Aus der Klinik für Psychiatrie und Psychotherapie, CCM
der Medizinischen Fakultät Charité – Universitätsmedizin Berlin

DISSERTATION

Resilienz und mentale Gesundheit während der COVID-19-Pandemie: Psychologische Risiko- und Schutzfaktoren

Resilience and mental health during the COVID-19 pandemic: psychological risk and protective factors

zur Erlangung des akademischen Grades
Doctor of Philosophy (PhD)

vorgelegt der Medizinischen Fakultät
Charité – Universitätsmedizin Berlin

von

Antje Riepenhausen

Datum der Promotion: 30.11.2023

Table of Contents

List of Tables

List of Figures

List of Abbreviations

BCS	Behavioural coping style
BFI-10	Big Five Inventory – 10 item version
CSS	Change in social support during COVID-19
DV	Dependent variable
GAD-7	7-item subscale of the Patient Health Questionnaire, assessing symptoms of general anxiety
GHQ-12	General Health Questionnaire – 12-item version
GHQ-28	General Health Questionnaire – 28-item version
GSE	General self-efficacy
IV	Independent variable
LOC	Locus of control
NEU	Neuroticism
OPT	Optimism
PAC	Positive appraisal specific to the COVID-19 pandemic
PAS	Positive appraisal style
PHQ	Patient Health Questionnaire
PHQ-4	Patient Health Questionnaire – 4-item version
PHQ-9	Patient Health Questionnaire – 9-item version
PSS	Perceived social support
REC	Perceived good stress recovery
RES	Resilience
RES_C	Resilience to combined stressors
RES_G	Resilience to general stressors
RES_S	Resilience to COVID-19-related stressors

Abstract

Mental resilience is the resistance to stressors. The coronavirus disease 2019 (COVID-19) pandemic was a considerable stressor in 2020 and 2021, affecting large parts of the population. In two complementary studies we investigated possible determinants of resilient responses to the pandemic by focusing on possible psycho-social resilience factors.

Study 1 cross-sectionally investigated the relationship of several proposed psycho-social resilience factors with outcome resilience in an international convenience sample (n=15,790) surveyed in March and April of 2020. Using multiple linear regressions, we identified perceived good stress recovery, positive appraisal specifically of the COVID-19 pandemic, optimism, perceived social support, general self-efficacy, perceived increase in social support during COVID-19, positive appraisal style, and behavioural coping as resilience factors, whereas neuroticism was identified as a risk factor. LASSO regularised regression determined perceived good stress recovery, positive appraisal specifically of the COVID-19 pandemic, and neuroticism as statistically most important predictors. Mediation analyses showed that the relationship between perceived social support and outcome resilience was mediated by positive appraisal style and that the relationship between positive appraisal style and outcome resilience was mediated by perceived good stress recovery.

Study 2 investigated psychological factors associated with changes in psychological distress using panel data representative of the German household population (n=6,684) with two peri-pandemic survey waves spanning from April-June of 2020 and January-February of 2021. Survey-weighted linear regressions with changes in psychological distress from pre-pandemic baseline levels as the outcome identified perceived good stress recovery as the most consistent protective factor, with positive reappraisal and optimism partly also being related to smaller increases or larger decreases in psychological distress. Catastrophising and neuroticism were the most consistent risk factors. LASSO regularized regression confirmed the relative importance of perceived good stress recovery, catastrophising, and neuroticism.

Both studies thus identified several psychological factors that are related to outcome resilience and/or changes in psychological distress during a period of increased stressor exposure. Given that the hypotheses of the reported studies were derived from evidence stemming from pre-pandemic contexts, these resilience factors seem to be global factors

that are essential beyond the COVID-19 pandemic. Importantly, several of these factors are possibly malleable and therefore offer potential foci for targeted interventions aiming at increasing resilience in stressful times.

Zusammenfassung

Psychische Resilienz ist die Widerstandsfähigkeit gegenüber Stress. Die COVID-19-Pandemie war in den Jahren 2020 und 2021 ein erheblicher Stressor, der große Teile der Bevölkerung betraf. In zwei sich ergänzenden Studien untersuchten wir potenzielle Determinanten der Resilienz im Kontext der Pandemie, indem wir uns auf mögliche psychosoziale Resilienzfaktoren konzentrierten.

Studie 1 untersuchte im März und April 2020 die Beziehung zwischen mehreren psychosozialen Faktoren und Resilienz in einer querschnittlichen internationalen Zufallsstichprobe (n=15.790). Mithilfe multipler linearer Regressionen identifizierten wir wahrgenommene Stressbewältigung, positive Bewertung der Pandemie, Optimismus, wahrgenommene soziale Unterstützung, allgemeine Selbstwirksamkeit, wahrgenommene Zunahme der sozialen Unterstützung während COVID-19, positiven Bewertungsstil und verhaltensbezogene Bewältigung als Resilienzfaktoren, während Neurotizismus als Risikofaktor identifiziert wurde. Mithilfe einer regularisierten Regression ermittelten wir wahrgenommene Stressbewältigung, positive Bewertung speziell der COVID-19-Pandemie und Neurotizismus als statistisch wichtigste Prädiktoren. Mediationsanalysen zeigten, dass die Beziehung zwischen wahrgenommener sozialer Unterstützung und Resilienz durch positiven Bewertungsstil mediiert wurde, dessen Zusammenhang mit Resilienz wiederum durch die wahrgenommene Stresserholung mediiert wurde.

Studie 2 untersuchte psychologische Prädiktoren für Veränderungen der psychischen Belastung während der Pandemie in Bezug zum prä-pandemischen Ausgangsniveau. Hierfür nutzten wir für die deutsche Haushaltsbevölkerung repräsentative Paneldaten (n=6.684) mit zwei peri-pandemischen Erhebungswellen, die von April-Juni 2020 und Januar-Februar 2021 stattfanden. In umfragegewichteten linearen Regressionen kristallisierte sich eine wahrgenommene gute Stressbewältigung als konsistentester Schutzfaktor, wobei positive Neubewertung und Optimismus teilweise auch mit einem geringeren Anstieg oder einer stärkeren Abnahme der psychischen Belastung verbunden waren.

Katastrophisieren und Neurotizismus waren die konsistentesten Risikofaktoren. Eine regularisierte Regression bestätigte die relative Bedeutung der wahrgenommenen guten Stressbewältigung, des Katastrophisierens und des Neurotizismus.

In beiden Studien wurden somit mehrere psychologische Faktoren identifiziert, die mit Resilienz und/oder den Veränderungen der psychischen Belastung während einer Periode erhöhter Stressor-Exposition in Zusammenhang stehen. Angesichts der Tatsache, dass die Hypothesen der berichteten Studien aus Erkenntnissen abgeleitet wurden, die aus der Zeit vor der Pandemie stammen, scheint es sich bei diesen Resilienzfaktoren um globale Faktoren zu handeln, die über die Pandemie hinaus bedeutsam sind. Maßgeblich ist, dass mehrere dieser Faktoren möglicherweise veränderbar sind und somit potenzielle Ziele für Interventionen zur Stärkung der Resilienz in belastenden Zeiten bieten.

1 Introduction

1.1 Of Stressors, Pandemics, and Psychological Consequences

The (accumulated) exposure to stressful events is associated with an increased risk for mental health problems (Chrousos, 2009; Shields & Slavich, 2017). Accordingly, it is to be expected that outbreaks of potentially deadly infectious diseases (epidemics or, when transmitting globally, pandemics) have a toll on psychological well-being: pandemics are not only marked by the physical threat of infection for oneself or loved ones, with all its associated consequences up to the possibility of death. Further, they bear uncertainty, changes to social life, and threats to the economic situation – all considerable stressors with potentially harmful effects on mental health.

Indeed, past pandemics and epidemics have been associated with mental health impacts – be it the Spanish flu (Menninger, 1919), SARS (Lee et al., 2007), H1N1 (Gu et al., 2015; Lau et al., 2010), or Ebola (Jalloh et al., 2018). An increase in symptoms of depression and anxiety has also been observed during the first wave of the coronavirus disease 2019 (COVID-19) pandemic (Daly et al., 2021; Dawel et al., 2020; Ettman et al., 2020; Peters et al., 2020; Pieh et al., 2020; Pierce et al., 2020; Sibley et al., 2020; Twenge & Joiner, 2020; Winkler et al., 2020). Meta-analytic evidence, however, indicates that those symptom changes were rather small and recovered over the timeframe of months (Prati & Mancini, 2021; Robinson et al., 2021).

The COVID-19 pandemic has now been lasting for more than two years, bearing several peaks (‘waves’) of infection rates. Although effects on mental health have been shown, initial evidence indicates that these are mostly transient and that, overall, people are largely resilient to the increased stressor load (Prati & Mancini, 2021; Robinson et al., 2021). Determining the psycho-social factors associated with such a resilient response and factors that are predictive of mental health during the pandemic can offer insights for prevention and intervention strategies for future crises.

1.2 Mental Health vs. Resilience

1.2.1 Operationalizations of Mental Health

Mental health outcomes can be investigated at different levels. On the one hand, one can conduct comprehensive clinical interviews such as the SCID (First, 2015) or the

M.I.N.I. (Sheehan et al., 1998), which are administered by trained interviewers to diagnose psychiatric disorders. On the other hand, there are self-report screening tools that measure symptoms related to certain disorders or general distress. These are not detailed enough to make a psychiatric diagnosis (e.g., assess the time course or differential diagnoses) but can estimate the presence of symptoms. Such self-report instruments can screen for disorder-specific symptoms, like the Patient Health Questionnaire (PHQ; Spitzer et al., 1999). The PHQ assesses the frequency of symptoms in the past two weeks and contains five modules related to depressive, anxiety, somatoform, alcohol, and eating disorder, respectively. Single modules have been used to assess depressive symptoms (PHQ-9; Kroenke et al., 2001; example items: “Little interest or pleasure in doing things”, “Feeling down, depressed, or hopeless”), anxiety symptoms (GAD-7; Spitzer et al., 2006; example items: “Feeling nervous, anxious, or on edge”, “Not being able to stop or control worrying”), and an ultra-short 4-item version screens for both depressive and anxiety symptoms using the four items mentioned above (PHQ-4; Kroenke et al., 2009). Other questionnaires, such as the General Health Questionnaire (GHQ), assess how participants felt in the past two weeks compared to how they normally feel. The GHQ has different versions with a varying number of items and slightly different foci. For example, the 28-item version consists of four subscales measuring somatic symptoms (e.g., “Have you been getting any pains in your head?”), anxiety and insomnia (e.g., “Have you felt constantly under strain?”), social dysfunction (e.g., “Have you felt that you are playing a useful part in things?”), and severe depression (e.g., “Have you felt that life isn’t worth living?”; GHQ-28; Goldberg & Hillier, 1979). A shorter 12-item version was designed as a unidimensional measure of psychological distress and assesses a variety of symptoms relevant for general mental health (GHQ-12; Goldberg et al., 1997; example items: “Have you been able to concentrate well on what you were doing?”, “Have you been thinking of yourself as a worthless person?”, “Have you lost much sleep over worry?”).

1.2.2 Operationalizations of Resilience

Whereas the above-mentioned measures of mental health are independent of experienced hardship, resilience research aims to identify specific factors that are relevant for maintaining or quickly recovering mental health or psychological well-being during and after experiencing adversity (Bonanno et al., 2011; Kalisch et al., 2017). The assessment of the experience of adversity in individuals is thus a prerequisite for investigating their resilience. Without estimating adversity, we can assess an individual’s mental health or

well-being using one of the questionnaires introduced above, but not their resilience. Since resilience thus always refers to the experienced adversity, it cannot be measured in the form of stable personality questionnaires. Although many questionnaires aim to measure such *trait resilience* (e.g., Connor & Davidson, 2003; Smith et al., 2008), these mostly rather assess *resilience factors*, i.e., factors that are associated with, or foster, resilient responses to adversity, but do not fully explain the resilient outcome. It is the interplay between these predisposing resilience factors and processes that happen during the experience of adversity that determines whether an individual will have a resilient outcome or not.

To estimate resilience, one thus needs to assess mental health against the stressors that were experienced. On average, mental health problems can be predicted by stressor exposure, i.e., the more stressors a person experiences, the higher the experienced mental health problems (Agid et al., 2000). However, there are interindividual differences: despite the average positive association between stressors and mental health problems, single individuals can suffer from severe mental health problems regardless of low stressor exposure or also show few mental health problems when they experienced a considerable number of stressful events.

Individual resilience scores can be calculated using a residualisation approach (Amstadter et al., 2014; van Harmelen et al., 2017). The regression line from stressor exposure on mental health problems reflects normative reactivity of mental health problems to stressor exposure in the given sample. A participant's deviation from this regression line suggests an above-average stressor reactivity (or lower resilience) in case of a positive residual, and below-average stressor reactivity (or higher resilience) in case of a negative residual. The residualisation approach to determine individual resilience is visualized in **Figure 1**. The schematically presented regression diagram represents the association between stressor exposure (x-axis) and psychological distress (y-axis). The overall relationship between these two measures is positive. Individual deviations from the regression line (residuals) are displayed as vertical lines. Participants lying above the regression line (red data points) have positive residuals and therefore experience higher psychological distress than would be expected given their level of stressor exposure (e.g., participant A). They have a relatively high stressor reactivity and thus low resilience. Participants lying below the regression line (green data points) have negative residuals and therefore experience less psychological distress than expected at their level of stressor exposure (e.g., participant B). They have a relatively low stressor reactivity and thus high

resilience. C and D are examples of participants who were exposed to different stressor quantities while showing the same levels of psychological distress. Without knowledge of stressor exposure, we would regard them as equal, although we here see that D is slightly more resilient than C when considering stressors. Details on this procedure can also be found in Kalisch et al. (2021).

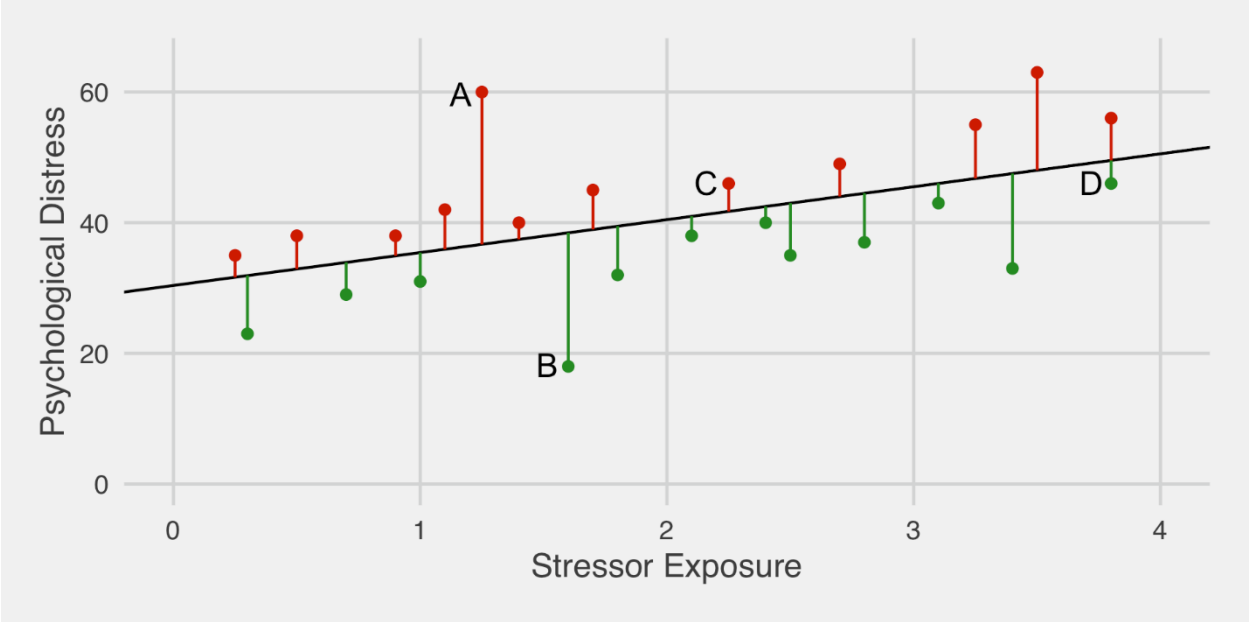

Figure 1. Resilience operationalised as (the inverse of) individual stressor reactivity. Positive residuals (red data points) represent higher stressor reactivity, and thus lower resilience. Negative residuals (green data points) represent lower stressor reactivity, and thus higher resilience (this figure is an own representation based on Figure 3 of Wackerhagen et al., (2021)).

When an accurate assessment of individual stressors, and therefore the computation of residualised outcome resilience, is not possible, researchers can compare mental health outcomes in individuals who experienced the same or similar situations that can be considered a stressor. Assuming that stressor exposure is the same for each participant, the differences in mental health should be explained by factors over and above stressor exposure. Although not as precise as the residualisation approach, this method can remove some of the variance in mental health outcomes that is merely explained by stressor exposure. The similarity of the experienced stressors is however crucial for effectively using this approach.

An alternative analysis approach when one is not interested in quantifying resilience, but rather whether certain features are resilience factors (i.e., associated with a more

resilient response to adversity), is to assess whether these features moderate the relationship between stressor exposure and mental health problems.

1.3 Predictors for Resilience and Mental Health During COVID-19

1.3.1 Predictors for Mental Health During COVID-19

Past research on mental health during COVID-19 revealed sociodemographic risk factors (i.e., factors associated with more mental health problems) such as female gender (Amendola et al., 2021; Amerio et al., 2021; Badellino et al., 2021; Daly et al., 2020; Daly & Robinson, 2020; Essangri et al., 2021; Fiorenzato et al., 2021; Gijzen et al., 2020; Gilleen et al., 2021; Holingue et al., 2020; Hubbard et al., 2021; Hyland et al., 2020; Li & Wang, 2020; Niedzwiedz et al., 2020; O'Connor et al., 2021; Peters et al., 2020; Pieh et al., 2020; Pierce et al., 2020; Ribeiro et al., 2021; Zajacova et al., 2020), younger age (Amendola et al., 2021; Badellino et al., 2021; Daly et al., 2020; Daly & Robinson, 2020; Every-Palmer et al., 2020; Fiorenzato et al., 2021; Holingue et al., 2020; Hubbard et al., 2021; Hyland et al., 2020; Li & Wang, 2020; Niedzwiedz et al., 2020; O'Connor et al., 2021; Peters et al., 2020; Pieh et al., 2020; Pierce et al., 2020; Ribeiro et al., 2021; Sojli et al., 2021; Zajacova et al., 2020), and living with young children (Pierce et al., 2020). More heterogeneous results have been reported regarding income, education, and employment status (Daly et al., 2020; Daly & Robinson, 2020; Li & Wang, 2020; Niedzwiedz et al., 2020; Pieh et al., 2020; Pierce et al., 2020). Health-related risk factors were preexisting mental health conditions (Batterham et al., 2021; Daly & Robinson, 2020; Essangri et al., 2021; Every-Palmer et al., 2020; Gilleen et al., 2021; Holman et al., 2020; McPherson et al., 2021; O'Connor et al., 2021) as well as poor physical health (Every-Palmer et al., 2020; Holman et al., 2020). Regarding psychological factors, studies found several protective factors such as cognitive flexibility (Dawson & Golijani-Moghaddam, 2020; McCracken et al., 2020), optimism (McElroy-Heltzel et al., 2022; Płomecka et al., 2020; Schug et al., 2021; Vos et al., 2021), self-control (Flesia et al., 2020; Schnell & Krampe, 2020), coping/emotion regulation skills (Ahrens et al., 2021; Budimir et al., 2021; Fernández et al., 2020; Flesia et al., 2020; Zhu et al., 2020), self-efficacy or internal locus of control (Bendau et al., 2021; Flesia et al., 2020), self-esteem (Arima et al., 2020), grit (McCracken et al., 2020), mindfulness (Conversano et al., 2020; Vos et al., 2021), altruism (Kornilaki, 2022), and (making) meaning (McPherson et al., 2021; Schnell & Krampe, 2020; Yang et al., 2021). Neuroticism (Fernández et al., 2020; Flesia et al., 2020) and

insecure-anxious attachment (Moccia et al., 2020) on the other hand have been found to be psychological risk factors. Identified social and lifestyle protective factors include (perceived) social support (Ahrens et al., 2021; Amendola et al., 2021; Hubbard et al., 2021; Schug et al., 2021) and maintaining social contacts (Bendau et al., 2021) next to adherence to daily routine (Kornilaki, 2022), frequent exercise (Kim et al., 2021), and frequent use of greenspace (Soga et al., 2021). Needing social support on the other hand was a risk factor (Hennein et al., 2021).

