Rumination, Anxiety, Depressive Symptoms and Subsequent Depression in Adolescents at Risk for Psychopathology: a Longitudinal Cohort Study

Dr Paul O Wilkinson, Dr Tim J Croudace, Prof Ian M Goodyer

All authors: Dept of Psychiatry, University of Cambridge, Cambridge, UK

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Correspondence to: Dr Paul Wilkinson
University of Cambridge
Douglas House
18b Trumpington Road
Cambridge. CB2 8AH
UK
e-mail: pow12@cam.ac.uk
Phone: 00 44 1223 746001
Fax: 00 44 1223 746002

Other Authors: TJC: tjc39@cam.ac.uk
IMG: ig104@cam.ac.uk
Abstract

**Background:** A ruminative cognitive style of responding to low mood is associated with subsequent elevated depressive symptoms and the onset of clinical depressive episodes in children, adolescents and adults. Scores on self-report rumination scales (such as the Responses to Depression Questionnaire, RDQ) correlate strongly with scores on anxiety and depression symptom scales. This may confound any associations between this mood-valent cognitive style and subsequent depression.

**Methods:** Our sample comprised 658 healthy adolescents at elevated risk for depression. This study used non-linear factor analysis using pooled items from three self-report questionnaires to explore whether there were separate latent constructs of rumination, depression and anxiety; and tested whether rumination independently predicted depressive disorder and depressive symptoms over the subsequent 12 months, using multiple logistic and linear regression to control for confounders.

**Results:** We identified a single rumination factor, which was correlated with factors representing cognitive symptoms of depression, somatic symptoms of depression and anxiety symptoms; and one factor representing adaptive responses to low mood. Elevated rumination scores predicted onset of depressive disorders over the subsequent year ($p = 0.035$), and depressive symptoms 12 months later ($p < 0.0005$), after adjustment for current levels of depressive and anxiety symptoms at study entry. Pubertal stage did not affect the predictive properties of rumination.
**Conclusion:** High rumination predicts onset of depressive disorder in healthy adolescents. Therapy that reduces rumination and increases distraction/problem-solving may reduce onset and relapse rates of depression.

**Key Words** Depression; Anxiety; Rumination; Factor Analysis; Adolescence
Background

A mood-related ruminative response style refers to how a person, when dysphoric, focuses attention on his or her symptoms, and their ‘potential causes, implications and consequences’ [1]. Rumination is usually assessed using the Response Styles Questionnaire (RSQ) [2]. High RSQ rumination predicts higher future depressive symptoms [3] and DSM-defined major depressive episodes [4-6] in children and adolescents.

This rumination-depression association appears to be higher in studies of adolescents than of children [3]. This may be due to greater exposure to negative stressors from the age of 13 (and rumination moderates the depressogenic effect of stressors)[6]; or differences in other cognitive vulnerability factors with age [7]. An additional/alternative explanation is that it is the effects of puberty (with the change in hormonal milieu) that increases the depressogenic effect of rumination, rather than age itself. This has not been tested to date.

Potential Confounders to Rumination-Depression Associations

Self-rated rumination is strongly correlated with concurrent depressive [3] and anxiety [8-10] symptoms, themselves strong predictors of future depressive symptoms and disorder [1]. This may confound the association found in above studies between rumination and future depression. Thus in studies investigating higher rumination as a predictor of subsequent depression, rumination may be a proxy measure for anxiety and/or depressive symptoms rather than an independent cognitive predictor.
Two methods have been used to control for such potential depressive symptom – rumination confounding. Firstly, some studies have statistically controlled for baseline depressive symptoms. For example, controlling for depressive symptoms attenuated the correlation between baseline rumination and follow-up depressive symptoms from $r=0.3$ to $r=0.07$ (95% CI 0.03-0.11) in a meta-analysis of childhood/adolescence studies [3]. Three studies (two in adolescents) have found that rumination scores are associated with future onset of depressive disorder, over and above the contribution from concurrent depressive symptoms [1, 4, 6]. No studies have controlled for baseline anxiety.

