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Abstract

Social relationships are of vital importance for children's and adolescents' development, and disruptions in these relationships can have serious implications. Such disruptions play a central role in both loneliness and social anxiety. Although both phenomena are closely related, they have largely been studied separately, and important questions have remained unanswered concerning how both go together within and across time. Multilevel meta-analyses were performed on 102 cross-sectional studies, published between 1981 and 2016, including 41,776 participants (39% males) with a mean age of 15.59 years. Longitudinal associations were examined in 10 studies, including 3,995 participants (46% males), using a novel technique that enables the examination of such associations even when these were not reported in the original empirical studies. Results indicated a strong, positive cross-sectional association between loneliness and social anxiety symptoms. This associations did not systematically differ in strength across childhood and adolescence. Moreover, results showed that loneliness and social anxiety symptoms were reciprocally associated over time. To conclude, loneliness and social anxiety symptoms are positively associated both within and across time, and across childhood and adolescence. Breaking this vicious cycle is of great importance, as both phenomena may be associated with profound problems in multiple domains of youth development. Moreover, failing to pay attention to both loneliness and social anxiety symptoms might substantially reduce the effectiveness of intervention programs focusing on either of the two.

Keywords: loneliness, social anxiety, children, adolescents, longitudinal, meta-analysis

Loneliness and Social Anxiety Across Childhood and Adolescence: Multilevel Meta-Analyses of Cross-Sectional and Longitudinal Associations

Across development, the need to belong represents the fundamental desire of all humans to form social relationships (Baumeister & Leary, 1995). These social relationships are of vital importance for individuals' well-being. The impact of social experiences on well-being and health emerges in childhood and has a cumulative influence across life, paving the pathway for advantageous or disadvantageous development (Umberson & Montez, 2010). The importance of different types of social relationships varies across age. During childhood, parents have a central role in children's life's, but when children grow into adolescence peers become increasingly important (Collins & Laursen, 2004; Umberson & Montez, 2010). Disruptions in peer relationships can have serious implications for youth development (Kingery, Erdley, Marshall, Whitaker, & Reuter, 2010), and such disruptions are common in children and adolescents who experience loneliness or social anxiety symptoms (Cavanaugh & Buehler, 2016). Although loneliness and social anxiety symptoms are related, both phenomena have largely been studied separately, resulting in separate research traditions. Recent work is increasingly trying to integrate both research traditions (e.g., Fung, Paterson, & Alden, 2017), and the present meta-analysis aims to contribute to this line of research.

Studies have typically found a positive association between loneliness and social anxiety symptoms, but estimates of the strength of this association vary considerably across studies. It remains unclear whether the strength of the association between loneliness and social anxiety symptoms differs systematically across development, characteristics of the participants (e.g., gender or clinical status), or characteristics of the study (e.g., the country in which the study was conducted or the specific questionnaires used). Moreover, it remains unclear how loneliness and social anxiety symptoms are related to each other longitudinally. In the current study, state-of-

the-art meta-analytic techniques are used to move beyond the individual studies published so far. More specifically, we aimed (a) to establish the association between loneliness and social anxiety symptoms across childhood and adolescence, (b) to examine the universality of this association by focusing on a number of potential moderators, and (c) to analyze the direction of effects using data from longitudinal studies that were not necessarily designed to answer this question.

Loneliness and Social Anxiety Symptoms in Childhood and Adolescence

Loneliness is commonly defined as the unpleasant feeling that occurs when people perceive their network of social relationships to be deficient, either quantitatively or qualitatively (Perlman & Peplau, 1981). The subjective experience of loneliness is not the same as the objective experience of being alone. People may feel lonely when alone, but also when they are surrounded by other people. Social anxiety involves a marked and persistent fear of one or more social situations in which the person is exposed to possible scrutiny by others (American Psychiatric Association, 2013). Social situations that typically provoke anxiety in socially anxious children and adolescents include social interactions (e.g., having a conversation), being observed (e.g., when eating), and performance situations (e.g., giving a presentation). Social anxiety is characterized by physical symptoms (e.g., blushing, increased heart rate), cognitive symptoms (e.g., worry), and a behavioral tendency to avoid social situations (Gallagher, Prinstein, Simon, & Spirito, 2014; Ollendick & Hirshfeld-Becker, 2002).

Both phenomena have been found to peak during adolescence, but can also be experienced during childhood (Ollendick & Hirshfeld-Becker, 2002; Qualter et al., 2015; Weeks & Asher, 2012). Addressing loneliness and social anxiety symptoms is essential, as these experiences provoke a great deal of impairment, hampering youth's psychological, social, and educational development (for reviews see Hawkley & Capitanio, 2015; Heinrich & Gullone, 2006; Hidalgo, Barnett, & Davidson, 2001; Kingery et al., 2010; Ollendick & Hirshfeld-Becker,

2002). Moreover, examining how both are related may provide important insights for the development of intervention programs aimed to diminish loneliness and social anxiety symptoms in children and adolescents and enhance their well-being.

Even though both loneliness and social anxiety symptoms involve experienced difficulties in social relationships, their distinctiveness has also been indicated by previous theoretical and empirical work. The painful feeling of loneliness arises when one is not satisfied with the quantity, or, more importantly, the quality of one's relationships (Qualter et al., 2015). For example, a child or adolescent who interacts and plays with peers without feeling anxious may still feel lonely when he or she feels that these relationships are not of satisfying quality. Hence, the core characteristic of social anxiety, which involves intense anxiety in social situations, is not necessarily present in individuals who feel lonely. Moreover, social anxiety implies a fear of social evaluation, but this does not necessarily involve a dissatisfaction with one's social relationships, which leads to loneliness. Furthermore, loneliness and social anxiety symptoms have been found to be better represented by two separate factors than by one general factor, in adolescents (Danneel et al., 2018) and undergraduate students (Fung et al., 2017), and to be differentially associated with other aspects of psychosocial functioning (e.g., Cavanaugh & Buehler, 2016).

Although loneliness and social anxiety symptoms are distinct concepts, they are positively related and may affect each other over time. It has been hypothesized that children and adolescents who experience social anxiety symptoms could subsequently feel more lonely. Social anxiety symptoms in children and adolescents are characterized by interpersonal difficulties and by a tendency to withdraw from social interactions. These children and adolescents do experience the need to belong and, as a consequence, would like to connect with others. However, their anxiety and tendency to withdraw hampers their ability to form meaningful connections, which

may lead to a perceived discrepancy in the quantity and quality of the social relationships they would like to have and the ones they actually have, which is reflected in heightened levels of loneliness (cf. Kingery et al., 2010; Lim, Rodebaugh, Zyphur, & Gleeson, 2016).

Whether loneliness could also predict subsequent social anxiety symptoms is less clear. According to the reaffiliation motive (RAM) model (Qualter et al., 2015), loneliness leads to cognitive biases, including a hypervigilance to social threat (e.g., heightened sensitivity to signs of rejection), a more negative interpretation of the behavior of others, and a self-defeating attributional style. In the social anxiety literature, these cognitive biases are put forward as important predictors of social anxiety symptoms (Muris, Merckelbach, & Damsma, 2000; Weeks, Ooi, & Coplan, 2016). Thus, children and adolescents who experience loneliness may see their social world as more threatening, may be more sensitive to rejection, and may interpret the behavior of others in a more negative way, which in turn leads to higher levels of subsequent social anxiety symptoms. However, most research in this regard has been cross-sectional, making it impossible to draw any conclusion on the temporal ordering. For example, it could also be that the cognitive biases that are characteristic of social anxiety would lead to subsequent feelings of loneliness (Lim et al., 2016; Spithoven, Bijttebier, & Goossens, 2017). Another possible mechanism that could link loneliness to subsequent social anxiety symptoms is the difficulty to (re)connect. It could be that lonely youth who experience such a difficulty miss out on important peer interactions, practice their social skills less, and become even more reserved and reluctant to connect to others, increasing their social anxiety symptoms. Unfortunately, empirical evidence from longitudinal studies on the direction of effects between loneliness and social anxiety symptoms in children and adolescence is rather scarce.