1.3.2 Predictors for Resilience During COVID-19

In contrast to the plethora of studies investigating mental health, literature investigating resilience during the COVID-19 pandemic is scarce. Studies that investigated resilience mostly did not assess outcome resilience, but trait resilience, which was assessed via self-report questionnaires. The weaknesses of such an operationalization are discussed above (see 1.2.2). Those studies found trait resilience to be associated with lower psychological distress during the COVID-19 pandemic in cross-sectional studies (Barzilay et al., 2020; Gilleen et al., 2021; Killgore et al., 2020; Kimhi et al., 2020; McElroy-Heltzel et al., 2022; Song et al., 2021; Verdolini et al., 2021; Vos et al., 2021; Yörük & Güler, 2021), besides smaller increases in psychological distress compared to pre-pandemic levels (Riehm et al., 2021) and a faster recovery of perceived stress in the first months of the pandemic (Osimo et al., 2021) in longitudinal studies. Trait resilience was moreover moderating the relationship between perceived stress and internalizing symptoms (Havnen et al., 2020). Altogether, these findings corroborate the role of questionnaire-assessed trait resilience as a resilience factor, as explained above, but do not give insights into which factors are related to resilience during COVID-19.

Only a few studies examined the relationship between resilience and factors other than measures of psychological distress or mental health symptoms. In these studies, older age and male gender, life satisfaction, higher positive and lower negative affect (Bozdağ & Ergün, 2021) as well as morbid curiosity (Scrivner et al., 2021) were associated with trait resilience. Merely one study investigated factors associated with outcome resilience (operationalized as low psychological distress when exposed to high levels of COVID-19 related stressors) and identified positive emotions, self-efficacy, purpose in life, social support, and low use of maladaptive coping strategies as resilience factors in front-line health care workers (Pietrzak et al., 2020).

1.4 Gaps in the Literature and Research Questions

Although many studies have been conducted on the topic of mental health outcomes during the COVID-19 pandemic, less focus has been laid on resilience. Those studies investigating resilience mostly assessed trait resilience. As elaborated upon above, resilience should not be investigated without considering the experienced adversity. Specifically, studies that focus on assessing trait resilience rather measure resilience factors and cannot fully explain whether participants actually are resilient when experiencing a given adverse event. Only one study investigated the association between different psychological factors and outcome resilience but focused on a very specific participant group, namely front-line health care workers (Pietrzak et al., 2020).

Study 1 (Veer et al., 2021) aims to close this research gap by investigating potential psycho-social predictors for outcome resilience in an international convenience sample of the general population. We specifically focus on described resilience factors from pre-pandemic contexts (i.e., perceived social support, general self-efficacy, optimism, perceived good stress recovery; Bonanno et al., 2015) as well as positive appraisal and behavioural coping as two newly proposed resilience factors stemming from positive appraisal style theory of resilience (PASTOR; Kalisch et al., 2015).

All studies investigating peri-pandemic resilience and most studies examining psychological predictors of mental health during the pandemic relied on specific samples such as health care workers or on convenience samples. Whether the findings of these studies can be generalised to the entire population, or whether self-selection of participants into the study on the one hand or the focus on specific sub-groups on the other hand have effects on the results is difficult to determine. Especially given the fact that COVID-19 universally affects large parts of the population, it would be helpful if findings from studies would also apply to the general population instead of specific subgroups. Random sampling and correcting for bias using survey weights is a solution for this problem that offers the possibility to draw inferences regarding the larger population of which non-random samples are only instances.

Moreover, there is a systematic lack of pre-pandemic baseline measures of mental health in those studies investigating possible psychological protective or risk factors. This is another factor hindering reliable conclusions from previous studies: the large proportion of studies on COVID-19 are cross-sectional and thus have the tendency to overestimate effect sizes (Allison, 2021). They can describe levels of mental health at a given time

point during the pandemic or refer to pre-pandemic levels in other samples to make claims regarding average peri-pandemic changes. They can, however, not give insights regarding intra-individual change.

Study 2 (Riepenhausen et al., 2022) targets these two described limitations by using data from a sample that is representative of the German household population and moreover offers pre-pandemic data from the same participants. We focus on similar psychological factors as in Study 1 and aim to assess their association with intra-individual changes in psychological distress from pre-pandemic levels to two peri-pandemic time points.

2 Methods

2.1 Study 1: Psycho-Social Factors Associated with Resilience in a Cross-Sectional Convenience Sample

2.1.1 Participants

Participants were recruited through email lists, social media channels as well as a campaign in general media between March 22, 2020, and April 20, 2020. The only inclusion criterion was being 18 years or older at the time of study conduct. Participation was possible in one of the following languages: Arabic, Chinese, Croatian, Czech, Danish, Dutch, English, Estonian, Finnish, French, German, Greek, Hebrew, Hungarian, Italian, Lithuanian, Norwegian, Polish, Portuguese, Serbian, Slovak, Spanish, Swedish or Ukrainian. In total, 15,790 participants provided valid and complete data, with large proportions of females, younger people, Europeans, people with higher education, and people with one of the following occupations: student, working in research/education, or working in health care.

The study was approved by the ethics committee of the State medical Board of Rhineland-Palatinate, Germany, and was conducted in accordance with the Declaration of Helsinki.

2.1.2 Independent Variables and Covariates

Based on the literature, the following independent variables (IVs) were hypothesized to be resilience factors (i.e., to statistically predict resilience): optimism, general self-efficacy, perceived good stress recovery (Smith et al., 2008), and perceived social support (Bonanno et al., 2015) as well as an increase in perceived social support over the course of the pandemic. In addition to these established resilience factors, we added factors that showed to be individually predictive for resilience in two ongoing longitudinal studies (Chmitorz et al., 2021; Kampa et al., 2018), namely emotional stability (i.e., low neuroticism), positive appraisal style, and behavioural coping. The latter two factors emerged from the Positive Appraisal Style Theory of Resilience (PASTOR; Kalisch et al., 2015), which claims that the positive appraisal of potentially threatening situations is a key resilience mechanism and proximal cause for resilience. Positive appraisal style and behavioural coping were determined via factor analysis of two established instruments on cognitive emotion regulation and coping, the Cognitive Emotion Regulation Questionnaire –

short form (CERQ-short; Garnefski & Kraaij, 2006) and the brief COPE (Carver, 1997). Specifically, the first factor “positive appraisal style” was composed of the subscales positive reappraisal (CERQ), acceptance (CERQ), putting into perspective (CERQ), refocus on planning (CERQ), positive refocusing (CERQ), humour (COPE), and distancing (self-formulated). The behavioural coping factor consisted of the subscales instrumental support seeking (COPE), emotional support seeking (COPE), venting of emotions (COPE), and acting out (COPE). Additionally, we included two self-formulated items capturing positive appraisal of the COVID-19 pandemic on a personal and societal level (‘*I expect that I will learn something positive from the corona pandemic for my own life*’ and ‘*In the long run, I think that society will change for the better because of the corona pandemic*’, respectively).

The following covariates were included in the survey: age, gender, education, household income, occupation, occupational status, nationality, survey language, country of residence, currently out of town, relationship status, number of people in the household, number of people below the age of 18 in the household, general health, past or present diagnosed mental health condition, belonging to a risk-group for a severe course of infection, having been in quarantine, having tested positive for COVID-19 at some point, agreement with authorities’ measures to curtail the spread of the virus, and following the recommended procedures to limit the spread of the virus.

2.1.3 Dependent Variable

Outcome resilience as the dependent variable (DV) was assessed using the residualisation approach introduced in section 1.2.2 (Amstadter et al., 2014; van Harmelen et al., 2017).

Mental health problems were assessed with the GHQ-12 (Goldberg et al., 1997). Stressor exposure was measured using eleven items that condensed daily hassles from the MIMIS (Chmitorz et al., 2020), and life events from the Life Events Inventory (Cochrane & Robertson, 1973). Additionally, 29 items were specifically asked for COVID-19-related stressors. In a first step, participants were asked if the given stressor occurred to them during the last two weeks (stressor count). If a stressor occurred, they were then asked how burdensome the experience was on a scale from 1 to 5 (stressor severity). Six different stressor exposure scores were calculated: a) stressor count using the 11 general stressors, b) stressor severity using the 11 general stressors, c) stressor count using the 29 COVID-19-related stressors, d) stressor severity using the 29 COVID-19-

related stressors, e) stressor count using all 40 combined stressors, f) stressor severity using all 40 combined stressors.

Out of the six different stressor exposure scores, the one that explained the most variance in mental health problems was identified using linear regression. A model with linear and quadratic effects explaining mental health problems from the reported stressor severity to all combined stressors (stressor exposure score f) provided the best fit.

Individual resilience scores (RES) were then calculated from the residuals of the regression line explaining mental health problems from stressor severity to all combined stressors (RES_C). Specifically, given that positive residuals reflect lower resilience and negative residuals reflect higher resilience, we operationalized resilience as the inverse of these residuals. To be able to later investigate possible differences between general and COVID-related stressors, we additionally calculated resilience to general stressors (RES_G) and resilience to COVID-19-related stressors (RES_S), separately.

2.1.4 Hypotheses

The formulation of the following hypotheses is identical to the one formulation in Veer et al. (2021).

H1: Positive appraisal style is positively associated with resilience.

H2: Perceived social support is positively associated with resilience.

H3: A perceived increase in social support during the COVID-19 pandemic is positively associated with resilience.

H4: Optimism is positively associated with resilience.

H5: Perceived general self-efficacy is positively associated with resilience.

H6: Perceived good stress recovery is positively associated with resilience.

H7: Neuroticism is negatively associated with resilience.

H8: Behavioural coping style is positively associated with resilience.

H9: Positive appraisal specifically of the COVID-19 pandemic is positively associated with resilience.

H10: The expected positive effect of perceived social support on resilience is positively mediated by its effect on positive appraisal style.

H11: The expected positive effect of positive appraisal style on resilience is positively mediated by its effects on perceived good stress recovery.

2.1.5 Analyses

The association of all socio-demographic and health-related covariates with RES was assessed using one univariate linear regression analysis per covariate. Covariates that survived a likelihood ratio test at $p < .2$ were included in the following main analyses.

Hypotheses H1-H9 were tested using individual multiple linear regression analyses per hypothesis, including all previously identified covariates in the model.

Hypotheses H10 and H11 on mediation, which aimed to investigate possible resilience mechanisms, were conducted following Baron and Kenny (Baron & Kenny, 1986).

The significance level α was $p < .01$, two-tailed, for all analyses.

The statistically most influential IVs were determined by including all IVs in a single model. To control for model complexity and avoid over-fitting, we used least absolute shrinkage and selection operator (LASSO) regularised regression using the glmnet R package (Friedman et al., 2010), which penalizes the L_1-norm of the coefficients with a parameter λ. The specific value of λ is determined using cross-validation. Specifically, to select the simplest model that is comparably accurate to the best model (Hastie et al., 2015), we selected optimal λ to be 1SE higher than the λ that minimizes cross-validation error.

Due to our unbalanced convenience sample, we additionally conducted exploratory subgroup analyses to determine whether the associations between IVs and RES diverged in different subgroups. To investigate this, for each covariate (gender, age, country of residence, household income, years of education, past or present mental health diagnosis) we repeated the individual multiple linear regression analyses that we conducted for H1-H9, adding an interaction term between the covariate of interest and the respective IV.

All analyses were performed in R v3.6.3 (R Core Team, 2020).

2.2 Study 2: Psychological Factors Associated with Changes in Psychological Distress in a Population-Representative Panel Study

2.2.1 Participants

Participants of study 2 were members of a long-running population-representative panel study ‘Socio-Economic Panel’ (SOEP; Goebel et al., 2019; Liebig et al., 2019). The SOEP consists of a stratified random sample of the German household population,

comprising over 30,000 participants coming from over 20,000 households. These participants are annually surveyed concerning different socio-economic as well as psychological topics. A random subset of this larger cohort, consisting of 12,000 households, was contacted in the context of the SOEP-CoV study (Kühne et al., 2020), for which telephone interviews were conducted between April 1, 2020, and July 4, 2020. Of those 12,000 contacted households, n=6,684 (one participant per household) agreed to take part in the survey. All 6,684 participants were recontacted between January 18, 2021, and February 15, 2021, of which n=6,006 took part in the follow-up survey.

2.2.2 Independent Variables and Covariates

Four single items from the CERQ-short (Garnefski & Kraaij, 2006) were adapted in wording to reflect the use of emotion regulation strategies during the COVID-19 pandemic (time frame of the past two weeks). They were used to assess positive reappraisal (*'I thought that the situation also has its positive sides'*), putting into perspective (*'I thought that it hasn't been too bad compared to other things'*), acceptance (*'I thought that I have to accept the situation'*), and catastrophising (*'I kept thinking about how terrible it is what I have experienced'*). One reformulated item from the Brief COPE (Carver, 1997) was used to assess the tendency to ask for instrumental support during the past two weeks (*'I've been trying to get advice or help from other people about what to do'*). The selected items were chosen based on yet unpublished research (see also 2.1.2) that identified them to represent positive appraisal style (positive reappraisal, putting into perspective, and acceptance), behavioural coping (asking for instrumental support), and maladaptive coping (catastrophising).

We furthermore measured positive appraisal of the COVID-19 pandemic on a personal and societal level using two self-formulated items (see section 2.1.2), and perceived good stress recovery using the item *'I tend to bounce back quickly after hard times'* of the Brief Resilience Scale (Chmitorz et al., 2018; Smith et al., 2008). All above-mentioned IVs were assessed during the 2020 survey wave.

Additionally, we were able to retrieve data from previous survey waves on locus of control (2015; SOEP-specific 10-item instrument), neuroticism (2017; BFI-S; Hahn et al., 2012), and optimism (2019; SOEP-specific 1-item instrument). The upper part of Figure 2 shows the timing of the assessment of the different IVs.

Covariates included age, gender, education, household income, being a risk group for a severe course of a possible COVID-19 infection, having been diagnosed with

depression in the past, and lockdown status (the latter for analyses involving data from the 2020 survey wave only).

2.2.3 Dependent Variables

Psychological distress was measured in 2016, 2019, 2020, and 2021 using the PHQ-4 (Kroenke et al., 2009; Löwe et al., 2010). Both pre-pandemic assessments (2016 and 2019) were averaged to yield a more robust baseline. Changes in psychological distress were then computed by subtracting the pre-pandemic baseline from PHQ-4 in 2020 (yielding ΔPHQ 2020) and in 2021 (ΔPHQ 2021). For control analyses, the change in psychological distress from 2016 to 2019 was additionally computed (yielding ΔPHQ 2019). The lower part of **Figure 2** shows the timing of the assessment of PHQ-4 as well as the calculation of the different ΔPHQ scores.

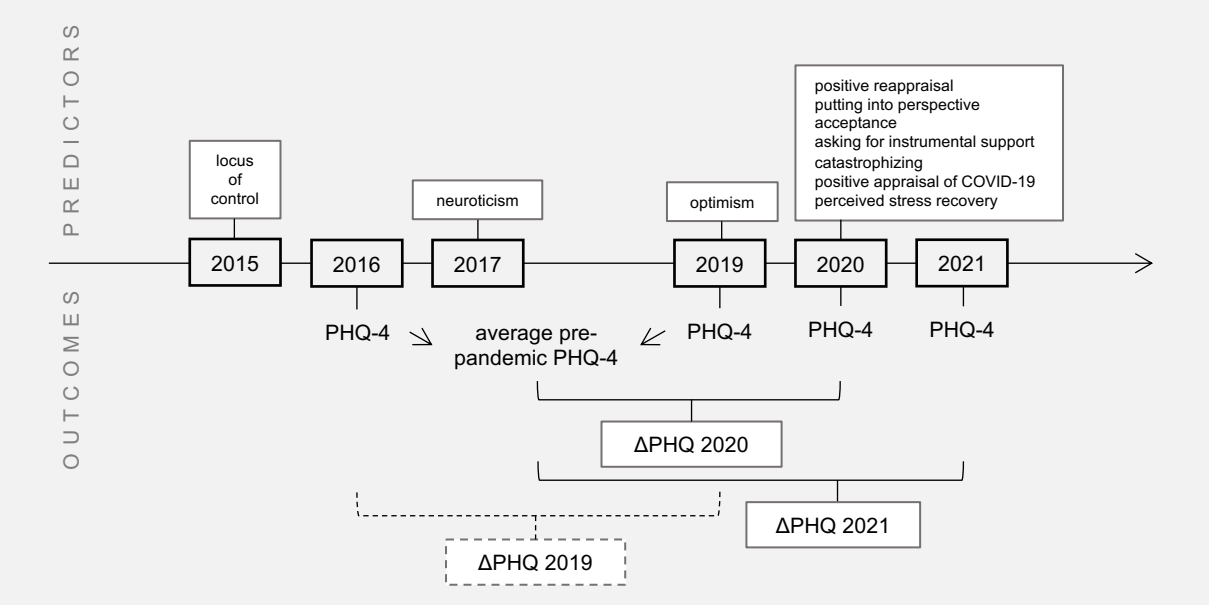

Figure 2. Timing of data collection for IVs and DVs. Ivs are represented in the upper part of the figure whereas DVs are represented in the lower part of the figure. *Note:* PHQ-4 = Patient Health Questionnaire, 4 item version; ΔPHQ 2019 = change in PHQ-4 from 2016 to 2019; ΔPHQ 2020 = change in PHQ-4 from 2019 to 2020, ΔPHQ 2021 = change in PHQ-4 from 2019 to 2021 (this figure is identical to Figure 1 of Riepenhausen et al., 2022).

2.2.4 Hypotheses

H12: Positive reappraisal is a protective factor, being negatively associated with ΔPHQ 2020 and ΔPHQ 2021.

H13: Putting into perspective is a protective factor, being negatively associated with ΔPHQ 2020 and ΔPHQ 2021.