The second method has been to try to identify items from the rumination questionnaire that are more likely to reflect the ruminating process (more cognitive), independent of depressed mood (more affective), using linear factor analysis methods or principal components analysis (PCA). Initial studies in community-recruited adults [9, 11, 12] identified a ‘brooding’ factor/principal component, which was more strongly associated with current and/or future depressive symptoms than any other dimension of the RSQ (in particular a ‘reflecting’ factor/PC). While some studies in adolescents found a similar two factor structure of the RSQ [10, 13], one found only one factor [14].

Our study is proposing a third method of measuring true rumination, separate to depressive and anxiety symptoms. The methods above make assumptions that items on depression questionnaires all measure an underlying continuous latent trait of ‘depression’, while a set of items identified from psychometric analysis of the rumination
questionnaire all measure an underlying continuous latent trait of ‘(brooding) rumination’, which is different to depression. However, ‘brooding’ items are still strongly associated with current depressive symptoms, raising the possibility that they all measure one common latent trait. This can best be resolved by entering all depression, (anxiety) and rumination questionnaire items into a single factor analysis. This may demonstrate that all items measure only one common latent trait, or may indicate that there are likely to be multiple latent traits, potentially including ‘rumination’. Such analysis would be independent of, possibly incorrect, a priori assumptions about which questionnaire items should be counted within. In particular, rumination items which are more strongly correlated with depressive symptoms than ‘true’ rumination would load highest onto the depression factor.

**Distraction and Problem-Solving**

There are also RSQ items that are postulated to be part of other, more adaptive, response styles termed distraction and problem-solving. Factor analysis suggests that items from both scales load onto a single factor and they both represent adaptive responses to low mood [15, 16].

High levels of distraction and problem-solving have been found to be associated with reduced future depressive symptoms in community [15] and high-risk [16] samples of children and adolescents, controlling for baseline depressive symptoms. In addition, the ratio of rumination to distraction/problem-solving is associated with increased depressive
symptoms at follow-up, suggesting that high levels of distraction/problem-solving mitigate some of the effects of rumination [15, 16].

**Goals of the Current Study**

Our analysis consisted of two phases. In our first phase, we investigated the factor structure of a joint set of items from three self report questionnaires purporting to measure depression, anxiety and rumination. We hypothesized that this would either identify that all items measure one underlying negative cognitions construct; or alternatively identify multiple separate constructs, including rumination (and possibly different forms of rumination), and would correctly assign each item from the pooled item set to the appropriate construct.

In our second phase, we hypothesized that high rumination (as measured by items identified as measuring rumination in the above factor analysis) would predict onset of a depressive episode over the subsequent 12 months and high depressive symptoms 12 months after baseline, controlling for confounding from baseline depressive and anxiety symptoms. We also hypothesized that a high ratio of rumination to distracting/problem-solving response styles would be associated with lower risk of depression onset/symptoms, indicating that these adaptive response styles partially mitigate the effects of rumination. We hypothesized that effects of rumination were stronger for mid/post-pubertal adolescents than pre/early-pubertal adolescents, and tested this with
pubertal stage x rumination interaction terms. To disentangle effects of age and puberty, we also tested age x rumination interactions.

Methods

Participants

A sample of 658 healthy adolescents aged 12 to 16 years was recruited from Cambridgeshire secondary schools from 1999 to 2002. All were currently mentally and physically well, and had no past episodes of depression.

We recruited a risk-enriched sample to increase the predicted depression episode onsets, to increase power of the study. Adolescents and their parents completed short, screening checklists at entry, which asked about family psychiatric history and social adversity. Mothers completed the EAS Temperament Survey [17]. Participants were included if they had a parent with a lifetime psychiatric history; or 2 or more of the following:

- 2 lifetime bereavements
- EAS emotionality>17
- chronic (> 6 months) marital dysharmony or parental separation
- 2 recent undesirable life events
- difficulties with family or friendships focused on the adolescent.
We have established that this risk profile is associated with a three to fivefold increase in the risk for onset of an episode of major depression over one year [18].

