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Comparing Different Sequential Mediational Interpretations of Beck's Cognitive Model of Depression in Adolescents

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Abstract

Depression is a developmental phenomenon with significantly increasing rates during adolescence. As Beck's cognitive model of depression has been commonly accepted to explain the development and maintenance of depression, it is crucial to understand how and when cognitive vulnerabilities predicted in this model begin to interact. Three sequential interpretations of this model were compared. The causal mediational interpretation identifies dysfunctional attitudes as most distal to depressive symptoms, followed by cognitive errors, cognitive triad, and negative automatic thoughts, with each construct successively more proximal to depressive symptoms. In the symptom model the causal chain is reversed, with depressive symptoms as the most distal construct, followed by negative automatic thoughts, the cognitive triad, cognitive errors, and then dysfunctional attitudes. The bidirectional model merges both interpretations in which the activation of cognitive constructs causes the development of depressive symptoms which in turn trigger and reinforce already existing dysfunctional attitudes. Further, while Beck's model of depression proposes full mediation, empirical studies identified repeatedly partial mediations. Thus, the causal meditational, the symptoms, and the bidirectional model were each tested as full and partial mediation models. Finally, sex differences in the associations between variables were studied. In the 3-wave longitudinal study, 518 high school students (62.7% female, average age: 15.09 years) completed questionnaires measuring all mentioned elements of Beck's model. The bidirectional model with partial mediation fits the data best. Cognitive errors emerged as the main mediator in the bidirectional model with partial mediation and significant sex differences in the strengths of associations were identified. The findings demonstrate the relevance of adolescence as developmental period during which the examined associations develop into the network they form in adulthood. Further, psychological interventions focusing on cognitive errors promise to be most effective.

Keywords: Beck's cognitive model of depression; adolescents; sequential model; causal mediation; symptom model.

Introduction

Depression is a developmental phenomenon with rates of subsyndromal levels of depression and Major Depression significantly increasing from as low as 2% during childhood (Bufferd, Dougherty, Carlson, Rose, & Klein, 2012) to up to 22-27% during adolescence (Bertha & Balázs, 2013; Kessler, Petukhova, Sampson, Zaslavsky, & Wittchen, 2012). Of adults with Major Depressive Disorder 27% report to have their first depressive episode during adolescence (Kessler et al., 2012). Although adolescence represents a critical period for the development of depression, it may too often be neglected (Jacobs et al., 2008). For example, as cognitive theories of depression gained attention, the number of studies testing these models grew significantly, but most of these studies were using exclusively adult samples with results having little transferability to children and adolescents (Abela & Hankin, 2008). Further, while some research has examined how cognitive vulnerabilities of depression emerge and develop during childhood and adolescence to explain the above mentioned increase depression from childhood to adulthood (Cole et al., 2008; Turner & Cole, 1994), much is unknown about how and when cognitive vulnerabilities begin to interact. To be more precise, a relatively recent review of adolescent cognitive vulnerabilities of depression demonstrated that there is a particular lack of research about Beck's cognitive theory of depression (1976) in adolescence (Lakdawalla, Hankin, & Mermelstein, 2007). Moreover, Hankin (2008) found that the constructs in Beck's theory are less stable in adolescence compared to the constructs proposed by other theories. Thus, an understanding of how these constructs might predict depressive symptoms in adolescence is needed to understand how and when these constructs begin to reliably predict depressive symptoms as they do in adulthood. This seems critical as despite this lack of research, Beck's cognitive model of depression (1976) has been commonly accepted to explain the development and maintenance of depression in adolescents and psychological interventions based on this model are among the most effective for adolescent depression (Weisz, McCarty, & Valeri, 2006; Pössel & Hautzinger, 2006). Thus, it becomes clear that a better understanding of how and when cognitive vulnerabilities begin to interact is urgently needed to allow us to decrease the prevalence of adolescent depression as well as its continuation into adulthood.

Within Beck's model (1976), dysfunctional attitudes, cognitive errors, the cognitive triad, and negative automatic thoughts are central constructs. In Beck's diathesis-stress theory, dysfunctional attitudes are relatively enduring, organizing structures that guide situational information processing (e.g., "People will probably think less of me if I make a mistake."). Once activated by a stressful situation, the dysfunctional attitudes lead to cognitive errors, which cause perception and thinking to be unrealistic, extreme, and distorted in a negative way. Beck proposed multiple types of cognitive errors including catastrophizing, overgeneralizing, personalizing, and selective abstraction. Catastrophizing, for example, causes an adolescent to radically overestimate the negative

consequences of a (singular) event. As a result, thinking is dominated by a negative view of the self (e.g., "I am a loser!", the world (e.g., "The world is bad!"), and the future (e.g., "It will never get better!") —the *cognitive triad*. According to Beck, the cognitive triad is expressed through negative automatic thoughts - temporary, non-emotional mental events that may be subjectively plausible in certain situations – which influence emotional, somatic, and motivational symptoms of depression.

Beck's cognitive model is often interpreted as a causal mediational model (Alloy, Clements, & Kolden, 1985), with the cognitive constructs of the model structured sequentially, based on their relationships to depressive symptoms. In this interpretation of the sequence, dysfunctional attitudes are seen as the most distal construct, followed by cognitive errors, the cognitive triad, and then negative automatic thoughts as the most proximal construct to depressive symptoms. In other words, dysfunctional attitudes trigger a chain of cognitive variables that finally lead to emotional, somatic, and motivational symptoms of depression. Additionally, the causal mediational model assumes that each cognitive construct fully mediates the relationship between its prior and subsequent constructs. For example, dysfunctional attitudes do contribute directly to cognitive errors because of the sequential order of the variables, but they do not contribute directly to the cognitive triad, negative automatic thoughts, and depressive symptoms.