H14: Acceptance is a protective factor, being negatively associated with ΔPHQ 2020 and ΔPHQ 2021.

H15: Positive appraisal specifically of the COVID-19 pandemic is a protective factor, being negatively associated with ΔPHQ 2020 and ΔPHQ 2021.

H16: Perceived good stress recovery is a protective factor, being negatively associated with ΔPHQ 2020 and ΔPHQ 2021.

H17: Instrumental support seeking is a protective factor, being negatively associated with ΔPHQ 2020 and ΔPHQ 2021.

H18: Optimism is a protective factor, being negatively associated with ΔPHQ 2020 and ΔPHQ 2021.

H19: Internal locus of Control is a protective factor, being negatively associated with ΔPHQ 2020 and ΔPHQ 2021.

H20: Catastrophising is a risk factor, being positively associated with ΔPHQ 2020 and ΔPHQ 2021.

H21: Neuroticism is a risk factor, being positively associated with ΔPHQ 2020 and ΔPHQ 2021.

2.2.5 Data Cleaning and Pre-processing

The dataset presented 4.5% of missing values, which were imputed with m=5 imputations and 50 iterations using the classification and regression trees method of the mice package (Buuren & Groothuis-Oudshoorn, 2011) in R v4.0.0 (R Core Team, 2020). Statistical outliers were not removed since all were in the range of the used scales and thus considered to be meaningful. Whereas all IVs were z-standardized, we did not z-standardize the DVs to allow for the comparison between different outcomes and enable clinically interpretable evaluations of the results.

2.2.6 Analyses

Separate survey-weighted multiple linear regression analyses were conducted for each pair of IVs and DVs. All above-reported covariates were included in the models (lockdown status for ΔPHQ 2020 only), and baseline psychological distress was added as an additional covariate to correct for regression to the mean. Details on the used survey weights can be found in Kroh (2009) and Siegers, Belcheva & Silbermann (2020).

Since the survey weight was equal to zero for 27 participants, the final n was 6,657 (5,981 at follow-up).

We subsequently used the miselect R package (Rix & Du, 2020) to conduct LASSO regularised regression (see 2.1.5) on the multiply imputed data set. Inclusion frequencies were computed to assess the stability of the results.

As an additional analysis, we conducted specification curve analyses (Simonsohn et al., 2020; Steegen et al., 2016) to investigate whether arbitrary choices in the process of data pre-processing and model specification influenced results (which should not be the case). For this, we compared models using linear vs. robust regression and using a cube-root-transformation of non-normally distributed variables vs. the non-transformed variable.

Finally, to investigate the association of the IVs with raw PHQ-4 scores over the years (as opposed to change between years), we computed linear mixed models. Next to a random intercept per subject, the respective IV, all covariates, year, and the interaction between IV and year were entered as fixed effects. This resulted in 10 individual linear mixed models (one model per IV). Subsequently, marginal effects at mean $\pm$ 1SD of the respective IV were predicted using the ggeffects R package (Lüdecke et al., 2021). During this prediction, all covariates were held constant at their respective marginal mean.

3 Results

3.1 Study 1: Psycho-Social Factors Associated with Resilience in a Cross-Sectional Convenience Sample

3.1.1 Descriptives

The average GHQ-12 scores reported were 15.5 ± 6.2 (SD), which was higher than in pre-pandemic representative samples where average scores of 9.7 and 8.3, respectively, have been reported (Rodrigo et al., 2019; Romppel et al., 2017). Even though we cannot provide pre-pandemic baseline GHQ-12 scores for our sample, this can be interpreted as an indication of an influence of the COVID-19 pandemic on mental health problems.

The most frequently reported experienced COVID-19-related stressors were COVID-19-related media coverage (reported by 93% or all participants), not being able to perform leisure activities (90%), loss of social contact (88%), and feeling restricted to leave home (86%). Regarding general stressors, the most often reported experiences were negative political events (83%), conflicts/disagreements in family, social, or professional settings (62%), and burdensome experiences at work/school/university/other occupation (61%).

With respect to stressor severity, the following COVID-19 related experiences have been rated as most burdensome: inability to attend a funeral of a loved one (3.75 on a scale from 1 to 5), loved ones being at the hospital with restrictions to visit (3.66), and loved ones being at increased risk for a severe course of COVID-19 in case of infection (3.5). Most strongly rated general stressors included the death of a loved one (3.85), separation from a loved one (3.56), and oneself or a loved one experiencing mental health problems (3.29).

3.1.2 Multiple Linear Regressions: Association of IVs with Resilience (H1-H9)

Hypotheses H1-H9 were confirmed (all $p < .0001$; note that results were Bonferroni-corrected and thus considered significant at $p < .01/9 = .0011$). That is, positive appraisal style, perceived social support, an increase in perceived social support during COVID-19, optimism, general self-efficacy, a perceived good stress recovery, behavioural coping, and positive appraisal of the COVID-19 pandemic specifically were all associated with higher, whereas neuroticism was associated with lower resilience. See **Figure 3A** for the results of all IVs' separate multiple linear regressions for the DVs RES_C, RES_G, and RES_S.

3.1.3 Mediation Analyses (H10 & H11)

Hypotheses H10 and H11 on mediation were both confirmed (see **Figure 3B**). The association of perceived social support with RES was mediated via positive appraisal style. Likewise, the association of positive appraisal style with RES was mediated via perceived good stress recovery.

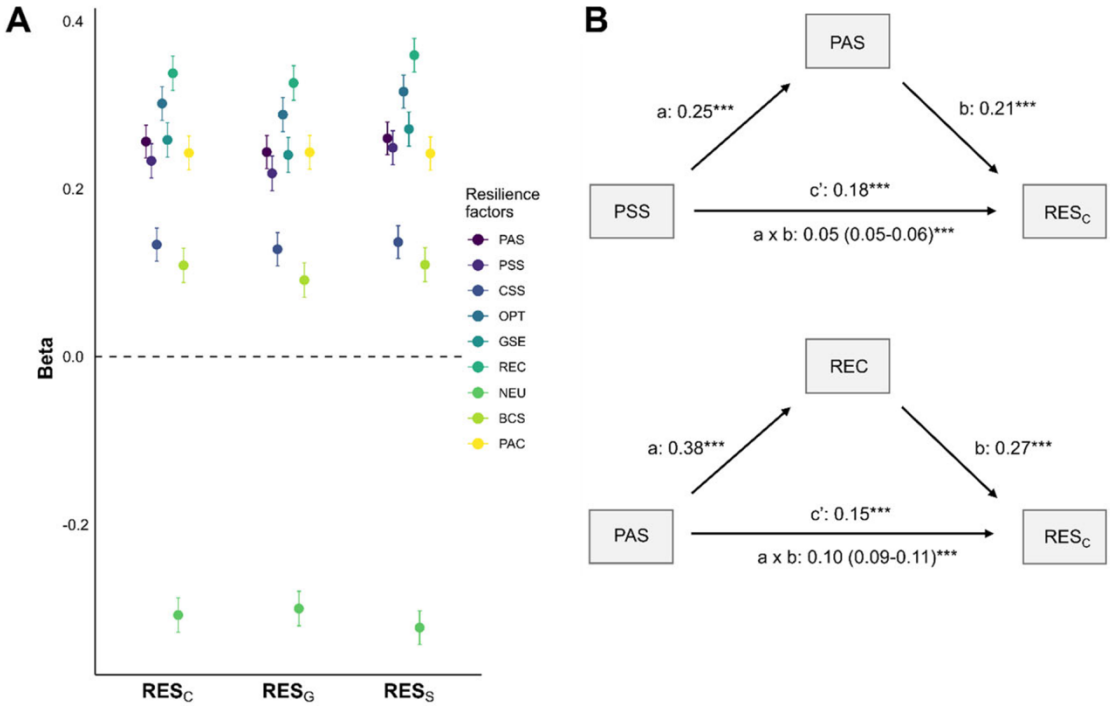

Figure 3. Results of H1-H11. **A)** Results of individual multiple linear regressions for each IV on resilience (H1-H9). Dots depict the β regression coefficients and error bars the 99% confidence interval. *Note:* PAS = positive appraisal style; PSS = perceived social support; CSS = perceived increase in social support during COVID-19; OPT = optimism; GSE = general self-efficacy; REC = perceived good stress recovery; NEU = neuroticism; BCS = behavioural coping style; PAC = positive appraisal specifically of the COVID-19 pandemic; RES_C = resilience to all combined stressors; RES_G = resilience to general stressors; RES_S = resilience to COVID-19-specific stressors. **B)** Mediation analyses testing if the association of PSS with RES_C is mediated by PAS (H10; top) and if the association of PAS with RES_C is mediated by REC (H11; bottom). β coefficients of all paths are shown. For the indirect path a x b, β with 99% confidence interval is shown. ***p < .0001 (this figure is identical to Figure 1 of Veer et al., 2021).

3.1.4 LASSO Regularised Regressions: Relative Importance of IVs

LASSO regularised regression, combining all IVs and determining their relative strength of association while controlling for overfitting, identified perceived good stress

recovery as the most important positive predictor, followed by positive appraisal specifically of the COVID-19 pandemic and, negatively, neuroticism. **Figure 4** displays the association strengths of all IVs with RES_C at varying λ. The position of each line on the y-axis (λ=0) depicts their association strength with RES_C in a model that is not penalized at all. Moving towards the right on the x-axis, the penalty parameter λ gets stricter, drawing the associations of IVs with RES_C towards zero with the strongest associations surviving stronger penalization.

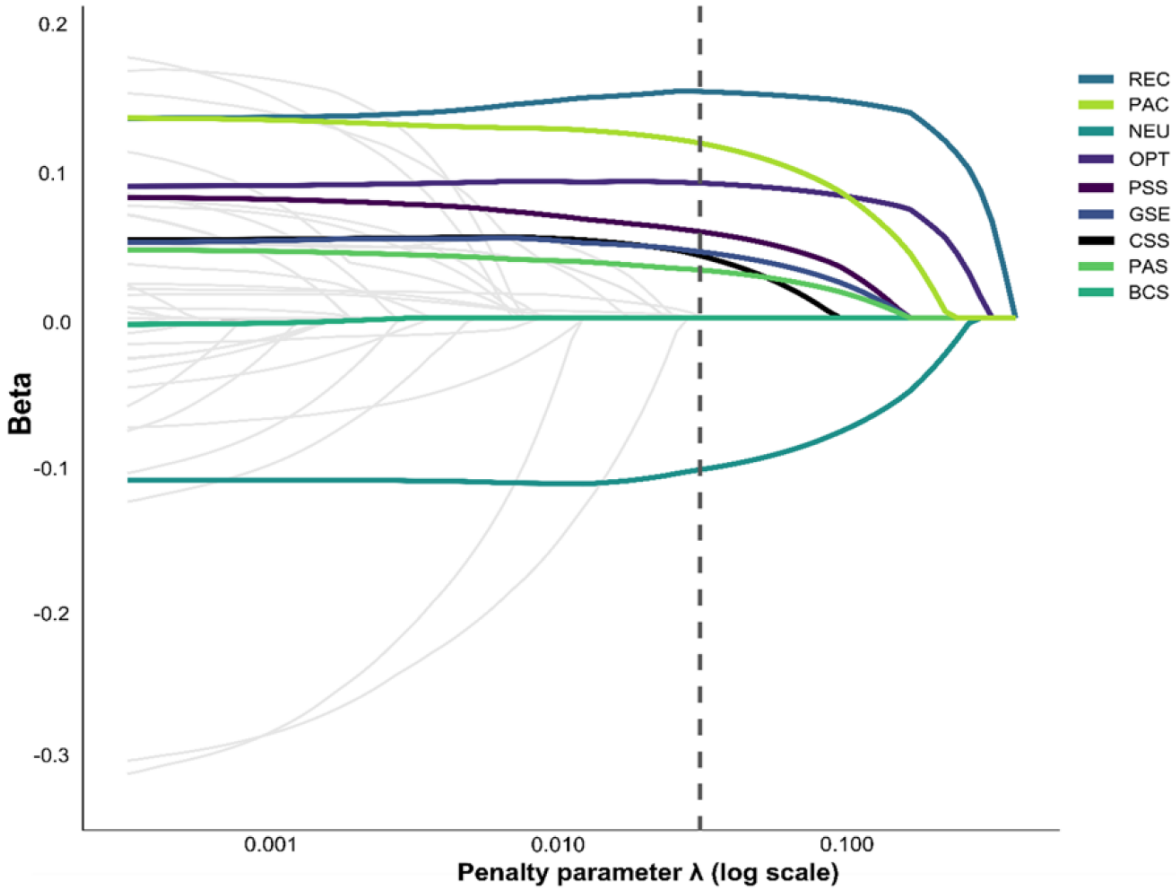

Figure 4. Results of the LASSO regularised regression. Coloured lines represent IVs; grey lines represent covariates. The order of IVs in the legend corresponds to their relative strength of association at optimal λ determined by cross-validation (dashed line). *Note:* REC = perceived good stress recovery; PAC = positive appraisal specifically of the COVID-19 pandemic; NEU = neuroticism; OPT = optimism; PSS = perceived social support; GSE = general self-efficacy; CSS = perceived increase in social support during COVID-19; PAS = positive appraisal style; BCS = behavioural coping style (this figure is identical to Figure 2 of Veer et al., 2021).

3.1.5 Subgroup Analyses

Exploratory analyses revealed differences between covariate-based subgroups regarding the association of IVs with RES. However, positive IVs remained positive at all levels of all covariates, and negative IVs remained negative at all levels of all covariates. In the LASSO analysis, the relative rank of IVs did not noticeably differ between different covariate levels.

3.2 Study 2: Psychological Factors Associated with Changes in Psychological Distress in a Population-Representative Panel Study

3.2.1 Descriptives

In the first peri-pandemic survey wave between April and July 2020, 38% of the study population experienced at least mild psychological distress (PHQ-4 score of ≥3), a number which slightly reduced to 36% during the second peri-pandemic survey wave in January and February 2021. Averaged pre-pandemic incidence of psychological distress was 31% (26% in 2019 and 36% in 2016).

Mean PHQ-4 was elevated in 2020 (weighted M = 2.45/12, SEM = 0.049) compared to pre-pandemic scores (2019: weighted M = 1.79/12, SEM = 0.048; $t(6655) = 9.73$, $p < 2.2e\text{-}16$; 2016: weighted M = 2.17/12, SEM = 0.061; $t(6655) = 3.34$, $p = .002$) and decreased again in 2021 (weighted M = 2.21/12, SEM = 0.048; $t(6655) = -3.41$, $p = 7.31e\text{-}4$). PHQ-4 levels in 2021 were elevated compared to 2019 ($t(6655) = 6.07$, $p = 1.345e\text{-}8$), but not compared to 2016 ($t(6655) = 0.455$, $p = .653$).

3.2.2 Multiple Linear Regressions: Association of Covariates with Changes in Psychological Distress

Having a history of diagnosed depression was positively associated with ΔPHQ 2020 (β = 0.697), ΔPHQ 2021 (β = 1.063), and ΔPHQ 2019 (β = 2.060). Moreover, ΔPHQ 2021 was higher in females compared to males as well as in participants between 18 and 24 years of age compared to the reference group of 45-54 years of age. Other covariates were not related to the different outcomes. Details can be found in **Tables 1-3**.

3.2.3 Multiple Linear Regressions: Association of IVs with Changes in Psychological Distress (H12-H21)

ΔPHQ 2020 was negatively predicted by perceived good stress recovery (H16; β = -0.473) and positive reappraisal (H12; β = -0.192), indicating their role as protective factors, and, positively, by catastrophising (H20; β = 0.553) and neuroticism (H21; β = 0.214), indicating that they are risk factors. Instrumental support-seeking (H6) was also positively related to ΔPHQ 2020 (β = 0.282), which was opposite to our hypotheses. Our hypotheses regarding putting into perspective (H13), acceptance (H14), positive appraisal of the COVID-19 pandemic (H15), optimism (H18), and internal locus of control (H19), all hypothesized to be protective factors, could not be confirmed for ΔPHQ 2020.

Regarding ΔPHQ 2021, perceived good stress recovery (H16; β = -0.332) and optimism (H18; β = -0.139) were identified as protective factors presenting a negative association, whereas catastrophising (H20; β = 0.259) and neuroticism (H21; β = 0.355) showed positive associations indicating their role as risk factors. Again, instrumental support-seeking (H17) was positively related to ΔPHQ 2021 (β = 0.170), contrasting with our initial hypotheses. The other IVs were not significantly associated with ΔPHQ 2021.

As a control analysis, we investigated associations of the IVs with changes in psychological distress between two pre-pandemic survey waves (2016 and 2019). Here, optimism (β = -0.175) was a protective factor, and neuroticism (β = 0.421) a risk factor. All other IVs were not related to changes between the pre-pandemic survey waves.

Tables 1-3 display the beta coefficients for all ten IVs and covariates for ΔPHQ 2020, ΔPHQ 2021, and ΔPHQ 2019, respectively.

