



Since January 2020 Elsevier has created a COVID-19 resource centre with free information in English and Mandarin on the novel coronavirus COVID-19. The COVID-19 resource centre is hosted on Elsevier Connect, the company's public news and information website.

Elsevier hereby grants permission to make all its COVID-19-related research that is available on the COVID-19 resource centre - including this research content - immediately available in PubMed Central and other publicly funded repositories, such as the WHO COVID database with rights for unrestricted research re-use and analyses in any form or by any means with acknowledgement of the original source. These permissions are granted for free by Elsevier for as long as the COVID-19 resource centre remains active.



Longitudinal examinations of changes in well-being during the early period of the COVID-19 pandemic: Testing the roles of extraversion and social distancing

Jongan Choi^{a,b}, Namhee Kim^c, Jinhyung Kim^{b,d,*}, Incheol Choi^{c,e,*}

^a Department of Psychology, Kangwon National University, South Korea

^b Institute for Hope Research, Sogang University, South Korea

^c Center for Happiness Studies, Seoul National University, South Korea

^d Department of Psychology, Sogang University, South Korea

^e Department of Psychology, Seoul National University, South Korea

ARTICLE INFO

Keywords:

Extraversion
Well-being
COVID-19
Person-environment fit
Longitudinal study

ABSTRACT

The present research, by using longitudinal data collected in South Korea ($N = 69,986$) during the early period of the COVID-19 pandemic (1 January–7 April 2020), examined the pandemic-related changes in the relationship between extraversion and well-being. Multilevel analyses revealed that participants experienced decreased well-being during the pandemic. When analyzing the responses ($n = 3,229$) completed during all the periods encompassing the COVID-19-related events (e.g., outbreak of COVID-19), we found the greater within-person decreases in well-being among extraverts than introverts after the intensive social distancing. This finding suggests that social distancing, as a necessary means to curb the spread of COVID-19, inadvertently reduced well-being of extraverts. Implications for the person-environment fit literature, limitations, and future research avenues are discussed.

1. Introduction

As of August 2022, more than 595 million people around the globe have been infected with the coronavirus disease 2019 (COVID-19), and more than 6.45 million deaths due to the virus ensued. With its global impacts on human health and lives, this ongoing pandemic has been accompanying a great deal of disruptions in every sector of our cultural systems. Amongst many, social disruption, through self-quarantining and social distancing, particularly has thwarted our basic need to belong (Baumeister & Leary, 1995) and thereby led to widespread emotional and psychological sufferings during the COVID-19 pandemic (e.g., Jacob et al., 2020). For example, Smith et al. (2020) probed 932 UK adults who reported that they were self-isolating or social distancing due to COVID-19 and found that 36 % of their sample suffered from poor mental health, which is much higher than 25 % of the prevalence rate of poor mental health during non-pandemic in the UK. They also reported that the participants exhibited greater depression as well as lower subjective well-being than what had been reported during non-pandemic

times. Similar patterns of reduced well-being during the COVID-19 pandemic have been documented in other countries including, Korea (Choi et al., 2020), Germany (Zacher & Rudolph, 2020), China (Wang et al., 2020), and the United States (VanderWeele, Fulks, Plake, & Lee, 2020).

Despite this ubiquitous psychological toll of COVID-19, some people seem to be handling this collective adversity more adaptively than others and maintaining an optimal level of well-being and mental health. One intriguing possibility for this observation is that the COVID-19 pandemic may have influenced well-being and psychological adaptation differently for extraverts and introverts. For instance, extraverts might have undergone steeper declines in well-being than introverts since the pandemic, as limited social interaction via self-quarantining and social distancing can be more detrimental to extraverts than introverts (Harris, English, Harms, Gross, & Jackson, 2017; Lee, Dean, & Jung, 2008; Srivastava, Angelo, & Vallereux, 2008). On the other hand, it also makes sense to speculate that because extraverts are dispositionally happy (Canli, 2004; Osinsky et al., 2010), they might have been able to

* Corresponding authors at: Sogang University, 35 Baekbeom-ro, Mapo-gu, Seoul 04107, South Korea (J.K.); Seoul National University, 1 Gwanak-ro, Gwanak-gu, Seoul 08826, South Korea (I.C.).

E-mail addresses: jinhjung@sogang.ac.kr (J. Kim), icho@snu.ac.kr (I. Choi).

<https://doi.org/10.1016/j.jrp.2022.104306>

Received 27 December 2021; Received in revised form 20 August 2022; Accepted 3 October 2022

Available online 11 October 2022

0092-6566/© 2022 Elsevier Inc. All rights reserved.

maintain their original baseline of happiness even with the catastrophic changes in life conditions including financial and social domains (Wei, 2020). While some attempted to address this question, existing evidence lacks methodological rigor and provides mixed results (e.g., Folk, Okabe-Miyamoto, Dunn, & Lyubomirsky, 2020; Morales-Vives, Dueñas, Vigil-Colet, & Camarero-Figuerola, 2020; Wei, 2020). In the present research, we aim to tackle the question as to whether and how the COVID-19 pandemic affects well-being for extraverts and introverts over time by analyzing longitudinal panel data.

1.1. Extraversion and well-being

For decades, personality research has consistently documented the positive association between trait extraversion and various indicators of well-being. Extraversion, characterized by individual's enduring tendencies to think, feel, and behave in a bold, assertive, energetic, talkative, and adventurous manner over time and across situations (McCrae & Costa, 2003), is positively linked with subjective perception of one's own happiness (Costa & McCrae, 1980), positive affect (Emmons & Diener, 1985; Lucas & Fujita, 2000), life satisfaction (DeNeve & Cooper, 1998; Steel, Schmidt, & Shultz, 2008), subjective vitality (Ryan & Frederick, 1997), and meaning in life (Steger, Frazier, Oishi, & Kaler, 2006). A recent meta-analysis further analyzed more than 460 studies and showed that extraversion is positively correlated with subjective well-being indices (e.g., affective balance and life satisfaction), with an averaged correlation coefficient of $r = 0.37$, and psychological well-being indices (e.g., self-acceptance, environmental mastery, and purpose in life), with an averaged correlation coefficient of $r = 0.48$ (Anglim, Horwood, Smillie, Marrero, & Wood, 2020).

Not only does being a *bona fide* extravert enjoy hedonic benefits, but also being a *faux* extravert by momentarily acting extraverted enhances one's happiness (Fleeson, Malanos, & Achille, 2002; McNiel & Fleeson, 2006; Sandstrom & Dunn, 2014; Zelenski, Santoro, & Whelan, 2012; Zelenski et al., 2013). In other words, state extraversion is also associated with well-being. For example, Fleeson et al. (2002) demonstrated that participants who were instructed to act extraverted (vs introverted) during a group discussion experienced a higher level of positive affect than their introverted counterparts. Notably, the increase in positive affect among the experimentally induced extraverts did not differ by their original level of trait extraversion, which suggests that dispositional introverts also enjoyed the hedonic benefits from acting extraverted. A more recent intervention study further corroborated the positive association between state extraversion and well-being by showing a week-long implementation of acting extraverted produced prolonged enhancement of well-being including positive affect and life satisfaction (Margolis & Lyubomirsky, 2020). Although another study has raised a concern about the generalizability of these findings (Jacques-Hamilton, Sun, & Smillie, 2019), ample evidence supports the idea that thinking, feeling, and behaving in an extraverted fashion enhances well-being at least in the short run. While it is still unclear about the precise nature of and psychological process by which extraversion is linked with happiness (e.g., Harris et al., 2017), it seems straightforward that people high in extraversion, whether trait or state, exhibit greater well-being than those low in extraversion (Anglim et al., 2020; Steel et al., 2008).

1.2. Pandemic and well-being

As previously described, COVID-19 has posed enormous challenges to our daily lives. Most governments have opted for the implementation of social distancing regulations and lockdowns in order to reduce the

spread of COVID-19 and urge people to stay at home and remain "contact-free" as much as possible. Some people even voluntarily choose to self-isolate out of fear of the novel virus. When in public necessarily, people are strongly encouraged (or even mandated) to wear a mask and stay at least 6 feet away from each other. All of such physical and social distancing practices counteract "our profoundly human and evolutionarily hard-wired impulses for connection" (Christakis, 2020). Consequently, our fundamental need for social connection (Baumeister & Leary, 1995; Ryan & Deci, 2000) is easily unmet, and people are very much likely to suffer from loneliness and social isolation during the pandemic. Empirical evidence for this possibility has been rapidly accumulating, converging in suggesting that a lack of social contact and belonging has led to considerable declines in well-being and poor mental health during the COVID-19 pandemic (e.g., Smith et al., 2020; Wang et al., 2020; Zacher & Rudolph, 2020).

Substantial reduction of social interactions during the pandemic suggests that it may be especially challenging to extraverts. Extraverts' dispositional tendency to socialize will be hardly exercised under this circumstance; extraverts will have to suppress their desires to engage in physical activities and social events to feel energetic and act sociable. Indeed, social distancing prohibits people from visiting places such as bars, cafés, and restaurants, all of which extraverts spend a great deal of time in daily life (Matz & Harari, 2020). Essentially, extraverts may find it particularly difficult to be *who they are* during this pandemic period. According to the literature on person-environment fit (e.g., Higgins, 2000; Schmader & Sedikides, 2018; Stephens, Townsend, Markus, & Phillips, 2012), this mismatch between the self and context will create a psychological tension, which then serves as a cue signaling that one is not living up to the ideal standards and thereby decreases a sense of well-being. Supporting this possibility, Fulmer et al. (2010) demonstrated that extraverts are less happy and evaluate themselves less favorably when residing in societies where other members are not as much extraverted as themselves. By the same token, the COVID-19 pandemic seems to have created an environment which fits better with introverts. Given that social distancing rules are like the "mirror image of this [acting extraverted] intervention" (Smillie & Haslam, 2020), introverts have been exercising social distancing throughout the whole life and thus experience little change in their social life during the pandemic. It is less conceivable that introverts actually feel happier during the pandemic than before as they have to undergo other kinds of difficulties alike; however, it seems plausible that they would suffer less from limited social interactions than extraverts. Taken together, these notions speak to the possibility that extraverts would experience greater declines in well-being than introverts during the COVID-19 pandemic, particularly due to restricted social contact and interaction through the governmental regulation of social distancing and self-quarantining.

On the contrary, it also makes sense to argue that the COVID-19 pandemic can be more disadvantageous to introverts than extraverts. No matter how the pandemic frustrates extraverts' desires to socialize, they still have better social and psychological resources, such as a larger social network (Harris et al., 2017), more available social support (Swickert, Rosentreter, Hittner, & Mushrush, 2002), and greater psychological resilience (Oshio, Taku, Hirano, & Saeed, 2018), than introverts. As social support alleviates feelings of loneliness during the COVID-19 lockdown (Luchetti et al., 2020), extraverts would maintain their well-being if they can tap their coping resources against the COVID-19 trauma. Indeed, one study examined a sample of Spanish population and found extraversion was positively associated with better adjustment to the lockdown, presumably due to extraverts' greater resilience and perceived social support (Morales-Vives et al., 2020). Moreover, extraverts would be able to adequately attribute their

negative feelings derived from the person-environment mismatch to the virus itself (e.g., “social distancing is essential for stopping the spread of COVID-19”, McGrail, Dai, McAndrews, & Kalluri, 2020). Conversely, introverts might be more vulnerable to loneliness and social isolation during the pandemic because they do not have as much social support and psychological resilience as extraverts. Rather than leading to the person-environment fit for introverts, social distancing may simply take an opportunity to act extraverted away from introverts and render their well-being below the optimal level (e.g., Fleeson et al., 2002; Sandstrom & Dunn, 2014; Zelenski et al., 2012).