Moderators of the Association Between Loneliness and Social Anxiety Symptoms

Age differences. As the nature and impact of peer relationships change with age, it could be hypothesized that the association between loneliness and social anxiety symptoms, which both involve difficulties in peer relationships, also varies with age. In previous work, which focused on age differences in the manifestation of social anxiety, it was hypothesized that loneliness and social anxiety symptoms are more strongly related in adolescence than in childhood (Rao et al., 2007). The authors argued that during adolescence, engaging with peers becomes increasingly important, while, at the same time, parents become less likely to arrange these interactions with peers (e.g., play dates or sport memberships). For socially anxious adolescents, these processes imply that they have more opportunities for social avoidance, which potentially results in fewer friendships and a stronger feeling of social isolation. In line with this reasoning, the authors found that socially anxious adolescents showed a broader pattern of fear and avoidance than socially anxious children, which, they argued, accounted for the higher levels of loneliness in this group. However, the higher levels of loneliness may also be explained by a general increasing trend in loneliness during this developmental period (Qualter et al., 2015). To our knowledge, no study has yet examined age differences in the association between loneliness and social anxiety symptoms.

Gender differences. Theoretical notions on gender differences in the association between loneliness and social anxiety symptoms are largely lacking, and empirical evidence is scarce and inconsistent, with some studies finding a stronger association for females among college students (Johnson et al., 2006) but no gender differences in late adolescence (Chen & Graham, 2012). In addition, regarding mean level gender differences in both constructs, research suggests no gender differences in loneliness across childhood and adolescence (Maes, Qualter, Vanhalst, Van den Noortgate, & Goossens, 2019), but more social anxiety symptoms in girls than boys from early adolescence onwards (Nelemans et al., 2014). Hence, we will not only examine the main effects

of age and gender on the association between loneliness and social anxiety symptoms, but also their interaction effect.

Social anxiety symptoms. Most research on social anxiety symptoms has looked at general(ized) social anxiety, involving both social avoidance of and distress over potential negative evaluations, across several social situations. However, some researchers distinguish between different aspects of social anxiety symptoms, for example by disentangling these two broad categories of symptoms and examining social avoidance and fear of negative evaluation separately. Another distinction that is sometimes made concerns the difference between general social anxiety, when symptoms are experienced across social situations, and non-general social anxiety, when symptoms are experienced in performance situations only (i.e., performance anxiety, with the most common subtype being public speaking anxiety). The strength of the association between loneliness and social anxiety symptoms could potentially depend on the specific aspects or types of social anxiety assessed. It could be hypothesized, for example, that especially social avoidance would lead children and adolescents to miss out on important social interactions, resulting in heightened levels of loneliness (cf. Wang, Rubin, Laursen, Booth-LaForce, & Rose-Krasnor, 2013).

Additional study and sample characteristics. Other study and sample characteristics that might affect the strength of the association between loneliness and social anxiety symptoms include the year in which the study was published, the country in which the study was conducted, the geographical representation within the sample, the measures that were used to assess loneliness and social anxiety and the reliability of those measures, and the clinical, socioeconomic, and ethnic background of the participants. We examined these additional study and sample characteristics in an explorative fashion.

The Present Study

The aim of the present study was to conduct a meta-analysis on the association between loneliness and social anxiety symptoms across childhood and adolescence. In numerous cross-sectional studies, a positive association between loneliness and social anxiety symptoms has been found, but estimates of this correlation vary considerably. Therefore, in addition to examining the overall cross-sectional association between loneliness and social anxiety symptoms across childhood and adolescence, we aimed to examine several study and sample characteristics that may moderate the strength of this association. Such moderation analyses would reveal whether loneliness and social anxiety are equally strongly related, for example, for boys and girls, across development, and across cultures. Because many studies report on multiple effect sizes, state-of-the-art multilevel meta-analytic techniques will be used to account for the resulting dependency in the data. Traditional meta-analyses do not take this dependency into account, leading to flawed inferences if the dependency is ignored, or a loss of important information if the dependency is avoided (e.g., by selecting a single estimate or averaging several estimates within studies).

Moreover, surprisingly little is known about how loneliness and social anxiety symptoms are related longitudinally. Such longitudinal analysis can give information about the direction of effects, revealing a potential developmental order. A novel meta-analytic technique that is based on a cross-lagged regression approach will be used to examine the longitudinal associations between loneliness and social anxiety symptoms. This technique enables researchers to examine cross-lagged effects, even when these effects were not reported in the original study (as long as the within- and across-time correlations are available).

Method

Identification of Studies

First, a broad literature search was conducted in the databases PsychInfo, ERIC, PubMed, and Web of Science using key terms that reflect the names of the eight main loneliness

questionnaires, with the aim of retrieving all studies in which those questionnaires had been used. For example, for the UCLA loneliness Scale, we used the search strings ("UCLA Loneliness Scale" or "UCLA Loneliness Questionnaire") and ((UCLA) and (lonel* or "perceived social isola*")). A full list of key terms can be found at the Open Science Framework (https://osf.io/tzg32/). Only empirical journal reports, books, and book chapters were included. The retrieved studies together form the MASLO database, and details on this literature search have been described elsewhere (Maes et al., 2019). In brief, the literature search was conducted in 2013 and resulted in 3,658 written reports, of which 1,585 were excluded because they did not use one of the loneliness measures, were written in a language other than Dutch, English, French, or German, or could not be retrieved (for a flow diagram of the selection process, see Figure 1). The remaining 2,073 reports were read in depth, after which 248 reports were excluded because of insufficient information. All reports were coded using a coding protocol which was piloted and developed by different experts in the field of loneliness. Undergraduate and graduate students in psychology were trained by the first author to code the articles until they reached a sufficient level of expertise. All articles coded by the students were checked by the first author.

From these coded reports, we subsequently selected the reports that examined social anxiety symptoms in children, adolescents, and college students. More precisely, studies were included when the mean age of the sample was below 21 years or when the sample consisted of college/university students (regardless of age). To select the studies examining social anxiety symptoms, two social anxiety experts independently compiled a list of key words. After discussing these lists, mutual agreement was reached on a final list of key terms, comprising ("social anx*"), ("social phob*"), ("fear of rejection"), ("fear of eval*" or "fear of negative eval*"), ("social avoid*"), ("social distress"), ("social inhib*"), ("interaction anx*"), and ("social

worry"). Reports selected by this list of key terms were read carefully to ensure social anxiety symptoms were measured. This procedure resulted in a final selection of 85 written reports.

In June 2016, we updated the search, using the same strategy, which yielded an additional 16 reports relevant for this study. From this total of 101 reports, 3 reports were excluded because they reported on the same sample of participants as another included report. These 98 reports were used for the analyses on the cross-sectional association between loneliness and social anxiety. For the longitudinal associations, we selected those reports that assessed both loneliness and social anxiety symptoms at a particular measurement occasion and one or both of them at a subsequent measurement occasion. Whereas 13 of such reports were found, only 7 reported sufficient information to calculate an effect size. Authors of the other 6 reports were contacted to request the information needed and for 3 reports, the authors effectively provided this information. Analyses on the longitudinal associations are thus based on 10 written reports.

Data Set

The final dataset consisted of 98 written reports that were published between 1981 and 2016 (Median = 2007), and reported on 128 effect sizes from 102 studies (k) which were mostly conducted in the US ($k = 69$; for study characteristics, see Supplemental File 1). Sample sizes ranged from 22 to 5,147 participants, with a total of 41,776 children and adolescents included in the present meta-analysis (39% males). In each study, both loneliness and social anxiety symptoms were measured using self-reports. In addition to self-reported social anxiety symptoms, one study also reported on mother-reported social anxiety symptoms and another study also reported on peer-reported social anxiety symptoms. However, because other-reports were only used twice, we decided to include only effect sizes based on self-reports.

For the longitudinal associations, 10 reports could be included (see Table 2). These reports were published between 1987 and 2016 (Median = 2011), with sample sizes ranging from

83 to 1,180. In all, 3,995 children and adolescents were included in the present analyses (46% males), mostly from the US ($k = 7$). Time between measurement occasions ranged from 1.25 months to 72 months (Median = 10.50 months).

Coding of Studies

Age. Information on the mean age of the participants was available for most studies ($k = 86$) and ranged from 9.28 to 24.30 years ($M = 15.59$, $SD = 4.27$). Because of the large age range, we also examined the quadratic effect of age. To avoid collinearity, we centered the moderator 'age' around the average, that is, 15.59 years.

Gender. Gender was coded as the proportion of males in the study. Information was available for 98 studies and the proportion ranged from 0.00 to 0.91 ($M = 0.39$, $SD = 0.16$).