Table 1. Beta Coefficients and Standard Errors of Multiple Linear Regression Models (Outcome: ΔPHQ 2020)

	Base Model	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8	Model 9	Model 10
(Intercept)	0.155 (0.170)	0.155 (0.170)	0.153 (0.170)	0.131 (0.169)	0.151 (0.171)	0.132 (0.168)	0.230 (0.168)	0.207 (0.166)	0.178 (0.172)	0.145 (0.182)	0.145 (0.165)
PREAP		**-0.192 (0.053)****									
PERSP			-0.052 (0.055)								
ACC				-0.129 (0.050)							
PAC					-0.096 (0.046)						
SUPP						**0.282 (0.052)*****					
CATA							**0.553 (0.054)*****				
REC								**-0.473 (0.057)*****			
OPT									-0.057 (0.061)		
LOC										0.001 (0.003)	
NEU											**0.214 (0.053)****
Age: 18-24	0.750 (0.298)	0.732 (0.295)	0.755 (0.297)	0.750 (0.292)	0.738 (0.299)	0.642 (0.283)	0.778 (0.279)	0.735 (0.298)	0.742 (0.299)	0.737 (0.303)	0.744 (0.291)
Age: 25-34	0.454 (0.207)	0.449 (0.204)	0.460 (0.208)	0.459 (0.205)	0.454 (0.207)	0.421 (0.207)	0.498 (0.197)	0.441 (0.195)	0.452 (0.211)	0.449 (0.209)	0.459 (0.198)
Age: 35-44	0.112 (0.158)	0.118 (0.160)	0.115 (0.158)	0.110 (0.156)	0.106 (0.157)	0.076 (0.155)	0.149 (0.156)	0.088 (0.152)	0.114 (0.158)	0.110 (0.156)	0.102 (0.150)
Age: 55-64	0.114 (0.143)	0.097 (0.140)	0.114 (0.143)	0.119 (0.140)	0.105 (0.143)	0.129 (0.139)	0.085 (0.129)	0.119 (0.141)	0.103 (0.142)	0.114 (0.143)	0.142 (0.148)
Age: 65-74	-0.071 (0.170)	-0.091 (0.171)	-0.073 (0.170)	-0.056 (0.169)	-0.081 (0.169)	-0.018 (0.167)	-0.061 (0.168)	-0.034 (0.158)	-0.086 (0.173)	-0.069 (0.171)	-0.055 (0.162)

	Base Model	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8	Model 9	Model 10
Age: 75-84	0.035 (0.173)	0.022 (0.175)	0.037 (0.174)	0.055 (0.174)	0.021 (0.173)	0.060 (0.175)	-0.044 (0.170)	0.024 (0.168)	0.012 (0.176)	0.042 (0.182)	0.058 (0.185)
Age: 85+	0.460 (0.389)	0.474 (0.389)	0.464 (0.392)	0.475 (0.392)	0.456 (0.387)	0.479 (0.386)	0.208 (0.380)	0.463 (0.392)	0.444 (0.387)	0.465 (0.395)	0.487 (0.398)
Gender: female	0.248 (0.091)	**0.263 (0.090)***	**0.253 (0.090)***	**0.263 (0.091)***	**0.260 (0.090)***	0.247 (0.091)	0.172 (0.088)	0.151 (0.089)	0.248 (0.091)	0.251 (0.092)	0.200 (0.091)
Household net income: low	0.246 (0.122)	0.247 (0.122)	0.245 (0.122)	0.230 (0.123)	0.248 (0.122)	0.228 (0.122)	0.174 (0.119)	0.217 (0.118)	0.246 (0.122)	0.245 (0.122)	0.220 (0.123)
Household net income: high	-0.173 (0.115)	-0.159 (0.116)	-0.173 (0.115)	-0.178 (0.114)	-0.177 (0.115)	-0.175 (0.116)	-0.122 (0.114)	-0.113 (0.110)	-0.166 (0.112)	-0.174 (0.114)	-0.180 (0.119)
Education: low	0.184 (0.131)	0.162 (0.129)	0.189 (0.133)	0.175 (0.131)	0.182 (0.131)	0.214 (0.133)	0.087 (0.127)	0.159 (0.125)	0.188 (0.131)	0.183 (0.131)	0.173 (0.128)
Education: high	-0.005 (0.129)	0.013 (0.133)	0.001 (0.130)	0.013 (0.130)	-0.003 (0.130)	-0.014 (0.125)	0.071 (0.135)	0.028 (0.119)	-0.005 (0.129)	-0.006 (0.129)	0.006 (0.127)
History of diagnosed depression	**0.697 (0.203)****	**0.705 (0.202)****	**0.705 (0.202)****	**0.713 (0.202)****	**0.696 (0.202)****	**0.684 (0.200)****	**0.718 (0.186)****	**0.539 (0.189)***	**0.659 (0.201)***	**0.697 (0.203)****	**0.674 (0.202)****
COVID-19 risk group	-0.115 (0.106)	-0.128 (0.105)	-0.115 (0.106)	-0.108 (0.106)	-0.116 (0.106)	-0.094 (0.107)	-0.157 (0.107)	-0.156 (0.102)	-0.120 (0.105)	-0.114 (0.105)	-0.134 (0.103)
Lockdown	-0.055 (0.101)	-0.053 (0.100)	-0.062 (0.103)	-0.043 (0.103)	-0.041 (0.100)	-0.043 (0.102)	-0.099 (0.097)	-0.008 (0.095)	-0.054 (0.101)	-0.055 (0.101)	-0.054 (0.102)
Mean PHQ-4 2016/2019	**-1.087 (0.070)*****	**-1.096 (0.069)*****	**-1.087 (0.070)*****	**-1.092 (0.070)*****	**-1.092 (0.069)*****	**-1.091 (0.071)*****	**-1.140 (0.067)*****	**-1.147 (0.064)*****	**-1.096 (0.070)*****	**-1.087 (0.070)*****	**-1.174 (0.072)*****
R^2	0.217	0.224	0.217	0.220	0.219	0.232	0.279	0.262	0.218	0.217	0.231
ΔR^2	/	0.007	0	0.003	0.002	0.015	0.062	0.045	0.001	0	0.014
Observations	6657	6657	6657	6657	6657	6657	6657	6657	6657	6657	6657

Note: $^{***}p < 0.0001$; $^{**}p < 0.001$; $^{*}p < 0.005$ (due to Bonferroni correction). PREAP = positive reappraisal; PERSP = putting into perspective; ACC = acceptance; PAC = positive appraisal specific to the COVID-19 pandemic; SUPP = asking for instrumental support; CATA = catastrophising; REC = perceived stress recovery; OPT = optimism; LOC = locus of control; NEU = neuroticism. Parameter estimates of psychological factors and factor levels of covariates that significantly predicted ΔPHQ-4 2020 are displayed in bold for increased readability (from Riepenhausen et al., 2022, supplementary materials).

Table 2. Beta Coefficients and Standard Errors of Multiple Linear Regression Models (Outcome: ΔPHQ 2021)

	Base Model	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8	Model 9	Model 10
(Intercept)	-0.254 (0.145)	-0.255 (0.145)	-0.261 (0.144)	-0.260 (0.144)	-0.248 (0.145)	-0.250 (0.142)	-0.226 (0.144)	-0.192 (0.143)	-0.211 (0.146)	-0.238 (0.148)	-0.239 (0.142)
PREAP		-0.065 (0.038)									
PERSP			-0.052 (0.046)								
ACC				-0.076 (0.040)							
PAC					-0.116 (0.043)						
SUPP						**0.170 (0.044)****					
CATA							**0.259 (0.049)*****				
REC								**-0.332 (0.048)*****			
OPT									**-0.139 (0.046)***		
LOC										-0.001 (0.002)	
NEU											**0.255 (0.049)*****
Age: 18-24	**1.118 (0.293)****	**1.117 (0.294)****	**1.122 (0.294)****	**1.119 (0.291)****	**1.109 (0.294)****	**1.034 (0.285)****	**1.144 (0.290)*****	**1.126 (0.288)*****	**1.104 (0.294)****	**1.140 (0.299)****	**1.089 (0.286)****
Age: 25-34	0.408 (0.173)	0.409 (0.173)	0.414 (0.172)	0.409 (0.173)	0.409 (0.173)	0.371 (0.173)	0.439 (0.169)	0.405 (0.169)	0.409 (0.172)	0.416 (0.172)	0.406 (0.173)
Age: 35-44	0.326 (0.158)	0.330 (0.159)	0.329 (0.158)	0.324 (0.158)	0.315 (0.157)	0.304 (0.157)	0.356 (0.155)	0.306 (0.150)	0.331 (0.155)	0.330 (0.157)	0.317 (0.157)
Age: 55-64	-0.053 (0.139)	-0.054 (0.139)	-0.051 (0.139)	-0.048 (0.139)	-0.056 (0.140)	-0.048 (0.138)	-0.053 (0.135)	-0.033 (0.138)	-0.071 (0.135)	-0.052 (0.139)	-0.023 (0.146)
Age: 65-74	-0.108 (0.181)	-0.112 (0.181)	-0.109 (0.181)	-0.098 (0.182)	-0.115 (0.180)	-0.080 (0.179)	-0.100 (0.175)	-0.084 (0.173)	-0.136 (0.179)	-0.108 (0.181)	-0.106 (0.179)

	Base Model	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8	Model 9	Model 10
Age: 75-84	0.012 (0.162)	0.008 (0.162)	0.015 (0.161)	0.026 (0.162)	-0.005 (0.161)	0.022 (0.161)	-0.014 (0.161)	0.010 (0.158)	-0.040 (0.160)	0.002 (0.164)	0.028 (0.168)
Age: 85+	0.266 (0.253)	0.267 (0.251)	0.269 (0.250)	0.271 (0.252)	0.244 (0.247)	0.281 (0.254)	0.111 (0.260)	0.242 (0.252)	0.214 (0.260)	0.258 (0.255)	0.282 (0.249)
Gender: female	**0.486 (0.081)*****	**0.491 (0.081)*****	**0.491 (0.081)*****	**0.493 (0.081)*****	**0.498 (0.081)*****	**0.475 (0.081)*****	**0.442 (0.080)*****	**0.414 (0.081)*****	**0.493 (0.081)*****	**0.483 (0.081)*****	**0.412 (0.083)*****
Household net income: low	0.166 (0.116)	0.168 (0.116)	0.166 (0.115)	0.152 (0.117)	0.170 (0.115)	0.150 (0.115)	0.130 (0.113)	0.126 (0.112)	0.161 (0.114)	0.165 (0.116)	0.141 (0.112)
Household net income: high	-0.121 (0.098)	-0.117 (0.099)	-0.121 (0.098)	-0.121 (0.098)	-0.125 (0.098)	-0.125 (0.098)	-0.108 (0.097)	-0.098 (0.095)	-0.117 (0.098)	-0.120 (0.098)	-0.109 (0.097)
Education: low	0.052 (0.113)	0.044 (0.112)	0.058 (0.113)	0.047 (0.113)	0.052 (0.113)	0.061 (0.112)	0.005 (0.110)	0.036 (0.109)	0.060 (0.112)	0.053 (0.112)	0.046 (0.112)
Education: high	0.091 (0.114)	0.098 (0.115)	0.099 (0.116)	0.101 (0.115)	0.095 (0.114)	0.084 (0.112)	0.129 (0.115)	0.124 (0.109)	0.095 (0.116)	0.092 (0.114)	0.107 (0.109)
History of diagnosed depression	**1.063 (0.217)*****	**1.067 (0.218)*****	**1.072 (0.217)*****	**1.074 (0.217)*****	**1.063 (0.218)*****	**1.061 (0.218)*****	**1.082 (0.211)*****	**0.973 (0.209)*****	**0.982 (0.223)*****	**1.063 (0.218)*****	**1.012 (0.217)*****
COVID-19 risk group	-0.050 (0.104)	-0.057 (0.104)	-0.053 (0.104)	-0.049 (0.105)	-0.056 (0.104)	-0.032 (0.103)	-0.069 (0.102)	-0.085 (0.102)	-0.063 (0.102)	-0.051 (0.104)	-0.069 (0.104)
Mean PHQ-4 2016/2019	**-0.994 (0.062)*****	**-0.998 (0.062)*****	**-0.995 (0.062)*****	**-0.997 (0.062)*****	**-1.002 (0.061)*****	**-0.998 (0.062)*****	**-1.019 (0.061)*****	**-1.048 (0.061)*****	**-1.021 (0.062)*****	**-0.994 (0.062)*****	**-1.095 (0.060)*****
R^2	0.208	0.208	0.208	0.209	0.211	0.214	0.222	0.232	0.213	0.208	0.225
ΔR^2	/	0	0	0.001	0.003	0.006	0.004	0.014	0.005	0	0.017
Observations	5981	5981	5981	5981	5981	5981	5981	5981	5981	5981	5981

Note: $^{***}p < 0.0001$; $^{**}p < 0.001$; $^{*}p < 0.005$ (due to Bonferroni correction). PREAP = positive reappraisal; PERSP = putting into perspective; ACC = acceptance; PAC = positive appraisal specific to the COVID-19 pandemic; SUPP = asking for instrumental support; CATA = catastrophising; REC = perceived stress recovery; OPT = optimism; LOC = locus of control; NEU = neuroticism. Parameter estimates of psychological factors and factor levels of covariates that significantly predicted ΔPHQ-4 2021 are displayed in bold for increased readability (from Riepenhausen et al., 2022, supplementary materials).

Table 3. Beta Coefficients and Standard Errors of Multiple Linear Regression Models (Outcome: ΔPHQ 2019; Control Analyses)

	Base Model	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8	Model 9	Model 10
(Intercept)	**-0.886 (0.140)*****	**-0.885 (0.139)*****	**-0.881 (0.141)*****	**-0.891 (0.140)*****	**-0.879 (0.138)*****	**-0.890 (0.140)*****	**-0.874 (0.140)*****	**-0.859 (0.140)*****	**-0.805 (0.147)*****	**-0.886 (0.146)*****	**-0.874 (0.140)*****
PREAP		-0.057 (0.048)									
PERSP			0.045 (0.044)								
ACC				-0.035 (0.052)							
PAC					-0.109 (0.049)						
SUPP						0.064 (0.050)					
CATA							0.127 (0.049)				
REC								-0.141 (0.057)			
OPT									**-0.175 (0.051)***		
LOC										0.000 (0.002)	
NEU											**0.421 (0.060)*****
Age: 18-24	0.259 (0.277)	0.254 (0.276)	0.255 (0.278)	0.259 (0.277)	0.245 (0.275)	0.234 (0.281)	0.264 (0.280)	0.254 (0.275)	0.227 (0.276)	0.259 (0.283)	0.235 (0.273)
Age: 25-34	0.192 (0.177)	0.191 (0.177)	0.187 (0.177)	0.193 (0.176)	0.191 (0.176)	0.185 (0.178)	0.202 (0.175)	0.186 (0.179)	0.181 (0.178)	0.192 (0.175)	0.187 (0.169)
Age: 35-44	0.050 (0.143)	0.051 (0.143)	0.048 (0.143)	0.049 (0.142)	0.042 (0.141)	0.041 (0.144)	0.058 (0.144)	0.041 (0.142)	0.054 (0.142)	0.050 (0.143)	0.026 (0.156)
Age: 55-64	0.005 (0.129)	0.000 (0.129)	0.005 (0.129)	0.007 (0.128)	-0.005 (0.129)	0.009 (0.129)	-0.002 (0.128)	0.007 (0.129)	-0.032 (0.129)	0.005 (0.129)	0.060 (0.130)
Age: 65-74	-0.227 (0.130)	-0.233 (0.129)	-0.225 (0.130)	-0.223 (0.130)	-0.239 (0.130)	-0.215 (0.129)	-0.224 (0.130)	-0.216 (0.130)	-0.274 (0.133)	-0.227 (0.130)	-0.176 (0.129)

	Base Model	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8	Model 9	Model 10
Age: 75-84	-0.068 (0.193)	-0.072 (0.192)	-0.070 (0.194)	-0.063 (0.196)	-0.083 (0.194)	-0.062 (0.191)	-0.086 (0.194)	-0.072 (0.194)	-0.143 (0.208)	-0.068 (0.194)	-0.012 (0.176)
Age: 85+	-0.041 (0.255)	-0.037 (0.253)	-0.044 (0.256)	-0.036 (0.253)	-0.045 (0.253)	-0.036 (0.252)	-0.098 (0.258)	-0.040 (0.253)	-0.098 (0.272)	-0.041 (0.256)	0.024 (0.222)
Gender: female	0.175 (0.092)	0.180 (0.093)	0.171 (0.093)	0.179 (0.093)	0.188 (0.091)	0.175 (0.092)	0.157 (0.092)	0.145 (0.090)	0.173 (0.092)	0.175 (0.093)	0.066 (0.091)
Household net income: low	0.333 (0.132)	0.333 (0.131)	0.333 (0.132)	0.329 (0.130)	0.335 (0.131)	0.329 (0.132)	0.315 (0.132)	0.322 (0.132)	0.330 (0.129)	0.333 (0.131)	0.258 (0.123)
Household net income: high	-0.001 (0.109)	0.003 (0.110)	-0.001 (0.109)	-0.003 (0.108)	-0.005 (0.109)	-0.002 (0.109)	0.011 (0.110)	0.016 (0.109)	0.021 (0.109)	-0.001 (0.109)	-0.015 (0.105)
Education: low	0.006 (0.120)	-0.000 (0.120)	0.001 (0.120)	0.004 (0.120)	0.004 (0.119)	0.013 (0.121)	-0.016 (0.120)	-0.002 (0.120)	0.018 (0.122)	0.006 (0.120)	-0.015 (0.109)
Education: high	-0.140 (0.153)	-0.135 (0.151)	-0.145 (0.153)	-0.135 (0.149)	-0.138 (0.153)	-0.142 (0.150)	-0.121 (0.151)	-0.130 (0.151)	-0.140 (0.158)	-0.140 (0.152)	-0.113 (0.129)
History of diagnosed depression	**2.060 (0.229)*****	**2.061 (0.229)*****	**2.053 (0.230)*****	**2.064 (0.230)*****	**2.053 (0.227)*****	**2.056 (0.231)*****	**2.057 (0.230)*****	**2.002 (0.225)*****	**1.920 (0.226)*****	**2.060 (0.229)*****	**1.883 (0.219)*****
COVID-19 risk group	0.297 (0.116)	0.293 (0.117)	0.298 (0.117)	0.299 (0.115)	0.295 (0.116)	0.302 (0.117)	0.286 (0.117)	0.284 (0.115)	0.277 (0.121)	0.297 (0.116)	0.237 (0.097)
PHQ-4 2016	**-1.575 (0.075)*****	**-1.577 (0.076)*****	**-1.573 (0.075)*****	**-1.576 (0.076)*****	**-1.578 (0.075)*****	**-1.574 (0.075)*****	**-1.583 (0.075)*****	**-1.588 (0.077)*****	**-1.592 (0.074)*****	**-1.575 (0.075)*****	**-1.666 (0.071)*****
R^2	0.383	0.384	0.384	0.383	0.385	0.384	0.386	0.387	0.391	0.383	0.431
ΔR^2	/	0.001	0.001	0	0.002	0.001	0.003	0.004	0.008	0	0.048
Observations	6657	6657	6657	6657	6657	6657	6657	6657	6657	6657	6657

Note: $^{***}p < 0.0001$; $^{**}p < 0.001$; $^{*}p < 0.005$ (due to Bonferroni correction). PREAP = positive reappraisal; PERSP = putting into perspective; ACC = acceptance; PAC = positive appraisal specific to the COVID-19 pandemic; SUPP = asking for instrumental support; CATA = catastrophising; REC = perceived stress recovery; OPT = optimism; LOC = locus of control; NEU = neuroticism. Parameter estimates of psychological factors and factor levels of covariates that significantly predicted ΔPHQ-4 2019 are displayed in bold for increased readability (from Riepenhausen et al., 2022, supplementary materials).

3.2.4 LASSO Regularised Regressions: Relative Importance of IVs

LASSO regularised regression identified catastrophising, perceived good stress recovery, neuroticism, and instrumental support-seeking as the most influential factors for ΔPHQ 2020. Neuroticism, perceived good stress recovery, and catastrophising were the statistically most relevant predictors for ΔPHQ 2021. For ΔPHQ 2019, LASSO highlighted the role of neuroticism and optimism.

3.2.5 Specification Curve Analysis: Stability of Findings

Specification curve analysis revealed that small arbitrary changes in the model specification (e.g., using robust vs. linear regression) did not affect the results of the analyses.

3.2.6 Linear Mixed Models: Psychological Distress over Time

Results of the linear mixed models investigating the association of the IVs with raw PHQ-4 scores over the years are displayed in **Figure 5**.

