



# DynaMORE

Dynamic MOdelling of REsilience

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## Executive Summary

**Background:** The COVID-19 pandemic might affect mental health. Data from population-representative panel surveys with multiple waves including pre-COVID data investigating risk and protective factors are still rare.

**Methods:** In a stratified random sample of the German household population (n=6,684), we conducted survey-weighted multiple linear regressions to determine the association of various psychological risk and protective factors with changes in psychological distress (PD; measured via PHQ-4) from pre-pandemic (average of 2016 and 2019) to peri-pandemic (both 2020 and 2021) time points. Control analyses on PD change between two pre-pandemic time points (2016 and 2019) were conducted. Regularized regressions were computed to inform on which factors were statistically most influential in the multicollinear setting.

**Results:** PHQ-4 in 2020 (M=2.45) and 2021 (M=2.21) was elevated compared to 2019 (M=1.79). Several risk factors (catastrophizing, neuroticism, asking for instrumental support) and protective factors (perceived stress recovery, positive reappraisal, optimism) were identified for the peri-pandemic outcomes. Control analyses revealed that in pre-pandemic times, neuroticism and optimism were predominantly related to PD changes. Regularized regression mostly confirmed the results and highlighted perceived stress recovery as most consistent influential protective factor across peri-pandemic outcomes.

**Conclusions:** We identified several psychological risk and protective factors related to PD outcomes during the COVID-19 pandemic. Comparison to pre-pandemic data stress the relevance of longitudinal assessments to potentially reconcile contradictory findings. Implications and suggestions for targeted prevention and intervention programs during highly stressful times such as pandemics are discussed.

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## Table of Contents

|  |           |
|--|-----------|
| <b>1. Deliverable report</b>   | <b>9</b>  |
| <b>2. Tables and other supporting documents where applicable and necessary</b> | <b>9</b>  |
| <b>3. Conclusion</b>   | <b>9</b>  |
| <b>Appendix 1: DynaSOEP publication</b>  | <b>10</b> |



## **1. Deliverable report**

The archive paper on DynaSOEP has been uploaded to PsyArXiv and can be found at <https://psyarxiv.com/fjqpb>.

## **2. Tables and other supporting documents where applicable and necessary**

Supplementary Material to the archive paper can be found at <https://osf.io/znwjt/>.

## **3. Conclusion**

Analyses for the DynaSOEP project were conducted and published as a public preprint on PsyArXiv. Results indicate that perceived stress recovery is the most stable psychological protective factor for mental health during COVID-19, next to optimism and positive reappraisal. Neuroticism and catastrophizing on the other hand present as psychological risk factors for peri-pandemic changes in mental health.

## **Appendix 1: DynaSOEP publication:**

### **Coping With COVID: Risk and Resilience Factors for Mental Health in a German Representative Panel Study**

**Coping With COVID: Risk and Resilience Factors for Mental Health  
in a German Representative Panel Study**

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## Abstract

**Background:** The COVID-19 pandemic might affect mental health. Data from population-representative panel surveys with multiple waves including pre-COVID data investigating risk and protective factors are still rare.

**Methods:** In a stratified random sample of the German household population (n=6,684), we conducted survey-weighted multiple linear regressions to determine the association of various psychological risk and protective factors with changes in psychological distress (PD; measured via PHQ-4) from pre-pandemic (average of 2016 and 2019) to peri-pandemic (both 2020 and 2021) time points. Control analyses on PD change between two pre-pandemic time points (2016 and 2019) were conducted. Regularized regressions were computed to inform on which factors were statistically most influential in the multicollinear setting.

**Results:** PHQ-4 in 2020 ( $M=2.45$ ) and 2021 ( $M=2.21$ ) was elevated compared to 2019 ( $M=1.79$ ). Several risk factors (catastrophizing, neuroticism, asking for instrumental support) and protective factors (perceived stress recovery, positive reappraisal, optimism) were identified for the peri-pandemic outcomes. Control analyses revealed that in pre-pandemic times, neuroticism and optimism were predominantly related to PD changes. Regularized regression mostly confirmed the results and highlighted perceived stress recovery as most consistent influential protective factor across peri-pandemic outcomes.

**Conclusions:** We identified several psychological risk and protective factors related to PD outcomes during the COVID-19 pandemic. Comparison to pre-pandemic data stress the relevance of longitudinal assessments to potentially reconcile

- 1 contradictory findings. Implications and suggestions for targeted prevention and
- 2 intervention programs during highly stressful times such as pandemics are discussed.

- 3 *Keywords:* COVID-19, psychological distress, mental health, resilience, risk
- 4 factors

5

## **Coping With Covid: Risk and Resilience Factors for Mental Health in a German Representative Panel Study**

The spread of the severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) globally affects people in various aspects of their life. Not only does the virus impose a physical threat of infection and the associated possibility of a severe course with its long-term consequences; being exposed to such threat constantly, as well as to changes in social life and the economic situation can harm mental well-being. Indeed, several studies have investigated mental health consequences of the coronavirus disease 2019 (COVID-19) pandemic in nationally representative probability samples, most of them referring to the first lockdown in spring 2020 (see *Table S1*). With some exceptions, most of these studies found higher average levels of self-reported depression and anxiety symptoms during the first months of the pandemic compared to pre-pandemic symptom levels (Daly, Sutin, & Robinson, 2021; Dawel et al., 2020; Ettman et al., 2020; Peters, Rospleszcz, Greiser, Dallavalle, & Berger, 2020; Pieh, Budimir, & Probst, 2020; Pierce et al., 2020; Sibley et al., 2020; Twenge & Joiner, 2020; Winkler et al., 2020). Meta-analytic evidence from not exclusively representative studies suggests that these increases in psychological distress were relatively small and recovered over time (Prati & Mancini, 2021; Robinson, Sutin, Daly, & Jones, 2021).

