. The findings of this study also support the indication that studying mental fortitude traits can support apprehending the functions of specific emotions and vice versa (Sung et al., 2020).

Against expectations, feeling focused and vigorous were not linked with beneficial *sisu*, albeit a positive trend emerged with focus. The two affective states can be conceptualized as subjective perceptions of alertness (Watson et al., 1988). Beneficial *sisu* in the *sisu* scale focuses more on determination and action when needed than the ability to be constantly alert, which might partly explain the results.

A negative association between beneficial *sisu* and negative affect was hypothesised. However, individuals with high beneficial *sisu* reported more, not less, anxiety and overall negative affect. The explanation might lie in the strong approach component of beneficial *sisu*. Traditionally positive affect has been linked with approach motivation (Fredrickson, 2004), but also negative affect can evoke the urge to act (Harmon-Jones et al., 2013). Additionally, facing challenges is likely to evoke negative affect, but mental fortitude allows overcoming them (Fredrickson, 2004; Hannah et al., 2007), which could partially explain the association between *sisu* and negative affectivity. Therefore, this reactive component might separate *sisu* from other mental fortitude constructs that focus more on the “long haul”. However, there were many missing values in the negative affect surveys, which creates ambiguity in the interpretation of the results. Therefore, there is a need for more research before drawing conclusions about the role of negative affectivity in beneficial *sisu*.

When it comes to harmful *sisu*, hypotheses about associations with affective states were not set since no existing concept is similar to harmful *sisu*. High harmful *sisu* was associated with reporting less satisfaction and more anxiety. Satisfaction allows an individual to pause and reflect to form a coherent whole from past experiences (Fredrickson, 1998). Dissatisfaction might prevent an individual from pausing and perhaps finding a better approach to the problem, therefore contributing to the emergence of harmful *sisu*. Anxiety, for its part, induces high arousal and favours inflexible and narrow cognitive processes to promote survival (Fredrickson, 2004). The anxiety experienced by individuals with high harmful *sisu* is likely to not only contribute negatively to reasoning, but also result from getting stuck, not reaching goals, or having problems with other people. However, as stated previously, the high missingness rate complicates the interpretation of the results regarding anxiety.

Harmful *sisu* was not associated with any of the positive affective states. In relation to the previous findings about the negative aspects of mental fortitude, it has been suggested that gritty individuals might persist in a task for too long due to positive emotions towards the task (G. M. Lucas et al., 2015). When it comes to harmful *sisu*, based on our study it seems unlikely that

excessively positive expectations could explain the adverse perseverance of harmful *sisu*. For grit, costly perseverance might be an occasional by-product, whereas in harmful *sisu* the adverse consequences of stubbornness are built-in.

4.3 Strengths, limitations, and future research

This study contributed to the *sisu*, as well as more general mental fortitude research in several ways. First, it helped to clarify the essence of both beneficial and harmful *sisu* by considering their state manifestations. The associations between *sisu* traits and corresponding short-time *sisu* states are especially noteworthy since it has often been challenging to link personality traits with everyday experiences (Fleeson, 2001; Mischel, 2004). Moreover, previously *sisu* has been linked to major adversities, but based on our study *sisu* has associations with daily experiences as well. This study also deepens the suggestion of Lahti (2022) about the link between *sisu* and positive attitude. Furthermore, the mechanisms through which harmful *sisu*, the adverse version of mental fortitude, might result in harmful outcomes were clarified. Additionally, this study is one of the first to examine associations between discrete affects and a mental fortitude construct (Sung et al., 2020).

The study also has some methodological strengths. First, mental fortitude state manifestations and associations with affects were examined with the experience sampling methodology. ESM minimizes the recall bias, and therefore the self-reports are considered more accurate than one-time assessments (Scollon et al., 2003; Shiffman et al., 2008). The good ecological validity provided by ESM is also worth noting: the study gained information about *sisu* in everyday life instead of laboratory settings. Additionally, the research period lasted three weeks, which is above the median of ESM studies (van Berkel et al., 2018). The extended time interval enabled covering various contexts, such as working days and weekends. Multilevel modelling allowed handling the missing values quite well and considered both within- and between-person variance in *sisu*-related and affective states.

