

## Fall From Grace: Increased Loneliness and Depressiveness Among Extraverted Youth During the German COVID-19 Lockdown

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The COVID-19 pandemic has substantially affected young people's social and emotional life. Based on longitudinal data provided by 843 adolescents (57.3% female) of the German Family Panel (pairfam), we investigated effects of extraversion on changes in loneliness and depressiveness between 2018 and 2019 and the first German COVID-19 lockdown in the first half of 2020. Findings of latent change modeling show that highly extraverted adolescents experienced a larger rise in depressiveness, and a third of this total effect was mediated through increases in loneliness. These results contradict previous work evidencing lower depressiveness among extraverted youth and challenge the notion of extraversion as a mere protective factor. Under conditions of restricted access to others, this personality trait may become a burden.

Key words: extraversion – loneliness – depressiveness – adolescence – COVID-19

The COVID-19 pandemic prompted countries worldwide to reduce the risk of infection by introducing measures of quarantine and limiting personal contact. As a result of these measures, an increase in loneliness has been reported to be prevalent especially among younger adults and women (Bu, Steptoe, & Fancourt, 2020), although findings are not entirely consistent (Luchetti et al., 2020). Younger adults (Pierce et al., 2020) and females (Vindegaard & Benros, 2020) also seem to be more prone to mental health issues during the COVID-19 pandemic. While much attention has been paid to the social, economic, and health conditions of (younger) adults, studies on adolescents during the COVID-19 pandemic are scarce. This research gap is even more remarkable since adolescents who experienced loneliness due to isolation in general are likely to be more prone to depression (Loades et al., 2020). Features suggesting a high sociability and need for social interaction like extraversion may be of particular interest in this context, since such social needs could only be partially satisfied during the pandemic lockdown. The restricted ability to satisfy one's social needs may have particularly affected these adolescents who find socializing especially rewarding (Wilkowski & Ferguson, 2014). The current study investigates

whether the conditions of the first COVID-19 lockdown in Germany provide different insights into the role of extraversion in adolescent loneliness and depressiveness than findings before the pandemic under normal conditions. We aim to test whether adolescents with high extraversion are particularly vulnerable to an increase in loneliness and depressiveness under lockdown conditions, as their social needs may have not been met under contact restrictions.

Germany started to impose these contact restrictions and quarantine measures in March 2020, when daily infection rates due to the coronavirus started to increase. Day care centers, schools, youth clubs, cinemas, and most shops were closed, and the population was instructed to stay at home and avoid contact to those who were not members of their household. Many workers had to work from home or involuntarily reduced their work hours, and social distancing measures (e.g., no public events or private parties) were implemented. Temporarily there was also a night curfew. This nationwide lockdown lasted from mid-March 2020 to early May 2020 and severely restricted people's lives in an unprecedented manner. This lockdown was followed by a policy of relaxations from early May 2020 to early July 2020. During the relaxation period, shops reopened, and day care centers as well as schools partially reopened in many states

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This paper uses data from the German Family Panel pairfam, coordinated by Josef Brüderl, Sonja Drobnič, Karsten Hank, Franz Neyer, and Sabine Walper. Pairfam is funded as a long-term project by the German Research Foundation (DFG).

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with reduced numbers of children, and people were allowed to meet members of other households in limited numbers (Steinmetz, Batzdorfer, & Bosnjak, 2020; Zacher & Rudolph, 2021). Findings from Germany suggest that the restriction of social contacts may have impaired older adults' ( $M = 40.5$ ,  $SD = 12.4$ ) mental well-being (Benke, Autenrieth, Asselmann, & Pané-Farré, 2020). Recent evidence also indicates that one third of younger adults ( $M = 21.30$ ,  $SD = 2.60$ ) in Germany often felt lonely during the pandemic, and that this loneliness was associated with increased psychological distress (Rauschenberg et al., 2021). Furthermore, mental health problems had doubled for children and adolescents ( $M = 12.2$ ,  $SD = 3.3$ ) in Germany under lockdown conditions compared to pre-pandemic prevalence rates (Ravens-Sieberer et al., 2021).

There is some growing evidence that extraverted adults may have suffered more from the lockdown measures during the pandemic (Wijngaards, de Zilwa, & Burger, 2020; Zacher & Rudolph, 2021). Furthermore, the observation that extraversion is not always protective has also been made in other contexts. In the aftermath of a disaster, higher strain was found among the extraverts, which was explained by the assumption that they might have talked more about the symptoms and thus increased their burden (Jeronimus, Snippe, Emerencia, de Jonge, & Bos, 2019). Additionally, in a study on divorced families, adolescents who showed high extraversion evidenced lower feelings of mastery if they alternated residing with each parent (joint physical custody), which was explained by the likely disruption of their social networks (Sodermans & Matthijs, 2014).

### **Extraversion, Loneliness, and Depressiveness During Adolescence**

Extraversion belongs to the big five personality factors which are considered of broad cross-cultural relevance (McCrae & Costa, 1997). It refers to the social dominance (e.g., self-confidence) and social vitality (e.g., sociability) in interpersonal situations. This broad personality trait can already be detected in adolescence and plays an important role in connection with psychopathology during this period (Tackett, 2006). Extraversion shows only small normative change across middle adolescence (Borghuis et al., 2017). For boys and girls alike, the rank-order stability of extraversion increases from early to late adolescence, reflecting settled interindividual differences. As these

interindividual differences become more stable, regardless of mean-level changes, the personality stabilizes which has been referred to as personality maturation (Klimstra, Hale, Raaijmakers, Branje, & Meeus, 2009; Roberts, Robins, Trzesniewski, & Caspi, 2003).

