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Research Paper

Maladaptive emotion regulation strategies in a vulnerable population predict increased anxiety during the Covid-19 pandemic: A pseudo-prospective study

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A B S T R A C T

Background: The Covid-19 pandemic has led to drastic public health measures with a substantial impact on the individual. Previous studies reported elevated levels of stress, anxiety, and depression in the general population as a consequence of pandemic-related public health measures. In vulnerable individuals, exposure to an uncontrolled global stressor like the Covid-19 pandemic might be felt as particularly threatening.

Methods: A population of 127 healthy individuals that expressed increased trait anxiety (HADS ≥ 8) already before the outbreak of the pandemic were tested on state and trait anxiety, stress and depression before and four weeks after the outbreak of the pandemic in the Netherlands. Online questionnaires were administered between April 16 and April 23, 2020.

Results: We observed an increase in state anxiety (STAI) during the pandemic but no change in depression. Yet, trait anxiety (STAI) before the pandemic did not predict the increase in state anxiety during the pandemic. Further, state anxiety during the pandemic was not associated with being in contact with an infected person, having symptoms of Covid-19, protective behavior, or degree of social isolation when controlling for state anxiety before the outbreak of the pandemic. However, maladaptive emotion regulation strategies measured before the pandemic predicted state anxiety and perceived stress during the pandemic, while adaptive strategies had no association with anxiety during the pandemic.

Conclusion: Reducing learned helplessness and self-blaming to prevent maladaptive emotion regulation strategies like giving up and self-devaluation might be more beneficial than training adaptive strategies.

Limitations: Time variation in baseline measurements.

1. Introduction

The Corona pandemic poses a global stressor on society with potential consequences for the mental health and well-being of individuals. Numerous studies reported increased levels of stress, anxiety, and depression, following the outbreak of the novel coronavirus (Covid-19) and implementation of pandemic-related measures (Fernández et al., 2020; Holmes et al., 2020; Korajlija & Jokic-Begic, 2020; Lahav, 2020; Shevlin et al., 2020; Tian et al., 2020; Wang & Zhao, 2020; Xiong et al., 2020). Likewise, studies on previous virus pandemics described a fear of contamination and restricted social contact due to distancing in private and professional life as main risk factors for increased anxiety (Blakey and Abramowitz, 2017).

The majority of the healthy population might experience the pandemic and related regulations as challenging. Nevertheless, healthy individuals presumably can draw on sufficient mental resources to cope with the situation (Fried, 2020). In contrast, the pandemic and related consequences might have a more negative impact on vulnerable individuals that already express elevated trait anxiety in normal times. Those individuals might experience increased stress during the Covid-19 pandemic, which eventually may lead to the clinical manifestation of anxiety or depression (Taylor and Asmundson, 2020). First studies on potential effects of the pandemic on mental health focused on healthy populations while clinical and subclinical groups received substantially less attention (Yao et al., 2020). Further, most studies only assessed mental health during the pandemic and were not able to relate results to measurements before the outbreak of the pandemic. We investigated anxiety, depression, and perceived stress as well as emotion regulation strategies in a vulnerable population of healthy individuals with increased trait anxiety. Importantly, the study data were acquired *before* the outbreak of the pandemic in the Netherlands, ensuring a population that had already shown vulnerability (but without clinical severity) before the occurrence of the pandemic, and thus, our approach enabled a pseudo-prospective study design.

Emotion regulation plays a crucial role in emotional well-being in healthy individuals. Emotion regulation involves cognitive and behavioral processes that influence emotional experiences and emotional re-

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actions (Gross, 1998). Those processes comprise a range of cognitive and behavioral strategies that have been categorized as adaptive and maladaptive strategies based on their effectiveness and the costs they carry along. Maladaptive emotion regulation strategies like suppression and avoidance behavior have been associated with higher levels of anxiety, lower well-being and reduced interpersonal functioning (Campbell-Sills and Barlow, 2007; Craske & Stein, 2016; Gross & John, 2003; Hofmann et al., 2009). Increased anxiety might therefore be a by-product of using maladaptive emotion regulation strategies. In contrast, reappraisal, which involves the benign or positive reinterpretation of an emotional stimulus or situation, is considered as an adaptive emotion regulation strategy and has been associated with lower levels of depression, stress, and anxiety (Martin and Dahlen, 2005). Yet, emotion regulation skills may be protective at normal times but may fail when being exposed to a serious global and ongoing stressor like the Covid-19 pandemic. Further, pandemic-related restrictions might impede adaptive emotion regulation, as people are limited in their ability of actively changing their situation.

As part of an ongoing study, we evaluated adaptive and maladaptive emotion regulation skills already before the outbreak of the pandemic and related these to changes in anxiety and depression during the pandemic. We aimed to investigate (a) if anxiety and depression increased in the early phase of the pandemic, and (b) whether trait anxiety measured before the outbreak of the pandemic predict potential increases in anxiety due to the pandemic. Further, we explored whether (c) anxietyor stress during the pandemic can be predicted based on adaptive or maladaptive emotion regulation strategies individuals preferably applied before the outbreak of the pandemic.