**Measures**

*Mood-Related Response Style:* The Responses to Depression Questionnaire, RDQ, is a modified version of the Response Styles Questionnaire [1], with wording of a small number of items slightly altered to make it more appropriate and simpler to understand for adolescents [19]. Additional file 1 shows all items in full. It comprises 39 items asking participants what they habitually think, do or feel when they experience low mood. Each item response is scored using four response levels (0=almost never, 1=sometimes, 2=often, and 3=almost always). There are four groups of items that are scored as sub-scales, which estimate the tendency to use different mental strategies for dealing with low mood: rumination, distraction, problem-solving and dangerous (acts). The RDQ contains 5 out of 6 items labeled as ‘brooding’ and all four ‘reflecting’ items in the Burwell and Shirk (2007) principal component analysis study in adolescents.

*Depressive Symptoms:* The self-rated Mood and Feelings Questionnaire, MFQ, was completed at study entry and at 12-month follow-up. The MFQ comprises 33-items measuring depressive symptoms [20]. Re-test reliability and criterion validity are high [21]. A four-point ordinal response scale was adopted instead of the original three categories, because of its embedding along with other assessments in a common format, the “Young Person Questionnaire (YPQ)”. Items were scored from 0-3 (never, sometimes, mostly, always). Responses in the “mostly” and “always” categories were
combined, to yield three response levels whose prevalence combined was found to be highly similar to the high upper rating category of the original version.

Anxiety Symptoms: The self-rated Revised Children's Manifest Anxiety Scale, RCMAS, contains 28 anxiety items. It has high internal consistency and reliability [22]. The RCMAS anxiety items were included as part of the YPQ and each item was scored from 0-3 (never, sometimes, mostly, always). Since 5 items from the MFQ and RCMAS had very similar wording, only the MFQ item for these questions was included; these were completed within the MFQ item block in the YPQ.

Diagnoses: The Lifetime Schedule for Affective Disorders and Schizophrenia for Adolescents, K-SADS-L, is a semi-structured interview which can be used to ascertain lifetime and current DSM-IV diagnoses of psychiatric disorders [23]. It was used to exclude participants with psychiatric disorder at baseline, and establish onsets of depressive disorders during 12 month follow-up. Depressive disorders were defined as DSM-IV major depressive episode (MDE) or minor depressive episode (3/4 symptoms together with significant psychosocial impairment, defined as a Children’s’ Global Assessment Score of <60). Raters were graduate research assistants who had extensive training. All possible diagnoses of disorder were discussed at consensus meetings with one of the senior investigators, to ensure reliability.

Pubertal Stage Assessment: Pubertal stage was assessed using schematic drawings of secondary sex characteristics associated with the five Tanner stages of pubertal
development [24]. Sketches were adapted from Greydanus and Shearin [25]. Participants were provided with gender appropriate sketches and were asked to select which of the sketches looked most like them. In view of the sample size and to allow adequate power, participants were a priori dichotomized into being either pre/early-puberty (Tanner stages 1, 2) or mid/post-puberty (Tanner stages 3-5).

**Procedure**

Adolescents were interviewed at study entry and 12 month follow-up. In a constant order, MFQ, K-SADS-PL, RCMAS then RDQ were administered at study entry. K-SADS-PL and MFQ were administered at 12 month follow-up.