Depressiveness, as the dimensional equivalent of depression, is characterized by mostly internalizing symptoms and from adolescence onwards, and females are affected significantly more often (Hankin & Abramson, 2001). In terms of emotionality, it is marked by high negative and low positive affect (Kotov et al., 2017). These two facets are also found in the tripartite model of depression and anxiety, where depression is characterized by increased negative affect and decreased positive affect. Anxiety, on the other hand, is characterized by increased negative affect and increased physical arousal (Clark & Watson, 1991). Thus, reduced positive affect in particular plays an important role in the symptomatology of depressiveness. This reduction can also be described as anhedonia ("loss of joy"). It is a phenomenon in which the ability to feel joy is completely or partially lost. While it reflects a state-symptom during a depressive episode, it also has a stable aspect that can be considered a personality facet (Rizvi, Pizzagalli, Sproule, & Kennedy, 2016; Shankman, Nelson, Harrow, & Faull, 2010). During adolescence, high levels of extraversion and its facet of sociability are associated with lower negative affect and less anhedonia (Anthony, Lonigan, Hooe, & Phillips, 2002). Furthermore, high extraversion in adolescents can act as a protective factor against mood disorders (Metts, Zinbarg, Hammen, Mineka, & Craske, 2021). The differential activation and inhibition of the neuronal reward circuits that are associated with anhedonia and extraversion may be the underlying link for both (Langvik & Borgen Austad, 2019).

Social connectedness is a likely mediator explaining the relationship between extraversion and well-being and the sociability component of extraversion seems to be specifically important for this link (Lee, Dean, & Jung, 2008). Experiencing unwanted social isolation can lead to loneliness as a form of social pain (Larsen & Hartl, 2013). Some evidence suggests that adolescents are likely to experience feelings of loneliness (Danneel, Maes, Vanhalst, Bijttebier, & Goossens, 2018), and young people who feel particularly lonely also seem to suffer more from depressive symptoms (Ladd & Ettekal, 2013). However, extraverted youth who seek and enjoy social contact experience less loneliness (Buecker, Maes, Denissen, & Luhmann, 2020),

at least under normal conditions which allow for social contact. In summary and on the basis of pre-pandemic studies, extraversion is already relatively stable in adolescence for both genders (Borghuis et al., 2017) and has protective properties with regard to loneliness and depressiveness (Buecker et al., 2020; Metts et al., 2021). Assuming that the sociability facet of extraversion drives contact seeking and—without contact restrictions—engagement in social interaction, loneliness could act as a mediating link between extraversion and depressiveness. The loss of pleasure as a depressive symptom due to loneliness might be of particular importance in this case.

### Recent Pandemic Evidence on the Links of Extraversion, Loneliness, and Depressiveness

Two cross-sectional studies, which focused on the effects of COVID-19 lockdowns, reported unchanged protective effects of extraversion. Kocjan, Kavčič, and Avsec (2021) found positive associations of extraversion with subjective well-being during the COVID-19 pandemic in an adult Slovenian sample ( $M = 36.4$ ,  $SD = 13.1$ ). The Slovenian survey lasted only three days and took place within only five days after the country had declared a lockdown. During the lockdown, all shops were closed, except for grocery stores and pharmacies. Schools and day care facilities were closed, while public transportation was stopped, and public gatherings prohibited (Kocjan et al., 2021). However, the short duration since the start of lockdown and of the survey itself may have limited potential detrimental effects as they might have not fully unfolded yet. Another recent study, which analyzed COVID-19 lockdown conditions in Spain in an adult sample ( $M = 41.6$ ,  $SD = 13.3$ ), similarly showed that high extraversion was associated with more life satisfaction, more resilience, and more happiness during the lockdown (Morales-Vives, Dueñas, Vigil-Colet, & Camarero-Figuerola, 2020). The Spanish government declared a national lockdown on March 14, 2020, but the first two weeks of confinement were less severe since exceptions were made for services and workers. However, on March 28, 2020, the lockdown became stricter, and all nonessential service workers had to stay at home (Morales-Vives et al., 2020). The fact that the study was conducted during the first five weeks of the lockdown may have also limited potential detrimental effects, as the Spanish lockdown was particularly mild during the first two weeks.

The remaining pandemic studies all found harmful or weakened protective effects of extraversion during lockdown conditions. A multinational study with data from 47 countries and an adult sample ( $M = 39.1$ ,  $SD = 13.0$ ) found that extraversion moderated the link between the strictness of lockdown rules and depressive symptoms. More stringent measures were associated with less depressive symptoms, but only for introverts (Wijngaards et al., 2020). A paper by Zacher and Rudolph (2021) with an adult German sample ( $M = 45.0$ ,  $SD = 10.7$ ) which modeled latent growth curves of stress during COVID-19 pandemic, reported similar results. Their study covered the period from the beginning of April 2020 to the beginning of September 2020 and thus included the phases of the first German lockdown and the following relaxation. Higher extraversion predicted higher increases in stress and these findings were stronger during the beginning of the pandemic.