2. Methods

2.1. Study population

Between November 2017 and January 2020 subjects were recruited based on an online screening, consisting of the Hospitality-Anxiety-and-Depression-Scale (HADS, Zigmond and Snaith, 1983), demographical data, and screening for MRI-compatibility (conducted on www.soscisurvey.de). The screening was advertised on university websites and announced in university lectures. The HADS evaluates anxiety and depression and is a valid tool to investigate variance of trait anxiety in a healthy population (Breeman et al., 2015). To oversample for high trait anxiety, all individuals with elevated scores (≥ 8) on the HADS anxiety-subscale (HADS-A) received a study invitation, while individuals with normal scores (HADS-A < 8) were selected for study participation based on a 25%-probability. Of 2206 subjects that completed the screening, 486 potential participants received a study invitation for a study on neural biomarkers of anxiety. In case of HADS-A scores > 15, presumably indicating clinical levels of anxiety, a structured interview (DSM-IV-based M.I.N.I) (van Vliet and de Beurs, 2007) was conducted with the study psychologist (AKB). Of 248 subjects that agreed to participate in an fMRI study, one subject was excluded due to a suspected psychiatric diagnosis in order to ensure a healthy study population. Further, 13 subjects were excluded because of reduced data quality, incidental findings, falling into sleep during the fMRI session, or incomplete data collection due to premature termination. Finally, 234 participants (63 males, 171 females, mean age 22.8 (4.85)) completed the test session including fMRI, physiological measurements (skin conductance, heart rate, pupil dilation), and a questionnaire battery on anxiety, stress, and personality (results will be reported elsewhere). The majority were university students with elevated HADS-A scores; 184 participants had a HADS-A score ≥8 (47 males, 137 females), and 50 participants had a HADS-A score < 8 (16 males, 34 females). This study was approved by the regional ethics committee (commissie mensgebonden onderzoek(CMO)) of the Radboudumc in Nijmegen/ The Netherlands (CMO 2017/3588). Four weeks after the pandemic-related regulations came into force in the Netherlands (15th of March 2020), all 234 participants that had completed the study were approached again for an online follow-up study. Of those, 127 participants (54%) completed the online follow-up (98 females, mean age: 22.8). This follow-up study was also approved by the CMO of the Radboudumc in Nijmegen/ The Netherlands (CMO2014/288).

2.2. Follow-up questionnaires

The follow-up study consisted of several questionnaires on anxiety, depression, and emotion regulation that were already administered once before the pandemic during the original study (see Table 1). To measure the change of anxiety and depression during the pandemic, the State and Trait Anxiety Index (STAI; Spielberger et al., 1983) and the HADS were measured before (original study) and during the pandemic. Adaptive and maladaptive emotion regulation strategies were evaluated on the Questionnaire on Emotion Regulation in Adults (FEEL-E; (Grob and Horowitz, 2015) only before the pandemic. The FEEL-E entails six subscales on adaptive strategies (problem-oriented, acceptance, cognitive problem solving, re-evaluation, positive mood, forgetting) and six subscales on maladaptive strategies (withdrawal, self-devaluation, giving up, rumination, negative thinking, allocating blame). Additionally, a questionnaire on the perception of and dealing with the Covid-19 pandemic evaluated if participants experienced symptoms that relate to Covid-19, had been in contact with a Covid-19 infected person, frequency of checking the news, fear of contamination, general health worry, degree of social isolation, protective behavior, and how appropriate regularities and media attention were perceived. Stress was evaluated on a validated questionnaire on stress perception only during the pandemic (PSS; Cohen et al., 1983). All questionnaires were administered in Dutch (for detailed description of all questionnaires see supplemental material, Section 8).

In the original study participants filled in the questionnaires during a test session at the institute, using a cloud-based clinical data platform (*Castor Electronic Data Capture*, 2019). The follow-up questionnaires during the pandemic were conducted online using the same platform. Participants received a link to their encrypted record to fill in the questionnaires. Participants had a time window of seven days to complete the questionnaires (April 16 - April 23, 2020). During this period, participants were most likely not able to continue their work or study normally and experienced a highly restricted social life due to the pandemic related regulations in the Netherlands (https://www.government.nl/topics/coronavirus-covid-19/tackling-new-coronavirus-in-the-netherlands).

2.3. Statistical analysis

To test the change of anxiety and depression levels before (baseline) and after the pandemic (pandemic), paired-sample t-tests were calculated. Further, we conducted Bayesian paired sample t-tests to estimate the probability of a potential change (or no change) in anxiety or depression during the pandemic. Bayesian statistics provides the probability of how much more likely the data are under the null hypothesis compared to the alternative hypothesis (Quintana and Williams, 2018). To investigate whether responders and non-responders to the follow-up questionnaire during the Covid-19 pandemic differed in their level of anxiety or depression an independent samples t-test was calculated. To test whether individuals that were highly anxious before the outbreak of the pandemic experienced a larger increase of state anxiety during the pandemic, we correlated trait anxiety before the pandemic with the difference score in state anxiety. Furthermore, state anxiety during the pandemic was correlated with variables of the Covid-19 questionnaires controlling for state anxiety before the pandemic. We conducted independent sample t-tests to test whether individuals that had Covid-19 like symptoms such as fever, cold or cough, or had been in contact with a Covid-19 patient differed in their state anxiety. Descriptive statistics,

