


Are social support, loneliness, and social connection differentially associated with happiness across levels of introversion-extraversion?

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Abstract

This study examines whether extraversion moderates the association between subjective happiness and measures of social connectedness using data from Canadian residents, aged 16+, recruited online during the third wave of the COVID-19 pandemic (21 April 2021–1 June 2021). To accomplish this aim we tested the moderating effect of extraversion scores on the association between Subjective Happiness scores and several social health measures: Perceived Social Support, Loneliness, social network size, and time with friends. Among 949 participants, results show that lower social loneliness ($p < .001$) and higher social support from friends ($p = .001$) and from family ($p = .007$) was more strongly correlated with subjective happiness for people with low extraversion compared to those with high extroversion. Anti-loneliness interventions should consider the need to promote social connections among individuals across the introversion-extraversion continuum.

Keywords

Social support, social interaction, lifestyle, public health psychology, satisfaction, well-being

Introduction

Loneliness, social isolation, and happiness

Loneliness and social isolation have been linked with increased risk for poor health (Holt-Lunstad, 2018). Loneliness describes the subjective experience of being alone, regardless of the amount of social contact one has. Meanwhile, social isolation describes the objective state of being separated from others (Holt-Lunstad, 2018). While social connectedness is among the most important predictors of happiness (Waldinger and Schulz, 2023) and among the most important protective factors against depression (Choi et al., 2020), people have varying levels of social need and they differ with respect to their vulnerability to loneliness (Cacioppo et al., 2014). Similarly, there is considerable variation in what generates happiness, which we describe as the subjective, affective and cognitive aspects of well-being and life satisfaction (Lyubomirsky and Lepper, 1999).

Individual variations in need for social connection

Many assume that introversion is associated with lesser need for social connection. For example, in the context of the COVID-19 pandemic, social connectedness has been of significant public interest – as have the differential effects of social isolation across individuals with high and low extraversion. Indeed, during this time, in an effort to control the spread of SARS-CoV-2, governments instituted quarantines, lockdowns, physical distancing guidelines, and

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other restrictions on social gatherings (Nussbaumer-Streit et al., 2020; Talic et al., 2021). These interventions have likely had modest effects in reducing COVID-19. They have also had unfortunate and unintended consequences for social health and wellbeing (Pai and Vella, 2021; Williams et al., 2021). While much of the unintended side-effects of COVID-19 restrictions have been negative, some commentators suggested that lockdowns and social distancing could actually be beneficial for people with higher introversion; given the longstanding expectations around people with higher introversion's preferences for isolation (Storr, 2005), autonomy (Jung, 1928), and lower levels of external stimulation (Eysenck and Eysenck, 1994). For example, a survey of news magazines from 2020 revealed headlines such as “No parties, no problem: People with higher introversion don't mind sheltering at home” (Bernstein, 2020); “For people with higher introversion, quarantine can be a liberation” (Kluth, 2020); and “For people with higher introversion, lockdown is a chance to play to our strengths” (Denham, 2020). However, as the realities of COVID-19 set in, the plight of lonely people with higher introversion has become more apparent. Notable news headlines ranging from “Lockdown was supposed to be an introvert's paradise. It's not” (Ohlheiser, 2020) to “Why people with higher introversion didn't actually ‘win’ lockdown” (Robson, 2021) have captured the reversal from expectations to reality nicely (Grant, 2020). These headlines are based on cross-sectional empirical evidence showing that people with higher introversion seemed to have no advantage over people with higher extraversion in terms of their experience of psychological distress during the early phases of the COVID-19 pandemic (Chernova et al., 2021; Rettew et al., 2021; Shokrkon and Nicoladis, 2021; Wei, 2020).

Understanding the links between introversion-extroversion and sociability

The assumptions of how introversion-extroversion impact happiness and health during the COVID-19 pandemic stem from the common view of the introversion-extroversion continuum, which conceptualizes people with higher introversion as reserved, quiet, and cerebral and people with higher extraversion as sociable, outgoing, talkative, and intrinsically motivated by interpersonal interaction (Ashton et al., 2002; Fishman et al., 2011; Lucas and Diener, 2001). Supporting this position, there is a considerable body of evidence supporting the assertion that social wellbeing is indeed correlated with extraversion (Deng et al., 2021). People with higher extraversion have been shown to be more averse to aloneness; to respond to social stimuli with greater attention, reward, and positivity; and to have greater social capital and support compared to people with higher introversion (Dumitrache et al., 2018; Fishman et al., 2011;

Fishman and Ng, 2013; Jacques-Hamilton et al., 2018; Lu et al., 2014; Smillie, 2013; Swickert et al., 2002; Teppers et al., 2013; Tulin et al., 2018). All of this evidence lends credibility to the belief that people with higher introversion enjoy solitude, whereas people with higher extraversion need social connection to thrive. These conceptualizations give the impression that social connection is less important to people with higher introversion—presumably because rational choice models of social behaviour conceptualize an individual's social life as an expression of the worth they assign to social connection; rather than the product of complex person-environment interactions that create unique facilitators and barriers for social inclusion (Lucas and Diener, 2001; Smillie and Haslam, 2020).

However, not all scholars agree that sociability is the core feature of extraversion (Smillie, 2013). While existing work has demonstrated that people with higher introversion may have fewer social ties, such ties are not necessarily less fulfilling or less important for people with higher introversion (Malcolm et al., 2021; Pollet et al., 2011). Studies on the introversion-extroversion trait suggest that elevated sociability among people with higher extraversion may be merely a by-product of greater sensitivity to rewarding stimuli (which includes, but is not limited to social stimuli; Lucas et al., 2000). From this perspective, people with higher extraversion simply receive greater reward from social connections, express greater positive affect as a result, and reap the benefits of doing so by attracting friends with their positive disposition (Feiler and Kleinbaum, 2015). Thus, even though people with higher extraversion may be better at accruing social connection and support, introversion-extroversion does not necessarily reflect actual differences in need for social connection.

The need for social support and to feel a sense of belonging and social inclusion may be better conceptualized as a universal human need (Baumeister and Leary, 1995). Indeed, even highly introverted individuals experience an increase in positive affect after socializing (Duffy et al., 2018) and the benefits of extraversion on happiness or coping with stress seem to be mediated by social support (Swickert et al., 2002; Tan et al., 2018)—suggesting that the challenge for people with higher introversion may lay in finding, recognising, and utilizing supportive social connections. Further, people with higher introversion have been shown to receive even a greater boost to happiness relative to people with higher extraversion when engaging in deeper conversations (Sun et al., 2020) and people with higher introversion who are instructed to act more extraverted experience more positive affect (similar to people with higher extraversion) than when they act more introverted (Zelenski et al., 2012). Other studies show that introversion, not extraversion, is associated with higher levels of loneliness (Buecker et al., 2020; Matthews et al., 2022; Mund and Neyer, 2019; Schermer and Martin, 2018; Wiczorek et al., 2021). Given these collective findings, there is little compelling

evidence to suggest that people with higher introversion are, by nature, immune to the adverse effects of social isolation and loneliness. Indeed, the extant work suggests that positive associations between extraversion and social wellbeing (Diener et al., 2003; Smillie et al., 2012; Zelenski et al., 2013) may arise simply as an artifact of differences in how social rewards are processed and reinforced, rather than an innate difference in social need (Ashton et al., 2002; Campbell et al., 2003; Leikas and Ilmarinen, 2017; Lucas et al., 2000). Continued investigation into the complex relationships between introversion–extraversion, social need, social ability, social contact, and other related concepts are needed to understand how introversion–extraversion shapes vulnerability to poor subjective social health and wellbeing.

Study aims

The present study aims to explicitly explore whether extraversion moderates the correlations between (a) social connection, (b) social support, and (c) loneliness and participant's subjective happiness in the context of the third wave of the COVID-19 pandemic in Canada. Our intention is to examine whether there are differences in the fundamental benefits of social connection between people with higher introversion and people with higher extraversion. We accomplish this by testing interaction terms between these social health measures and extraversion scores in modeling subjective happiness. Furthermore, our models control for emotional stability and the other five-factor model personality traits which have been shown to be key confounders of the relationship between extraversion and wellbeing (Rigon et al., 2019). In undertaking these analyses, we hypothesize that social health factors, like social connection, support, and loneliness, will have an equal or stronger correlation on the happiness of people with higher introversion compared to people with higher extraversion. This analysis has important implications to potentially counter-act the common misunderstanding that people with higher introversion don't need or value social connection or that they fare better alone compared to people with higher extraversion.