Previous studies have directly and indirectly explored how extraversion is associated with well-being during the COVID-19 pandemic (e.g., Gupta & Parimal, 2020; Liu, Lithopoulos, Zhang, Garcia-Barrera, & Rhodes, 2020; Morales-Vives et al., 2020). Of the particular relevance to the present research, Folk et al. (2020) explicitly tested whether the COVID-19 pandemic affected social relatedness (i.e., social connection and loneliness) and well-being (i.e., lethargy and life satisfaction) more negatively for extraverts than introverts, or vice versa. By recruiting Canadian, US, and UK samples, they found that extraverts exhibited greater declines in social connection than introverts, and introverts showed reduced loneliness while extraverts revealed no change in loneliness during the pandemic compared to the pre-pandemic period. These results support the notion that extraverts are more negatively affected by the COVID-19 pandemic; however, they also showed that these differences between extraverts and introverts did not exist any longer when social relatedness in the pre-pandemic time was statistically controlled for, which indicates that extraverts fared worse than introverts simply because extraverts have more to lose. They further tested whether the changes in social relatedness led to well-being differently for extraverts and introverts but did not find any evidence for such possibilities.

Although Folk et al. (2020) and other research provide valuable insight into understanding how extraversion is related to well-being under the COVID-19 regime, those studies lack methodological rigor and produce mixed, inconclusive results. For instance, several studies adopted a cross-sectional study design in which extraversion and well-being indices were measured at a certain point of time since the COVID-19 outbreak (Gupta & Parimal, 2020; Liu et al., 2020; Morales-Vives et al., 2020). Such studies cannot adequately test whether COVID-19 influenced well-being of extraverts and introverts over time but only imply the between-person difference in well-being by trait extraversion. Folk et al. (2020) used an improved study design by assessing well-being before and after the pandemic; however, the measurement times at which they assessed well-being were loosely arranged (e.g., January 6–February 12, 2020 for pre-pandemic and April 1–8, 2020 for during the pandemic), and they used the difference scores of well-being between the two measurement times in their analyses. These limitations make it harder to conclude whether social distancing affected the within-person changes in social connection and well-being for extraverts and introverts. Another potential issue is that most of the previous studies used samples with cultural backgrounds where compliance with the governmental implementations of social distancing and other regulations cannot be ensured (e.g., Canada, US, UK, and Spain) as confidently as other cultures (South Korea; Gelfand et al., 2020). This demographic tilt may have attenuated the true effect of social distancing on well-being especially for extraverts. Addressing these limitations, the current study examines the role of COVID-19 pandemic, specifically through social distancing, in temporal changes in well-being between extraverts and introverts.

1.3. Conceptualization of well-being

In exploring the relationship between extraversion and well-being during the COVID-19 pandemic, we conceptualize well-being as a multifaceted construct that includes the various aspects of what it means to be living a *good life*. Both scholars and laypeople view good life as consisting of happiness and meaning (King & Napa, 1998; Peterson, Park, & Seligman, 2005), broadly distinguished as hedonic and eudaimonic well-being (Ryan & Deci, 2001). Hedonic well-being focuses on maximizing pleasure and minimizing dissatisfaction; eudaimonic well-being emphasizes actualizing one’s true potentials and achieving a sense of autonomy, maturity, and growth. With these broad definitions, hedonic well-being is regularly assessed with subjective well-being (SWB), conceptualized as the combination of life satisfaction and affective balance between positive and negative emotions (Diener, 1984), and eudaimonic well-being is often measured with psychological well-being (PWB), conceptualized as the combination of self-acceptance, positive relation with others, autonomy, environmental mastery, purpose in life, and personal growth (Ryff, 1989). Each of the SWB and PWB indicators has been linked with a myriad of predictors such as social relationships (e.g., Diener, Ng, Harter, & Arora, 2010), life events (e.g., Lucas, Clark, Georgellis, & Diener, 2003), purchase behaviors (e.g., Van Boven & Gilovich, 2003), and outcomes such as physical health (e.g., Koivumaa-Honkanen et al., 2001), income (e.g., Lucas, Clark, Georgellis, & Diener, 2004), and parenthood (e.g., Kim & Hicks, 2016). Also, a number of research demonstrates the small-to-moderate sizes of correlations between the well-being indicators and personality factors (e.g., Keyes, Shmotkin, & Ryff, 2002; Steel et al., 2008) and the effectiveness of happiness intervention programs (e.g., gratitude; Seligman, Steen, Park, & Peterson, 2005), suggesting that well-being is best understood as having both trait and state features.

Guided by this comprehensive framework on well-being, we operationalized well-being as consisting of the multiple indicators encompassing facets of hedonic well-being (i.e., life satisfaction and affective balance) and eudaimonic well-being (i.e., a sense of meaning). We also added stress as a mental health indicator to our well-being construct given the mental health implications of the pandemic. This operational approach has two major advantages: First, by relying on a multitude of well-being measures instead of any single one, it is possible to draw a broader conclusion about the global relationship between extraversion and well-being during the pandemic, as well as their more nuanced relationships across well-being indicators (this analytic decision depends on dimensionality of the well-being indicators). Second, as mentioned earlier, SWB and PWB indicators have been found to be correlated with extraversion to a small-to-moderate extent (Anglim et al., 2020); thus, it is expected for each of the well-being indicators to have some variability at between- and within-person levels, that may fluctuate along with the COVID-19-related events.

1.4. Present research

To more properly examine whether and how the COVID-19 pandemic impacted well-being differently for introverts and extraverts, the present research employed a longitudinal panel survey in which participants report their well-being multiple times over three months. Specifically, we used a large dataset of South Korean’s well-being ($N = 69,986$), collected from January 1 to April 7, 2020. The merit of using this dataset is diverse: First, the data collection period encompasses the critical COVID-19-related events that occurred during the early stage of the pandemic in South Korea, such as the first confirmed case reported (i.e., January 22) and the first governmental

implementation of an intensive social distancing regulation (i.e., March 22). This feature enables us to directly test a notion that restricted social interactions via social distancing regulations would be more detrimental to extraverts than introverts. Second, given that South Korea is one of the countries where the spread of the coronavirus was most successfully managed, an analysis of South Korean data minimizes the possibility of failing to test our research question simply because respondents were reluctant to comply with the social distancing or other equivalent governmental regulations (Zajenkowski, Jonason, Leniarska, & Koza-kiewicz, 2020). Third, we assessed multifaceted aspects of well-being, including life satisfaction, affect, meaning, and stress, to further examine whether these various well-being indicators differently changed and were differently related to extraversion over the course of the COVID-19 pandemic. Fourth, this dataset contains multiple responses from a number of participants, which allows us to examine within-person changes in daily well-being as a function of the COVID-19-related events and extraversion. Finally, we explored the link of extraversion to well-being in the period of COVID-19 pandemic across various age groups, including adolescents (e.g., teenagers), younger adults (e.g., college students), older adults (e.g., middle age), and seniors (e.g., 65 years and over). With this variety of age groups, we can also address the limitation of previous studies tapping college students only (e.g., Folk et al., 2020) and further test a possibility that the COVID-19 pandemic might have stronger influences on well-being of younger extraverts than their older counterparts.

2. Methods

2.1. Participants

A total of 69,986 South Korean participants completed online surveys available during January 1 to April 7, 2020. The surveys were distributed via an online survey platform (<https://together.kakao.com/hello>) launched by Kakao Corporation, the leading information technology company in South Korea (Choi et al., 2020). Participants were allowed to access and respond to the survey with smartphone or computer at any time across multiple occasions. Because participation was completely voluntary, the number of responses varied across individuals. On average, participants completed the survey 1.87 times ($SD = 1.57$), with the highest number of individual responses being 96. Specifically, 54 % of participants ($n = 37,521$) completed the survey-one time; 27 % ($n = 18,796$) two times; 10 % ($n = 7,033$) three times; 5 % ($n = 3,431$) four times; and 4 % ($n = 3,205$) more than five times (see Table S1 in online supplemental materials for details about the response distribution). This yielded a total of 130,798 valid observations. Fig. 1 illustrates a flow line that details the number of participants and observations along with their ratios across different time periods. Finally, as mandated by the Kakao's privacy policy, we asked demographic information of age, gender, and region of residence only. Participants' ages ranged from 14 to 70 years ($M = 30.62$, $SD = 9.93$), with 81 % females ($n = 56,996$) and 19 % males ($n = 12,990$).¹ 60 % of participants resided in the capital area ($n = 42,284$) while the rest in the noncapital area ($n = 27,702$) in South Korea. See Table 1 for a summary of demographic information.

2.1.1. Statistical power

Given that the sample size of the data was not determined a priori, we conducted power analyses via Optimal Design software (Raudenbush et al., 2011) to examine the statistical power for the multilevel data structure to detect the predicted effect. The power analyses revealed that

¹ The descriptive statistics of age were calculated from the 61,684 participants who provided their exact age information. The remaining participants ($n = 8,302$) reported which age group they belong to (i.e., 10s, 20s, 30s, 40s, 50s, or over 60s).

the total sample size for the polynomial regression analyses ($N = 69,998$) has a statistical power close to 1 to detect a small effect size ($\delta = 0.2$) within an MLM framework (assuming effect size variability $\sigma^2 = 1.15$, proportion of explained variance by the blocking variable as 0), and the subsample size for the mixed effects analyses ($n = 3,229$) has a statistical power close to 1 to detect a small effect size ($\delta = 0.20$) within an MLM framework (assuming effect size variability $\sigma^2 = 1.28$, proportion of explained variance by the blocking variable as 0). Details about the power analyses are available on the Open Science Framework (OSF) webpage at <https://osf.io/xcwq2/>.

2.2. Procedure and measures

Upon entering the website (<https://together.kakao.com/hello>) for completing online surveys, participants were instructed to take a "happiness" test that includes various well-being measures (see below). They also voluntarily completed several of other personality tests that are irrelevant to the current study (e.g., narcissism, perfectionism, political orientation). For extraversion, participants were escorted to a different webpage (<https://together.kakao.com/big-five>) in which they completed the extraversion questionnaire (see below). As noted above, participants were able to complete the survey multiple times; however, most participants completed the extraversion questionnaire once ($n = 64,508$, 92.2 %). For those who provided extraversion responses more than two times, we only used their initial response for the primary analyses.² Thus, extraversion was treated as a between-person variable (see Fig. 1 for the detailed information about the completion of extraversion across different time periods). To ensure data confidentiality, participants were provided with an encrypted, unique identification number by Kakao Corporation. We used this information to match multiple responses of the same participants.

2.2.1. Well-being

To reflect the multifaceted aspects of well-being, we used various well-being indicators. Specifically, the well-being questionnaire measured satisfaction with life (SWL), positive affect (PA), negative affect (NA), meaning in life (MIL), and stress. When responding to the questionnaire, participants were asked to report what they were thinking or feeling at the moment. First, single items were used to assess SWL (i.e., "How satisfied are you with your life right now?"), MIL (i.e., "How meaningful do you feel your life is right now?"), and stress (i.e., "How stressed are you right now?"). For affective well-being indices, participants indicated their emotional experiences (i.e., "How much are you feeling each emotion right now?") by responding to 3 items for PA (i.e., "happy," "joyful," and "relaxed") and 4 items for NA (i.e., "bored," "annoyed," "depressed," and "anxious"). Across all well-being items, ratings were made on an 11-point scale (0 = *not at all*, 10 = *very*). We computed composite PA and NA scores by averaging the ratings (e.g., aggregated scores: $\alpha = 0.88$ for PA; $\alpha = 0.87$ for NA). Descriptive statistics for the well-being measures are presented in Table 2.

