Running head: *Worry development and impact through childhood*

The development of worry throughout childhood: ALSPAC data

Line Caes[1,*], Emma Fisher[2], Jacqui Clinch[3], Jonathan H Tobias[4] and Christopher Eccleston[2]

[1]School of Psychology, NUI Galway, University Road, Galway, Ireland
[2]Centre for Pain Research, The University of Bath, Bath, UK
[3]Bristol Royal Children's Hospital, University of Bristol, Bristol, UK and Royal National Hospital for Rheumatic Diseases, Bath, UK
[4]Musculoskeletal Research Unit, School of Clinical Sciences, University of Bristol, Bristol; UK

Word count (exc. figures/tables): 4941

Acknowledgements:
We are extremely grateful to all the families who took part in this study, the midwives for their help in recruiting them, and the whole ALSPAC team, which includes interviewers, computer and laboratory technicians, clerical workers, research scientists, volunteers, managers, receptionists and nurses. This publication is the work of the authors and they will serve as guarantors for the contents of this paper. There are no conflicts of interest that may arise as a result of the research presented in this article. The first author Dr Line Caes was awarded with The Southwood Adolescent Chronic Pain Visiting Award enabling her to visit the Centre for Pain Research at the University of Bath, UK in December 2012. This study was designed and initiated during her visit. At the time of the visit and further study analyses, Dr Line Caes was a postdoctoral fellow funded by the Louise & Alan Edwards Post-Doctoral Fellowship in Pediatric Pain Research. Emma Fisher is a PhD student funded through the University of Bath by the University Research Studentship Graduate School Award. Pain in Child Health (PiCH) funded Emma Fisher's visit in February 2013 to the Centre for Pediatric Pain Research at the IWK Health Centre, Nova Scotia, Halifax, Canada, which was intended to complete all aspects of this study.

*Requests for reprints should be addressed to Line Caes, School of Psychology, NUI Galway,University Road, Galway, Ireland (e-mail: line.caes@nuigalway.ie).

Statement of Contribution

What is already known on this subject?

- Worrying is a normal part of childhood, making distinguishing between normal and pathological worrying challenging.
- Worry content remains consistent between age 4 and 7, but only for boys.
- The complexity and elaboration of worrisome thoughts increase from 8 years onwards.

What does this study add?

- Worry frequency peaks at 10 and a low ability to control those worries can be observed at this age.
- The highest level of interference in performing daily activities due to worries is observed at age 13.
- Child sex and pubertal status play a role in understanding how normal worry patterns develop from age 10 onwards

The development of worry throughout childhood: ALSPAC data

Abstract

Objectives. Anxiety is a normal part of childhood and adolescence, however, longitudinal research investigating the development of worrisome thoughts throughout childhood is lacking. This study investigated mothers' perspectives on their child's normal development of worry as the cognitive component of anxiety and its impact on child functioning in a longitudinal population-based cohort. **Methods.** The data for the current study were extracted from the Avon Longitudinal Study of Parents and Children (ALSPAC). Mothers (*N*=2227) reported on their child's worry content, frequency, control, emotional disruption, and interference when their child was 7, 10, and 13 years old using the parent component of the Development and Well-being Assessment (DAWBA). At age 10 and 13, pubertal status was assessed using children's self-report of pubic hair developmental progress. **Results.** Mothers reported a peak of worrisome thoughts at 10. Emotional disruption was highest at 10, and the highest level of interference in daily life was observed at 13, especially for girls. Advanced pubertal status and worry frequency were positively associated for boys at 10 and girls at 13. Advanced puberty at 10 was also associated with overall higher worry frequency and emotional disruption. **Conclusions.** Findings are discussed within a developmental framework outlining the normal development of worrisome thoughts, associated distress, and interference throughout early adolescence. Increased knowledge of normative worry could be informative to further our understanding of adolescence as a vulnerable period for the development of mental health problems, such as Generalized Anxiety Disorder.

Keywords: worry; anxiety; child development; emotional disruption; interference

Introduction

Anxiety is described as *"...the tense, unsettling anticipation of a threatening but vague event, a feeling of uneasy suspense..."* (Rachman, 2004, p. 3) and involves the interplay of various cognitive processes (i.e. vigilance, attention, perception, reasoning, and memory; Rachman, 2004). Worry is defined as the dynamic cognitive component of anxiety (Borkovee, Shadiek, & Hopkins, 1991; Silverman, La Greca, & Wasserstein, 1995). Worry is a normal adaptive response to an anticipated threat. However, excessive worry can be maladaptive when it interferes with daily functioning and evokes excessive levels of distress (Silverman et al., 1995). Late childhood and adolescence are important periods for the development of worry (Copeland, Angold, Shanahan, & Costello, 2014), with verbal rumination about threat ranging from mild quotidian worry causing little disruption to severe, highly disruptive interference (Beesdo, Knappe, & Pine, 2009). Extreme worry is a component of Generalized Anxiety Disorder (GAD), a common mental health condition that can develop throughout childhood, with a prevalence ranging between 0.8% (UK; Green, McGinnity, Meltzer, Ford, & Goodman, 2005) and 2.4% (USA; Merikangas, Nakamura, & Kessler, 2009). Higher prevalence is found in girls from mid adolescence on (Copeland et al., 2014; Green et al., 2005).

Worrying is, however, a normal part of childhood which changes throughout a child's development, making distinguishing between normal and pathological forms of worrying challenging. The domain of developmental psychopathology postulates that knowledge on normal development can contribute to a bettter understanding of psychopathological development (Cicchetti & Rogosh, 2002). Previous research has shown that the level, complexity, and elaboration of worrisome thoughts increase from 8 years onwards (Vasey, Crnic & Carter, 1994), with the most common content of worry relating to school, health, and social

contact (Muris, Meesters, Merckelbac, Sermon, & Zwakhalen, 1998; Silverman et al., 1995). Between ages 7-9, children are most likely to worry about personal harm or harm to others and health (Muris, Merckelbach, Gadet, & Moulaert, 2000; Vasey & Daleiden, 1994; Vasey et al., 1994). Between 10-12, the most prevalent worries relate to behavioural competence and social evaluations (Vasey et al., 1994). Girls have also been found to worry more than boys, especially regarding academic performance, sport, and social competence (Muris et al., 1998; 2000; Silverman et al., 1995).

Despite being able to show with relative accuracy the content and prevalence of childhood worries at different ages and developmental perspectives on risk factors for developing anxiety disorders, such as GAD (Hale, Raaijmakers, Muris, van Hoof, & Meeus, 2008; Kertz & Woodruff-Borden, 2011), little is known about the fluctuating nature of worry frequency throughout development. Longitudinal data exploring the epidemiology, developmental changes and impact of normal worries throughout childhood is lacking (Kertz & Woodruff-Borden, 2011). Stevenson-Hinde and Shouldice (1995) have shown that, according to mother-report, worries remain consistent between ages 4-7, but only for boys. Despite cross-sectional evidence indicating higher worry frequency after age 7 (Muris et al., 2000; Muris, Merckelbach, Meesters & van den Brand, 2002), no research tracking the development and characteristics of worries has been undertaken during middle childhood and adolescence. Early adolescence, characterized by pubertal development and changes, is a crucial period in the development of worries. Pubertal status is an important contributing factor in explaining anxiety symptomatology, with higher levels of anxiety found in girls with an advanced pubertal status (Deardorff et al., 2007; Reardon, Leen-Feldner, & Hayward, 2009). Consequently, the potential role of puberty needs to be considered for a comprehensive perspective on the epidemiology of worry (Reardon et al., 2009).