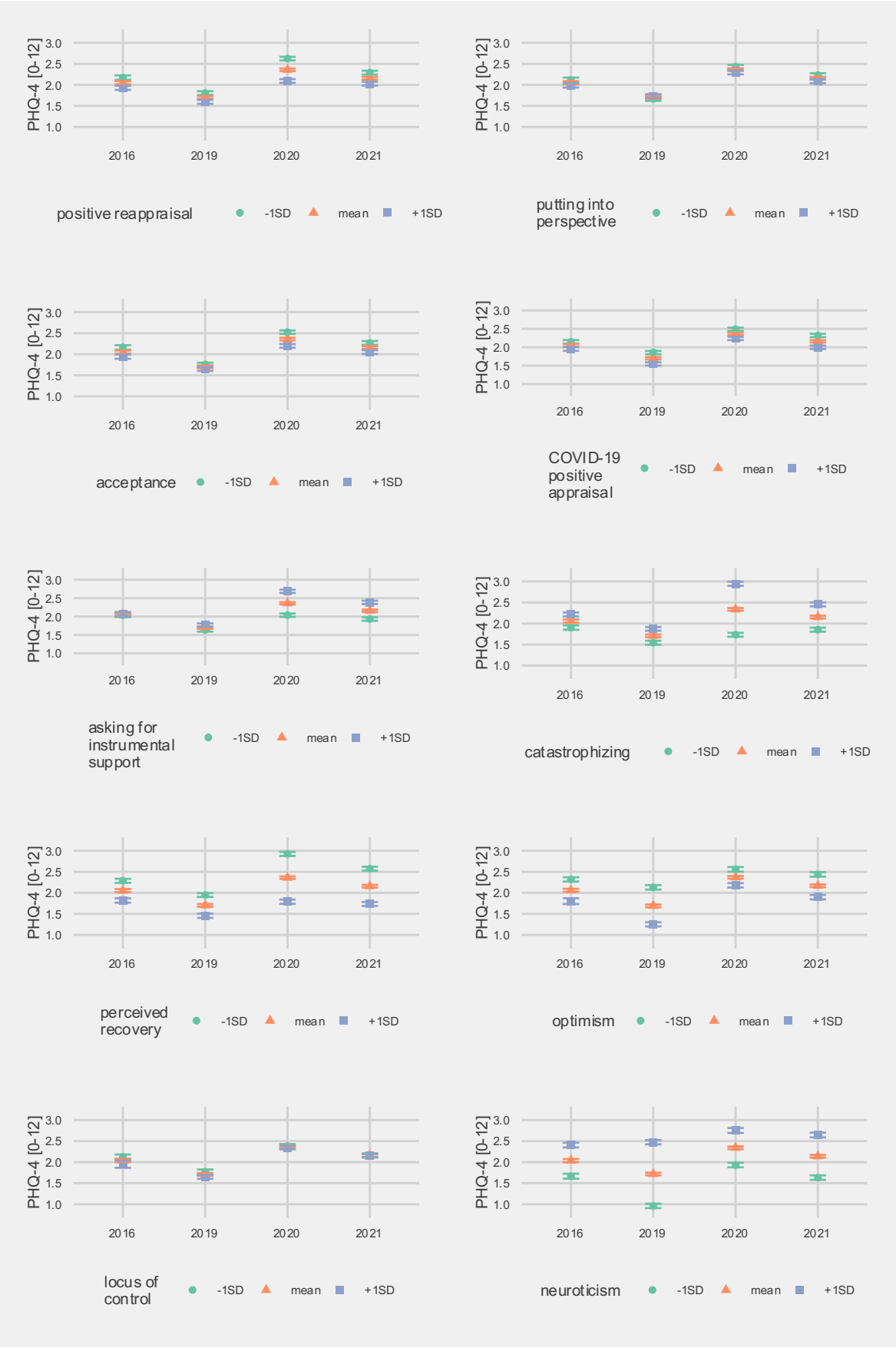

Figure 5. Results of the linear mixed models. Predicted levels for PHQ-4 are shown for the different years for hypothetical individuals displaying average levels in the respective IV (orange

triangles), or levels one standard deviation below (green circle) or above (violet square) the mean regarding the IV. *Note:* PHQ-4 = Patient Health Questionnaire, 4-item version; SD = standard deviation (this figure is identical to Figure S1 of Riepenhausen et al., 2022, supplementary materials).

4 Discussion

4.1 Summary of Results

Both studies presented above revealed higher levels of psychological distress during COVID-19 compared to average pre-pandemic levels in other samples (study 1) or to individual pre-pandemic levels in the same sample (study 2).

Study 1 identified several psycho-social factors associated with outcome resilience during COVID-19 in an international convenience sample. Perceived good stress recovery, positive appraisal specifically of the COVID-19 pandemic, optimism, perceived social support, general self-efficacy, perceived increase in social support during COVID-19, positive appraisal style, and behavioural coping were all identified as resilience factors, whereas neuroticism was a risk factor. These findings were all in line with the pre-registered hypotheses. Exploratory LASSO regularised regression revealed perceived good stress recovery and positive appraisal specifically of the COVID-19 pandemic to be the most important resilience factors, followed by neuroticism as a risk factor. Mediation analyses revealed that the association of perceived social support and resilience was mediated by positive appraisal style, which itself indirectly acted on resilience via perceived stress recovery, providing evidence supporting the PASTOR theory and insights into possible resilience mechanisms.

Study 2 investigated psychological factors associated with changes in mental health during COVID-19. Perceived good stress recovery emerged as the most important peri-pandemic protective factor, with positive reappraisal being an additional protective factor during the first wave of infections, and optimism being an additional protective factor during the second wave. Catastrophising and neuroticism were identified as peri-pandemic risk factors. These findings were in line with our expectations. Contrary to our hypotheses, however, asking for instrumental support was also related to higher increases or smaller decreases in psychological distress and all other investigated factors (putting into perspective, acceptance, locus of control, and positive appraisal specifically of the COVID-19 pandemic) were not related.

4.2 Interpretation and Embedding of Results into the Current State of Research

Our studies are in line with previous studies showing slightly higher levels of psychological distress during (the first waves of) the COVID-19 pandemic compared to before the pandemic (Daly et al., 2021; Dawel et al., 2020; Ettman et al., 2020; Peters et al., 2020; Pieh et al., 2020; Pierce et al., 2020; Sibley et al., 2020; Twenge & Joiner, 2020; Winkler et al., 2020). Whereas a meta-analysis found levels of psychological distress to recover over time (Robinson et al., 2021), we still observed elevated levels of psychological distress during our second peri-pandemic wave in Study 2. This discrepancy can most likely be explained by differences in timing: whereas the meta-analysis by Robinson and colleagues compared studies from March-April 2020 with those from May-July 2020, our first sampling time point covers March-June 2020, whereas the second one covers January-February 2021. While the summer of 2020 was a period of relatively low occurrence of infection, our second time point covers a period during which the second, much more severe, wave of COVID-19 was slowly starting to decline in Germany. It is thus to be expected that levels of psychological distress were higher during that period than during the summer of 2020. However, although the second wave was characterized by considerably higher levels of infections and hospitalizations compared to the first one (Robert Koch Institute, 2021), psychological distress at the second time point indeed was lower than in the spring of 2020. Possible explanations for this are on the one hand a habituation to the pandemic circumstances as well as an adjustment to the measures of physical distancing and other changes in daily life. On the other hand, more precise knowledge regarding the virus and the expectation of starting vaccination campaigns likely led to a reduced uncertainty of the situation, thus reducing its impact on mental health.

Although we had similar hypotheses in both studies, slightly different patterns emerged: whereas all hypotheses on resilience factors of study 1 were confirmed, only a subset of the hypothesized protective factors in study 2 were found to be significantly related to changes in mental health. One explanation that might easily come to mind is the smaller sample size and thus lower statistical power in study 2 (n=6,657 vs. n=15,790 in study 1). However, the small effect sizes indicate that this sample size difference is not the reason for the absence of a significant association. Rather, the difference in outcome might be the reason for the diverging findings. When investigating mental health in study 2, those factors that are conceptually closest to symptoms (e.g., catastrophising, neuroticism, perceived stress recovery) were the ones that were most strongly associated with

the outcome. Factors conceptually further away from symptoms (e.g., positive reappraisal, acceptance, optimism, locus of control) were by contrast either not related to the outcome at all, or only weaker and not for all outcomes. When the outcome is however more abstracted and not a direct representation of symptom severity (as in study 1, where outcome resilience is attained via a residualisation approach), other, more socio-cognitive, factors seem to be stronger predictors. This once more underlines the importance of considering stressor exposure instead of merely investigating mental health outcomes when interested in factors that are associated with individuals successfully dealing with adversity.

4.3 Strengths and Limitations

Although study 1 investigated a large international sample, the fact that it was a self-selected convenience sample recruited via a snowball-sampling method limits the generalisability of the results. Specifically, despite attempts to recruit as broadly as possible, our sample was predominantly female, highly educated, and German. Another very important limitation is the fact that study 1 is a cross-sectional study. All variables were assessed at the same time point, which can lead to an overestimation of effects (Allison, 2021). Baseline levels of mental health in the individual participants were unavailable, and changes were assessed retrospectively, thus possibly affected by memory biases. Besides, assessing resilience as the inverse of individual stressor reactivity at one single time point is only a single (potentially noisy) snapshot of an approximation of someone's resilience. The latest directions in resilience research propose to instead assess stressors and mental health outcomes at several points in time to yield individual stressor reactivity time courses, which are a more robust measure of resilience and moreover enable the investigation of dynamic resilience processes (Kalisch et al., 2021).

Nevertheless, study 1 offers a first mechanistic insight into possible resilience factors during the COVID-19 pandemic, which should be investigated in future longitudinal studies using representative samples.

Unlike study 1, study 2 does have the strength to use a representative sample that provides individual pre-pandemic baseline levels, and thus allows for a generalisation of the results to the German population. However, there are several limitations as well: while psychological distress was assessed multiple times, the IVs were not assessed at all survey waves. Firstly, this hinders disentangling the directionality between psychological

factors, psychological distress, and the context. Secondly, some of these factors were assessed several years apart from the outcomes: locus of control (2015 survey wave), neuroticism (2017 survey wave), and optimism (2019 survey wave) were assessed in pre-pandemic survey waves and therefore might have been outdated when assessing peri-pandemic outcomes. However, since these constructs are relatively stable (Cobb-Clark & Schurer, 2011; Cobb-Clark & Schurer, 2013; Scheier et al., 1994) we do not expect this to have majorly influenced the results. Moreover, factors assessed in the 2020 survey wave were included in the control analysis investigating changes in psychological distress between the 2016 and 2019 survey waves. While this does not make much sense from a prediction point of view, we decided to keep the model for the control analysis maximally similar to the peri-pandemic models to enable setting the peri-pandemic results into perspective. Another weakness of study 2 is the fact that single items instead of entire validated questionnaires were used to assess coping dimensions in 2020. While pragmatically necessary for reasons related to the length of the questionnaire battery, this likely limited statistical power.

Another important limitation is that we did not assess specific stressors in study 2 and are therefore unable to determine whether changes in psychological distress between time points can be fully attributed to the pandemic, let alone investigate outcome resilience. It is in general possible to draw some inferences regarding resilience from studies in which all participants experienced the same or a very similar stressful situation (see section 1.2.2). Thus, one could argue that some of the variance in psychological distress that is explained by stressor exposure is removed because all participants experienced the COVID-19 pandemic. However, given that COVID-19 affects several domains of life and individual participants likely experienced a variety of different sub-stressors (e.g., caring for one's children while working from home vs. losing one's job vs. losing a relative to COVID-19), the amount of variance that is still explained by differential stressor exposure is likely considerably large, and inferences regarding outcome resilience can thus not be drawn in Study 2.

Finally, a limitation that both studies share is the self-report nature of assessments which can lead to biases related to a lack of introspective ability, problems correctly understanding the wording of the questions and the used scales, as well as socially desirable reporting. Nevertheless, self-report assessments are widely used in psychological

research and it has been suggested that the above-mentioned issues are often less problematic than is repeatedly stated (Chan, 2008).

4.4 Implications for Practice and Future Research

Our hypotheses for both studies were based on prior research involving stressors that are different from a pandemic. The confirmation of these hypotheses therefore indicates that the psycho-social factors that we found to be related to resilience and/or changes in mental health during COVID-19 are global resilience factors that are protective in a variety of adverse circumstances. This means that the findings of our studies can inform research not only specific to the COVID-19 pandemic but related to adversity in general.

However, the studies reported above are only a first step to identify global resilience factors: we identified factors associated with resilience during COVID-19, but only in a cross-sectional sample, which is suboptimal in resilience research (for a detailed explanation of quality standards for resilience research see Kalisch et al., 2017). Although we then prospectively investigated the association of these factors with changes in psychological distress during COVID-19 in a longitudinal study, we here did not assess stressors and were thus unable to calculate outcome resilience. As mentioned above (see section 1.2.2), when interested in the protective nature of certain factors against the experience of adversity, investigating outcome resilience instead of mental health has the advantage that it prevents differences in the outcome to be trivially explained by differences in stressor exposure. An ideal study combining the advantages of both studies while omitting the flaws would be a longitudinal study with a thorough assessment of psychological factors of interest at baseline, followed by several measurement occasions of stressors and mental health outcome, which can be used to calculate a more robust outcome resilience and furthermore enables the investigation of resilience processes (for more details, see Kalisch et al., 2021). Moreover, when aiming to draw inferences regarding the general population, the sample should ideally be representative. Alternatively, one can investigate specific sub-populations at increased levels of stress (e.g., front-line health-care workers during COVID-19, university students during exam periods, soldiers during deployment), with the limitation that conclusions can then not be generalised to other populations. The latter approach might however be even more suitable when investigating resilience, given the prerequisite of experienced adversity.

Importantly, the identification of several potentially malleable psychological resilience/protective factors during times of hardship offers a starting point for interventions that are aimed at increasing resilience or well-being by strengthening these factors. For instance, perceived good stress recovery was the most important resilience/protective factor in both reported studies. Approaches to promote perceived stress recovery could for example include physical exercise in the nature (Wooller et al., 2018) or (smartphone-assisted) biofeedback (Hunter et al., 2019). Smartphone-based cognitive behavioural interventions (Ebert et al., 2017; Marciniak et al., 2020) have the potential to target changes in coping or emotion regulation (e.g., global positive appraisal style, or more specific strategies such as positive reappraisal or catastrophising tendencies). Finally, optimism can be increased by e.g. using the 'best possible self' intervention (Malouff & Schutte, 2017), and self-efficacy can be improved by interventions that are usually targeted at specific groups or specific contexts (Cepukiene et al., 2018; Craig et al., 2012; Nallapothula et al., 2020). Effects of such interventions on outcome resilience should be investigated in future randomized controlled trials.

5 Conclusions

The two studies presented above show that several psychological factors are associated with outcome resilience or protect against mental health deterioration during the COVID-19 pandemic. Identifying such conceivably malleable resilience factors is an important first step to inform evidence-based resilience interventions. The presented findings thus offer first insights for the development of specific interventions targeting perceived stress recovery, positive appraisal style, individual coping strategies including positive reappraisal or catastrophising, optimism, or general self-efficacy for the improvement of stress resilience.

Reference list

Agid, O., Kohn, Y., & Lerer, B. (2000). Environmental stress and psychiatric illness. *Biomedicine & Pharmacotherapy*, *54*(3), 135–141. https://doi.org/10.1016/S0753-3322(00)89046-0

Ahrens, K. F., Neumann, R. J., Kollmann, B., Brokelmann, J., von Werthern, N. M., Malyshau, A., Weichert, D., Lutz, B., Fiebach, C. J., Wessa, M., Kalisch, R., Plichta, M. M., Lieb, K., Tüscher, O., & Reif, A. (2021). Impact of COVID-19 lockdown on mental health in Germany: Longitudinal observation of different mental health trajectories and protective factors. *Translational Psychiatry*, *11*(1), 1–10. https://doi.org/10.1038/s41398-021-01508-2

Allison, P. (2021). *Fixed Effects Regression Models*. https://doi.org/10.4135/9781412993869

Amendola, S., Spensieri, V., Hengartner, M. P., & Cerutti, R. (2021). Mental health of Italian adults during COVID-19 pandemic. *British Journal of Health Psychology*, *26*(2), 644–656. https://doi.org/10.1111/bjhp.12502

Amerio, A., Lugo, A., Stival, C., Fanucchi, T., Gorini, G., Pacifici, R., Odone, A., Serafini, G., & Gallus, S. (2021). COVID-19 lockdown impact on mental health in a large representative sample of Italian adults. *Journal of Affective Disorders*, *292*, 398–404. https://doi.org/10.1016/j.jad.2021.05.117

Amstadter, A. B., Myers, J. M., & Kendler, K. S. (2014). Psychiatric resilience: Longitudinal twin study. *The British Journal of Psychiatry*, *205*(4), 275–280. https://doi.org/10.1192/bjp.bp.113.130906

Arima, M., Takamiya, Y., Furuta, A., Siriratsivawong, K., Tsuchiya, S., & Izumi, M. (2020). Factors associated with the mental health status of medical students during the COVID-19 pandemic: A cross-sectional study in Japan. *BMJ Open*, *10*(12), e043728. https://doi.org/10.1136/bmjopen-2020-043728

Badellino, H., Gobbo, M. E., Torres, E., & Aschieri, M. E. (2021). Early indicators and risk factors associated with mental health problems during COVID-19 quarantine: Is there a relationship with the number of confirmed cases and deaths? *International Journal of Social Psychiatry*, *67*(5), 567–575. https://doi.org/10.1177/0020764020966020

Baron, R. M., & Kenny, D. A. (1986). The moderator–mediator variable distinction in social psychological research: Conceptual, strategic, and statistical considerations. *Journal of Personality and Social Psychology*, *51*(6), 1173–1182. https://doi.org/10.1037/0022-3514.51.6.1173

Barzilay, R., Moore, T. M., Greenberg, D. M., DiDomenico, G. E., Brown, L. A., White, L. K., Gur, R. C., & Gur, R. E. (2020). Resilience, COVID-19-related stress, anxiety and depression during the pandemic

in a large population enriched for healthcare providers. *Translational Psychiatry*, *10*(1), 1–8. https://doi.org/10.1038/s41398-020-00982-4

Batterham, P. J., Calear, A. L., McCallum, S. M., Morse, A. R., Banfield, M., Farrer, L. M., Gulliver, A., Cherbuin, N., Rodney Harris, R. M., Shou, Y., & Dawel, A. (2021). Trajectories of depression and anxiety symptoms during the COVID-19 pandemic in a representative Australian adult cohort. *Medical Journal of Australia*, *214*(10), 462–468. https://doi.org/10.5694/mja2.51043

Bendau, A., Plag, J., Kunas, S., Wyka, S., Ströhle, A., & Petzold, M. B. (2021). Longitudinal changes in anxiety and psychological distress, and associated risk and protective factors during the first three months of the COVID-19 pandemic in Germany. *Brain and Behavior*, *11*(2), e01964. https://doi.org/10.1002/brb3.1964

Bonanno, G. A., Romero, S. A., & Klein, S. I. (2015). The Temporal Elements of Psychological Resilience: An Integrative Framework for the Study of Individuals, Families, and Communities. *Psychological Inquiry*, *26*(2), 139–169. https://doi.org/10.1080/1047840X.2015.992677

Bonanno, G. A., Westphal, M., & Mancini, A. D. (2011). Resilience to Loss and Potential Trauma. *Annual Review of Clinical Psychology*, *7*(1), 511–535. https://doi.org/10.1146/annurev-clinpsy-032210-104526

Bozdağ, F., & Ergün, N. (2021). Psychological Resilience of Healthcare Professionals During COVID-19 Pandemic. *Psychological Reports*, *124*(6), 2567–2586. https://doi.org/10.1177/0033294120965477

Budimir, S., Probst, T., & Pieh, C. (2021). Coping strategies and mental health during COVID-19 lockdown. *Journal of Mental Health*, *30*(2), 156–163. https://doi.org/10.1080/09638237.2021.1875412

Buuren, S. van, & Groothuis-Oudshoorn, K. (2011). mice: Multivariate Imputation by Chained Equations in R. *Journal of Statistical Software*, *45*(1), 1–67. https://doi.org/10.18637/jss.v045.i03

Carver, C. S. (1997). You want to measure coping but your protocol' too long: Consider the brief cope. *International Journal of Behavioral Medicine*, *4*(1), 92. https://doi.org/10.1207/s15327558ijbm0401_6

Cepukiene, V., Pakrosnis, R., & Ulinskaite, G. (2018). Outcome of the solution-focused self-efficacy enhancement group intervention for adolescents in foster care setting. *Children and Youth Services Review*, *88*, 81–87. https://doi.org/10.1016/j.childyouth.2018.03.004

Chan, D. (2008). So Why Ask Me? Are Self-Report Data Really That Bad? In *Statistical and Methodological Myths and Urban Legends*. Routledge.