Previous research on mental health during the COVID-19 pandemic has moreover identified several relevant demographic and socio-economic risk and protective factors. Higher psychological distress during the COVID-19 pandemic has been consistently found to be associated with female gender (Daly & Robinson, 2020; Daly, Sutin, & Robinson, 2020; Gijzen et al., 2020; Holingue et al., 2020; Hyland et al.,



1 2020; Li & Wang, 2020; Niedzwiedz et al., 2020; Peters et al., 2020; Pieh et al., 2020;  
2 Pierce et al., 2020; Zajacova et al., 2020), younger age (Daly & Robinson, 2020; Daly  
3 et al., 2020, 2021; Every-Palmer et al., 2020; Holingue et al., 2020; Hyland et al., 2020;  
4 Li & Wang, 2020; Niedzwiedz et al., 2020; Peters et al., 2020; Pieh et al., 2020; Pierce  
5 et al., 2020; Zajacova et al., 2020), pre-existing mental conditions (Daly & Robinson,  
6 2020; Every-Palmer et al., 2020; Holman, Thompson, Garfin, & Silver, 2020), poor  
7 physical health status (Every-Palmer et al., 2020; Holman et al., 2020), and living with  
8 young children (Pierce et al., 2020). The results for level of education, income, and  
9 employment status are more heterogenous, with studies finding evidence of these  
10 being both potential protective as well as risk factors (Daly & Robinson, 2020; Daly et  
11 al., 2020; Ettman et al., 2020; Li & Wang, 2020; Niedzwiedz et al., 2020; Pieh et al.,  
12 2020; Pierce et al., 2020).

13         The impact of psychological factors on mental health during the COVID-19  
14 pandemic, however, has received less attention particularly in representative studies.  
15 Identifying such – possibly malleable – psychological factors in the general population  
16 will be of great value for informing tailored prevention and intervention efforts to  
17 reduce mental health problems and improve well-being during crises (Kunzler et al.,  
18 2021).

19         Insights from studies using non-random convenience sampling suggest that  
20 several psychological factors are protective factors associated with lower psychological  
21 distress or resilience (operationalized as lower psychological distress than expected  
22 given a certain exposure to stressors) during the COVID-19 pandemic: These studies  
23 found lower psychological distress to be predicted by cognitive flexibility (Dawson &

1 Golijani-Moghaddam, 2020; McCracken, Badinlou, Buhrman, & Brocki, 2020), grit  
2 (McCracken et al., 2020), meaning in life (Schnell & Krampe, 2020), dispositional  
3 mindfulness (Conversano et al., 2020), secure and avoidant attachment styles (Moccia  
4 et al., 2020), optimism (Płomecka et al., 2020; Veer et al., 2021), emotional stability  
5 (i.e., low neuroticism; Fernández, Crivelli, Guimet, Allegri, & Pedreira, 2020; Flesia et  
6 al., 2020; Veer et al., 2021), self-control (Flesia et al., 2020; Schnell & Krampe, 2020),  
7 perceived stress recovery (Veer et al., 2021), positive appraisal style and positive  
8 appraisal specific to the COVID-19 pandemic (Veer et al., 2021), both positive (Flesia  
9 et al., 2020; Zhu et al., 2020) and behavioral (Veer et al., 2021) coping skills as well as  
10 coping skills specific for the COVID-19 pandemic (Fernández et al., 2020), making  
11 meaning in negative experiences (Yang et al., 2021), general self-efficacy (Bendau et  
12 al., 2020; Veer et al., 2021), internal locus of control (Flesia et al., 2020), and self-  
13 esteem (Arima et al., 2020).

14       Due to the non-random sampling strategy of most of the studies until now, it  
15 is however difficult to assess to what degree these results generalize to the general  
16 population or to what degree they might be driven by (self-) selection of the  
17 respondents into the sample (Fink, 2003). A further problem that prohibits reliable  
18 conclusions from previous studies on psychological factors and mental health during  
19 the COVID-19 pandemic is the systematic lack of pre-pandemic baseline  
20 measurements. Whereas these studies can thus describe psychological distress during  
21 the pandemic or make claims on average changes by referring to average pre-  
22 pandemic health in other samples, they cannot draw inferences regarding measures of  
23 intra-individual change.

1           In the current study, we addressed both shortcomings in the literature and  
2   investigated the relationship between psychological factors (selected based on cross-  
3   sectional findings in a large convenience sample (Veer et al., 2021)) and changes in  
4   depression and anxiety symptoms (psychological distress; PD) during the COVID-19  
5   pandemic in a sample that is both representative of the German household population  
6   and has pre-pandemic baseline measures of the same individuals. Moreover, the long-  
7   running panel study allowed us to compare these associations to those with changes  
8   from 2016–2019, a ‘normal’ period without a singular and ubiquitous stressor like the  
9   pandemic.

10           In accordance with most studies on depression and anxiety in the pandemic,  
11   we assumed that the pandemic influenced PD, expecting an increase in PD in 2020 and  
12   2021 compared to 2019 and 2016. We moreover hypothesized neuroticism and  
13   catastrophizing to be risk factors, expecting higher scores to be associated with larger  
14   increases or smaller decreases in PD. We finally expected the following psychological  
15   factors to be associated with smaller increases or larger decreases in PD, as protective  
16   factors: positive reappraisal, putting into perspective, acceptance, use of instrumental  
17   support, positive appraisal specific to the COVID-19 pandemic, perceived stress  
18   recovery, optimism, and locus of control.



1 symptoms that has already been used in pre-pandemic waves in this sample (Kroenke,  
2 Spitzer, Williams, & Löwe, 2009; Löwe et al., 2010). The PHQ-4 is a validated mental  
3 health screening instrument and measures general anxiety and depressive symptoms  
4 using a 4-point Likert scale ranging from 0 (*'not at all'*) to 3 (*'nearly every day'*). Overall  
5 sum scores range from 0 to 12 with classifications into no (0–2), mild (3–5), moderate  
6 (6–8), and severe (9–12) symptoms of general anxiety and depression. The PHQ-4 was  
7 assessed in 2016, 2019, 2020 and 2021.