The symptom model is another interpretation of Beck's cognitive model (Brewin, 1985). The symptom model assumes the sequential reverse of the causal mediational model. This model purports that cognitive constructs are a reflection of changes in depressive symptoms and that there is no causal impact on the development or maintenance of depressive symptoms. In the symptom model the causal chain is reversed, with depressive symptoms as the most distal construct, followed by negative automatic thoughts, the cognitive triad, cognitive errors, and then dysfunctional attitudes (Kwon & Oei, 1992; Parry & Brewin, 1988). In other words, the symptom model proposes that emotional, somatic, and motivational symptoms of depression trigger a chain of cognitive variables.

In addition to the causal mediational and symptom models, a combination of the two creates a third, bidirectional model. Beck (1967, 1996; Beck & Weishaar, 2005) himself assumed bidirectional effects between cognitive constructs and depressive symptoms. Beck (1967) proposed that the activation of cognitive constructs causes the development of depressive symptoms (top-down processes), including negative emotions, which in turn further trigger and reinforce already existing dysfunctional attitudes (bottom-up influences).

Although Beck's cognitive model (1996; Beck & Weishaar, 2005) has been explored in adult populations, the empirical literature has been somewhat limited. Several studies have tested both the causal mediational and the symptom model in adults, with mixed results (Kwon & Oei, 1992; Oei, Goh, & Kwon,

1996; Oei & Kwon, 2007; Joiner, Metalsky, Lew & Klocek, 1999). Most recently, Pössel and Winkeljohn Black were the first to test all three interpretations in a sample of young adults (2014). In this 3-wave longitudinal study, the bidirectional, partial mediation was the best fitting model. Their findings did not support distal and proximal variables in relation to depressive symptoms in the model, and conclude that most cognitive variables influenced each other and each other's effect on depressive symptoms. However, Pössel and Winkeljohn Black (2014) identified cognitive errors as sole mediator between the cognitive variables proposed in Beck's cognitive model.

As described above, the downward extension of Beck's cognitive model on adolescents has been slow moving (Abela & Hankin, 2008; Lakdawalla et al., 2007). Our own review of the research finds that an investigation of the sequential order of all five cognitive constructs of Beck's model in adolescents has not been done. Instead, emphasis has been placed on the relationship between dysfunctional attitudes and depressive symptoms in youth. All studies we are aware of found that dysfunctional attitudes predict depressive symptoms (Abela & Skitch, 2007; Abela & Sullivan, 2003; Lee & Hankin, 2009; Lewinsohn et al., 2001; Marcotte, Lévesque, & Fortin, 2006; McCreary, Joiner, Schmidt, & Ialongo, 2004). Contrary to these studies Kercher, Rapee, and Schniering (2009) and LaGrange et al. (2011) also examined the symptom model. Those studies found that depressive symptoms predict both the cognitive triad and negative automatic thoughts but not vice versa.

Summarized, there is some evidence that dysfunctional attitudes serve as cognitive vulnerability for depressive symptoms in youth, but none of the aforementioned studies tested the symptom or bidirectional models with regards to dysfunctional attitudes. However, the studies examining the symptom model regarding the cognitive triad and negative automatic thoughts in adolescents provide support for this model. Finally, the only study examining the causal and the symptom model found only support for the latter model for the cognitive triad and negative automatic thoughts. Thus, based on the inconsistent findings and the fact that no previous study has addressed the bidirectional model or researched all five cognitive constructs of Beck's model in adolescents (1996; Beck & Weishaar, 2005), it is unclear which sequential interpretation of Beck's model describes the associations best.

The empirical research examining the associations between cognitive variables and depressive symptoms as they relate to differences in sex is very limited. While epidemiological studies indicate that adolescent girls show significantly more depressive symptoms and up to double the rate of depression than adolescent boys (Ge, Conger, & Elder, 2001; Hankin, Mermelstein, & Roesch, 2007). However, we found no studies with youth but two studies examining possible differences in the associations between the cognitive

variables as proposed in Beck's cognitive model (1996; Beck & Weishaar, 2005) and between the cognitive variables and depressive symptoms (Pössel, 2011; Pössel & Thomas, 2011). Neither of the two studies found sex differences in these associations, making it more likely that our findings can be generalized to male populations. However, even the authors of both former studies pointed out that their male samples were relatively small. Due to the lack of research with adolescents, sex differences in the associations between cognitive variables and depressive symptoms in adolescents cannot be excluded.