Finally, this study responds to the need to understand humanity from a broader perspective than the North American culture and lexicon (Bermant et al., 2011; Lomas, 2016). *Sisu* has been central in the Finnish culture and global image for nearly a hundred years, and the word emerged to the literary sources for the first time already in the 16th century, being among the oldest known Finnish vocabulary (Helminen, 2020). Therefore, this study has provided insight into a broader and more linguistically inclusive understanding of human potential.

There were also some limitations that are important to consider. The first applies to the missing values. The multilevel models can handle missing values quite well if they are missing at random (Tabachnick & Fidell, 2013). However, there were considerably more missing values in the variables measuring negative affectivity and criticism towards others, compared to other variables. Moreover, in this study a missing value indicated that some parts of the ESM survey were answered while others were not. Since the values were not missing at random in the negative state variables, interpreting the associations between *sisu* and negative states is complicated. Therefore, future studies should reaffirm the connections between *sisu* and negative affectivity.

Another limitation is the number of multilevel models, and therefore separate comparisons performed during the analyses. A series of multilevel models with related variables were built, increasing the likelihood of significant associations emerging by chance. Many of the discrete outcomes, such as enthusiasm and happiness, are likely to correlate, which deteriorates the statistical power of the models (Goeman & Solari, 2014). However, in multilevel modelling traditional post-hoc adjustments such as Bonferroni are likely to produce overly conservative

significance estimates (Jensen et al., 2015) and therefore were not used in this study. Thus, especially the weaker significance estimates should be interpreted with caution. Regardless of this, there were multiple robust associations, and additionally the found associations mainly were in line with expectations and previous research. Therefore, it seems unlikely that most associations would have resulted from a multiple comparison problem. Furthermore, due to the explorative nature of the study, it was essential to preserve as much statistical power as possible.

It is also not clear if the measured sisu states are the best way to capture the occasional short-time manifestations of sisu. However, the states were modified from the items of the validated Sisu Scale, which is the recommended practice for studying personality states (Ching et al., 2014; Fleeson, 2001). Therefore, it seems likely that the sisu states used in this study represent adequately the short-time manifestations of beneficial or harmful sisu, but future studies could seek to validate the state measures. Finally, it is important to highlight that the harm to others subscale shows only moderate reliability, according to Henttonen, Määttänen et al. (2022). Therefore, it is advisable to interpret the results related to this subscale with some caution.

4.4 Conclusions and practical implications

The everyday beneficial sisu can manifest as determination and feelings of control, whereas individuals with high harmful sisu reported more often getting stuck on problems, completing a task they did not enjoy, or accepting a task that was too challenging. Furthermore, beneficial sisu might strengthen or be strengthened via positive affectivity. Harmful sisu, for its part, is linked with less satisfaction. The findings also indicate that the Sisu Scale successfully captures tendencies that have correlates in every-day behavior.

Although it now seems that sisu is not reserved only for significant psychological or physical hardships, it does not mean that (beneficial) sisu would not be particularly crucial or prominent in those situations. Though sisu has attracted international interest in the past (see Lomas, 2016), future studies should pursue to expand the concept beyond Finnish borders, for example via cross-cultural validation of the scale in different languages and cultural contexts. Cross-cultural validation is already underway: samples from Australia, Germany and Spain have been collected, and preliminary results have been presented (Henttonen, Määttänen & Hoferichter, 2021).” As has been described, Finland is the “home” of sisu. However, taking it to other cultures and languages would broaden the understanding of humanity through the non-English lexicon.

Based on the results of this study, future studies should involve similar ESM-methodology as they appear to reveal differences in challenges and affects in everyday situations, which may have cumulative impacts on individual well-being and even health.

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Funding

This work was supported by Academy of Finland [project 313399], European Social Funds Plus [project S22390].

Conflict of interest statement

The authors report no conflicts of interest.

Data availability statement

The data utilized in this study can be accessed on request from the corresponding author.

AI statement

During the preparation of this work the author(s) used ChatGPT in order to improve the readability of the text. After using this tool, the authors reviewed and edited the content as needed and take full responsibility for the content of the publication.

