Developmental Trajectories and Stability of Social Anxiety from Toddlerhood to Adolescence: A Three-Level Meta-Analysis Based on Longitudinal Studies

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Abstract

Given the high prevalence and extensive adverse sequelae of social anxiety, numerous theoretical and longitudinal studies have explored its development, yet viewpoints and research findings remain contradictory. To resolve these controversies and accurately characterize age-related trends in mean-level changes and stability of social anxiety, we employed a three-level modeling approach to conduct a meta-analysis of 192 independent samples (N = 170,197) from 173 longitudinal studies. Results revealed: (1) At the mean level, social anxiety exhibited a gradual declining trend from toddlerhood to young adulthood, with only a slight increase during middle adolescence. (2) In terms of stability, social anxiety was relatively high during toddlerhood and preschool age, dropped to its lowest point during primary school age, then gradually increased again, stabilizing at a relatively high level in young adulthood. (3) Mean-level changes in social anxiety were not influenced by study characteristics, participant characteristics, or variable characteristics. (4) The stability of social anxiety was moderated by article language, continent, culture, gender, and measurement method. (5) The stability of social anxiety showed a decreasing trend that was initially rapid then slowed as the time interval lengthened. This study is the first to utilize meta-analytic techniques to delineate the developmental trajectory of social anxiety from toddlerhood to young adulthood, where the developmental pattern generally supports personality maturation theory, while its stability demonstrates strong trait-like properties. These findings provide a novel perspective for exploring the lifespan development of social anxiety and its intervention.

Full Text

Developmental Trajectories and Stability of Social Anxiety from Toddlerhood to Young Adulthood: A Three-Level Meta-Analysis of Longitudinal Studies

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Abstract

Given the high prevalence and extensive adverse consequences of social anxiety, numerous theoretical and longitudinal studies have examined its development, yet findings remain inconsistent and contradictory. To resolve these discrepancies and accurately characterize age-related trends in mean-level changes and stability, we conducted a three-level meta-analysis of 173 longitudinal studies comprising 192 independent samples (N = 170,197). Results revealed: (1) Mean levels of social anxiety showed a gradual decline from toddlerhood to young adulthood, with only a slight uptick in mid-adolescence. (2) In terms of stability, social anxiety was relatively high during toddlerhood and preschool years, dropped to its lowest point during middle childhood, then gradually increased, stabilizing at a high level in young adulthood. (3) Mean-level changes were not influenced by study characteristics, participant characteristics, or measurement features. (4) Stability was moderated by publication language, continent, culture, gender, and measurement method. (5) Stability decreased rapidly at first and then more slowly as time intervals lengthened. This study provides the first meta-analytic depiction of social anxiety development from toddlerhood to young adulthood, with trajectories generally supporting personality maturation theory and stability patterns indicating strong trait-like properties, offering new perspectives for exploring lifelong development and interventions for social anxiety.

Keywords: social anxiety, mean-level change, stability, longitudinal studies, three-level meta-analysis

Social anxiety refers to individuals' irrational fear of being scrutinized or evaluated by others in social situations (Morrison & Heimberg, 2013). When this condition becomes chronic and severely impairs social functioning, it develops into a mental disorder (Rapee & Spence, 2004). In the United States, the lifetime prevalence of social anxiety disorder reaches 12.1% (Ruscio et al., 2008). Among Chinese individuals aged 15 and above, social anxiety disorder shows the highest detection rate among all anxiety subtypes (Guo et al., 2016). Social anxiety severely restricts satisfaction of the basic psychological need for relat-

edness and hinders social development (Ryan & La Guardia, 2000), exerting widespread negative effects on children and adolescents' social adjustment, such as increasing loneliness (Maes et al., 2019) and undermining peer relationship quality (Chiu et al., 2021). Given its high prevalence and extensive adverse outcomes, clarifying social anxiety's development across life stages holds significant practical importance.

Social anxiety is not a stable personality trait; it can exhibit curvilinear changes over more than a decade (Ladd et al., 2019) while also fluctuating within daily observation periods (Kashdan & Steger, 2006). Numerous longitudinal studies have directly or indirectly addressed social anxiety's developmental trends, yet corresponding theories and empirical evidence remain inconsistent or even contradictory. Additionally, debates persist regarding whether social anxiety represents a trait or state, and age trends in its stability remain underexplored. Therefore, to clarify previous controversies and derive more accurate conclusions based on larger samples, this study quantitatively integrated longitudinal studies on social anxiety through meta-analysis to delineate its developmental trajectory and within-age-group stability from toddlerhood to young adulthood, while examining potential moderators influencing these patterns.

1.1 Structure and Connotation of Social Anxiety

Current scholarship typically defines social anxiety across four dimensions: emotional, cognitive, behavioral, and physiological experiences (Maes et al., 2019). Emotionally, social anxiety manifests as intense subjective experiences of tension, anxiety, and distress when individuals anticipate or actually face interpersonal interactions (Morrison & Heimberg, 2013). Cognitively, socially anxious individuals exhibit biased information processing favoring negative evaluation—fear of negative evaluation (Rapee & Heimberg, 1997). They construct distorted self-impressions or mental representations and believe others will detect these flaws, becoming preoccupied with potential evaluative threats (Liu & Zhang, 2010). Behaviorally, socially anxious individuals employ avoidance and withdrawal strategies to escape interpersonal tension and discomfort (Rubin et al., 2003). Physiologically, they exhibit arousal symptoms such as blushing, accelerated heartbeat, and sweating (Patterson & Ritts, 1997).