The Current Study

Based on the literature described above, the current study sought to expand the downward extension of Beck's cognitive model to adolescents. The overall purpose of the present study was to provide information about how the cognitive constructs proposed by Beck (1976) interact with one another in predicting depressive symptoms, which can inform preventions and interventions for adolescents. The following three interpretations of Beck's cognitive model of depression were tested: the causal mediational model, the symptoms model, and the bidirectional model. While no study with adolescents compared full and partial meditational models and Beck's cognitive model (1996; Beck & Weishaar, 2005) predicts full mediation, empirical studies with adults that tested for partial mediation confirmed partial mediation but not full mediation (Kwon & Oei, 1992; Oei et al., 1996; Pössel & Winkeljohn Black, 2014). Thus, all models were tested as both full and partial mediational models. Because previous studies with an adolescent population have yet to examine the symptom or bidirectional models, hypotheses were formulated by drawing from previous findings with adults (Pössel & Winkeljohn Black, 2014). Based on Beck's cognitive model (1996; Beck & Weishaar, 2005) and these previous findings, it was hypothesized that the bidirectional interpretation would fit the data best. Additionally, and similarly based on previous literature (Pössel & Winkeljohn Black, 2014; Kwon & Oei, 1992; Oei et al., 1996) but contrary Beck's conceptualization (1996; Beck & Weishaar, 2005) it was hypothesized that a model allowing for partial mediation would fit better than a full mediation model. Finally, Beck's cognitive model (1996; Beck & Weishaar, 2005) and previous empirical studies with young adults (Pössel, 2011; Pössel & Thomas, 2011) regarding potential sex differences in the associations between the cognitive variables and between the cognitive variables and depressive symptom no significant differences were proposed.

Method

Participants

Participants were 518 students (mean age = 15.09 years; *SD* = 0.76) in a high school in the mid-south of the United States; 62.7% were female. The sample consistent of 72.8% Caucasian, 14.7% African-American, 5.4% Latino, 1.4% Asian/Pacific Islander, 0.8% Native American, 4.4% Mixed Heritage, and 0.6% Other.

Almost one third of the students were eligible for free or reduced price lunch programs and the school serves predominantly working to middle class families. Participants completed the measures every three months, resulting in three waves of data collection. From the first to the third wave 37 adolescents (19 females) dropped out. There were no differences between the dropouts and remaining adolescents in sex, $\chi^2(1) = 2.26$, $p = .133$, or race/ethnicity, $\chi^2(6) = 6.67$, $p = .352$. However, dropouts were significantly older, $t(60.0) = -4.44$, $p < .001$, and reported more depressive symptoms at wave 1 than the remaining adolescents, $t(497) = -2.59$, $p = .010$.

Measures

Depressive symptoms. To measure self-reported depressive symptoms the Center for Epidemiological Studies – Depression Scale (CES – D; Radloff, 1977), a 20 item (e.g., "I was bothered by things that usually don't bother me.") instrument, was used in the current study. The CES-D is quickly administered, and thus an economical screening instrument. Frequency of symptoms is rated on a 4-point Likert scale, with higher numbers indicating a higher frequency of occurrence. The scale has a range from 0 to 60. The internal consistency in our sample was $\alpha = .92$ for all waves.

Dysfunctional attitudes. The Dysfunctional Attitude Scale (DAS; Weissman & Beck, 1978) assesses depressive beliefs as described by Beck (1976). The 40-item DAS (form A) was used in the current study, with some of the wording modified to make it understandable to this age group (Garber, Weiss, & Shanley, 1993). Items (e.g., "People will probably think less of me if I make a mistake.") are rated on a 5-point Likert scale, with higher numbers indicating a higher agreement with the dysfunctional attitudes. Total scores can range from 40 to 200, with higher scores representing greater endorsement of dysfunctional beliefs. In the current sample, internal consistency of the DAS ranged from $\alpha = .84$-$.86$ across waves.

Cognitive errors. The Children's Negative Cognitive Error Questionnaire (CNCEQ; Leitenberg, Yost, & Carroll-Wilson, 1986) is a 24-item self-report measure designed to assess four types of cognitive errors (catastrophizing, overgeneralizing, personalizing, and selective abstraction). Each item assesses possible cognitive responses to a fictional scenario (e.g., "You invite one of your friends to stay overnight at your home. Another one of your friends finds out about it. You think, 'S/he will be really mad at me for not asking him/her and will never want to be friends again.'"). The items are rated on a 5-point Likert scale, with higher numbers representing more cognitive error. Total scores can range from 24 to 120, with higher scores representing greater endorsement of cognitive errors. In the current sample, internal consistency of the CNCEQ was $\alpha = .96$ for all waves.

Cognitive triad. The Cognitive Triad Inventory for Children (CTI-C; Kaslow et al., 1992) consists of 36 items. View of self (e.g., "I can do a lot of things well."), world (e.g., "The world is a very hostile place."), and future

(e.g., "There is nothing to look forward to in the years ahead.") are each measured with ten items. The remaining six items are filler items that are not scored. The items are phrased in both positive and negative directions. Students are asked to rate how the item applies to them on a 7-point Likert scale. Before calculating the scores for the CTI scales, all items are poled in a way that higher scores represent positive views and low scores represent negative views. Therefore, an overall score is used in analysis. In the current sample, internal consistencies of the CTI-C scales ranged from $\alpha = .92$ to $\alpha = .93$ across waves.

Automatic thoughts. The Automatic Thoughts Questionnaire-Revised (ATQ-R; Kendall, Howard, & Hays, 1989) measures automatic thoughts, as described by Beck (1976). It includes the subscales "negative self-statements" (12 items; e.g., "Why can't I ever succeed?"), "well-being" (5 items; e.g., "I feel fine."), and "self-confidence" (4 items; "No matter what happens, I know I'll make it.") on a 5-point Likert scale. A higher summary score in the subscale "negative self-statements" indicates more negative automatic thoughts, whereas higher scores in the subscales "well-being" and "self-confidence" indicate more positive automatic thoughts. Only the negative self-statements subscale was used in the present study. In the current sample, internal consistency of the ATQ-R negative self-statements subscale was $\alpha = .97$ for all waves.