Methods

Participants and procedure

The present study leverages baseline data from the 2021 Canadian Social Connection Survey, which was conducted among people living in Canada, aged 16 years or older during the Third Wave of the COVID-19 pandemic in Canada (21 April 2021–1 June 2021). The Canadian Social Connection Survey is a serial cross-sectional study with a longitudinal sub-cohort. Baseline data for the cohort and the first cross-sectional study were launched in 2021; with

continuing data collection planned each year until at least 2024. The present study leverages the 2021 data and future studies will further assess differences in pandemic recovery using longitudinal and serial cross-sectional data. Ethics approval for this study was provided by the Simon Fraser University and University of Victoria Research Ethics Boards (Ethics Protocol Number 21-0115). Participants were recruited through paid advertisements in French and English on social media websites. After seeing advertisements, participants were screened for eligibility (i.e., residence in Canada, 16+ years or older), and provided informed consent. The survey could be completed in French or English. The 2021 Canadian Social Connect Survey core questionnaire included assessments of a range of social, behavioural, mental health, and social health factors, as well as information about participant's demographic characteristics. Participants were randomized to complete one of three sub-modules – one of which assessed psychological factors, including extraversion. Data from only the participants who completed this module are included in the current analyses.

Measures

Subjective happiness ($\alpha = 0.72$). The primary outcome variable for this study was the Subjective Happiness Scale (Lyubomirsky and Lepper, 1999), which is a previously validated measure that consists of four questions rated on a 7-point Likert scale. Final scores are averages of each scale item (scored 1–7) and higher final scores represent greater subjective experiences of happiness. The four questions assess whether participants consider themselves to be a generally happy or unhappy person, whether they consider themselves more or less happy compared to their peers, whether they enjoy life regardless of what is going on, and whether they seem happy to others.

Extraversion ($\alpha = 0.40$). The 10 Item Personality Inventory (TIPI) was included to measure the Five Factor model of personality, which is a previously validated measure that includes subscales of Extraversion, Agreeableness, Conscientiousness scores, Emotional Stability, and Openness to Experience (Gosling, 2021; Gosling et al., 2003). As noted in Gosling et al. (2003), the TIPI scale items have low reliability scores for internal consistency by design as they were developed to capture diverse facets of personality traits in a short form (rather than achieving high alphas and good CFA fits). We acknowledge that our results should be replicated with other more detailed and extensive tools, however, the TIPI was selected because it is a brief measure for large surveys (taking approximately 1 min to complete) – and has been shown to achieve better validity compared to other brief measures of the Big Five (Furnham, 2008). As noted by Nunes et al. (2018), the TIPI has strong

temporal stability and strong correlations with longer five factor personality measures (Nunes et al., 2018). Each subscale is composed of two items, which present word pairs representing dipoles of each scale. For example, the Extraversion subscale asks participants whether they see themselves as (1) extraverted, enthusiastic and (2) reserved, quiet. The use of the wording “extraverted, enthusiastic” in the scale is advantageous as it captures how people view themselves directly in relation to extravertedness – a strength for this study given that our research aims to highlight some of the challenges associated with people viewing themselves as “extraverted.” Each word pair is rated on a 7-point Likert scale ranging from Disagree strongly to Agree Strongly. An average of forward-scored and reverse scored items on each subscale is calculated, with final scores on each subscale ranging from 1 to 7.

Perceived social support ($\alpha = 0.94$). The Zimet Multidimensional Scale of Perceived Social Support was used to measure social support (Zimet, 2016). This previously validated measure consists of 12 items, each of which is scored on a 7-point Likert scale ranging from Very Strongly Disagree to Very Strongly Agree. Three subscales are included and analyzed here assessing social support from “significant others,” ($\alpha = 0.92$; e.g., “I have a special person who is a real source of comfort to me.”) “family,” ($\alpha = 0.88$; e.g., “My family really tries to help me.”) and “friends” ($\alpha = 0.88$; e.g., “I have friends with whom I can share my joys and sorrows.”). Each scale is scored as an average of scale items, with final scores ranging from 1 (Lower Support) to 7 (higher Support).

Loneliness ($\alpha = 0.67$). The 6-item DeJong Gierveld Emotional and Social Loneliness Scale, which is a previously validated measure, was used to measure emotional ($\alpha = 0.62$; e.g., “I miss having people around.”) and social ($\alpha = 0.72$; e.g., “There are enough people I feel close to”) dimensions of loneliness (De Jong Gierveld, Van Tilburg, 2010). Each item in the scale is scored on a three-point Likert scale (Yes, More or Less, No). On negatively worded scale items, the neutral and positive answers are scored as “1”. On the positively worded items, the neutral and negative answers are scored as “1”. Each dimension of emotional and social loneliness is scored on a separate scale, consisting of 3-items each, and an average of subscale items is taken such that final scores on each subscale range from 0 (Low loneliness) to 3 (High loneliness).

Social connection. Five novel measures were used to assess social connectedness: number of friends, time spend with friends, satisfaction with number of friends, satisfaction with amount of time spend with friends, and how much time participants wished to spend with friends. One item asked participants “How many close friends do you have?” and

allowed responses such as having “None,” “1 or 2,” “3 or 4,” or “5 or more.” The second item measuring social connection asked participants “In the past week, how many hours in total did you spend socializing with friends?” Participants could respond as having spent “No time,” “Less than 1 h,” “1–4 h,” or “5 or more hours.” Recording participants’ number of friends and time spent with friends categorically was done to improve ease of participation and avoid the use of write-in responses based on recommendations from community piloting. Furthermore, in relation to the present study, a categorical version of this numeric quantity was considered a potential strength given the potential for a long right tail capturing close friendships of varying quality and the tendency for large scale surveys to collect poorer quality data (e.g., imprecise use of rounding for values above 10) for large self-reported estimates of network size. In the 2021 surveys we also included additional questions in relation to network size, including whether participants were satisfied, wanted more friends, or wanted fewer friends; whether they were satisfied with the amount of time they spend with friends, wanted to spend more time with others, or wanted to spend less time with others; and how much time participants wanted to spend with their friends. We also recognize that a non-binned version for the number of close friends and time-spent with friends was a valuable addition and, therefore, in the 2022 cohort survey and 2022 cross-sectional survey non-binned version of the questions were assessed and were reviewed to assess sensitivity to variable structure. These analyses revealed little differences.

Demographics. Demographic factors included self-reported assessments of age, gender, ethnicity, educational attainment, and income.

Data analyses

All statistical analyses were conducted in R (R Core Team, 2021). Descriptive results for the overall sample were calculated using the tableone package in R (Yoshida et al., 2021). Spearman correlation coefficients, implemented using the cor.test function, tested bivariable correlations with continuous TIPI Extraversion Scores and continuous Subjective Happiness Scores, DeJong Emotional and Social Loneliness Subscale Scores, and Zimet Multidimensional Social Support Subscale scores. Polyserial correlation, implemented using the polyserial function from the polycor package, compared TIPI Extraversion Scores by the number of “close friends” participants reported having, the amount of time participants reported spending with friends in the past week, how much time participant’s wanted to spend with their friends, whether participants were satisfied with the amount of time they spent with friends, and whether they were satisfied with the number of friends they had.

Multivariable linear regression models were constructed using the `glm` function to identify the factors associated with participant's happiness. The explanatory factors of interest entered included: The DeJong Emotional and Social Loneliness Subscale Scores, the Zimet Multidimensional Social Support Subscale scores, participant's self-reported number of "close friends," and the amount of time participants reported spending with their friends over the past week. Separate models were constructed for each explanatory factor and all analyses controlled for age, gender, ethnicity, educational attainment, income, TIPI Extraversion scores, TIPI Agreeableness scores, TIPI Conscientiousness scores, TIPI Emotional Stability scores, and TIPI Openness scores. These additional personality factors were controlled for in order to account for the independent effect of the extraversion personality trait.

For models with significant main effects on explanatory variables of interest, interaction terms between each of the explanatory factors and TIPI Extraversion scores were used to identify differences in the effect of the explanatory factor on Subjective Happiness scores. Interaction plots were constructed using the `plot_model` function from the `sjPlot` package to aid in the interpretation of interaction terms (Lüdtke et al., 2021).