8       The coping dimensions of positive reappraisal, putting into perspective and  
9 acceptance were assessed using three single items from the Cognitive Emotion  
10 Regulation Questionnaire (CERQ; Garnefski & Kraaij, 2007; Loch, Hiller, & Witthöft,  
11 2011), adapted in wording to assess emotion regulation during the previous two  
12 weeks. Likewise, catastrophizing was measured using a reformulated item from the  
13 CERQ scale 'catastrophizing'. The rationale for reformulating the CERQ items to reflect  
14 state- rather than trait-like coping was to capture emotion regulation strategies  
15 specifically used during the COVID-19 pandemic. Finally, instrumental support-  
16 seeking was measured using the first item of the 'using instrumental support' scale of  
17 the brief COPE (Carver, 1997). These coping items were selected because they were  
18 identified to load most strongly on three factors that were identified using principle  
19 component analysis in yet unpublished research (for details, see Supplement 2). The  
20 items for positive reappraisal, putting into perspective and acceptance loaded most  
21 strongly on a factor representing positive appraisal style, using instrumental support  
22 best reflected a behavioral coping style factor, whereas catastrophizing best  
23 represented maladaptive coping.

1        Additionally, positive appraisal specific to the COVID-19 pandemic was  
2        assessed with two self-formulated items. Perceived stress recovery was measured  
3        using one item from the Brief Resilience Scale (Chmitorz et al., 2018; Smith et al.,  
4        2008). All coping, COVID-19 appraisal, and recovery items were answered on a Likert  
5        scale from 0 (*'don't agree at all'*) to 4 (*'fully agree'*) and were collected during the 2020  
6        survey period. Optimism was assessed in 2019 using one item asking about the  
7        attitude towards the future, ranging from 1 (*'pessimistic'*) to 4 (*'optimistic'*). Locus of  
8        Control was assessed in 2015 and measured using a 10-item instrument with a Likert  
9        scale ranging from 1 (*'disagree completely'*) to 4 (*'agree completely'*). Higher values  
10       indicate an internal locus of control. Neuroticism was assessed in 2017 using the Big  
11       Five Inventory – short version (BFI-S; Hahn, Gottschling, & Spinath, 2012). Answers on  
12       the 7-point Likert scale range from 1 (*'does not apply'*) to 7 (*'applies fully'*).

13       Example items for all measures and information on included covariates can be  
14       found in *Table 1*, which additionally summarizes the hypothesized relation between  
15       psychological factors and outcomes. An overview of the timing of data assessment for  
16       the different variables can be found in *Figure 1*.

## 17       **Statistical Analyses**

### 18       ***Data Preprocessing***

19       Data cleaning and analyses were performed in R v4.0.0 (R Core Team, 2020).  
20       The code used for preprocessing and analyses is available at <https://osf.io/znwjt/>.

21       Missing values (4.5%) were imputed by means of the MICE R package (Buuren &  
22       Groothuis-Oudshoorn, 2011) using classification and regression trees with  $m=5$   
23       imputations and 50 iterations. Statistical outliers were all within the range of the used

scales, therefore considered meaningful and not removed. Predictor variables were z-standardized; outcome variables were not z-standardized. This enabled a) comparison between different PD outcomes irrespective of their variance and b) clinically interpretable evaluation of the relation between psychological factors and absolute change in PD.

As shown in *Table 1* and *Figure 1*, pre-pandemic PD was calculated by averaging PHQ-4 scores from 2016 and 2019 to create a more robust baseline. Change in PD was then calculated by taking difference scores between pre-pandemic PD to 2020 ( $\Delta$ PHQ 2020) and pre-pandemic PD to 2021 ( $\Delta$ PHQ 2021); To better understand whether the examined psychological factors predicted change specifically during the COVID-19 pandemic or were generally related with changes in PD over time, we additionally investigated the relation of the predictors with the change in PD from 2016 to 2019 ( $\Delta$ PHQ 2019).

### ***Descriptive Statistics***

We conducted survey-weighted linear models to compare levels in PD between pre- and peri-pandemic survey waves.

### ***Testing of Main Hypotheses***

The above-mentioned hypotheses were tested using separate multiple linear regression analyses for each psychological factor/outcome pair, including all covariates in each model. This resulted in 10 regressions per outcome. Results were Bonferroni-corrected and hence considered significant at  $p < .005$ . Baseline PD levels were added to the models as an additional covariate to control for regression to the mean; we however refrain from reporting their associations with changes in PD. To

1 counteract possible biases in sample selection and due to selective response rates,  
2 population survey weights were used (Kroh, 2009; Siegers, Belcheva, & Silbermann,  
3 2020). Because the survey weight was zero for 27 participants, final sample size was  
4  $n=6657$  ( $n=5981$  at follow-up).

5 In order to determine which of the significant predictors found were most  
6 strongly associated with the outcomes in the multivariate setting with partly correlated  
7 variables, and at the same time avoid overfitting in a model with many predictors, we  
8 subsequently conducted LASSO (Least Absolute Shrinkage and Selection Operator)  
9 regularized regression analyses (Hastie, Tibshirani, & Wainwright, 2015) using the  
10 *miselect* R package (Rix & Du, 2020) and calculated inclusion frequencies. Details on  
11 this analysis can be found in *Supplement 3*. Note that it was not possible to include  
12 survey weights into the LASSO analysis. As background information for interpretation  
13 of the unweighted LASSO results, a comparison of results from the unweighted linear  
14 regressions and weighted linear regressions can therefore be found in *Table S3*.

### 15 ***Additional Analyses***

16 As robustness analyses, we ran multiverse or specification curve analyses  
17 (Simonsohn, Simmons, & Nelson, 2020; Steegen, Tuerlinckx, Gelman, & Vanpaemel,  
18 2016). Here, slightly different model specifications (linear vs. robust regression, cube-  
19 root-transformation of non-normally distributed variables vs. no transformation) were  
20 used to ensure that small arbitrary changes did not have major influences on the results  
21 of the study (see *Supplement 4*).