Type of social anxiety. The effect sizes (n) of the present dataset could be categorized as follows: (0) general social anxiety ($n = 81$), (1) fear of negative evaluation or rejection ($n = 25$), and (2) social avoidance and distress ($n = 18$). Only two effect sizes could be categorized as social performance anxiety and were, therefore, not included in the moderator analysis regarding type of social anxiety. Two other effect sizes, tapping into social anxiety-shyness and physiological symptoms, were also excluded as they could not be categorized properly.

Additional study and sample characteristics. First, year of publication was included as a continuous variable, centered around the year of publication of the oldest article included (i.e., 1981). Second, the moderator reflecting the country in which the study was conducted was coded as (0) US ($k = 69$), (1) Western non-US ($k = 24$), and (2) non-Western countries ($k = 6$). Three studies could not be categorized and were not included in the analysis on this moderator. Third, geographical representation was coded as follows: (1) participants were sampled from a single city ($k = 57$); (2) participants were sampled from multiple cities within one geographical area ($k =$

13); and (3) participants were sampled from multiple geographical areas ($k = 13$). For 19 studies, this information was missing.

Fourth, regarding the measurement of loneliness, most effect sizes were based on the Children's Loneliness Scale ($n = 52$; Asher, Hymel, & Renshaw, 1984) and the University of California Los Angeles (UCLA) Loneliness Scale ($n = 65$; Russell, Peplau, & Cutrona, 1980). Other measures included were the Differential Loneliness Scale ($n = 4$; Schmidt & Sermat, 1983), the Social and Emotional Loneliness Scale for Adults ($n = 3$; DiTommaso & Spinner, 1993), the Loneliness and Aloneness Scale for Children and Adolescents ($n = 2$; Marcoen, Goossens, & Caes, 1987), and the Peer Network and Dyadic Loneliness Scale ($n = 2$; Hoza, Bukowski, & Beery, 2000), but these categories were not included in this moderator analysis because of the small number of effect sizes available. Reliability of the loneliness scores were indicated by Cronbach's alpha, which was available for 103 of the effect sizes and ranged from .61 to .95 ($M = .87$, $SD = .06$). Fifth, regarding the measurement of social anxiety symptoms, several different questionnaires have been used, including the Social Anxiety Scale for Children/Adolescents ($n = 45$; La Greca & Lopez, 1998; La Greca & Stone, 1993), the Fear of Negative Evaluation Scale ($n = 12$; Watson & Friend, 1969), the Self-Consciousness Scale ($n = 12$; Fenigstein, Scheier, & Buss, 1975), the Social Anxiety and Social Avoidance Scale ($n = 8$; Franke & Hymel, 1984), the Social Interaction Anxiety Scale ($n = 8$; Mattick, R. P., & Clarke, J. C. (1998), the Interaction Anxiousness Scale ($n = 8$; Leary, 1983), the Social Avoidance and Distress Scale ($n = 4$; Watson & Friend, 1969), and the Social Phobia and Anxiety Inventory ($n = 3$; Turner, Beidel, Dancu, & Stanley, 1989). In addition, 28 effect sizes were based on a measure that was used only once or twice in the present dataset or on a combination of measures. Because of insufficient data available, we included only the categories with at least five effect sizes in the moderator analysis of the social anxiety symptoms measure used. Reliability of the social anxiety

symptoms scores were indicated by Cronbach's alpha, which was available for 104 of the effect sizes and ranged from .55 to .99 (M = .85, SD = .08).

Sixth, we coded whether studies included participants who had physical illnesses, special educational needs, or mental health problems. However, there were not enough studies to examine each of these categories separately. Therefore, we dichotomized the studies into (0) non-clinical samples (k = 92) and (1) clinical and mixed (i.e., both clinical and non-clinical) samples (k = 10). Seventh, information on socioeconomic status (SES) was often missing (k = 69). Regarding the studies for which this information was available (k = 33), 5 studies included a sample in which more than 75% of the participants had low SES, 21 studies included a sample in which more than 75% of the participants had middle to high SES, and 7 studies included a sample that was more equally mixed regarding SES. Information on the ethnic background of the participants was also often missing (n = 30). Regarding the studies for which this information was available (k = 72), 6 studies included a sample in which more than 75% of the participants came from an ethnic minority group, 40 studies included a sample in which more than 75% of the participants came from the ethnic majority group, and 26 studies included a sample that was more equally mixed regarding ethnic background.

Statistical Analyses

Cross-sectional associations. In most studies, Pearson product-moment correlations were reported to represent the association between loneliness and social anxiety symptoms. One study reported on Spearman's rho, which we transformed to a product-moment correlation using the formula from Rupinski and Dunlap (1996). Next, we transformed all correlations using Fisher's Z_r transformation (Lipsey & Wilson, 2001). In the analyses, the effect sizes were weighted by the inverse variance, such that samples with higher precision got a greater weight in the analyses.

Effect sizes for the cross-sectional analyses were derived from 98 written reports that reported on 128 effect sizes from 102 studies. When primary studies report multiple effect sizes (commonly obtained using the same sample), traditional meta-analytic approaches make the strong assumption of independence among effect sizes, although effect sizes obtained from the same study will be more similar than effect sizes obtained from different studies. Ignoring this dependency may lead to flawed inferences, because the standard errors will be underestimated, resulting in too small confidence intervals and an inflated Type I error rate (Van den Noortgate, López-López, Marín-Martínez, & Sánchez-Meca, 2015). Avoiding dependency by selecting just a single estimate or by averaging several estimates may result in a loss of information. In the present dataset, for example, it was often the case that multiple effect sizes could be computed within a particular study, because data were available for different types of social anxiety. Aggregating these different effect sizes would significantly reduce the information available, hampering the examination of the moderating effect of type of social anxiety symptoms.

A multilevel meta-analysis does not make the strong assumption of independence, but explicitly accounts for possible dependencies among effect sizes (Hox, 2002; Van den Noortgate et al., 2015). Hence, we used a three-level model, accounting for sampling variance at Level 1 (i.e., sampling variation of the observed effect sizes around the 'true' population effect sizes), within-study variance at Level 2 (i.e., variation of the true effect sizes within a study), and between-study variance at Level 3 (i.e., variation of effect sizes over studies). Hence, because variability between effect sizes is taken into account (and this total variability is divided in two variance components: within-study and between-study variance), a random-effects model is used.

To examine whether the association between loneliness and social anxiety symptoms varied according to study and sample characteristics, we conducted moderation analyses by including the characteristics as predictors in the three-level models. Analyses were conducted

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with the Metafor package (version 1.9-9) in R using restricted maximum likelihood (REML) as estimation method (Assink & Wibbelink, 2016; Viechtbauer, 2010). Mean and moderating effects were statistically tested by means of a Wald test, comparing the ratio of the estimate over the corresponding standard error estimate to a *t*-distribution.

Longitudinal associations. To examine longitudinal associations between two variables, while controlling for prior levels of these variables, a cross-lagged regression approach was used (cf. Sowislo & Orth, 2013)[1]. This approach allows researchers to examine cross-lagged effects (e.g., the effect of Time 1 loneliness on Time 2 social anxiety symptoms), controlling for prior levels of the variables (e.g., the stability from Time 1 social anxiety symptoms to Time 2 social anxiety symptoms, and the cross-sectional correlation between Time 1 loneliness and Time 1 social anxiety symptoms). Moreover, this approach allows researchers to examine these cross-lagged effects even when this was not the focus of the original study.

Using correlation coefficients between constructs, standardized regression coefficients can be computed representing, for example, the cross-lagged effect of Time 1 loneliness on Time 2 social anxiety symptoms, using the following equation (Becker, 1992, p. 359):

$$\beta_1 = \frac{r_{yx1} - r_{yx2}\, r_{x1x2}}{1 - r_{x1x2}^2}$$

In this equation, β_1 represents the standardized regression weight of X_1 predicting Y, controlling for the effect of X_2. For example, to examine the effect of Time 1 loneliness on Time 2 social anxiety symptoms, we would use the above equation with Y being Time 2 social anxiety symptoms, X_1 representing Time 1 loneliness, and X_2 being Time 1 social anxiety symptoms. In

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[1] An alternative approach is the random-effects meta-analytic structural equation model (MASEM). When applying this approach using the metaSEM package (Cheung, 2014), we obtained very similar results. MASEM is a promising approach, but a current drawback is that it is not yet clear how study and sample characteristics can be incorporated in the analyses. Solutions have been proposed for categorical moderators, but examining continuous moderators, such as the time lag between assessments, remains problematic (Card, 2017; Cheung & Cheung, 2016).

addition, the stability of, for example, loneliness, can be computed, controlling for Time 1 social anxiety symptoms, and the cross-sectional correlation between Time 1 loneliness and Time 1 social anxiety symptoms.