Further, little is known about the severity of worrisome thoughts at different levels of development (Muris et al., 2000). Excessive worry can have a profound impact on functioning, indicating the need for clinical attention. Beyond the relevance to GAD, worry is also a feature of other mental health problems (e.g. depression). Moreover, depression and anxiety disorders show a considerable overlap and frequently co-occur (Reardon et al., 2009). Accordingly, from a developmental psychopathological perspective, increased understanding of the epidemiology of normal worry would be beneficial in furthering our understanding of a range of mental health problems (Cicchetti & Rogosh, 2002). Consequently, the current study aims to investigate the normal development, depending on child sex and pubertal status, of worrisome thoughts and associated impact on daily functioning from late childhood through young adolescence.

The Avon Longitudinal Study of Parents and Children (ALSPAC) is a longitudinal population-based cohort study that enrolled pregnant women in the early stages of their pregnancy between April 1991-December 1992. Mothers completed self-report questionnaires on their child's development and health at regular intervals (Boyd et al., 2013; see http://www.bristol.ac.uk/alspac/ for more details of all the data that are available through a fully searchable data dictionary: http://www.bris.ac.uk/alspac/researchers/data-access/data-dictionary/). Mothers reported on their child's level of worry and the impact on daily functioning at age 7, 10, and 13. These time points reflect important stages of a child's cognitive development (Piaget, 1987), which is of importance as differences in cognitive and language capabilities might be fundamental for the varying expression of worries throughout development (Beesdo et al., 2009; Kertz & Woodruff-Borden, 2011). In particular, the cognition of children before age 7 (i.e. first data point) is characterised as pre-operational (i.e. limited causal and allocentric reasoning). Between ages 7-12 (i.e. second data point), children are classed as being

in the 'concrete operational' stage with the critical elements of being able to infer cause-effect relationships and potential negative outcomes. Formal operations develop from age 12 (i.e. third data point), meaning that adolescents are more flexible in their thinking (Piaget, 1987). This cognitive maturation is assumed to be related to increasing and changing manifestations of worry, which might explain vulnerability for worrying in early adolescence (Muris, 2006). Additionally, assessing anxiety at these developmental stages allows for assessment and exploration of the role of pubertal status in the development of worries. Consequently, this longitudinal cohort-study in a representative community sample presents a unique opportunity to investigate the normal development of worry.

We rely on the mother-report of early child worry experiences, which is relatively common in community samples because the use of self-report in younger children has raised concerns (Schwab-Stone, Fallon, Briggs, & Crowther, 1994). In particular, self-report questionnaires inquiring about the degree of worry are interpreted differently throughout development. While adults respond in terms of the frequency of worrisome thoughts, young children (below age 10) report on the degree of aversiveness associated with these thoughts (Campbell, Rapee, & Spence, 2000). Furthermore, parental perspective on child worries was considered particularly relevant as children depend on their parents' interpretation on the seriousness of worries to seek professional help (Johnston, Seipp, Hommersen, Hoza, & Fine, 2005). Therefore, a consistent use of mother-report of childhood worry over the years was selected as the preferred measurement strategy for ALSPAC.

We aimed to assess the content and frequency of worry, to what extent children and adolescents are able to control their worries, emotional disruption due to their worries, and the severity of interference caused by worry to daily functioning at age 7, 10 and 13. Due to the sole reliance on

maternal reports we controlled for the primary source of bias, the mother's own level of anxiety (Briggs-Gowan, Carter, & Schwab-Stone, 1996). To investigate the impact of pubertal status on worry development, we explored differences in worry frequency, emotional disruption and interference depending on adolescents' pubertal status for boys and girls separately.

Methods

Participants and procedure

The data for the current study were extracted from ALSPAC. The results reported here are based on questionnaire data collected from mothers reporting on their child's worries at age 7, 10, and 13. At 7, 8090 mothers completed the self-report measurements, at 10 this assessment was completed by 4549 mothers, and 3903 mothers completed the questionnaire when their child was 13. All reported analyses are conducted on the sample of mothers who completed the questionnaire at all three ages (N=2227; 1021 boys; 1206 girls)[1]. The majority of mothers (62.9%) had completed school. Ethical approval was obtained from the ALSPAC Law and Ethics committee and the Local Research Ethics Committees.

Measures

Mother's perspective on child worries. When children were aged 7, 10, and 13, mothers completed the parent component of the Development and Well-being Assessment (DAWBA; Goodman, Ford, Richards, Gatward, & Meltzer, 2000). The DAWBA is a valid and reliable epidemiological and clinical assessment tool for making DSM IV diagnoses of a number of psychiatric disorders including GAD, which has been frequently used in clinical and community samples (Aebi, Kuhn, Metzke, Stringaris, Goodman, & Steinhausen, 2012; American Psychiatric Association, 1994; Ford, Goodman & Meltzer, 2003). For this study we were particularly

[1]Although this might represent a selected sample, results in the sample without this limitation, but including all available data at any given age revealed identical results.

interested in the child general anxiety section in order to describe the children's frequency of worries, emotional disruption and interference. The DAWBA is most commonly used as a clinical interview, however, due to the set-up of ALSPAC, parents in this study completed the DAWBA using a self-report format (see Appendix A; for more information on the DAWBA see http://www.dawba.info/a0.html).

Parents first reported how often ('Not at all (=1)', 'Sometimes (=2)' or 'Often (=3)') their child worried about six predefined situations: schoolwork; disasters; the future; health; past behaviour; and bad things happening to others. Mothers also had the opportunity to report one other situation that their child was worrying about, resulting in a total of seven possible child worries. A sum score was computed ranging from 6 to 21 with higher scores indicating more frequent worries. Cronbach's alpha of these seven items revealed a low, but acceptable due to the large sample size (Bacon, 2004), internal consistency across all ages (α=.67 age 7, α=.55 age 10, α=.60 age 13). Second, mothers indicated their child's ability to control worry ('Yes'/'No'). Children were considered to have poor control of their worries if their mother responded 'yes' to this item. Finally, mothers reported on the emotional disruption (i.e. feelings of distress) and interference of four predefined daily activities (e.g. making and keeping friends; learning or schoolwork) due to the various worries by means of a 4-point response scale from 'Not at all (=0)' to 'A great deal (=3)'. Summary scores were created for the four activities with a total score ranging from 0 to 16, with a good internal consistency across all ages (α=.75 age 7; α=.78 age 10; α=.82 age 13). Higher scores indicated a higher level of interference in daily activities due to worries.

Mothers' general level of anxiety. When their child was 7 years old, mothers completed the Trait form of the State-Trait Anxiety Inventory (STAI-T) reporting on their own level of anxiety. The STAI-T is reliable, valid, and the leading measure of measuring anxiety in normal adult samples,

consisting of 20 items (e.g. 'I am worried', 'I am scared'; McDowell, 2006; Spielberger, Gorsuch, Lushene, Vagg, & Jacobs, 1993). Mothers rated how much each item/statement is true for them, using a 4-point scale (1='not at all' to 4='very much'). After reversing the score for positively-worded items, the total score is calculated by summing all items and ranges from 20 to 80, with higher scores indicating higher levels of trait anxiety (McDowell, 2006). The internal consistency in the current study was excellent (α=.94).