1           To investigate how the psychological factors are associated with PHQ-4 in the  
2 individual years (vs. the change between years), we ran linear mixed models and  
3 estimated margins (mean $\pm$ 1SD) for all predictors (see *Supplement 5*).  
4

## 1 Results

### 2 Sample Description

3 Between April and June 2020, 31% (vs. 20% in 2019 and 28% in 2016) of the  
 4 population reported mild, 5% (vs. 4% in 2019 and 6% in 2016) moderate, and 2% (vs.  
 5 2% in 2019 and 2% in 2016) severe PD. Peri-pandemic PHQ-4 in 2020 (weighted  
 6  $M=2.45/12$ ,  $SEM=0.049$ ) was significantly elevated compared to pre-pandemic levels  
 7 in 2019 (weighted  $M=1.79/12$ ,  $SEM=0.048$ ;  $t(6655)=9.73$ ,  $p<2.2e-16$ ) and 2016  
 8 (weighted  $M=2.17/12$ ,  $SEM=0.061$ ;  $t(6655)=3.34$ ,  $p=.002$ ). In January and February  
 9 2021, 29% reported mild, 5% moderate, and 2% severe symptoms. Peri-pandemic PHQ-  
 10 4 in 2021 ( $M=2.21/12$ ,  $SEM=0.048$ ) was significantly elevated compared to 2019  
 11 ( $t(6655)=6.07$ ,  $p=1.345e-8$ ), but not compared to 2016 ( $t(6655)=0.455$ ,  $p=.653$ ), and  
 12 significantly lower than in 2020 ( $t(6655)=-3.41$ ,  $p=7.31e-4$ ). *Figure 2* displays  
 13 weighted means and 95% confidence interval of the mean for PHQ-4 across the  
 14 different years (panel A) and the nine individual tranches assessed in 2020 (panel B).

### 15 Socio-Demographic Variables

16 With respect to socio-demographic factors, history of depression was positively  
 17 related with  $\Delta PHQ$  2020 ( $\beta=0.697$ ),  $\Delta PHQ$  2021 ( $\beta=1.063$ ), and  $\Delta PHQ$  2019 ( $\beta=2.060$ ).  
 18 Age group 18–24 ( $\beta=1.075$ ) and female gender ( $\beta=0.419$ ) were positively related with  
 19  $\Delta PHQ$  2021. All other socio-demographic variables were not significantly related with  
 20 the outcomes. Exact relations of all covariates with the outcomes can be found in  
 21 *Tables S4, S5 and S6*.

### 22 Multiple Linear Regressions

As hypothesized, perceived recovery ( $\beta=-0.473$ ) and reappraisal ( $\beta=-0.192$ ) were negatively, whereas catastrophizing ( $\beta=0.553$ ) and neuroticism ( $\beta=0.214$ ) were positively related with  $\Delta$ PHQ 2020. Contrary to our hypotheses, instrumental support-seeking ( $\beta=0.282$ ) was also positively related. All other predictors were not significantly associated with  $\Delta$ PHQ 2020 (see *Table S4*).

As expected, perceived recovery ( $\beta=-0.332$ ) and optimism ( $\beta=-0.139$ ) were negatively, whereas catastrophizing ( $\beta=0.259$ ) and neuroticism ( $\beta=0.355$ ) were positively associated with  $\Delta$ PHQ 2021. Instrumental support-seeking ( $\beta=0.170$ ) was again positively related. All other predictors were not significantly associated with  $\Delta$ PHQ 2021 (see *Table S5*).

To see if these factors were specifically relevant during the COVID-19 pandemic or also relevant before, we repeated the analyses with the change in PD during a control period (2016–2019) as the outcome (see *Table S6*). Optimism ( $\beta=-0.175$ ) was negatively, whereas neuroticism ( $\beta=0.421$ ) was positively associated with  $\Delta$ PHQ 2019. All other psychological factors were not related. Beta coefficients for all psychological factors and all outcomes are shown in *Figure 3*.

### LASSO Regularized Regressions

LASSO regularized regression analysis highlighted the roles of catastrophizing, perceived recovery, neuroticism, and asking for instrumental support for  $\Delta$ PHQ 2020, of neuroticism, perceived recovery and catastrophizing for  $\Delta$ PHQ 2021, and of neuroticism as well as optimism for  $\Delta$ PHQ 2019 (see *Table S7*).

### Specification Curve Analyses

1           The performed specification curve analyses indicate that results remained  
2   stable across model specifications (see *Supplement 4*).

### 3   **Linear Mixed Models**

4           Linear mixed models revealed similar patterns of predictors for pre- vs. peri-  
5   pandemic PHQ-4 compared to the multiple linear regressions on  $\Delta$ PHQ outcomes (see  
6   Supplement 5).

7

## Discussion

The goal of this study was to investigate if mean psychological distress (PD) increased compared to pre-pandemic times and which risk and resilience factors are associated with the change in PD in a sample representative of the German household population.

First, as expected, we found that PD was on average significantly higher in both 2020 and 2021 compared to 2019. It however must be mentioned that pre-pandemic PD in 2019 was lower than in 2016. Due to these PD fluctuations at baseline, averaged baseline scores were used in all subsequent analyses.

Second, in line with our hypotheses, we found catastrophizing and neuroticism to be risk factors for PD. Unexpectedly, asking for instrumental support also was positively associated with PD across peri-pandemic outcomes.

Third, the most consistent protective factor across all analyses was self-perceived recovery from stress, whereas other factors like optimism and positive reappraisal were only partially supported as protective factors. Contrary to our expectations, putting things into perspective, acceptance, and positive appraisal specific to the COVID-19 pandemic did not emerge as protective factors. We will discuss these results in more detail below.

### PDIncrease in the General Population

In our analyses there was an increase in PD in 2020 (2.45/12) and 2021 (2.21/12) compared to 2019 (1.79/12). PD in 2020, but not 2021, was also higher than in 2016 (2.17/12). PD in 2021 was again significantly lower than in 2020.

1           These average numbers are clearly not in the pathological range, as scores of  
2   6 and higher reflect moderate to severe PD. However, systematic increases of average  
3   PD into the pathological range can hardly be expected in a sample consisting of over  
4   6000 participants. Especially the proportion of participants reporting mild (vs. no)  
5   symptoms was elevated compared to pre-pandemic times. Our findings of only small  
6   but significant increases during the pandemic are in accordance with many other  
7   findings in population-based studies (Daly et al., 2020; Niedzwiedz et al., 2020; Peters  
8   et al., 2020; Pierce et al., 2020; Twenge & Joiner, 2020). Intriguingly, this small effect  
9   may be caused by (vulnerable) subpopulations as indicated by longitudinal samples  
10  (e.g., Ahrens et al., 2021).