Acknowledgements

The authors would like to thank the individuals and organizations that participated in the study. We thank Emilia Makkonen for her assistance with data collection. We would also like to express our sincere gratitude to the reviewer and editor for their valuable insights and suggestions. Their input has significantly contributed to the improvement of this work.

Publishing Timeline

Received 10 October 2023

Revised version received 7 February 2025

Accepted 7 February 2025

Published 31 May 2025

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Appendices

Appendix 1. Sisu Scales

Table A1. English translation of Sisu Scale, including instructions, item descriptions and formulas for calculation of subscale sum scores

On a scale from 1 to 5, how well do the following statements describe you? (1=Strongly disagree 5=Strongly agree)

Beneficial sisu	LP1	I often surprise myself by finding inner strength that lies beyond my perceived limitations.
	LP2	In the face of challenges or adversities, I often find that I exceed myself.
	LP3	I often feel like I am finding a new gear when I face adversity.
	AM1	I always face my fears rather than avoid them.
	AM2	I am willing to take risks to achieve important goals.
	AM3*	I avoid challenges. (REVERSE CODED ITEM)
	EP1	Once I am resolved to do something, there is nothing that can stop me from doing it.
	EP2	I often survive adversities by sheer determination alone.
	EP3	In important situations I often find strength to try one more time, even though I am physically and mentally exhausted.
Harmful sisu	HR1	I usually spend too much time on unnecessary pursuits.
	HR2	I often get stuck on problems.
	HR3	I often lose sight of what I am doing and fail to see the big picture.
	HS1	I often find myself in situations where I have taken a challenge way beyond my perceived capacities.
	HS2	I often put myself in difficult situations.
	HS3	I tend to accept tasks that exceed my capabilities.
	HO1	My determination often leads to conflict with other people.
	HO2	I have endangered or damaged my relationships while pursuing an important goal.
	HO3	I usually find it difficult to take other people's opinions into consideration.

Note. Subscale calculation: Reverse code item AM3. Latent power=LP1+LP2+LP3. Action mindset=AM1+AM2+AM3. Extraordinary perseverance = EP1+EP2+EP3. Harm to reasoning=HR1+HR2+HR3. Harm to self=HS1+HS2+HS3. Harm to others=HO1+HO2+HO3. Beneficial sisu=LP1+LP2+LP3+AM1+AM2+AM3+EP1+EP2+EP3. Harmful sisu=HR1+HR2+HR3+HS1+HS2+HS3+HO1+HO2+HO3. For alternative beneficial sisu measure, include the reverse-coded "Harm to reasoning" items.

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Table A2. Finnish version of Sisu Scale, including instructions, item descriptions and formulas for calculation of subscale sum scores

Asteikolla 1-5, kuinka hyvin seuraavat väittämät kuvaavat sinua? (1=Ei ollenkaan samaa mieltä, 5=Erittäin samaa mieltä).

Hyödyllinen sisu	LP1	Yllätyn usein siitä, että löydän itsestäni uusia, aiemmin havaitsemattomia voimavaroja
	LP2	Vastoinkäymisten tai haasteiden edessä huomaan usein ylittäväni itseni.
	LP3	Haasteen edessä tunnen usein löytäväni "uuden vaihteen".
	AM1	Kohtaan pelkoni mieluummin kuin välttelen niitä.
	AM2	Olen halukas ottamaan riskejä saavuttaakseni tärkeitä päämääriä.
	AM3*	Välttelen haasteita. (KÄÄNNETTY MUUTTUJA)
	EP1	Kun olen päättänyt tehdä jotakin, mikään ei voi estää minua toteuttamasta aiettani.
	EP2	Selviän vaikeuksista usein pelkällä päättäväsyydellä.
	EP3	Tärkeissä tilanteissa löydän usein voimaa yrittää vielä yhden kerran, vaikka olisin fyysisesti ja henkisesti täysin lopussa.
Haitallinen sisu	HR1	Käytän usein liian paljon aikaa tarpeettomien asioiden tavoitteluun.
	HR2	Jumiudun usein ongelmiin.
	HR3	Usein minulta hämärtyy, mitä olen tekemässä, enkä kykene näkemään kokonaisuutta.
	HS1	Ajaudun usein tilanteeseen, jossa selvästi otan vastaan kykyni ylittävän haasteen.
	HS2	Asetan usein itseni vaikeisiin tilanteisiin.
	HS3	Otan usein vastaan tehtäviä, jotka ylittävät kykyni.
	HO1	Päättäväsyyteni johtaa usein konflikteihin muiden ihmisten kanssa.
	HO2	Olen vahingoittanut tai vaarantanut ihmissuhteitani tavoitellessani tärkeää päämäärää.
	HO3	Minulla on yleensä vaikeuksia ottaa muiden mielipiteitä huomioon.