Table 1
Questionnaires on anxiety, depression, stress, and emotion regulation strategies applied between 27 and 2 months before, and 1 month after the Covid-19 outbreak in the Netherlands. The PSS was only included in the pandemic measurement. The FEEL-E was only administered at baseline.

	before Covid-19 outbreak(baseline)				after Covid-19 outbreak(follow-up during the pandemic)			
	min	*max*	*mean*	*std*	*min*	*max*	*mean*	*Std*
Anxiety								
HADS-A	2	16	9.09	3.05	0	14	6.33	2.96
STAI-state	25	64	39.55	8.25	23	72	44.00	9.54
STAI-trait	21	73	43.55	9.93	24	68	42.82	9.51
Depression								
HADS-D	0	16	4.78	3.27	0	18	5.15	3.53
Perceived Stress								
PSS	-	-	-	-	8	36	20.72	5.31
Adaptive emotion regulation strategies								
Problem oriented	11	30	21.09	3.45	-	-	-	-
Acceptance	9	29	19.84	3.37	-	-	-	-
Cognitive problem solving	15	30	22.65	3.34	-	-	-	-
Reappraisal	7	28	18.52	3.94	-	-	-	-
Positive mood	7	30	19.84	4.31	-	-	-	-
Forgetting	9	30	20.63	3.89	-	-	-	-
Maladaptive emotion regulation strategies								
Withdrawal	6	30	19.09	4.97	-	-	-	-
Self-devaluation	12	29	21.90	3.98	-	-	-	-
Giving up	7	26	16.46	4.30	-	-	-	-
Rumination	11	29	22.14	2.77	-	-	-	-
Negative thinking	6	29	11.16	4.98	-	-	-	-
Allocating blame	6	26	13.29	4.40	-	-	-	-

correlations, and t-tests were conducted in SPSS (*SPSS Statistics for Windows*, 2015). Bayesian statistics were conducted in JASP (*JASP*, 2020).

2.4. Bayesian regression models

In a pseudo-prospective design, we assessed whether the level of anxiety during the pandemic was more accurately predicted by (a) emotion regulation strategies (FEEL-E subscales) than by (b) the level of anxiety measured before the pandemic. We assumed that anxiety levels at baseline have an inherent association with anxiety during the pandemic, and therefore are strong predictors of variance in anxiety during the pandemic. Bayesian regression models were chosen for statistical analysis as they allow to include such previous assumptions as model parameters (regressors) and provide probability of those prior parameters to be predictive for a dependent variable (Baldwin and Larson, 2017) as well as convenient comparison of models. Bayesian regression models provide the advantage of testing a regression model composed of several regressors against a null-model that already considers regressors that are expected to affect the dependent variable, such as variation of state anxiety at baseline. Thereby effects due to i.e. regression to the mean and related correlational biases such as the selection-distortion bias can be ruled out. The null-model is composed of regressors that are assumed to have a strong effect on the dependent variable. This way the likelihood of a simple null-model relates to simple effects of anxiety values in the initial sample. Possible regression effects are compared to a more elaborate model that includes additional effects of interest. Bayesian statistics allow to calculate the likelihood that a more elaborate regression model explains the data better than the trivial null-model. We conducted Bayesian linear regression models to compare the probability of different predictive models to the assumed prediction of baseline anxiety on pandemic anxiety. Regressors included in the null model were tested against the alternative regressor models containing combinations of additional regressors. We included anxiety scores measured before the pandemic and the time interval between the baseline and follow-up measure in the null models, assuming that those had a predictive effect towards anxiety during the pandemic. By including anxiety scores measured before the pandemic in the null model we consider state variation at baseline and therefore correct for potential regression towards the mean and additional correlation biases (i.e. selection-distortion effect). As the time interval between baseline measure and pandemic measure was in some of the early participants over a time period of 2.5 years and therefore highly variable between individuals, it was included as a regressor in the null model. Comparing the null model to alternative models including adaptive and maladaptive emotion regulation strategies allowed to determine the probability of whether a certain emotion regulation strategy or combinations of strategies predicted anxiety during the pandemic above and beyond anxiety before the outbreak of the pandemic.

Bayesian regression models were only conducted for scales that indicated a change when comparing baseline to pandemic measures. Finally, four Bayesian regression models were conducted to determine the probability of (A) adaptive emotion regulation strategies and (B) maladaptive emotion regulation strategies to predict (a) state anxiety (STAI-S) or (b) trait anxiety (HADS-A) more accurately than anxiety at baseline only (null model). For validation purposes, the analysis was repeated with another dependent variable (perceived stress). Therefore, two additional Bayesian regression models were conducted to determine the probability of (A) adaptive emotion regulation strategies and (B) maladaptive emotion regulation strategies to predict perceived stress (PSS) during the pandemic more accurately than state anxiety (STAI-S) at baseline only (null model).

In all analyses, a Bayes factor $BF_M > 3$ indicates moderate to strong evidence of the model to explain variance in the dependent variable (Wagenmakers et al., 2018). The Bayes factor BF_{10} estimates the evidence for the alternative model in comparison to the null model. Only models with moderate to high probability ($BF_M > 3$, $BF_{10} > 3$) accounting for at least 10% more variance compared to the null model are reported (all other models can be found in the supplemental materials, Section 4).