11           Existing meta-analytic evidence suggests a recovery of PD over time (Robinson  
12  et al., 2021). In our sample, PD in 2021 was still elevated, which we attribute to the  
13  fact that unlike the studies included in the meta-analysis, we covered a later time point  
14  in the middle of another wave of COVID-19 infections. PD in 2021 was however lower  
15  than in 2020. This might on the one hand be explained by a habituation effect to the  
16  pandemic consequences, including an adjustment to the changes in daily life and social  
17  distancing measures. On the other hand, the existence of more precise knowledge  
18  about the virus and the prospect of starting vaccination campaigns in Germany in the  
19  beginning of 2021 might have led to lower uncertainty compared to 2020 and therefore  
20  a different appraisal of the situation, which in turn differentially influenced mental  
21  well-being.

22   **Risk Factors for PD**

1           Female gender and younger age were socio-demographic risk factors for peri-  
2   pandemic PD in 2021 but not in 2020, adding to the mixed picture that although many  
3   studies reported these to be risk factors (see introduction), meta-analytic evidence did  
4   not find this relationship (Robinson et al., 2021). The most important psychological  
5   risk factor was catastrophizing as it showed positive associations with PD changes  
6   across peri-pandemic analyses (but not in the control analyses for the pre-pandemic  
7   change from 2016–2019). Catastrophizing is the tendency to think that things are  
8   worse than they are or will have a far worse outcome than is realistic. Confirming  
9   previous research that highlights catastrophizing as one of the most prominent  
10   emotion regulation strategies predicting PD (Garnefski & Kraaij, 2007; Martin & Dahlen,  
11   2005), our results indicate that this type of coping is the most maladaptive of those  
12   included as predictor. Neuroticism also showed a positive association with PD  
13   outcomes in almost all analyses, also for the pre-pandemic control analyses, an  
14   association that is well known from the literature (Lahey, 2009). Unexpectedly, asking  
15   for instrumental support as coping strategy also emerged as quite consistently  
16   positively associated with PD, contrary to what we hypothesized. However, it is  
17   conceivable that this predictor was confounded with having negative experiences or  
18   symptoms in the first place. The specific formulation of this item was: *‘I’ve been trying*  
19   *to get advice or help from other people about what to do’*. People might have only  
20   reached out to other people for help if they already experienced significant burden,  
21   whereas individuals with less burden might not have sought to do so, especially under  
22   the given pandemic circumstances.

## 23   **Protective Factors for PD**

1 Overall, we found perceived recovery from stress to be the most consistent  
2 protective factor across peri-pandemic analyses. Optimism and positive reappraisal  
3 were at least partially found to be protective factors, consistent with previous research  
4 on their association with mental health (Martin & Dahlen, 2005; Plomin et al., 1992).  
5 Contrary to our expectations we did not find support for putting things into  
6 perspective, acceptance, and positive appraisal specific to COVID-19 to be protective  
7 factors.

8 Optimism and perceived recovery were the only protective factors associated  
9 also with PD change in the pre-pandemic control period.

10 These findings could thus indicate that the results regarding other  
11 psychological protective factors such as positive reappraisal are specific to the COVID-  
12 19 pandemic and that they are not related with changes in PD under normal  
13 circumstances. However, an additional, and more likely, explanation is that the  
14 temporal distance between the assessment of the pre-pandemic PD change score on  
15 the one hand and psychological factors assessed in 2020 on the other hand is too large  
16 to find associations. The fact that coping items such as positive reappraisal were  
17 reformulated to reflect state-like coping in 2020 substantiates this possible  
18 explanation, especially since perceived stress recovery, a trait-like measure assessed  
19 in the same wave, does show relation with  $\Delta$ PHQ 2019.

## 20 Limitations

21 Despite the strengths of our study such as the representativeness of the sample  
22 and existence of individual pre-pandemic baseline PD, which have been considered  
23 important specifically in the context of the COVID-19 pandemic (Kunzler et al., 2021;



1 Nieto, Navas, & Vázquez, 2020), as well as the comparison with change in PD during a  
2 pre-pandemic period and the use of LASSO regularized regression that selects the  
3 most promising variables in a model with many potential variables, there also are  
4 several limitations: Most importantly, psychological factors were not assessed at all  
5 survey waves (see *Figure 1*). Given that many psychological factors such as coping may  
6 be variable and malleable (Compas, Forsythe, & Wagner, 1988), this impedes  
7 disentangling directionality of causation between psychological factors, PD, and  
8 pandemic context. We are also aware of the second major limitation that results from  
9 the uneven sampling of psychological factors: We were forced to include variables that  
10 were assessed in 2020 to the model predicting change from 2016 to 2019. Our  
11 rationale to nevertheless include the factors into the model was to keep the models as  
12 similar as possible to set the peri-pandemic results into perspective. We moreover  
13 included variables that were assessed during previous survey waves, such as locus of  
14 control in 2015, neuroticism in 2017, and optimism in 2019. Although it would have  
15 been preferred to have more recent data, based on the literature we expect a relative  
16 stability of these constructs (Cobb-Clark & Schurer, 2011; Cobb-Clark & Schurer, 2013;  
17 Scheier, Carver, & Bridges, 1994). Other limitations are the self-report nature of  
18 assessments and that the use of single items instead of entire validated questionnaires  
19 to assess the coping dimensions, although necessary for pragmatic reasons, might  
20 have led to a reduced statistical power. Lastly, we do not have knowledge of specific  
21 stressors that might have occurred between the two measurements; changes in PD  
22 from baseline to 2020 and baseline to 2021 can therefore only be partly, and only on  
23 average, attributed to experiencing the COVID-19 pandemic. However, although there

undoubtedly are other influences on changes in PD that we did not assess and that therefore cannot be controlled for, these are expected to occur at random, whereas every participant experienced the COVID-19 pandemic during data collection.