Procedures

Letters describing the study were sent to parents of all students in 9th grade. Students who received parental consent were invited to participate and asked for their assent. Assessments were conducted three-times, (three month gaps between waves) in group sessions during school hours. Participation was voluntary and neither students nor parents received any incentives. The study was approved by the university's Institutional Review Board.

Data Analysis

The hypothesized mediation models were tested using Cole and Maxwell's (2003) approach for 3-wave studies using structure equation models and Martens and Haase's (2006) suggestion on how to compare different models. The structural equation models were calculated and analyzed in AMOS 21 using maximum likelihood method; missing data were handled with the Full-Information Maximum Likelihood (FIML) method (Arbuckle, 1999), which allows to include participants with missing data. In FIML estimation with missing data, observations are sorted into missing data patterns and each parameter is estimated using all available data, including observed portions of other variables. Consequently, maximum likelihood procedures are less biased than traditional approaches to missing data that eliminate subjects from analyses, such as listwise and pairwise deletion (Wothke, 1998).

The models' were tested with χ^2, which is considered the traditional measure for evaluating model fit index, assessing the discrepancy between the sample and the fitted covariance matrices (Kline, 2011). χ^2 values are influenced by the sample size. Thus, they tend not only to be statistically significant when the tested model is not consistent with the data but also when the sample size is large (Jöreskog & Sörbom, 1993). Thus, χ^2 values were complemented with χ^2/df, the comparative fit index (CFI; Bentler, 1990), the root mean square error of approximation (RMSEA; Steiger & Lind, 1980), and the Tucker-Lewis Index (TLI; Tucker & Lewis, 1973), and. When interpreting findings, nonsignificant χ^2 values and χ^2/df values under 2 are preferred. For CFI and TLI, values > .95 are considered good model fit and values > .90 are considered acceptable. Lastly, RMSEA values <.05 demonstrate good model fit and values <.08 are acceptable fit (Hu & Bentler, 1999).

The data were first fit to (a) an autoregressive model, (the null model), where only the paths between each variable at one wave and the same variable at the next vary freely and all other paths are set to 0 (Figure 1, top left graph). Next data were fit to the (b) fully mediated causal mediational model. This model added the paths between each variable at one wave and the variable right after this variable in the theoretical sequence at the following wave are allowed to vary freely, all other paths are set to 0 (Figure 1, top right graph). The next tested model was the (c) fully mediated symptom model, which was a reversed direction of the theoretical sequence. This model allowed paths between each variable at one wave and the variable right before this variable in the theoretical sequence at the following wave to vary freely with all other paths set to 0 (Figure 1, bottom left graph). The (d) fully mediated bidirectional model was next, where the paths between each variable at one wave and the variable right before and after this variable in the theoretical sequence at the following wave vary freely, and all other paths are set to 0 (Figure 1, bottom right graph). Next, the causal mediational, symptom and bidirectional models were tested using partial mediation. The (e) partially mediated causal mediational model allowed the paths between each variable at one wave and all variables after this variable in the theoretical sequence at the following waves to vary freely, and all other paths were set to 0 (Figure 1, top right graph). The (f) partially mediated symptom model allowed paths between each variable at one wave and all the variables right before this variable in the theoretical sequence at the next waves to vary freely with all other paths set to 0 (Figure 1, bottom left graph). Lastly, (g) the partially mediated bidirectional (fully cross-lagged) model had all paths between any variable at one wave and all variables at the following waves to vary freely (Figure 1, bottom right graph). The autoregressive model was compared to the causal mediational and the symptom models (both full and partial mediations). Next, the model fitting the data best was compared to the bidirectional models (Martens & Haase, 2006).

Because all but the causal mediational and symptoms models were nested, the χ^2 difference tests (subtract χ^2 values and *df*s of the models that are compared) procedure was used. The models are significantly different from each other when $\Delta\chi^2$ is significant for Δdf. In addition, the CFI values of the two models that were compared were subtracted from each other, resulting in ΔCFI values. If a ΔCFI is > .002, the model with higher CFI fits the data significantly better than the other model. On the other hand, if ΔCFI is ≤ .002 neither of the models fit the data significantly better. Thus, the more parsimonious model should be retained (Meade, Johnson, & Braddy, 2008). To assess whether a mediated effect in the final model was large enough to be considered important, the 95% confidence intervals of the possible mediated effects were calculated using the product method. As this method follows an asymmetrical distribution, the upper and lower confidence limits have different critical values (MacKinnon, Fritz, Williams, & Lockwood, 2007). The analyses were calculated using PRODCLIN (MacKinnon et al., 2007). When the confidence interval does not contain zero, a statistically significant mediation effect exists.

Although this study was not designed for subsample analyses, it seemed informative for future research to examine the stability of the final model across both sexes. Thus, a multi-group analysis was calculated. First, the final model was calculated with no between-group constraints. This model was used to test for equivalence across sexes when additional cross-group constraints are imposed. Then, a series of chi-square tests were conducted comparing the unconstrained model to subsequent models with increasing numbers of constraints. The constraints were applied in the following order: measurement weights, measurement intercepts, structural weights, structural covariances, structural residuals, and measurement residuals. If the chi-square change between the unconstrained model and the final model with all cross-group constraints imposed is not statistically significant, then equivalence between groups is supported. According to Byrne (2001), invariance between groups means that the groups - in the present study girls and boys - should be analyzed together. For each model, results from the multi-group analyses are reported first. Next, parameter estimates for the girls and boys from the unconstrained model as well as the paths which are significantly different between both sexes in the unconstrained model are reported.

