

The combined influence of cognitions in adolescent depression: biases of interpretation, self evaluation and memory

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Abstract

Objectives: Depression is characterised by a range of systematic negative biases in thinking and information processing. These biases are believed to play a causal role in the aetiology and maintenance of depression, and it has been proposed that the combined effect of cognitive biases may have greater impact on depression than individual biases alone. Yet little is known about how these biases interact during adolescence when onset is most common.

Methods: In the present study adolescents were recruited from the community ($n = 212$) and from a child and adolescent mental health service ($n = 84$). Participants completed measures of depressive symptoms, interpretation bias, self evaluation and recall memory. These included the Mood and Feelings Questionnaire, Ambiguous Scenarios Test for Depression in Adolescents, Self Description Questionnaire and an immediate recall task. The clinically referred sample also took part in a formal diagnostic interview.

Results: Individual cognitive biases were significantly inter-correlated, and associated with depression severity. The combination of cognitive biases was a stronger predictor of depression severity than individual biases alone, predicting 60% of the variance in depression severity across all participants. There were two significant predictors, interpretation bias and negative self evaluation; however, almost all of the variance was explained by negative self evaluation.

Conclusions: The findings support the interrelationship and additive effect of biases in explaining depression and suggest that understanding the way in which cognitive biases interact could be important in advancing methods of identification, early intervention and treatment.

Practitioner Points

- A combination of biases was a better predictor of depression symptom severity than individual biases
- Interpretation and self evaluation were better predictors of depression symptom severity than recall
- Negative self evaluation was the strongest individual predictor of depression symptom severity
- Negative self evaluation was able to classify depressed from non-depressed adolescents
- The cross-sectional design of the study precludes any conclusions about the potential causal role of these variables
- Different tasks were used to assess different types of cognitive bias meaning that the possible linear operation along an information processing 'pathway' could not be examined

Keywords: depression; adolescence; cognition; bias

People who are depressed tend to show systematic biases in thinking which affect all stages of information processing (Phillips, Hine, & Thorsteinsson, 2010; Vasey, Dalglish, & Silverman, 2003) including attention, interpretation of ambiguous information, memory, decision-making and reasoning (e.g. Gotlib & Joorman, 2010; Jacobs, Reinecke, Gollan, & Kane, 2008). Cognitive biases are hypothesised to play a key role in the aetiology of depression (Jacobs et al., 2008) and are observed across the life span (e.g. Gotlib & Joorman, 2010; Platt, Waters, Schulte-Koerne, Engelmann, & Salemink, 2017). They typically present as the absence of a positive bias and the presence of a negative bias. In clinical settings a range of treatments target negative cognitive biases through direct therapy, and experimental studies have demonstrated that negative cognitive biases can be modified by training (Cristea, Kok, & Cuijpers, 2015; Hallion & Ruscio, 2011; Hertel & Mathews, 2011).

Research on cognitive biases has typically examined biases in isolation from each other. Hirsch, Clark and Mathews (2006) proposed that cognitive biases influence each other and that the combined effect of cognitive biases may have greater impact on the maintenance of social anxiety disorder than if individual biases were functioning alone. Everaert, Koster and Derakshan (2012) reviewed research on the combined effect of cognitive biases on depression. They concluded that studies using different methods (correlational and experimental) tended to support the hypothesis that cognitive biases are inter-correlated (Ellis, Beevers, & Wells, 2011; Koster, De Raedt, Leyman, & De Lissnyder, 2010; Wells, Beevers, Robison, & Ellis, 2010) and that manipulating the interpretation of ambiguous scenarios can alter the recall of these scenarios (Salemink, Hertel, & Mackintosh, 2010; Tran, Hertel, & Joorman, 2011). Subsequently there has been further experimental support for the hypothesis that cognitive biases have an effect on each other (e.g. Blaut, Paulewicz, Szastok, Prochwicz, & Koster, 2013; Ellis, Wells, Vanderlind, & Beevers, 2014; Everaert, Duyck, & Koster, 2014; Everaert, Tierens, Uzieblo, & Koster, 2013). For example, Blaut et al. (2013)