Gubler, Makowski, Troche, and Schlegel (2021) found only weak associations of extraversion with loneliness and well-being in their cross-sectional analyses during the pandemic lockdown in Switzerland. The data of their adult sample ( $M = 31.7$ ,  $SD = 16.2$ ) were collected from the end of March to the end of April. During this time, Swiss citizens were subject to numerous restrictions. For example, schools and shops were closed and gatherings of more than five people were prohibited. Furthermore, the Swiss were urged to leave the house only in urgent cases (e.g., grocery shopping or doctor's appointments). They concluded that extraversion may have lost some of its protective qualities when social interactions were limited.

However, none of the studies specifically examined the adolescent age period. In this phase, extraversion already plays a decisive protective role in relation to loneliness and depressiveness. Furthermore, it is during this developmental phase that increased autonomy and the choice of one's own peers gains importance (McElhaney, Allen, Stephenson, & Hare, 2009) and the heightened sensitivity to social contacts may increase the need for peer interaction (Orben, Tomova, & Blakemore, 2020). Preventing access to these peer networks may therefore have affected young people. It seems likely that extraverted adolescents, like adults, have also suffered particularly from the lockdown. However, to our knowledge, there are no empirical findings on this issue yet. This raises the question, whether youth with higher extraversion would suffer more under lockdown conditions. Due to their

outgoing personality, extraverted young people are more likely to have better social support (Swickert, Rosentreter, Hittner, & Mushrush, 2002), and this higher access to supportive relationships may protect against depressiveness (Mak, Fosco, & Lanza, 2021). But since extraversion reflects not only higher social skills but also higher needs for relatedness and social interaction, restricted social contact during lockdown conditions may likely conflict with this personality trait.

### **Aims of the Current Study**

The current study investigates whether conditions of the first COVID-19 lockdown in Germany yield different insight into the role of extraversion in adolescents' loneliness and depressiveness than pre-pandemic evidence. It is tested whether adolescents with high extraversion are prone for a rise in loneliness and depressiveness under lockdown conditions as their social needs might not be met. Furthermore, it is assumed that the more pronounced increase in depressiveness among extraverted youth should at least partly be mediated by their higher increase in loneliness. We provide the first study which evaluates the connections of changes in loneliness and depressiveness with extraversion in middle adolescence during the first German COVID-19 lockdown. Furthermore, our study contributes to existing COVID-19 research by being one of the few genuine longitudinal studies in the cultural context of Germany which can trace changes in adolescents' depressiveness from prior to the pandemic to the time of the lockdown. Based on a large national representative sample, we investigated the influence of adolescents' extraversion on changes in depressiveness and possible mediating effects of changes in loneliness by implementing a latent change score model emphasizing intraindividual change.

## **METHOD**

### **Procedure and Design**

Our analyses are based on wave 11 of the German Family Panel (pairfam) (release 11.0; Brüderl et al., 2020) and the pairfam COVID-19 data (Walper et al., 2020a). Pairfam is a long-term project, which collects annual data on the topics of child development, partnership, and family dynamics in Germany since 2008. The panel is based on a nationwide, representative sample of over 12,000 respondents of four birth cohorts (1971–1973, 1981–

1983, 1991–1993, 2001–2003). The youngest cohort born in 2001–2003 was added in wave 11 as a refreshment sample. In addition to the main interviewees (so-called anchor persons), their parents, partners, and children can also be interviewed. The children, in turn, can continue to participate as later adolescents in the main interview program as so-called step-ups. These step-ups, together with the youngest cohort of 2001–2003 formed the target population for our sample, as they were in the relevant age range. Prior to the pandemic, the interviews of anchor persons were conducted face to face in the participants' homes using a computer-assisted personal interview (CAPI). Sensitive questions, for example, about loneliness or depressiveness, were asked in a computer-assisted self-interview (CASI), in which the respondents used the computer themselves to answer the questions thus avoiding social desirability. The interviews of wave 11 (mid-October of 2018 to mid-August of 2019) lasted approximately 60 min and represent the first measurement point used here (T1).

To capture the strains during the COVID-19 pandemic, an additional web survey for anchor participants was conducted. Anchor persons were invited to participate in an online questionnaire of approximately 15 min and their data served as the second measurement point here (T2). The field period of the supplementary pairfam COVID-19 survey (T2) ranged from mid-May of 2020 to mid-July of 2020. Thus, the range between the two measurement points could be between 9 and 21 months. The programming and field work for the panel interviews and the online questionnaire were executed by Kantar Public. Because a large proportion of the adolescent respondents was under the age of consent, parental consent was obtained. A detailed description of the pairfam COVID-19 survey can be found in Walper et al. (2020b), and a detailed description of the pairfam study was provided by Huinink et al. (2011). Since the survey phase of the supplementary pairfam COVID-19 survey (mid-May 2020 to mid-July 2020) took place after the first German lockdown (mid-March 2020 to early May 2020), the questions on loneliness and depressiveness during the lockdown had to be asked retrospectively.