3. Results

Overall, 127 of the original participants completed the follow-up measurement during the pandemic. An attrition analysis revealed no significant differences between participants and drop-outs when comparing baseline scores. Participants of the follow-up were not significantly different regarding their baseline scores from participants that did not take part in the follow-up measurement (supplemental mate-

Table 2
A Bayesian regression model including all subscales of maladaptive emotion regulation measured at baseline as regressors of state anxiety (STAI-S) during the pandemic. All models include STAI-S at baseline. The best 10 models are displayed.

Model Comparison: Maladaptive emotion regulation strategies predicting anxiety Models	P(M)	P(M|data)	BF_M	BF_{10}	R^2
Null model (incl. STAI-S at baseline, time difference)	0.143	0.120	0.815	1.000	0.136
withdrawal + self-devaluation + giving up + rumination + negative thinking + allocating blame	0.143	0.152	1.073	1.269	0.243
withdrawal + self-devaluation + giving up	0.007	0.078	11.816	13.103	0.230
self-devaluation	0.024	0.067	2.962	3.380	0.174
withdrawal + self-devaluation + giving up + negative thinking + allocating blame	0.024	0.055	2.398	2.773	0.240
giving up	0.024	0.049	2.107	2.453	0.170
withdrawal + self-devaluation + giving up + rumination + allocating blame	0.024	0.048	2.088	2.432	0.238
withdrawal + self-devaluation + giving up + rumination	0.010	0.048	5.278	6.059	0.235
withdrawal + self-devaluation + giving up + rumination + negative thinking	0.024	0.045	1.926	2.251	0.236
withdrawal + self-devaluation + giving up + allocating blame	0.010	0.041	4.400	5.091	0.233

P(M) = prior model probability, P(M|data) = posterior model probability, BF_M = change from prior model odds to posterior model odds, BF_{10} = Bayes factor for each row (model) against the one on top (H_1 vs. H_0)

rial, Section 7). Table one displays all conducted measurements before the outbreak of the Covid-19 pandemic in the Netherlands (baseline) and 32 to 39 days after the outbreak (follow-up during the pandemic). Baseline measures were conducted between 98 and 868 days before the pandemic measure (*mean time difference* = 590 days, *sd* = 228). A full correlation table is provided in the supplemental material (Section 8).

Figure one displays the distribution of state and trait anxiety and trait depression at baseline and during the pandemic. Paired-sample t-tests indicated a significant increase in state anxiety measured on the STAI-S comparing the baseline measure to the follow-up during the pandemic $t(126) = 4.945$, $p < .001$. However, there was a significant decrease in trait anxiety measured on the HADS-A during the pandemic compared to the baseline measurement, $t(126) = -9.533$, $p < .001$, while trait anxiety measured on the STAI-T did not significantly change, $t(126) = -.937$, $p = .351$. There was also no significant change in depression (HADS-D), $t(126) = 1.147$, $p = .253$. There was no correlation between trait anxiety before the pandemic and increase of state anxiety (baseline – follow up), neither for trait anxiety measured on the STAI-T ($r = .139$, $p > .05$), nor for trait anxiety measured on the HADS-A ($r = .082$, $p > .05$). Figure two displays the change in anxiety and depression comparing the measurement before the pandemic to the measurement taken four weeks after the outbreak of the pandemic. Time differences in the baseline measure did not affect changes in anxiety or depression during the pandemic (see supplemental material, Section 6). There was no difference between man and women in state anxiety during the pandemic, $t(125) = .176$, $p > .05$. Also, change in state anxiety during the pandemic relative to the baseline measurement was not different comparing women and men, $t(125) = 1.895$, $p > .05$.

Two-sided Bayesian t-tests were conducted to estimate the evidence for there being no change in anxiety and depression during the pandemic. For the measurements on HADS-A and STAI-S, Bayesian Factors revealed that the likelihood for no change between the baseline and the pandemic measurement was close to zero. Two-sided Bayesian t-tests for the HADS-D measurements suggested that depression was 5.3 times more likely not to change during the pandemic. The Bayes factor ($BF_{01} = 6.221$) for the STAI-T measurements suggested that trait anxiety was 6.6 times more likely not to change during the pandemic (see supplemental material, Table 2, Fig. 1).

3.1. Association between state anxiety and pandemic related variables

General health worry correlated positively with state anxiety during the pandemic (STAI-S) when controlling for state anxiety before the pandemic, $r = .285$ $p < .001$. Also worry of contamination correlated positively with state anxiety, $r = .257$, $p < .05$. There were no significant correlations between state anxiety during the pandemic (STAI-S) and any other variables of the Covid-19 questionnaire when controlling for state anxiety before the outbreak of the pandemic (supplementary material, Section 1). Further, there was no significant difference in state anxiety measured during the pandemic between participants that were currently experiencing symptoms that are associated with Covid-19 or had been in contact with a patient that had been tested positively for Covid-19 (supplementary material, Section 1).