compared memory bias in undergraduates with elevated depression, who had and had not received training to change their attentional bias. Those who received the attention bias training did not subsequently display a memory bias, whereas those in the control condition did display a bias. Steps have also been made towards identifying a pathway between biases. Everaert et al. (2013) found some evidence of an indirect effect of attentional bias on memory bias, via interpretation bias. There is also some evidence that cognitive biases predict future mental health symptoms. In a one year longitudinal study, Everaert, Duyck and Koster (2015) found that the cognitive process with the strongest negative bias was a better predictor of future depression symptoms than the additive effect of four different types of bias. The strongest negative bias also significantly improved the prediction of depression severity after including initial depression severity and perceived stress.

The combined cognitive bias hypothesis has a number of important implications for the development of effective interventions to modify cognitive biases, and more importantly to reduce symptoms of depression and low mood, and improve functioning. As yet there is no evidence that these cognitive bias interventions reduce symptoms of depression in either adults (Cristea, Kok & Cuijpers, 2015; Hallion & Ruscio, 2011) or adolescents (Cristea, Mogoase, David & Cuijpers, 2015). However, research evidence is still emerging and may inform the development of alternative intervention methods that have greater impact on symptoms. For example if negative attentional bias is primary and influences both interpretation bias and memory bias in individuals (Blaut et al., 2013; Everaert et al., 2013), it may be most effective to target and change negative attention bias in preference to interpretation bias or memory bias. In contrast, if it is each individual's most dominant negative bias that best predicts future depression symptoms, rather than their combination or any specific bias (Everaert et al., 2015), then the target of any intervention designed to prevent or reduce depression would be best decided on the basis of an individual's profile and

the relative strength of their cognitive biases.

The potential role of cognitive biases also has important implications for prevention and treatment of adolescent depression. Depression is highly prevalent during adolescence (Thapar, Collishaw, Pine, & Thapar, 2012), and has long-term adverse effects on functioning and health (e.g. Bridge, Goldstein, & Brent, 2006; Fergusson, Boden, & Horwood, 2007; Halperin, Rucklidge, Powers, Miller, & Newcorn, 2011; Rudolph & Klein, 2009).

Adolescence is a transitional period marked by major and rapid changes in biological, psychological and social status (Steinberg, 2010). Social and academic demands significantly increase during adolescence and peer relationships and social comparison with peers become much more salient to adolescents. Rapid cognitive changes during adolescence are observed in parallel with major neural development in the prefrontal cortex (Blakemore, 2012). Many researchers and clinicians have speculated that the onset of depression during adolescence is triggered by a combination of age-specific changes (e.g. Hankin, 2006; Thapar et al., 2012). Given these clear and important distinctions between adolescents and adults it is important not to routinely apply adult models of depression to adolescents without clear empirical support that this is justified.

There is evidence that a range of cognitive biases are associated with depression and low mood during adolescence (Orchard, Pass, & Reynolds, 2016b; Platt et al., 2017). However, the specific way in which cognitive biases interact across development is not understood and amongst adolescents, for whom cognitive development is ongoing, depressive cognitive biases may precede, amplify, consolidate or impede the development and maintenance of depression and low mood (Raes, Verstraeten, Bijttebier, Vasey, & Dalgleish, 2010; Wagner, Müller, Helmreich, Huss, & Tadić, 2015).

Negative cognitive biases are proposed to interact and predict severity of depression amongst adolescents (Auerbach, Stanton, Proudfit, & Pizzagalli, 2015; Chan, Goodwin, &

Harmer, 2007; Dalgleish et al., 2003). Platt et al. (2017) highlight that relatively little research has been conducted with adolescents, particularly with adolescents who have elevated symptoms of depression or have a diagnosis of depression. Recently Klein, de Voogd, Wiers and Saleminck (2017) assessed attention and interpretation bias in adolescents recruited from the community. Biases in attention and interpretation explained small but significant variance in severity of depression and anxiety symptoms.