Of the gross sample of 9640 individuals who were contacted during the pairfam COVID-19 survey, a total of 3182 participated. Of these, 22 cases were excluded due to predominantly incomplete interviews on all study variables. Thus, even in the context of a full information likelihood estimation, the subjects would not have contributed anything to the estimator, since not only individual items of

some scales were missing, but the whole questionnaire was not completed. Six further cases were excluded as it was obvious their partner had completed the questionnaire. Of these 3154 respondents, 843 were in middle adolescence (14–17 years) and had participated in wave 11. These were selected for further analysis. 56 (6.6%) of these selected adolescents had no data on their extraversion items, because they were step-ups and had not received the extraversion items in wave 11. To keep these 56 adolescents in our sample, we decided to use their extraversion scores from the previous year (wave 10). These were available for 23 (41.0%) of the 56 cases, further reducing the missing values of extraversion to  $n = 33$  (3.9%) of our sample of 843 cases. Considering the high rank-order stability and small mean-level change of extraversion during this age period (Borghuis et al., 2017; Klimstra et al., 2009), we saw this as a suitable strategy to minimize missing data. We also carried out a robustness check in which the analyses were carried out without using the extraversion values from the previous wave. This robustness check, without the values from a prior measurement, yielded the same results as our main analyses. Another robustness check, in which all 56 step-ups were excluded completely, also yielded the same findings as our main analyses.

### Participants

Participants were 843 adolescents aged 14 to 17 years (57.8% female; age at T1:  $M = 16.11$ ,  $SD = 0.78$ ) who participated in wave 11 and the COVID-19 survey of the pairfam study. At T1, 95.0% of participants reported living with their parents, while 4.9% had already moved out (one missing). 97.5% of the adolescents were currently enrolled in the educational system. Most participants were German natives (75.7%), while the remaining were first- or second-generation immigrants (22.0%) or had missing data (2.3%). Parental education was used to indicate educational background (ISCED-97 classification, Schneider, 2008). 52.4% of parents had some form of tertiary education or higher (Bachelor's or equivalent or higher). 33.5% had some form of post or upper secondary education, 2.4% had lower secondary education or no degree (12.0% missing).

### Measures

**Depressiveness.** Depressiveness was measured using the adapted German version of the State-

Trait Depression Scales (STDS) (Krohne, Schmukle, Spaderna, & Spielberger, 2002). For the present study, only the trait scale of the instrument was used as only the trait scale was available in the pairfam panel. During the first measurement, young people were asked to indicate how they feel, and the items were formulated in the present tense. During the second measurement, respondents were asked to indicate how they had felt during the lockdown and the items were phrased in the past tense. This difference in timeframe will be considered in the discussion. The trait scale consists of five items assessing negative mood (e.g., T1: "I feel sad," T2: "I felt sad") and five items assessing positive mood (e.g., T1: "I feel secure," T2: "I felt secure"). The positive mood items were recoded to represent anhedonia ("loss of positive") (Spaderna, Schmukle, & Krohne, 2002). The response format ranged from 1 = *almost never* to 4 = *almost always*. Both subscales had a good reliability for both measurement points (negative mood: T1  $\alpha = .82$ , T2  $\alpha = .87$ ; anhedonia: T1  $\alpha = .78$ , T2  $\alpha = .83$ ).

**Extraversion.** To capture extraversion, we used a short version of the Big Five Inventory (Rammstedt & John, 2005). Extraversion was assessed with four items. The response format ranged from 1 = *absolutely incorrect* to 5 = *absolutely correct*. Extraversion was assessed at T1 and its items had a good reliability ( $\alpha = .78$ ).

**Loneliness.** Only one item from the UCLA (University of California, Los Angeles), Loneliness Scale (Russell, Peplau, & Cutrona, 1980) was available in the pairfam panel to indicate the feeling of loneliness. Like depressiveness, the item on loneliness was also recorded with different time references at the two measurement points. At T1, young people were asked to state how they felt, and the item was formulated in the present tense ("I feel alone"), whereas at T2 they were asked to state how they had felt during the last four weeks and the item was formulated in the past tense ("I felt alone"). Resulting limitations are also addressed in the discussion. The response format ranged from 1 = *not at all* to 5 = *absolutely*.

### Analytic Strategy and Model Building

Analyses were conducted in Mplus version 7.0 (Muthén & Muthén, 1998). We decided to use a latent change score model within a structural equation modeling context to map intraindividual changes in the two facets of depressiveness

(McArdle, 2009). To model the change in loneliness between the measurement points, a manifest change score (difference from T2 minus T1) was formed, since the construct was measured with only one item at each measurement. A latent change score model could be implemented for the change in the two facets of depressiveness, as it was measured with several items. By modeling these changes, it was possible to control for the levels of loneliness and each aspect of depressiveness before the lockdown. Since we also wanted to test the mediation of the effect of extraversion on the two facets of depressiveness via loneliness as a linking element, it was advisable to model the change in loneliness and the aspects of depressiveness. This is consistent with recommendations by Cole and Maxwell (2003) for testing mediation with only two measurement time points, thereby controlling for previous values of mediator and outcome.

Initially, we tested for a relationship between missingness and the observed data of the selected 843 adolescents on all 27 study variables. This included the four items on extraversion, 20 items on depressiveness (5 items per subscale \* 2 subscales \* 2 measurement time points), two items on loneliness (1 item \* 2 measurement time points), and the covariate gender. We found no relationship between missingness and the observed data, as tested by a nonparametric MCAR test,  $p = .56$  (Jamshidian, Jalal, & Jansen, 2014). Because covariance coverage was above the minimum of .1 (range: .88–.99), we could use full information maximum likelihood (FIML) estimation for handling missing data without the necessity to impute. We chose the robust maximum likelihood estimation as it is more suitable for non-normality of the data. For the evaluation of our model fit, we used Root Mean Square Error of Approximation (RMSEA)  $\leq .05$  and comparative fit index (CFI)  $\geq .95$  to indicate a good fit (Little, 2013). Furthermore, we implemented the Satorra-Bentler Correction for Chi-Square difference testing to compare nested models (Satorra & Bentler, 2010).