Finally, we constructed a supplementary multivariable linear regression model for the overall sample. This model identified the independent and adjusted effects of each variable on subjective happiness in order to help us identify the independent effect of different dimensions of social support, loneliness, and social connection. Forrest plots were plotted using the `plot_models` function. Subsequent dominance analyses, constructed using the `dominanceanalysis` package (Navarrete and Soares, 2020), were conducted using to identify which variables were most important in the overall regression model (Azen and Traxel, 2009; Budescu, 1993). The `dominanceanalysis` package in R is a tool that allows users to perform dominance analysis on regression models. Dominance analysis is a statistical technique used to identify the relative importance of predictor variables in a regression model. The technique involves comparing the variance explained by each predictor variable when it is used alone in a simple regression model, to the variance explained when it is used in combination with all the other predictor variables in a multiple regression model. The resulting scores are then used to rank the variables in terms of their importance. In this analysis, the importance of each predictor variable is assessed after controlling for the effects of other variables in the model. This is done by evaluating their relative importance in combination with each other and alone. We plotted these results to assess the unique contribution of each variable when controlling for an increasing number of predictors. The variables assessed included the TIPI scores for each personality trait, the number of close friends, hours spent

with friends, social support subscale scores, and emotional and social loneliness scores. The model also included the demographic factors as constants, which means that they are held constant across all analyses. This was done to reduce the computational intensity of adding many categorical variables to the model.

For all analyses a p -value less than .05 was considered statistically significant. We did not correct for multiple comparisons and as such, readers should be aware of marginally significant p -values.

Analyses for this study were exploratory and not pre-registered. Data for this study is available on our web site (www.casch.org) and analysis scripts are available upon request to the first author.

Results

The original sample size for this survey was 2488. However, the questions required in this analyses were included in one of the randomized modules, as such only 949 participants completed the Ten-Item Personality Inventory and were included in this analysis. Table 1 provides an overview of the sample demographics. In brief, the median age was 38 years ($SD = 15$), 52.2% of respondents self-identified as women, 46.9% were in a relationship; 65.6% were White, 42.0% reported income above \$60,000, and 86.5% had at least some post-secondary education. Table 2 provides

Table 1. Sample demographic characteristics.

	N = 949
Age (<i>M</i> (<i>SD</i>))	38.02 (14.98)
Gender (<i>N</i> (%))	
Man	437 (46.0)
Non-binary	17 (1.8)
Woman	495 (52.2)
Ethnicity (<i>N</i> (%))	
African, Caribbean, or Black	89 (9.4)
Arab/West Asian	32 (3.4)
East Asian	59 (6.2)
Indigenous	68 (7.2)
Latin	36 (3.8)
South Asian	14 (1.5)
White	623 (65.6)
Other	28 (3.0)
Educational attainment (<i>N</i> (%))	
High school diploma or lower	128 (13.5)
At least some college	821 (86.5)
Income (<i>N</i> (%))	
Less than \$30000	273 (28.8)
\$30000 to \$59999	277 (29.2)
\$60000 to \$89999	167 (17.6)
\$90000 or more	232 (24.4)

Table 2. Descriptive statistics for social connection and wellbeing measures.

	N = 949
Time with friends (N (%))	
Less than 1 h	446 (47.0)
1–4 h	383 (40.4)
5 or more hours	120 (12.6)
Preferred amount of time with friends (N (%))	
Less than 1 h	314 (33.1)
1–4 h	425 (44.8)
5 or more hours	210 (22.1)
Satisfied with time with friends (N (%))	
No, I want to spend LESS time with others	23 (2.4)
Yes	521 (54.9)
No, I want to spend MORE time with others	405 (42.7)
Number of close friends (N (%))	
None	42 (4.4)
1 to 2	343 (36.1)
3 to 4	384 (40.5)
5 or more	180 (19.0)
Satisfied with number of friends (N (%))	
No, I want to have FEWER friends	36 (3.8)
Yes	553 (58.3)
No, I want to have MORE friends	360 (37.9)
Subjective happiness scale score (mean (SD))	4.43 (1.16)
Social support from family score (mean (SD))	4.84 (1.28)
Social support from friends scores (mean (SD))	4.89 (1.18)
Social support from significant other score (mean (SD))	5.05 (1.29)
Emotional loneliness (mean (SD))	2.16 (0.92)
Social loneliness (mean (SD))	1.75 (1.15)
TIPI Agreeable score (mean (SD))	4.79 (1.19)
TIPI conscientiousness score (mean (SD))	4.75 (1.30)
TIPI emotional stability score (mean (SD))	4.37 (1.30)
TIPI openness to experience score (mean (SD))	4.62 (1.17)
TIPI extraversion score (mean (SD))	3.92 (1.20)

descriptive statistics for the social connection, personality, and wellbeing measures.

In bivariable tests (See [Figure 1](#)), higher subjective happiness scores ($p < .001$) were correlated with higher extraversion. Further, higher extraversion scores were associated with lower emotional ($p < .001$) and social ($p < .001$) loneliness; higher social support from family members ($p < .001$), friends ($p < .001$), and significant others ($p < .001$). In polyserial correlations, extraversion was associated with having more close friends ($p < .001$); spending 1 or more hours with friends in the past week ($p < .001$); the amount of time they said they wanted to spend with friends on a weekly basis ($p < .001$); participant's levels of satisfaction with the number of friends they had ($p < .001$); and the amount of time they spent with friends ($p < .001$).

Our multivariable linear regression model examining the association between subjective happiness and five factor model personality traits showed that higher subjective

happiness was associated with higher extraversion (Model 1: $\beta = 0.231$, $SE = 0.028$, $t(929) = 8.336$, $p < .001$), higher emotional stability (Model 1: $\beta = 0.139$, $SE = 0.015$, $t(929) = 9.533$, $p < .001$), higher agreeableness (Model 1: $\beta = 0.042$, $SE = 0.017$, $t(929) = 2.472$, $p = .014$), and higher conscientiousness (Model 1: $\beta = 0.031$, $SE = 0.015$, $t(929) = 2.024$, $p = .043$), and but with not higher openness to experience (Model 1: $\beta = 0.004$, $SE = 0.016$, $t(929) = 0.279$, $p = .780$).

Multivariable linear regression models examining associations with each of our social health measures and subjective happiness showed that, regardless of extraversion level, higher subjective happiness was associated with higher social support from friends (Model 2: $\beta = 0.247$, $SE = 0.028$, $t(928) = 8.689$, $p < .001$), family (Model 3: $\beta = 0.301$, $SE = 0.026$, $t(928) = 11.660$, $p < .001$), and significant others (Model 4: $\beta = 0.221$, $SE = 0.026$, $t(928) = 8.549$, $p < .001$); lower emotional (Model 5: $\beta = -0.309$,

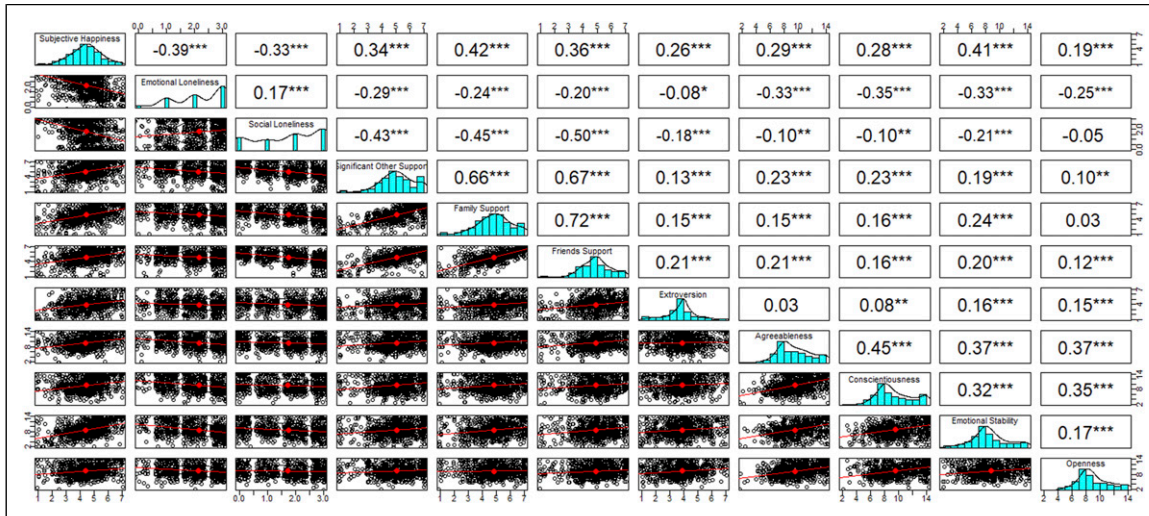


Figure 1. Correlation plot for subjective happiness, social health measures, and personality traits.