3.2. Bayesian regression models to predict anxiety during the pandemic based on emotion regulation strategies

Bayesian regression models have been conducted for measurements that revealed a change when comparing baseline measures and follow-up measures during the pandemic (STAI-S, HADS-A). There was no to low evidence for adaptive emotion regulation strategies to predict anxiety (STAI-S, HADS-A) during the pandemic more accurately than the null model. The null model included only the baseline measure of anxiety and the time difference between the baseline and follow-up measurement. For maladaptive strategies, we found strong evidence for a model containing 'withdrawal' ($ß = -.504$), 'self-devaluation' ($ß = .531$), and 'giving up' ($ß = .662$), accounting for 23% of the variance in state anxiety (STAI-S) during the pandemic, ($BF_{10} = 13.103$), (Table 2, for posterior summaries of coefficients and credible interval, see supplemental material, Table 3, Fig. 2).

Testing the probability of maladaptive regulation strategies measured before the pandemic to predict trait anxiety (HADS-A) indicated high evidence for the strategies 'withdrawal' (ß = -.107) and 'giving up' (ß = .178) to predict trait anxiety *during* the pandemic ($BF_{10} = .9$). However, predicting trait anxiety during the pandemic based on the expression of the 'withdrawal' and 'giving up' and trait anxiety *before* the pandemic accounted for only 3.8% more variance compared to the null model which included trait anxiety and time difference only (supplemental material, Section 4.3).

3.3. Bayesian regression model to predict perceived stress during the pandemic

For additional validation, a Bayesian regression model was conducted to determine the probability of maladaptive emotion regulation strategies to predict perceived stress (PSS) during the pandemic while controlling for state anxiety before the pandemic. Perceived stress correlated positively with increase in state anxiety on the STAI-S, $r = .465$, $p < .001$ (see all correlation measures between anxiety measures and stress in the supplemental material, Section 8, Tables 13 and 15). As perceived stress is conceptually related to anxiety increase during the pandemic, we aimed to use the perceived stress score as a conceptual validation of the prediction of anxiety increase during the pandemic. There was strong evidence ($BF_{10} = 130.569$) for a regression model containing the strategies 'self-devaluation' ($ß = .212$) and 'giving up' ($ß = .345$) to predict perceived stress. The model accounted for 11.8%