**Statistical analysis**

*Factor Analysis of Cognitive Styles:* Participants’ scores were included if they had at least 50% of items completed within each of the RDQ, MFQ and RCMAS. We initially carried out exploratory factor analysis (EFA) for ordinal items using MPlus, Version 5.2 [26] via a latent probit item response model approach, of all items from the RDQ, MFQ and RCMAS. MPlus allows for accurate results to be given if some data is missing. As items are scored on an ordinal scale, these were treated as categorical, and a polychoric correlation matrix was used; parameters reported are the weighted least square parameter estimates using a diagonal weight matrix (WLSMV). Linear factor models for ordinal
psychopathology and self-reported mood and cognition data can yield misleading factor solutions such as factors defined by prevalence and skew rather than content and other distortions of the true factor structure due to aspects of scale use. EFA solutions were rotated using Promax (correlated factors) to aid interpretation. Confirmatory factor analysis was performed using MPlus Version 5.2 to further examine the fit of the factor structures estimated by EFA in the same sample. Items loading highest on each factor were summed to give scale scores for each factor. Where fewer than 50% of items were missing for each scale for a participant, missing values were imputed as being the average for that scale from present data. The 3 items only present on the dangerous scale were not included, in view of their poor validity and poor suitability to define a factor.

**Predicting Onset of Disorders and Symptoms:** We tested whether scale scores were associated with risk of onset of a new depressive episode over the following 12 months, using Stata 11 [27]. For our prediction analyses, we related each item and factor score to the (binary) diagnostic outcomes. To provide a non-parametric estimate of the overall strength of this predictive relationship, we used Receiver Operating Characteristic (ROC) curve methods (roccomp on Stata 11). An area under the curve (AUC) AUC of 0.5 suggests the predictive properties of an item are no better than chance. AUC>0.5 suggests that presence of an item predicts the outcome of interest. AUC<0.5 suggests that presence of an item reduces the risk of the outcome of interest. We tested whether our scales predicted depressive symptoms (measured by the MFQ) at 12 month follow-up. The roccomp function was used to compare strength of association between predictors and depression onset.
Simple ROC methods do not allow for adjustment by other variables. We used multiple logistic and linear regression to test for whether rumination at baseline predicts onset of depression and 12 month depressive symptoms, controlling for the possible confounding variables of baseline depressive and anxiety symptoms and gender, age and pubertal stage; interaction terms were used to test whether effects of rumination were different between ages and between pubertal groups.

All participants gave written informed consent for clinical and questionnaire assessment and follow-up. Ethical approval was given by the Cambridge Local Research Ethics Committee.

**Results**

Descriptive statistics for the demographics of the sample and item sum questionnaire scores are presented in Table 1.

**Table 1**

**Factor Analysis of The RDQ, MFQ and RCMAS**

*Exploratory Factor Analysis (EFA) of RDQ, MFQ and RCMAS Items:* The six largest eigenvalues from the EFA were 20.6, 6.9, 4.7, 3.8, 2.5, 2.1 and 2.0. Inspection of the scree plot suggested a four or five factor solution. The six factor solution contained one
extra factor with relatively low determinacy (0.885); no items loaded highest on this extra factor, and all other items loaded onto the same factors as in the five factor solution.

*Confirmatory Factor Analysis (CFA) of RDQ, MFQ and RCMAS Items:* The four and five factor solutions were entered estimated as separate CFAs. Model fit was slightly better for the five than four factor solution (four factor: CFI 0.840, TLI 0.901, RMSEA 0.064; five factor: CFI 0.850, TLI 0.908; RMSEA 0.062). Additional file 2 shows results of the five factor CFA. The five factor solution was chosen as the most appropriate in view of best model fit. Item scores were summed for each of the five factors for inclusion in regression analyses.

There was a strong and interpretable pattern in the Promax-rotated results of the five factor solution from the joint factor analysis of pooled items from the RDQ, MFQ and RCMAS. 19 out of 21 rumination items loaded highest on factor 4 (Rumination Factor); 21 MFQ items, referring to emotional or cognitive symptoms of depression, loaded onto factor one (Cognitive Factor); 11 MFQ items, referring to more physiological and ‘melancholic’ symptoms of depression including poor concentration and anhedonia, 2 RDQ rumination items (‘I think about how hard it is to concentrate’ and ‘I think about my feelings of tiredness’) and one RCMAS-only item (‘It was hard for me to keep my mind on my schoolwork’) loaded highest on factor two (Somatic Factor); 22 out of 23 RCMAS-only items loaded highest on factor 3 (Anxiety Factor). All distraction and problem-solving items from the RDQ loaded highest on factor 5 (Adaptive Factor). Of the 5 RCMAS items also found in (and completed within) the MFQ, 3 (referring to
primarily cognitive/emotional symptoms) loaded highest on Cognitive factor and 2
(referring to primarily physiological symptoms) loaded highest on Somatic factor.