SE = 0.038, $t(928) = -8.075$, $p < .001$) and social (Model 6: $\beta = -0.224$, SE = 0.029, $t(928) = -7.793$, $p < .001$) loneliness; and having 1–2 (vs. None; Model 7: $\beta = 0.515$, SE = 0.162, $t(926) = 3.180$, $p = .002$), 3–4 (vs. None; Model 7: $\beta = 0.712$, SE = 0.162, $t(926) = 4.386$, $p < .001$), or 5 or more close friends (vs. None; Model 7: $\beta = 0.867$, SE = 0.174, $t(926) = 4.990$, $p < .001$). Furthermore, these models showed that subjective happiness was not associated with the amount of time spend with friends in the past week (1–4 h vs. Less than 1 h; Model 8: $\beta = 0.083$, SE = 0.070, $t(927) = 1.192$, $p = .234$; 5 or more hours versus Less than 1 h; Model 8: $\beta = 0.081$, SE = 0.103, $t(927) = 0.784$, $p = .433$).

Models were re-tested with interaction terms between each social health measures and the extraversion subscale. Figure 2 shows interaction plots for each multivariable interaction. These models examined the differing impact of social health measures (the x -axis) on subjective happiness scores (the y -axis) across levels of extraversion (the separate linear effects). Results show that the correlation higher social support from friends ($p = .001$) and from family ($p = .007$) was larger in predicting subjective happiness for people with low extraversion compared to those with high extraversion (See Panels A and B). The interaction effect between extraversion and social support from significant others was not statistically significant ($p = .309$; See Panel C). Likewise, emotional loneliness had a similar correlation on subjective happiness scores for individuals with high versus low extraversion ($p = .64$; See Panel D), whereas social loneliness had a stronger negative correlation with subjective happiness among people with lower extraversion compared to among those with high extraversion ($p < .001$; See Panel E). The interaction effects with participant's number of "close friends"

showed that having more close friends was correlated with higher happiness among people with higher introversion, but not people with higher extraversion; See Panel F). Meanwhile, the (non-significant) effect of the amount of hours spent with friends in the past week did not differ by levels of extraversion (1–4 h vs. Less than 1 h, $p = .13$; 5 or more hours vs. Less than 1 h, $p = .76$; See Panel G). Regression coefficients with 95% Confidence Intervals for multivariable-adjusted main effects and interaction terms are provided in Table 3.

Supplemental Figure 1 shows the results of multivariable analyses aiming to identify the independent and adjusted effect of all social health measures under consideration. The results show that emotional stability, extraversion, family social support, and lower emotional and social loneliness had significant independent correlations with subjective happiness and that these effects tended to be similar across all levels of extraversion. The R^2 value for the full model was 0.41. Results from our dominance analyses, shown in Supplemental Figure 2, agree with these results and suggest that emotional and social loneliness, family social support, and extraversion all cluster as uniquely strong, independent predictors of subjective happiness.

Discussion

Primary findings

The present study examined whether social connection, social support, and loneliness were differentially correlated with subjective happiness across levels of extraversion. Overall, we found that demographic factors, personality traits, and measures of social connectedness explained approximately two-fifths of the variation in

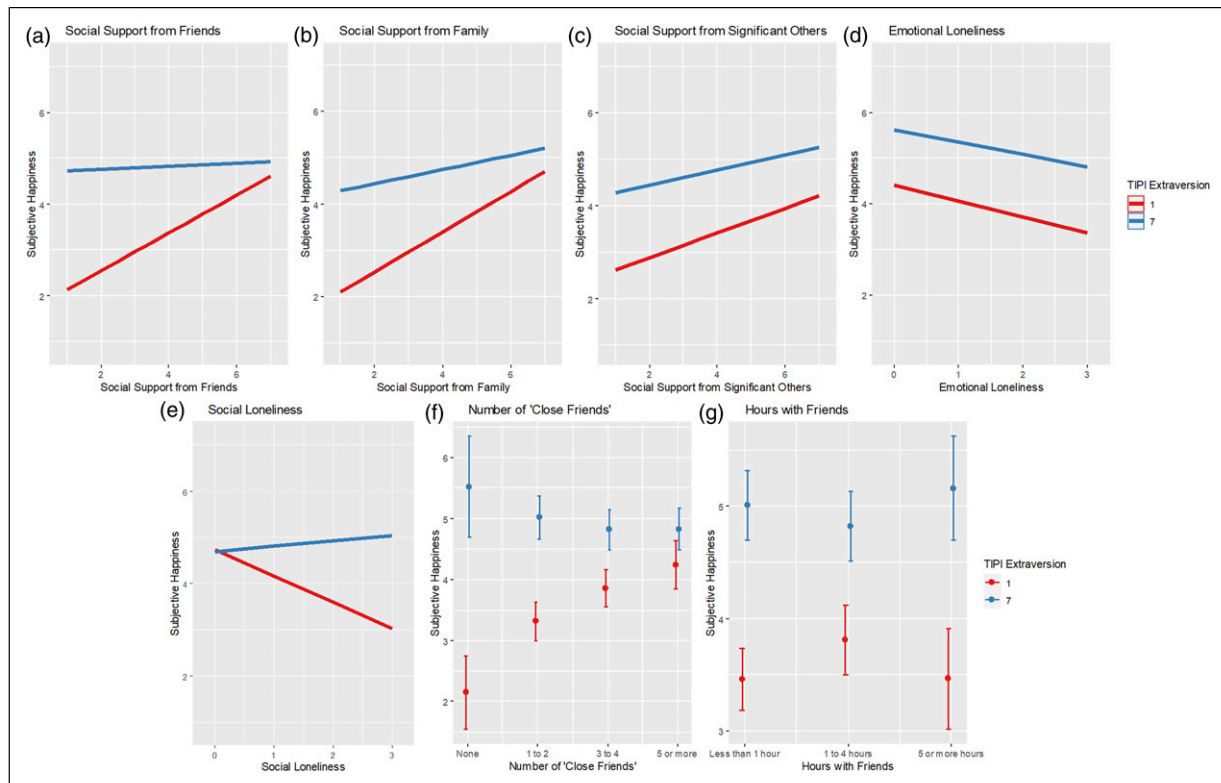


Figure 2. Interaction plots testing interaction between extraversion and social health measures in predicting subjective happiness.

subjective happiness – with the effect sizes for most variables being small to moderate. Importantly, through interaction analyses we find only small or non-significant differences in effect sizes of social variables on subjective happiness across levels of introversion-extraversion. Despite the size of these effects, our results showed that social support from friends and family and having more close friends were more strongly correlated with subjective happiness among people with higher introversion than among people with higher extraversion. Similarly, the correlation of social loneliness with happiness was larger among people with higher introversion compared to people with higher extraversion. This may suggest that social connection is, indeed, very important for the wellbeing of people with higher introversion. In other words, our findings indicate that these individuals are not immune and may, in fact, be quite sensitive to feelings of disconnection or lack of support (Baumeister and Leary, 1995). We also observed that for both people with higher introversion and people with higher extraversion, satisfaction with social time spent with others increases as participants' report spending more time with others. Taken together, these results challenge the common narrative that people with higher introversion need or want less social connection or that they benefit less from having a healthy

social life. This supports similar work showing that higher social connection among introverted individuals was associated with greater self-esteem (Tuovinen et al., 2020) and the benefits to positive affect when people with higher introversion act more in line with expectations for people with higher extraversion (Zelenski et al., 2012). Of course, it is important to contextualize these findings with the general result that higher extraversion is associated with greater subjective well-being. Indeed, we find this even in the context of the COVID-19 pandemic (Shokrkon and Nicoladis, 2021) and our own results show that extraversion is negatively correlated with loneliness, positively associated with social support, and positively correlated with having more close friends, spending more time with friends, participant's satisfaction with the number of friends they had, the time they spend with their friends over the previous week, and how much time they would like to spend with friends on a weekly basis. Although people with higher extraversion may very well have experienced a greater change in their social lives, relative to people with higher introversion, as a result of pandemic restrictions (Folk et al., 2020), our findings nevertheless demonstrate that higher extraversion is correlated with stronger social connectedness, more positive interpretation of their social situation, and greater perceived social

Table 3. Multivariable interaction models.