2.2.2. Extraversion

We used the 24-item extraversion scale adapted from the revised NEO Personality Inventory (Maples, Guan, Carter, & Miller, 2014). Sample items include: "Make friends easy," "Talk to a lot of people at parties," and "Seek adventure" (see Appendix for full items). Participants responded each item on a 5-point scale (0 = *do not agree at all*, 4 = *strongly agree*). As in the previous research (Maples et al., 2014), we found a good reliability ($\alpha = 0.90$) and therefore created a composite extraversion score by averaging the ratings (see Table 2 for descriptive statistics).

² All analysis results did not change substantially when we used the aggregated extraversion scores for those who completed the extraversion questionnaire more than one time (details are available upon request). Hence, we reported the results from the initial extraversion response.

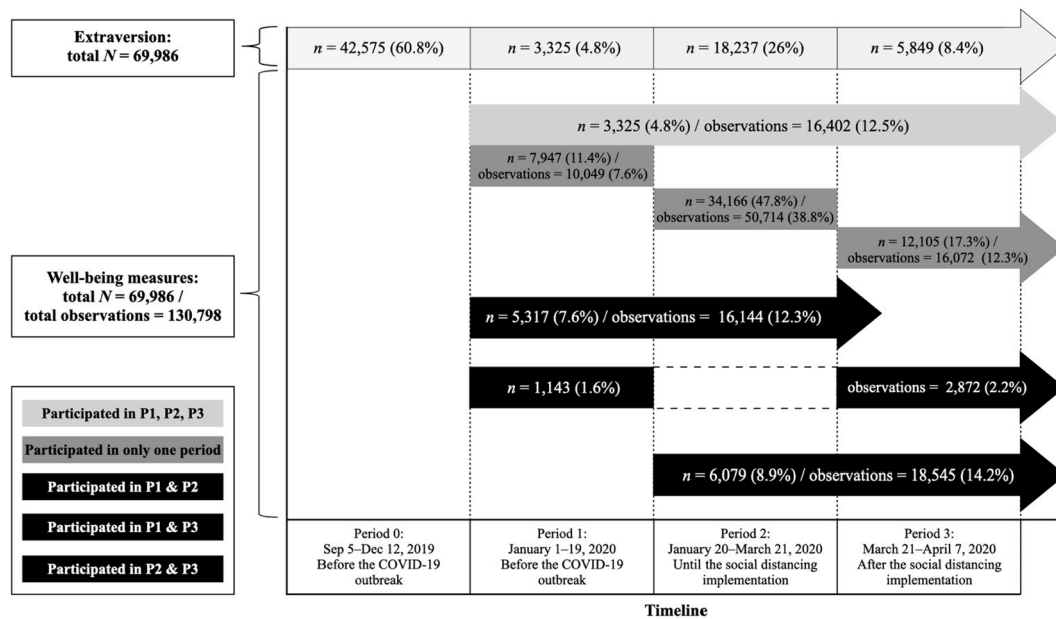


Fig. 1. Flowline of Participants Information About Extraversion and Well-Being Measures Completions Across Time Periods. In this flowline, participants completed extraversion one time during Period 0 through Period 3. Thus, the sum of the number of participants who provided extraversion in each period is equal to the total number of participants ($N = 69,986$). For the well-being measures, participants completed the measures multiple times, which resulted in the total number of 130,798 observations during Period 1 through Period 3. Thus, the sum of the number of observations in each case of measurement completions is equal to the total number of observations.

Table 1
Demographic Information of Participants.

	Full sample ($N = 69,986$)	Subsample ($n = 3,229$) ^a
	N (%)	N (%)
Gender		
Female	56,996 (81.4)	2,806 (86.9)
Male	12,990 (18.6)	423 (13.1)
Age		
10s	13,689 (19.6)	909 (28.2)
20s	28,902 (41.3)	901 (27.9)
30s	16,180 (23.1)	626 (19.4)
40s	7,368 (10.5)	436 (13.5)
50s	3,234 (4.6)	284 (8.8)
Over 60 s	613 (0.9)	73 (2.3)
Region of residence		
Capital area	42,284 (60.4)	1,920 (59.5)
Noncapital area	27,702 (39.6)	1,309 (40.5)
# of responses per person		
1	37,521 (53.6)	N/A
2	18,796 (26.9)	N/A
3 or more	13,669 (19.5)	3,229 (100.0)

Note. ^aThe subsample consists of the participants who completed the well-being surveys during all of the three periods: Period 1 = January 1–19, 2020; Period 2 = January 20–March 21, 2020; Period 3 = March 22–April 7, 2020. N/A = not applicable.

2.3. Analytic approaches

To examine whether well-being has changed during the COVID-19 pandemic, possibly differently for extraverts and introverts, we relied on two analytic approaches. First, we attempted to provide an initial exploratory look at how well-being is changing over the course of the COVID-19 pandemic. Specifically, we explored the trajectories of well-being by using polynomial regression models because the changes in well-being during the COVID-19 pandemic would have occurred in a curvilinear trend (e.g., no change before the outbreak of COVID-19,

slight declines after the outbreak, and then steeper declines after social distancing) with the full sample ($N = 69,986$).³ In determining an optimal degree of polynomial, we basically took a bottom-up approach by first looking at what the data points seem to suggest about how well-being shifted over time (see Fig. 2). We then tested polynomial models with varying degrees, up to a third-order (cubic) polynomial, and decided the best model by comparing the model fit based on the chi-square likelihood ratio tests.⁴ Also, to capture the trajectories of well-being, we created a Day variable, which refers to a specific day when observations were made during the entire study period. Because our data were collected for 98 days from January 1, 2020 to April 7, 2020, the Day variable was coded to range from 1 to 98. For ease of computation, we rescaled it so that it ranges from 0 (January 1) to 1 (April 7) as a continuous variable. Given that observations are nested within person, we used multilevel modeling (MLM, Raudenbush & Bryk, 2002; Snijders

³ Our multilevel data are unbalanced given that the spacing of measurement occasions varied across individuals and a lot of participants provided their responses only in one measurement occasion (54%, $n = 37,521$). Although balanced data structure is better than imbalanced one in analysis, a major advantage of the multilevel model for longitudinal change is that “it is easily fit to unbalanced data” (p. 146, Singer & Willett, 2003). For example, even though one-time respondents provide no information about within-person variation, “they can still contribute to the estimation of fixed effects where appropriate” (p. 147, Singer & Willett, 2003). In general, unless the data set is severely unbalanced, the imbalance can be ignored in the multilevel data structure (Cools et al., 2009).

⁴ Although it is possible to test models with a higher-order polynomial such as quartic and quintic, it is not generally recommended to do so due to the problem of overfitting. Moreover, our data with a huge sample size are likely to detect a very small but not so meaningful shift in well-being from models with such higher-order polynomials. Indeed, our data were best fitted with the quintic polynomial model (details are available upon request); however, we suspect that this is the result of overfitting at the cost of precision (i.e., unbiasedness vs generalization), and it is also difficult to explain why well-being changed during the study period in this complex trend. Hence, we remained the highest-order polynomial models as cubic and reported the corresponding results only.

Table 2
Descriptive Statistics and Zero-Order Correlations Among Study Variables.

Measure	1	2	3	4	5	6	7	M	SD
1. Extraversion	–	0.34	0.34	–0.21	0.35	–0.12	0.32	2.13	0.66
2. SWL	0.37	–	0.81	–0.50	0.77	–0.40	0.79	5.88	2.43
3. PA	0.35	0.84	–	–0.52	0.75	–0.43	0.84	5.58	2.22
4. NA	–0.21	–0.46	–0.44	–	–0.46	0.71	–0.88	4.83	2.44
5. MIL	0.36	0.81	0.79	–0.40	–	–0.30	0.74	5.51	2.71
6. Stress	–0.15	–0.37	–0.40	0.77	–0.30	–	–0.71	5.93	2.65
7. WBI	0.33	0.79	0.82	–0.86	0.74	–0.74	–	5.29	2.00
M	2.10	6.03	5.72	4.48	5.84	5.44	5.57		
SD	0.68	2.59	2.40	2.64	2.80	2.87	2.12		

Note. Values above diagonal indicate the descriptive statistics and correlation coefficients among variables from the full sample ($N = 69,986$); values below diagonal indicate those from the subsample ($n = 3,229$). SWL = satisfaction with life; PA = positive affect; NA = negative affect; MIL = meaning in life; WBI = well-being index. Well-being variables are aggregated scores across all the responses provided by participants. All correlation coefficients are statistically significant at $p < .001$.

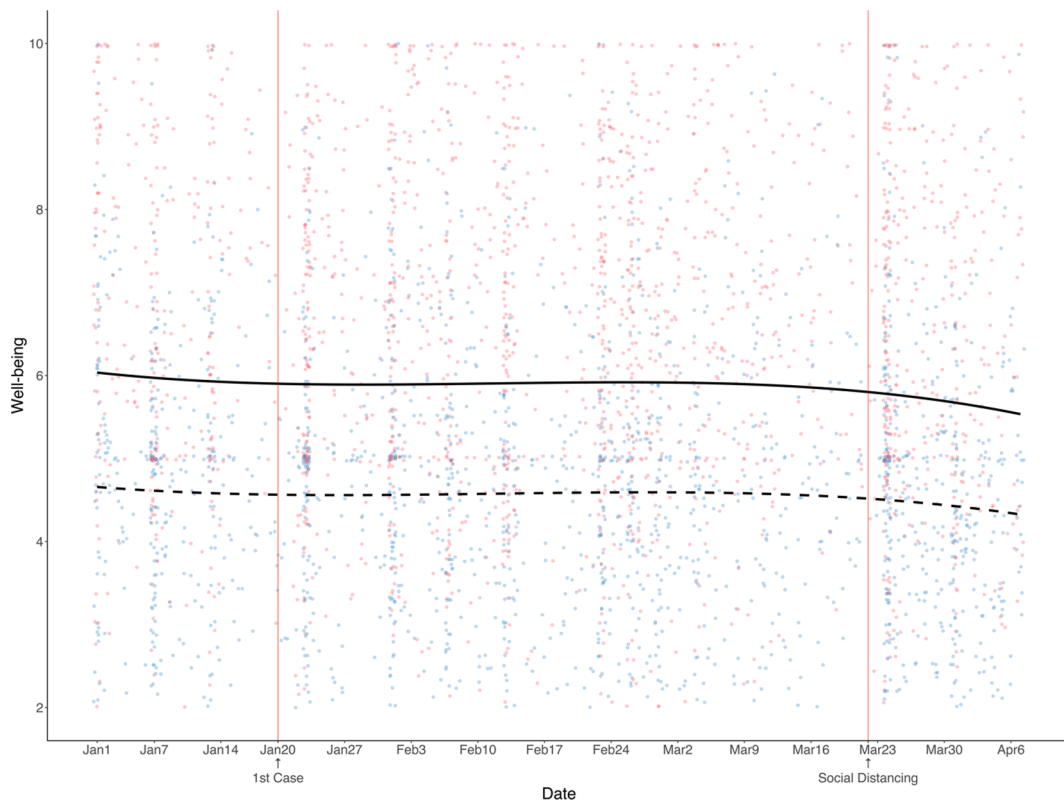


Fig. 2. Trajectories of Well-Being Over the Course of Study Period by Extraversion. The estimated mean of well-being index was obtained by collapsing between- and within-person effects. The red dots and solid lines indicate extraverts (1 SD above the mean of extraversion), and the blue dots and solid lines indicate introverts (1 SD below the mean of extraversion).