Chmitorz, A., Kurth, K., Mey, L. K., Wenzel, M., Lieb, K., Tüscher, O., Kubiak, T., & Kalisch, R. (2020). Assessment of Microstressors in Adults: Questionnaire Development and Ecological Validation of the Mainz Inventory of Microstressors. *JMIR Mental Health*, *7*(2), e14566. https://doi.org/10.2196/14566

Chmitorz, A., Neumann, R. J., Kollmann, B., Ahrens, K. F., Öhlschläger, S., Goldbach, N., Weichert, D., Schick, A., Lutz, B., Plichta, M. M., Fiebach, C. J., Wessa, M., Kalisch, R., Tüscher, O., Lieb, K., & Reif, A. (2021). Longitudinal determination of resilience in humans to identify mechanisms of resilience to modern-life stressors: The longitudinal resilience assessment (LORA) study. *European Archives of Psychiatry and Clinical Neuroscience*, *271*(6), 1035–1051. https://doi.org/10.1007/s00406-020-01159-2

Chmitorz, A., Wenzel, M., Stieglitz, R.-D., Kunzler, A., Bagusat, C., Helmreich, I., Gerlicher, A., Kampa, M., Kubiak, T., Kalisch, R., Lieb, K., & Tüscher, O. (2018). Population-based validation of a German version of the Brief Resilience Scale. *PLOS ONE*, *13*(2), e0192761. https://doi.org/10.1371/journal.pone.0192761

Chrousos, G. P. (2009). Stress and disorders of the stress system. *Nature Reviews Endocrinology*, *5*(7), 374–381. https://doi.org/10.1038/nrendo.2009.106

Cobb-Clark, D. A., & Schurer, S. (2011). *The Stability of Big-Five Personality Traits* (SSRN Scholarly Paper ID 1919414). Social Science Research Network. https://doi.org/10.2139/ssrn.1919414

Cobb-Clark, D. A., & Schurer, S. (2013). Two Economists' Musings on the Stability of Locus of Control. *The Economic Journal*, *123*(570), F358–F400. https://doi.org/10.1111/ecoj.12069

Cochrane, R., & Robertson, A. (1973). The Life Events Inventory: A measure of the relative severity of psycho-social stressors. *Journal of Psychosomatic Research*, *17*(2), 135–139. https://doi.org/10.1016/0022-3999(73)90014-7

Connor, K. M., & Davidson, J. R. T. (2003). Development of a new resilience scale: The Connor-Davidson Resilience Scale (CD-RISC). *Depression and Anxiety*, *18*(2), 76–82. https://doi.org/10.1002/da.10113

Conversano, C., Di Giuseppe, M., Miccoli, M., Ciacchini, R., Gemignani, A., & Orrù, G. (2020). Mindfulness, Age and Gender as Protective Factors Against Psychological Distress During COVID-19 Pandemic. *Frontiers in Psychology*, *11*, 1900. https://doi.org/10.3389/fpsyg.2020.01900

Craig, S. L., McInroy, L., Austin, A., Smith, M., & Engle, B. (2012). Promoting Self-Efficacy and Self-Esteem for Multiethnic Sexual Minority Youth: An Evidence-Informed Intervention. *Journal of Social Service Research*, *38*(5), 688–698. https://doi.org/10.1080/01488376.2012.718194

Daly, M., & Robinson, E. (2020). Psychological distress and adaptation to the COVID-19 crisis in the United States. *Journal of Psychiatric Research*. https://doi.org/10.1016/j.jpsychires.2020.10.035

Daly, M., Sutin, A. R., & Robinson, E. (2020). Longitudinal changes in mental health and the COVID-19 pandemic: Evidence from the UK Household Longitudinal Study. *Psychological Medicine*, 1–10. https://doi.org/10.1017/S0033291720004432

Daly, M., Sutin, A. R., & Robinson, E. (2021). Depression reported by US adults in 2017-2018 and March and April 2020. *Journal of Affective Disorders*, *278*, 131–135. https://doi.org/10.1016/j.jad.2020.09.065

Dawel, A., Shou, Y., Smithson, M., Cherbuin, N., Banfield, M., Calear, A. L., Farrer, L. M., Gray, D., Gulliver, A., Housen, T., McCallum, S. M., Morse, A. R., Murray, K., Newman, E., Rodney Harris, R. M., & Batterham, P. J. (2020). The Effect of COVID-19 on Mental Health and Wellbeing in a Representative Sample of Australian Adults. *Frontiers in Psychiatry*, *11*, 579985. https://doi.org/10.3389/fpsyt.2020.579985

Dawson, D. L., & Golijani-Moghaddam, N. (2020). COVID-19: Psychological flexibility, coping, mental health, and wellbeing in the UK during the pandemic. *Journal of Contextual Behavioral Science*, *17*, 126–134. https://doi.org/10.1016/j.jcbs.2020.07.010

Ebert, D. D., Cuijpers, P., Muñoz, R. F., & Baumeister, H. (2017). Prevention of Mental Health Disorders Using Internet- and Mobile-Based Interventions: A Narrative Review and Recommendations for Future Research. *Frontiers in Psychiatry*, *8*. https://doi.org/10.3389/fpsyt.2017.00116

Essangri, H., Sabir, M., Benkabbou, A., Majbar, M. A., Amrani, L., Ghannam, A., Lekehal, B., Mohsine, R., & Souadka, A. (2021). Predictive Factors for Impaired Mental Health among Medical Students during the Early Stage of the COVID-19 Pandemic in Morocco. *The American Journal of Tropical Medicine and Hygiene*, *104*(1), 95–102. https://doi.org/10.4269/ajtmh.20-1302

Ettman, C. K., Abdalla, S. M., Cohen, G. H., Sampson, L., Vivier, P. M., & Galea, S. (2020). Prevalence of Depression Symptoms in US Adults Before and During the COVID-19 Pandemic. *JAMA Network Open*, *3*(9), e2019686. https://doi.org/10.1001/jamanetworkopen.2020.19686

Every-Palmer, S., Jenkins, M., Gendall, P., Hoek, J., Beaglehole, B., Bell, C., Williman, J., Rapsey, C., & Stanley, J. (2020). Psychological distress, anxiety, family violence, suicidality, and wellbeing in New Zealand during the COVID-19 lockdown: A cross-sectional study. *PloS One*, *15*(11), e0241658. https://doi.org/10.1371/journal.pone.0241658

Fernández, R. S., Crivelli, L., Guimet, N. M., Allegri, R. F., & Pedreira, M. E. (2020). Psychological distress associated with COVID-19 quarantine: Latent profile analysis, outcome prediction and mediation analysis. *Journal of Affective Disorders*, *277*, 75–84. https://doi.org/10.1016/j.jad.2020.07.133

Fiorenzato, E., Zabberoni, S., Costa, A., & Cona, G. (2021). Cognitive and mental health changes and their vulnerability factors related to COVID-19 lockdown in Italy. *PLOS ONE*, *16*(1), e0246204. https://doi.org/10.1371/journal.pone.0246204

First, M. B. (2015). Structured Clinical Interview for the DSM (SCID). In *The Encyclopedia of Clinical Psychology* (pp. 1–6). John Wiley & Sons, Ltd. https://doi.org/10.1002/9781118625392.wbecp351

Flesia, L., Monaro, M., Mazza, C., Fietta, V., Colicino, E., Segatto, B., & Roma, P. (2020). Predicting Perceived Stress Related to the Covid-19 Outbreak through Stable Psychological Traits and Machine Learning Models. *Journal of Clinical Medicine*, *9*(10), 3350. https://doi.org/10.3390/jcm9103350

Friedman, J., Hastie, T., & Tibshirani, R. (2010). Regularization Paths for Generalized Linear Models via Coordinate Descent. *Journal of Statistical Software*, *33*(1). https://doi.org/10.18637/jss.v033.i01

Garnefski, N., & Kraaij, V. (2006). Cognitive emotion regulation questionnaire – development of a short 18-item version (CERQ-short). *Personality and Individual Differences*, *41*(6), 1045–1053. https://doi.org/10.1016/j.paid.2006.04.010

Gijzen, M., Shields-Zeeman, L., Kleinjan, M., Kroon, H., van der Roest, H., Bolier, L., Smit, F., & de Beurs, D. (2020). The Bittersweet Effects of COVID-19 on Mental Health: Results of an Online Survey among a Sample of the Dutch Population Five Weeks after Relaxation of Lockdown Restrictions. *International Journal of Environmental Research and Public Health*, *17*(23). https://doi.org/10.3390/ijerph17239073

Gilleen, J., Santaolalla, A., Valdearenas, L., Salice, C., & Fusté, M. (2021). Impact of the COVID-19 pandemic on the mental health and well-being of UK healthcare workers. *BJPsych Open*, *7*(3). https://doi.org/10.1192/bjo.2021.42

Goebel, J., Grabka, M. M., Liebig, S., Kroh, M., Richter, D., Schröder, C., & Schupp, J. (2019). The German Socio-Economic Panel (SOEP). *Jahrbücher Für Nationalökonomie Und Statistik*, *239*(2), 345–360. https://doi.org/10.1515/jbnst-2018-0022

Goldberg, D. P., Gater, R., Sartorius, N., Ustun, T. B., Piccinelli, M., Gureje, O., & Rutter, C. (1997). The validity of two versions of the GHQ in the WHO study of mental illness in general health care. *Psychological Medicine*, *27*(1), 191–197. https://doi.org/10.1017/S0033291796004242

Goldberg, D. P., & Hillier, V. F. (1979). A scaled version of the General Health Questionnaire. *Psychological Medicine*, *9*(1), 139–145. https://doi.org/10.1017/S0033291700021644

Gu, J., Zhong, Y., Hao, Y., Zhou, D., Tsui, H., Hao, C., Gao, Q., Ling, W., & Lau, J. T. F. (2015). Preventive Behaviors and Mental Distress in Response to H1N1 Among University Students in Guangzhou, China. *Asia Pacific Journal of Public Health*, *27*(2), NP1867–NP1879. https://doi.org/10.1177/1010539512443699

Hahn, E., Gottschling, J., & Spinath, F. M. (2012). Short measurements of personality – Validity and reliability of the GSOEP Big Five Inventory (BFI-S). *Journal of Research in Personality*, *46*(3), 355–359. https://doi.org/10.1016/j.jrp.2012.03.008

Hastie, T., Tibshirani, R., & Wainwright, M. (2015). *Statistical Learning with Sparsity: The Lasso and Generalizations*. CRC Press.

Havnen, A., Anyan, F., Hjemdal, O., Solem, S., Gurigard Riksfjord, M., & Hagen, K. (2020). Resilience Moderates Negative Outcome from Stress during the COVID-19 Pandemic: A Moderated-Mediation Approach. *International Journal of Environmental Research and Public Health*, *17*(18), 6461. https://doi.org/10.3390/ijerph17186461

Hennein, R., Mew, E. J., & Lowe, S. R. (2021). Socio-ecological predictors of mental health outcomes among healthcare workers during the COVID-19 pandemic in the United States. *PLOS ONE*, *16*(2), e0246602. https://doi.org/10.1371/journal.pone.0246602

Holingue, C., Badillo-Goicoechea, E., Riehm, K. E., Veldhuis, C. B., Thrul, J., Johnson, R. M., Fallin, M. D., Kreuter, F., Stuart, E. A., & Kalb, L. G. (2020). Mental distress during the COVID-19 pandemic among US adults without a pre-existing mental health condition: Findings from American trend panel survey. *Preventive Medicine*, *139*, 106231. https://doi.org/10.1016/j.ypmed.2020.106231

Holman, E. A., Thompson, R. R., Garfin, D. R., & Silver, R. C. (2020). The unfolding COVID-19 pandemic: A probability-based, nationally representative study of mental health in the United States. *Science Advances*, *6*(42). https://doi.org/10.1126/sciadv.abd5390

Hubbard, G., den Daas, C., Johnston, M., & Dixon, D. (2021). Sociodemographic and Psychological Risk Factors for Anxiety and Depression: Findings from the Covid-19 Health and Adherence Research in Scotland on Mental Health (CHARIS-MH) Cross-sectional Survey. *International Journal of Behavioral Medicine*, *28*(6), 788–800. https://doi.org/10.1007/s12529-021-09967-z

Hunter, J. F., Olah, M. S., Williams, A. L., Parks, A. C., & Pressman, S. D. (2019). Effect of Brief Biofeedback via a Smartphone App on Stress Recovery: Randomized Experimental Study. *JMIR Serious Games*, *7*(4), e15974. https://doi.org/10.2196/15974

Hyland, P., Shevlin, M., McBride, O., Murphy, J., Karatzias, T., Bentall, R. P., Martinez, A., & Vallières, F. (2020). Anxiety and depression in the Republic of Ireland during the COVID-19 pandemic. *Acta Psychiatrica Scandinavica*, *142*(3), 249–256. https://doi.org/10.1111/acps.13219

Jalloh, M. F., Li, W., Bunnell, R. E., Ethier, K. A., O'Leary, A., Hageman, K. M., Sengeh, P., Jalloh, M. B., Morgan, O., Hersey, S., Marston, B. J., Dafae, F., & Redd, J. T. (2018). Impact of Ebola experiences and risk perceptions on mental health in Sierra Leone, July 2015. *BMJ Global Health*, *3*(2), e000471. https://doi.org/10.1136/bmjgh-2017-000471

Kalisch, R., Baker, D. G., Basten, U., Boks, M. P., Bonanno, G. A., Brummelman, E., Chmitorz, A., Fernàndez, G., Fiebach, C. J., Galatzer-Levy, I., Geuze, E., Groppa, S., Helmreich, I., Hendler, T., Hermans, E. J., Jovanovic, T., Kubiak, T., Lieb, K., Lutz, B., Müller, M. B., Murray, R. J., Nievergelt, C. M., Reif, A., Roelofs, K., Rutten, B. P. F., Sander, D., Schick, A., Tüscher, O., Diest, I. V., Harmelen, A.-L. van, Veer, I. M., Vermetten, E., Vinkers, C. H., Wager, T. D., Walter, H., Wessa, M., Wibral, M., & Kleim, B. (2017). The resilience framework as a strategy to combat stress-related disorders. *Nature Human Behaviour*, *1*(11), 784–790. https://doi.org/10.1038/s41562-017-0200-8

Kalisch, R., Köber, G., Binder, H., Ahrens, K. F., Basten, U., Chmitorz, A., Choi, K. W., Fiebach, C. J., Goldbach, N., Neumann, R. J., Kampa, M., Kollmann, B., Lieb, K., Plichta, M. M., Reif, A., Schick, A., Sebastian, A., Walter, H., Wessa, M., Yuen, K. S. L., Tüscher, O., & Engen, H. (2021). The Frequent Stressor and Mental Health Monitoring-Paradigm: A Proposal for the Operationalization and Measurement of Resilience and the Identification of Resilience Processes in Longitudinal

Observational Studies. *Frontiers in Psychology*, *12*. https://www.frontiersin.org/article/10.3389/fpsyg.2021.710493

Kalisch, R., Müller, M. B., & Tüscher, O. (2015). A conceptual framework for the neurobiological study of resilience. *Behavioral and Brain Sciences*, *38*. https://doi.org/10.1017/S0140525X1400082X

Kampa, M., Schick, A., Yuen, K., Sebastian, A., Chmitorz, A., Saase, V., Wessa, M., Tüscher, O., & Kalisch, R. (2018). *A Combined Behavioral and Neuroimaging Battery to Test Positive Appraisal Style Theory of Resilience in Longitudinal Studies* (p. 470435). https://doi.org/10.1101/470435

Killgore, W. D. S., Taylor, E. C., Cloonan, S. A., & Dailey, N. S. (2020). Psychological resilience during the COVID-19 lockdown. *Psychiatry Research*, *291*, 113216. https://doi.org/10.1016/j.psychres.2020.113216

Kim, S.-W., Park, I.-H., Kim, M., Park, A.-L., Jhon, M., Kim, J.-W., Kang, H.-J., Ryu, S., Lee, J.-Y., & Kim, J.-M. (2021). Risk and protective factors of depression in the general population during the COVID-19 epidemic in Korea. *BMC Psychiatry*, *21*(1), 445. https://doi.org/10.1186/s12888-021-03449-y

Kimhi, S., Marciano, H., Eshel, Y., & Adini, B. (2020). Resilience and demographic characteristics predicting distress during the COVID-19 crisis. *Social Science & Medicine*, *265*, 113389. https://doi.org/10.1016/j.socscimed.2020.113389

Kornilaki, E. N. (2022). The psychological effect of COVID-19 quarantine on Greek young adults: Risk factors and the protective role of daily routine and altruism. *International Journal of Psychology*, *57*(1), 33–42. https://doi.org/10.1002/ijop.12767

Kroenke, K., Spitzer, R. L., & Williams, J. B. W. (2001). The PHQ-9. *Journal of General Internal Medicine*, *16*(9), 606–613. https://doi.org/10.1046/j.1525-1497.2001.016009606.x

Kroenke, K., Spitzer, R. L., Williams, J. B. W., & Löwe, B. (2009). An Ultra-Brief Screening Scale for Anxiety and Depression: The PHQ–4. *Psychosomatics*, *50*(6), 613–621. https://doi.org/10.1016/S0033-3182(09)70864-3

Kroh, M. (2009). *Short-Documentation of the Update of the SOEP-Weights, 1984–2008*. DIW Berlin.