	β	95% CI
Model 9		
Extraversion score	0.30	0.11,0.48
Social support from significant other score	0.28	0.15,0.42
Interaction: Extraversion * social support from significant other score	-0.02	-0.05,0.02
Model 10		
Extraversion score	0.41	0.25,0.58
Social support from family score	0.48	0.34,0.62
Interaction: Extraversion * social support from family score	-0.05	-0.08,-0.01
Model 11		
Extraversion score	0.50	0.30,0.69
Social support from friends score	0.47	0.33,0.62
Interaction: Extraversion * social support from friends score	-0.06	-0.10,-0.02
Model 12		
Extraversion score	0.20	0.08,0.32
Emotional loneliness score	-0.36	-0.59,-0.13
Interaction: Extraversion * emotional loneliness score	0.01	-0.04,0.07
Model 13		
Extraversion score	-0.01	-0.10,0.09
Social loneliness score	-0.68	-0.87,-0.50
Interaction: Extraversion * social loneliness score	0.11	0.07,0.16
Model 14		
Extraversion score	0.56	0.35,0.77
Number of close friends		
None	Reference	
1 to 2	1.44	0.58,2.30
3 to 4	2.11	1.25,2.96
5 or more	2.55	1.64,3.46
Interaction: Extraversion * number of close friends (ref = none)		
1 to 2	-0.28	-0.51,-0.05
3 to 4	-0.40	-0.63,-0.17
5 or more	-0.46	-0.70,-0.23
Model 15		
Extraversion score	0.26	0.18,0.34
Time with friends		
Less than 1 h	Reference	
1-4 h	0.44	-0.04,0.92
5 or more hours	-0.02	-0.64,0.61
Interaction: Extraversion * time with friends (ref = less than 1 h)		
1-4 h	-0.09	-0.21,0.03
5 or more hours	0.02	-0.13,0.18

Note: Models are adjusted for age, gender, ethnicity, educational attainment, income, TIPI agreeableness scores, TIPI conscientiousness scores, TIPI emotional stability scores, and TIPI openness scores; **BOLD** indicates statistical significance at $p < .05$.

support, which supports much of the extant work on this topic (Ilmarinen, 2018; Pollet et al., 2011; Roberts et al., 2008; Wang et al., 2021).

Implications

The implications for these findings, when interpreted in the context of similar related studies, are broad. They demonstrate that misconceptions about the social needs of

people with higher introversion are potentially harmful; people with higher introversion who do not take care of their social connection needs may be putting themselves at risk, as are those who make assumptions about the social needs of their friends and family members who seem to be more introverted. Social connection is fundamentally beneficial to health and wellness (Campagne, 2019; Larrabee Sonderlund et al., 2019; Marziali et al., 2020; Marziali et al., 2020; Marziali et al., 2020). Indeed,

multiple meta-analyses show that healthy social relationships are associated with a 26–50% reduction in mortality—effect-size estimates rivaling those of other major risk factors for death. For example, [Pantell et al. \(2013\)](#) estimates low social is associated with a hazard ratio of 1.62 among men, reviling the effects of smoking (HR = 1.72), poverty (HR = 1.65), high blood pressure (HR = 1.16), obesity (HR = 1.09), and high cholesterol (HR = 1.10; [Lavie et al., 2019](#); [Pantell et al., 2013](#); [Pranata et al., 2020](#)). The list of diseases and conditions that are associated with social disconnection is expansive: it includes cardiovascular disease, cancer, diabetes, substance use disorder, anxiety, and depression ([Adam et al., 2017](#); [Wang et al., 2018](#)). Given these harmful effects, the widespread prevalence of loneliness is concerning and any hesitancy to socially engage people with higher introversion out of a belief that they are immune from the harmful effects of loneliness is even more worrisome. Indeed, even prior to the COVID-19 pandemic Canadians were showing increasing levels of disconnection and isolation ([Government of Canada, 2019](#)); [Angus Reid Institute's 2019](#) (pre-pandemic) report on social isolation and loneliness in Canada showed that approximately 48% of the population is struggling to some degree with either loneliness or social isolation (“A Portrait of Social Isolation and Loneliness in Canada Today,” 2019).

Understanding the true importance of social connection for people with higher introversion and people with higher extraversion can help support these interventions to ensure that both people with higher introversion and people with higher extraversion are appropriately included and engaged. For example, some studies suggest that teaching people with higher introversion to “act extraverted” can provide significant social and emotional benefit ([Margolis and Lyubomirsky, 2020](#); [McCabe and Fleeson, 2012](#); [Szczygiel and Mikolajczak, 2018](#)). For these interventions to be effective, there may be a need for many to be disabused of the myth that people with higher introversion don't need to connect with others to be happy. We may also need to overcome the fact that many individuals will overestimate the costs of social connection and underestimate the potential benefits of engaging with others ([Jiang et al., 2018](#); [O'Brien and Hess, 2020](#)). Further, people may not be good judges of the social interests of others – and therefore avoid opportunities to build social connections out of fear that others are not interested in connecting ([Michela et al., 1982](#); [Smith and Betz, 2000](#)). For people with higher introversion, these assumptions may be particularly self-defeating, the findings of the current study, showing the importance of loneliness and social support in predicting happiness among people with higher introversion specifically. Additionally, we were able to identify family as a key source of social support that might be especially generative for people with higher introversion in producing higher subjective

happiness. This is especially important in the context of the COVID-19 pandemic, which has limited sources of social support and social connection from many outside sources such as friends, colleagues, and casual acquaintances ([Mull, 2021](#)).

Limitations

Our study has both strengths and limitations. One significant strength is the relatively large sample size compared to much of the extant work on the topic of loneliness and social connection. However, similar to many of these existing studies, we relied on online, opt-in, convenience sample and this may reduce the generalizability and representativeness of our findings. Our analyses are cross-sectional and correlational. No causal conclusions can be drawn regarding the observed relationships between these variables. Similarly, our analyses were conducted during COVID-19, which may pose a constraint on generalizability. From our cross-sectional analysis, it remains unclear whether the general findings of this study would be replicable in time periods less strongly influenced by the spread of COVID-19. Future research is needed to assess how these relationships may change over time and in different contexts. Second, although we have primarily used validated scales, the variable structure used for several of our novel measures of social connection (e.g., use of categorical measures for number of friends and time spent with friends) may obscure some kinds of information patterns that could influence the conclusions reached in this study. Third, although our multivariable linear regression models account for key constructs such as emotional stability and other personality traits, they are largely focused on demographic and person-level traits. We have not explicitly accounted for participant's observed social behaviour, nor identified which features of support, connection, and mental state are unique contributors to subjective happiness. It may be that people with higher introversion and people with higher extraversion do differ in terms of the types of social interaction and support that are helpful to prevent loneliness and generate social support. Finally, in utilizing the TIPI, we recognize that brief measures of the Big Five personality traits may be vulnerable to critique. While a short measure is desirable for large survey (and could produce superior measurement due to lesser fatigue), we included a brief comparison of the TIPI using additional data collected as part of the 2022 cross-sectional Canadian Social Connection Survey. In this survey, a subset of participants were asked to complete the Big Five Inventory, in addition to the TIPI. BFI-Extraversion sub-scores were calculated as the sum of the 8-item subscale score. Final scores on the BFI-Extraversion subscale ranged from 8 (Low Extraversion) to 37 (High Extraversion). A Pearson correlation between the TIPI and BFI was assessed and indicated strong correlation between the two

extraversion sub-scales ($r = 0.74$, $t(229) = 16.83$, p -value $< .0001$). Sensitivity analyses across several variables demonstrated similar correlations with the BFI and TIPI across variables analyzed in the present study. Undoubtedly, there continues to be a need to replicate our findings in studies with larger, more representative samples that will allow for more nuanced analyses that account for a wide range of factors.

Conclusion

The present study highlights the importance of social health – for both people with higher extraversion and people with higher introversion. In doing so, our findings contradict a commonly held narrative that people with higher introversion are specially equipped to handle pandemic-related social restrictions because they want or need less social support or are somehow less vulnerable to loneliness. In fact, the people with higher introversion in the current study were quite sensitive to loneliness and loss of social connection. Public health guidelines and health promotion campaigns focused on social connection may therefore be important for helping all individuals prioritize their social need. Continued research is undoubtedly needed to understand how to best support individuals, across all levels of extraversion, so that they achieve social connections that will have protective benefits against the mental, emotional, and social stressors arising during the COVID-19 pandemic and in the late-pandemic period.