& Bosker, 2012). Specifically, the multilevel analyses using polynomial model included two levels with Level 1 representing Day variables (all three polynomial orders) nested within individuals and Level 2 representing differences in extraversion between individuals. Thus, the WBI was regressed onto (a) first-, second-, and third-order polynomials of Day, (b) extraversion, and (c) the cross-level interaction terms between each polynomial of Day and extraversion. Extraversion were grand-mean centered, and as mentioned above, the polynomials of Day were based on the rescaled variable.

In the second approach, analyses explicitly considered the critical COVID-19-related events, namely the outbreak of COVID-19 and the implementation of social distancing. Specifically, we partitioned the entire study time into three periods: Period 1 (January 1–19, before the COVID-19 outbreak), Period 2 (January 20–March 21, until the social distancing implementation), and Period 3 (March 22–April 7, after the

social distancing implementation). We therefore analyzed only the participants who completed the well-being surveys in all three periods, which yielded $n = 3,229$ ($M_{age} = 34.10$, $SD = 12.03$; female = 2,806, male = 423; see Table 1). For comparing well-being across the periods, we created two dummy variables: in the first dummy variable, observations made during Period 1 (i.e., before the COVID-19 outbreak) were coded as 1 while the rest as 0; in the second dummy variable, those made during Period 3 (i.e., after the social distancing implementation) were coded as 1 while the rest as 0. Because observations made during Period 2 (i.e., in between the COVID-19 outbreak and the social distancing implementation) were coded as 0 in both dummy variables, Period 2 served as a reference group, and therefore the first dummy variable reflects the differences in well-being between Periods 1 and 2 (i.e., before vs after the COVID-19 outbreak until the social distancing implementation), while the second dummy variable reflects the

differences in well-being between Periods 2 and 3 (i.e., before vs after the social distancing implementation). In this MLM approach, we particularly sought for disentangling between-person and within-person effects.⁵ To do this, we used a contextual effects model (Enders & Tofghi, 2007) to decompose differences in well-being at between- and within-person levels. Specifically, we decomposed each dummy variable into two components: the person-specific mean (i.e., the group mean of the dummy variable) and the deviation from it (i.e., group-mean centered dummy variable). The former indicates between-person differences in well-being (e.g., how well-being across individuals differs between Periods 1 and 2), while the latter indicates within-person changes in well-being over time (e.g., how well-being of each individual changes through Periods 1 and 2). Thus, we regressed the WBI onto four dummy variables (2 between- and 2 within-person levels), extraversion (between-person level), and four cross-level interaction terms between each of the dummy variables and extraversion.

In both analytic approaches, we included age and gender as covariates in the multilevel regression models.⁶ All MLM analyses were performed with the *lme4* R package (Bates, Mäechele, Bolker, & Walker, 2015) and estimated the parameters with maximum likelihood for the random-intercept model. Key features of the two analytic approaches are summarized in Table 3. All study materials, data, and R syntax are available on the OSF webpage at <https://osf.io/xcwq2/>.

3. Results

3.1. Preliminary analyses

Descriptive statistics and zero-order correlations of the study variables are presented in Table 2. In these elementary statistics, for ease of interpretation, we used aggregated scores of the variables for participants who provided multiple responses. Consistent with the literature, extraversion was positively correlated with SWL (e.g., $r = 0.34$ for the full sample), PA (e.g., $r = 0.34$ for the full sample), and MIL (e.g., $r = 0.35$ for the full sample) while negatively with NA (e.g., $r = -0.21$ for the full sample) and stress (e.g., $r = -0.12$ for the full sample). Notably, the well-being measures were strongly intercorrelated (e.g., $r = 0.81$ between SWL and PA; $r = 0.75$ between PA and MIL for the full sample). This suggests a possibility that well-being measures may be better suited as aggregately than separately; indeed, when checking an internal reliability of the well-being measures (by reverse-coding NA and stress items), we found supporting evidence for the unidimensionality ($\omega = 0.893$, 95 % CI [0.891, 0.894]). Hence, we computed the composite well-being score by averaging all of the ten individual items (with reverse-coded NA and stress items) and used this index (referred to as a well-being index, or WBI, hereinafter) as an outcome variable in primary

⁵ We should note that the first analytic approach with the polynomial regression models do not distinguish between- and within-person effects for two reasons. First, the polynomial variables of Day were not group-mean centered, and thus the between- and within-person effects were not separated. Second, as mentioned in footnote 3, more than half of the observations were obtained from the single-time respondents, suggesting that the effects found in the polynomial regression models were driven partly by those who do not contribute to the within-person variations. Thus, we stress that readers should not interpret the findings of the trajectories of well-being as purely within-person changes in well-being.

⁶ As noted in footnote 1, some participants provided their age group information (e.g., 40s) instead of their exact age. To include age as a covariate, we first transformed the age values of those whose exact age information is available (e.g., 37 years) into the corresponding age group (e.g., 30s). Then we regrouped them into three broader age groups: young (10s and 20s), middle (30s and 40s), and old (50s and 60s or higher). Finally, we created dummy variables—Age_{middle} and Age_{old}—so that the young group serves as a reference group (Age_{middle}: middle group coded as 1 and others as 0; Age_{old}: old group coded as 1 and others as 0) and included them in analyses.

analyses (see Table 2).⁷ Finally, we computed the intraclass correlation coefficient (ICC) for the well-being index and found the ICC was 0.72. This result suggests that the substantial amount of variance in the well-being index is explained by the variance at a between-person level, thereby justifying the use of MLM for analyzing the data.

3.1.1. Attrition analyses

Because participants completed the surveys as many times as they wanted on their own needs, the varying number of responses across individuals may reflect some systematic, rather than random, differences between single-time and multiple-time respondents. For example, it is possible that multiple time respondents are more extraverted and happier than single-time respondents. To check such selection biases in our data, we probed if there were any differences in extraversion and well-being indicators between participants who completed the survey one time only ($n = 37,521$) and more than once ($n = 32,465$). For extraversion, we found no difference between the multiple-time ($M = 2.14$, $SD = 0.65$) and single-time respondents ($M = 2.13$, $SD = 0.67$), $t(69984) = 0.72$, $p = .47$. When comparing the initial reports of the well-being measures, we found consistent patterns in which the multiple-time respondents reported higher well-being than their single-time counterparts (e.g., WBI: $M_{\text{multiple-time}} = 5.38$, $SD = 2.07$ vs $M_{\text{single-time}} = 5.21$, $SD = 1.93$, $t(69984) = 11.39$, $p < .001$, $d = 0.09$); however, the effect sizes were very small ($ds < 0.10$), and the statistical significance was largely due to the large sample size. We discuss the implications of this selection bias for our findings in the Discussion.

3.2. Primary analyses

3.2.1. Trajectories of well-being

As outlined above, we explored the trajectories of well-being by using polynomial regression models. First of all, we found that the cubic model fit the data best, compared to linear and quadratic ones, and therefore reported the results of the cubic model (see Table S2 for other well-being indicators in online supplemental materials). As seen in Table 4, extraversion was a significant and strong predictor for well-being ($b = 0.98$, $SE = 0.01$, $p < .001$, 95 % CI = [0.96, 1.00]), suggesting that the positive association between extraversion and well-being held constant during the early time of the COVID-19 pandemic. Regarding the trajectories of well-being, the results revealed significant linear ($b = -22.66$, $SE = 1.54$, $p < .001$, 95 % CI = [-25.69, -19.64]) and quadratic changes ($b = -10.52$, $SE = 1.51$, $p < .001$, 95 % CI [-13.48, -7.56]) in well-being. Of a particular importance, we found a significant cubic effect ($b = -14.45$, $SE = 1.56$, $p < .001$, 95 % CI [-17.51, -11.39]), such that well-being declined in the early period, stabilized afterwards, and then decreased again in the latter period (see Fig. 2).

Would the trajectories of well-being differ between extraverts and introverts? As presented in Table 4, there was a statistically significant moderating effect of extraversion on the linear changes in well-being during the early pandemic time ($b = -8.76$, $SE = 2.30$, $p < .001$, 95 % CI [-13.27, -4.25]). Consistent with the notion that extraverts would experience more declines in well-being than introverts during the pandemic, this result indicates that there was a greater linear decrease in well-being for extraverts during the early period of the pandemic. We

⁷ Given that our well-being measures are often considered as conceptually and empirically distinct, we also performed the analyses for each of the well-being measures separately. In general, we found inconsistent findings regarding the main research question across well-being measures and level of analysis. For instance, for the within-person changes in NA, we found support for the notion that extraverts experienced more declined well-being than introverts as a result of social distancing; however, we found little or mixed support for other well-being indicators. Detailed findings are available in online supplemental materials (see Tables S3 and S4).

Table 3
Summaries of Key Features of Two Analytic Approaches.

Analytic approach	Modeling	Sample size	Outcome variable	Predictor			
				Variable	Level	Centering	Effect
1st Approach	Multilevel Polynomial regression model	69,986	Well-being index	Extraversion	Level 2	Grand-mean	Between-person effect
				Day ¹	Level 1	No centering	Both between- and within-person effects
				Day ²	Level 1	No centering	
				Day ³	Level 1	No centering	
				Age _{middle}	Level 2	No centering	Between-person effect
				Age _{old}	Level 2	No centering	Between-person effect
2nd Approach	Mixed-effects model	3,229	Well-being index	Gender	Level 2	No centering	Between-person effect
				Extraversion	Level 2	Grand-mean	Between-person effect
				Period _{Dummy1}	Level 1	Group-mean	Within-person effect
				Period _{Dummy2}	Level 1	Group-mean	Within-person effect
				Group mean of Period _{Dummy1}	Level 2	No centering	Between-person effect
				Group mean of Period _{Dummy2}	Level 2	No centering	Between-person effect
				Age _{middle}	Level 2	No centering	Between-person effect
				Age _{old}	Level 2	No centering	Between-person effect
				Gender	Level 2	No centering	Between-person effect

Note. Superscript numbers attached to Day variables represent polynomial orders: 1 = linear; 2 = quadratic; 3 = cubic. Age_{middle} represents the first dummy variable for Age (0 = 10s–20s, 1 = 30s–40s, 0 = over 50s); Age_{old} represents the second dummy variable for Age (0 = 10s–20s, 1 = 30s–40s, 1 = over 50s). Period_{Dummy1} represents the first dummy variable for Period (Period 1, 0 = Period 2, 0 = Period 3); Period_{Dummy2} represents the second dummy variable for Period (0 = Period 1, 0 = Period 2, 1 = Period 3).

Table 4
Polynomial (Cubic) Models: Predicting Well-Being by Day Variables, Extraversion, and Interactions.