The change in loneliness was represented by the difference of the two manifest indicators. Depressiveness was modeled by four separate latent factors, negative mood, and anhedonia with two measurement points, without a second-order factor of depressiveness. Extraversion was modeled by one latent construct at T1. The loading structure of all latent constructs was examined to choose the best reference indicator for each latent construct (Van de Schoot, Lugtig, & Hox, 2012). We decided

to model indicator-specific effects by correlation of errors (Reuter et al., 2010).

Confirmatory factor analyses (CFA) were applied to test measurement models and invariance across measurement points (Van de Schoot et al., 2012). Since, complete scalar measurement invariance was not achieved, partial scalar measurement invariance was aimed for instead. For establishing partial measurement invariance (PMI), we implemented a forward confidence interval approach because it is less prone for falsely rejecting PMI (Jung & Yoon, 2016). After partial scalar invariance was established, the model was reparametrized as a latent change score model to capture true intraindividual change in the depressiveness facets (McArdle, 2009). In this parametrization, the latent variable of the second measurement point, while restricting its variance to 0, is perfectly predicted (by loadings of 1) through the latent variable of the first measurement point and a newly created latent difference variable (McArdle, 2009). Thus, the mean of this new difference variable represents averaged intraindividual change, while its variance reflects interindividual differences in intraindividual change. This was done for both facets of depressiveness.

Based on these latent change models of negative mood and anhedonia, change in loneliness was introduced as a mediator (Cole & Maxwell, 2003; MacKinnon & Fairchild, 2009). In a final step, all regressions within the structural model were controlled for adolescents' gender to control for known gender differences in depressiveness (Hankin & Abramson, 2001) and loneliness during the pandemic (Bu et al., 2020; Pierce et al., 2020). In an earlier version of the manuscript, it was originally planned to control for age differences, as the age range of the young people was wider. However, in the revised version, the age range was reduced and against this background, we no longer expected age effects, so we no longer included age as a covariate. Exploratory analyses also showed no significant association of age with the other variables within the new sample, similar to the original analyses.

To obtain the effect sizes, the standardized beta coefficients of the regressions were converted into correlation coefficients (Peterson & Brown, 2005), which can be interpreted in the metric according to Cohen (1992) where  $r = .1$  represents a small effect,  $r = .3$  a medium effect, and  $r = .5$  a large effect. The 95% confidence intervals were calculated for these correlation coefficients as well as for model estimates of means and variances. For the

mediation analysis, we used a bias-corrected bootstrap with 1000 replications to calculate limits for a 95% confidence intervals for all paths within the model (MacKinnon & Fairchild, 2009).

RESULTS

Model Fit and Sample Statistics

Model evolution and fit are depicted in Table 1. Table 2 shows means, standard deviations, and correlations of all indicators from the sample.

Change of Depressiveness and Loneliness

The means of the latent change variables indicated an intraindividual rise of negative mood ( $M = .27, p < .001$ ; 95% CI = 0.21, 0.32) and an increase of anhedonia ( $M = .53, p < .001$ ; 95% CI = 0.47, 0.59). The variances of the change variables indicated interindividual differences in the changes of negative mood ( $M = .42, p < .001$ ; 95% CI = 0.36, 0.49) and anhedonia ( $M = .47, p < .001$ ; 95% CI = 0.40, 0.54). An exploratory Wald Test revealed a greater increase of anhedonia than rise of negative mood,  $Wald(1) = 88.995, p < .001$ .

The mean of the change of loneliness indicated a rise of loneliness ( $M = .18, p < .001$ ; 95% CI = 0.08, 0.28) with a significant variance ( $M = 2.22, p < .001$ ; 95% CI = 1.99, 2.46).

Effects of Extraversion on Depressiveness and Loneliness

We found evidence for the hypothesized detrimental effect of extraversion during lockdown conditions. Inspecting change, higher extraversion at T1 predicted a greater increase in negative mood ( $b = .14, p = .003, r = .19, 95\% \text{ CI} = 0.11, 0.29$ ), more anhedonia ( $b = .15, p = .002, r = .20, 95\% \text{ CI} = 0.11, 0.32$ ), and a higher increase of loneliness ( $b = .15, p < .001, r = .20, 95\% \text{ CI} = 0.13, 0.29$ ). A higher rise in loneliness predicted a stronger increase of both negative mood ( $b = .44, p < .001, r = .49, 95\% \text{ CI} = 0.39, 0.54$ ) and anhedonia ( $b = .38, p < .001, r = .43, 95\% \text{ CI} = 0.37, 0.54$ ). Inspecting prepandemic associations at T1, extraversion was negatively correlated with anhedonia ( $r = -.39, p < .001, 95\% \text{ CI} = -0.45, -0.33$ ) and negative mood ( $r = -.26, p < .001, 95\% \text{ CI} = -0.31, -0.19$ ). Standardized model coefficients are depicted in Figure 1.