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Supplemental Material

Supplemental material for this article is available online.

References

- Angus Reid Institute (2019) *A Portrait of Social Isolation and Loneliness in Canada Today*. Vancouver, BC: Angus Reid Institute. <https://angusreid.org/social-isolation-loneliness-canada/>
- Adam EK, Quinn ME, Tavernier R, et al. (2017) Diurnal cortisol slopes and mental and physical health outcomes: a systematic review and meta-analysis. *Psychoneuroendocrinology* 83: 25–41. DOI: [10.1016/j.psyneuen.2017.05.018](https://doi.org/10.1016/j.psyneuen.2017.05.018).
- Ashton MC, Lee K and Paunonen SV (2002) What is the central feature of extraversion? social attention versus reward sensitivity. *Journal of Personality and Social Psychology* 83(1): 245–252.
- Azen R and Traxel N (2009) Using dominance analysis to determine predictor importance in logistic regression. *Journal of Educational and Behavioral Statistics* 34(3): 319–347.
- Baumeister RF and Leary MR (1995) The need to belong: desire for interpersonal attachments as a fundamental human motivation. *Psychological Bulletin* 117(3): 497–529. DOI: [10.1037/0033-2909.117.3.497](https://doi.org/10.1037/0033-2909.117.3.497).
- Bernstein S (2020) *No Parties, No Problem: Introverts Don't Mind Sheltering at Home*. London, UK: Reuters. <https://www.reuters.com/article/us-health-coronavirus-usa-introverts-idUSKBN21N0D4>
- Budescu DV (1993) Dominance analysis: a new approach to the problem of relative importance of predictors in multiple regression. *Psychological Bulletin* 114(3): 542–551. DOI: [10.1037/0033-2909.114.3.542](https://doi.org/10.1037/0033-2909.114.3.542).
- Buecker S, Maes M, Denissen JJA, et al. (2020) Loneliness and the big five personality traits: a meta-analysis. *European Journal of Personality* 34(1): 8–28. DOI: [10.1002/per.2229](https://doi.org/10.1002/per.2229).
- Cacioppo JT, Cacioppo S and Boomsma DI (2014) Evolutionary mechanisms for loneliness. *Cognition and Emotion* 28(1): 3–21. DOI: [10.1080/02699931.2013.837379](https://doi.org/10.1080/02699931.2013.837379).
- Campagne DM (2019) Stress and perceived social isolation (loneliness). *Archives of Gerontology and Geriatrics* 82: 192–199. DOI: [10.1016/j.archger.2019.02.007](https://doi.org/10.1016/j.archger.2019.02.007).
- Campbell L, Simpson JA, Stewart M, et al. (2003) Putting personality in social context: extraversion, emergent leadership, and the availability of rewards. *Personality and Social Psychology Bulletin* 29(12): 1547–1559. DOI: [10.1177/0146167203256920](https://doi.org/10.1177/0146167203256920).
- Chernova A, Frajo-Apor B, Pardeller S, et al. (2021) The mediating role of resilience and extraversion on psychological distress and loneliness among the general population of Tyrol, Austria between the first and the second wave of the COVID-19 pandemic. *Frontiers in Psychiatry* 12: 766261. Scopus. DOI: [10.3389/fpsy.2021.766261](https://doi.org/10.3389/fpsy.2021.766261).
- Choi KW, Stein MB, Nishimi KM, 23rd Me Research Team, Major Depressive Disorder Working Group of the Psychiatric Genomics Consortium, et al. (2020) An exposure-wide and mendelian randomization approach to identifying modifiable factors for the prevention of depression. *The American Journal of Psychiatry*, 177(10), 944–954. DOI: [10.1176/appi.ajp.2020.19111158](https://doi.org/10.1176/appi.ajp.2020.19111158).
- De Jong Gierveld J and Van Tilburg T (2010) The De Jong Gierveld short scales for emotional and social loneliness: tested on data from 7 countries in the UN generations and gender surveys. *European Journal of Ageing* 7(2): 121–130. DOI: [10.1007/s10433-010-0144-6](https://doi.org/10.1007/s10433-010-0144-6).
- Deng Y, Chen H and Yao X (2021) Curvilinear effects of extraversion on socialization outcomes among Chinese college

- students. *Frontiers in Psychology* 12: 652834. DOI: [10.3389/fpsyg.2021.652834](https://doi.org/10.3389/fpsyg.2021.652834).
- Denham J (2020) *For Introverts, Lockdown Is a Chance to Play to Our Strengths*. London, UK: The Guardian. <https://www.theguardian.com/lifeandstyle/2020/may/02/for-introverts-lockdown-is-a-chance-to-play-to-our-strengths>
- Diener E, Oishi S and Lucas RE (2003) Personality, culture, and subjective well-being: emotional and cognitive evaluations of life. *Annual Review of Psychology* 54: 403–425. DOI: [10.1146/annurev.psych.54.101601.145056](https://doi.org/10.1146/annurev.psych.54.101601.145056).
- Duffy KA, Helzer EG, Hoyle RH, et al. (2018) Pessimistic expectations and poorer experiences: the role of (low) extraversion in anticipated and experienced enjoyment of social interaction. *PLoS One* 13(7): e0199146. DOI: [10.1371/journal.pone.0199146](https://doi.org/10.1371/journal.pone.0199146).
- Dumitrache CG, Rubio L and Rubio-Herrera R (2018) Extroversion, social support and life satisfaction in old age: a mediation model. *Aging and Mental Health* 22(8): 1063–1071. DOI: [10.1080/13607863.2017.1330869](https://doi.org/10.1080/13607863.2017.1330869).
- Eysenck HJ and Eysenck SBG (1994) *Manual of the Eysenck Personality Questionnaire: (EPQ-R Adult)*. San Diego, CA: EdITS/Educational and Industrial Testing Service.
- Feiler DC and Kleinbaum AM (2015) Popularity, Similarity, and the Network extraversion bias. *Psychological Science* 26(5): 593–603. DOI: [10.1177/0956797615569580](https://doi.org/10.1177/0956797615569580).
- Fishman I and Ng R (2013) Error-related brain activity in extraverts: evidence for altered response monitoring in social context. *Biological Psychology* 93(1): 225–230. DOI: [10.1016/j.biopsycho.2013.02.010](https://doi.org/10.1016/j.biopsycho.2013.02.010).
- Fishman I, Ng R and Bellugi U (2011) Do extraverts process social stimuli differently from introverts? *Cognitive Neuroscience* 2(2): 67–73. DOI: [10.1080/17588928.2010.527434](https://doi.org/10.1080/17588928.2010.527434).
- Folk D, Okabe-Miyamoto K, Dunn E, et al. (2020) Did social connection decline during the first wave of COVID-19?: the role of extraversion. *Collabra: Psychology* 6(1): 37. DOI: [10.1525/collabra.365](https://doi.org/10.1525/collabra.365).
- Furnham A (2008) Relationship among four big five measures of different length. *Psychological Reports* 102(1): 312–316. DOI: [10.2466/pr0.102.1.312-316](https://doi.org/10.2466/pr0.102.1.312-316).
- Gosling SD (2021) *A Note on Alpha Reliability and Factor Structure in the TIPI*. <http://gosling.psy.utexas.edu/scales-weve-developed/ten-item-personality-measure-tipi/a-note-on-alpha-reliability-and-factor-structure-in-the-tipi/>
- Gosling SD, Rentfrow PJ and Swann WB (2003) A very brief measure of the big-five personality domains. *Journal of Research in Personality* 37(6): 504–528. DOI: [10.1016/S0092-6566\(03\)00046-1](https://doi.org/10.1016/S0092-6566(03)00046-1).
- Government of Canada SC (2019) *Living alone in Canada*. Ottawa, ON: Government of Canada. <https://www150.statcan.gc.ca/n1/pub/75-006-x/2019001/article/00003-eng.htm>
- Grant A (2020) *Yes, Even Introverts Can Be Lonely Right Now*. New York, NY: The New York Times. <https://www.nytimes.com/2020/04/16/smarter-living/coronavirus-introverts-lonely.html>
- Holt-Lunstad J (2018) Why social relationships are important for physical health: a systems approach to understanding and modifying risk and protection. *Annual Review of Psychology* 69: 437–458. DOI: [10.1146/annurev-psych-122216-011902](https://doi.org/10.1146/annurev-psych-122216-011902).
- Ilmarinen V-J (2018) When and why is “extraversion” associated with social popularity? DOI: [10.31237/osf.io/3nfgH](https://doi.org/10.31237/osf.io/3nfgH).
- Jacques-Hamilton R, Sun J and Smillie L (2018) Costs and benefits of acting extraverted: a randomized controlled trial. Psy-ArXiv. DOI: [10.31234/osf.io/8ze6w](https://doi.org/10.31234/osf.io/8ze6w).
- Jiang L, Drolet A and Kim HS (2018) Age and social support seeking: understanding the role of perceived social costs to others. *Personality and Social Psychology Bulletin* 44(7): 1104–1116. DOI: [10.1177/0146167218760798](https://doi.org/10.1177/0146167218760798).
- Jung C (1928) *L'inconscient Sans la vie Psychique Normale et Anormale [The Unconscious in Normal and Abnormal Psychic Life]*. Neuilly, UK: Payot, p. 192.
- Kluth A (2020) *For Introverts, Quarantine Can Be a Liberation*. New York, NY: Bloomberg.Com. <https://www.bloomberg.com/opinion/articles/2020-03-28/coronavirus-for-introverts-quarantine-can-be-a-liberation>
- Larrabee Sonderlund A, Thilising T and Sondergaard J (2019) Should social disconnectedness be included in primary-care screening for cardiometabolic disease? a systematic review of the relationship between everyday stress, social connectedness, and allostatic load. *PLoS One* 14(12): e0226717. DOI: [10.1371/journal.pone.0226717](https://doi.org/10.1371/journal.pone.0226717).
- Lavie CJ, Ozemek C, Carbone S, et al. (2019) Sedentary behavior, exercise, and cardiovascular health. *Circulation Research* 124(5): 799–815. DOI: [10.1161/CIRCRESAHA.118.312669](https://doi.org/10.1161/CIRCRESAHA.118.312669).
- Leikas S and Ilmarinen V-J (2017) Happy now, tired later? extraverted and conscientious behavior are related to immediate mood gains, but to later fatigue. *Journal of Personality* 85(5): 603–615. DOI: [10.1111/jopy.12264](https://doi.org/10.1111/jopy.12264).
- Lu A, Yu Y, Hong X, et al. (2014) Peer attachment and loneliness among adolescents who are deaf: the moderating effect of personality. *Social Behavior and Personality: An International Journal* 42(4): 551–560. DOI: [10.2224/sbp.2014.42.4.551](https://doi.org/10.2224/sbp.2014.42.4.551).
- Lucas RE and Diener E (2001) Understanding extraverts' enjoyment of social situations: the importance of pleasantness. *Journal of Personality and Social Psychology* 81(2): 343–356. DOI: [10.1037//0022-3514.81.2.343](https://doi.org/10.1037//0022-3514.81.2.343).
- Lucas RE, Diener E, Grob A, et al. (2000) Cross-cultural evidence for the fundamental features of extraversion. *Journal of Personality and Social Psychology* 79(3): 452–468. DOI: [10.1037/0022-3514.79.3.452](https://doi.org/10.1037/0022-3514.79.3.452).
- Lüdtke D, Bartel A, Schwemmer C, et al. (2021) sjPlot: data visualization for statistics in social science. <https://CRAN.R-project.org/package=sjPlot.2.8.10>
- Lyubomirsky S and Lepper HS (1999) A measure of subjective happiness: preliminary reliability and construct validation. *Social Indicators Research* 46(2): 137–155. DOI: [10.1023/A:1006824100041](https://doi.org/10.1023/A:1006824100041).
- Malcolm C, Saxton T, McCarty K, et al. (2021) Extraversion is associated with advice network size, but not network density