Pubertal status. Children's puberty status was assessed at 10 and 13 by means of the Tanner stages of puberty (Tanner, 1962). Child self-ratings of pubic hair development were obtained with the aid of sex-appropriate schematic drawings of pubic hair, which corresponds well with physical examination (Morris & Udry, 1980). Children were divided into Tanner stages according to pubic hair development ranging from one (pre-pubertal) to five (adult level). The five categories were reduced to three categories by combining stages I and II and stages IV and V (Angold, Costello, & Worthman, 1998).

Analytical procedure

Descriptive analyses were used to compare worry frequency, emotional disruption and interference at 7, 10, and 13, and ANOVA analyses were applied to explore mean levels stratified by sex and puberty status at the ages of 10 and 13. Changes over time in the percentage of mothers who indicated their child experiencing problems controlling their worries and presence of each worry content were analysed using the Friedman test. Possible changes within mothers in their perception of worry frequency, emotional disruption, and interference due to worry were investigated by means of multilevel regression analyses (using Mixed Model Analyses). Multilevel analyses were deemed most appropriate as our data are hierarchically nested: repeated assessment of worry frequency, distress and interference (Level 1) is nested

within individuals (child; Level 2). In contrast with traditional statistical methods (e.g. repeated-measures ANOVA), multilevel modelling allows more precise parameter estimates (Nezlek, 2001). Furthermore, the baseline model (i.e. without any predictors in the model) which allows a two-level structure provided a better fit than the one-level structure for all dependent variables (worry frequency: $\chi^2_{(2)}$=140.11; distress: $\chi^2_{(2)}$=287.67.11; interference: $\chi^2_{(2)}$=463.32; all *p's*<.001). The following set of analyses was performed for each dependent variable. In a first step, a baseline model, without any predictors except 'age' (i.e. 7, 10, 13) and a random intercept was run to explore changes within subjects over time (Level 1). In the second step, the between-level variables (level 2, i.e. child sex, pubertal status, and mother's anxiety), were added as fixed effects. In the third step, we defined a random slope for the variable 'age'. In the final step, the interaction term between child age and sex was added as a fixed effect. All continuous independent variables were standardized to allow more coherent interpretations of the coefficients. Full maximum likelihood estimation was applied and for each step the likelihood ratio deviance test was used to determine whether the changes made within the step should be retained. The likelihood ratio deviance test compares the deviance, or lack of fit between model and data, of two models to determine the best-fitting model. Only if the fit of the model improved compared to the model of the previous step were the changes retained (Nezlek, 2001).

Results

Descriptive data

Table 1 provides descriptive data for all variables at each age. Figure 1 illustrates the distribution according to age for child's frequency of worrying according to maternal report. Average levels of worry frequency reported at age 7 was 8.39 (*SD*=1.84), 11.58 (*SD*=1.81) at 10, and 9.70 (*SD*=1.92) at 13. Pearson correlation analyses indicated that worry frequency across all ages

correlated with each other ($r_{7\text{-}10years}$=.30; $r_{7\text{-}13years}$=.26; $r_{10\text{-}13years}$=.31, all *p*'s<.01). Specifically, frequency of child worry at age 7 explained 9% and 6.9% of the variance of worry frequency at 10 and 13 years respectively. The frequency of worry at age 10 explained 9.7% of the variance in worrisome thoughts at 13. Overall mean levels of child emotional disruption due to worries remained fairly stable over time (mean range 1.64 to 1.66), while interference due to worries showed a slight increase over age from a mean level of 5.09 at age 7 to 5.32 at 13.

- Insert table 1 and Figure 1 about here -

Differences according to pubertal status and sex

The mean mother-reported levels of worry frequency, emotional disturbance, and interference stratified by sex and puberty status at age 10 and 13 can be found in Tables 2 and 3 respectively. No significant differences according to pubertal status at age 10 or 13 (all F<2.03) were found for any of the variables. Only a main effect of sex was found at 13, with mothers reporting higher frequency of worry for girls compared to boys ($F(1,1631)=11.34$, $p<.01$). However, for worry frequency, we found an interaction between child sex and pubertal status at 10 ($F(2,1631)=5.94$, $p<.01$) and 13 ($F(2,1862) = 3.41$, $p<.05$). Specifically, at age 10 higher levels of pubertal status were related to higher frequency of child worry, but only for boys. At age 13, boys with a higher pubertal status were less worried; while an advanced pubertal status for girls was associated with higher frequency of worry.

- Insert Table 2 and 3 about here -

Control of worrying

Results of the Friedman test showed that the number of children experiencing difficulties controlling their worries, as reported by mothers, differed significantly between age groups ($\chi^2_{(2)}=24.81$, $p<.001$). Specifically, at 7, 15.6% of the children experienced difficulties to control

their worries, compared with 16.6% at age 10, and 12.9% at age 13. Moreover, at 13, a significantly higher proportion of girls had problems controlling their worries, compared to boys ($\chi^2_{(1)}$=7.99, p<.01), 14.74% girls vs. 10.69% boys). No differences according to child sex were found at 7 or 10 (7 years: $\chi^2_{(1)}$=2.23, *ns*, 14.41% girls vs. 17.10% boys; 10 years: $\chi^2_{(1)}$=3.70, p=.05, 18.00% girls vs. 14.92% boys).

Worry content prevalence

Friedman tests performed for each worry content or situation separately indicated that, according to mothers, there were significant differences in the content of child worry between 7, 10, and 13 years of age ($\chi^2_{(2)}$=21.91-648.83, all p's<.001). For almost all situations, 10 year olds were the largest group to report worrying about the assessed situations with two exceptions. First, mothers were more likely to report that their child 'sometimes' worried about schoolwork and health at age 13. Second, 13 year olds were the largest group to 'often' worry about past behaviour and health at 13.

Frequency of worries

Mixed Model Analysis of the baseline model indicated that mother-reported frequency of child worry significantly changed with child age (β_{10}=.32, t(3003)=8.67, p<.001). Adding the second-level variables yielded a significant likelihood ratio test compared to the baseline model ($\chi^2_{(4)}$=58.69, p<.001). While including a random slope for the variable age did not produce a better fit ($\chi^2_{(1)}$=0, *ns*), adding the interaction between age and sex did ($\chi^2_{(1)}$=9.25; p<.01) and was therefore chosen as the final model, excluding the random slope for age. The final model revealed that the interaction between child sex and age was significant (β_{11}=.23, t(3006)=3.04, p<.01). With the exception of 7 year olds (t(2225)=-.65, *ns*, M_{girls}=9.17, SD_{girls}=1.91, M_{boys}=9.12, SD_{boys}=2.03), mothers reported a higher frequency of worries for girls compared to boys (10

years: $t(2225)=-2.46$, $p<.05$, $M_{girls}=11.79$, $SD_{girls}=1.76$, $M_{boys}=11.61$, $SD_{boys}=1.83$; 13 years: $t(2225)=-5.4$, $p<.001$, $M_{girls}=10.03$, $SD_{girls}=2.03$, $M_{boys}=9.60$, $SD_{boys}=1.81$). Lastly, there was a positive effect of mother's own anxiety level ($\beta_{04}=.22$, $t(1499)=6.13$, $p<.001$) and puberty status at 10 ($\beta_{02}=.14$, $t(1507)=3.26$, $p<.01$) on child worry frequency (see Table 4 for the final model estimations).