An exploratory Wald Test revealed equal effects of extraversion on the two dimensions of

TABLE 1  
Evolution of Models and Fit-Indices for all Models

Model	Model comp. <sup>a</sup>	$\chi^2$ (df)	CFI	RMSEA (90% CI)	$\Delta \chi^2$ ( $\Delta$ df)	$\Delta$ CFI	$\Delta$ RMSEA
M1: Configurational Invariance	—	539.65 (231)	.960	.040 (0.035–0.044)	—	—	—
M2: Metric Invariance	M1	574.38 (239)	.957	.041 (0.037–0.045)	35.30** (8)	.003	.001
M2a: Partial Metric Invariance	M1	553.54 (238)	.960	.040 (0.035–0.044)	13.73 (7)	.000	.000
M3: Scalar Invariance	M2a	716.85 (246)	.940	.048 (0.044–0.052)	176.46** (8)	.020	.008
M3a: Partial Scalar Invariance	M2a	555.27 (241)	.960	.039 (0.035–0.044)	1.48 (3)	.001	.000
M4: Latent Change Mediation	—	604.31 (260)	.957	.040 (0.036–0.044)	—	—	—
M4a: Latent Change Mediation with Covariates	—	757.24 (280)	.947	.045 (0.041–0.049)	—	—	—

Note.  $N = 843$ . Model 4 and Model 4a were not compared, based on Chi-Square difference testing, as they were not nested models.

\* $p \leq .05$ ; \*\* $p \leq .01$ .

<sup>a</sup>Model compared to.

TABLE 2  
Sample Means, Standard Deviations, and Zero-Order-Correlations of Study Variables

Construct	M	SD	2	3	4	5	6	7	8	9	10
1 T1 Extraversion	3.32	0.90	-.18**	-.19**	-.25**	-.02	.02	-.08*	.13**	.17**	.13**
2 T1 Loneliness	2.10	1.15		.55**	.51**	.26**	.30**	.26**	-.54**	-.14**	-.18**
3 T1 Negative mood	1.74	0.54			.66**	.25**	.44**	.35**	-.20**	-.36**	-.21**
4 T1 Anhedonia	1.85	0.55				.26**	.34**	.42**	-.17**	-.19**	-.43**
5 T2 Loneliness	2.27	1.30					.53**	.44**	.67**	.34**	.21**
6 T2 Negative mood	1.91	0.68						.69**	.23**	.68**	.40**
7 T2 Anhedonia	2.14	0.65							.18**	.43**	.63**
8 Δ Loneliness <sup>a</sup>	0.18	1.50								.40**	.32**
9 Δ Negative mood <sup>a</sup>	0.17	0.65									.58**
10 Δ Anhedonia <sup>a</sup>	0.29	0.65									

Note. N = 739 (not all cases were included in the sample correlation due to listwise deletion).

<sup>a</sup>Δ represents the difference between T2 and T1.  $p \leq .05$ .

\*\* $p \leq .01$ .

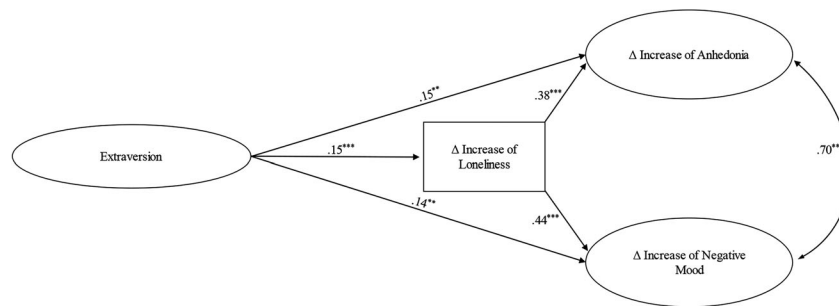


FIGURE 1 Simplified representation of final mediation model. Standardized coefficients are displayed. Rectangular variables indicate manifest variables, whereas oval variables indicate latent constructs. The (latent) change variables are indicated through Δ and the naming of the change variable reflects the direction of its mean. Analyses were controlled for sex. \* $p \leq .05$ ; \*\* $p \leq .01$ . \*\*\* $p \leq .001$ .

depressive change,  $Wald(1) = .178, p = .67$ . Similarly, the effects of loneliness on the two facets of depressiveness did not differ,  $Wald(1) = .590, p = .44$ . The results of the regression indicated that 3.0% ( $R^2 = .03$ ) of the variance in change of loneliness, 25.0% ( $R^2 = .25$ ) of the variance in change of negative mood, and 20.3% ( $R^2 = .20$ ) of the variance in change of anhedonia was explained.

**Tests of Mediation**

The total effects of extraversion on increased negative mood ( $b = .21, p < .001, r = .26, 95\% \text{ CI} = 0.16, 0.35$ ) and increased anhedonia ( $b = .21, p < .001, r = .26, 95\% \text{ CI} = 0.17, 0.35$ ) were about the same. About a third of the total effect of extraversion on increased depressiveness was mediated through increases in loneliness with similar indirect effects for negative mood ( $b = .07, p < .001, r = .12, 95\% \text{ CI} = 0.08, 0.15$ ) and anhedonia ( $b = .06, p < .001, r = .11, 95\% \text{ CI} = 0.08, 0.14$ ).