Most studies had only data available for two measurement waves, except for one study that included three waves. However, one study reporting on multiple effect sizes is not enough to fit a model with an extra level, so we decided to include from this study only the data from the first two measurement waves. Hence, for each study only one effect size was included in each analysis so we could use a two-level model including sampling variance at Level 1 and between-study variance at Level 2. Separate models were run for the different effects, that is, the stability of loneliness, the stability of social anxiety symptoms, and the two cross-lagged effects between the two constructs. In those four models, effect sizes were weighted by the inverse variance. To estimate the sampling variance, formulas derived from statistical theory can be used that correspond to the type of effect sizes used (Lipsey & Wilson, 2001). Such formulas are readily available for commonly used effect sizes, such as Fisher's Z or the standardized mean difference. However, computing the sampling variance for effect sizes representing standardized regression coefficients is still somewhat less straightforward. If the researcher has information about the correlation coefficients between the variables of interest, the standardized regression coefficients and their sampling variances can be obtained using the formulation presented in Becker (1992, 2009). To facilitate these computations, an R code including notes on its use can be found in Supplemental File 2. The meta-analyses were again conducted with the Metafor package (version 1.9-9) in R using restricted maximum likelihood (REML) as estimation method.

Publication bias. The presence of publication bias was examined in three ways. First, we created funnel plots. In the absence of publication bias, we would expect that such a plot is shaped as a symmetric funnel, suggesting that as sample size increases, studies converge around

the true mean (Sterne, Becker, & Egger, 2005). Second, to test statistically whether the mean

observed effect size depends on sample size, we added sample size as a predictor to each model

(one model for the cross-sectional association and four models for the longitudinal associations)

and evaluated the significance of its coefficient (Card, 2012). Third, for the cross-sectional

associations, we applied an improved version of the p-uniform method (Van Aert, 2018). A

novelty of this version, compared to the original proposal (Van Assen, Van Aert, & Wicherts,

2015) is that non-significant effect sizes can also be included in the analyses. For these analyses,

we randomly selected one effect size per study, as dependent effect sizes cannot be included in

these analyses. Next, we applied p-uniform* using this app: https://rvanaert.shinyapps.io/p-

uniformstar/. For the longitudinal associations, these analyses cannot yet be conducted as the only

effect sizes for which these analyses are available are standardized mean differences and Pearson

correlation coefficients.

Results

Cross-Sectional Association Between Loneliness and Social Anxiety Symptoms

All cross-sectional correlations between loneliness and social anxiety symptoms were

positive, ranging from $r = .10$ to .72, except for one correlation that was large and negative ($r = -$

.75). Because this value was extremely different from the other values (which raises questions

regarding the correctness of the value), we decided to drop this outlier from the present analyses.

To show the general pattern of findings, the 127 resulting Fisher's Z transformed effect sizes,

together with the 95% confidence intervals that indicate the precision of each study, are presented

in a caterpillar plot (cf. Houben, Van den Noortgate, & Kuppens, 2015; see Supplemental File 4).

Analyses revealed an estimated mean Fisher's $Z = .49$ ($SE = 0.02$, $p < .001$). Back transformation

into standard correlational form yielded a mean estimated effect size of $r = .46$, 95% CI [.43, .48].

Furthermore, we examined how the total variance was decomposed into sampling variance (because the sampling variance depends on the size of the study, we used the median sampling variance for this calculation), within-study variance, and between-study variance (i.e., intraclass correlation coefficients; Cheung, 2014). The median sampling variance was 0.005 and represented 17.24% of the total variance. Significant within-study variance was found (0.008, $\chi^2(1) = 82.58$, $p < .001$), representing 27.59% of the total variance, suggesting that differences in effect sizes reported within the same study are larger than expected based on sampling variance alone, and therefore that there are systematic differences in the effect sizes that are estimated within studies. In other words, it is necessary to account for the within-study variance and to apply a three-level model. The between-study variance was also found to be significant (0.016, $\chi^2(1) = 10.48$, $p = .001$) and represented 55.17% of the total variance, suggesting that there were systematic differences in effect sizes between studies.

Moderators of the Association Between Loneliness and Social Anxiety Symptoms

The results of the moderation analyses are presented in Table 1. Five of the moderators significantly affected the strength of the association between loneliness and social anxiety symptoms. The moderator year of publication reached significance ($b = 0.004$, $p = .049$, 95% CI [0.000, 0.008]), but explained only 6.67% of the between-study variance. The socioeconomic status of the participants also significantly affected the association between loneliness and social anxiety symptoms, explaining 42.68% of the within-study variance and 12.73% of the between-study variance. Specifically, a stronger association between loneliness and social anxiety symptoms was found for studies in which most of the participants had a middle or high socioeconomic status.

The moderator reflecting the questionnaire used to assess social anxiety symptoms explained 59.76% of the within-study variance and 12.34% of the between-study variance. The

strongest estimated mean correlation was found when the Social Anxiety Scale for Children/Adolescents (SAS-C/A) was used, whereas the Fear of Negative Evaluation scale yielded the smallest estimated mean correlation. The estimated mean correlations for the questionnaires tapping into social avoidance and social interaction anxiousness did not significantly differ from the estimated mean correlation for the SAS-C/A. This finding is in line with the significant moderator distinguishing different types of social anxiety symptoms, which explained 4.88% of the within-study variance and 5.45% of the between-study variance.. Specifically, results showed that loneliness was more strongly related to general social anxiety and to social avoidance and distress than to fear of negative evaluation. Lastly, the moderator reflecting the reliability of social anxiety symptoms scores reached significance and explained 19.51% of the within-study variance and none of the between-study variance. The association between loneliness and social anxiety symptoms was stronger when this association was based on social anxiety scores with higher reliability. Specifically, when one would have a one unit increase in the Cronbach's reliability score, the expected mean estimated effect sizes increases by 0.62.

Longitudinal Associations Between Loneliness and Social Anxiety Symptoms

Standardized regression coefficients for each study are presented in Table 2, reflecting the stability coefficients of loneliness and social anxiety symptoms and the cross-lagged effects between these two constructs (controlling for prior levels of the variables and the cross-sectional correlation between loneliness and social anxiety symptoms on Time 1). The mean estimated stability coefficient was 0.53 for loneliness ($SE = 0.07$, $p < 0.001$, 95% CI [0.38, 0.68]) and 0.50 for social anxiety symptoms ($SE = 0.03$, $p < .001$, 95% CI [0.43, 0.58]). The mean estimated cross-lagged effect of loneliness on subsequent social anxiety symptoms was 0.12 ($SE = 0.04$, $p =$

.011, 95% CI [0.04, 0.21]). The mean estimated cross-lagged effect of social anxiety symptoms on subsequent loneliness was 0.09 ($SE = 0.03$, $p = .009$, 95% CI [0.03, 0.15]).

Furthermore, we examined whether there was, in addition to random sampling variance, systematic between-study variance. Significant between-study variance was found for all four effects, that is, the stability coefficients of loneliness (0.043, $\chi^2(1) = 300.46$, $p < .001$, representing 94% of the total variance), the stability coefficients of social anxiety symptoms (0.006, $\chi^2(1) = 18.19$, $p < .001$, representing 73% of the total variance), the cross-lagged effects of loneliness on social anxiety symptoms (0.008, $\chi^2(1) = 27.30$, $p < .001$, representing 72% of the total variance), and the cross-lagged effects of social anxiety symptoms on loneliness (0.004, $\chi^2(1) = 23.76$, $p < .001$, representing 58% of the total variance). These results suggest that there were systematic differences in effect sizes between studies. However, not enough data was available to examine moderator effects. Given the large range of time lags represented in the longitudinal studies (i.e., 1.25 to 72 months), it would be interesting for future work to test whether the examined associations differ in strength based on the time lag between measurements. Such tests would provide important information about the timing of effects, guiding future research designs.