Results

Descriptive data and correlations for all instruments are presented in Table 1. All measures were moderately to highly correlated with each other.

The proposed model with the most paths was the partially mediated bidirectional model. This model included 50 paths. Based on Kline's (2011) suggested 10 to 1 ratio of participants to estimated parameters, the

minimum number of participants necessary for this study is 500. Thus, with 518 participants, the study has sufficient power.

Determination of the Best Fitting Model (Using the Total Sample)

Six theory-driven interpretations of Beck's cognitive model of depression and an autoregressive model were fit to the data (N = 518; see Table 2). Models with full mediation were tested first and compared using the χ^2 difference test and the ΔCFI. Comparisons of the autoregressive model with the causal mediational, $\Delta\chi^2$ (8, N = 518) = 99.72, $p < .05$, ΔCFI = .02, and the symptom model, $\Delta\chi^2$ (8, N = 518) = 58.82, $p < .05$, ΔCFI = .011, revealed that both theory-driven models provided a significantly better fit to the data than the autoregressive model. Second, the causal mediational, $\Delta\chi^2$ (8, N = 518) = 60.79, $p < .05$, ΔCFI = .011, and the symptom model, $\Delta\chi^2$ (8, N = 518) = 101.69, $p < .05$, ΔCFI = .02, were compared to the bidirectional model. Results of the χ^2 difference tests and the ΔCFI's indicated that the bidirectional model with full mediation fit the data better than either the causal mediational or the symptom interpretations of Beck's cognitive model.

Next, theory-driven models with partial mediation were tested and compared. Comparing the autoregressive model with the causal mediational, $\Delta\chi^2$ (20, N = 518) = 163.56, $p < .05$, ΔCFI = .031, and the symptom model, $\Delta\chi^2$ (20, N = 518) = 139.19, $p < .05$, ΔCFI = .026, revealed that both theory-driven models provided a significantly better fit to the data than the autoregressive model. Therefore, the causal mediational, $\Delta\chi^2$ (20, N = 518) = 81.15, $p < .05$, ΔCFI = .014, and the symptom model, $\Delta\chi^2$ (20, N = 518) = 105.51, $p < .05$, ΔCFI = .019, were compared to the bidirectional model. Results of the χ^2 difference tests indicated that the bidirectional model with partial mediation fits the data better than either the causal mediational or symptom interpretations of Beck's cognitive model with partial mediation.

Lastly, the fully mediated and partially mediated bidirectional models were compared using the χ^2 difference test, $\Delta\chi^2$ (24, N = 518) = 84.19, $p < .05$, ΔCFI = .014. This revealed that the bidirectional model with partial mediation fits the data best.

The correlations between scales at the same wave are presented in Table 3 and the standardized regression weights of the bidirectional model are presented in Table 4. Some specifics should be noted. First, the correlations (Table 3) demonstrate that every scale correlated significantly with all other scales at the same wave. Second, each scale at one wave significantly predicted the same scale at a later wave (Table 4). Third, of 20 nonautoregressive paths predicted by the causal meditational model, only 8 were significant or marginally significant (dysfunctional attitudes at W1 predicting cognitive errors at W2, cognitive errors at W1 predicting negative automatic thoughts at W2, negative automatic thoughts at W1 predicting depressive symptoms at W2,

dysfunctional attitudes, cognitive errors, and cognitive triad at W2 predicting negative automatic thoughts at W3, negative automatic thoughts at W2 predicting depressive symptoms at W3). Further, of 20 nonautoregressive paths predicted by the symptom model, only 6 were significant (depressive symptoms at W1 predicting negative automatic thoughts at W2, negative automatic thoughts at W1 predicting cognitive triad and cognitive errors at W2, negative automatic thoughts at W2 predicting cognitive triad at W3, cognitive triad and cognitive errors at W2 predicting dysfunctional attitudes at W3). Fourth, at any wave depressive symptoms is not affected by any cognitive scales but the negative automatic thoughts. Fifth, the patterns of significant nonautoregressive paths were different between W1 – W2 and W2 – W3. Dysfunctional attitudes and negative automatic thoughts at W1 predicted cognitive errors at W2 and cognitive errors at W2 predicted dysfunctional attitudes and negative automatic thoughts at W3. Similarly, cognitive triad at W2 and at W3 is only marginally predicted by the negative automatic thoughts one wave earlier while the cognitive triad at W2 significantly predicted dysfunctional attitudes and negative automatic thoughts at W3. Further, it seems that dysfunctional attitudes (cognitive errors, cognitive triad) and negative automatic thoughts (dysfunctional attitudes, cognitive errors, cognitive triad) at W3 are predicted by more variables than dysfunctional attitudes (none) and negative automatic thoughts (cognitive errors, depressive symptoms) at W2.