- or emotional closeness to network members. *Personality and Individual Differences* 168(110311): 110311. DOI: [10.1016/j.paid.2020.110311](https://doi.org/10.1016/j.paid.2020.110311).
- Margolis S and 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. DOI: [10.1037/xge0000668](https://doi.org/10.1037/xge0000668).
- Marzali ME, Armstrong HL, Closson K, et al. (2020) Loneliness and self-rated physical health among gay, bisexual and other men who have sex with men in Vancouver, Canada. *Journal of Epidemiology and Community Health* 74(7): 553–559. DOI: [10.1136/jech-2019-213566](https://doi.org/10.1136/jech-2019-213566).
- Marzali ME, Card KG, McLinden T, et al. (2021) Correlates of social isolation among people living with HIV in British Columbia, Canada. *AIDS Care* 33(0): 566–574. DOI: [10.1080/09540121.2020.1757607](https://doi.org/10.1080/09540121.2020.1757607).
- Marzali ME, McLinden T, Card KG, et al. (2021) Social isolation and mortality among people living with HIV in British Columbia, Canada. *AIDS and Behavior* 25: 377–388. DOI: [10.1007/s10461-020-03000-2](https://doi.org/10.1007/s10461-020-03000-2).
- Matthews T, Fisher HL, Bryan BT, et al. (2022) This is what loneliness looks like: a mixed-methods study of loneliness in adolescence and young adulthood. *International Journal of Behavioral Development* 46(1): 18–27. Scopus DOI: [10.1177/0165025420979357](https://doi.org/10.1177/0165025420979357).
- McCabe KO and Fleeson W (2012) What is extraversion for? integrating trait and motivational perspectives and identifying the purpose of extraversion. *Psychological Science* 23(12): 1498–1505. DOI: [10.1177/0956797612444904](https://doi.org/10.1177/0956797612444904).
- Michela JL, Peplau LA and Weeks DG (1982) Perceived dimensions of attributions for loneliness. *Journal of Personality and Social Psychology* 43(5): 929–936. DOI: [10.1037/0022-3514.43.5.929](https://doi.org/10.1037/0022-3514.43.5.929).
- Mull A (2021) *The Pandemic Has Erased Entire Categories of Friendship*. Washington, DC: The Atlantic. <https://www.theatlantic.com/health/archive/2021/01/pandemic-goodbye-casual-friends/617839/>
- Mund M and Neyer FJ (2019) Loneliness effects on personality. *International Journal of Behavioral Development* 43(2): 136–146. DOI: [10.1177/0165025418800224](https://doi.org/10.1177/0165025418800224).
- Navarrete CB and Soares FC (2020) *Dominanceanalysis: Dominance Analysis (1.3.0)*. <https://CRAN.R-project.org/package=dominanceanalysis>
- Nunes A, Limpo T, Lima CF, et al. (2018) Short scales for the assessment of personality traits: development and validation of the portuguese ten-item personality inventory (TIPI). *Frontiers in Psychology* 9: 461. DOI: [10.3389/fpsyg.2018.00461](https://doi.org/10.3389/fpsyg.2018.00461).
- Nussbaumer-Streit B, Mayr V, Dobrescu AI, et al. (2020) Quarantine alone or in combination with other public health measures to control COVID-19: a rapid review. *The Cochrane Database of Systematic Reviews* 4: CD013574. DOI: [10.1002/14651858.CD013574.pub2](https://doi.org/10.1002/14651858.CD013574.pub2).
- O'Brien EL and Hess TM (2020) Perceived benefits and costs contribute to young and older adults' selectivity in social relationships. *GeroPsych* 33(1): 42–51. DOI: [10.1024/1662-9647/a000218](https://doi.org/10.1024/1662-9647/a000218).
- Ohlheiser A (2020) Lockdown was supposed to be an introvert's paradise. It's not. *MIT Technology Review*. Cambridge, MA: Elizabeth Bramson-Boudreau. <https://www.technologyreview.com/2020/04/02/998440/lockdown-was-supposed-to-be-an-introverts-paradise-its-not/>
- Pai N and Vella S-L (2021) COVID-19 and loneliness: a rapid systematic review. *The Australian and New Zealand Journal of Psychiatry* 55(12): 1144–1156. DOI: [10.1177/00048674211031489](https://doi.org/10.1177/00048674211031489).
- Pantell M, Rehkopf D, Jutte D, et al. (2013) Social isolation: a predictor of mortality comparable to traditional clinical risk factors. *American Journal of Public Health* 103(11): 2056–2062. DOI: [10.2105/AJPH.2013.301261](https://doi.org/10.2105/AJPH.2013.301261).
- Pollet TV, Roberts SGB and Dunbar RIM (2011) Extraverts have larger social network layers. *Journal of Individual Differences* 32(3): 161–169. DOI: [10.1027/1614-0001/a000048](https://doi.org/10.1027/1614-0001/a000048).
- Pranata R, Vania R, Tondas AE, et al. (2020) A time-to-event analysis on air pollutants with the risk of cardiovascular disease and mortality: a systematic review and meta-analysis of 84 cohort studies. *Journal of Evidence-Based Medicine* 13(2): 102–115. DOI: [10.1111/jebm.12380](https://doi.org/10.1111/jebm.12380).
- R Core Team (2021) *R: A Language and Environment for Statistical Computing*. Vienna, Austria: R Core Team. <https://www.r-project.org/>
- Rettew DC, McGinnis EW, Copeland W, et al. (2021) Personality trait predictors of adjustment during the COVID pandemic among college students. *PLoS One* 16(3): e0248895. DOI: [10.1371/journal.pone.0248895](https://doi.org/10.1371/journal.pone.0248895).
- Rigon A, Duff MC and Beadle J (2019) Lonely but not alone: neuroticism mediates the relationship between social network size and loneliness in individuals with traumatic brain injury. *Journal of the International Neuropsychological Society: JINS* 25(3): 285–292. DOI: [10.1017/S1355617718001108](https://doi.org/10.1017/S1355617718001108).
- Roberts SGB, Wilson R, Fedurek P, et al. (2008) Individual differences and personal social network size and structure. *Personality and Individual Differences* 44(4): 954–964. DOI: [10.1016/j.paid.2007.10.033](https://doi.org/10.1016/j.paid.2007.10.033).
- Robson D (2021) *Why Introverts Didn't Actually "Win" Lockdown*. London, UK: BBC. <https://www.bbc.com/worklife/article/20210705-why-introverts-didnt-actually-win-lockdown>
- Schermer J and Martin N (2019) A behavior genetic analysis of personality and loneliness. *Journal of Research in Personality* 78: 133–137. DOI: [10.1016/j.jrp.2018.11.011](https://doi.org/10.1016/j.jrp.2018.11.011).
- Shokrkon A and Nicoladis E (2021) How personality traits of neuroticism and extroversion predict the effects of the COVID-19 on the mental health of Canadians. *PLoS One* 16(5): e0251097. DOI: [10.1371/journal.pone.0251097](https://doi.org/10.1371/journal.pone.0251097).
- Smillie L, Cooper AJ, Wilt J, et al. (2012) Do extraverts get more bang for the buck? refining the affective-reactivity hypothesis of extraversion. *Journal of Personality and Social Psychology* 103(2): 306–326. DOI: [10.1037/a0028372](https://doi.org/10.1037/a0028372).