Beck and colleagues (1967; Beck, Rush, Shaw, & Emery, 1979) identified a key cognitive bias that was a core characteristic of depression – negative self evaluation (Jacobs et al., 2008). Consistent with this, negative self evaluation is one of the most common symptoms of depression in adolescents (Goodyer et al., 2017; Orchard, Pass, Marshall, & Reynolds, 2017). Negative self evaluation in adolescents is particularly salient given that this is a period of when individuals face increasing academic and social demands, engage in social comparison with their peers, and begin to develop and consolidate a sense of ‘self’. Surprisingly perhaps negative self evaluation bias has rarely been examined in relation to depression generally, or specifically in relation to depression amongst adolescence.

The primary objective of the current study was to explore associations between different cognitive biases and depression severity, and to examine whether a combination of cognitive biases is a better predictor of depression than individual cognitive biases. We measured three cognitive biases: interpretation bias, self evaluation bias, and recall memory bias. These were assessed in adolescents recruited from a community and clinical setting. We hypothesised that:

1. Interpretation, self evaluation and memory biases would be positively inter-correlated, and each would be correlated with severity of depression.
2. The combination of three cognitive biases would account for significantly more variance in depression severity than individual biases alone.

3. The combination of cognitive biases would be a better predictor of diagnostic status in the clinically referred sample than individual biases alone.

Method

Participants

Two hundred and ninety six participants aged 12-18 years were recruited from schools in Berkshire and West London, UK, and through referrals for depression to the specialist Anxiety and Depression pathway of a local Child and Adolescent Mental Health Service in the UK. Sample sizes were determined on the basis of the medium to large effect sizes found in Bradley, Mogg and Williams (1995) and Borna et al. (2011); 75 participants were required to conduct correlational analyses and multiple regression models (effect size $r = .04$; power 95%). A larger sample was recruited from the community in order to include a range of individuals experiencing symptoms of depression.

Table 1. Sample Characteristics of Clinically Referred Sample and Community Sample

		Clinic (N = 84)	Community (N = 212)	
Age	Mean (SD)	15.81 (1.10)	16.12 (1.23)	$t(167.35) = -2.06, p = .04$
	Range	13.24 – 17.58	12.48 – 18.61	
Gender	% Female	86%	68%	$\chi^2 (1) = 8.49, p < .01$
MFQ-C	Mean (SD)	37.83 (12.91)	17.82 (12.83)	$t(285) = 11.96, p < .001$
	Range	11 – 60	0 – 59	

NB. MFQ-C: Mood and Feelings Questionnaire- Child Version; SD: Standard Deviation

Characteristics of the community and clinic groups are shown in Table 1. The mean age of participants in the clinically referred and community samples were comparable,

although a higher proportion of females were recruited from the clinic, reflecting the typically higher rates of depression reported amongst girls and women compared with boys and men (Angold et al., 1996; Angold, Erkanli, Silberg, Eaves, & Costello, 2002). As expected, on average, the clinically referred group reported significantly more symptoms of depression than those recruited from the community. Some of the young people recruited from the community reported high levels of depression; 46 had depression scores above the clinical cut off of 27 on the Mood and Feelings Questionnaire (Wood, Kroll, Moore, & Harrington, 1995).

Recruitment

Clinically referred sample. Eighty-four young people consented and took part in the study. They were recruited through consecutive referrals for depression to the specialist Anxiety and Depression pathway of a local Child and Adolescent Mental Health Service (CAMHS) in the UK. Adolescents and their parent/caregiver(s) attended an initial assessment where they completed diagnostic interviews and research measures.

Community sample. Two hundred and twelve adolescents were recruited. Most were recruited through schools ($n = 175$). Letters were sent to head teachers requesting permission to conduct research at the school. Once approval was obtained, information packs were provided for adolescents and parents describing the study and its purpose. An additional thirty-seven adolescents were recruited by advertisement. Adolescents completed research measures at school, at home or in the laboratory (depending on recruitment). Unlike the clinically referred sample, they did not complete diagnostic interviews.

Ethical Approval

Data collection was approved by the University of Reading and Berkshire NHS Research Ethics Committee (13/SC/0485). Informed consent was obtained from all individual participants included in the study. In the clinically referred sample, participants aged 16-17

years provided informed written consent and adolescents aged 12-15 years provided informed written assent, and consent was given by a parent. In the community sample, young people provided informed consent if they were over 16 years. For adolescents aged 12-15 years, parents provided informed opt-out consent and young people provided informed assent. None of the parents that were approached chose to opt out of the study.