#### **Outlook**

In the present research, we identified several psychological factors that are associated with changes in psychological distress during the COVID-19 pandemic in the general population of Germany. Although due to the used instruments our results can strictly only give insights regarding PD, in light of past findings (Veer et al., 2021) we also expect these psychological factors to be related to general mental health and resilience (i.e., mental health controlled for stressor exposure; see Kalisch et al., 2020 for further details). The exact pattern of predictors might certainly be different when investigating these slightly different outcomes. For example, it should be noted that the strongest predictors for PD in our study were those that are conceptually closest to PD (catastrophizing, asking for instrumental support, neuroticism, and perceived stress recovery), whereas psychological factors that are conceptually further away from symptoms such as positive reappraisal, optimism, or locus of control, show weaker relationships with PD. These latter factors however seem to be stronger predictors for resilience, as for instance shown in Veer et al. (2021). Future representative studies should investigate this in more detail.

Our results do point to some possibly malleable factors that we found to be prospectively associated with changes in PD during COVID-19 and that are therefore possible candidates for targeted prevention and intervention programs to improve general mental well-being during challenging times such as pandemics. Given the

1 pandemic situation, these prevention efforts should ideally be widely accessible and  
2 allow for a remote delivery via internet and/or mobile phone. Above all, improving  
3 stress recovery, e.g., via physical exercise in the nature (Wooller, Rogerson, Barton,  
4 Micklewright, & Gladwell, 2018) or smartphone-assisted biofeedback (Hunter, Olah,  
5 Williams, Parks, & Pressman, 2019), appears to be the most promising starting point.  
6 Moreover, reducing catastrophizing tendencies, for example via smartphone-based  
7 cognitive behavioral interventions for mental health prevention (Ebert et al., 2018;  
8 Marciniak et al., 2020), increasing internal locus of control, e.g., via online  
9 interventions as has been done by Nallapothula et al. (2020) in an academic context,  
10 increasing optimism, e.g. using the Best Possible Self intervention (Malouff & Schutte,  
11 2017), and learning to also see positive aspects in the overall challenging situation,  
12 e.g., via mobile cognitive behavioral interventions (Ebert et al., 2018; Marciniak et al.,  
13 2020) are promising paths to increase individual well-being. Future research should  
14 corroborate these directions using interventional studies.

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17 **Conflicts of Interest**

18 None.

19 **Ethical Standards**

20 The authors assert that all procedures contributing to this work comply with  
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22 experimentation and with the Helsinki Declaration of 1975, as revised in 2008.

23

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- 3

Table 1

*Overview of Variables and Instruments Used*

| <i>Variable</i>   | <i>Instrument</i>   | <i>Type</i> | <i>Expected relation to PD</i> |
|---|---|-------------|--------------------------------|
| <i>Dependent Variables</i>  |   |             |                                |
| Change in PD from pre-pandemic levels (mean of 2016 and 2019) to 2020 | $\Delta\text{PHQ 2020} = \text{PHQ-4 2020} - (\text{PHQ-4 2016} + \text{PHQ-4 2019})/2$   |             |                                |
| Change in PD from pre-pandemic levels (mean of 2016 and 2019) to 2021 | $\Delta\text{PHQ 2021} = \text{PHQ-4 2021} - (\text{PHQ-4 2016} + \text{PHQ-4 2019})/2$   |             |                                |
| Change in PD from 2016 to 2019  | $\Delta\text{PHQ 2019} = \text{PHQ-4 2019} - \text{PHQ-4 2016}$   |             |                                |
| <i>Independent Variables</i>  |   |             |                                |
| Coping: positive reappraisal (PREAP)                                  | CERQ positive reappraisal scale (1 item); <i>'I thought that the situation also has its positive sides'</i>   | State       | ⊖                              |
| Coping: putting into perspective (PERSP)                              | CERQ putting into perspective scale (1 item); <i>'I thought that it hasn't been too bad compared to other things'</i>   | State       | ⊖                              |
| Coping: acceptance (ACC)  | CERQ acceptance scale (1 item); <i>'I thought that I have to accept the situation'</i>  | State       | ⊖                              |
| Positive appraisal specific to the COVID-19 pandemic (PAC)            | Self-formulated; positive appraisal of COVID-19 situation on a personal & societal level (2 items); <i>'I expect that I will learn something positive from the corona pandemic for my</i> | State       | ⊖                              |

|   |  |       |   |
|---|--|-------|---|
|   | <i>own life' and 'In the long run, I think that society will change for the better because of the corona pandemic'</i>   |       |   |
| Coping: using instrumental support (SUPP) | Brief COPE: using instrumental support scale (1 item); <i>'I've been trying to get advice or help from other people about what to do'</i>                      | State | ⊖ |
| Coping: catastrophizing (CATA)            | CERQ: catastrophizing scale (1 item); <i>'I kept thinking about how terrible it is what I have experienced'</i>  | State | ⊕ |
| Perceived stress recovery (REC)           | Brief Resilience Scale (1 item); <i>'I tend to bounce back quickly after hard times'</i>   | Trait | ⊖ |
| Optimism (OPT)                            | SOEP-specific item (1 item); <i>'If you think about the future, are you...' (1, pessimistic – 4, optimistic)</i>   | Trait | ⊖ |
| Locus of Control (LOC)                    | SOEP-specific questionnaire (10 items); e.g., <i>'My life's course depends on me'</i> and <i>'Success is a matter of fate and luck' (-)</i>                    | Trait | ⊖ |
| Neuroticism (NEU)                         | BFI-S (3 items); <i>'I am...' 'nervous' 'a worrier', 'relaxed, able to deal with stress' (-)</i>   | Trait | ⊕ |
| <i>Covariates</i>                         |  |       |   |
| Age (in years)                            | 18–24, 25–34, 35–44, 45–54, 55–64, 65–74, 75–84, 85+   |       |   |
| Gender                                    | m/f  |       |   |
| Education                                 | 1: no degree, still in school or lower degree; 2: middle or high school degree; 3: high school degree with subsequent vocational training or university degree |       |   |
| Household income                          | Lower/middle/upper tercile   |       |   |

|  |   |
|--|---|
| Risk group status for severe course in case of infection with SARS-CoV-2 | Yes/no (determined based on age and BMI as well as self-report of at least one of the following diagnoses: asthma, cardiovascular disease, diabetes, cancer, stroke, high blood pressure, dementia, rheumatism, handicap) |
| History of diagnosed depression  | Yes/no (self-report)  |
| Lockdown status  | Yes/no (participation in 2020 up to/after May 5)  |