**Effects of Gender**

Females showed a higher increase in negative mood ( $b = .09, p = .005, r = .14, 95\% \text{ CI} = 0.07, 0.20$ ) and anhedonia ( $b = .08, p = .024, r = .13, 95\% \text{ CI} = 0.06, 0.20$ ). Change in loneliness was not predicted by gender ( $b = .05, p = .143, r = .10, 95\% \text{ CI} = -0.06, 0.17$ ). At T1, being female was correlated with higher extraversion ( $r = .13, p = .002, 95\% \text{ CI} = 0.06, 0.19$ ), more negative mood ( $r = .25, p < .001, 95\% \text{ CI} = 0.18, 0.31$ ) and more anhedonia ( $r = .09, p = .022, 95\% \text{ CI} = 0.02, 0.15$ ).

**DISCUSSION**

The aim of the present study was to investigate effects of adolescents' extraversion on their loneliness and depressiveness during the first COVID-19 lockdown in Germany. Extraversion commonly functions as resource protecting against depressiveness and loneliness in adolescence (Buecker et al., 2020; Metts et al., 2021; Swickert et al., 2002). But



more recent longitudinal studies from the pandemic with adult samples were able to show that extraversion can be a burden under conditions of lockdown (Gubler et al., 2021; Wijngaards et al., 2020; Zacher & Rudolph, 2021). We therefore expected a stronger increase in loneliness and depressiveness among highly extraverted youth in the context of restricted contact to others.

Our findings revealed significant increases in loneliness and depressiveness among adolescents which is in line with findings from adult samples (Bu et al., 2020; Vindegaard & Benros, 2020). The overall rise in depressiveness resulted mainly from an increase of anhedonia rather than an increase of negative mood. Girls showed higher levels and increases of depressiveness which is in line with previous research (Hankin & Abramson, 2001), but no gender differences emerged for the change of loneliness. Our findings also support the protective effect of extraversion under normal conditions as sample correlations of the trait and both facets of depressiveness were inversely correlated prior to the pandemic. However, under the compromised conditions of the lockdown, the correlation between extraversion and negative mood was no longer significant and the correlation between extraversion and anhedonia was still significant and negative, but smaller. Thus, only in conjunction with the pre-pandemic measurement, the actual weakening of this association was detectable.

More importantly, we found evidence of the hypothesized detrimental effects of extraversion on loneliness and depressiveness during conditions of the lockdown. Highly extraverted adolescents experienced a more pronounced increase in depressiveness than youth with lower extraversion, and this higher increase in depressiveness was partially mediated by a higher rise in loneliness among extraverted youth. These results challenge the notion that extraversion stably functions as a protective factor against depressiveness. Under the conditions of the first German COVID-19 lockdown, this personality trait seemed to be more of a burden for adolescents. The usually increased contact of extraverted adolescents with their friends (Swickert et al., 2002), which they find rewarding (Wilkowski & Ferguson, 2014) and which normally protects them from depressive experience (Mak et al., 2021), was not possible during the lockdown. This disruption of the extraverts' social networks, which has been speculated to play a role in other contexts (Sodermans & Matthijs, 2014), probably played a salient role in the worsening of young people's mood.

These results are also in contrast to some studies (Kocjan et al., 2021; Morales-Vives et al., 2020), which, however, all used cross-sectional designs. This may have obscured the real story, as cross-sectional findings do not inform about differences in change. Furthermore, in the context of increased autonomy with age and the accompanying freedom over one's own social contacts (McElhaney et al., 2009), the adults investigated in the contradicting studies (Kocjan et al., 2021; Morales-Vives et al., 2020) may have had better chances to still pursue social contacts despite the lockdown, maybe even in their regular work environments outside their homes. In contrast, all schools were closed in Germany and adolescents had hardly any chance to see their friends.

Furthermore, the cultural differences of the countries should also be considered. In comparative cultural research, Germany can be described as a rather tight culture, because it has strong norms and little tolerance for deviant behavior. Spain and Slovenia, on the other hand, which are seen as loose cultures in comparison to Germany, have weaker norms and higher tolerance for deviant behavior (Uz, 2015). It is possible that the extraverted adults in Spain and Slovenia did not follow the rules as much as the extraverted youths in Germany who were still under parent's supervision. There also seems to be a general tendency of extraverts not to abide by the rules on social distancing (Brouard, Vasilopoulos, & Becher, 2020), which may have played a bigger role in Spain and Slovenia due to the higher tolerance for deviant behavior. In addition, in Spain, the negative effects of isolation may have been mitigated by extended family structures and more family members living within the same household (Iacovou & Skew, 2011).

The lack of gender differences in the increase of loneliness, in contrast to previous findings (Bu et al., 2020), could possibly be attributed to the overall low variance explanation (3%) for the observed variable of loneliness. In contrast, variances explained for the latent constructs were significantly higher at 25% for negative mood and 20% for anhedonia. The fact that loneliness was only represented by one item, and thus measurement error was not adjusted for, may have amplified this circumstance. Future studies should therefore examine the mediating mechanisms more closely, especially since a large part of the effect of extraversion on the facets of depressiveness was not mediated by loneliness.

Our analyses also showed a large interindividual variance in the change of loneliness and depressiveness, which indicates that young people did cope with the lockdown differently, although it was a burden on average in our sample. Even though face-to-face communication was not possible due to the lockdown, some adolescents may have used more technical possibilities (e.g., mobile phones) to stay in contact with their peers (Orben et al., 2020). Future work could possibly examine these interindividual differences more thoroughly and shed more light on them with the help of person-centered methods.