Furthermore, several constructs overlap with social anxiety to varying degrees, with shyness being the most typical example. Shyness is a trait-like construct referring to self-focused anxiety in real or imagined social situations (Melchior & Cheek, 1990). Due to highly similar symptomatology and frequent co-occurrence with social anxiety (Rapee & Spence, 2004), some scholars classify shyness as a subtype of social anxiety (Beidel & Turner, 1999; Leary, 2013). Moreover, mainstream social anxiety scales include shyness items, such as the Multidimensional Anxiety Scale for Children (MASC; March et al., 1997) and the Social Anxiety Subscale of the Self-Consciousness Scale (SAS-SCS; Scheier & Carver, 1985).

In summary, this study conceptualizes social anxiety as encompassing four aspects: emotional states (social tension, anxiety, distress), cognitive features (fear of negative evaluation), behavioral tendencies (social withdrawal, social avoidance), and trait-like characteristics (shyness) in face-to-face or imagined social situations. However, because physiological responses differ substantially from other self-report dimensions and lack specificity—appearing similarly across other anxiety subtypes—this study excludes physiological reactions from consideration.

1.2 Social Anxiety Development Across Age Groups

Two primary approaches examine psychological and behavioral development across the lifespan at the group level: mean-level change and rank-order stability (Roberts & DelVecchio, 2000). The former examines trajectories of construct means over time, while the latter—typically using test-retest correlations as effect sizes—measures the degree to which individuals maintain their relative positions in a group over time, describing individual differences in development. Although both approaches concern cross-time consistency, they are theoretically independent (Roberts et al., 2006); fluctuations in group means do not imply that all individuals change in the same direction or magnitude. Integrating Erikson's personality development theory with children's primary learning stages, this study examines social anxiety development across six stages: toddlerhood, preschool childhood, elementary childhood, adolescence, early young adulthood, and late young adulthood.

1.2.1 Mean-Level Changes in Social Anxiety

Toddlerhood (1–3 years). Shortly after birth, temperament-based individual differences related to shyness emerge, manifesting as early behavioral inhibition tendencies (Fox et al., 2001). Around 18 months, toddlers develop fearful shyness toward various novel social stimuli, representing the nervous system's ongoing adaptation to external environments (Buss, 1986). By ages 2–3, self-awareness awakens and peer interactions begin, prompting self-conscious shyness characterized by tension in social situations and heightened sensitivity to external evaluation (Lagattuta & Thompson, 2007). Overall, toddlerhood represents the transition from "no social interaction" to "some social interaction," where neurological development and self-cognitive growth may cause social anxiety (particularly shyness) to remain stable or increase slowly (Baardstu et al., 2020; Eggum-Wilkens et al., 2015).

Preschool childhood (3–6 years). Expanded physical and psychological development and broadened life experiences significantly enhance preschoolers' independence and autonomy (Munley, 1977). However, social anxiety's development during this period remains controversial. One perspective emphasizes that children who develop autonomy and overcome shyness during this period hold positively biased self-evaluations, typically overestimating their social competence (Harter, 2006b), suggesting social anxiety should decline (Bekkhus et al.,

2022). Conversely, attachment bonds with primary caregivers face disruption as social activities shift from one-on-one to group settings, creating substantial social adaptation challenges that may cause social anxiety to increase (Baardstu et al., 2020; Karevold et al., 2012).

Elementary childhood (6–12 years). Physiologically, brain and nervous system development in elementary children proceeds evenly and smoothly; psychologically, their mental activities remain open and innocent without obvious signs of withdrawal. Consequently, parent-child, peer, and teacher-student relationships are generally harmonious during this period (Lin, 2009). This coordinated development may cause social anxiety to gradually decline (Ettekal et al., 2022) or remain stable (Booth-LaForce & Oxford, 2008). However, children in late elementary school may experience interpersonal discomfort due to early physical development. Meta-analyses indicate that social anxiety disorder typically first appears in late childhood (Lijster et al., 2017), with some studies finding transient increases in social anxiety during this period (Ahlen & Ghaderi, 2020).

Adolescence (12–18 years). Research conclusions about social anxiety during adolescence also show substantial variation. On one hand, adolescence's characteristic mismatch between accelerated physical development and slower psychological development poses significant challenges to self-evaluation, including self-perceived social competence (Harter, 2006a). The disruption hypothesis also posits that socially adaptive personality traits (such as agreeableness and emotional stability) temporarily decline in early adolescence (Soto & Tackett, 2015), suggesting social anxiety should increase during this stage (Weymouth & Buehler, 2018). On the other hand, the maturity principle emphasizes that personality development becomes more mature by late adolescence (Harter, 2006b; Roberts et al., 2006), facilitating improved interpersonal quality and social support acquisition (Barańczuk, 2019; Mund & Neyer, 2014), thereby weakening social anxiety. However, some studies find that the maturity principle applies throughout adolescence, with social anxiety showing a continuous decline across the entire period (Ladd et al., 2019).

Early young adulthood (18–25 years) and late young adulthood (25–35 years). Neo-socioanalytic theory suggests personality becomes more mature during early young adulthood (Roberts & Wood, 2006), with self-esteem showing significant improvement compared to adolescence (Orth et al., 2018), potentially further reducing young adults' social anxiety (Zhang et al., 2019). Additionally, according to the social investment principle, individuals entering late young adulthood begin assuming multiple social roles such as child, parent, and employee, requiring greater investment in managing various interpersonal relationships, typically yielding higher relationship satisfaction (Roberts & Mroczek, 2008). Thus, social anxiety during young adulthood may show a steady declining trend.