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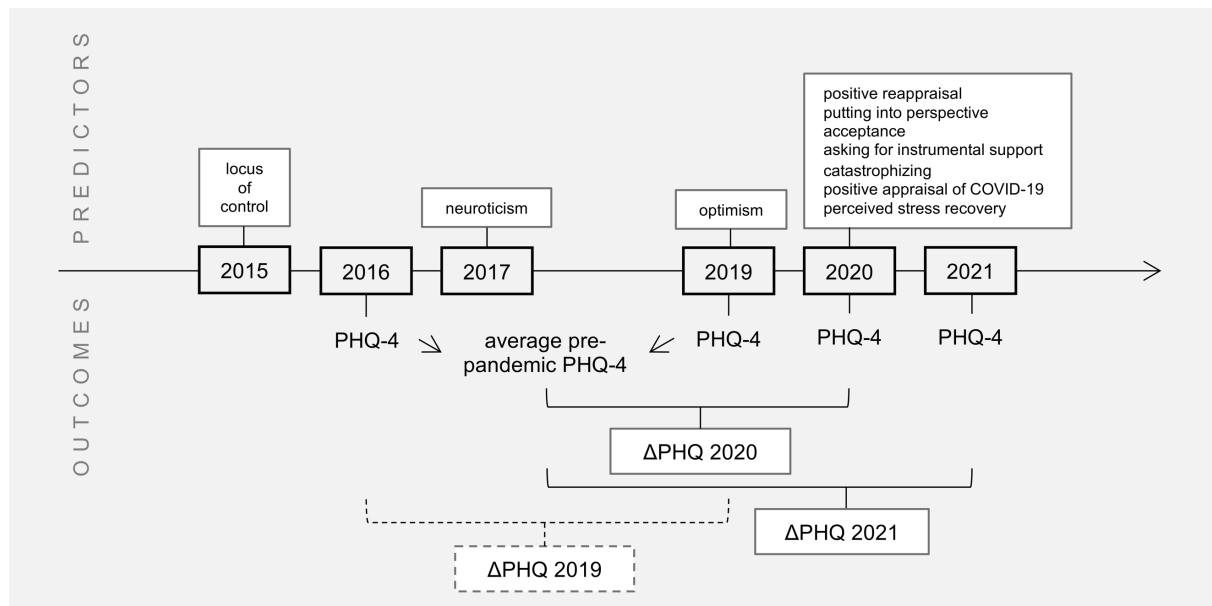
*Note.* PD= psychological distress; PHQ=Patient Health Questionnaire; CERQ=Cognitive Emotion Regulation Questionnaire; SOEP=Socio-economic

Panel; BFI-S=Big Five Inventory, short version; m=male, f=female; SARS-CoV-2= severe acute respiratory syndrome coronavirus 2; BMI=body

mass index. Expected relation to PHQ indicates the hypothesized relationship between the respective independent variable and  $\Delta$ PHQ 2020 as well as  $\Delta$ PHQ 2021.

**Table 2***Sample Characteristics (N=6,684)*

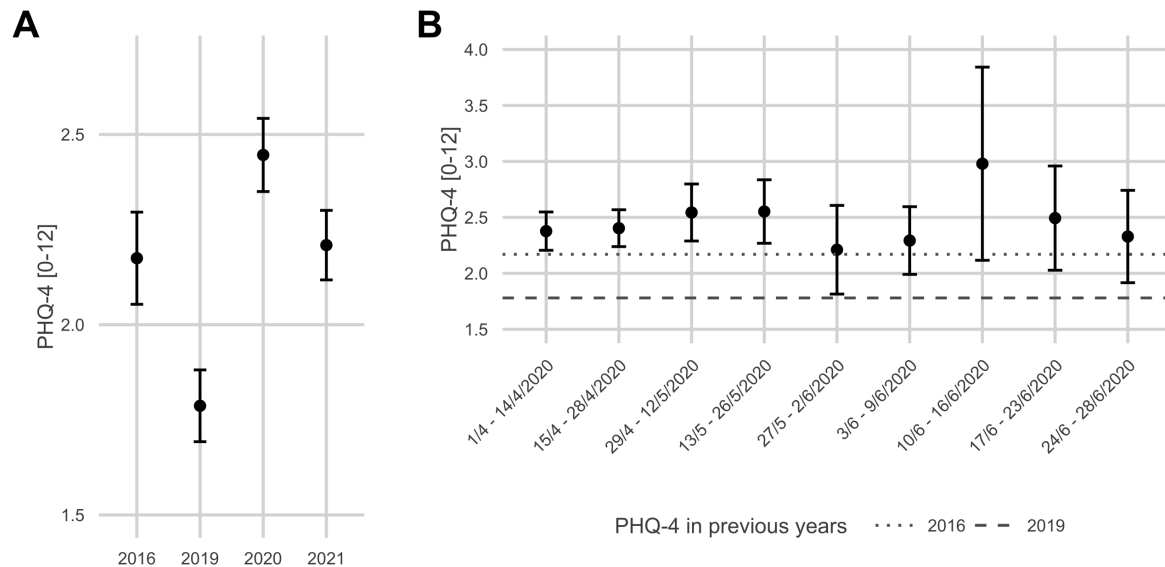
|   | %     |
|---|-------|
| <b>Gender</b>   |       |
| Male  | 39.32 |
| Female  | 60.68 |
| <b>Age</b>  |       |
| 18–24   | 2.5   |
| 25–34   | 9.38  |
| 35–44   | 16.37 |
| 45–54   | 23.21 |
| 55–64   | 21.27 |
| 65–74   | 15.61 |
| 75–84   | 9.63  |
| 85+   | 2.02  |
| <b>Education</b>  |       |
| No degree, still in school or lower degree                                      | 24.29 |
| Middle or high school degree  | 43.88 |
| High school degree with subsequent vocational training or university degree     | 31.83 |
| <b>Income</b>   |       |
| Lower tertile   | 32.96 |
| Medium tertile  | 33.49 |
| Higher tertile  | 33.55 |
| <b>Risk group status for severe course in case of infection with SARS-CoV-2</b> |       |
| Yes   | 51.26 |
| No  | 48.74 |
| <b>History of depression</b>  |       |
| Yes   | 9.78  |
| No  | 90.22 |