- Smillie LD (2013) Extraversion and reward processing. *Current Directions in Psychological Science* 22(3): 167–172. DOI: [10.1177/0963721412470133](https://doi.org/10.1177/0963721412470133).
- Smillie L and Haslam N (2020) *Personalities That Thrive In Isolation And What We Can All Learn From Time Alone*. Melbourne, VIC: The Conversation. <http://theconversation.com/personalities-that-thrive-in-isolation-and-what-we-can-all-learn-from-time-alone-135307>
- Smith HM and Betz NE (2000) Development and validation of a scale of perceived social self-efficacy. *Journal of Career Assessment* 8(3): 283–301. DOI: [10.1177/106907270000800306](https://doi.org/10.1177/106907270000800306).
- Storr A (2005) *Solitude: A Return to the Self*. Reissue ed. edition. Mumbai, India: Free Press.
- Sun J, Harris K and Vazire S (2020) Is well-being associated with the quantity and quality of social interactions? *Journal of Personality and Social Psychology* 119(6): 1478–1496. DOI: [10.1037/pspp0000272](https://doi.org/10.1037/pspp0000272).
- Swickert RJ, Rosentreter CJ, Hittner JB, et al. (2002) Extraversion, social support processes, and stress. *Personality and Individual Differences* 32(5): 877–891. DOI: [10.1016/S0191-8869\(01\)00093-9](https://doi.org/10.1016/S0191-8869(01)00093-9).
- Szczygiel D and Mikolajczak M (2018) Is it enough to be an extrovert to be liked? emotional competence moderates the relationship between extraversion and peer-rated likeability. *Frontiers in Psychology* 9: 804. DOI: [10.3389/fpsyg.2018.00804](https://doi.org/10.3389/fpsyg.2018.00804).
- Talic S, Shah S, Wild H, et al. (2021) Effectiveness of public health measures in reducing the incidence of covid-19, SARS-CoV-2 transmission, and covid-19 mortality: systematic review and meta-analysis. *BMJ (Clinical Research Ed.)* 375: e068302. DOI: [10.1136/bmj-2021-068302](https://doi.org/10.1136/bmj-2021-068302).
- Tan C-S, Low S-K and Viapude GN (2018) Extraversion and happiness: the mediating role of social support and hope. *PsyCh Journal* 7(3): 133–143. DOI: [10.1002/pchj.220](https://doi.org/10.1002/pchj.220).
- Teppers E, Klimstra TA, Damme CV, et al. (2013) Personality traits, loneliness, and attitudes toward aloneness in adolescence. *Journal of Social and Personal Relationships* 30(8): 1045–1063. DOI: [10.1177/0265407513481445](https://doi.org/10.1177/0265407513481445).
- Tulin M, Lancee B and Volker B (2018) Personality and social capital. *Social Psychology Quarterly* 81(4): 295–318. DOI: [10.1177/0190272518804533](https://doi.org/10.1177/0190272518804533).
- Tuovinen S, Tang X and Salmela-Aro K (2020) Introversions and social engagement: scale validation, their interaction, and positive association with self-esteem. *Frontiers in Psychology* 11: 590748. DOI: [10.3389/fpsyg.2020.590748](https://doi.org/10.3389/fpsyg.2020.590748).
- Waldinger R and Schulz M (2023) *The Good Life: Lessons from the World's Longest Scientific Study of Happiness*. New York, NY: Simon and Schuster.
- Wang J, Mann F, Lloyd-Evans B, et al. (2018) Associations between loneliness and perceived social support and outcomes of mental health problems: a systematic review. *BMC Psychiatry* 18(1): 156. DOI: [10.1186/s12888-018-1736-5](https://doi.org/10.1186/s12888-018-1736-5).
- Wang X, Zhen Z, Xu S, et al. (2022) Behavioral and neural correlates of social network size: the unique and common contributions of face recognition and extraversion. *Journal of Personality* 90: 294–305. DOI: [10.1111/jopy.12666](https://doi.org/10.1111/jopy.12666).
- Wei M (2020) Social distancing and lockdown – an introvert's paradise? an empirical investigation on the association between introversion and the psychological impact of COVID19-related circumstantial changes. *Frontiers in Psychology* 11: 561609. Scopus. DOI: [10.3389/fpsyg.2020.561609](https://doi.org/10.3389/fpsyg.2020.561609).
- Wieczorek LL, Humberg S, Gerstorff D, et al. (2021) Understanding loneliness in adolescence: a test of competing hypotheses on the interplay of extraversion and neuroticism. *International Journal of Environmental Research and Public Health* 18(23): 12412. Scopus DOI: [10.3390/ijerph182312412](https://doi.org/10.3390/ijerph182312412).
- Williams CYK, Townson AT, Kapur M, et al. (2021) Interventions to reduce social isolation and loneliness during COVID-19 physical distancing measures: a rapid systematic review. *PLoS One* 16(2): e0247139. DOI: [10.1371/journal.pone.0247139](https://doi.org/10.1371/journal.pone.0247139).
- Yoshida K, Bartel A, Chipman JJ, et al. (2021) *Tableone: Create "Table 1" to Describe Baseline Characteristics With or without Propensity Score Weights (0.13.0)*. <https://CRAN.R-project.org/package=tableone>
- Zelenski JM, Santoro MS and Whelan DC (2012) Would introverts be better off if they acted more like extraverts? exploring emotional and cognitive consequences of counterdispositional behavior. *Emotion (Washington, D.C.)* 12(2): 290–303. DOI: [10.1037/a0025169](https://doi.org/10.1037/a0025169).
- Zelenski JM, Sobocko K, Whelan, et al. (2013) Introversions, solitude, and subjective well-being. *The Handbook of Solitude*. Hoboken, NJ: John Wiley and Sons, Ltd, pp. 184–201. DOI: [10.1002/9781118427378.ch11](https://doi.org/10.1002/9781118427378.ch11).
- Zimet G (2016) *Multidimensional Scale of Perceived Social Support (MSPSS)—Scale Items and Scoring Information*.