In summary, theoretical perspectives on social anxiety's developmental direction are relatively consistent for toddlerhood and young adulthood, suggesting

slow increases and decreases respectively. During preschool childhood, social anxiety may either decline due to positively biased self-concepts or increase due to difficulties adapting to rapidly expanding social circles. For elementary childhood, controversy exists regarding whether a transient increase occurs in late childhood. For adolescence, contradictory perspectives emerge between the maturity principle (social fearlessness due to mature social cognition) and the disruption hypothesis (social anxiety due to pubertal development).

1.2.2 Rank-Order Stability of Social Anxiety

Compared to mean-level changes, researchers have paid less attention to social anxiety stability. First, how stable is social anxiety? On one hand, as noted earlier, early behavioral inhibition tendencies emerge in infancy and gradually generalize to broad fear in social situations, leading some researchers to view social anxiety as a trait-like construct (Hayward et al., 2008; Modini et al., 2015). On the other hand, studies have found that social anxiety can change within short observation intervals, fluctuating with momentary emotional states (Kashdan & Steger, 2006) and social behaviors (Goodman et al., 2022), exhibiting state-like characteristics. Second, what age trends characterize social anxiety stability? Examining this question holds substantial intervention implications. Periods of lower stability may indicate optimal windows for intervention, where effects may be stronger; periods of higher stability suggest social anxiety is more difficult to change, requiring greater personal effort and external attention. Research shows that pre-adulthood represents a period of gradual personality maturation, with stability of traditional personality traits increasing from preschool to middle adulthood (Roberts & DelVecchio, 2000). Children and adolescents show lower personality stability and greater plasticity. Additionally, childhood through young adulthood involves gradual social network expansion (Wrzus et al., 2013), during which individuals form their own social attitudes and interpersonal norms (Bühler & Orth, 2022). Therefore, if social anxiety exhibits trait-like properties, we would expect its stability to gradually increase with age.

1.3 Moderating Variables

As previously noted, substantial heterogeneity exists in previous research on social anxiety development, suggesting the need to explore potential moderating factors. Based on existing literature, the following sample and variable characteristics may exert influence.

Regarding sample characteristics, birth cohort, gender, and culture may play key roles. First, age differences in psychological development may be confounded with birth cohort effects. Previous cross-temporal meta-analyses have revealed 逐年上升趋势 in social anxiety levels among Chinese adolescents and college students (Shi et al., 2019; Xin et al., 2022), with rising consumption levels and declining social connections explaining this birth cohort effect (Xin et al., 2022). However, these results only reveal mean-level birth cohort effects; whether social

anxiety development also shows birth cohort effects remains unknown. Second, although females exhibit significantly higher social anxiety levels than males (van Loo et al., 2023), their developmental trajectories are highly similar (Ye et al., 2019; Ladd et al., 2019). Meta-analyses of similar constructs also indicate that mean-level changes and stability of loneliness and self-esteem are not affected by gender (Mund et al., 2020; Orth et al., 2018). Thus, we hypothesized that social anxiety's mean-level changes and stability would not be influenced by gender. Finally, social anxiety is more accepted and even considered reasonable in collectivistic cultures (Heinrichs et al., 2006). Meta-analyses also find that Asian samples report significantly higher social anxiety than European samples (Woody et al., 2015). However, whether higher social anxiety levels in certain cultures imply faster growth rates or lower stability remains unclear. In addition to examining the moderating effect of male ratio, we also examined the role of masculinity index at the cultural level. Higher masculinity index indicates more pronounced masculine traits (e.g., competitiveness, coldness, assertiveness) in a society, with research showing that identification with traditional male roles can reduce social anxiety risk (Moscovitch et al., 2005).

Regarding variable characteristics, social anxiety type and measurement method may also significantly influence results. On one hand, social anxiety represents a continuum from social fearlessness to social phobia, with fear of negative evaluation being most common, general emotional anxiety and shyness in the middle range, and social withdrawal at the extreme end (Rapee & Spence, 2004). Do differences in symptom severity across dimensions imply different developmental trends? Additionally, implicit theories of shyness emphasize that shyness is a stable personality trait (Beer, 2002), whereas meta-analytic evidence supports that social anxiety disorder is not necessarily lifelong (Vriends et al., 2014). This may suggest that shyness shows higher stability than other dimensions. On the other hand, regarding measurement methods, some studies indicate that self-reported social anxiety is more valid and stable than teacher or parent reports (DiBartolo & Grills, 2006), while others find that mother-reported shyness stability is significantly higher than adolescents' self-reports (Lawson et al., 2023). Thus, measurement method may moderate results, though the direction remains unclear.

For robustness, beyond these moderators, we also included study characteristic variables (publication year, language, publication status, article quality) to further examine the severity of selective reporting bias.

This meta-analysis was conducted following PRISMA 2020 guidelines (Page et al., 2021). To align with open science practices, the meta-analysis protocol was pre-registered on PROSPERO (registration number: CRD42022341547) before literature retrieval began.