Multi-group Analyses

Multi-group analyses comparing girls (n = 325) and boys (n = 193) indicate the individual paths of the partial mediation model are not invariant between both sexes, $\chi^2_{\text{unconstrained}}$ (50) = 185.48, $p < .001$, $\chi^2/df = 3.71$, CFI = .970, TLI = .858, RMSEA = .072; $\chi^2_{\text{fully constrained}}$ (160) = 456.83, $p < .001$, $\chi^2/df = 2.855$, CFI = 1.000, TLI = 1.000, RMSEA = .060; $\Delta\chi^2(110) = 271.35$, $p < .001$. To be more precise, 11 of 50 paths across different waves are significantly different between girls and boys. Three of those differences come from significantly stronger autoregressive paths between the cognitive triad (W1-W2) and negative automatic thoughts (W1-W2, W2-W3) in boys compared to girls. While these findings seem to point to more stable cognitive triad and negative automatic thoughts in boys, it should be considered that these autoregressive paths are significant in girls as well. Further, the paths from depressive symptoms to dysfunctional attitudes at W3, cognitive errors at W2, and negative automatic thoughts at W 2 and W3 and between cognitive triad at W2 and cognitive errors at W3 are stronger in girls compared to boys. While these findings seem to - at least partially – provide a stronger support for the symptom model in girls compared to boys, two of those four paths remain non-significant in girls. In addition, the path between cognitive triad at W1 and negative automatic thoughts at W2 is significantly stronger in boys than in girls while the path between cognitive triad at W2 and negative automatic thoughts at

W3 is significantly weaker in boys than in girls. Finally, the path between dysfunctional attitudes at W2 and automatic thoughts at W3 is stronger in girls than in boys.

Tests for Mediation

Considering the differences between girls and boys, all tests for mediation were calculated for the total sample as well as separated for girls and boys. The results of the analyses for all possible mediation effects are presented in Table 5.

In the overall sample, four of nine possible mediation effects are significant. In particular, the association between dysfunctional attitudes at W1 and negative automatic thoughts at W3 as well as the association between automatic thoughts at W1 and dysfunctional attitudes at W3 were mediated by cognitive errors at W2. Further, the association between depressive symptoms at W1 and the cognitive triad was mediated by negative automatic thoughts at W2 and the association between depressive symptoms at W1 and dysfunctional attitudes at W3 was mediated by the cognitive triad at W2 as none of these confidence intervals contained zero.

In the female subsample, all six possible mediation effects are significant. In this subsample, cognitive errors at W2 mediate the associations between dysfunctional attitudes at W1 and the cognitive triad, negative automatic thoughts, and depressive symptoms at W3. Further, cognitive errors at W2 mediate the associations between depressive symptoms at W1 and dysfunctional attitudes at W3. The only other mediator in this subsample is the cognitive triad mediating the association between automatic thoughts at W1 and dysfunctional attitudes at W3.

In the male subsample, only one possible mediation effect was tested. This analysis revealed that the association between negative automatic thoughts at W1 and dysfunctional attitudes at W3 was significantly mediated by cognitive errors at W2.

Discussion

Depression is a developmental phenomenon with rates of subsyndromal levels of depression and Major Depression significantly increasing during adolescence (Bertha & Balázs, 2013; Kessler et al., 2012) and girls in adolescence starting to show significantly more depressive symptoms and up to double the rate of depression than adolescent boys (Ge et al., 2001; Hankin et al., 2007). As Beck's cognitive model of depression (1976) has been commonly accepted to explain the development and maintenance of depression in adolescents and psychological interventions based on this model are among the most effective for adolescent depression (Weisz et al., 2006; Pössel & Hautzinger, 2006), it is crucial to understand how and when cognitive vulnerabilities (dysfunctional attitudes, cognitive errors, cognitive triad, negative automatic thoughts) predicted in this model

begin to interact. Thus, in the present study three different sequential interpretations of Beck's cognitive model were tested and compared. In the causal meditational interpretation, dysfunctional attitudes are seen as the most distal construct, followed by cognitive errors, the cognitive triad, and then negative automatic thoughts as the most proximal construct to depressive symptoms. In the symptom model the causal chain is reversed, with depressive symptoms as the most distal construct, followed by negative automatic thoughts, the cognitive triad, cognitive errors, and then dysfunctional attitudes (Kwon & Oei, 1992; Parry & Brewin, 1988). The combination of the two creates a third, bidirectional model. In this model the activation of cognitive constructs causes the development of depressive symptoms (top-down processes), including negative emotions, which in turn further trigger and reinforce already existing dysfunctional attitudes (bottom-up influences). Two understudied issues related to the sequential interpretation of Beck's cognitive model are whether the mediation effects are full or partial meditational and if the associations between the cognitive variables and between the cognitive variables and depressive symptoms in adolescent girls and boys are comparable or meaningfully different. While no study with adolescents compared full and partial meditational models and Beck's cognitive model (1996; Beck & Weishaar, 2005) predicts full mediation, empirical studies with adults that tested for partial mediation confirmed partial mediation but not full mediation (Kwon & Oei, 1992; Oei et al., 1996; Pössel & Winkeljohn Black, 2014). Based on Beck's cognitive model (1996; Beck & Weishaar, 2005) and previous findings with adults (Pössel & Winkeljohn Black, 2014), it was hypothesized that the bidirectional interpretation would fit the data best. Additionally, and similarly based on previous literature (Pössel & Winkeljohn Black, 2014; Kwon & Oei, 1992; Oei et al., 1996) but contrary to Beck's conceptualization (1996; Beck & Weishaar, 2005) it was hypothesized that a model allowing for partial mediation would fit better than a full mediation model. Finally, Beck's cognitive model (1996; Beck & Weishaar, 2005) and previous empirical studies with young adults (Pössel, 2011; Pössel & Thomas, 2011) regarding potential sex differences in the associations between the cognitive variables and between the cognitive variables and depressive symptom no significant differences were proposed.