Publication Bias

First, we created five funnel plots, that is, one for the cross-sectional association between loneliness and social anxiety symptoms (Figure 2) and four for the longitudinal associations (Figure 3). All funnel plots showed more or less a symmetric funnel shape. Second, testing the moderating effect of sample size yielded non-significant results in all cases, except for the cross-lagged effect of loneliness on social anxiety symptoms. As this effect was very small (i.e., $b = 0.000$, $SE\ b = 0.000$, $p = .049$), we concluded that the data showed little evidence for publication bias. Third, results from the p-uniform* method on the cross-sectional associations showed no

evidence for publication bias (L.pb = 1.83, $p = .398$), and that the corrected estimate ($r = .427$), CI[.36, .496]) is really close to the observed estimate.

Discussion

The present state-of-the-art multilevel meta-analysis examined the association between loneliness and social anxiety symptoms across child and adolescent development. Across studies, a strong, positive cross-sectional association was found between loneliness and social anxiety symptoms. Moreover, using novel longitudinal meta-analytic techniques, we found significant but small cross-lagged effects in both directions, that is, loneliness predicted subsequent social anxiety symptoms and social anxiety symptoms predicted subsequent loneliness.

The multilevel meta-analytic technique used, holds great promise for (developmental) psychological science, as it solves the problem of dependency among effects sizes (i.e., when multiple effect sizes are reported within a study) in a much better way than is possible with traditional techniques. Such multilevel techniques have become increasingly accessible and easy to apply with the emergence of different convenient guidelines and tutorials (e.g., Assink & Wibbelink, 2016; Van den Noortgate et al., 2015; Viechtbauer, 2010). The novel technique that was applied to examine the longitudinal associations between loneliness and social anxiety symptoms, enables the examination of longitudinal associations between two constructs, controlling for prior levels of those constructs, even when these associations were not examined in the original empirical article – as long as the within- and between-time correlations are available.

Cross-Sectional Association Between Loneliness and Social Anxiety Symptoms

In line with previous research showing that loneliness and social anxiety symptoms are related but distinct phenomena (Fung et al., 2017), we found a strong, positive cross-sectional association ($r = .46$), indicating both the relatedness and distinctiveness of the two. In addition,

we examined whether the association between loneliness and social anxiety symptoms changes across age. Strikingly, findings in the present meta-analysis showed that the association between these two phenomena does not systematically vary across age from childhood to adolescence. This suggests that although peers become increasingly important in adolescence, this does not seem to affect the association between loneliness and social anxiety symptoms. Based on previous work (Rao et al., 2007), it was hypothesized that loneliness and social anxiety symptoms would be more strongly related in adolescence than in childhood. The main idea was that it would be easier for adolescents to avoid social situations as parents may be less likely to arrange interactions with peers for adolescents than for children. However, it could be that avoiding social situations is less harmful for adolescents than it is for children, as adolescents may be better able to use time alone in a constructive way, for example, for emotional self-regulation and identity development (Larson, 1997; Long & Averill, 2003). Moreover, even if socially anxious children are more in arranged social situations than socially anxious adolescents, this does not necessarily mean that this will also protect them from feeling lonely. If (socially anxious) children are members of a sports club, but still have difficulties with connecting to others or do not feel like they belong to this group, they will likely experience loneliness. This is in line with a meta-analysis on loneliness interventions, showing that interventions merely focusing on increasing opportunities for social contact are not very effective in reducing feelings of loneliness (Masi, Chen, Hawkley, & Cacioppo, 2011).

To examine the universality of the cross-sectional association between loneliness and social anxiety symptoms, we also tested other moderators in addition to age. We found that the association did not systematically vary according to the gender of the participants, the country the study was conducted in, the geographical representation of the sample, the loneliness questionnaire used, and the clinical and ethnic status of the participants.

The socioeconomic status of the participants was a significant moderator, with the highest estimated mean association between loneliness and social anxiety symptoms found for studies including mostly participants with a middle or high socioeconomic status (SES). However, results showed no clear pattern across the SES categories and were based on a small number of effect sizes, making it difficult to interpret these findings. Specifically, we had three categories, that is, studies that included mostly participants with a low SES, studies that were mixed and included a substantial number of participants with both a low and middle/high SES, and studies that included mostly participants with a middle/high SES. However, it was not the case that the first category had the lowest estimated mean effect size, and the third category had the highest one. Rather, the lowest estimated mean effect size was found for the second category (i.e., the 'mixed' category), and the first category (i.e., the low SES category) was in the middle and not significantly different from the other two categories. Further empirical work may shed additional light on this issue.

The specific assessment of social anxiety symptoms also affected the strength of the association between loneliness and social anxiety symptoms. We found that the association was stronger when the reliability of social anxiety scores was higher. This makes sense as measurement error (e.g., lower reliability) creates a downward bias of correlations (Hunter & Schmidt, 2004). In addition, associations were strongest when the Social Anxiety Scale for Children/Adolescents was used, which was the most commonly used measure for social anxiety symptoms in our meta-analysis. However, these associations were not significantly different from the associations based on the Social Anxiety and Social Avoidance Scale, the Social Interaction Anxiousness Scale, and the Interaction Anxiousness Scale. Interestingly, all of these social anxiety questionnaires appear to assess the broader symptomatology of social anxiety focusing on a range of different symptoms, rather than focusing on more specific types of social anxiety.

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Associations were lowest, but still of medium size, when the Fear of Negative Evaluation Scale had been used, assessing a specific type of social anxiety symptoms. These results were in line with the findings concerning moderation by distinguishing different types of social anxiety symptoms, which suggested lower associations between loneliness and fear of negative evaluation and higher associations between loneliness and both social avoidance and distress, and general social anxiety. Hence, researchers aiming to examine social anxiety symptoms should carefully think about which aspects of social anxiety they wish to examine before choosing among the different instruments available. In addition, future research could examine whether it is especially the intense fear for and the avoidance of social situations, more than a fear of negative evaluation, that hampers the social functioning of children and adolescents, putting them at risk for loneliness.

Another explanation for the effect of measurement on the association, is a possible overlap in item content. Evidence from factor analyses, however, is scarce. A study focusing on the UCLA Loneliness Scale (UCLA) and the Social Interaction Anxiety Scale (SIAS) in undergraduate students found one cross-loading, that is, the UCLA item "I am an outgoing person" (Fung et al., 2017). Another study on undergraduate students, focusing on the UCLA and the Social Anxiety Scale for Adolescents (SAS-A), also found some cross-loadings, all derived from the General Social Avoidance and Distress subscale of the SAS-A (Vanhalst, 2015). Concerning adolescents, a study focusing on the Loneliness and Aloneness Scale for Children and Adolescents (LACA) and the SAS-A did not reveal any cross-loadings. So, the relatively strong correlations between loneliness and both social avoidance and distress, and general social anxiety, could in part be explained by an overlap in item content. However, when we closely look at those items, we see that the large majority of social anxiety items refer to "feeling nervous", "worrying", or "being afraid", whereas such terms are generally not used in the loneliness items

(except for the General Social Avoidance and Distress subscale of the SAS-A). So, whereas the loneliness items mostly refer to the feeling of lacking someone to turn to, most social anxiety items refer to feeling nervous to turn to someone. Moreover, items tapping into social avoidance and distress symptoms really refer to avoiding social situations, whereas the loneliness measures do not include such items. Finally, both the UCLA and some social anxiety measures (e.g., the SAS-A) refer to "shyness". So, there seems to be some overlap in item content between loneliness and social anxiety measures, which could in part explain why we found somewhat higher correlations for some of the scales. However, looking at the items, there also seem to be clear differences, which is in line with only few cross-loadings found in factor analyses. Hence, we should continue to critically reflect on the measures we use and to optimize them where needed.