All measures collected in this research have been reported here. Results from interpretation bias measures have been published independently elsewhere to demonstrate development of the measure, and the presence of these biases in an adolescent population (Orchard, Pass & Reynolds, 2016a, 2016b).

Measures

Measures of symptom and diagnostic status. The Mood and Feelings Questionnaire – Child Version (MFQ-C; Costello & Angold, 1988) was used to measure depressive symptoms in all participants. It is a 33-item self-report scale of depressive symptoms which has good psychometric properties (Burleson Daviss et al., 2006). Each symptom is rated on a 3-point scale from 0 (not true) to 2 (true). In this study internal consistency for the MFQ was excellent (MFQ-C $\alpha = .96$).

Adolescents in the clinically referred sample (but not the community sample) were also assigned diagnoses based on the Kiddie Schedule of Affective Disorders and Schizophrenia (K-SADS; Kaufman et al., 1997), a semi-structured diagnostic interview for DSM-IV affective disorders and schizophrenia, with well-established psychometric properties (Kaufman et al., 1997). As is conventional, the interview was conducted with adolescents and caregivers separately, and diagnoses were based on information obtained from both interviews. Assessors (psychology graduates) were trained on the standard administration and scoring of the K-SADS through verbal instruction, listening to assessment audio-recordings and participating in diagnostic consensus discussions. Competence was

evaluated with reference to the assessors' ratings of a standard assessment recording. Once trained, all diagnoses were double-rated by both the assessor and an experienced member of the assessment team. Inter-rater reliability for K-SADS diagnoses overall was $\kappa = .97$ and reliability for depression diagnosis specifically was $\kappa = 1.00$. Information on the diagnoses assigned to the clinically referred group can be found in Table 2.

Table 2. Diagnostic characteristics of clinically referred sample ($n = 82$)

Psychiatric diagnoses primary (overall, %)

Major depressive disorder	37.8 (40.2)
Social anxiety disorder	8.5 (25.6)
Generalised anxiety disorder	8.5 (17.1)
Schizoaffective depressive disorder	2.4 (2.4)
ADNOS	2.4 (3.7)
Separation anxiety disorder	1.2 (1.2)
Obsessive compulsive disorder	1.2 (1.2)
Panic with agoraphobia	0 (1.2)
No diagnosis	37.8

NB. ADNOS: Anxiety disorder not otherwise specified

Measures of cognitive bias.

Interpretation Bias. The Ambiguous Scenarios Test for Depression in Adolescents (AST-DA; Orchard et al., 2016a) is an adolescent-specific 20-item measure. Each item consists of a scenario (e.g. “Your best friend convinces you to go on a blind date and as you sit and wait to meet your date, you think about how it will go”). Participants are instructed to (a) generate and describe an imagined outcome to each scenario and (b) rate the imagined

outcome for pleasantness on a 9-point Likert scale (from 1 = *Extremely unpleasant*; to 9 = *Extremely pleasant*). A mean pleasantness rating across the 20 scenarios was calculated for each participant. Internal consistency for pleasantness ratings was good ($\alpha = .86$). Written responses were coded into one of four response categories: positive, negative, neutral and mixed. Coding was conducted by two independent raters; inter-rater reliability was assessed on 10% of the sample and was excellent ($k = 0.89$). Proportions of positive and negative responses for each participant were computed. Neutral and mixed categories were not analysed due to the low frequency of these codes.

Self Evaluation. Participants completed a 30-item Self-Description Questionnaire (Kelvin, Goodyer, Teasdale, & Brechin, 1999) which includes 12 positive adjectives (lovable, amusing, confident, bright, trustworthy, interesting, cheerful, kind, friendly, respected, skilful, successful), 12 negative adjectives (weak, pathetic, feeble, stupid, pitiful, failure, unwanted, useless, incapable, loser, foolish, worthless), and 6 neutral adjectives. The order of the positive and negative adjectives was randomised and two different randomised versions of the questionnaire were created. Neutral adjectives were placed at the start and end of each questionnaire to prevent primacy and recency memory effects in the recall task (detailed below), and were not included in analyses. Participants were asked to read each adjective one at a time and to rate each to indicate how well it described them; 0 (not at all like me) to 3 (very much like me). Participant's mean scores were computed for the 12 positive words and the 12 negative words.