The study had four main results. First, consistent with the hypotheses and previous studies with adults (Kwon & Oei, 1992; Oei et al., 1996; Pössel & Winkeljohn Black, 2014), the bidirectional model with partial mediation fit the data best. It is possible that the impression of bidirectional relationships in adolescents is caused by a blending of top-down processes and bottom-up influences (Beck, 1967). A differentiation between top-down processes and bottom-up influences can be drawn with the first being seen as dysfunctional attitudes causing negative automatic thoughts and depressive symptoms while in the latter negative automatic thoughts and depressive symptoms only activate existing dysfunctional attitudes. Two experimental studies, one with

adult participants with a current Major Depression and one with adults without any psychological diagnosis, designed to trigger only top-down processes found effects of attitudes on attitudes, thoughts, and emotions while thoughts and emotions showed no effect on attitudes (Pössel & Knopf, 2008). Pössel and Winkeljohn Black interpret these findings in a way that the impression of bidirectional effects in longitudinal studies may be caused by the fact that top-down processes and bottom-up influences are not separable. Thus, further experimental studies seem necessary to test this hypothesis.

The second main finding was that while most of the cognitive variables influenced each other in the total sample and in the female and male subsamples, in the total sample and the male subsample depressive symptoms were only influenced by negative automatic thoughts and depressive symptoms predicted only negative automatic thoughts (at Wave 2). Thus, cognitive constructs influenced each other and each other's impact on depressive symptoms. In other words, the findings did not support the concept of distal and proximal variables in relation to depressive symptoms in adolescents. Instead, the bidirectional relations highlighted the flexibility of cognitive constructs in girls and boys. As this finding is similar to the finding of a study with comparable design with college students (Pössel & Winkeljohn Black, 2014), this seems to be true for adolescents and young adults.

The third main finding was that the pattern of significant individual paths and mediations between adolescent girls and boys is different. Thus, both subgroups should not be analyzed together. This was not expected as previous studies with young adults researching possible sex difference in the associations between the cognitive variables as proposed in Beck's cognitive model (1996; Beck & Weishaar, 2005) and between the cognitive variables and depressive symptoms did not find meaningful differences (Pössel, 2011; Pössel & Thomas, 2011). Within the sex differences two tendencies were identifiable. First, the cognitive triad and negative automatic thoughts seem to be more stable in boys than in girls. This finding is surprising as Cole et al. (2009) found the cognitive triad in 6th to 9th graders (but not in an independent sample of 4th to 6th graders) to be more stable in girls than in boys. Second, associations that belong to the interpretation of Beck's cognitive model as symptom model (depressive symptoms to dysfunctional attitudes at W3, cognitive errors at W2, and negative automatic thoughts at W 2 and W3; cognitive triad at W2 to cognitive errors at W3) were significantly stronger in girls compared to boys. Beyond these two tendencies, it is obvious that the number of significant associations in the male but also in the female subgroup is lower than in previous research with young adults (Pössel, 2011; Pössel & Thomas, 2011). Considering that adolescent cognitive development takes place earlier in girls compared to boys and that the number of significant associations in girls is numerically higher than in boys the sex differences in the findings between previous studies and the present study as well as between both

sexes in the present study might be caused by developmental factors. Thus, a replication study including subsamples from childhood to young adulthood is warranted to examine the changing pattern of sex differences in this crucial developmental period.

The fourth main finding was that, summarized across the total sample and both subsamples, cognitive errors served as mediator in seven of the eleven significant mediation effects. Based on Pössel and Winkeljohn Black's (2014) findings and Ilardi and Craighead's (1999) conceptualization that changing cognitive errors is the primary mechanism of change, it is not surprising that cognitive errors are the main mediator in the present study with adolescents. Ilardi and Craighead further propose that changing cognitive errors ultimately modifies dysfunctional attitudes as well. Thus, it seems cognitive errors are a core element of Beck's cognitive model of the development of depression (Beck, 1967, 1996; Beck & Weishaar, 2005).

An interesting finding is that within the bidirectional model with partial mediation, different associations were significant from wave 1 to wave 2 than from wave 2 to wave 3. To explain a similar finding in college students, Pössel and Winkeljohn Black (2014) suggest that this result might be evidence for nonlinear relations (Cole & Maxwell, 2003) that can be caused by a violation of the stationarity assumption. The stationarity assumption implies that in a time series, the degree to which one variable produces changes in another variable does not fluctuate. It is possible that the differences in significant paths from Wave 1 - Wave 2 compared to Wave 2 - Wave 3 might refer to periodic fluctuations - acceleration or deceleration - of causal relations between the cognitive constructs. Building on this hypothesis, the continuing cognitive development in adolescence – and young adulthood for that matter – could have caused the violation of the stationary assumption. Evidence related to variables as diverse as brain development, executive functioning, and social information processing demonstrate that the cognitive development that starts with puberty is not concluded until the early tween years and that none of these developments is linear (Blakemore & Mills, 2014; Taylor, Barker, Heavey, & McHale, 2015). Thus, it is possible that spikes in the cognitive development are responsible for the differences in significant paths between the waves. If this explanation is correct, a replication study with adult participants that outgrew this phase of rapid and fluctuating cognitive development should not find such differences in significant paths between waves. Another possible way to reduce the likelihood for differences in significant paths between waves would be to reduce the time between the waves (time lag). The time lag is also related to another explanation for the differences in significant paths between the waves is that the optimal time between two waves (time lag) may have varied from one part of the model (e.g., dysfunctional attitudes to cognitive errors) to another part of the same model (e.g., cognitive errors to negative automatic thoughts). This seems logical as dysfunctional attitudes, cognitive errors, and the cognitive triad are relatively stable over time,