2.1 Literature Search

Initial searches were conducted in two Chinese databases (CNKI, Wanfang Data) and three English databases (Web of Science, ProQuest, PubMed) in June 2022. To enhance comprehensiveness, we also supplemented literature from previous meta-analyses on social anxiety (e.g., Chiu et al., 2021; Maes et al., 2019). A second search was conducted in December 2022, updating the previous five databases and adding EBOSCO (including MEDLINE, PsycINFO, and PsycArticles). Chinese search terms included social anxiety (社交焦虑, 社交回避, 社交苦恼, 交往焦虑, 害羞, 羞怯, 社交恐惧, 社交恐怖, 互动焦虑, 人际焦虑, 评价恐惧) and longitudinal research (纵向, 追踪, 前瞻, 交叉滞后, 面板, T1, T2, 时间点, 队列, 纵断). English search terms similarly included social anxiety ("SAD", "social anxi*", "social phobi*", "interaction anxi*", "social avoid*", "social distress", "social fear", "fear of eval*", "fear of negative eval*", "communication anxi*", "fear of rejection", "social inhib*", "social worry", "shy*") and longitudinal research ("stability", "consistency", "continuity", "change", "longit*", "lagged", "panel", "prospective", "follow up", "follow-up", "reciprocal", "cohort", "time point"). The asterisk (*) indicates term expansion (e.g., "social avoid*" expands to social avoidance, social avoiding). Specific search strategies for each database and the screening flowchart for the second search are available in Supplementary Material 1 (https://osf.io/5u2aq).

2.2 Literature Screening

Inclusion criteria: (1) Effective sample size of at least 30; (2) Given our focus on age effects, sample age dispersion should be within reasonable limits. Following previous recommendations (Orth et al., 2018; Orth et al., 2021), we included samples with standard deviation of age at T1 $\leq$ 5. For studies not reporting age standard deviation but described as being in the same school grade, we considered this dispersion reasonable to maximize data retention; (3) Studies must have measured at least one aspect of social anxiety as defined earlier (emotional, cognitive, behavioral, shyness); (4) Studies must employ longitudinal tracking designs; (5) Wave intervals must be at least 6 months, with the longest interval overlapping at least 50% with the planned age range (Hoff et al., 2018). The 6-month minimum was chosen to reduce carry-over effects (Orth et al., 2018; Orth et al., 2021); (6) The same social anxiety scale must be used across all waves in terms of content, number of items, and scoring method; (7) Sufficient effect size information must be available, including means, standard deviations, and inter-wave correlations for social anxiety at each wave; (8) Articles must be written in Chinese or English.

Exclusion criteria: (1) Clinical samples; (2) Samples experiencing special events (e.g., major natural disasters) or psychological interventions; (3) Studies using experimental, observational, or peer nomination methods to measure social anxiety; (4) Studies that categorized social anxiety into categorical variables using certain criteria, reporting only OR, RR, or similar values.

The first author initially conducted screening using a rapid screening method. Following previous meta-analyses (Orth et al., 2018; Orth et al., 2021), we then randomly selected 60 remaining articles and assigned them to two other psychology graduate students, who independently evaluated inclusion based on the above criteria. Inter-rater agreement was high (90% and 87%). Primary reasons for disagreement included failure to identify supplementary materials not provided in the main text and mistakenly including studies reporting only prevalence rates. The PRISMA flowchart for literature screening is shown in Figure 1 [Figure 1: see original paper].

Figure 1. PRISMA literature screening flowchart. Note: "Format mismatch" refers to articles reporting non-comparable non-continuous data, such as categorical data (OR and RR) or peer nomination data. "Other reasons" include non-Chinese/English papers, effective sample size < 30, sample mean age standard deviation > 5, and inconsistent scales across waves.

2.3 Literature Coding

After developing the coding sheet, two psychology graduate students independently coded the literature. Discrepancies were resolved through discussion or by re-reading original articles. Cohen's kappa was used to assess inter-coder agreement, with values ≥ 0.80 indicating high agreement (McHugh, 2012).

2.3.1 Effect Sizes

This study used standardized mean differences (d) and correlation coefficients (r) between two adjacent waves as effect sizes. Standardized mean differences examined mean-level changes. Following previous research (e.g., Roberts et al., 2006), d was calculated as the difference between T2 and T1 means divided by the T1 standard deviation (Morris & DeShon, 2002). As mean-level changes typically increase with longer intervals (Orth et al., 2018), we further divided d values by the number of years between waves to obtain annualized standardized mean differences (d_{year}). Since longitudinal studies rarely report d values directly, we coded means and standard deviations for social anxiety at each wave, requiring intervals ≥ 6 months with no overlap (Kappa = 0.96–0.98). For example, for a study with five measurements at 3-month intervals, we selected data from T1, T3, and T5. Correlation coefficients examined stability, directly selecting correlations between adjacent waves (Kappa = 0.95–1.00).

We conducted separate meta-analyses for each age group. To quantify developmental trends more precisely, we divided school-age periods into narrower age bands, as these represent critical periods for personality and social development and provided sufficient effect sizes. Eleven age groups were created: toddlerhood (1–3 years), preschool childhood (3–6 years), early elementary childhood (6–8 years), middle elementary childhood (8–10 years), late elementary childhood (10–12 years), early adolescence (12–14 years), middle adolescence (14–16 years), late adolescence (16–18 years), young adult transition (18–20 years),

early young adulthood (20–25 years), and late young adulthood (25–35 years). We used the mean age between two adjacent waves to assign effect sizes to age groups (Orth et al., 2018; Orth et al., 2021). For example, if a sample was 10 years old at T1 and 13 at T2, the mean age of 11.5 years would place this effect size in late elementary childhood. Studies not reporting mean age but providing clear inferential information (e.g., college student samples coded as 20 years) were retained. Kappa for T1 mean age was 0.96.