Parameters	Estimates	SE	p-value	95 % CI	
				LL	UL
Intercept	5.21	0.01	<0.001	5.20	5.23
Within-person predictors					
Day ¹	-22.66	1.54	<0.001	-25.69	-19.64
Day ²	-10.52	1.51	<0.001	-13.48	-7.56
Day ³	-14.45	1.56	<0.001	-17.51	-11.39
Between-person predictors					
Extraversion	0.98	0.01	<0.001	0.96	1.00
Gender	0.30	0.02	<0.001	0.26	0.33
Age _{middle}	0.03	0.01	0.091	-0.001	0.05
Age _{old}	0.49	0.03	<0.001	0.43	0.55
Interaction					
Day ¹ × Extraversion	-8.76	2.30	<0.001	-13.27	-4.25
Day ² × Extraversion	-2.44	2.24	0.276	-6.82	1.95
Day ³ × Extraversion	-3.18	2.31	0.168	-7.70	1.34
Random effects					
σ ²	1.15				
τ ₀₀	2.54				
AIC	495453.2				
BIC	495580.4				
Deviance	495427.2				

Note. Results are based on the full sample (N = 69,986). CI = confidence interval; LL = lower limit; UL = upper limit. Superscript numbers attached to Day variables represent polynomial orders: 1 = linear; 2 = quadratic; 3 = cubic. Gender: 1 = male; 0 = female. Age variables are dummy coded such that the young group serves as a reference group (i.e., Age_{middle}: 0 = 10s–20s, 1 = 30s–40s, 0 = over 50s; Age_{old}: 0 = 10s–20s, 1 = 30s–40s, 1 = over 50s). Statistically significant p-values are bolded.

did not find a significant moderating effect of extraversion on the quadratic ($b = -2.44, SE = 2.24, p = .276, 95\% \text{ CI} [-6.82, 1.95]$) or cubic changes in well-being ($b = -3.18, SE = 2.31, p = .168, 95\% \text{ CI} [-7.70, 1.34]$), albeit the direction of their patterns was consistent with the linear trend. Thus, the results of the polynomial regression models provide partial support for the notion that the trajectories of well-being changes over the COVID-19 pandemic differently for extraverts and introverts.

Overall, we found the robust relation between extraversion and

enhanced well-being even during the early time of the COVID-19 pandemic. The polynomial analyses further revealed that people experienced declines in well-being to a varying degree over time. As to whether such declines in well-being over the pandemic were intensified or attenuated depending on one’s extraversion level, evidence suggests that the negative impact of the pandemic on well-being seemed worse for extraverts than introverts, particularly when the changes in well-being were assumed to take place in a linear trend. However, the polynomial analyses have several limitations. First, the polynomial models are vulnerable to subtle differences in the data configuration, so it is possible that the effect might have been obscured. Second, given that we used the full sample with many single-time respondents included, the observed effects from polynomial models were driven partly by those who do not contribute to the within-person variations. Hence, even though we examined the “trajectories” of well-being, it should not be interpreted as reflecting purely within-person changes in well-being. Third, in a related vein, the polynomial analyses estimated the mixed effects of the between- and within-person variations in well-being, which could not adequately tease the between- and within-person effects apart. The effect of the pandemic on well-being for extraverts and introverts may be observed differently for the between- and within-person levels, which was examined in the following analyses.

3.2.2. Changes in well-being across the periods

For the second set of analyses, we took a top-down approach to explore the question as to whether and how well-being changed differently for extraverts and introverts during the early time of the COVID-19 pandemic. As outlined earlier, we examined the changes in well-being by comparing the specific periods that are demarcated by the critical COVID-19-related events, namely Period 1 (since the beginning of the study until a day before the COVID-19 outbreak), Period 2 (since the COVID-19 outbreak until a day before the implementation of social distancing), and Period 3 (since the implementation of social distancing until the end of the study). It is noteworthy that we chose these events not arbitrarily but for reason. Meaningful changes in well-being seem to have occurred around those critical events (see the vertical lines drawn on January 20 and March 23 in Fig. 2), which justifies our rationale for examining whether those events played key roles in the changes in well-being during the pandemic. Also, we used the contextual effects model (Enders & Tofghi, 2007) to decompose the changes in well-being at

between- and within-person levels.

First, we looked into how well-being differed across the periods for within- and between-person effects. As shown in Table 5, we found significant within-person changes in well-being between Periods 1 and 2 ($b = 0.07, SE = 0.02, p = .001, 95\% \text{ CI } [0.03, 0.12]$) and between Periods 2 and 3 ($b = -0.12, SE = 0.02, p < .001, 95\% \text{ CI } [-0.17, -0.08]$). As aforementioned, because two dummy variables were created in a manner that Period 2 served as a reference point (i.e., 1st dummy variable: Period 1 = 1, Period 2 = 0, Period 3 = 0; 2nd dummy variable: Period 1 = 0; Period 2 = 0, Period 3 = 1), the positive beta coefficient observed for the comparison between Periods 1 and 2 and the negative beta coefficient observed for the comparison between Periods 2 and 3 suggest that participants experienced within-person declining changes in well-being from Periods 1 to 2 and from Periods 2 to 3. For the between-person effects, we found significant differences in well-being between Periods 2 and 3 ($b = -0.82, SE = 0.33, p = .012, 95\% \text{ CI } [-1.46, -0.18]$), but not between Periods 1 and 2 ($b = -0.19, SE = 0.31, p = .530, 95\% \text{ CI } [-0.79, 0.41]$). That is, participants reported lower levels of well-being in Period 3 than Period 2, but their well-being did not differ between Periods 1 and 2. These findings suggest that well-being decreased around the COVID-19-related events, particularly after the intensive social distancing regulation was implemented compared to before (i.e., Period 2 vs Period 3), and these effects were consistent at both within- and between-person levels.

Would well-being have changed differently for extraverts and introverts across the periods? As shown in Table 5, we found a significant interaction effect between extraversion and the within-person changes from Periods 2 to 3 ($b = -0.08, SE = 0.03, p = .017, 95\% \text{ CI } [-0.14, -0.01]$). This indicates that compared to introverts, extraverts underwent a steeper decrease in well-being after the intensive social

Table 5
Mixed-Effects Models: Predicting Well-Being by Critical COVID-19 Events-Related Periods, Extraversion, and Interaction.

Parameters	Estimates	SE	p-value	95 % CI	
				LL	UL
Intercept	5.67	0.14	<0.001	5.40	5.94
Within-person predictors					
W-Period 1–2	0.07	0.02	0.001	0.03	0.12
W-Period 2–3	-0.12	0.02	<0.001	-0.17	-0.08
Between-person predictors					
B-Period 1–2	-0.19	0.31	0.530	-0.79	0.41
B-Period 2–3	-0.82	0.33	0.012	-1.46	-0.18
Extraversion	1.40	0.20	<0.001	1.01	1.78
Gender	0.24	0.09	0.007	0.07	0.42
Age _{middle}	0.03	0.07	0.674	-0.10	0.16
Age _{old}	0.67	0.10	<0.001	0.48	0.87
Interaction					
W-Period 1–2 × Extraversion	-0.004	0.03	0.891	-0.07	0.06
W-Period 2–3 × Extraversion	-0.08	0.03	0.017	-0.14	-0.01
B-Period 1–2 × Extraversion	-0.56	0.45	0.208	-1.44	0.31
B-Period 2–3 × Extraversion	-0.72	0.48	0.134	-1.66	0.22
Random effects					
σ^2	1.28				
τ_{00}	2.74				
AIC	58435.6				
BIC	58551.2				
Deviance	58405.6				

Note. Results are based on the subsample ($n = 3,229$). W-indicates within-person effects; B-indicates between-person effects. CI = confidence interval; LL = lower limit; UL = upper limit. Period variables are dummy coded such that Period 2 serves as a reference period (i.e., Period 1–2: 1 = Period 1, 0 = Period 2, 0 = Period 3; Period 2–3: 0 = Period 1, 0 = Period 2, 1 = Period 3). Gender: 1 = male; 0 = female. Age variables are dummy coded such that the young group serves as a reference group (i.e., Age_{middle}: 0 = 10s–20s, 1 = 30s–40s, 0 = over 50s; Age_{old}: 0 = 10s–20s, 1 = 30s–40s, 1 = over 50s). Statistically significant p-values are bolded.

distancing was implemented since the outbreak of the COVID-19 pandemic (see Fig. 3). We found no significant interaction between extraversion and within-person changes from Periods 1 to 2 ($b = -0.004, SE = 0.03, p = .891, 95\% \text{ CI } [-0.07, 0.06]$). For the between-person differences in well-being, we found significant interaction effects neither for the comparisons between Periods 1 and 2 ($b = -0.56, SE = 0.45, p = .208, 95\% \text{ CI } [-1.44, 0.31]$) nor between Periods 2 and 3 ($b = -0.72, SE = 0.48, p = .134, 95\% \text{ CI } [-1.66, 0.22]$), though the latter was trending and consistent with the within-person finding.

In sum, we found some support for the possibility that the COVID-19 pandemic was more detrimental to well-being for extraverts than introverts. That is, our findings suggest that the steeper declines in well-being were more likely to be observed among extraverts than introverts particularly due to the implementation of the intensive social distancing policy during the early time of the pandemic, and this reduction in well-being was more likely to be experienced as a within-person change rather than a between-person difference.

4. Discussion

The current study investigated the emerging question as to whether the COVID-19 pandemic has differentially influenced well-being for extraverts and introverts (e.g., Miller, 2020). A few prior studies have explored the same question and have provided mixed findings (e.g., Folk et al., 2020; Wei, 2020). We attempted to test this idea more adequately by employing the large-scale longitudinal online data, which afforded us a rare opportunity to directly investigate whether and how the relationship between well-being and extraversion might have changed over the course of the early period of the COVID-19 pandemic. In so doing, we were guided by two distinct but related analytic approaches, namely that (a) tracked the trajectories of well-being over the pandemic and (b) evaluated the changes of well-being as a function of the critical COVID-19-related events. With the latter approach, we also explored the effect of the COVID-19 pandemic on well-being at between- and within-person levels separately, given the possibility that the interplay among the pandemic, well-being, and extraversion would be captured differently at each level.

Overall, the results suggest that people reported the declines in well-being over the course of the COVID-19 pandemic. For example, the polynomial analyses revealed that well-being declined in a cubic trend over time. The follow-up analysis helped illuminate the process by which well-being changed during the pandemic. When examined across the periods partitioned by the critical COVID-19-related events, well-being was reduced especially after the intensive social distancing regulation was implemented versus before. This was consistent at both within- and between-person levels.

Was the reduced well-being during the early period of the pandemic more pronounced among extraverts? We found some evidence indicating that extraverts underwent the declines in well-being to a greater extent than introverts especially after the intensive social distancing regulation was implemented. In the polynomial regression analysis, the greater reduction in well-being among extraverts was observed only in the linear trend. When the effect was examined at within- and between-person levels across the periods divided by the critical COVID-19-related events, well-being was reduced to a greater extent among extraverts after the social distancing regulation at the within-person level. Thus, since the outbreak of the COVID-19 pandemic, particularly after the intensive social distancing regulation was implemented to curb the spread of the virus, extraverts were likely to experience reduced well-being than their usual level.