- Insert Table 4 around here -

Emotional disruptions

Mixed Model Analyses of the baseline model revealed no significant main effect of child age on emotional disruption ($\beta_{12}=-.001$, $t(2770)=-.18$, *ns*). Similar to the model for worry frequency, adding the second level variables revealed a better fit compared to the baseline model ($\chi^2_{(4)}=63.49$, $p<.001$). However, the model also including the interaction between age and sex, but excluding the random effect for age provided the best fit ($\chi^2_{(1)}=4.90$, $p<.05$). Within the final model a significant main effect of age was found ($\beta_{10}=-.08$, $t(2784)=-2.15$, $p<.05$). However, the interaction between child age and sex was also significant ($\beta_{11}=.05$, $t(2777)=2.21$, $p<.05$). An independent t-test showed that at 13 girls were more disrupted by their anxious thoughts compared to boys ($t(2204)=-2.820$, $p<.01$, $M_{girls}=1.68$, $SD_{girls}=.63$, $M_{boys}=1.60$, $SD_{boys}=.63$). No differences for boys and girls were found at 7 ($t(1665)=.75$, *ns*, $M_{girls}=1.63$, $SD_{girls}=.62$, $M_{boys}=1.65$, $SD_{boys}=.63$), or at 10 ($t(2204)=-.41$, *ns*, $M_{girls}=1.66$, $SD_{girls}=.64$, $M_{boys}=1.65$, $SD_{boys}=.61$; see Figure 2). Mother's level of anxiety ($\beta_{04}=.14$, $t(1464)=7.42$, $p<.001$) and puberty status at age 10 ($\beta_{02}=.05$, $t(1455)=3.18$, $p<.01$) were also found to have a significant impact, indicating higher levels of distress are associated with higher maternal anxiety and advanced pubertal status at age 10 (Table 4).

- Insert Figure 2 about here -

Interference with daily activities.

Analyses with the baseline model indicated a significant change in level of mother-reported interference in child daily life due to worries across ages (β_{10}=.12, t(2756)=4.30, p<.001). Each step in the multilevel analyses process improved the fit of the model; consequently the model including the second level variables, random slope of age and interaction between age and sex was chosen as the final model ($\chi^2_{(1)}$=*16.67*, p<.001). The final model revealed a main effect of age (β_{10}=-.26, t(2757)=-2.66, p<.01) and child sex (β_{01}=-.50, t(2437)=-3.62, p<.001). However, the interaction between child age and sex (β_{11}=.12, t(2762)=4.18, p<.001) made a significant contribution in explaining interference of worrying on daily activities. Independent t-tests showed that at 13 girls were more interfered in their daily activities by worry compared to boys (t(2209)=-2.75, p<.01, M_{girls}=5.43, SD_{girls}=2.04, M_{boys}=5.20, SD_{boys}=1.88). No sex differences were found at 7 (t(4270)=3.35, p=.06, M_{girls}=5.02, SD_{girls}=1.57, M_{boys}=5.18, SD_{boys}=1.82) or at 10 (t(4657)=1.36, p=.18, M_{girls}=5.18, SD_{girls}=1.83, M_{boys}=5.17,SD_{boys}=1.72; Figure 3). Higher levels of anxiety in mothers (β_{04}=.28, t(1478)=7.94, p<.001) contributed to higher interference in the child's daily activities due to worry, as reported by the mother (Table 4).

- Insert Figure 3 about here -

Discussion

We investigated the development of child worry content, frequency, level of control, emotional disruption, and interference, as perceived by their mothers, in a large epidemiological sample of British children recruited. Our results indicate that all investigated aspects of worry change over time. Specifically, at age 10 mothers observe a peak of child worry including a lower reported ability to control those worries and more emotional disruption due to worry. Supporting earlier results (Muris et al., 1998; Silverman et al., 1995), the most prevalent worry across all ages was

school and homework and at 13, mothers reported that children worried more often about health and past behaviour than when they were 10. The highest level of interference in performing daily activities due to worries was found at age 13. However, these changes over time were found to be dependent upon the child's sex. Girls were more worried at 10 and 13. Compared with boys, 13 year old girls were also reported to have more difficulty controlling their worry, were more emotionally disrupted, and experienced more interference in their daily activities due to worry. Additionally, endorsing previous evidence (Deardorff et al., 2007; Reardon et al., 2009), we found differences in worry between the pubertal stages depending on the child's sex. At age 10, boys with an advanced pubertal status were observed by their mothers to worry more. At 13 however, mothers reported that girls with an advanced pubertal status worried more, compared to children with a less advanced pubertal status. Our findings not only fit within the anxiety literature, but also align with the larger field of developmental psychopathology and identified patterns of childhood depression. Evidence finds that depressive symptoms and disorders become more frequent during adolescence, especially in girls with advanced puberty status in early adolescence (Hyde, Mezulis, & Abramson, 2008).

The results add to our understanding of how normal worry patterns develop in early adolescence. Integrated cognitive-behavioural models explain the development of risk factors for GAD (Kertz & Woodruff-Borden, 2011). However, no integrated model currently exists outlining normal development, coping, and impact of childhood worries. The results of the current analyses could contribute in formulating such a model by revealing different pathways, dependent on child sex and pubertal status, of normal development of worrisome thoughts.

Important for clinical practice is the finding that although mothers perceive that control over worries was greater at 13, the impact of worries on daily life was reported to peak at this age,

especially in girls. This might indicate that parents perceive heightened frequency of worry and difficulty controlling their worry as a normal developmental process at 10 and does not necessarily need to raise concern (Muris et al., 2002). It is important to note that at age 10, British children typically are preparing to transfer from primary to secondary school, which could partially explain the high frequency of worries at 10, especially the high prevalence of worry about schoolwork. The heightened mother-perceived interference despite the reduced frequency of worries at 13 could be explained by the increased cognitive maturation at this age, which might be a requisite for elevated interference (Muris, 2006) and further explain heightened vulnerability for intrusive levels of worrying in early adolescence (Beesdo et al., 2009, Copeland et al., 2014, Kertz & Woodruff-Borden, 2011). Although further inquiry is needed, the level of interference in daily activities and emotional disruption due to normal worries, independent of the level of worry frequency, might be key in early identification of intrusive worries.