**Figure 1***Timing of Data Collection for Predictors and Outcome Variables*

*Note.* OPT = optimism; LOC = locus of control; NEU = neuroticism; PREAP = positive reappraisal; PERSP = putting into perspective; ACC = acceptance; SUPP = asking for instrumental support; CATA = catastrophizing; PAC = positive appraisal specific to the COVID-19 pandemic; REC=perceived stress recovery; PHQ-4 = Patient Health Questionnaire, 4 item version; ΔPHQ 2019=change in PHQ-4 from 2016 to 2019; ΔPHQ 2020=change in PHQ-4 from 2019 to 2020, ΔPHQ 2021=change in PHQ-4 from 2019 to 2021.

**Figure 2**

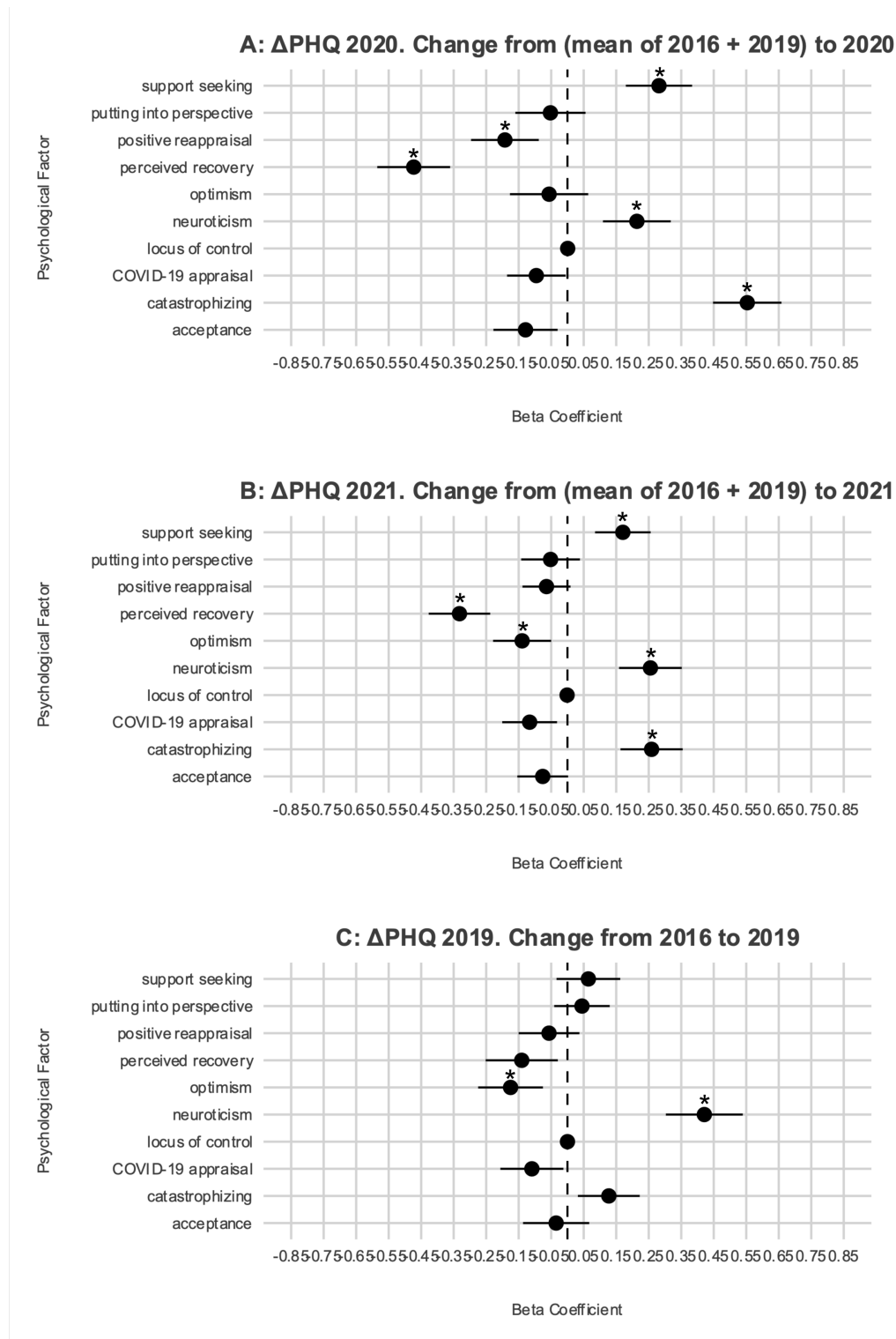
*Psychological Distress (PHQ-4) Across Years (A) and Across the 9 Tranches Ranging From April 1 to June 28, 2020 (B)*



*Note.* Error bars depict the 95% confidence interval. PHQ-4 values range from 0 to 12, higher values indicating higher psychological distress. As weighted means are used, means of each individual tranche are representative for the German population. In B, weighted mean PHQ-4 values of the entire sample in 2016 and 2019 are displayed as dotted and dashed horizontal lines, respectively.

**Figure 3**

*Beta Coefficients of Multiple Linear Regressions for  $\Delta$ PHQ 2020 (A),  $\Delta$ PHQ 2021 (B), and  $\Delta$ PHQ 2019 (C).*





*Note.* This figure shows beta coefficients of the psychological factors for the three outcomes.

Complete output tables of the respective linear regressions can be found in Tables S4–S6.

Predictors are z-standardized, outcomes are not standardized. Error bars depict the 95% confidence interval.