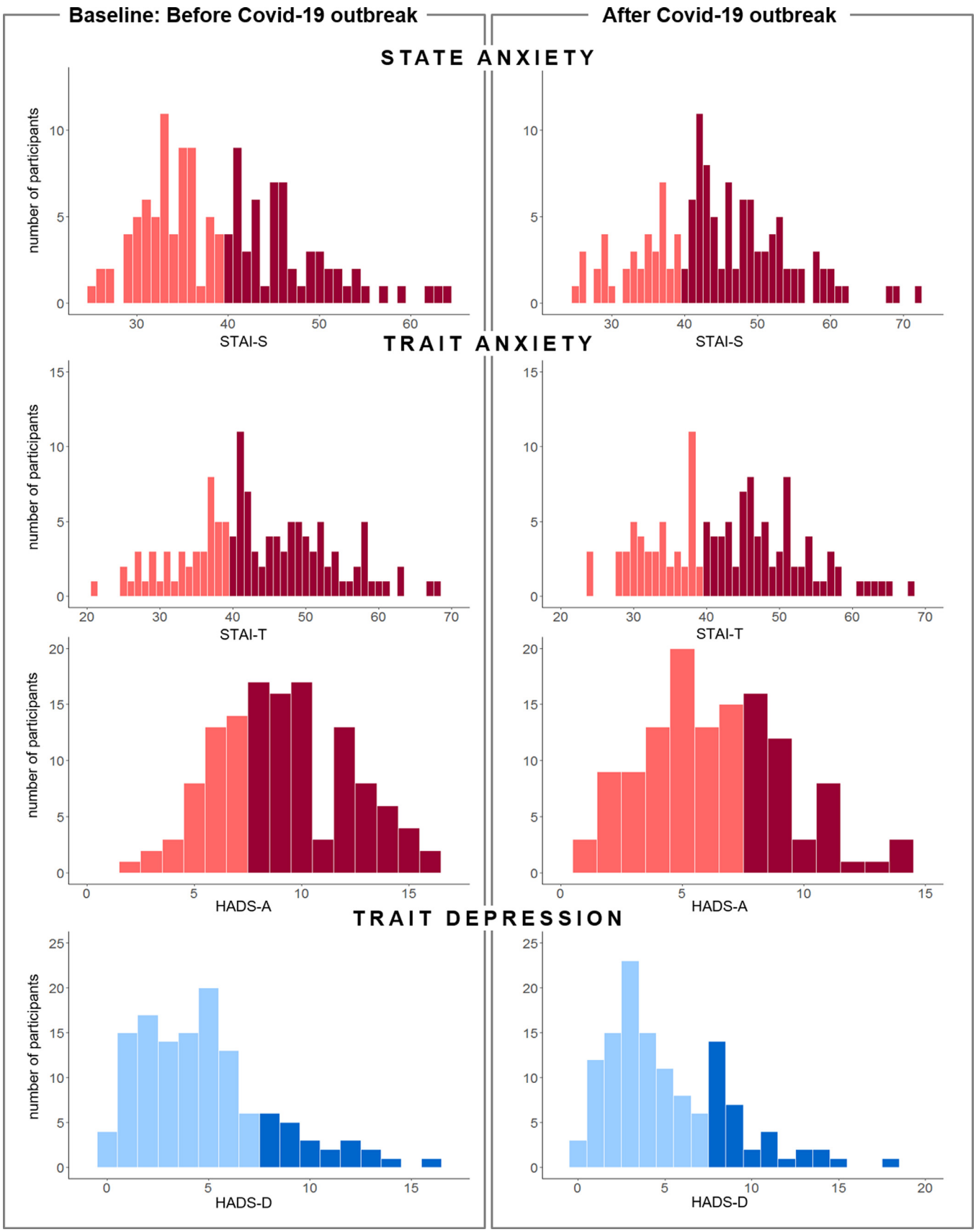

Fig. 1. Distribution of state anxiety scores on the STAI-S, trait anxiety scores on the STAI-T and HADS-A, and trait depression scores on the HADS-D before the Covid-19 outbreak and 4 weeks after the Covid-19 outbreak in the Netherlands. The color intensity of bars indicates the severity of anxiety/depression. A HADS-A score ≥8 and STAI scores ≥ 39 indicate increased levels of anxiety. A HADS-D score ≥8 indicates increased levels of depression.

Table 3
A Bayesian regression model including all subscales of maladaptive emotion regulation measured at baseline as regressors of perceived stress during the pandemic (PSS). All models include state anxiety (STAI-S) at baseline. The best 10 models are displayed.

Model Comparison: Maladaptive emotion regulation strategies predicting perceived stress Models	P(M)	P(M|data)	BF_M	BF_{10}	R^2
Null model (incl. STAI-S at baseline, time difference)	0.143	0.013	0.076	1.000	0.050
giving up	0.024	0.194	9.846	92.526	0.144
self-devaluation + giving up	0.010	0.109	12.762	130.569	0.168
withdrawal + self-devaluation + giving up + rumination + negative thinking + allocating blame	0.143	0.066	0.426	5.284	0.182
self-devaluation + giving up + allocating blame	0.007	0.047	6.899	75.317	0.177
withdrawal + self-devaluation + giving up	0.007	0.036	5.182	57.245	0.173
self-devaluation + giving up + negative thinking	0.007	0.032	4.633	51.380	0.171
giving up + negative thinking	0.010	0.029	3.121	34.805	0.148
withdrawal + self-devaluation + giving up + allocating blame	0.010	0.028	3.050	34.035	0.181
withdrawal + self-devaluation + giving up + rumination + allocating blame	0.024	0.028	1.169	13.245	0.182

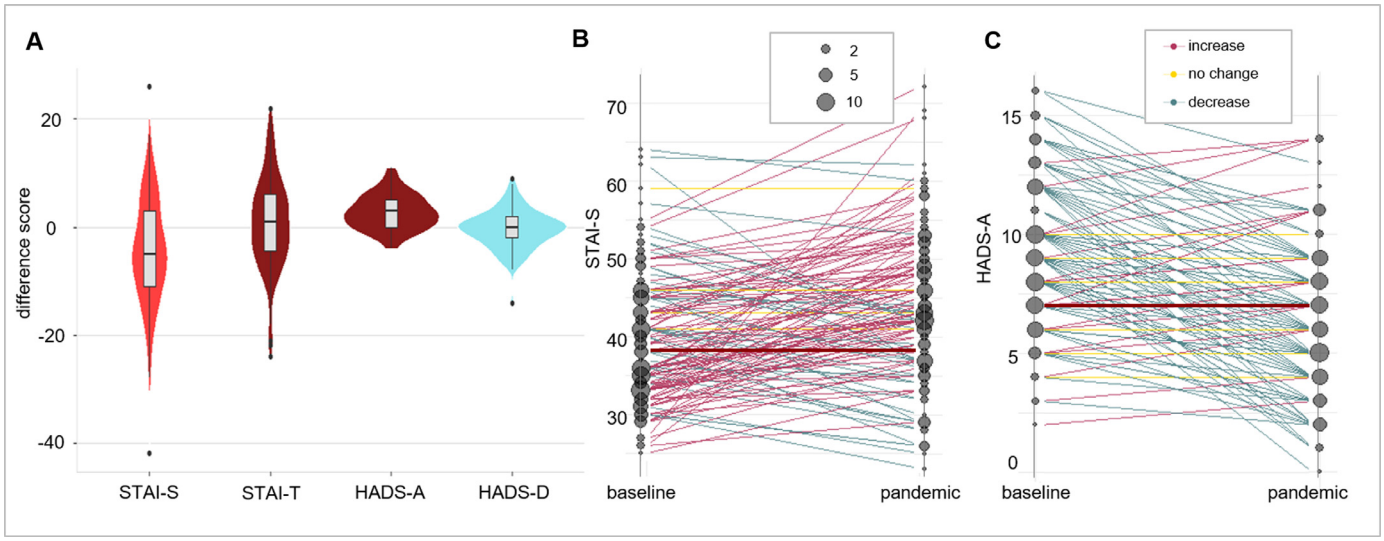

Fig. 2. A. Difference scores (baseline minus follow-up) are displayed for anxiety and depression on the HADS (HADS-A and HADS-D), and state and trait anxiety on the STAI (STAI-S and STAI-T). A negative value indicates increased anxiety or depression during the pandemic, a positive value indicates decreased anxiety or depression during the pandemic relative to the baseline measurement. The shape width indicates the distribution of the difference scores. The black line within the boxplot defines the median. **B.** Individual changes in state anxiety at baseline and during the pandemic; the red line indicates the cut-off value for increased anxiety (STAI –S ≥ 39), the dot size represents the number of participants. **C.** Individual changes in trait anxiety; the red line indicates the cut-off value for increased anxiety (HADS-A ≥ 8), the dot size represents the number of participants.