Our study provides several noteworthy findings. First, due to the richness of our data quality in terms of the number of observations and the data collection period, we are better positioned to evaluate whether the early days of the COVID-19 pandemic had been more difficult for extraverts than introverts. Compared to previous studies that used a cross-sectional study design (e.g., Wei, 2020) or two time points of

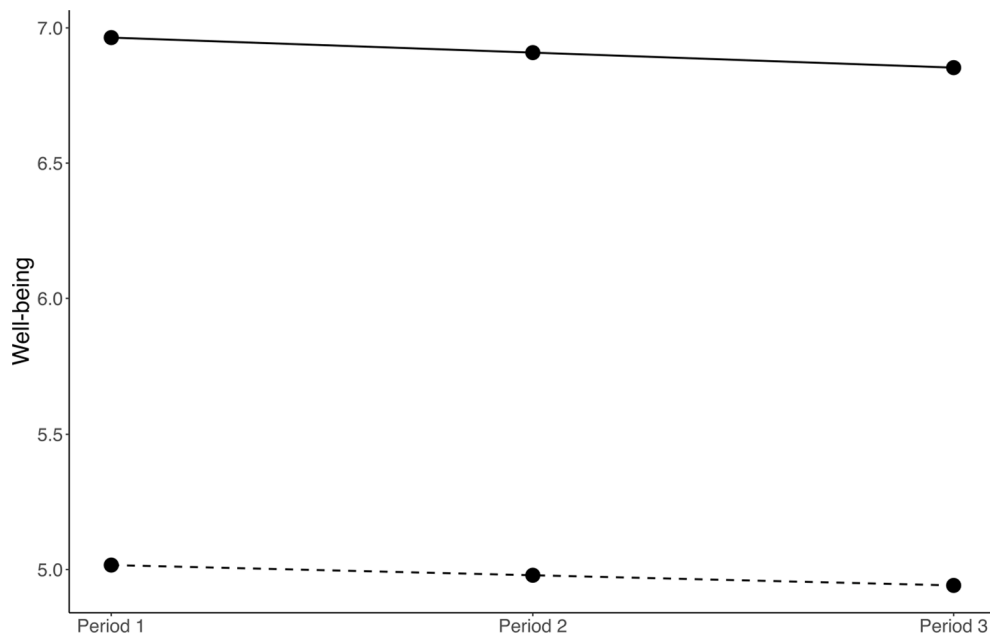


Fig. 3. Temporal Changes in Well-Being for Extraverts and Introverts Across Three Periods. Results are based on the subsample ($n = 3,229$). The estimated mean of well-being index was obtained by collapsing between-person and within-person effects. Period 1 = January 1–19. Period 2 = January 20–March 21. Period 3 = March 22–April 7. The solid lines indicate extraverts (1 *SD* above the mean of extraversion) and dotted lines introverts (1 *SD* below the mean of extraversion).

longitudinal data (e.g., Folk et al., 2020), our research systematically investigated well-being of extraverts and introverts over the course of the COVID-19 pandemic. It is worth noting that we conducted a longitudinal analysis of participants who repeatedly reported their well-being throughout the critical data collection periods. We showed that the changes in well-being occurred at both between- and within-person levels. In addition, our South Korean data allowed for having more confidence in the findings: the possibility that participants might not comply with the social distancing regulations is less of a concern in our data. Although it is still possible that extraverts' compliance may not be as strong as that of introverts (Zajenkowski et al., 2020), such a possibility would only amplify the devastating effect of the COVID-19 pandemic on extraverts' well-being. Second, our respondents varied greatly in terms of age, region of residence, and occupation (although these factors were not directly measured). Thus, our findings are more generalizable. In regard with age, our analyses included age as a covariate and statistically controlled for its effect. Additional analyses, in which age was treated as a moderator, showed that the overall pattern remained consistent across age groups (i.e., 10s–20s vs 30s–40s vs over 50s; see Table S5 in online supplemental materials). Third, we operationalized well-being as having the multiple components—life satisfaction, affect, meaning, and stress—and found that the extent to which well-being of extraverts and introverts changed during the COVID-19 pandemic differed across the levels of analysis. Of a particular interest is the finding from the contextual effects model that there was a significant within-person effect of the pandemic, particularly via the social distancing regulation, on well-being for extraverts than introverts. The same moderating effect was not observed at the between-person level. These findings are particularly important because the negative effects of the social distancing regulation on the experience of well-being among extraverts are only manifested as a within-person change, but not necessarily as a between-person difference. Given that the COVID-19 pandemic is still ongoing and expected to last for a longer period of time, future investigations with extended data collection are warranted in order to draw firmer conclusions about the relationship among the pandemic, well-being, and extraversion.

4.1. Person-environment fit and COVID-19

One theoretical contribution of the current research to the literature is that the robust association between extraversion and well-being is not fixed; rather, it may be mutable, depending on how environmental prescriptions are configured onto individuals. According to the person-environment fit perspective, individuals feel better suited and more adjusted when they find similarities and a match between their personalities and their environment. Put differently, they experience greater satisfaction and higher self-esteem when they live in cultures where more people share their personality characteristics (e.g., Fulmer et al., 2010). Otherwise, they may struggle from a lack of perceived belongingness and negative feelings (e.g., Stephens et al., 2012) and may eventually flee from their current place to look for a more suitable one (e.g., Kitayama, Ishii, Imada, Takemura, & Ramaswamy, 2006). The socially deprived environmental pressures caused by the COVID-19 pandemic go against what extraverts normally feel as natural and familiar. When picking up cues such as “Stay at home” and “Keep your distance away from each other,” extraverts are likely to find such cues unnerving and discomforting because these are antagonistic to their gregarious proclivity, compared to introverts. This scenario received some support, based on the results of the current research.

Thus, it is important to discuss the underlying mechanism by which the pandemic could exert a more negative effect on extraverts than introverts. Although our data point to the possibility that the social distancing regulations impeded extraverts' enduring tendency to socialize with other people (and thus deteriorate their well-being), it is not exactly clear how social distancing has decreased their well-being. Several possibilities exist. First, the COVID-19 pandemic and social distancing could prevent extraverts from satisfying their basic psychological needs (Ryan & Deci, 2000). Whether social distancing has made it more difficult for extraverts to be sociable, extraverts may likely feel that they are being forced to act in a manner inconsistent with their general nature (i.e., lacking autonomy), that they are not capable of doing things as they usually do (i.e., lacking competence), and that they are not able relate to other people (i.e., lacking relatedness). Introverts, on the contrary, would be less likely to feel that they are particularly unfulfilling the basic psychological needs as much as in usual times,

because of the social distancing.

Another potential psychological mechanism relates to the high energy levels and assertiveness that extraverts likely endorse. According to Soto and John (2017), there are three facets of extraversion, namely, sociability, assertiveness, and energy level. Social distancing restricts social contact and interaction, which may also attenuate extraverts' socializing proclivity, thereby reducing their well-being. However, this sociability account may be too simplistic and not fully explain the current findings. Indeed, our exploratory analyses with extraversion decomposed into three facets yielded that the moderating effect of extraversion was not derived by the sociability facet of extraversion, but by the assertiveness and energy level facets.⁸ Thus, alternatively, it is possible that social distancing may prevent extraverts from expressing their assertiveness and energy levels. For example, extraverts go to parties not only to look for socializing opportunities, but also to feel energetic and lead conversations (Matz & Harari, 2020). In this sense, social distancing may disrupt extraverts' tendencies to seek social situations where they can be energetic, active, enthusiastic, and assertive. Supporting this possibility, a recent study suggests that the association between extraversion and well-being is accounted for by people's energy levels rather than their sociability (Margolis, Stapley, & Lyubomirsky, 2020). While these findings seem to give us a hint about the underlying mechanism, it should be interpreted with caution because the extraversion measure we used (Maples et al., 2014) was not specifically developed to decompose extraversion into the three facets. It is also possible that assertiveness and energy level may have played critical roles during the early stage of the pandemic, but sociability might have emerged as crucial during the latter stages of the pandemic. Understanding exact psychological mechanisms awaits further investigation.

4.2. Limitations and future research

While addressing many drawbacks of previous studies, we should acknowledge several limitations in our own research. First, as noted above, we did not measure variables that explicitly inform us about what might underlie the differential experiences of well-being between extraverts and introverts after the social distancing regulations are implemented. Follow-up studies should directly assess whether there are marked changes in social interactions, energy levels, and satisfaction of basic psychological needs for extraverts, and test whether these changes account for their increased negative feelings during the pandemic.

Second, although our data collection period was long enough to cover the critical events and thus adequately examine the changes of well-being during the early time of the COVID-19 pandemic, an extended data collection, particularly during 2021, would allow for an even better understanding of the current phenomena. For example, extraverts' well-being may fluctuate to a greater extent than that of introverts, depending on the intensity of the social distancing regulations (e.g., lockdown or curfew) and/or the effectiveness of getting vaccinated. Relatedly, a more interesting future direction would be to examine the possible long-term consequences of the pandemic. Given the global uncertainty about the end of this pandemic, extraverts are

⁸ Given our extraversion measure (Maples et al., 2014) was developed to include multiple facets of extraversion, such as friendliness, gregariousness, assertiveness, activity level, excitement seeking, and cheerfulness, we explored the possibility that the effect of the social distancing policy during the pandemic is greater for extraverts characterized as high energy level or other facets. Based on the three-facet model of extraversion (Soto & John, 2017), we created three facets, sociability (friendliness and gregariousness), assertiveness, and energy level (activity level, excitement seeking, and cheerfulness), and found supporting evidence for the notion that energy level accounts for the reduced well-being of extraverts after the social distancing. The results also revealed a consistent pattern with assertiveness but not with sociability (see Table S6 in online supplemental materials for the detailed results).

likely to continue experiencing a mismatch between their personality and the environment over and over. This situation may lead to a temporary personality change, such that extraverts may become introverted by repeatedly acting less social during the pandemic. They may also *intentionally* choose to be introverts in order to reduce their person-environment misfit. On the other hand, it is possible that extraverts may maintain their extraversion over the long run by creating new lifestyles that help them remain extraverted (e.g., having virtual social hours with friends and colleagues through an online meeting platform). Future research should explore in which direction psychological adjustment might take place for extraverts over the extended period of the COVID-19 pandemic, and which psychological adjustment strategies may be more beneficial to extraverts' well-being in the long term.

Third, although we used a longitudinal data set that includes rich information about the experience of well-being during the early stage of the pandemic, our data were unbalanced given the varying intervals of the measurement occasions and the presence of many single-time respondents. Although the MLM analytic approach is robust to such imbalance of the data structure and missingness (Cools, Van den Noortgate, & Onghena, 2009; Singer & Willett, 2003), our data nonetheless suffer from selection biases such that the multiple-time respondents were happier than the single-time respondents. This difference makes sense because participants voluntarily completed the well-being surveys on their own needs, and thus those who are interested in improving their well-being were more likely to revisit the survey (Lyubomirsky, Sheldon, & Schkade, 2005). How might this selection bias have influenced our main findings? While it is uncertain, it may have weakened the effect of the pandemic (or social distancing) on well-being of extraverts because this finding was drawn from the subsample which did not include the single-time respondents. If they have provided more responses and been included in the analysis, it would have been possible to more precisely capture the attenuating effect of the pandemic on well-being of extraverts. Future research should address this limitation by using more balanced data.

Fourth, it should be noted that the effect size of our main finding is considerably small and thus may be questioned about its practical importance. For example, how important and meaningful is it to consider environmental changes such as governmentally forced social distancing regulations for understanding the experiences of well-being among extraverts and introverts, with the strong and robust association of well-being and extraversion even during the pandemic? It is generally not advisable to interpret our findings in a counterintuitive manner such that extraverts have been unhappier than introverts during the COVID-19 pandemic because of the limited social interactions and heightened social distancing; however, if the effect is contextualized, it will be more appropriately interpretable and have more implications. For instance, the within-person changes in well-being of extraverts after the social distancing regulation suggest that a typical extravert (who would score 4 out of the 5-point scale on our extraversion measure), compared to a typical introvert (who would score 2 out of the 5-point scale on our extraversion measure), would experience of reduced well-being due to the social distancing practice (approximately a 0.28 point out of the 11-point scale on our well-being measure, given the effect size of $b = 0.07$ and approximately a 4-unit difference between extravert and introvert, i.e., 3-point difference in extraversion $\sim 4 \times 0.66$ of SD) to a comparable degree with a boost in well-being during the 1st year of marriage (Lucas et al., 2003). Thus, while our findings suggest that the effect is not considerably large, the meaning of it should be interpreted with caution and may be more practically construed if properly contextualized (Funder, 2019).

Finally, we demonstrated our findings solely by relying on a South Korean sample. While using this specific sample minimizes the potential effect of extraneous factors such as compliance with the social distancing regulations, more evidence is warranted before generalizing our findings to other cultural groups. For example, South Koreans are comparatively lower in extraversion (Schmitt, Allik, McCrae, & Benet-

Martínez, 2007) and are willing to tailor their degree of extraversion to situational demands (Choi & Choi, 2002). Our findings would be more generalizable if future research could replicate the current study with methodological rigor and culturally diverse samples where extraversion is highly valued.