Incidental Recall Memory. Immediately after completing the Self-Description Questionnaire, the questionnaire was removed and participants were asked to complete a surprise recall task. They were instructed to recall and write down as many of the words from the questionnaire as possible. These were not required to be recalled in the same order as presentation and there was no time limit. Recall memory was measured as the number of

correct positive and negative words that each participant recalled.

Procedure

All adolescents completed the self-report measure of depression, followed by the ambiguous scenarios questionnaire, self-description questionnaire and recall memory task. All measures were administered via paper and pencil. In the clinically referred sample, these measures were completed following the diagnostic interview. The recall task always followed the self-description questionnaire in order to conduct immediate, surprise recall. However, the presentation of these two tasks and the ambiguous scenarios questionnaire was randomized across participants. A member of the research team was always present.

Results

Preliminary analyses and analytic plan

Participant data on each measure was excluded if more than 25% of the responses were missing. Participants were included in analyses if they had sufficient data on the MFQ and at least one measure of cognitive bias; 256 participants had complete data on all measures, and 286 participants had complete data on the MFQ and at least one measure of cognitive bias.

Continuous data were screened in relation to the assumptions of parametric tests (Tabachnick & Fidell, 2007). Where assumptions were violated, confirmatory analyses were conducted by running analyses with 1000 bootstrap samples. All results were consistent, suggesting that the original analyses were robust to the violations of assumptions. For simplicity, results based on the original (non-bootstrapped) analyses are presented below.

Depression was analysed as a continuous and dichotomous variable. MFQ score provided a continuous measure in both groups. In the clinically referred sample, participants were also classified on the basis of their diagnosis; those that did have depression as a primary or secondary diagnosis ($n = 33$), and those that did not meet diagnostic criteria for

depression ($n = 49$) (see Table 2). Cognitive bias variables were all continuous. These were proportion of positive interpretations, proportion of negative interpretations, mean pleasantness ratings of ambiguous scenarios, mean positive self evaluation, mean negative self evaluation, total positive recall and total negative recall score.

Hypotheses were tested using correlations and regression models. Correlational analyses were used to investigate bivariate associations between variables, and regression models were used to explore multivariate relationships and test the hypothesis relating to prediction of depressive symptomatology and depression diagnoses by cognitive biases. Uncorrected p values are reported, however, even using the most conservative correction (i.e. Bonferroni for all analyses) all results remain significant.

Hypothesis testing

Associations between cognitive biases and depression symptomatology. As hypothesised and predicted by the cognitive model, depression severity amongst all participants (MFQ score) was correlated with positive and negative interpretations, pleasantness ratings, positive and negative self evaluation, and positive recall (Table 3). There was no association between negative recall and severity of depression. Most of the cognitive bias measures were significantly correlated with each other, and all significant associations between biases scores remained after partialling out MFQ score.

As pleasantness ratings correlated so highly with positive and negative interpretations, and are likely to be measuring a similar construct, pleasantness ratings were not used in subsequent analyses. The positive and negative interpretation ratings were retained so that both the absence of positive bias and presence of negative bias could be examined as predictors of depression.

Table 3. Descriptive statistics and inter-correlations between cognitive measures, age and depressive symptoms amongst all participants (N = 286)

	Age	MFQ	Positive Interpretations	Negative Interpretations	Mean Pleasantness	Positive Self Evaluation	Negative Self Evaluation	Positive Recall	Negative Recall
Mean	16.04	23.61	0.38	0.42	5.13	1.54	0.72	4.70	4.11
(SD)	(1.20)	(15.72)	(0.18)	(0.20)	(1.13)	(0.51)	(0.60)	(2.10)	(2.05)
Age	-								
MFQ	-.06	-							
Positive Interpretations	.11	-.57*	-						
Negative Interpretations	.11	.62*	-.81*	-					
Mean Pleasantness	.05	-.59*	.81*	-.85*	-				
Positive Self Evaluation	.02	-.42*	.54*	.54*	.48*	-			
Negative Self Evaluation	-.13	.73*	-.54*	.58*	-.53*	-.48*	-		
Positive Recall	.15	-.21*	.21*	-.22*	.17	.16	-.28*	-	
Negative Recall	.04	.05	.02	-.01	.02	-.03	.05	.27*	-