Inter-factor correlations for factor scores are presented in table 2, demonstrating
moderate-high associations between all factors except Adaptive.

**Table 2**

**Association Between Baseline Rumination and Onset of DSM-IV Depressive
Episode over Subsequent 12 Months**

*Prediction of Depression Onset:* 12 month follow-up data was available for 598 out of
658 (91%) participants. Younger cohort members less likely to be retained in the study
[mean(sd) 13.7(1.1) vs 14.6(1.2), \(Z = 5.5, p < 0.0005\)]. There were no major differences
in attrition by sex, pubertal group nor initial questionnaire scores (all \(p > 0.15\)). 62
(10.4%) had onset of a depressive episode.

Additional file 1 shows the ROC area under the curve (AUC) estimates for predicting
binary outcomes capturing depression onset over 12 months from all RDQ, MFQ items
and RCMAS items. Table 3 compares the AUCs for the scale scores from our factors.
Rumination, Cognitive, Somatic and Anxiety factors were all significantly associated
with risk of depression onset. High Rumination:Adaptive ratio was significantly
associated with risk of depression onset, although this association was not significantly different to Rumination alone (p = 0.8).

Only three pre/early pubertal participants had depression onset, so we were unable to test whether puberty moderated other risk factors. Age x Rumination interaction was non-significant (p = 0.3).

Table 3

Results of our multiple logistic regression for significant independent predictors of depression onset are shown in table 4. Higher Rumination was independently associated with risk of clinical depression episode onset (OR = 1.04, p = 0.035). There was a trend for higher Adaptive factor scores (distraction/problem-solving) to be associated with lower risk of depression onset (OR = 0.96, p = 0.053). MFQ factors, Anxiety, gender, age and pubertal group were not significantly independently associated with risk of depression onset.

The regression was repeated with the Rumination:Adaptive ratio included rather than separate Rumination and Adaptive factors. This Rumination:Adaptive ratio was significantly associated with risk of depression onset (OR = 1.25, p = 0.018). Model fit was marginally better for this regression (Akaike Information Criterion, AIC = 366.8) than the one with separate Rumination and Adaptive items (AIC = 367.6).
Table 4

Prediction of Depressive Symptoms (MFQ Scores) at 12 Month Follow-Up: Total MFQ scores at 12 months (MFQ12m) were available for 590 out of 658 (90%) participants. Table 2 demonstrates that our measures of baseline ruminative style, depressive symptoms and anxiety were strongly correlated with MFQ12m. High Adaptive was correlated with lower MFQ12m. Rumination was more strongly correlated with MFQ12m than Rumination:Adaptive ratio (z = 7.4, p < 0.0001).

Table 5 shows the results of multiple linear regression with MFQ12m as outcome variable (total n = 584). Rumination (β = 0.14, p < 0.0005), Cognitive, Somatic and Anxiety and female gender were significantly and independently associated with higher depressive symptoms at 12 months. The Adaptive factor, pubertal group and age were not significantly associated with higher depressive symptoms at follow-up.

In separate regressions, there were no significant interaction effects for Rumination with pubertal group nor age on MFQ12m (p > 0.5). Regressions were performed separately for pre/early-pubertal participants and mid/post-pubertal participants. Regression coefficients were similar for rumination in each (PEP: 0.13, MPP: 0.14).

Table 5 here
Discussion

Factor Structure of the RDQ, MFQ and RCMAS

We found that most of the RDQ rumination and MFQ depression items loaded onto separate factors in EFA, suggesting that these measure different, albeit quite correlated, constructs. We found the MFQ items at baseline capture two important dimensional factors, one with cognitive-emotional symptoms, the other with somatic-physical symptoms. However, we did not find any evidence for the discriminant validity of the two subtypes of depressive symptoms, so this statistical separation may not be clinically important. One factor (Anxiety) contained 22 RCMAS items and appears to be a measure of anxiety symptoms, that is separate to (but correlated with) rumination and depressive symptoms.