Note. Summapisteiden laskenta: Käännä kysymys AM3. Piilevä voima=LP1+LP2+LP3.

Toimintasuuntautuneisuus=AM1+AM2+AM3. Peräänantamattomuus= EP1+EP2+EP3. Haitat ajattelulle=HR1+HR2+HR3. Haitat itselle=HS1+HS2+HS3. Haitat muille=HO1+HO2+HO3. Hyödyllinen sisu=LP1+LP2+LP3+AM1+AM2+AM3+EP1+EP2+EP3. Haitallinen sisu= HR1+HR2+HR3+HS1+HS2+HS3+HO1+HO2+HO3. Käyttääksesi vaihtoehtoista hyödyllisen sisun skaalaa, ota mukaan käännetty "Haitat ajattelulle"-kysymykset.

Appendix 2. Missing values analysis

The data from the point of measure in the *affect* questionnaires were removed if the participant had already answered the questionnaire within the previous three hours, or if the participant had just opened the application without answering to any of the questions. As follows, duplicate answers and the overestimation of missing values were avoided. Three hours was chosen as a threshold since it was the shortest plausible time interval between separate questionnaires. Eventually, there were 3572 points of measurement of affects across participants. For the *sisu state* questionnaires, only one answer per day was included, and of those, the application openings without answering were excluded, resulting in 1159 points of measure in total. The average number of included separate questionnaires per participant was 43.6 for affects (SD = 16.1, range = 2–70) and 14.3 for sisu states (SD = 5.8, range = 1–22).

After the previous procedure, a missing value in the analysed data indicated that some parts of the questionnaire were answered, whereas simultaneously others were not. Partially missing data seems to be unusual in ESM studies (Silvia et al., 2013). Examination revealed that the negatively nuanced states and affects had noticeably more missing values (range 28.0 % – 80.9 %) than positive states and affects (range 1.0 % – 23.8 %). The proportion of missing values increased over time during the experimental periods. The highest missingness rates were for *sadness* (80.9 %), *anger* (79.2 %), *anxiety* (62.0 %), and *criticism* (57.9 %). Thus, it can be concluded that the participants often collectively left negatively nuanced claims unanswered.

A missing value in the data was represented with the value of 0. However, there was a default answer '0' visible for participants of two organizations for the Likert scale questions. Thus, it was not certain if a 0 in the answers of these participants referred to a missing value or the lowest value ("*not true at all*"). There were no differences in the number of missing values between different organizations which indicates that the default value of 0 was not misinterpreted as the lowest option on a Likert scale in most cases.

The momentary correlation between negative and positive affect is often inverse (Diener & Emmons, 1984; Zelenski & Larsen, 2000). Indeed, higher positive affect was associated with a lower number of responses in negative affect, indicating that missing responses could be interpreted as the absence of negative affect (the value 1 on a Likert scale). It is also notable that the value 1 ("*not true at all*") was relatively rare in the data (2.6 % for affects and 1.4 % for sisu states), which might indicate that it was not appropriately used as an indicator of the absence of a state. However, the models with imputed values ("*1*" on a Likert scale instead of a missing value in all cases or only when positive affect was high) predicting the negative affect variables did not perform better compared to the original models. Therefore, reliably imputing or handling the missing responses in the negatively nuanced states would be complicated. Based on the residual plots, the multilevel models with the negative affect variables performed adequately. Therefore, the missing responses were included in the analyses as such. However, the response rate must be considered when interpreting the results.