Longitudinal Associations Between Loneliness and Social Anxiety Symptoms

Based on previous theoretical work, it was hypothesized that social anxiety symptoms would be associated with subsequent loneliness. In addition, it was hypothesized that loneliness would be associated with subsequent social anxiety symptoms, although strong theoretical notions on the mechanisms are currently missing. Empirical research testing both directions of effects whilst controlling for previous levels of the constructs is scarce. In this study, we applied a novel meta-analytic technique that enabled us to examine these longitudinal associations, even when they were not the focus of the original studies included in our meta-analysis. None of the longitudinal studies in our dataset, indeed, had the longitudinal, potentially reciprocal, association between loneliness and social anxiety symptoms as its primary focus. Our findings suggested that loneliness and social anxiety symptoms were reciprocally related over time, although relatively small effect sizes were found, pointing towards a vicious cycle. Children and adolescents who feel lonely may encounter difficulties in connecting to others and are likely to see their social

world as more threatening and the behavior of their peers as more negative. Repeatedly experiencing these social difficulties might subsequently be associated with an increase in social anxiety symptoms, such as social worry and a tendency to avoid social situations. These experiences of social anxiety make it even harder to connect to others and thereby be associated with increased feelings of loneliness. Breaking such a vicious cycle is important, as both phenomena have been associated with profound problems in multiple domains of child and adolescent development. The relatedness between loneliness and social anxiety symptoms across different circumstances and different groups of participants emphasizes the importance of addressing both loneliness and social anxiety symptoms in interventions aiming to diminish one or both phenomena (cf. Lim et al., 2016).

Another explanation for the vicious circle of loneliness and social anxiety symptoms may include cognitive biases. Even though research on loneliness and social anxiety symptoms has largely been conducted in two separate research lines, striking parallels exist, including a common focus on cognitive biases (Fung et al., 2017). Such biases have been identified in both research traditions as an important underlying mechanism that influences the development and maintenance of both loneliness and social anxiety symptoms. Examples of specific cognitive biases include a hypervigilance to social threat (e.g., heightened sensitivity to signs of rejection), a negative interpretation of the behavior of others, and a self-defeating attributional style (Muris, Merckelbach, & Damsma, 2000; Qualter et al., 2015; Vanhalst et al., 2015; Weeks, Ooi, & Coplan, 2016). These potential mechanisms should be taken into account when interpreting the findings of the present study.

Addressing these cognitive biases in intervention programs to diminish both loneliness and social anxiety symptoms could be an important avenue for future work. In fact, a meta-analysis on interventions to reduce loneliness already indicated that the most effective

interventions addressed maladaptive social cognitions (Masi et al., 2011). Such interventions were more effective than interventions that aimed to improve social skills, enhance social support, or increase opportunities for social contact – interventions that are frequently offered in practice. Similarly, in the social anxiety literature, cognitive-behavioral therapy has been put forward as the best initial treatment of social anxiety disorder (Mayo-Wilson et al., 2014).

In line with the above hypotheses, the theoretical model developed by Rubin and colleagues (e.g., Rubin & Mills, 1988; Rubin & Mills, 1991; for a review see Rubin, Coplan, & Bowker, 2009) is of special interest and may provide some focal points for future intervention work. This model proposes a pathway to the development of both loneliness and social anxiety symptoms in middle childhood and early adolescence. The pathway starts with newborns who are hyperaroused when confronted with social (or nonsocial) stimuli. This hyperarousal, in turn, will lead to particular parenting styles (e.g., overprotective parenting), resulting in an insecure parent-infant attachment relationship. Such feelings of insecurity together with the infant's temperament are thought to initiate a trajectory toward behavioral inhibition, causing these children to miss out on the positive outcomes associated with social interactions. When they miss out on such interactions, these children cannot develop their social skills, and they consequently become increasingly anxious and isolated from the peer group. This isolation, in turn, could lead to the development of low self-esteem and negative perceptions of social skills and peer relationships. These processes (together with other factors that are described in more detail in the review of Rubin et al., 2009) would not only lead to the development of negative thoughts and feelings about the self, but also to the development of both loneliness and social anxiety symptoms. From infancy to adolescence, this model provides opportunities for interventions to prevent the development of loneliness and social anxiety.

Limitations and Suggestions for Future Research

Reviewing the literature on the associations between loneliness and social anxiety symptoms across childhood and adolescence leads us to several suggestions for future research. As a research community, we should aim to base our conclusions on a set of studies that is representative of the global population of children and adolescents. For example, 68% of the studies included in the present meta-analysis were conducted in the US, whereas countries from Africa, the Middle East, and South-America were largely underrepresented. Furthermore, the majority of studies did not report on the socioeconomic status or ethnicity of the participants. We would like to urge researchers to include information on these demographic characteristics of their sample in their research reports. Of the studies that did report on the socioeconomic and ethnic background of the participants, most included samples in which more than 75% of the participants had middle to high SES and came from the ethnic majority group. Furthermore, almost all studies included non-clinical samples, and we were not able to separately examine the effect for different types of clinical samples, such as samples including participants who had physical illnesses, special educational needs, or mental health problems.

Research on social anxiety symptoms suggests that different types exist, including performance (often public speaking) anxiety (Hidalgo et al., 2001). However, the number of studies currently available is insufficient to examine the association between loneliness and performance anxiety in children and adolescents. Similarly, research on loneliness increasingly emphasizes the importance of distinguishing among different loneliness types, such as intimate and relational loneliness. Intimate loneliness is the feeling of lacking a close, intimate attachment to another person, whereas relational loneliness is the feeling of lacking a network of social relationships (Cacioppo, Grippo, London, Goossens, & Cacioppo, 2015). Both types of loneliness are related to problems in different domains and to different forms of psychopathology in youth (e.g., Lasgaard, Goossens, Bramsen, Trillingsgaard, & Elklit, 2011; Maes, Vanhalst, Spithoven,

Van den Noortgate, & Goossens, 2016), suggesting that they may be differently related to social anxiety symptoms too. However, this hypothesis could not be examined in this meta-analysis because the large majority of studies used unidimensional scales (i.e., the CLS and UCLA Loneliness Scale) that do not distinguish between different types of loneliness.

The present meta-analysis only included published studies, which could potentially have led to biased results. However, there is some debate in the literature on meta-analysis regarding the inclusion of unpublished work (e.g., Ferguson & Brannick, 2012), as this could also introduce other sources of biases. For instance, researchers who happen to know the members of the meta-analysis team might be more likely to share their research with them, and findings that are in line with the expectations are also more likely to be shared. Moreover, we tested for publication bias in different ways and those results showed little or no evidence for publication bias.

Conclusion

To conclude, results of the present meta-analysis, covering over 100 studies across childhood and adolescence, indicated a strong cross-sectional association between loneliness and social anxiety symptoms. Moreover, by using data from 10 longitudinal studies, we could examine the associations over time. Results indicated that loneliness was positively associated with subsequent social anxiety symptoms, but also that social anxiety symptoms were positively associated with subsequent loneliness. It is of great importance to break this vicious cycle as both loneliness and social anxiety symptoms in children and adolescents may be associated with profound problems in multiple domains. Failing to pay attention to both phenomena might substantially reduce the effectiveness of intervention programs focusing on either loneliness or social anxiety symptoms.

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Table 1

Regression Analyses for Moderators of the Association Between Loneliness and Social Anxiety Symptoms

Model	Moderator	*n*	*b*	*SE b*	95% CI		*F*	*df*	*p*
1	Age	109	-0.00	0.00	-0.01,	0.01	0.47	1, 107	.495
2	Age	109	-0.00	0.00	-0.01,	0.00	1.81	2, 106	.169
	Age quadratic	109	0.00	0.00	-0.00,	0.00			
3	Gender	123	-0.17	0.12	-0.40,	0.07	2.02	1, 121	.158
4	Age	108	-0.02	0.01	-0.04,	0.00	1.96	3, 104	.125
	Gender	108	-0.13	0.13	-0.38,	0.13			
	Age * Gender	108	0.05	0.03	-0.01,	0.10			
5	Social anxiety symptoms	123					3.43	2, 120	.034
	Fear of negative evaluation	25	0.43_a	0.03	0.37,	0.49			
	General social anxiety	81	0.51_b	0.02	0.47,	0.55			
	Social avoidance and distress	18	0.52_b	0.04	0.45,	0.60			
6	Year of publication	127	0.00	0.00	0.00,	0.01	4.28	1, 125	.049
7	Country	124					0.82	2, 121	.442
	US	90	0.48	0.02	0.44	0.52			
	Western non-US	28	0.53	0.04	0.46	0.60			
	Non-Western	6	0.51	0.07	0.37	0.65			
8	Geographical representation	102					0.22	2, 99	.801
	1 city	74	0.49	0.02	0.45	0.54			
	>1 city, 1 area	14	0.46	0.05	0.37	0.56			
	>1 area	14	0.47	0.05	0.37	0.56			
9	Loneliness questionnaire	116					0.45	1, 114	.506
	CLS	51	0.51	0.03	0.46	0.56			
	UCLA	65	0.49	0.02	0.44	0.53			
10	Reliability loneliness questionnaire	102	0.35	0.26	-0.17	0.87	1.74	1, 100	.190
11	Social anxiety questionnaire	92					6.17	5, 86	<.001
	FNE	12	0.37_a	0.04	0.29	0.45			
	Self-Consciousness Scale	12	$0.40_{a,b}$	0.05	0.30	0.50			
	SASA	8	$0.45_{a,b,c}$	0.05	0.34	0.56			
	SIAS	8	$0.52_{b,c,d}$	0.05	0.42	0.63			
	Interaction Anxiousness Scale	8	$0.53_{b,c,d}$	0.05	0.43	0.62			
	SAS-C / SAS-A	44	0.58_d	0.02	0.54	0.63			
12	Reliability social anxiety questionnaire	104	0.62	0.21	0.19	1.04	8.26	1, 102	.005
13	Clinical status	127					1.74	1, 125	.190
	Non-clinical	118	0.49	0.02	0.45	0.52			
	Clinical and mixed	9	0.58	0.07	0.45	0.72			
14	Socioeconomic status	41					5.73	2, 38	.007
	Mostly low SES	7	$0.48_{a,b}$	0.07	0.34	0.62			
	Mixed SES	8	0.40_a	0.06	0.29	0.52			
	Mostly Middle/high SES	26	0.62_b	0.04	0.55	0.69			
15	Ethnic majority/minority	94					0.89	2, 91	.414
	Mostly minority	8	0.45	0.07	0.31	0.59			
	Mixed minority/majority	30	0.47	0.03	0.41	0.54			
	Mostly majority	56	0.52	0.03	0.47	0.58			