In line with our developmental perspective, the findings further indicate that girls in particular are vulnerable during early adolescence (i.e. age 13) to develop intrusive worries. The sex differences found in our analyses endorse previous research (Copeland et al., 2014, Muris et al. 1998; Silverman et al., 1995), with the only difference being the age at which the differences were found: Muris and colleagues (2002) found more anxious thoughts in girls compared to boys in 7-9 year olds, while our sample reported differences from age 10 onwards. However, our sex-specific findings map well onto patterns identified for rumination, which is defined as a repetitive and passive thinking pattern and shows considerable conceptual overlap with worrying (Jose & Brown, 2008). Specifically, sex differences in rumination, with higher levels amongst girls, typically start to emerge around age 12 and although rumination is a general cognitive vulnerability for the development of depression, this vulnerability is especially pronounced for

girls (Hyde et al., 2009; Jose & Brown, 2008). Future research is warranted to further explore the age-dependent sex differences in worry processes. Our findings related to the role of pubertal status support previous findings indicating that early advanced pubertal development might play an important role in age-related sex differences (Deardorff et al., 2007). Aside from the impact on overall frequency of worry, early pubertal development (i.e. at age 10) played an important role in heightened levels of emotional distress caused by worry and therefore might be important risk factor when identifying children at risk of developing heightened levels of worry that interrupts daily functioning (Reardon et al., 2009).

Lastly, mother's own anxiety levels were important in explaining their perception of child's worry frequency, emotional disruption and interference due to worries. Although mother's perspective on child worry might be biased by their own anxieties, these results are in accordance with research suggesting that anxiety symptoms aggregate in families. Although ample evidence is available for this aggregation, less is known about the transmission patterns of anxiety and worry within families. Genetics play a role but cannot explain all transmission thereby directing research to psychological variables (Whaley, Pinto, & Sigman, 1999). Parental anxious behaviour has been shown to be an important contributor (Moore, Whaley, & Sigman, 2004) with anxious mothers more likely to model an anxious cognitive style (e.g. catastrophic thinking) compared to low anxious mothers, thereby putting their children at risk of heightened frequency of worry. However, due to the interdependence between parents and children, it is likely that children who have increased worry could also influence the level of anxiety experienced by their mothers. Furthermore, beyond mother's own anxiety, other factors have the potential to influence mother's perception of child worries (e.g. child disclosure level, family functioning, parenting style and mother's depression; Bögels & Brechman-Toussaint, 2006).

Longitudinal research using multiple informants and assessment of family environment is needed to disentangle these bidirectional dyadic influences, which will allow investigation of observed changes in worry patterns that reflect actual changes or changes in child disclosure or mother's perception of worry.

Potential limitations should be considered. First, although significant differences were found across age and between sexes, with the exception of worry frequency, the differences found were small and the overall frequency of worry, emotional disruption, and interference with daily activities were low. Although this reflects a low frequency/impact of worry in a community sample (Muris et al., 1998), future studies and replication are needed to determine the clinical significance and generalizability of these findings. The generalizability and validity of our results might also be restricted by the sole reliance on mothers' report of child worry. This might be of particular importance for our last time point (i.e. age 13), given evidence that discrepancy between parent and child reports of internalizing symptoms tend to increase in adolescence (Handwerk, Larzelere, Soper, & Friman, 1999), with greater discrepancies associated with continued emotional problems later on in development (Ferdinand, van der Ende, & Verhulst, 2004). Despite discrepancies, parent report can reveal unique and relevant information and even the discrepancy with child report itself could be informative, thereby highlighting the continuing need for, but changing quality and function of parental report across development (Ferdinand et al., 2004). Second, the questions included in the current study were part of a larger questionnaire inquiring about the child's health and therefore kept brief and general. Detailed studies investigating childhood worry (e.g. investigation of specific activities interfered due to worries) are needed to fully understand normal worry patterns and potential sex differences in early adolescence. Furthermore, no data is available on child worry before 7 or after 13 years of age,

and mother's anxiety was only assessed at 7. Therefore, we cannot identify whether children with higher levels of worry during this period went on later to develop a clinical disorder, and whether mother's anxiety later on impacted their perception of child worry. Moreover, no cognitive measures were included to verify whether or not the participating children followed a normal cognitive development pattern. Lastly, other risk and protective factors that could potentially influence the development of worrying, such as the experience of traumatic events, child attachment and effortful control, were not investigated (Beesdo et al., 2009). Although further inquiry is necessary, based on their relevance for the development of anxiety disorders (Muris, 2006), it is likely that these factors could impact the normal development of worrisome thoughts and associated distress and interference. Moreover, the potential differential impact of these factors according to child age, sex and pubertal status is unknown.

Despite these considerations the findings add to our understanding of the normal development of worry, and impact on emotions and daily life in children between 7-13 years. Mothers perceive heightened frequency of worry, and the least amount of control over these worries when children are 10. However, the interference of worry in daily life increases at 13, especially in girls with an advanced pubertal status.

Figure Legend

Figure 1: Mean scores for worrying across ages.

Figure 2: Impact of age and sex on emotional disruption due to worries.

Figure 3: Impact of age and sex on Interference in daily activities due to worrying

References

Aebi, M., Kuhn, C., Metzke, C.W., Stringaris,A., Goodman, R., & Steinhausen, H.C. (2012). The use of the development and well-being assessment (DAWBA) in clinical practice: a randomized trial. *European Child & Adolescent Psychiatry, 21(10)*, 559-567. DOI: 10.1007/s00787-012-0293-6

American Psychiatric Association. *Diagnostic and Statistical Manual of Mental Disorders (Fourth Edition)*. Washington, D.C.: Author, 1994.

Angold, A., Costello, E. J., & Worthman, C. M. (1998). Puberty and depression: the roles of age, pubertal status and pubertal timing. *Psychological Medicine, 28*, 51-61.

Bacon, D. (2004). The contributions of reliability and pretests to effective assessment. *Practical Assessment, Research & Evaluation, 9(3)*.

Beesdo, K., Knappe, S., &Pine, D.S. (2009). Anxiety and anxiety disorders in children and adolescents: developmental issues and implications for DSM-V. *Psychiatric Clinic of North America, 32*, 483-524. DOI: 10.1016/j.psc.2009.06.002

Bögels, S.M., & Brechman-Toussaint, M.L. (2006). Family issues in child anxiety: Attachment, family functioning, parental rearing and beliefs. Clinical Psychology Review 26, 834–856. DOI: 10.1016/j.cpr.2005.08.001

Borkovee, T.D., Shadiek, R., & Hopkins, M. (1991). The nature of normal worry and pathological worry. In R.M. Rapee & D.H. Barlow (Eds.), *Chronic anxiety: Generalized anxiety disorder and mixed anxiety-depression* (pp. 29-51). New York: Guilford Press.

Boyd, A., Golding, J., Macleod, J., Lawlor, D.A., Fraser, A., Henderson, J., Molloy, L., Ness, A., Ring, S., & Smith, D.G. (2013). Cohort Profile: The 'Children of the 90s'--the index offspring

of the Avon Longitudinal Study of Parents and Children. *International Journal of Epidemiology, 42(1),* 111-27. DOI: 10.1093/ije/dys064

Briggs-Gowan, M.J., Carter, A.S., & Schwab-Stone, M. (1996). Discrepancies among mother, child, and teacher reports: Examining the contributions of maternal depression and anxiety. *Journal of Abnormal Child Psychology, 24(6),* 749-765. DOI: 10.1007/BF01664738

Campbell, M.A., Rapee, R.M., & Spence, S.H. (2000). Developmental changes in the interpretation of rating format on a questionnaire measure of worry. *Clinical Psychologist, 5(2),* 49-59. DOI:10.1080/13284200108521078

Cicchetti, D., & Rogosch, F.A.(2002). A Developmental Psychopathology Perspective on Adolescence. Journal of Consulting and Clinical Psychology, 70(1), 6–20. DOI:10.1037/0022-006X.70.1.6

Copeland, W.E., Angold, A., Shanahan, L., & Costello, E.J. (2014). Longitudinal patterns of anxiety from childhood to adulthood: the Great Smoky Mountains Study. *Journal of the American Academy of Child & Adolescent Psychiatry, 53(1)*, 21-33.