2.3.2 Study Characteristics

Publication year was recorded as the year the article was formally published; for dissertations, the year of defense was coded (Kappa = 1.00). Article language included Chinese and English categories (Kappa = 1.00). Publication status included published journal articles and unpublished dissertations (Kappa = 0.96). For article quality, we developed quality assessment criteria (see Appendix) based on the NIH Quality Assessment Tool for Observational Cohort and Cross-Sectional Studies (National Institutes of Health, 2014) and scales from Zhang et al. (2019), focusing on methodological quality rather than theoretical depth or writing quality. The criteria included six indicators: participant selection, T1 data validity rate, sample attrition rate, scale reliability, longitudinal measurement invariance testing, and publication tier, with total scores ranging from 0–12, higher scores indicating better quality (Kappa = 0.84–1.00). Specific scores for each article are available in Supplementary Material 2 (https://osf.io/2sp6m).

2.3.3 Sample Characteristics

Birth cohort was calculated by subtracting mean sample age from T1 data collection year (Kappa = 0.94). For studies not reporting data collection year, we used: T1 data collection year = publication year − 2 (a common practice in cross-temporal meta-analysis; Xin & Zhang, 2009) − data collection time span. Gender was coded as the proportion of male participants (Kappa = 0.97). We also coded each sample's country and continent and extracted corresponding individualism and masculinity indices for each country based on Hofstede's (1983) cultural dimensions theory (Kappa = 1.00), with data from https://www.hofstede-insights.com/country-comparison/.

2.3.4 Variable Characteristics

Based on each measure's content and nature, and referencing previous reviews of social anxiety measures (Modini et al., 2015; Wong et al., 2016), we coded social anxiety type into five categories: general (measuring multiple dimensions), emotional, cognitive (i.e., fear of negative evaluation), behavioral, and trait-like (i.e., shyness). Kappa for social anxiety type was 0.92. Measurement method was coded based on the rater: self-report versus other-report (Kappa = 1.00).

2.4 Publication Bias

Publication bias—when published studies inadequately represent the total research population—threatens meta-analytic accuracy (Borenstein et al., 2009). We employed two methods to assess publication bias. First, by including unpublished dissertations, we directly tested publication bias by examining publication status as a moderator. Second, we used Begg's rank correlation test and Egger's linear regression test. Begg's test assesses publication bias severity through Kendall's τ correlation between standardized effect sizes and their variances, with non-significant τ indicating minimal bias (Begg & Mazumdar, 1994). Egger's test uses linear regression to examine funnel plot symmetry; a significant non-zero intercept indicates publication bias (Borenstein et al., 2009).

2.5 Data Analysis

Since this study conducted effect size integration separately for each age group, a single study could contribute multiple effect sizes to one age group or across multiple age groups, violating the independence assumption in conventional meta-analysis (Lipsey & Wilson, 2001). Some similar studies (e.g., Orth et al., 2018; Orth et al., 2021; Roberts et al., 2006) have addressed effect size dependency by averaging effect sizes, but this approach loses substantial information, reduces statistical power, and increases standard errors, weakening estimation precision (Cheung, 2014). Therefore, this study employed three-level meta-analysis to estimate overall effect sizes and test moderators. Three-level models allow extraction of multiple effect sizes from single studies while accounting for dependency, partitioning variance into Level 1 sampling error, Level 2 within-study error, and Level 3 between-study error, thereby improving meta-analytic precision (Cheung, 2014). Following Cheung's (2019) protocol, we conducted analyses using the metaSEM package in R x64 4.2.1-win. Sampling errors for each effect size were calculated using Borenstein et al.'s (2009) formulas. Heterogeneity was assessed via Q statistics, with I^2 measuring the proportion of variance at Level 2 and Level 3. For moderator tests, given that some age groups had very few or missing effect sizes for categorical moderators, we followed previous practices (Mund et al., 2020; Orth et al., 2018; Orth et al., 2021) by testing moderators across all age groups (i.e., using all effect sizes).

For stability analyses, we first converted correlation coefficients to Fisher's Z values, obtained overall effect size estimates, then back-transformed them to overall correlation coefficients r. To compare with Roberts and DelVecchio's (2000) findings on personality stability, we controlled time interval to one year to examine social anxiety stability over a one-year period (Mund et al., 2020). Additionally, examining a psychological construct's stability requires investigating the relationship between correlation coefficients and time intervals (Fraley & Roberts, 2005). Correlations typically show negative relationships with time intervals; if correlations decline linearly toward zero as intervals increase, the construct has weak trait properties. If correlations show a rapid-then-slow decline pattern, plateauing after long intervals, the construct has strong trait

properties (Fraley & Roberts, 2005). Therefore, we used SPSS 24.0 to conduct curve estimation with time interval as the predictor and correlation coefficient as the outcome. To provide more effect sizes for longer intervals, we selected correlations between the first and last waves for studies with three or more waves. In curve estimation, multiple effect sizes from the same independent sample were averaged.

3.1 Descriptive Statistics

The final sample included 173 studies with 192 independent samples and 221 effect sizes, totaling 170,197 participants (SD = 1,591.60). Among these, 203 effect sizes were available for mean-level change meta-analysis (N = 158,799) and 163 for stability meta-analysis (N = 123,888). Distribution of effect sizes across study characteristics is shown in Table 1 . Detailed information and coding for all included studies are available in Supplementary Material 2 (https://osf.io/q4n5x).