NB. * $p < .001$; MFQ: Mood and Feelings Questionnaire; SD: Standard Deviation

Predicting depression symptomatology. Next, a hierarchical multiple regression with MFQ score as the dependent variable was conducted. In the first step, gender and age were entered. In the second step, positive interpretation, negative interpretation, positive self evaluation, negative self evaluation, positive recall and negative recall were entered as predictors (see Table 4). The first step was significant, and predicted 9% of the variance in depression severity, with gender associated with severity of depression. The second step, i.e. the combination of cognitive bias variables predicted an additional 51% of the variance in depression severity. However, only two cognitive bias measures, negative interpretation and negative self evaluation, were significant independent predictors of depression severity. Positive interpretation, positive self evaluation, positive recall and negative recall did not contribute to the prediction of severity of depression.

Table 4. Multiple regression model of cognitive bias scores predicting depressive symptoms (MFQ) amongst all participants (N = 256)

Model	<i>F</i>	<i>df</i>	<i>R</i> ²	ΔR^2	<i>B</i> (95% CI)	<i>r</i> _s	<i>t</i>
Step 1	11.72	2, 248	.09	-			
Gender					-.30 (-.40, -.16)	-.29	-4.74**
Age					-.12 (-.23, .00)	-.12	-1.95
Step 2	44.94*	8, 248	.60	.59*			
Gender					-.14 (-.22, -.05)	-.13	-3.11*
Age					.01 (-.07, .09)	.01	0.21
Positive interpretation					-.06 (-.19, .09)	-.03	-0.76
Negative interpretation					.23 (.08, .36)	.13	3.06*
Positive self evaluation					.02 (-.08, .12)	.02	0.44
Negative self evaluation					.56 (.46, .67)	.43	10.49**
Positive recall					.02 (-.07, .10)	.02	0.37
Negative recall					.03 (-.05, .11)	.03	0.77

NB. **p* < .01; ***p* < .001; CI: Confidence Interval

To identify if the variance explained by all cognitive bias scores, was greater than that of the variance explained by individual cognitive bias scores, we report r^2 values for the association between depression severity, and negative interpretation and negative self evaluation (as these were the only significant predictors in the model above). Negative interpretation had an associated r^2 of .39, and negative self evaluation had an r^2 of .53.

Table 5. Logistic regressions examining the contribution of cognitive variables and severity of depression to the prediction of diagnostic status

	<i>b</i> (Wald statistic)	Odds Ratio (95% CI)	R ²	Model
Cognitive variables model				
Step 1				
Constant	3.86 (0.93)			
Gender	0.33 (0.19)	1.39 (0.31-6.15)	.03 (Cox&Snell)	$X^2(2) = 1.82$
Age	-.029 (0.93)	0.75 (0.46-1.21)	.04 (Nagelkerk)	
Step 2				
Negative interpretation bias	0.03 (1.91)	1.03 (0.99-1.07)	.21 (Cox&Snell)	$X^2(2) = 12.97^{**}$
Negative self evaluation	1.30 (4.25)*	3.67 (1.07- 12.61)	.29 (Nagelkerk)	
MFQ model				
Step 1				
Constant	1.35 (0.16)			
Gender	0.73 (1.05)	2.08 (0.51-8.41)	.02 (Cox&Snell)	$X^2(2) = 1.83$
Age	-0.15 (0.53)	0.86 (0.57-1.30)	.03 (Nagelkerk)	
Step 2				
MFQ	0.10 (13.37)***	1.10 (1.05-1.16)	.23 (Cox&Snell) .31 (Nagelkerk)	$X^2(1) = 19.10^{***}$