Unlike most previous research, including in adolescents (Burwell and Shirk, 2007), we found the rumination items in the RDQ scale to be essentially unidimensional. In addition, supplementary analysis (available from the 1st author on request) demonstrated no difference in predictive effect between ‘brooding’ and ‘reflecting’ items and that total rumination was more strongly associated with future depressive disorder and depressive symptoms than total score of ‘brooding’ items. One other study in adolescents had a similar finding of unidimensionality [14]. One study demonstrated that while brooding and reflecting factors are both identified in healthy adults, they are not in depressed adults [28]. Another adult study demonstrated no difference in correlation between depressive symptoms and brooding or reflection [29]. Such contradictory evidence
makes it unclear whether the RSQ should be treated as a unifactorial or multifactorial scale.

**Prediction of Depressive Disorder and Depressive Symptoms**

This study has confirmed previous findings that rumination increases the risk of future depression onset independently of baseline depressive symptoms. In addition, this study has demonstrated that this effect is independent of another potential confounder – baseline anxiety symptoms. This suggests that, as predicted, a ruminative style of responding to low mood does in itself make people more prone to developing depression, rather than simply being a proxy measure of depressive and/or anxiety symptoms.

**Distraction and Problem-Solving Response Styles**

EFA replicated prior findings that distraction and problem-solving items are most appropriately treated as lying on a single factor. We found a trend for greater use of these adaptive strategies to confer resilience against risk of onset of depression. Rumination:Adaptive ratio was not a stronger predictor of depression/depressive symptoms than Rumination alone, therefore we did not find evidence that Adaptive strategies significantly mitigated the effects of Rumination. However, we still believe it is worthwhile to include these items in larger longitudinal research to test whether they reduce depression risk over time.
**Pubertal Stage and Rumination**

There was no evidence that either pubertal stage or age moderated the effects of rumination on depressive symptoms. This may reflect the relatively narrow age range of the sample (12-16) and the fact that more than 80% of the sample were in mid-late puberty. This suggests that a sample with a wider age range is needed to disentangle the effects of puberty and age on rumination.

**Limitations**

A major limitation of this study is that the sample was of adolescents at risk for depression, and so results may not be generalizable to the whole population; however, understanding the roles of these cognitive styles in those at high risk for depression will help us in developing appropriate interventions for adolescents at greatest risk. Our study was also limited by the lack of power resultant from an incidence of depressive episode onset of only 10%, despite a risk-enriched sample. Our sample was aged 12-16, and this may explain why we were unable to find significant moderating effects of age or puberty on rumination.

**Clinical Implications and Conclusions**

This study has demonstrated that a ruminative style of responding to low mood is indeed unhelpful and increases the risk of developing depressive disorders. Therapy that reduces rumination may thereby reduce the risk of subsequent emotional disorders. This study also provides some preliminary support for further investigating whether increasing the
use of distraction/problem-solving response styles reduces risk of onset of depressive disorders. Cognitive-behavioural therapy (CBT) has been shown to reduce rumination in currently-depressed adolescents [30]. Ruminating-focused CBT reduces both depressive symptoms and rumination in adults in partial remission from depression [31]. The current findings support further investigations into the efficacy and effectiveness of a psychological treatment that reduces ruminative thinking style and promotes cognitive resilience in adolescents at risk for or suffering from depressive disorders.

**List of Abbreviations**

RDQ: Responses to Depression Questionnaire

MFQ: Mood and Feelings Questionnaire

RCMAS: Revised Children's Manifest Anxiety Scale

K-SADS-L: Lifetime Schedule for Affective Disorders and Schizophrenia for Adolescents

EFA: Exploratory Factor Analysis

ROC: Receiver Operating Characteristic

AUC: Area Under the Curve

OR: Odds Ratio

AIC: Akaike Information Criterion

PEP: Pre/Early-Pubertal

MPP: Mid/Post-Pubertal
Competing Interests

None of the authors have competing interests.