Table 1. Study Information for 221 Effect Sizes

Note: M = mean (continuous variables), K = frequency (categorical variables), Min and Max = minimum and maximum values for continuous variables, SD = standard deviation, % = percentage of frequencies.

3.2 Publication Bias

Since unpublished studies contributed far fewer effect sizes than published studies, with some age groups lacking unpublished effect sizes, we tested publication status moderation (1 = published, 0 = unpublished) via meta-regression across all effect sizes. Results showed that for mean-level changes, publication status had no significant moderating effect (B = –0.01, p = 0.860); for stability, published effect sizes were significantly higher than unpublished ones (B = 0.12, p = 0.017). Further publication bias test results are shown in Table 2 , with no consistent evidence pointing to publication bias in any analysis group. Overall, this meta-analysis appears minimally affected by publication bias.

Table 2. Publication Bias Tests for Mean-Level Change (Left) and Stability (Right)

Note: Egger's linear regression test and Begg's rank correlation test results are presented for each age group and all effect sizes combined.

3.3 Mean-Level Changes in Social Anxiety

Independent meta-analyses for mean-level changes across 11 age groups revealed results shown in Table 3 . Except for a slight increase in middle adolescence (14–16 years), the other 10 age groups showed declining trends, with the most pronounced decreases in preschool childhood (3–6 years) and young adult transition (18–20 years). Based on these 11 independent meta-analyses, we plotted cu-

mulative d_{year} values (see Figure 2 [Figure 2: see original paper]), showing that social anxiety remained relatively stable in toddlerhood, declined markedly in preschool childhood, continued decreasing through elementary childhood (cumulative d_{year} = –0.314) and adolescence (cumulative d_{year} = –0.268) with a small uptick in middle adolescence, further declined during the young adult transition, and slowed its decline after formally entering young adulthood. Moderator test results are shown in the left side of Table 4 ; none reached statistical significance.

Table 3. Estimates of Mean-Level Changes in Social Anxiety by Age Group

Note: K = number of independent samples; N_{effect} size = number of effect sizes; M = weighted mean birth cohort; d_{year} = annualized standardized mean difference; Level 2 I^2 = proportion of within-study variance; Level 3 I^2 = proportion of between-study variance. The 1–3 years group used two-level analysis due to no effect size nesting. $p < 0.05$, **$p < 0.01$,** *$p < 0.001$.*

Figure 2. Developmental trend of social anxiety mean levels from toddlerhood to young adulthood.

Table 4. Moderator Tests for Mean-Level Change (Left) and Stability (Right)

Note: Publication language (1 = Chinese, 0 = English); Measurement method (1 = self-report, 0 = other-report); Continent with Asia as reference; Social anxiety type with general type as reference.

3.4 Stability of Social Anxiety

Independent meta-analyses for social anxiety stability across 11 age groups yielded results shown in Table 5 . Rank-order correlation coefficients controlling for one-year intervals ranged from 0.467 to 0.657. Based on these meta-analytic results, we plotted age trends (see Figure 3 [Figure 3: see original paper]), showing that stability was relatively high in toddlerhood and preschool years, dropped rapidly to its lowest point in elementary childhood, gradually recovered after middle adolescence, peaked during the young adult transition, and remained stable at a high level in young adulthood. Moderator test results are shown on the right side of Table 4 . For study characteristics, stability from Chinese-language articles was significantly lower than from English articles. For sample characteristics, male ratio and masculinity index showed significant negative correlations with stability; individualism index showed significant positive correlations; stability from North American and European samples was significantly higher than from Asian samples. For variable characteristics, stability from other-reports was significantly higher than from self-reports.

Additionally, we examined the "stability of stability." Partial correlations controlling for sample size showed that stability was significantly negatively correlated with time interval ($r = –0.41$, $p < 0.001$). Curve estimation results indicated that among 11 function models, the logarithmic model showed the best fit ($F = 53.15$, $R^2 = 0.28$), with the linear model ranking seventh ($F =$

30.06, $R^2 = 0.18$). Therefore, social anxiety stability follows a logarithmic function with time interval (see Figure 4 [Figure 4: see original paper]), showing a rapid-then-slow decline pattern that noticeably slowed after approximately 6 years.

Table 5. Estimates of Social Anxiety Stability by Age Group

Note: r_{before} = correlation without controlling time interval; r_{after} = correlation controlling for one-year interval; 95%CI = 95% confidence interval for r_{after}.

Figure 3. Developmental trend of social anxiety stability from toddlerhood to young adulthood (plotted at each age group's midpoint).

Figure 4. Trend of social anxiety rank-order stability across time intervals.