NB. * $p < .05$; ** $p < .01$; *** $p < .001$; CI: Confidence Interval

Predicting depression diagnosis. To test the hypothesis that a combination of cognitive biases would significantly identify individuals with a diagnosis of major depressive disorder, we conducted a multiple logistic regression model on the clinically referred sample, with depression diagnostic status (depressed: not depressed) as the dependent variable. Gender and age were entered as predictors in the first step, and negative interpretation and negative self evaluation were included in the second step. The demographic variables correctly classified 60% of the group; this was not a significant model (Table 5). The addition of the cognitive bias scores correctly classified 71% of the group, only negative self evaluation was a significant predictor (Table 5). Although not a planned hypothesis, for comparison, we conducted a post hoc analysis to test how well the MFQ score predicts diagnostic status. Using a simple logistic regression, MFQ was a significant predictor and correctly classified 70% of the group (Table 5).

Discussion

In a large sample of young people recruited from clinical and community settings we examined the relationship between cognitive biases in interpretation, self evaluation and recall memory with severity of depression and diagnostic status. Individual cognitive biases were significantly inter-correlated, as predicted by the combined cognitive bias hypothesis and consistent with research with adults (Everaert et al., 2012; Hirsch et al., 2006). Cognitive biases (except negative recall memory) were also significantly correlated with severity of depression. As predicted by Hirsch et al.'s (2006) combined cognitive biases hypothesis, the combination of cognitive biases was a stronger predictor of depression severity than individual biases alone. Overall the combined cognitive biases predicted 60% of the variance in depression severity across all participants. There were two significant predictors, interpretation bias and negative self evaluation. In the clinically referred sample, we then examined the extent to which cognitive biases predicted depression diagnosis. The

combination of the two significant cognitive biases correctly predicted 71% of cases compared with a standard measure of depression symptoms (the MFQ), which correctly predicted 70% of cases.

The cognitive theory of depression (Beck, 1967) proposes that interpretation bias and negative self evaluation are core processes underlying and maintaining depression. Research supports a relationship between interpretation bias and depression in adults (Gotlib & Joorman, 2010) and adolescents (Platt et al., 2017). However, the association between negative self evaluation and depression is rarely examined in adults or adolescents. In this study, negative self evaluation was the strongest predictor of depression severity in young people, with a large effect size ($r = .73$, explaining 53% of the variance). This effect size is comparable to the correlation between two measures of depression ($r = .78$; Orchard et al., 2017)¹. Although the combination of biases significantly predicted severity of depression symptoms and diagnostic status, the combination of biases added only 7% to the variance predicted by negative self evaluation.

This study is distinctive in its focus on adolescents – a group who are at increased risk of depression and for whom depression presents a significant risk to future well-being and functioning. Despite the obvious and many differences between adolescents and adults, depression research and treatment continues to be dominated by models developed and designed on the basis of adults' experiences. It is essential to establish to what extent these models are appropriate for, or can be adapted to meet the needs of young people. In this study the inclusion of self evaluation as a cognitive bias reflects both the original cognitive theory of depression, and addresses a key developmental feature of adolescence, the emergence and consolidation of self-concept (Sebastian, Burnett, & Blakemore, 2008). Arguably, this measure may have the greatest risk of being confounded with depressive symptoms as it

¹ We thank an anonymous reviewer for making this observation

relies on participant's endorsement of positive and negative adjectives as self-descriptive. As such, future research would benefit from examining the relationship between self evaluation and depression symptoms in young people in more detail. It would be particularly useful to explore how young people describe themselves using free response measures. This would help to tease apart whether the present ratings of self indicate a general bias towards negativity, or if young people with elevated depression also generate negative self-descriptions.