Authors’ Contributions

POW analysed the data and wrote the first draft of the manuscript. IMG designed the study and contributed to the writing of the manuscript. TJC supervised statistical analysis and contributed to the writing of the manuscript.

Acknowledgements

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References

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Table 1  Characteristics of final sample at study entry and MFQ at follow-up

<table>
<thead>
<tr>
<th></th>
<th>Boys (n=338, 57%)</th>
<th>Girls (n=260, 43%)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Age</strong></td>
<td>13.7 (1.2)</td>
<td>13.7 (1.1)</td>
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<tr>
<td><strong>Pubertal status at entry</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pre/early-puberty</td>
<td>66 (19.6%)</td>
<td>19 (7.4%)</td>
</tr>
<tr>
<td>Mid/post-puberty</td>
<td>271 (80.4%)</td>
<td>238 (92.6%)</td>
</tr>
<tr>
<td><strong>Initial scores at study entry</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MFQ</td>
<td>17.2 (8.7)</td>
<td>19.1 (9.4)</td>
</tr>
<tr>
<td>Rumination</td>
<td>13.8 (9.3)</td>
<td>17.3 (10.4)</td>
</tr>
<tr>
<td>Distraction</td>
<td>12.1 (5.2)</td>
<td>13.4 (6.3)</td>
</tr>
<tr>
<td>Problem-solving</td>
<td>3.4 (2.3)</td>
<td>4.5 (2.7)</td>
</tr>
<tr>
<td>RCMAS</td>
<td>16.6 (8.0)</td>
<td>17.7 (8.7)</td>
</tr>
<tr>
<td><strong>Follow-up at 12 months</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MFQ</td>
<td>14.0 (8.4)</td>
<td>16.5 (10.1)</td>
</tr>
</tbody>
</table>

All entries are mean (standard deviation) unless stated otherwise

MFQ = Mood and Feelings Questionnaire, RCMAS = Revised Children's Manifest Anxiety Scale.
### Table 2  Pairwise correlations between factor item totals at study entry and MFQ scores at 1 year follow-up

<table>
<thead>
<tr>
<th></th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
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<tbody>
<tr>
<td>1. Rumination</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Adaptive</td>
<td>0.24*</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. Cognitive</td>
<td>0.42*</td>
<td>0.03</td>
<td>1</td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>4. Somatic</td>
<td>0.41*</td>
<td>0.10*</td>
<td>0.54*</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. Anxiety</td>
<td>0.54*</td>
<td>0.05</td>
<td>0.55*</td>
<td>0.55*</td>
<td>1</td>
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<td></td>
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<tr>
<td>6. Rumination : Adaptive Ratio</td>
<td>0.55*</td>
<td>-0.39*</td>
<td>0.25*</td>
<td>0.20*</td>
<td>0.35*</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>7. MFQ at 12 months</td>
<td>0.49*</td>
<td>0.10*</td>
<td>0.55*</td>
<td>0.51*</td>
<td>0.60*</td>
<td>0.26*</td>
<td>1</td>
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</table>

* p < 0.05

Items 1-6 are total factor scores, as described in the text
Table 3 Prediction of depression outcomes over one year from factor scores of mid/post-pubertal participants

<table>
<thead>
<tr>
<th>Factors Derived from Five Factor EFA</th>
<th>Area Under the Curve</th>
<th>Asymptotic 95% confidence interval</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rumination</td>
<td>0.681</td>
<td>0.612 – 0.750 *</td>
</tr>
<tr>
<td>Adaptive</td>
<td>0.472</td>
<td>0.393 – 0.551</td>
</tr>
<tr>
<td>Cognitive</td>
<td>0.710</td>
<td>0.649 – 0.772 *</td>
</tr>
<tr>
<td>Somatic</td>
<td>0.671</td>
<td>0.599 – 0.742 *</td>
</tr>
<tr>
<td>Anxiety</td>
<td>0.681</td>
<td>0.609 – 0.753 *</td>
</tr>
<tr>
<td>Rumination : Adaptive Ratio</td>
<td>0.687</td>
<td>0.617 – 0.756 *</td>
</tr>
</tbody>
</table>