Deardorff, J., Hayward, C., Wilson, K.A., Bryson, S., Hammer, L.D., & Agras, S. (2007). Puberty and gender interact to predict social anxiety symptoms in early adolescence. *Journal of Adolescent Health, 41(1),* 102–104.

Edelbrock, C., Costello, A.J., Dulcan, M.K., Kalas, R. & Conover, N.C. (1985). Age differences in the reliability of the psychiatric interview of the child. *Child Development, 56(1),* 265-275.

Edelbrock, C., Costello, A.J., Dulcan, M.K., & Conover, N.C. (1986). Parent-child agreement on child psychiatric symptoms assessed via structured interview. *Journal of Child Psychology and Psychiatry 27, (2),* 181–190. DOI: 10.1111/j.1469-7610.1986.tb02329.x

Ferdinand, R. F., van der Ende, J., & Verhulst, F. C. (2004). Parent adolescent disagreement regarding psychopathology in adolescents from the general population as a risk factor for adverse outcome. *Journal of Abnormal Psychology, 113*, 198-206. DOI: 0.1037/0021-843X.113.2.198

Ford, T., Goodman, R., & Meltzer, H. (2003). The British child and adolescent mental health survey 1999: the prevalence of DSM-IV disorders. *Journal of the American Academy of Child & Adolescent Psychiatry, 42(10)*, 1203–1211.

Goodman, R., Ford, T., Richards, H., Gatward, R., & Meltzer, H. (2000). The Development and Well-Being Assessment: description and initial validation of an integrated assessment of child and adolescent psychopathology. *Journal of Child Psychology and Psychiatry, 41,* 645-655. DOI: 10.1111/j.1469-7610.2000.tb02345.x

Green, H., McGinnity, A., Meltzer, H., Ford, T., & Goodman, R. (2005). Mental Health of Children and Young People in Great Britain, 2004. Palgrave MacMillan.

Hale, W.W., III, Raaijmakers, Q., Muris, P., van Hoof, A., & Meeus, W. (2008). Developmental trajectories of adolescent anxiety disorder symptoms: A 5-year prospective community study. *Journal of the American Academy of Child and Adolescent Psychiatry*, *47(5)*, 556–564.

Handwerk, M.L., Larzelere, R.E., Soper, S.H., & Friman, P.C. (1999). Parent and child discrepancies in reporting severity of problem behaviors in three out-of-home settings. *Psychological Assessment, 11*, 14-23. DOI: 10.1037/1040-3590.11.1.14.

Hyde, J. S., Mezulis, A. H., & Abramson, L. R. (2008). The ABCs of depression: integrating affective, biological, and cognitive models to explain the emergence of the gender difference in depression. *Psychological Review, 115*, 291−313. DOI: 10.1037/0033-295X.115.2.291

Johnston, C., Seipp, C., Hommersen, P., Hoza, B., & Fine, S. (2005). Treatment choices and experiences in attention deficit and hyperactivity disorder: relations to parent's beliefs and attributions. *Child Care, Health and Development, 31*, 669-677. DOI: 10.1111/j.1365-2214.2005.00555.x

Kertz, S.J. & Woodruff-Boren, J. (2011). The developmental psychopathology of worry. *Clinical Child & Family Psychology Review, 14*, 174–197. DOI 10.1007/s10567-011-0086-3

McDowell, I. (2006). *Measuring Health: a Guide to Rating Scales and Questionnaires*. New York: Oxford University Press.

Merikangas, K.R., Nakamura, B.A., & Kessler, R.C. (2009). Epidemiology of mental disorders in children and adolescents. *Dialogues in Clinical Neuroscience, 11*, 7-20.

Moore, P.S., Whaley, S.E., & Sigman, M. (2004). Interactions between mothers and children: impacts of maternal and child anxiety. *Journal of Abnormal Psychology*, *113(3)*, 471–476. DOI: 10.1037/0021-843X.113.3.471

Morris, N. M. & Udry, J. R. (1980). Validation of a self-administered instrument to assess stage of adolescent development. *Journal of Youth and Adolescence, 9*, 271–280. DOI: 10.1007/BF02088471

Muris, P. (2006). The pathogenesis of childhood anxiety disorders: Considerations from a developmental psychopathology perspective. International Journal of Behavioral Development, 30 (1), 5–11. DOI: 10.1177/0165025406059967

Muris, P., Meesters, C., Merckelbach, H., Sermon, A., & Zwakhalen, S. (1998). Worry in normal children. *Journal of American Academy of Child and Adolescent Psychiatry, 37,* 703-710.

Muris, P., Merckelbach, H., Gadet, B., & Moulaert, V. (2000). Fears, worries and scary dreams in 4- to 12-year-old children: their content, developmental pattern and origins. *Journal of Clinical Child & Adolescent Psychology, 29*, 43-52. DOI:10.1207/S15374424jccp2901_5

Muris, P., Merckelbach, H., Meesters, C., & van den Brand, K. (2002). Cognitive development and worry in normal children. *Cognitive Therapy and Research, 26(6),* 775-787. DOI: 10.1023/A:1021241517274

Nezlek, J. B. (2001). Multilevel random coefficient analysis of event- and interval-contingent data in social and personality psychology research. *Personality and Social Psychology Bulletin*, *27*, 771–785. DOI: 10.1177/0146167201277001

Piaget, J. (1987). *Possibility and necessity* (Vol. 1): University of Minnesota Press.

Rachman, S. (2004). *Anxiety (Clinical Psychology, a modular course)* Second Edition. East Sussex: Psychology Press Ltd.

Reardon, L.E., Leen-Feldner, E.W., & Hayward, C. (2009). A critical review of the empirical literature on the relation between anxiety and puberty. *Clinical Psychology Review, 29(1),* 1–23.

Schwab-Stone, M., Fallon, T., Briggs, M., Crowther, B. (1994). Reliability of diagnostic reporting for children aged 6-11 years: a test-retest study of the Diagnostic Interview Schedule for Children- Revised. *The American Journal of Psychiatry, 151(7)*, 1048-1054. DOI: 10.1176/ajp.151.7.1048

Silverman, W.K., La Greca, A.M., & Wasserstein, S. (1995). What do children worry about? Worries and their relation to anxiety. *Child Development, 66*, 671-686. DOI: 10.1111/j.1467-8624.1995.tb00897.x

Spielberger, C.D., Gorsuch, R.L., Lushene, R.E., Vagg, P.R.,& Jacobs, G.A. (1993). *State-trait anxiety inventory for adults*. Palo Alto, CA, Mind Garden.

Stevenson-Hinde, J., & Shouldice, A. (1995). 4.5 to 7 years: fearful behaviour, fears and worries. *The Journal of Child Psychology and Psychiatry, 56*, 1027-1038. DOI: 10.1111/j.1469-7610.1995.tb01348.x

Tanner, J. M. (1962). *Growth at Adolescence: With a General Consideration of the Effects of Hereditary and Environmental Factors Upon Growth and Maturation from Birth to Maturity*. Blackwell Scientific Publications: Oxford.