The design of this study was cross-sectional. The sample included participants with a range of depression severity, including a sample recruited from routine clinical services and for whom diagnosis was established. Different tasks were used to assess different types of cognitive bias. These tasks were mostly simple self-report tasks that can be administered to groups of young people. This may be a limitation because the combined cognitive hypothesis is typically tested experimentally using the same stimuli across different biases, e.g. interpretation and memory (Everaert et al., 2015). Everaert and colleagues (2014; 2013) suggest that cognitive biases operate in a linear process along an information processing 'pathway'. Using the same stimuli makes it possible to test this pathway and to manipulate individual biases and observe their effect on subsequent biases in the pathway. However, using different stimuli and methods may offer greater confidence in the generalizability of the data across different biases and reduces the inflating effect of common method variance (e.g. Klein et al., 2017). In addition, the tasks used in this study are easy to administer in a wide range of settings. To fully understand the effect of bias interactions, and the implications for treatment, research studies are needed that investigate both the same stimuli, and different stimuli.

Having demonstrated that, in adolescents, depression symptoms and diagnosis are significantly associated with specific cognitive biases (and not others) provides important

preliminary data on which to develop a more extensive and systematic programme of research. This would use a combination of experimental, observational and longitudinal designs, and different methods to assess different cognitive biases, in depressed and non-clinical participants. The results reported here suggest for the first time, that for adolescents, negative evaluation of the self is strongly associated with depression severity and with a diagnosis of depression. In addition to cognitive biases in attention, memory and interpretation, this self evaluation bias warrants further investigation, in adolescents and adults. There are many other directions in which this research might advance including better descriptions of sample characteristics e.g. better delineation of developmental stage, medication status in depressed participants, and recruitment of samples large enough to examine possible moderators (e.g. gender and culture) of the development and maintenance of cognitive biases.

This research area has enormous potential to improve our understanding of adolescent depression and to contribute to advances in identification, prevention and treatment of depression in young people. If cognitive biases can be assessed reliably and easily they may offer an alternative method to identify individuals at risk of depression. Typically identification and screening of depression is via self-report questionnaire measures of symptoms. These have been adapted for adolescents, have excellent face validity and often have good construct validity; however, they are also transparent and can be easily 'faked', and they require a degree of introspection and self-monitoring which may be demanding for many adolescents. Therefore it may be useful to assess the validity of using cognitive bias measures, such as those used in this study, to identify young people with depression who may have impaired cognitive ability to self-reflect, or be reluctant to report symptoms because of perceived stigma.

Cognitive theories of depression are the foundations of Cognitive Behaviour Therapy

(CBT), which has a focus on identifying and then modifying interpretation biases. CBT is moderately effective as a treatment for adolescent depression (Goodyer et al., 2017).

Cognitive theory has also stimulated direct modification of cognitive biases through experimental training. There is reliable evidence that cognitive biases can be modified in the laboratory, but these changes are not effectively translated into improvements in mood or functioning (e.g. Cristea, Kok, et al., 2015; Cristea, Mogoșe et al., 2015; Hallion & Ruscio, 2011). The combined cognitive bias hypothesis provides a framework to understand how cognitive biases may impact on mood and thus to improve the effectiveness of cognitive bias modification as a way of reducing symptoms or improving well-being. However, there is still limited evidence that modifying negative attention biases has any effect on cognitive biases further along the pathway or on mood or symptoms of depression. The results of this study suggest that further experimental research to assess the causal relationship between interpretation bias and depression symptoms is needed. Given the strong relationship between negative interpretation and depression symptoms this would then justify further assessment of interpretation bias modification as a potential method to prevent or reduce depression symptoms. In addition, experimental research to examine the causal relationship between negative self evaluation and depression is strongly supported by this study. Whilst there is some evidence of a causal relationship between attention bias and depression, and interpretation bias and depression, we do not know if negative self evaluation is simply a consequence of depression, rather than a cause of depression and low mood.

Conclusion

In a sample of adolescents aged 12 to 18 years the combination of two cognitive biases (interpretation bias and self evaluation bias) was a better predictor of depression severity than individual biases alone. This supports the combined hypothesis of Hirsch et al. (2006), and suggests that it may be helpful to consider the combination of biases when

working with depression in both adults and adolescents. Of particular interest was the role of negative evaluation of the self; this was the strongest individual predictor of depression severity. Given the central role of negative self evaluation in the cognitive model of depression and the particular sensitivity of adolescents to social and peer feedback this suggests that self evaluation should be given greater emphasis by researchers and clinicians who work with adolescents.

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