Kühne, S., Kroh, M., Liebig, S., & Zinn, S. (2020). The Need for Household Panel Surveys in Times of Crisis: The Case of SOEP-CoV. *Survey Research Methods*, *14*(2), 195–203. https://doi.org/10.18148/srm/2020.v14i2.7748

Lau, J. T., Griffiths, S., Choi, K. C., & Tsui, H. Y. (2010). Avoidance behaviors and negative psychological responses in the general population in the initial stage of the H1N1 pandemic in Hong Kong. *BMC Infectious Diseases*, *10*(1), 139. https://doi.org/10.1186/1471-2334-10-139

Lee, A. M., Wong, J. G., McAlonan, G. M., Cheung, V., Cheung, C., Sham, P. C., Chu, C.-M., Wong, P.-C., Tsang, K. W., & Chua, S. E. (2007). Stress and Psychological Distress among SARS Survivors 1 Year after the Outbreak. *The Canadian Journal of Psychiatry*, *52*(4), 233–240. https://doi.org/10.1177/070674370705200405

Li, L. Z., & Wang, S. (2020). Prevalence and predictors of general psychiatric disorders and loneliness during COVID-19 in the United Kingdom. *Psychiatry Research*, *291*, 113267. https://doi.org/10.1016/j.psychres.2020.113267

Liebig, S., Goebel, J., Kroh, M., Schröder, C., Grabka, M. M., Schupp, J., Bartels, C., Fedorets, A., Franken, A., Jacobsen, J., Kara, S., Krause, P., Kröger, H., Metzing, M., Richter, D., Schacht, D., Schmelzer, P., Schmitt, C., Schnitzlein, D., Siegers, R., Wenzig, K., & Zimmermann, S. (2019). *Socio-Economic Panel (SOEP), data from 1984-2018, version 35*. https://doi.org/10.5684/soep-core.v35

Löwe, B., Wahl, I., Rose, M., Spitzer, C., Glaesmer, H., Wingenfeld, K., Schneider, A., & Brähler, E. (2010). A 4-item measure of depression and anxiety: Validation and standardization of the Patient Health Questionnaire-4 (PHQ-4) in the general population. *Journal of Affective Disorders*, *122*(1), 86–95. https://doi.org/10.1016/j.jad.2009.06.019

Lüdecke, D., Aust, F., Crawley, S., & Ben-Shachar, M. S. (2021). *ggeffects: Create Tidy Data Frames of Marginal Effects for "ggplot" from Model Outputs* (1.1.1). https://CRAN.R-project.org/package=ggeffects

Malouff, J. M., & Schutte, N. S. (2017). Can psychological interventions increase optimism? A meta-analysis. *The Journal of Positive Psychology*, *12*(6), 594–604. https://doi.org/10.1080/17439760.2016.1221122

Marciniak, M. A., Shanahan, L., Rohde, J., Schulz, A., Wackerhagen, C., Kobylińska, D., Tuescher, O., Binder, H., Walter, H., Kalisch, R., & Kleim, B. (2020). Standalone Smartphone Cognitive Behavioral Therapy–Based Ecological Momentary Interventions to Increase Mental Health: Narrative Review. *JMIR MHealth and UHealth*, *8*(11), e19836. https://doi.org/10.2196/19836

McCracken, L. M., Badinlou, F., Buhrman, M., & Brocki, K. C. (2020). The Role of Psychological Flexibility in the Context of COVID-19: Associations with Depression, Anxiety, and Insomnia. *Journal of Contextual Behavioral Science*. https://doi.org/10.1016/j.jcbs.2020.11.003

McElroy-Heltzel, S. E., Shannonhouse, L. R., Davis, E. B., Lemke, A. W., Mize, M. C., Aten, J., Fullen, M. C., Hook, J. N., Van Tongeren, D. R., Davis, D. E., & Miskis, C. (2022). Resource loss and mental health during COVID-19: Psychosocial protective factors among U.S. older adults and those with chronic disease. *International Journal of Psychology*, *57*(1), 127–135. https://doi.org/10.1002/ijop.12798

McPherson, K. E., McAloney-Kocaman, K., McGlinchey, E., Faeth, P., & Armour, C. (2021). Longitudinal analysis of the UK COVID-19 Psychological Wellbeing Study: Trajectories of anxiety, depression and COVID-19-related stress symptomology. *Psychiatry Research*, *304*, 114138. https://doi.org/10.1016/j.psychres.2021.114138

Menninger, K. A. (1919). PSYCHOSES ASSOCIATED WITH INFLUENZA: I. GENERAL DATA: STATISTICAL ANALYSIS. *Journal of the American Medical Association*, *72*(4), 235–241. https://doi.org/10.1001/jama.1919.02610040001001

Moccia, L., Janiri, D., Pepe, M., Dattoli, L., Molinaro, M., De Martin, V., Chieffo, D., Janiri, L., Fiorillo, A., Sani, G., & Di Nicola, M. (2020). Affective temperament, attachment style, and the psychological impact of the COVID-19 outbreak: An early report on the Italian general population. *Brain, Behavior, and Immunity*, *87*, 75–79. https://doi.org/10.1016/j.bbi.2020.04.048

Nallapothula, D., Lozano, J. B., Han, S., Herrera, C., Sayson, H. W., Levis-Fitzgerald, M., & Maloy, J. (2020). M-LoCUS: A Scalable Intervention Enhances Growth Mindset and Internal Locus of Control in Undergraduate Students in STEM. *Journal of Microbiology & Biology Education*, *21*(2). https://doi.org/10.1128/jmbe.v21i2.1987

Niedzwiedz, C. L., Green, M. J., Benzeval, M., Campbell, D., Craig, P., Demou, E., Leyland, A., Pearce, A., Thomson, R., Whitley, E., & Katikireddi, S. V. (2020). Mental health and health behaviours before and during the initial phase of the COVID-19 lockdown: Longitudinal analyses of the UK Household Longitudinal Study. *Journal of Epidemiology and Community Health*. https://doi.org/10.1136/jech-2020-215060

O'Connor, R. C., Wetherall, K., Cleare, S., McClelland, H., Melson, A. J., Niedzwiedz, C. L., O'Carroll, R. E., O'Connor, D. B., Platt, S., Scowcroft, E., Watson, B., Zortea, T., Ferguson, E., & Robb, K. A.

(2021). Mental health and well-being during the COVID-19 pandemic: Longitudinal analyses of adults in the UK COVID-19 Mental Health & Wellbeing study. *The British Journal of Psychiatry*, *218*(6), 326–333. https://doi.org/10.1192/bjp.2020.212

Osimo, S. A., Aiello, M., Gentili, C., Ionta, S., & Cecchetto, C. (2021). The Influence of Personality, Resilience, and Alexithymia on Mental Health During COVID-19 Pandemic. *Frontiers in Psychology*, *12*. https://www.frontiersin.org/article/10.3389/fpsyg.2021.630751

Peters, A., Rospleszcz, S., Greiser, K. H., Dallavalle, M., & Berger, K. (2020). The Impact of the COVID-19 Pandemic on Self-Reported Health. *Deutsches Aerzteblatt Online*. https://doi.org/10.3238/arztebl.2020.0861

Pieh, C., Budimir, S., & Probst, T. (2020). The effect of age, gender, income, work, and physical activity on mental health during coronavirus disease (COVID-19) lockdown in Austria. *Journal of Psychosomatic Research*, *136*, 110186. https://doi.org/10.1016/j.jpsychores.2020.110186

Pierce, M., Hope, H., Ford, T., Hatch, S., Hotopf, M., John, A., Kontopantelis, E., Webb, R., Wessely, S., McManus, S., & Abel, K. M. (2020). Mental health before and during the COVID-19 pandemic: A longitudinal probability sample survey of the UK population. *The Lancet Psychiatry*, *7*(10), 883–892. https://doi.org/10.1016/S2215-0366(20)30308-4

Pietrzak, R. H., Feingold, J. H., Feder, A., Charney, D. S., Peccoralo, L., Southwick, S. M., & Ripp, J. (2020). Psychological Resilience in Frontline Health Care Workers During the Acute Phase of the COVID-19 Pandemic in New York City. *The Journal of Clinical Psychiatry*, *82*(1), 16115. https://doi.org/10.4088/JCP.20l13749

Płomecka, M. B., Gobbi, S., Neckels, R., Radziński, P., Skórko, B., Lazzeri, S., Almazidou, K., Dedić, A., Bakalović, A., Hrustić, L., Ashraf, Z., Haghi, S. E., Rodríguez-Pino, L., Waller, V., Jabeen, H., Alp, A. B., Behnam, M. A., Shibli, D., Barańczuk-Turska, Z., Haq, Z., Qureshi, S. U., Strutt, A. M., & Jawaid, A. (2020). Mental Health Impact of COVID-19: A global study of risk and resilience factors. *MedRxiv*, 2020.05.05.20092023. https://doi.org/10.1101/2020.05.05.20092023

Prati, G., & Mancini, A. D. (2021). The psychological impact of COVID-19 pandemic lockdowns: A review and meta-analysis of longitudinal studies and natural experiments. *Psychological Medicine*, *51*(2), 201–211. https://doi.org/10.1017/S0033291721000015

R Core Team. (2020). *R: A Language and Environment for Statistical Computing*. R Foundation for Statistical Computing, Vienna, Austria. http://www.R-project.org/

Ribeiro, F., Schröder, V. E., Krüger, R., & Leist, A. K. (2021). The evolution and social determinants of mental health during the first wave of the COVID-19 outbreak in Luxembourg. *Psychiatry Research*, *303*, 114090. https://doi.org/10.1016/j.psychres.2021.114090

Riehm, K. E., Brenneke, S. G., Adams, L. B., Gilan, D., Lieb, K., Kunzler, A. M., Smail, E. J., Holingue, C., Stuart, E. A., Kalb, L. G., & Thrul, J. (2021). Association between psychological resilience and changes in mental distress during the COVID-19 pandemic. *Journal of Affective Disorders*, *282*, 381–385. https://doi.org/10.1016/j.jad.2020.12.071

Riepenhausen, A., Veer, I. M., Wackerhagen, C., Reppmann, Z. C., Köber, G., Ayuso-Mateos, J. L., Bögemann, S. A., Corrao, G., Felez-Nobrega, M., Abad, J. M. H., Hermans, E., Leeuwen, J. van, Lieb, K., Lorant, V., Mary-Krause, M., Mediavilla, R., Melchior, M., Mittendorfer-Rutz, E., Compagnoni, M. M., Pan, K.-Y., Puhlmann, L., Roelofs, K., Sijbrandij, M., Smith, P., Tüscher, O., Witteveen, A., Zerban, M., Kalisch, R., Kröger, H., & Walter, H. (2022). Coping with COVID: Risk and resilience factors for mental health in a German representative panel study. *Psychological Medicine*, 1–11. https://doi.org/10.1017/S0033291722000563

Rix, A., & Du, J. (2020). *miselect: Variable Selection for Multiply Imputed Data* (0.9.0). https://CRAN.R-project.org/package=miselect

Robert Koch Institute. (2021). *Coronavirus Disease 2019 (COVID-19) Daily Situation Report of the Robert Koch Institute 15/02/2021*. https://www.rki.de/DE/Content/InfAZ/N/Neuartiges_Coronavirus/Situationsberichte/Feb_2021/2021-02-15-en.pdf?__blob=publicationFile

Robinson, E., Sutin, A. R., Daly, M., & Jones, A. (2021). *A systematic review and meta-analysis of longitudinal cohort studies comparing mental health before versus during the COVID-19 pandemic* (p. 2021.03.04.21252921). https://doi.org/10.1101/2021.03.04.21252921

Rodrigo, M. F., Molina, J. G., Losilla, J.-M., Vives, J., & Tomás, J. M. (2019). Method effects associated with negatively and positively worded items on the 12-item General Health Questionnaire (GHQ-12): Results from a cross-sectional survey with a representative sample of Catalonian workers. *BMJ Open*, *9*(11), e031859. https://doi.org/10.1136/bmjopen-2019-031859

Romppel, M., Hinz, A., Finck, C., Young, J., Brähler, E., & Glaesmer, H. (2017). Cross-cultural measurement invariance of the General Health Questionnaire-12 in a German and a Colombian population sample. *International Journal of Methods in Psychiatric Research*, *26*(4), e1532. https://doi.org/10.1002/mpr.1532

Scheier, M. F., Carver, C. S., & Bridges, M. W. (1994). Distinguishing optimism from neuroticism (and trait anxiety, self-mastery, and self-esteem): A reevaluation of the Life Orientation Test. *Journal of Personality and Social Psychology*, *67*(6), 1063–1078. https://doi.org/10.1037/0022-3514.67.6.1063

Schnell, T., & Krampe, H. (2020). Meaning in Life and Self-Control Buffer Stress in Times of COVID-19: Moderating and Mediating Effects With Regard to Mental Distress. *Frontiers in Psychiatry*, *11*, 582352. https://doi.org/10.3389/fpsyt.2020.582352

Schug, C., Morawa, E., Geiser, F., Hiebel, N., Beschoner, P., Jerg-Bretzke, L., Albus, C., Weidner, K., Steudte-Schmiedgen, S., Borho, A., Lieb, M., & Erim, Y. (2021). Social Support and Optimism as Protective Factors for Mental Health among 7765 Healthcare Workers in Germany during the COVID-19 Pandemic: Results of the VOICE Study. *International Journal of Environmental Research and Public Health*, *18*(7), 3827. https://doi.org/10.3390/ijerph18073827

Scrivner, C., Johnson, J. A., Kjeldgaard-Christiansen, J., & Clasen, M. (2021). Pandemic practice: Horror fans and morbidly curious individuals are more psychologically resilient during the COVID-19 pandemic. *Personality and Individual Differences*, *168*, 110397. https://doi.org/10.1016/j.paid.2020.110397

Sheehan, D. V., Lecrubier, Y., Sheehan, K. H., Amorim, P., Janavs, J., Weiller, E., Hergueta, T., Baker, R., & Dunbar, G. C. (1998). The Mini-International Neuropsychiatric Interview (MINI): The development and validation of a structured diagnostic psychiatric interview for DSM-IV and ICD-10. *Journal of Clinical Psychiatry*, *59*(20), 22–33.

Shields, G. S., & Slavich, G. M. (2017). Lifetime Stress Exposure and Health: A Review of Contemporary Assessment Methods and Biological Mechanisms. *Social and Personality Psychology Compass*, *11*(8), e12335. https://doi.org/10.1111/spc3.12335

Sibley, C. G., Greaves, L. M., Satherley, N., Wilson, M. S., Overall, N. C., Lee, C. H. J., Milojev, P., Bulbulia, J., Osborne, D., Milfont, T. L., Houkamau, C. A., Duck, I. M., Vickers-Jones, R., & Barlow, F. K. (2020). Effects of the COVID-19 pandemic and nationwide lockdown on trust, attitudes toward government, and well-being. *The American Psychologist*, *75*(5), 618–630. https://doi.org/10.1037/amp0000662

Siegers, R., Belcheva, V., & Silbermann, T. (2020). *SOEP-Core v35 – Documentation of Sample Sizes and Panel Attrition in the German Socio-Economic Panel (SOEP) (1984 until 2018)*.

Simonsohn, U., Simmons, J. P., & Nelson, L. D. (2020). Specification curve analysis. *Nature Human Behaviour*, *4*(11), 1208–1214. https://doi.org/10.1038/s41562-020-0912-z

Smith, B. W., Dalen, J., Wiggins, K., Tooley, E., Christopher, P., & Bernard, J. (2008). The brief resilience scale: Assessing the ability to bounce back. *International Journal of Behavioral Medicine*, *15*(3), 194–200. https://doi.org/10.1080/10705500802222972

Soga, M., Evans, M. J., Tsuchiya, K., & Fukano, Y. (2021). A room with a green view: The importance of nearby nature for mental health during the COVID-19 pandemic. *Ecological Applications*, *31*(2), e2248. https://doi.org/10.1002/eap.2248

Sojli, E., Tham, W. W., Bryant, R., & McAleer, M. (2021). COVID-19 restrictions and age-specific mental health—U.S. probability-based panel evidence. *Translational Psychiatry*, *11*(1), 1–7. https://doi.org/10.1038/s41398-021-01537-x

Song, S., Yang, X., Yang, H., Zhou, P., Ma, H., Teng, C., Chen, H., Ou, H., Li, J., Mathews, C. A., Nutley, S., Liu, N., Zhang, X., & Zhang, N. (2021). Psychological Resilience as a Protective Factor for Depression and Anxiety Among the Public During the Outbreak of COVID-19. *Frontiers in Psychology*, *11*. https://www.frontiersin.org/article/10.3389/fpsyg.2020.618509

Spitzer, R. L., Kroenke, K., Williams, J. B. W., & and the Patient Health Questionnaire Primary Care Study Group. (1999). Validation and Utility of a Self-report Version of PRIME-MDThe PHQ Primary Care Study. *JAMA*, *282*(18), 1737–1744. https://doi.org/10.1001/jama.282.18.1737

Spitzer, R. L., Kroenke, K., Williams, J. B. W., & Löwe, B. (2006). A Brief Measure for Assessing Generalized Anxiety Disorder: The GAD-7. *Archives of Internal Medicine*, *166*(10), 1092–1097. https://doi.org/10.1001/archinte.166.10.1092

Steegen, S., Tuerlinckx, F., Gelman, A., & Vanpaemel, W. (2016). Increasing Transparency Through a Multiverse Analysis. *Perspectives on Psychological Science*, *11*(5), 702–712. https://doi.org/10.1177/1745691616658637

Twenge, J. M., & Joiner, T. E. (2020). Mental distress among U.S. adults during the COVID-19 pandemic. *Journal of Clinical Psychology*, *76*(12), 2170–2182. https://doi.org/10.1002/jclp.23064

van Harmelen, A.-L., Kievit, R. A., Ioannidis, K., Neufeld, S., Jones, P. B., Bullmore, E., Dolan, R., Consortium, T. N., Fonagy, P., & Goodyer, I. (2017). Adolescent friendships predict later resilient functioning across psychosocial domains in a healthy community cohort. *Psychological Medicine*, *47*(13), 2312–2322. https://doi.org/10.1017/S0033291717000836

Veer, I. M., Riepenhausen, A., Zerban, M., Wackerhagen, C., Puhlmann, L. M. C., Engen, H., Köber, G., Bögemann, S. A., Weermeijer, J., Uściłko, A., Mor, N., Marciniak, M. A., Askelund, A. D., Al-Kamel, A., Ayash, S., Barsuola, G., Bartkute-Norkuniene, V., Battaglia, S., Bobko, Y., Bölte, S., Cardone, P., Chvojková, E., Damnjanović, K., De Calheiros Velozo, J., de Thurah, L., Deza-Araujo, Y. I., Dimitrov, A., Farkas, K., Feller, C., Gazea, M., Gilan, D., Gnjidić, V., Hajduk, M., Hiekkaranta, A. P., Hofgaard, L. S., Ilen, L., Kasanova, Z., Khanpour, M., Lau, B. H. P., Lenferink, D. B., Lindhardt, T. B., Magas, D. Á., Mituniewicz, J., Moreno-López, L., Muzychka, S., Ntafouli, M., O'Leary, A., Paparella, I., Põldver, N., Rintala, A., Robak, N., Rosická, A. M., Røysamb, E., Sadeghi, S., Schneider, M., Siugzdaite, R., Stantić, M., Teixeira, A., Todorovic, A., Wan, W. W. N., van Dick, R., Lieb, K., Kleim, B., Hermans, E. J., Kobylińska, D., Hendler, T., Binder, H., Myin-Germeys, I., van Leeuwen, J. M. C., Tüscher, O., Yuen, K. S. L., Walter, H., & Kalisch, R. (2021). Psycho-social factors associated with mental resilience in the Corona lockdown. *Translational Psychiatry*, *11*(1), 1–11. https://doi.org/10.1038/s41398-020-01150-4