4.3. Conclusion

The purpose of the current research was to provide a better-informed answer to the emerging question posed by psychologists during the early time of the COVID-19 pandemic: “Do extraverts suffer more during the COVID-19 pandemic than introverts, or vice versa?” We attempted to accomplish this goal in a distinctive manner from the previous explorations, namely, by considering the role of the social distancing regulations and disentangling the between- and within-person effects. Our data suggest that people experienced the substantive changes in well-being during the early period of the COVID-19 pandemic. Significant reductions in well-being were also observed as a function of the implementation of the social distancing regulation, particularly at the within-person level. More importantly, our data also suggest that extraverts can be more vulnerable to the pandemic than introverts. We found supporting evidence such as the greater decreases in the experiences of well-being among extraverts. Future research should further explore how well-being has been affected by the pandemic more recently as a function of personality and environmental changes.

Appendix

Extraversion measure

Instruction: Please answer 24 questions in order. Please read the question and choose it right away rather than thinking too much.

0	1	2	3	4
Do not agree at all				Strongly agree

1. Make friends easily.
2. Warm up quickly to others.
3. Feel comfortable around people.
4. Act comfortably with others.
5. Love large parties.
6. Talk to a lot of different people at parties.
7. Don't like crowded events.*
8. Avoid crowds.*
9. Take charge.
10. Try to lead others.
11. Take control of things.
12. Wait for others to lead the way.*
13. Am always busy.
14. Am always on the go.
15. Do a lot in my spare time.
16. Can manage many things at the same time.
17. Love excitement.
18. Seek adventure.
19. Love action.
20. Enjoy being reckless.
21. Radiate joy.
22. Have a lot of fun.
23. Love life.

Author contributions statement

Incheol Choi contributed to the conception of the core research idea. Jinhyung Kim, Namhee Kim, and Jongan Choi performed the data analyses and interpreted the results. Jinhyung Kim, Jongan Choi, Namhee Kim, and Incheol Choi prepared the manuscript. Jongan Choi and Namhee Kim equally contributed to the completion of this manuscript. All authors approved the final version of this manuscript.

CRediT authorship contribution statement

Jongan Choi: Data curation, Formal analysis, Writing – original draft. **Namhee Kim:** Data curation, Formal analysis, Writing – original draft. **Jinhyung Kim:** Data curation, Formal analysis, Writing – original draft, Writing – review & editing. **Incheol Choi:** Conceptualization, Writing – original draft.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Acknowledgements

This work was funded by Grant 0404-20200007 from KaKao Corporation. This research was not pre-registered.

24. Laugh aloud.

*Reverse-coded items.

Appendix A. Supplementary material

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.jrp.2022.104306>.

References

- Anglim, J., Horwood, S., Smillie, L. D., Marrero, R. J., & Wood, J. K. (2020). Predicting psychological and subjective well-being from personality: A meta-analysis. *Psychological Bulletin*, 146(4), 279–323. <https://doi.org/10.1037/bul0000226>
- Bates, D. M., Mäechler, M., Bolker, B., & Walker, S. (2015). Fitting linear mixed-effects models using lme4. *Journal of Statistical Software*, 67(1), 1–48. <https://doi.org/10.18637/jss.v067.i01>
- Baumeister, R. F., & Leary, M. R. (1995). The need to belong: Desire for interpersonal attachments as a fundamental human motivation. *Psychological Bulletin*, 117(3), 497–529. <https://doi.org/10.1037/0033-2909.117.3.497>
- Canli, T. (2004). Functional brain mapping of extraversion and neuroticism: Learning from individual differences in emotion processing. *Journal of Personality*, 72(6), 1105–1132. <https://doi.org/10.1111/j.1467-6494.2004.00292.x>
- Choi, I., & Choi, Y. (2002). Culture and self-concept flexibility. *Personality and Social Psychology Bulletin*, 28(11), 1508–1517. <https://doi.org/10.1177/014616702237578>
- Choi, I., Kim, J. H., & Kim, N., Choi, E., Choi, J., Suk, H. W., & Na, J. (2020). How COVID-19 affected mental well-being: An 11-week trajectories of daily well-being of Koreans amidst COVID-19 by age, gender and region [Manuscript submitted for publication].
- Christakis, N. A. (2020, March 12). *Compassion in the time of coronavirus*. The Washington Post. <https://www.washingtonpost.com/opinions/2020/03/11/compassion-tim-e-coronavirus/>.
- Cools, W., Van den Noortgate, W., & Onghena, P. (2009). Design efficiency for imbalanced multilevel data. *Behavior Research Methods*, 41(1), 192–203. <https://doi.org/10.3758/BRM.41.1.192>
- Costa, P. T., & McCrae, R. R. (1980). Influence of extraversion and neuroticism on subjective well-being: Happy and unhappy people. *Journal of Personality and Social Psychology*, 38(4), 668–678. <https://doi.org/10.1037/0022-3514.38.4.668>
- DeNeve, K. M., & Cooper, H. (1998). The happy personality: A meta-analysis of 137 personality traits and subjective well-being. *Psychological Bulletin*, 124(2), 197–229. <https://doi.org/10.1037/0033-2909.124.2.197>
- Diener, E. (1984). Subjective well-being. *Psychological Bulletin*, 95(3), 542–575. <https://doi.org/10.1037/0033-2909.95.3.542>
- Diener, E., Ng, W., Harter, J., & Arora, R. (2010). Wealth and happiness across the world: Material prosperity predicts life evaluation, whereas psychosocial prosperity predicts positive feeling. *Journal of Personality and Social Psychology*, 99(1), 52–61. <https://doi.org/10.1037/a0018066>
- Emmons, R. A., & Diener, E. (1985). Personality correlates of subjective well-being. *Personality and Social Psychology Bulletin*, 11(1), 89–97. <https://doi.org/10.1177/0146167285111008>
- Enders, C. K., & Tofighi, D. (2007). Centering predictor variables in cross-sectional multilevel models: A new look at an old issue. *Psychological Methods*, 12(2), 121–138. <https://doi.org/10.1037/1082-989X.12.2.121>
- Fleeson, W., Malanos, A. B., & Achille, N. M. (2002). An intraindividual process approach to the relationship between extraversion and positive affect: Is acting extraverted as “good” as being extraverted? *Journal of Personality and Social Psychology*, 83(6), 1409–1422. <https://doi.org/10.1037/0022-3514.83.6.1409>
- Folk, D., Okabe-Miyamoto, K., Dunn, E., & Lyubomirsky, S. (2020). Did social connection decline during the first wave of COVID-19? The role of extraversion. *Collabra Psychology*, 6(1), 37. <https://doi.org/10.1525/collabra.365>
- Fulmer, C. A., Gelfand, M. J., Jackson, J. C., Pan, X., Nau, D., Dagher, M., Van Lange, P., & Chiu, C. Y. (2010). On “feeling right” in cultural contexts: How person-culture match affects self-esteem and subjective well-being. *Psychological Science*, 21(11), 1563–1569. <https://doi.org/10.1177/0956797610384742>
- Funder, D. C., & Ozer, D. J. (2019). Evaluating effect size in psychological research: Sense and nonsense. *Advances in Methods and Practices in Psychological Science*, 2(2), 156–168. doi: 10.1177/2515245919847202.
- Gelfand, M. J., Jackson, J. C., Pan, X., Nau, D., Dagher, M., Van Lange, P., & Chiu, C. Y. (2020). *The importance of cultural tightness and government efficiency for understanding COVID-19 growth and death rates*. PsyArXiv. doi: 10.31234/osf.io/m7f8a.
- Gupta, K., & Parimal, B. S. (2020). Relationship between personality dimensions and psychological well-being among university students during pandemic lockdown. *Journal of Global Resources*, 6(01a), 10–19. <https://doi.org/10.46587/JGR.2020.v06i01.002>
- Harris, K., English, T., Harms, P. D., Gross, J. J., & Jackson, J. J. (2017). Why are extraverts more satisfied? Personality, social experiences, and subjective well-being in college. *European Journal of Personality*, 31(2), 170–186. <https://doi.org/10.1002/per.2101>
- Higgins, E. T. (2000). Making a good decision: Value from fit. *American Psychologist*, 55(11), 1217–1230. <https://doi.org/10.1037/0003-066X.55.11.1217>
- Jacob, L., Tully, M. A., Barnett, Y., Lopez-Sanchez, G. F., Butler, L., Schuch, F., ... Yakkundi, A. (2020). The relationship between physical activity and mental health in a sample of the UK public: A cross-sectional study during the implementation of COVID-19 social distancing measures. *Mental Health and Physical Activity*, 19, Article 100345. <https://doi.org/10.1016/j.mhpa.2020.100345>
- Jacques-Hamilton, R., Sun, J., & Smillie, L. D. (2019). Costs and benefits of acting extraverted: A randomized controlled trial. *Journal of Experimental Psychology: General*, 148(9), 1538–1556. <https://doi.org/10.1037/xge0000516>
- Keyes, C. L., Shmotkin, D., & Ryff, C. D. (2002). Optimizing well-being: The empirical encounter of two traditions. *Journal of Personality and Social Psychology*, 82(6), 1007–1022. <https://doi.org/10.1037/0022-3514.82.6.1007>
- Kim, J., & Hicks, J. A. (2016). Happiness begets children? Evidence for a bi-directional link between well-being and number of children. *The Journal of Positive Psychology*, 11(1), 62–69. <https://doi.org/10.1080/17439760.2015.1025420>
- King, L. A., & Napa, C. K. (1998). What makes a life good? *Journal of Personality and Social Psychology*, 75(1), 156–165. <https://doi.org/10.1037/0022-3514.75.1.156>
- Kitayama, S., Ishii, K., Imada, T., Takemura, K., & Ramaswamy, J. (2006). Voluntary settlement and the spirit of independence: Evidence from Japan’s “northern frontier”. *Journal of Personality and Social Psychology*, 91(3), 369–384. <https://doi.org/10.1037/0022-3514.91.3.369>
- Koivumaa-Honkanen, H., Honkanen, R., Viinamaeki, H., Heikkilae, K., Kaprio, J., & Koskenvuo, M. (2001). Life satisfaction and suicide: A 20-year follow-up study. *American Journal of Psychiatry*, 158, 433–439. <https://doi.org/10.1176/appi.ajp.158.3.433>
- Lee, R. M., Dean, B. L., & Jung, K. R. (2008). Social connectedness, extraversion, and subjective well-being: Testing a mediation model. *Personality and Individual Differences*, 45(5), 414–419. <https://doi.org/10.1016/j.paid.2008.05.017>
- Liu, S., Lithopoulos, A., Zhang, C. Q., Garcia-Barrera, M. A., & Rhodes, R. E. (2020). Personality and perceived stress during COVID-19 pandemic: Testing the mediating role of perceived threat and efficacy. *Personality and Individual Differences*, 168, Article 110351. <https://doi.org/10.1016/j.paid.2020.110351>
- Lucas, R. E., Clark, A. E., Georgellis, Y., & Diener, E. (2003). Reexamining adaptation and the set point model of happiness: Reactions to changes in marital status. *Journal of Personality and Social Psychology*, 84(3), 527–539. <https://doi.org/10.1037/0022-3514.84.3.527>
- Lucas, R. E., Clark, A. E., Georgellis, Y., & Diener, E. (2004). Unemployment alters the set point for life satisfaction. *Psychological Science*, 15(1), 8–13. <https://doi.org/10.1111/j.0963-7214.2004.01501002.x>
- Lucas, R. E., & Fujita, F. (2000). Factors influencing the relation between extraversion and pleasant affect. *Journal of Personality and Social Psychology*, 79(6), 1039–1056. <https://doi.org/10.1037/0022-3514.79.6.1039>
- Luchetti, M., Lee, J. H., Aschwanden, D., Sesker, A., Strickhouser, J. E., Terracciano, A., & Sutin, A. R. (2020). The trajectory of loneliness in response to COVID-19. *American Psychologist*, 75(7), 897–908. <https://doi.org/10.1037/amp0000690>
- Lyubomirsky, S., Sheldon, K. M., & Schkade, D. (2005). Pursuing happiness: The architecture of sustainable change. *Review of General Psychology*, 9(2), 111–131. <https://doi.org/10.1037/1089-2680.9.2.111>
- Maples, J. L., Guan, L., Carter, N. T., & Miller, J. D. (2014). A test of the International Personality Item Pool representation of the Revised NEO Personality Inventory and development of a 120-item IPIP-based measure of the five-factor model. *Psychological Assessment*, 26(4), 1070–1084. <https://doi.org/10.1037/pas0000004>
- Margolis, S., & Lyubomirsky, S. (2020). Experimental manipulation of extraverted and introverted behavior and its effects on well-being. *Journal of Experimental Psychology: General*, 149(4), 719–731. <https://doi.org/10.1037/xge0000668>
- Margolis, S., Stapley, A. L., & Lyubomirsky, S. (2020). The association between Extraversion and well-being is limited to one facet. *Journal of Personality*, 88(3), 478–484. <https://doi.org/10.1111/jopy.12504>
- Matz, S. C., & Harari, G. M. (2020). Personality–place transactions: Mapping the relationships between Big Five personality traits, states, and daily places. *Journal of Personality and Social Psychology*. <https://doi.org/10.1037/pspp0000297>
- McCrae, R. R., & Costa, P. T., Jr. (2003). *Personality in adulthood: A five-factor theory perspective* (2nd ed.). Guilford Press. doi: 10.4324/9780203428412.
- McGrail, D. J., Dai, J., McAndrews, K. M., & Kalluri, R. (2020). Enacting national social distancing policies corresponds with dramatic reduction in COVID19 infection rates. *PLoS ONE*, 15(7), Article e0236619. <https://doi.org/10.1371/journal.pone.0236619>
- McNiel, J. M., & Fleeson, W. (2006). The causal effects of extraversion on positive affect and neuroticism on negative affect: Manipulating state extraversion and state neuroticism in an experimental approach. *Journal of Research in Personality*, 40(5), 529–550. <https://doi.org/10.1016/j.jrp.2005.05.003>
- Miller, G. (2020, March 16). *Social distancing prevents infections, but it can have unintended consequences*. Science. <https://www.sciencemag.org/news/2020/03/we-are-social-species-how-will-social-distancing-affect-us>.