### Limitations

An obvious weakness is the retrospective survey of loneliness and depressiveness. In one study, differences in the comparison of the currently reported mood and the later remembered mood emerged, and this was particularly the case for depressed people (Urban, Charles, Levine, & Almeida, 2018). The remembered mood was systematically worse than the earlier reported mood. However, this was only true for negative mood and there was no recall bias for positive mood. Thus, the recall of positive mood in our study (recoded as anhedonia) may be considered less biased. The delayed survey may also have had a beneficial side effect, as more time allowed the detrimental effect of lockdown to unfold. The studies that surveyed very shortly after the introduction of lockdowns did not find any harmful effect of extraversion (Kocjan et al., 2021; Morales-Vives et al., 2020). Additionally, in the study by Zacher and Rudolph (2021), extraversion predicted an increase in stress from April 2020 to July 2020, which marked the end of lockdown and the beginning of relaxation period. Thus, in their study, the effects of the lockdown may have reverberated into the relaxation phase. Given the same cultural context, this could also apply to our study as well.

Loneliness was assessed with only one item because large-scale panel surveys like pairfam often work with shortened scales for reasons of time and cost. Accordingly, reliability and validity of the measure may be suboptimal. However, a single indicator may be an adequate replacement for a whole scale. For example, a one-item question adequately measured current anxiety as evidenced by a very high correlation of .75 (95%-CI.70-.79) with the State-Trait Anxiety Inventory (Davey, Barratt, Butow, & Deeks, 2007).

We have only used two waves and recognize that this only allows for limited conclusions to be drawn about the intraindividual development of the adolescents. But confronted with the decision to wait and integrate a possible post-COVID wave or to use only two waves to at least be able to identify emerging trends, we decided for the latter. In view of this decision, the latent change model may be considered a suitable choice, especially since it allows modeling without measurement error (Henk & Castro-Schilo, 2016). Regarding the mediation, the assessment of only two waves is not optimal either since the mediator and outcome were surveyed at the same time. From a modeling point of view, a mediation with two measurement points is possible if the condition of stationarity is fulfilled, meaning that the influence of one variable on the other remains the same over time (Cole & Maxwell, 2003). Vanhalst et al. (2012) found a constant influence of adolescents' loneliness on their depressiveness across five years so this requirement may be fulfilled.

The variance in the span between the first and second measurement point could also have influenced the results, as the largest gap between the measurements could have been 21 months and the smallest 9 months. However, this heterogeneity may even have been beneficial, as it corresponds to continuous rather than discrete-time modeling (Deboeck & Preacher, 2016). The different spans may have mapped the natural underlying process more appropriately because the influence of extraversion on loneliness and depressiveness also happens continuously.

Within the pairfam panel, unfortunately, only trait scales and no state scales of depressiveness were assessed. Thus, we had to rely on the trait constructs of negative mood and anhedonia which is not optimal. However, the correlation between the latent trait scale and the latent state scale seems to be very strong for anhedonia ( $r = .80, p < .001$ ) and moderate for negative mood ( $r = .48, p < .001$ ) (Krohne et al., 2002). This could suggest that the stable aspects of anhedonia (Shankman et al., 2010) and the more modifiable aspects of the construct have a large overlap, so our use of the trait construct may have been acceptable after all.

### Conclusion and Implications

This is the first study to analyze the effects of adolescents' extraversion on their loneliness and depressiveness during the first German COVID-19

lockdown. We are convinced that our study can make a valuable contribution to the better understanding of adolescent personality, even though it has some shortcomings. From our point of view, the advantages of longitudinal data collection and the use of the German lockdown as a natural experiment outweigh the disadvantages. At the very least, the study can be seen as a first step towards examining the differential reactivity of extraverted adolescents in different environments more thoroughly (Slagt, Dubas, van Aken, Ellis, & Deković, 2017). Until now, extraversion has mainly been a desirable trait with positive effects on psychological well-being. Our findings draw a more nuanced picture revealing this personality trait as potentially disadvantageous for adolescents under conditions of contact restrictions. Given the elevated levels of loneliness and depressiveness in adolescence, this age group is a particularly important target for policy interventions, not only to relieve current psychological burden, but also to prevent worse symptoms and chronification. Strengthening the rights of these young people at risk during the pandemic could thus be pronounced as a key objective. One conceivable goal for future pandemics could be to adjust the risk criteria for determining the vaccination order. If not only somatic pre-existing conditions but also psychological and developmental vulnerabilities were to play a role, it might be possible to vaccinate young people at risk earlier so that they are entitled to participate in social life sooner. The findings can thus serve as a warning to raise awareness for this likely undetected risk group of extraverted adolescents in current policy decisions. Whether the epidemiological benefits of public health measures outweigh potential psychological costs are a question every policy maker should consider.

#### ACKNOWLEDGEMENTS

This work was supported by the German Research Foundation (DFG) under grant number Wa 949/11-1 through 11-6 awarded to Sabine Walper as co-principle investigator of the pairfam panel. This paper uses data from the German Family Panel pairfam, coordinated by Josef Brüderl, Sonja Drobnič, Karsten Hank, Bernhard Nauck, Franz Neyer, and Sabine Walper. Pairfam is funded as long-term project by the German Research Foundation. We would like to thank the anonymous reviewers for their valuable comments and suggestions on an earlier draft of this paper.

We would also like to thank Simon Boehm and Sabine Krueger who assisted with proof reading. We are most grateful to all participants of pairfam (<http://www.pairfam.de/en/>).

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