Note. n is the number of effect sizes; *b* = regression coefficient; For the categorical variables, the given regression coefficients represent the mean effect sizes (Fisher's Z) for each category. CI = confidence interval. Note that an overlap in confidence intervals does not necessarily mean that two statistics are not significantly different (Schenker & Gentleman, 2001). Effects sizes are significantly different if they do not have the same subscript. CLS = Children's Loneliness Scale; UCLA = UCLA Loneliness Scale. FNE = Fear of Negative Evaluation Scale; SASA = Social Anxiety and Social Avoidance Scale; SIAS = Social Interaction Anxiety Scale; SAS-C / SAS-A = Social Anxiety Scale for Children/Adolescents.

Table 2

Longitudinal Studies of the Association Between Loneliness (L) and Social Anxiety Sympotms (SA) Arranged by Time Lag

Study		Sample characteristics				Correlations						Effect sizes			
	N	Country	Age group	Time lag (months)	Social anxiety type	L1SA1	L1L2	L1SA2	SA1SA2	SA1L2	L2SA2	L→L	SA→SA	L→SA	SA→L
Spitzberg & Hurt (1987)	160	US	College students	1.25	General social anxiety	0.35	0.85			0.31		0.85			0.01
Gable (2006)	132	US	College students	2	Fear of rejection	0.33	0.66			0.26		0.64			0.05
London et al. (2007)	150	US	Children	4	General social anxiety	0.42	0.61	0.31	0.58	0.41	0.49	0.53	0.55	0.08	0.19
DeRosier & Mercer (2009)	1,180	US	Children	6	General social anxiety	0.55	0.82	0.53	0.59	0.43	0.68	0.84	0.43	0.29	-0.03
Gallagher et al. (2014)	83	US	Adolescents	9	General social anxiety	0.59	0.40	0.51	0.63	0.32	0.58	0.33	0.50	0.21	0.13
Van den Eijnden et al. (2014)	836	NL	Adolescents	12	Social avoidance and distress	0.43	0.51	0.35	0.62	0.33	0.49	0.45	0.58	0.10	0.14
Vanhalst et al. (2013)	267	NL	Adolescents	12	General social anxiety	0.50	0.63	0.42	0.69	0.40	0.47	0.57	0.64	0.10	0.11
Rowe et al. (2015)	601	AU	Children	14	General social anxiety	0.54	0.57	0.39	0.58	0.42	0.53	0.48	0.52	0.11	0.16
Cavanaugh & Buehler (2016)	340	US	Children	24	General social anxiety	0.53	0.42	0.32	0.47	0.32	0.52	0.35	0.42	0.10	0.14
Prinstein & La Greca (2002)	246	US	Children	72	General social anxiety	0.60	0.23	0.17	0.33	0.19	0.61	0.18	0.36	-0.04	0.08