of the variance in perceived stress during the pandemic (Table 3, for posterior summaries of coefficients and credible interval, see supplemental material, Section 3), while anxiety at baseline (null model) predicted only 5% of the variance in perceived stress during the pandemic.

4. Discussion

Using a pseudo-prospective design, anxiety, depression, and stress were evaluated in a population of healthy individuals oversampled for high trait anxiety (HADS ≥ 7) measured before and one month after the outbreak of the Covid-19 pandemic in the Netherlands. On a group level, there was strong evidence for increased state anxiety during the pandemic compared to the pre-pandemic baseline. There was substantial evidence for no change in trait anxiety (STAI) and depression (HADS-D) during the pandemic. However, trait anxiety measured on the HADS decreased. The study population was selected based on increased trait anxiety on the HADS and might have regressed to lower levels. Yet, regression towards the mean did not fully explain the observed decrease, since testing low anxious subjects separately led to the same decrease in trait anxiety. Trait anxiety before the outbreak of Covid-19 did not correlate with increases in state anxiety during the pandemic, indicating that healthy but highly anxious individuals did not experience more severe increases in state anxiety than individuals with normal trait anxiety. Manifestation of maladaptive emotion regulation strategies evaluated before the outbreak of the pandemic predicted the increase in state anxiety measured during the pandemic.

In the scope of the trait vs. state concept, trait anxiety is a stable characteristic that is less affected by spontaneous threatening events, while state anxiety is transitory and might vary with the occurrence of a threatening event (Cattell and Scheier, 1961; Spielberger et al., 1983). As we found a significant decrease in trait anxiety on the HADS during the pandemic but an increase in state anxiety, it might be debatable whether the trait vs state distinction holds at times of a global stressor like a pandemic as individuals are exposed to a stressful context over a long and unforeseeable period. Simultaneously, many constant daily stressors we encounter at normal times, like for example work pressure or social comparison are diminished during the pandemic due to pandemic-related regulations enforcing social distancing. As the majority of participants were university students and Dutch Universities were closed when the Covid-19 follow up measurement was conducted, those potential usual daily stressors might have been reduced at that time. Hence, a decrease in trait anxiety during the pandemic may be explained by a reduction of daily stressor due to pandemic-related regulations while state anxiety might increase as the responses were given in direct relation to the acute stressor of the pandemic. Since the STAI did not indicate changes in trait anxiety, it cannot be ruled out that

decreases in trait anxiety on the HADS occur due to methodological differences between the STAI and HADS. The HADS is a short screening instrument of seven items that might be less applicable in the context of the pandemic and therefore leading to contradictory results (see single item regression analysis in the supplemental material, Section 5).

Numerous studies measured anxiety and stress after the outbreak of Covid-19. A recent study applying the HADS in Turkey reported higher than normal levels of trait anxiety and depression in a healthy population (Özdin and Özdin, 2020). However, there was no baseline measurement supporting that heightened anxiety and depression were related to the pandemic. Higher than normal anxiety and depression levels were also reported after the outbreak of Covid-19 in Italy measured on the DASS-21. Heightened anxiety and depression levels were associated with experiencing stressful situations and having medical problems. Further, having an infected family member increased anxiety levels (Mazza et al., 2020). Controlling for state anxiety before the pandemic, we were not able to replicate those results in the Netherlands. There was no association between state anxiety during the pandemic and being in contact with a Covid-19 infected person or experiencing symptoms oneself. Since our population mainly consisted of university students, those differences might be less representative for the general population. Although the study population was selected based on elevated trait anxiety, the Covid-19 pandemic might have affected this group less severely than a general (older) population. Furthermore, the progression of the pandemic was less severe in the Netherlands and therefore might have represented a less intense threat. In summary, controlling for anxiety and depression before the outbreak of the pandemic, there was an increase in state anxiety related to worry of contamination and worry about general health but no increase in anxiety was associated with being in contact with a patient or experiencing symptoms one selves.

Instead of high trait anxiety, maladaptive emotion regulation strategies predicted state anxiety during the pandemic. There was a high likelihood of 'giving up', 'self-devaluation', and 'withdrawal' in combination with state anxiety before the pandemic explaining 21% of the variance in state anxiety during the pandemic. Importantly, anxiety during the pandemic was predicted more accurately when taking into account the expression of those maladaptive emotion regulation strategies in addition to state anxiety before the pandemic instead of basing the prediction solely on state anxiety before the pandemic.