4.1 Mean-Level Changes in Social Anxiety

Results show that social anxiety mean levels gradually declined from toddlerhood to young adulthood, generally supporting personality maturation theory rather than maladaptive difficulty perspectives. Although toddlers may exhibit behavioral inhibition due to increased novel stimuli, shyness at this stage—particularly stranger fear—primarily reflects biological neurotic reactions, with true social fear still relatively rare (Buss, 1986). Therefore, for most toddlers, this biologically based shyness response weakens over time (Bastien et al., 2020; Buss, 1986). After entering preschool, enhanced self-awareness leads children to hold positively biased self-concepts, and expanded social circles may be socially facilitative rather than maladaptive for children exploring the world through play (Munley, 1977). Moreover, true friendship begins to emerge in preschool, helping reduce social anxiety (Rubin et al., 2009). In elementary school, children gain more autonomy as their social world expands further, personality's social adaptability continues developing, and self-esteem increases substantially (Harter, 2006b; Orth et al., 2018)—likely contributing to the significant decline in social anxiety during this stage. Social anxiety continued declining in adolescence, though the rate slowed compared to elementary years, still supporting the maturity principle over the disruption hypothesis. The deficits-breeds-growth perspective emphasizes that although adolescence faces various psychological crises from mismatched physical and psychological development, most individuals gradually achieve social adaptation through these challenges while avoiding personality deficits (Baltes et al., 1999; Hoff et al., 2018). As results show, the transient increase in social anxiety during middle adolescence returns to the maturation track by late adolescence. Along this adaptive developmental path, post-adolescence individuals not only establish self-identity but also gradually build stable social connections, with social network size peaking (Wrzus et al., 2013) and social anxiety stabilizing at lower levels.

4.2 Stability of Social Anxiety

Regarding age trends, social anxiety stability was relatively high in toddlerhood and preschool years, lowest in elementary childhood, gradually recovered after middle adolescence, peaked during the young adult transition, and remained stable at high levels in young adulthood. According to Fraley and Roberts (2005), psychological construct stability depends on random environmental events (e.g., moving, changing schools), person-environment transactions (including proactive, reactive, and evocative processes), and developmental constant factors (e.g., genes, heredity). Random environmental events are low in early childhood while developmental constants are high. Toddlers' psychological states are primarily influenced by genetic factors, with social anxiety mainly manifesting as a biological temperament (Buss, 1986). Although social contact increases in preschool years, the developmental environment remains primarily family-based with strong parent-child attachment bonds (Lin, 2009). This may explain why social anxiety stability from toddlerhood to preschool exceeds that during school years. As age increases, developmental constants decrease while environmental factors' influence on stability grows (Briley & Tucker-Drob, 2014). Upon school entry, teacher-student and peer relationships emerge, social life events gradually increase (Wrzus et al., 2013), but personality development remains in a shaping period, making it difficult for children to mobilize person-environment transaction processes (Roberts & DelVecchio, 2000). Therefore, environmental, interpersonal, and personality instability may account for lower social anxiety stability in elementary and early adolescent years. However, by late adolescence and especially adulthood, person-environment transactions play a primary role (Fraley & Roberts, 2005). At this stage, individuals' self-identity gradually solidifies, and strong identity and sense of control not only lead adults to choose environments matching their identity but also evoke identity-consistent responses from others (Roberts & DelVecchio, 2000), further increasing stability of psychological characteristics including social anxiety in adulthood. That is, socially anxious adults actively choose "safe" environments to cope with anxiety and unconsciously induce others to treat them in "socially anxious" ways, making adult social anxiety more stable and difficult to change.

Regarding stability magnitude, one-year-interval correlation coefficients for social anxiety ranged from 0.467 to 0.657, essentially equivalent to the stability range for traditional personality traits (0.31 to 0.71) (Roberts & DelVecchio, 2000), indicating high stability over short intervals. Moreover, social anxiety stability follows a logarithmic function with time interval, with the rate of decline slowing over longer intervals. As shown in the logarithmic curve in Figure 4, correlations of 0.3 and above represent relatively large effect sizes (Gignac & Szodorai, 2016), suggesting that initial social anxiety levels retain some predictive power for social anxiety years later. According to Fraley and Roberts (2005), this suggests social anxiety possesses strong trait properties, tending toward a trait-like construct.

4.3 Comparison with Related Constructs

First, self-esteem shows moderate negative correlations with social anxiety (Zhang et al., 2019). Research finds that self-esteem mean levels increase from ages 4 to 11, remain stable from 11 to 15, then increase significantly until age 30 before stabilizing (Orth et al., 2018). In contrast, this study found social anxiety continued declining in early adolescence, suggesting this stage may represent a period of differentiation between self-esteem and social anxiety. Regarding stability, self-esteem development resembles social anxiety, showing continuous increase from late childhood to middle adulthood (Trzesniewski et al., 2013). Second, traditional personality traits (agreeableness, conscientiousness, emotional stability, openness) show fluctuating increasing trends from adolescence to late young adulthood (Roberts & Wood, 2006), again suggesting that gradually increasing personality adaptability may contribute to age-related declines in social anxiety. For stability, personality traits also show fluctuating increases from early childhood to old age, essentially equivalent to social anxiety. Finally, because both loneliness and social anxiety reflect interpersonal maladjustment, numerous studies have compared their connotations, antecedents, and consequences. A recent meta-analysis found loneliness stability gradually increased from childhood to middle adulthood, also showing trait-like properties; however, loneliness showed no clear age trends in mean-level changes (Mund et al., 2020), providing further evidence for distinguishing social anxiety from loneliness.

4.4 Moderating Effects

For mean-level changes, moderating effects of study characteristics, sample characteristics, and variable characteristics were all non-significant, suggesting the depicted developmental trajectory is robust. However, significant heterogeneity remained among effect sizes in all age groups except late young adulthood, indicating need for future research to explore additional potential moderators.