Note. L1SA1 represents the correlation between Time 1 loneliness and Time 1 social anxiety symptoms. L1L2 represents the correlation between Time 1 loneliness and Time 2 loneliness. L1SA2 represents the correlation between Time 1 loneliness and Time 2 social anxiety symptoms. SA1SA2 represents the correlation between Time 1 social anxiety symptoms and Time 2 social anxiety symptoms. SA1L2 represents the correlations between Time 1 social anxiety symptoms and Time 2 social anxiety symptoms. Effect sizes represent standardized regression coefficients. L→L represents the stability of loneliness, controlling for Time 1 social anxiety symptoms. SA→SA represents the stability of social anxiety symptoms, controlling for Time 1 loneliness. L→SA represent the cross-lagged effect of Time 1 loneliness on Time 2 social anxiety symptoms, controlling for Time 1 social anxiety symptoms. SA→L represents the cross-lagged effect of Time 1 social anxiety symptoms on Time 2 loneliness, controlling for Time 1 loneliness. In all four effects, the cross-sectional association at Time 1 between loneliness and social anxiety symptoms was also controlled for. Country abbreviations refer to the ISO alpha-2 country codes.
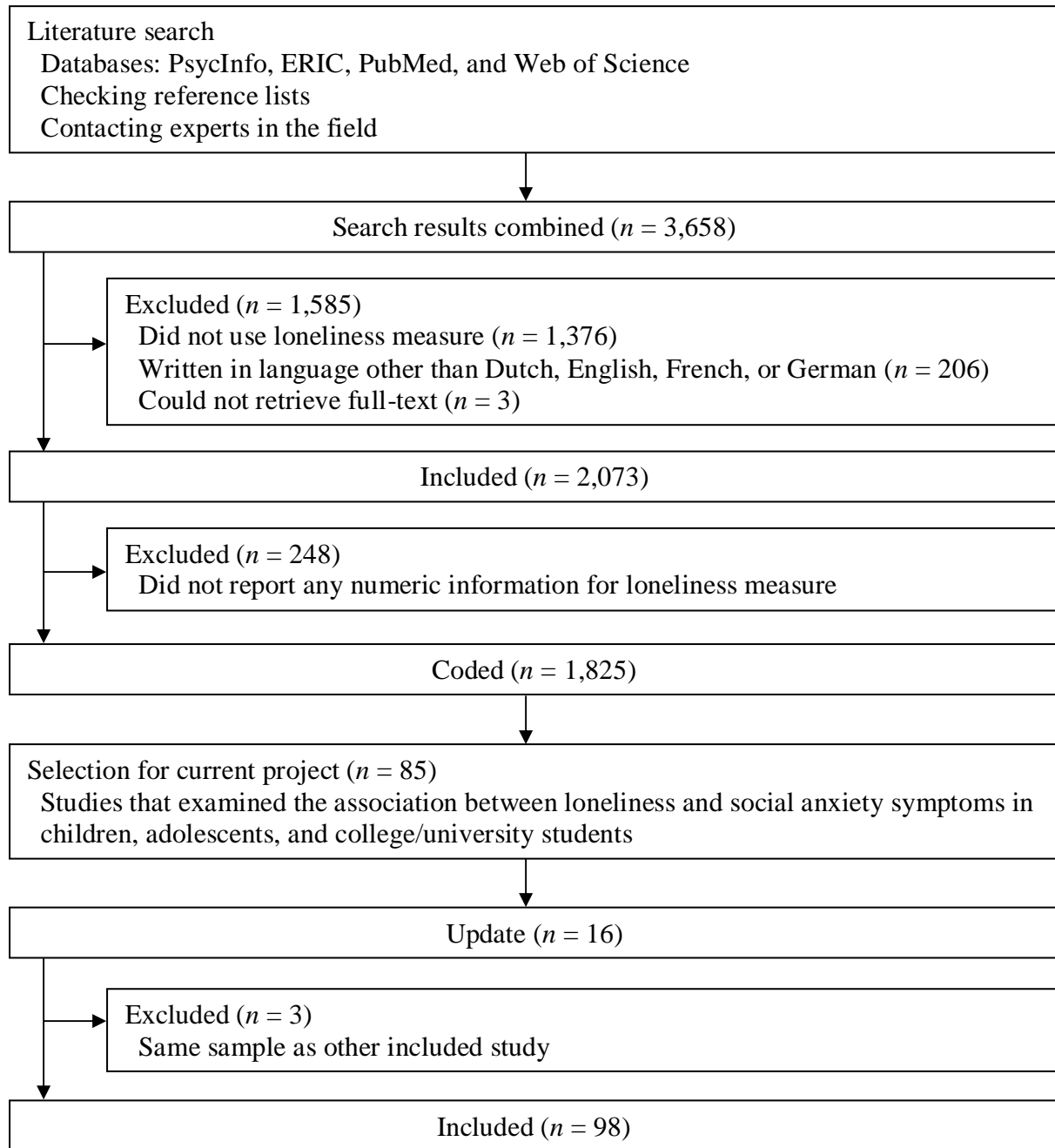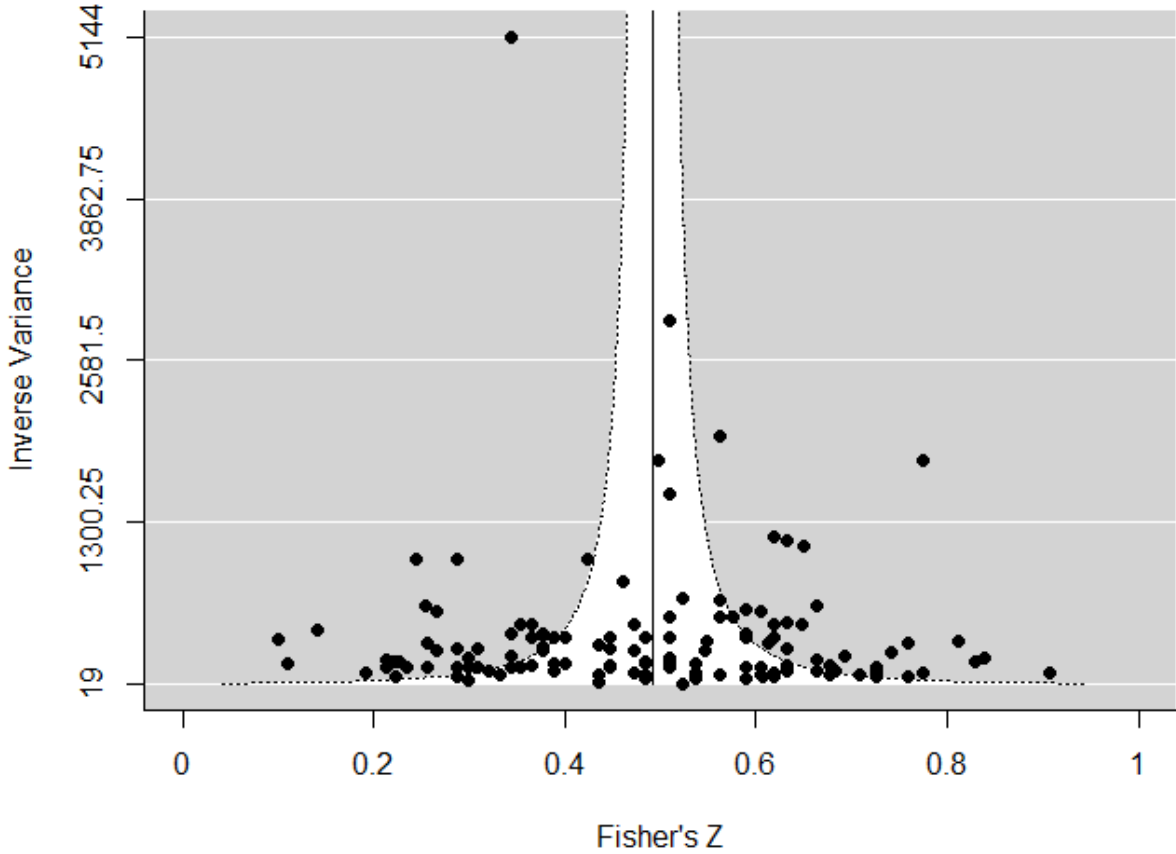
Figure 1. PRISMA flow diagram.

Figure 2. Funnel plot for the effect sizes of the cross-sectional association between loneliness and social anxiety symptoms. The solid vertical line represents the weighted mean effect size.
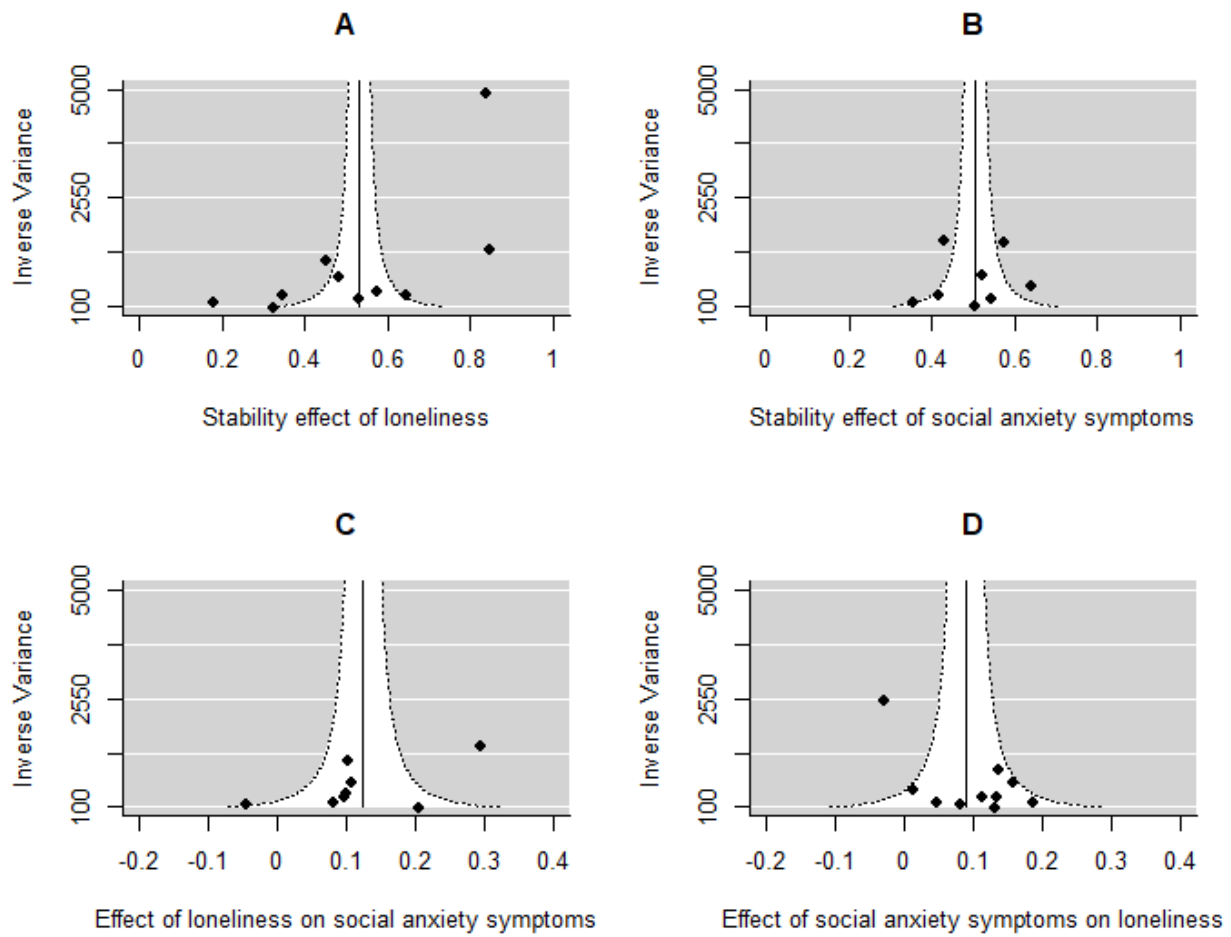
Figure 3. Funnel plots for the effect sizes of the longitudinal associations between loneliness and social anxiety symptoms. The solid vertical lines represent the weighted mean effect size.