* 95% confidence interval of AUC does not include 0.5
Table 4  Multiple logistic regression analysis demonstrating the contribution of cognitive styles and initial symptom levels to liability of clinical depression episode onsets over 12 months

<table>
<thead>
<tr>
<th></th>
<th>Coefficient</th>
<th>Odds Ratio</th>
<th>95% CI of OR</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rumination</td>
<td>0.03</td>
<td>1.04</td>
<td>1.00 – 1.07</td>
<td>0.035</td>
</tr>
<tr>
<td>Adaptive</td>
<td>-0.04</td>
<td>0.96</td>
<td>0.92 – 1.00</td>
<td>0.053</td>
</tr>
<tr>
<td>Cognitive</td>
<td>0.04</td>
<td>1.04</td>
<td>0.99 – 1.09</td>
<td>0.15</td>
</tr>
<tr>
<td>Somatic</td>
<td>0.07</td>
<td>1.08</td>
<td>0.99 – 1.17</td>
<td>0.071</td>
</tr>
<tr>
<td>Anxiety</td>
<td>0.02</td>
<td>1.02</td>
<td>0.97 – 1.07</td>
<td>0.5</td>
</tr>
<tr>
<td>Gender</td>
<td>0.33</td>
<td>1.40</td>
<td>0.77 – 2.54</td>
<td>0.3</td>
</tr>
<tr>
<td>Age (years)</td>
<td>-0.07</td>
<td>0.93</td>
<td>0.72 – 1.20</td>
<td>0.6</td>
</tr>
<tr>
<td>Pubertal group</td>
<td>1.12</td>
<td>3.08</td>
<td>0.88 – 10.7</td>
<td>0.077</td>
</tr>
</tbody>
</table>
Table 5  Multiple linear regression analysis demonstrating the contribution of cognitive styles and baseline symptoms to MFQ score at 12 month follow-up

<table>
<thead>
<tr>
<th></th>
<th>β Coefficient</th>
<th>95% CI of β</th>
<th>t</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rumination</td>
<td>0.14</td>
<td>0.07 – 0.22</td>
<td>3.7</td>
<td>&lt;0.0005</td>
</tr>
<tr>
<td>Adaptive</td>
<td>0.02</td>
<td>-0.05 – 0.10</td>
<td>0.6</td>
<td>0.5</td>
</tr>
<tr>
<td>Cognitive</td>
<td>0.34</td>
<td>0.22 – 0.46</td>
<td>5.6</td>
<td>&lt;0.0005</td>
</tr>
<tr>
<td>Somatic</td>
<td>0.33</td>
<td>0.16 – 0.49</td>
<td>3.9</td>
<td>&lt;0.0005</td>
</tr>
<tr>
<td>Anxiety</td>
<td>0.41</td>
<td>0.30 – 0.52</td>
<td>7.2</td>
<td>&lt;0.0005</td>
</tr>
<tr>
<td>Gender</td>
<td>1.26</td>
<td>0.04 – 2.48</td>
<td>2.0</td>
<td>0.043</td>
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<tr>
<td>Age</td>
<td>0.11</td>
<td>-0.42 – 0.64</td>
<td>0.4</td>
<td>0.7</td>
</tr>
<tr>
<td>Pubertal status</td>
<td>-0.69</td>
<td>-2.45 – 1.06</td>
<td>-0.8</td>
<td>0.4</td>
</tr>
</tbody>
</table>
Additional files provided with this submission:

Additional file 1: Rumination Additional File 1.docx, 30K
http://www.biomedcentral.com/imedia/1055403513700101/supp1.docx
Additional file 2: Rumination Additional File 2.docx, 20K
http://www.biomedcentral.com/imedia/1789649317001013/supp2.docx