For stability, continent showed significant moderating effects, with stability from Asian samples significantly lower than from European and North American samples—likely due to cultural differences (individualism index and masculinity index). The publication language effect may also relate to this, as Chinese-language effect sizes corresponded to Asian samples. Regarding individualism, higher individualism index countries showed higher social anxiety stability, possibly related to social norms and self-construal types. In individualistic cultures, behavior depends on personal thoughts and feelings, whereas in collectivistic cultures, individuals must conform to different social norms and role expectations, making social anxiety more volatile (Hofmann et al., 2010). Additionally, compared to independent self-construal in individualistic cultures, collectivistic cultures emphasize interdependent self-construal, where individuals frequently reference others' feelings and behaviors to understand and construct themselves, making their social anxiety more susceptible to external influence (Hong & Woody, 2007) and thus less stable. Regarding masculinity

index, results showed that countries with higher masculinity indices had lower social anxiety stability, possibly because masculine cultures feature stronger social competitiveness (Hofstede, 1983), where social connection establishment often depends on achieved success, making social anxiety more susceptible to competitive outcomes and personal honor (Howell et al., 2015). Additionally, male ratio showed significant moderating effects: samples with higher male proportions showed greater rank-order changes over time. Although females are more likely to develop social anxiety disorder, males with the disorder experience more distress and are more likely to seek help despite this (Asher et al., 2017), suggesting male social anxiety is more prone to worsening or improvement while females tend to maintain status quo. Finally, other-reported social anxiety stability was significantly higher than self-reported stability, possibly because parents and teachers typically assess based on observable social avoidance behaviors while having difficulty observing children's internal subjective experiences (DiBartolo & Grills, 2006), making them prone to judgmental set.

4.5 Research Significance, Implications, and Limitations

First, previous research on social anxiety development has shown substantial heterogeneity, particularly during preschool childhood, late elementary childhood, and adolescence, where different theories propose different developmental directions with supporting empirical evidence. Based on this, our study integrated relevant longitudinal research to delineate social anxiety's developmental trajectory, generally supporting personality maturation theory and clarifying previous controversies from a more comprehensive perspective. Second, previous research has rarely examined age effects on social anxiety stability; this study is the first to identify developmental trends in stability, preliminarily supporting social anxiety as tending toward a trait rather than state construct. Moreover, relatively lower stability in elementary childhood and early adolescence suggests these may be golden periods for social anxiety intervention, preventing progression to mental disorders. Finally, single longitudinal studies often struggle to exclude confounding sample characteristics, limiting generalizability. Using meta-analysis, we found social anxiety development is not confounded by birth cohort effects, but cultural factors may be key to explaining social anxiety stability.

Nevertheless, this study has several limitations warranting future exploration. First, effect sizes for toddlerhood and late young adulthood were relatively few, potentially limiting accurate estimation of mean-level changes and stability in these age groups. Second, we found no studies on periods beyond late young adulthood, preventing inferences about social anxiety development in middle and older adulthood; future research should adopt a lifespan perspective to examine social anxiety in these periods. Third, Weeks et al. (2009) emphasize that fear of evaluation represents the core feature of social anxiety, including positive and negative aspects; the former refers to distress and worry about positive evaluation from others, independent of the latter (Liu & Zhang, 2010).

As fear of positive evaluation is a core cognitive feature distinguishing social anxiety from depression and has been suggested for inclusion in diagnostic criteria (Ye et al., 2021), it is regrettable that longitudinal research on fear of positive evaluation remains scarce and requires future investigation. Fourth, although this study comprehensively included cognitive, emotional, behavioral, and trait-like dimensions of social anxiety, it still represents broad social anxiety without considering situation-specific forms such as appearance anxiety or speech anxiety. Fifth, this study examined overall developmental trends in social anxiety, which cannot infer homogeneity in individual development. For example, research finds that although most individuals' shyness remains stable or declines from childhood to young adulthood, over 20% of participants show increasing trends (Tang et al., 2017), suggesting future research should apply person-centered approaches to examine social anxiety developmental trends.

To accurately characterize age trends in social anxiety mean levels and stability, this three-level meta-analysis of 192 independent samples from 173 longitudinal studies yielded the following conclusions: (1) Mean levels of social anxiety showed a gradual decline from toddlerhood to young adulthood, generally supporting personality maturation theory. (2) Stability showed a U-shaped trend before young adulthood, remaining high during young adulthood. (3) Mean-level changes were not influenced by study characteristics, participant characteristics, or measurement features. (4) Stability was moderated by publication language, continent, culture, gender, and measurement method. (5) Stability coefficients decreased rapidly then slowly as time intervals lengthened, tending toward a trait-like construct.

References

Note: The reference list is preserved in its original format as provided in the Chinese text.

Appendix: Article Quality Assessment Criteria

Six indicators: (1) Participant selection. Random selection = 2 points, non-random selection = 1 point, not reported = 0 points. (2) T1 data validity rate. Rate ≥ 0.9 = 2 points, 0.8–0.9 = 1 point, < 0.8 or not reported = 0 points. (3) Sample attrition rate. Average attrition rate across waves $\leq 20\%$ = 2 points, 20%–40% = 1 point, $> 40\%$ or not reported = 0 points. (4) Internal consistency reliability of measurement tool. Reliability ≥ 0.8 = 2 points, 0.7–0.8 = 1 point, < 0.7 or not reported = 0 points. (5) Longitudinal measurement invariance testing. Strong invariance (scalar invariance) or above = 2 points, below = 1 point, not reported = 0 points. (6) Publication tier. CSSCI and SSCI Q1–Q3 journals = 2 points; CSSCI extended, Peking University core journals, SSCI Q4, and doctoral dissertations = 1 point; regular journals and master's theses = 0 points.

Note: Figure translations are in progress. See original paper for figures.