Verdolini, N., Amoretti, S., Montejo, L., García-Rizo, C., Hogg, B., Mezquida, G., Rabelo-da-Ponte, F. D., Vallespir, C., Radua, J., Martinez-Aran, A., Pacchiarotti, I., Rosa, A. R., Bernardo, M., Vieta, E., Torrent, C., & Solé, B. (2021). Resilience and mental health during the COVID-19 pandemic. *Journal of Affective Disorders*, *283*, 156–164. https://doi.org/10.1016/j.jad.2021.01.055

Vos, L. M. W., Habibović, M., Nyklíček, I., Smeets, T., & Mertens, G. (2021). Optimism, mindfulness, and resilience as potential protective factors for the mental health consequences of fear of the coronavirus. *Psychiatry Research*, *300*, 113927. https://doi.org/10.1016/j.psychres.2021.113927

Wackerhagen, C., Reppmann, Z., Riepenhausen, A., Veer, I. M., & Walter, H. (2021). Kognitive Neurowissenschaft der psychischen Resilienz. *Nervenheilkunde*, *40*(04), 249–258. https://doi.org/10.1055/a-1371-9465

Winkler, P., Formanek, T., Mlada, K., Kagstrom, A., Mohrova, Z., Mohr, P., & Csemy, L. (2020). Increase in prevalence of current mental disorders in the context of COVID-19: Analysis of repeated nationwide cross-sectional surveys. *Epidemiology and Psychiatric Sciences*, *29*, e173. https://doi.org/10.1017/S2045796020000888

Wooller, J. J., Rogerson, M., Barton, J., Micklewright, D., & Gladwell, V. (2018). Can Simulated Green Exercise Improve Recovery From Acute Mental Stress? *Frontiers in Psychology*, *9*. https://doi.org/10.3389/fpsyg.2018.02167

Yang, Z., Ji, L.-J., Yang, Y., Wang, Y., Zhu, L., & Cai, H. (2021). Meaning Making Helps Cope with COVID-19: A Longitudinal Study. *Personality and Individual Differences*, 110670. https://doi.org/10.1016/j.paid.2021.110670

Yörük, S., & Güler, D. (2021). The relationship between psychological resilience, burnout, stress, and sociodemographic factors with depression in nurses and midwives during the COVID-19 pandemic: A cross-sectional study in Turkey. *Perspectives in Psychiatric Care*, *57*(1), 390–398. https://doi.org/10.1111/ppc.12659

Zajacova, A., Jehn, A., Stackhouse, M., Choi, K. H., Denice, P., Haan, M., & Ramos, H. (2020). Mental health and economic concerns from March to May during the COVID-19 pandemic in Canada: Insights from an analysis of repeated cross-sectional surveys. *SSM - Population Health*, *12*, 100704. https://doi.org/10.1016/j.ssmph.2020.100704

Zhu, J., Sun, L., Zhang, L., Wang, H., Fan, A., Yang, B., Li, W., & Xiao, S. (2020). Prevalence and Influencing Factors of Anxiety and Depression Symptoms in the First-Line Medical Staff Fighting Against COVID-19 in Gansu. *Frontiers in Psychiatry*, *11*, 386. https://doi.org/10.3389/fpsyt.2020.00386

Statutory Declaration

“I, Antje Riepenhausen, by personally signing this document in lieu of an oath, hereby affirm that I prepared the submitted dissertation on the topic ‘Resilience and mental health during the COVID-19 pandemic: Psychological risk and protective factors’ (‘Resilienz und mentale Gesundheit während der COVID-19-Pandemie: Psychologische Risiko- und Schutzfaktoren’), independently and without the support of third parties, and that I used no other sources and aids than those stated.
All parts which are based on the publications or presentations of other authors, either in letter or in spirit, are specified as such in accordance with the citing guidelines. The sections on methodology (in particular regarding practical work, laboratory regulations, statistical processing) and results (in particular regarding figures, charts and tables) are exclusively my responsibility.

Furthermore, I declare that I have correctly marked all of the data, the analyses, and the conclusions generated from data obtained in collaboration with other persons, and that I have correctly marked my own contribution and the contributions of other persons (cf. declaration of contribution). I have correctly marked all texts or parts of texts that were generated in collaboration with other persons.

My contributions to any publications to this dissertation correspond to those stated in the below joint declaration made together with the supervisor. All publications created within the scope of the dissertation comply with the guidelines of the ICMJE (International Committee of Medical Journal Editors; http://www.icmje.org) on authorship. In addition, I declare that I shall comply with the regulations of Charité – Universitätsmedizin Berlin on ensuring good scientific practice.

I declare that I have not yet submitted this dissertation in identical or similar form to another Faculty.

The significance of this statutory declaration and the consequences of a false statutory declaration under criminal law (Sections 156, 161 of the German Criminal Code) are known to me.”

Date Signature

Declaration of Contribution to the Publications

Antje Riepenhausen contributed the following to the below-listed publications:

Publication 1: Veer*, Riepenhausen*, Zerban*, Wackerhagen*, Puhlmann* et al., Psycho-social factors associated with mental resilience in the Corona lockdown, Translational Psychiatry, 2021
Contribution (please set out in detail):

- Study design: I was actively involved in the process of deciding for the questionnaire battery that was used in the DynaCORE-C study
- Survey generation and data collection: I created a German version of the questionnaire battery, coordinated the translation to other languages, and advertised the questionnaire via social media & email lists
- Writing: I critically edited and revised the manuscript

Publication 2: Riepenhausen et al., Coping With COVID: Risk and Resilience Factors for Mental Health in a German Representative Panel Study, Psychological Medicine, 2022
Contribution (please set out in detail):

- Study design: I was actively involved in the process of deciding the set of questions on protective factors that were then included in the SOEP-CoV study
- Analysis plan: I set up the analysis plan which included a decision for the variables of interest, formulating the hypotheses, and determining the concrete analysis methods to be used
- Data pre-processing: making use of some pre-existing code for pre-processing SOEP data in general, but also adding new code that was specific to my own analyses, I created and applied the R code that was needed for pre-processing the data to get a workable dataset
- Data analysis: the code for all analyses, except for the specification curve analysis that is reported in the supplementary material, was written by me in R, and all analyses were conducted by me based on this code
- Writing: I drafted and revised the entire manuscript, created all figures and tables based on the R code that I have written, and put together the supplementary material
- Publication: I submitted, revised, and resubmitted the manuscript to Psychological Medicine, and communicated with the journal in the process of publication.

Signature, date and stamp of first supervising university professor / lecturer

Signature of doctoral candidate

Excerpt from Journal Summary List

Journal Data Filtered By: **Selected JCR Year: 2019** Selected Editions: SCIE,SSCI
Selected Categories: **"PSYCHIATRY"** Selected Category
Scheme: WoS
Gesamtanzahl: 216 Journale

Rank	Full Journal Title	Total Cites	Journal Impact Factor	Eigenfactor Score
1.	World Psychiatry	6,486	40.595	0.017130
2.	JAMA Psychiatry	13,433	17.471	0.056110
3.	Lancet Psychiatry	6,405	16.209	0.028290
4.	PSYCHOTHERAPY AND PSYCHOSOMATICS	4,275	14.864	0.006480
5.	AMERICAN JOURNAL OF PSYCHIATRY	41,967	14.119	0.034380
6.	MOLECULAR PSYCHIATRY	22,227	12.384	0.054730
7.	BIOLOGICAL PSYCHIATRY	44,016	12.095	0.053910
8.	JOURNAL OF NEUROLOGY NEUROSURGERY AND PSYCHIATRY	30,621	8.234	0.028510
9.	SCHIZOPHRENIA BULLETIN	17,703	7.958	0.027070
10.	BRITISH JOURNAL OF PSYCHIATRY	24,380	7.850	0.020520
11.	JOURNAL OF CHILD PSYCHOLOGY AND PSYCHIATRY	19,837	7.035	0.021080
12.	JOURNAL OF CHILD PSYCHOLOGY AND PSYCHIATRY	19,837	7.035	0.021080
13.	JOURNAL OF THE AMERICAN ACADEMY OF CHILD AND ADOLESCENT PSYCHIATRY	19,831	6.936	0.017840
14.	NEUROPSYCHOPHARMACOLOGY	26,281	6.751	0.040680
15.	BRAIN BEHAVIOR AND IMMUNITY	16,285	6.633	0.028560
16.	JOURNAL OF ABNORMAL PSYCHOLOGY	16,003	6.484	0.014170
17.	ADDICTION	19,861	6.343	0.030820
18.	Epidemiology and Psychiatric Sciences	1,584	5.876	0.004770
19.	PSYCHOLOGICAL MEDICINE	26,702	5.813	0.039350
20.	Clinical Psychological Science	2,599	5.415	0.011100

Rank	Full Journal Title	Total Cites	Journal Impact Factor	Eigenfactor Score
21.	BIPOLAR DISORDERS	4,838	5.410	0.006610
22.	ACTA PSYCHIATRICA SCANDINAVICA	13,539	5.362	0.011750
23.	Translational Psychiatry	9,160	5.280	0.029500
24.	Journal of Behavioral Addictions	2,184	5.143	0.005970
25.	CNS DRUGS	4,768	4.786	0.007670
26.	PSYCHONEUROENDOCRINOLOGY	19,287	4.732	0.027100
27.	DEPRESSION AND ANXIETY	9,355	4.702	0.013860
28.	AUSTRALIAN AND NEW ZEALAND JOURNAL OF PSYCHIATRY	7,192	4.657	0.008620
29.	Current Psychiatry Reports	4,785	4.539	0.010670
30.	EUROPEAN PSYCHIATRY	6,054	4.464	0.009470
31.	CURRENT OPINION IN PSYCHIATRY	4,182	4.392	0.006260
32.	JOURNAL OF PSYCHIATRY & NEUROSCIENCE	3,297	4.382	0.004290
33.	PROGRESS IN NEURO-PSYCHOPHARMACOLOGY & BIOLOGICAL PSYCHIATRY	11,179	4.361	0.013670
34.	PHARMACOPSYCHIATRY	1,787	4.340	0.001580
35.	INTERNATIONAL JOURNAL OF NEUROPSYCHOPHARMACOLOGY	6,749	4.333	0.011150
36.	npj Schizophrenia	502	4.304	0.002060
37.	JOURNAL OF CLINICAL PSYCHIATRY	18,652	4.204	0.018530
38.	WORLD JOURNAL OF BIOLOGICAL PSYCHIATRY	2,567	4.164	0.004200
39.	DRUG AND ALCOHOL DEPENDENCE	20,269	3.951	0.040630
40.	EUROPEAN CHILD & ADOLESCENT PSYCHIATRY	5,422	3.941	0.009450
41.	JOURNAL OF AFFECTIVE DISORDERS	32,869	3.892	0.055920
42.	SUICIDE AND LIFE-THREATENING BEHAVIOR	4,512	3.867	0.005980

Selected JCR Year: 2019; Selected Categories: "PSYCHIATRY"

Journal Data Filtered By: **Selected JCR Year: 2020** Selected Editions: SCIE,
Selected Categories: **"PSYCHIATRY"** Selected Category
Scheme: WoS

Gesamtanzahl: 156 Journale

Rank	Full Journal Title	Total Cites	Journal Impact Factor	Eigenfactor Score
1	World Psychiatry	9,619	49.548	0.020030
2	Lancet Psychiatry	14,839	27.083	0.036240
3	JAMA Psychiatry	19,105	21.596	0.052990
4	AMERICAN JOURNAL OF PSYCHIATRY	48,206	18.112	0.031970
5	PSYCHOTHERAPY AND PSYCHOSOMATICS	6,123	17.659	0.006750
6	MOLECULAR PSYCHIATRY	28,622	15.992	0.046220
7	BIOLOGICAL PSYCHIATRY	50,155	13.382	0.045540
8	JOURNAL OF NEUROLOGY NEUROSURGERY AND PSYCHIATRY	37,094	10.154	0.026380
9	BRITISH JOURNAL OF PSYCHIATRY	30,003	9.319	0.019160
10	SCHIZOPHRENIA BULLETIN	21,642	9.306	0.023290
11	JOURNAL OF CHILD PSYCHOLOGY AND PSYCHIATRY	25,273	8.982	0.021190
12	JOURNAL OF THE AMERICAN ACADEMY OF CHILD AND ADOLESCENT PSYCHIATRY	25,046	8.829	0.017190
13	Evidence-Based Mental Health	1,201	8.141	0.003220
14	NEUROPSYCHOPHARMACOLOGY	30,856	7.853	0.034600
15	PSYCHOLOGICAL MEDICINE	34,876	7.723	0.038850
16	BRAIN BEHAVIOR AND IMMUNITY	24,161	7.217	0.026930
17	Clinical Psychological Science	3,811	7.169	0.010420
18	Epidemiology and Psychiatric Sciences	2,571	6.892	0.005580
19	Journal of Behavioral Addictions	4,024	6.756	0.008100
20	BIPOLAR DISORDERS	6,185	6.744	0.007510

Printing Copies of the Publications

The following publications contributed to this dissertation:

- Veer, I. M., Riepenhausen, A., Zerban, M.*, Wackerhagen, C.*, Puhlmann, L. M.*, Engen, H., ... & Kalisch, R. (2021). Psycho-social factors associated with mental resilience in the Corona lockdown. *Translational Psychiatry*, *11*(1), 1-11. https://doi.org/10.1038/s41398-020-01150-4
- Riepenhausen, A., Veer, I.M., Wackerhagen, C., Reppmann, Z. C., Köber, G., Ayuso-Mateos, J. L., Bögemann, S.A., Corrao, G., Felez-Nobrega, M., Haro Abad, J.M., Hermans, E., van Leeuwen, J., Lieb, K., Lorant, V., Mary-Krause, M., Mediavilla, R., Melchior, M., Mittendorfer-Rutz, E., Monzio Compagnoni, M., Pan, K.-Y., Puhlman, L., Roelofs, K., Sijbrandij, M., Smith, P., Tüscher, O., Witteveen, A., Zerban, M., Kalisch, R., Kröger, H., & Walter, H. (2022). Coping with COVID: Risk and Resilience Factors for Mental Health in a German Representative Panel Study. *Psychological Medicine* 1-11. https://doi.org/10.1017/S0033291722000563

Curriculum Vitae

My curriculum vitae will not be published in the electronic version of my dissertation for data protection reasons.

Publication List

Wackerhagen, C.*, Veer, I.M.*, van Leeuwen, J.M.C.*, Reppmann, Z.C.*, *Riepenhausen, A.**, Bögemann, S.A., Mor, N., Puhlmann, L.M.C., Uściłko, A., Zerban, M., Yuen, K., Köber, G., Pooseh, S., Weermeijer, J., Marciniak, A.M., Arias-Vásquez, A., Binder, H., de Raedt, W., Kleim, B., Myin-Germeys, I., Roelofs, K., Timmer, J., Tüscher. O., Hendler, T., Hermans, E., Kalisch, R., Kobylińska, D., & Walter, H. (in press). Study protocol description: Dynamic Modelling of Resilience-Observational Study (DynaM-OBS). *JMIR Research Protocols*. http://doi.org/10.2196/preprints.39817

Riepenhausen. A., Wackerhagen, C., Reppmann, Z. C., Deter, H.-C., Kalisch, R., Veer, I., & Walter, H. (2022). Positive Cognitive Reappraisal in Stress Resilience, Mental Health, and Well-Being: a Comprehensive Systematic Review. *Emotion Review.* http://doi.org/10.1177/17540739221114642 Impact Factor 2022: 7.345

Riepenhausen, A., Veer, I.M., Wackerhagen, C., Reppmann, Z. C., Köber, G., Ayuso-Mateos, J. L., Bögemann, S.A., Corrao, G., Felez-Nobrega, M., Haro Abad, J.M., Hermans, E., van Leeuwen, J., Lieb, K., Lorant, V., Mary-Krause, M., Mediavilla, R., Melchior, M., Mittendorfer-Rutz, E., Monzio Compagnoni, M., Pan, K.-Y., Puhlman, L., Roelofs, K., Sijbrandij, M., Smith, P., Tüscher, O., Witteveen, A., Zerban, M., Kalisch, R., Kröger, H., & Walter, H. (2022). Coping with COVID: Risk and Resilience Factors for Mental Health in a German Representative Panel Study. *Psychological Medicine* 1-11. https://doi.org/10.1017/S0033291722000563 Impact Factor 2022: 10.592

Wackerhagen, C., Reppmann, Z., *Riepenhausen, A.*, Veer, I. M., & Walter, H. (2021). Kognitive Neurowissenschaft der psychischen Resilienz. *Nervenheilkunde*, *40*(04), 249-258. https://doi.org/10.1055/a-1371-9465 Impact Factor 2021: 0.189

Veer, I. M.*, *Riepenhausen, A.**, Zerban, M.*, Wackerhagen, C.*, Puhlmann, L. M.*, Engen, H., ... & Kalisch, R. (2021). Psycho-social factors associated with mental resilience in the Corona lockdown. *Translational Psychiatry*, *11*(1), 1-11. https://doi.org/10.1038/s41398-020-01150-4 Impact Factor 2021: 7.989

Golde, S., Wingenfeld, K., *Riepenhausen, A.*, Schröter, N., Fleischer, J., Prüssner, J., Grimm, S., Fan, Y., Hellmann-Regen, J., Beck, A., Gold, S.M., & Otte, C. (2020). Healthy women with severe early life trauma show altered neural facilitation of emotion inhibition under acute stress. *Psychological Medicine*, *50*(12), 2075-2084. https://doi.org/10.1017/S0033291719002198 Impact Factor 2020: 7.723

Engert, V., Koester, A. M., *Riepenhausen, A.*, & Singer, T. (2016). Boosting recovery rather than buffering reactivity: Higher stress-induced oxytocin secretion is associated with increased cortisol reactivity and faster vagal recovery after acute psychosocial stress. *Psychoneuroendocrinology*, *74*, 111-120. http://dx.doi.org/10.1016/j.psyneuen.2016.08.029 Impact Factor 2016: 5.16

Acknowledgments

I would like to express my sincere gratitude to my supervisors, Prof. Dr. Dr. Henrik Walter, Prof. Dr. Hans-Christian Deter, and Dr. Ilya Veer for their help and advice during my PhD. Special thanks go to Prof. Dr. Raffael Kalisch for his continuous support and mentorship and to Dr. Hannes Kröger for the good collaboration and for providing valuable advice regarding analyses. I would moreover like to thank my colleagues at the Research Division of Mind and Brain and at the DynaMORE project, with a particular focus on the DynaTEAM Berlin, especially Zala Reppmann, for the nice working atmosphere. Thanks to my weekly success team (Julia Lange, Maria Börno, Monika Thiel and Sarah Hiller), to my fellow PhD candidates from cohort 12 at the Berlin School of Mind and Brain, and to the Scholar Minds team for the possibilities to connect, exchange, and share honest experiences of the PhD, as well as to Dr. Dorota Kobylińska for her mentorship.

Thanks to Dr. Alexander Angelidis, Anna Daniels, Zala Reppmann, Dr. Ilya Veer, Dr. Carolin Wackerhagen, Sarah Wellan, and Dr. Frederik Wolf for proofreading my dissertation.

Lastly, I would like to thank the Berlin School of Mind and Brain and the Studienstiftung des deutschen Volkes for their doctoral scholarships that allowed me to conduct my thesis and the EU Horizon 2020 projects DynaMORE and RESPOND for funding my research.