Vasey, M.W., Crnic, K.A., & Carter, W.G. (1994). Worry in childhood: a developmental perspective. *Cognitive Therapy and Research, 18*, 529-549. DOI: 10.1007/BF02355667

Vasey, M.W., & Daleiden, E.I. (1994). Worry in children. In G. Davey & F. Tallis. *Worrying: Perspectives on theory, assessment and treatment*. New York: Wiley & Sons.

Whaley, S.E., Pinto, A. & Sigman, M. (1999). Characterizing interactions between anxious mothers and their children. *Journal of Consulting and Clinical Psychology, 67(6)*, 826-836. DOI: 10.1037/0022-006X.67.6.826

Appendix A. Children's worries questions.

1) Does your child worry a lot about:

A) Past behaviour (e.g. Did I do that wrong? Have I upset someone? Have they forgiven me?)

No, not at all Sometimes Often

B) School work, homework or tests/ examinations

No, not at all Sometimes Often

C) Disasters (e.g. burglaries, muggings, fires, bombs)

No, not at all Sometimes Often

D) His/her own health

No, not at all Sometimes Often

E) Bad things happening to others (e.g. family, friends, pets, the world)

No, not at all Sometimes Often

F) The future (e.g. changing school, growing up, getting a job)

No, not at all Sometimes Often

G) Any other worries? (please tick and describe).....

No, not at all Sometimes Often

2) Does your child find it difficult to control the worry?

Yes No

3) Overall, how upset and distressed is your study child as a result of all her various worries?

Not at all A little Quite a lot A great deal

4) Have these worries interfered with her day-to-day life?

A) how well he/she gets on with you and the rest of the family

No, not at all Only a little Quite a lot A great deal

B) making and keeping friends

No, not at all Only a little Quite a lot A great deal

C) learning or school work

No, not at all Only a little Quite a lot A great deal

D) playing, hobbies, sports or other leisure activities

No, not at all Only a little Quite a lot A great deal

Table 1: Mean levels of worry frequency, emotional disruption and interference across ages (N = 2227)

	7 years			10 years			13 years		
	M	SD	range	M	SD	range	M	SD	range
Worry frequency	9.15	1.96	6-18	11.71	1.80	6-21	9.83	1.95	6-20
Emotional disruption	1.64	.62	1-4	1.66	.63	1-4	1.64	.63	1-4
Interference	5.09	1.68	2-16	5.17	1.78	1-16	5.32	1.97	3-16

Table 2. Means scores and confidence intervals for level of worry, emotional disruption and interference at 10 years, stratified by puberty status and sex ($N = 2227$).

	Worries			**Emotional disruption**			**Interference**		
	PS I-II	**PS III**	**PS IV-V**	**PS I-II**	**PS III**	**PS IV-V**	**PS I-II**	**PS III**	**PS IV-V**
Boys	11.56 (11.43-11.69)	11.06 (10.45-11.66)	13.25 (11.49-15.01)	1.66 (1.61-1.70)	1.51 (1.30-1.73)	1.75 (1.14-2.36)	5.16 (5.03-5.29)	4.82 (4.21-5.42)	6.25 (4.51-7.99)
Girls	11.78 (11.66-11.90)	11.94 (11.59-12.29)	11.74 (11.25-12.24)	1.65 (1.61-1.69)	1.71 (1.59-1.83)	1.72 (1.55-1.90)	5.12 (5.01-5.24)	5.48 (5.14-5.83)	5.41 (4.92-5.90)
Total	11.67 (11.58-11.76)	11.50 (11.15-11.85)	12.50 (11.58-13.41)	1.65 (1.62-1.68)	1.61 (1.49-1.73)	1.74 (1.42-2.05)	5.14 (5.06-5.23)	5.15 (4.80-5.50)	5.83 (4.92-6.74)

Note. PS = Puberty Status.

Table 3. Means scores and confidence intervals for general level of anxiety, emotional disruption and interference at 13 years, stratified by puberty status and sex (N = 2227).

	Worries			**Emotional disruption**			**Interference**		
	PS I-II	**PS III**	**PS IV-V**	**PS I-II**	**PS III**	**PS IV-V**	**PS I-II**	**PS III**	**PS IV-V**
Boys	9.79 (9.56-10.02)	9.78 (9.52-10.04)	9.31 (9.07-9.55)	1.63 (1.55-1.71)	1.60 (1.52-1.69)	1.57 (1.49-1.65)	5.16 (4.93-5.39)	5.24 (4.98-5.49)	5.17 (4.93-5.41)
Girls	9.99 (9.68-10.29)	9.82 (9.55-10.09)	10.12 (9.96-10.28)	1.69 (1.59-1.79)	1.61 (1.53-1.70)	1.67 (1.62-1.72)	5.40 (5.10-5.69)	5.13 (4.87-5.40)	5.40 (5.25-5.56)
Total	9.89 (9.70-10.08)	9.80 (9.61-9.99)	9.71 (9.57-9.86)	1.66 (1.60-1.72)	1.61 (1.55-1.67)	1.67 (1.57-1.67)	5.28 (5.09-5.46)	5.18 (5.00-5.37)	5.29 (5.14-5.43)

Note. PS = Puberty Status

Table 4. Parameter estimates for fixed effects of the final mixed model for worry frequency, emotional distress and interference.

	Worry frequency			***Emotional distress***			***Interference***		
	Coeff.	*SE*	*T*	*Coeff.*	*SE*	*T*	*Coeff.*	*SE*	*T*
Intercept (β_{00})	9.84	0.29	34.35***	1.78	0.87	20.41***	5.67	0.24	23.99***
Age (β_{10})	-0.04	0.12	-.33	-0.08	0.04	-2.15*	-0.26	0.10	2.66**
Child sex (β_{01})	-0.20	0.17	-1.17	0.09	0.05	-1.73	-0.50	0.14	-3.62***
Pubertal status at 10 (β_{02})	0.14	0.04	3.26**	0.05	0.01	3.18**	0.07	0.04	1.55
Pubertal status at 13 (β_{03})	-0.04	0.03	-1.37	-0.02	0.01	-1.63	-0.01	0.03	-0.42
Mother's anxiety (β_{04})	0.22	0.04	6.13***	0.09	0.01	7.42***	0.28	0.04	7.94***
Age*Child sex (β_{11})	0.23	0.08	3.04**	0.05	0.02	2.21*	0.24	0.06	4.09***