- Morales-Vives, F., Dueñas, J. M., Vigil-Colet, A., & Camarero-Figuerola, M. (2020). Psychological variables related to adaptation to the COVID-19 lockdown in Spain. *Frontiers in Psychology, 11*, 2438. <https://doi.org/10.3389/fpsyg.2020.565634>
- Oshio, A., Taku, K., Hirano, M., & Saeed, G. (2018). Resilience and Big Five personality traits: A meta-analysis. *Personality and Individual Differences, 127*, 54–60. <https://doi.org/10.1016/j.paid.2018.01.048>
- Osinsky, R., Alexander, N., Schmitz, A., Kuepper, Y., Müller, E., Beer, L., Koeppel, L., & Hennig, J. (2010). Genetic influences on implicit measures of personality. *Journal of Individual Differences, 31*(3), 115–123. <https://doi.org/10.1027/1614-0001/a000007>
- Peterson, C., Park, N., & Seligman, M. E. P. (2005). Orientations to happiness and life satisfaction: The full life versus the empty life. *Journal of Happiness Studies, 6*(1), 25–41. <https://doi.org/10.1007/s10902-004-1278-z>
- Raudenbush, S. W., & Bryk, A. S. (2002). *Hierarchical linear models: Applications and data analysis methods*. Sage.
- Raudenbush, S. W., Spybrook, J., Congdon, R., Liu, X. F., Martinez, A., Bloom, H., & Hill, C. (2011). Optimal design software for multi-level and longitudinal research (Version 3.01) [Software]. Available from www.wtgrantfoundation.org.
- Ryan, R. M., & Deci, E. L. (2000). The darker and brighter sides of human existence: Basic psychological needs as a unifying concept. *Psychological Inquiry, 11*(4), 319–338. https://doi.org/10.1207/S15327965PLI1104_03
- Ryan, R. M., & Deci, E. L. (2001). On happiness and human potentials: A review of research on hedonic and eudaimonic well-being. *Annual Review of Psychology, 52*, 141–166. <https://doi.org/10.1146/annurev.psych.52.1.141>
- Ryan, R. M., & Frederick, C. (1997). On energy, personality, and health: Subjective vitality as a dynamic reflection of well-being. *Journal of Personality, 65*(3), 529–565. <https://doi.org/10.1111/j.1467-6494.1997.tb00326.x>
- Ryff, C. D. (1989). Happiness is everything, or is it? Explorations on the meaning of psychological well-being. *Journal of Personality and Social Psychology, 57*(6), 1069–1081. <https://doi.org/10.1037/0022-3514.57.6.1069>
- Sandstrom, G. M., & Dunn, E. W. (2014). Social interactions and well-being: The surprising power of weak ties. *Personality and Social Psychology Bulletin, 40*(7), 910–922. <https://doi.org/10.1177/0146167214529799>
- Schmader, T., & Sedikides, C. (2018). State authenticity as fit to environment: The implications of social identity for fit, authenticity, and self-segregation. *Personality and Social Psychology Review, 22*(3), 228–259. <https://doi.org/10.1177/1088868317734080>
- Schmitt, D. P., Allik, J., McCrae, R. R., & Benet-Martínez, V. (2007). The geographic distribution of Big Five personality traits: Patterns and profiles of human self-description across 56 nations. *Journal of Cross-Cultural Psychology, 38*(2), 173–212. <https://doi.org/10.1177/00220222106297299>
- Seligman, M. E. P., Steen, T. A., Park, N., & Peterson, C. (2005). Positive psychology progress: Empirical validation of interventions. *American Psychologist, 60*(5), 410–421. <https://doi.org/10.1037/0003-066X.60.5.410>
- Singer, J. D., & Willett, J. B. (2003). *Applied longitudinal data analysis: Modeling change and event occurrence*. Oxford University Press. doi: 10.1093/acprof:oso/9780195152968.001.0001.
- Smillie, L., & Haslam, N. (2020, April 9). *Personalities that thrive in isolation and what we can all learn from time alone*. Medical Xpress. <https://medicalxpress.com/news/2020-04-personalities-isolation.html>.
- Smith, L., Jacob, L., Yakkundi, A., McDermott, D., Armstrong, N. C., Barnett, Y., ... Tully, M. A. (2020). Correlates of symptoms of anxiety and depression and mental wellbeing associated with COVID-19: A cross-sectional study of UK-based respondents. *Psychiatry Research, Article 113138*. <https://doi.org/10.1016/j.psychres.2020.113138>
- Snijders, T. A. B., & Bosker, R. (2012). *Multilevel analysis: An introduction to basic and advanced multilevel modeling* (2nd ed.). Sage.
- Soto, C. J., & John, O. P. (2017). The next Big Five Inventory (BFI-2): Developing and assessing a hierarchical model with 15 facets to enhance bandwidth, fidelity, and predictive power. *Journal of Personality and Social Psychology, 113*(1), 117–143. <https://doi.org/10.1037/pspp0000096>
- Srivastava, S., Angelo, K. M., & Vallereux, S. R. (2008). Extraversion and positive affect: A day reconstruction study of person-environment transactions. *Journal of Research in Personality, 42*(6), 1613–1618. <https://doi.org/10.1016/j.jrp.2008.05.002>
- Steel, P., Schmidt, J., & Shultz, J. (2008). Refining the relationship between personality and subjective well-being. *Psychological Bulletin, 134*(1), 138–161. <https://doi.org/10.1037/0033-2909.134.1.138>
- Steger, M. F., Frazier, P., Oishi, S., & Kaler, M. (2006). The meaning in life questionnaire: Assessing the presence of and search for meaning in life. *Journal of Counseling Psychology, 53*(1), 80–93. <https://doi.org/10.1037/0022-0167.53.1.80>
- Stephens, N. M., Townsend, S. S. M., Markus, H. R., & Phillips, L. T. (2012). A cultural mismatch: Independent cultural norms produce greater increases in cortisol and more negative emotions among first-generation college students. *Journal of Experimental Social Psychology, 48*(6), 1389–1393. <https://doi.org/10.1016/j.jesp.2012.07.008>
- Swickert, R. J., Rosentreter, C. J., Hittner, J. B., & Mushrush, J. E. (2002). Extraversion, social support processes, and stress. *Personality and Individual Differences, 32*(5), 877–891. [https://doi.org/10.1016/S0191-8869\(01\)00093-9](https://doi.org/10.1016/S0191-8869(01)00093-9)
- Van Boven, L., & Gilovich, T. (2003). To do or to have? That is the question. *Journal of Personality and Social Psychology, 85*(6), 1193–1202. <https://doi.org/10.1037/0022-3514.85.6.1193>
- VanderWeele, T. J., Fulks, J., Plake, J. F., & Lee, M. T. (2020). National well-being measures before and during the COVID-19 pandemic in online samples. *Journal of General Internal Medicine, 1–3*. <https://doi.org/10.1007/s11606-020-06274-3>
- Wang, C., Pan, R., Wan, X., Tan, Y., Xu, L., Ho, C. S., & Ho, R. C. (2020). Immediate psychological responses and associated factors during the initial stage of the 2019 coronavirus disease (COVID-19) epidemic among the general population in China. *International Journal of Environmental Research and Public Health, 17*(5), 1729. <https://doi.org/10.3390/ijerph17051729>
- Wei, M. (2020). Social distancing and lockdown—an introvert’s paradise? An empirical investigation on the association between introversion and the psychological impact of COVID-19-related circumstantial changes. *Frontiers in Psychology, 11*, 2440. <https://doi.org/10.3389/fpsyg.2020.561609>
- Zacher, H., & Rudolph, C. W. (2020). Individual differences and changes in subjective wellbeing during the early stages of the COVID-19 pandemic. *American Psychologist, https://doi.org/10.1037/amp0000702*
- Zajenkowski, M., Jonason, P. K., Leniarska, M., & Kozakiewicz, Z. (2020). Who complies with the restrictions to reduce the spread of COVID-19?: Personality and perceptions of the COVID-19 situation. *Personality and Individual Differences, 166*, 110199. doi: 10.1016/j.paid.2020.110199.
- Zelenski, J. M., Santoro, M. S., & Whelan, D. C. (2012). Would introverts be better off if they acted more like extraverts? Exploring emotional and cognitive consequences of counterdispositional behavior. *Emotion, 12*(2), 290–303. <https://doi.org/10.1037/a0025169>
- Zelenski, J. M., Whelan, D. C., Nealis, L. J., Besner, C. M., Santoro, M. S., & Wynn, J. E. (2013). Personality and affective forecasting: Trait introverts underpredict the hedonic benefits of acting extraverted. *Journal of Personality and Social Psychology, 104*(6), 1092–1108. <https://doi.org/10.1037/a0032281>