The scale 'giving up' entails items like "I anyways can do nothing about my anxiety" or " I do not want to do anything anymore" and may reflect the expression of learned helplessness (Abramson et al., 1978). Learned helplessness has been associated with the progression of anxiety disorders (Mineka and Zinbarg, 2006). Individuals that tend to perceive problems as being beyond their control might experience more severe increases in anxiety when being exposed to a global stressor like the pandemic. Uncontrollable stress has been associated with subclinical anxiety and depression (Havranek et al., 2016). The threat from Covid-19 to the individual and the social network is an uncontrollable stressor. This might amplify the experience of helplessness in individuals that already have a high tendency to give up in the presence of a stressor.

Further, the maladaptive strategy 'self-devaluation' predicted increased state anxiety during the pandemic. The FEEL-E scale 'self-devaluation' reflects the tendency of self-attribution, indicating that the experience of anxiety might be evaluated as a personal weakness. Pandemic-related regulations that enforce social distancing might enhance this inherent tendency of self-devaluation as exchange with others experiencing similar feelings might be limited. Using another outcome measure evaluating perceived stress levels (PSS) corroborated those results. The regulation strategies 'giving up' and 'self-devaluation' were also the best predictors of perceived stress during the pandemic, explaining 11.8% of the variance.

While 'giving up' and 'self-devaluation' increased state anxiety during the pandemic, the regulation strategy 'social withdrawal' was associated with lower anxiety levels during the pandemic. Avoidance behavior like social withdrawal is a common symptom across anxiety disorders (Craske and Stein, 2016). While at normal times, social withdrawal is considered as a maladaptive regulation strategy, social withdrawal efficiently reduced state anxiety during the pandemic, leading to the consideration whether strategies that are usually considered as maladaptive might be appropriate and efficient in times that require social distancing. Individuals that cope with anxiety by withdrawing themselves might suffer less from regulations that request social distancing and thereby can reduce their anxiety effectively. This interpretation is supported by the negatively predictive value of withdrawal in the model. A tendency for withdrawal as an emotion regulation strategy buffered against an increase in anxiety.

Adaptive emotion regulation strategies, in contrast, had no predictive value regarding state anxiety during the pandemic. Adaptive regulation strategies that involve active involvement to change an anxiety-evoking situation might not be feasible in the context of a pandemic. However, in a German cohort, adaptive emotion regulation strategies (including acceptance, refocus on planning, positive refocusing, positive appraisal, and putting into perspective) moderated the correlation between feeling well informed about the pandemic and anxiety to become infected, while maladaptive emotion regulation strategies did not affect this association in a healthy study population (Jungmann and Witthöft, 2020).

Our results implicate that reducing maladaptive emotion regulation strategies in vulnerable groups in the first place might prevent increased anxiety in response to an uncontrollable stressor. Reducing maladaptive strategies might be more effective than training adaptive strategies as those may not always be feasible in the context of an uncontrollable stressor like a pandemic. In particular, reducing learned helplessness by strengthening self-efficiency might be beneficial. These implications are based on the observed relation between emotion regulation strategies and variances in state anxiety due to a global stressor like the pandemic in healthy but highly anxious individuals. Reducing maladaptive emotion regulation strategies might prevent acute anxiety in response to stress. However, in clinical populations, trait anxiety (STAI-T) rather than state anxiety (STAI-S) is a strong indicator for clinical depression and anxiety disorders (Knowles and Olatunji, 2020). Concerning clinical practice, trait anxiety might therefore be a more transferable measure.

To detect pandemic-related changes in mental states, there is a need for studies that include measurements before the outbreak of a pandemic to provide matched baseline values. As current standardized measures might change their meaning in the context of a pandemic due to changes in interpretation, validated measures on mental states like anxiety and depression in the context of a pandemic are required to reliably evaluate mental states and relate those to the occurrence of the pandemic.

5. Conclusion

In a vulnerable population of healthy individuals with elevated trait anxiety, state anxiety increased after the outbreak of Covid-19 in the Netherlands. However, heightened trait anxiety before the pandemic did not lead to a more severe increase in state anxiety during the pandemic. Maladaptive emotion regulation strategies predicted the increase in state anxiety. It remains challenging to relate changes in anxiety, stress, and depression to the global stressor of the pandemic, as pandemic-related regulations may simultaneously lead to a reduction of daily stressors in the social and professional life. Therefore, measurements without comparison to a baseline before the outbreak of the pandemic must be interpreted with caution.

6. Limitations

The study population consisted of young and healthy individuals that might experience the pandemic as less frightening as they have a lower risk of a severe progression of Covid-19 than older individuals or individuals with pre-existing health conditions. Further, the pandemic might

have represented a less intense threat to this study population compared to study populations in areas that have been affected more severely by the pandemic than the Netherlands. Baseline measurements have been conducted over a time span of 2.5 years, which might have induced additional variance. However, time differences did not correlate with changes in anxiety or depression and were considered in the regression models.

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Contributors

AKB conducted the data collection, data analysis, and manuscript preparation. NK contributed to the data analysis, manuscript revision and submission. AS and GF contributed to the overall design and manuscript revision.

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Supplementary materials

Supplementary material associated with this article can be found, in the online version, at doi:10.1016/j.jadr.2021.100113.

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