Coeff. = Coefficient; *$p < .05$; **$p < .01$; ***$p < .001$

Figure 1

Click here to download Supplementary figure Fig 1.tiff

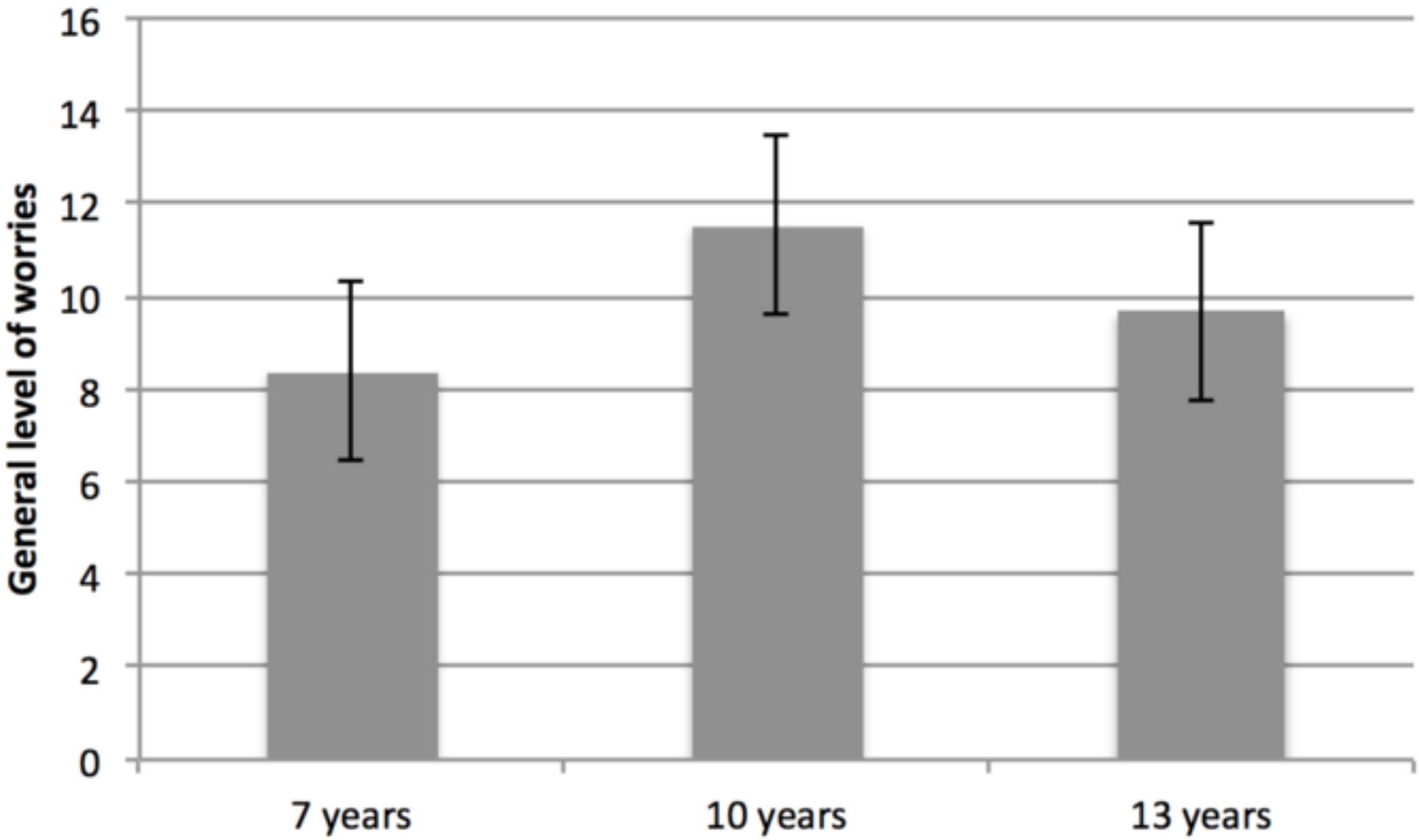

Figure 2

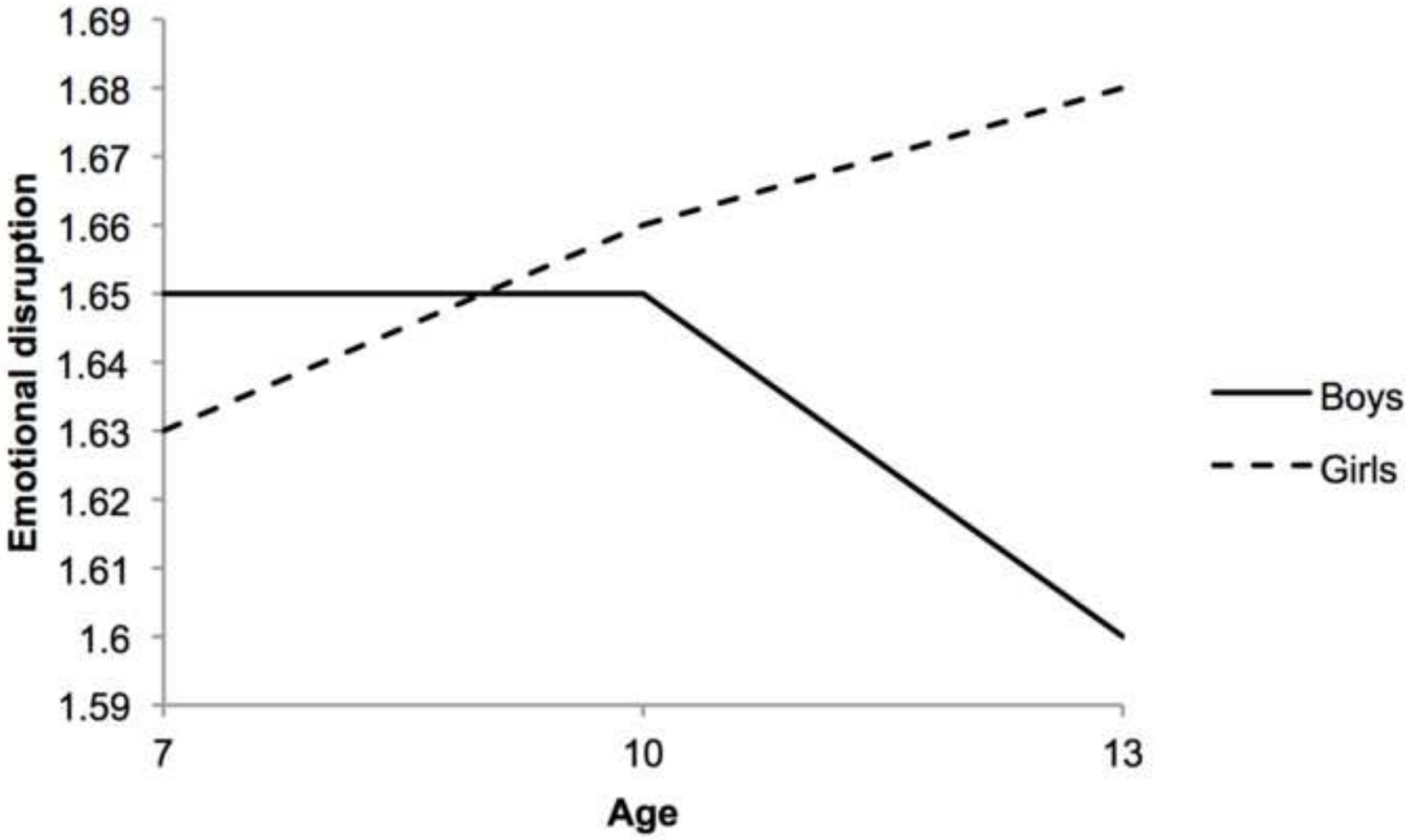

Figure 3

Click here to download Supplementary figure Fig 3.tiff