negative automatic thoughts fluctuate on a moment-to-moment basis, thus would be better captured in different time lags (Hollon, DeRubeis, & Evans, 1996). This is further supported by Pössel and Knopf (2008), who argued that the activation of dysfunctional attitudes triggers negative automatic thoughts within seconds, which cause immediately depressed mood. Thus, the selected time lag of three months between waves may not have been optimal to measure the full causal effect of all variables (Cole & Maxwell, 2003). Nevertheless, previous longitudinal studies with adults used time lags between two weeks (Joiner et al., 1999) and six months (Oei & Kwon, 2007; Stewart et al., 2004) and measured dysfunctional attitudes, negative automatic thoughts, and depressive symptoms. Further, longitudinal studies with adolescents used five weeks (Lee & Hankin, 2009) to one year (Kercher et al, 2009; LaGrange et al., 2011; Lewinsohn, Joiner, & Rohde, 2001; McCreary et al., 2004). Thus, with a time lag of three months, the current study was well within the range established by previous studies. Further, it seems relevant that a previous 3-wave study using a time lag of 4 weeks found similar inconsistencies in the associations between Wave 1 - Wave 2 and Wave 2 - Wave 3 (Pössel & Winkeljohn Black, 2014). These findings combined with the considerations that some constructs in Beck's cognitive model (Beck 1976, 1996; Beck & Weishaar, 2005) are more stable than others raise the question is there is any one "perfect" time lag, or if different time legs are better suited for associations between different constructs.

The present study is noteworthy for its relatively large sample size and longitudinal design. Further, with almost 28% of the students belonging to a racial/ethnic minority and about one third of the students being eligible for free or reduced price lunch programs while this sample could have been more diverse, the findings seem generalizable to the broader population of high school students. Finally, it is the first comprehensive study to test multiple causal interpretations of Beck's (1976, 1996; Beck & Weishaar, 2005) cognitive model of the development of depression using all of the cognitive variables in an adolescent population. However, it is not without limitations. The nonsignificance of specific paths should be interpreted with cautions, as it is unclear whether the stationarity assumption is true for the sequential interpretation of Beck's cognitive model (Beck, 1976, 1996; Beck & Weishaar, 2005).

The present study is the second testing of Beck's cognitive model (Beck, 1976, 1996; Beck & Weishaar, 2005; Pössel & Winkeljohn Black, 2014) using a 3-wave longitudinal design, and the first in an adolescent population. The 3-wave design allows inferences to be made about all three relationships in a mediation model. Yet, it can be argued that a 5-wave longitudinal design is necessary to test Beck's model as it includes five elements (dysfunctional attitudes, cognitive errors, cognitive triad, negative automatic thoughts, and depressive symptoms). For example and as described above, the association between depressive symptoms

at wave 1 and the cognitive triad was mediated by negative automatic thoughts at wave 2 and the association between depressive symptoms at wave 1 and dysfunctional attitudes at wave 3 was mediated by the cognitive triad at wave 2. A study with 5 waves would have allowed to test whether (a) there is an association between depressive symptoms at wave 1 and dysfunctional attitudes at wave 4 and (b) this association is mediated by negative automatic thoughts at wave 2, and the cognitive triad at wave 3. Thus, the findings of the current study should be considered with this limitation in mind.

As previously mentioned, some of the goodness of fit indices demonstrated that the bidirectional model is the best fit of the proposed models, but that it does *not* fit the data well (TLI and RMSEA). Hu and Bentler (1998) point out that goodness of fit indices are better at distinguishing between models that have different degrees of misspecification than providing absolute guidelines about the acceptability of a particular model. Marsh, Hau, and Wen (2004) recommend using fit indices to compare the fit of various models to each other, rather than as absolute cutoff values. Nevertheless, the question remains what a model with all calculated goodness of fit indices in the acceptable range would look like.

The mono-method bias of the data collection may be seen as another limitation of the current study. Additionally, the use of self-report instruments to measure cognitive variables representing a style of thinking (i.e., dysfunctional attitudes, cognitive errors) may be criticized because it is questionable how much insight individuals really have into their own style of thinking (see Scher, Ingram, & Segal, 2005, for a review). It could be that the insight of an individual's own thinking pattern lies outside of their awareness, thus limiting the ability to accurately capture the constructs in self-report measures. As self-report instruments already exist for all of the measured constructs, their use was deemed adequate for this study.

This study was the first of its kind to examine the sequential order of Beck's cognitive model of the development of depression in adolescents (Beck, 1976, 1996; Beck & Weishaar, 2005). The findings though tested in a different population, support Pössel and Winkeljohn Black's (2014) research on the bidirectional model that integrates both causal mediational and symptom interpretations. Nevertheless, replication of the present findings is needed.

Finally, Beck (1976, 1996; Beck & Weishaar, 2005) conceptualized this cognitive model of depression as vulnerability-stress model. In other words, stressful events activate the dysfunctional attitudes. Thus, that stress was not measured and accounted for in the current study is another limitation. This may have led to an underestimation of the associations of cognitive constructs with depressive symptoms (Pössel, 2011). Therefore, future studies examining not only the sequential interpretation of the cognitive model but also any study

researching how the cognitive constructs proposed by Beck interact in predicting depressive symptoms in adolescents should include stress measures.

Conclusion

Because of the increasing rates of subsyndromal levels of depression and Major Depression (Bertha & Balázs, 2013; Kessler et al., 2012) and the developing sex difference in depression rates (Ge et al., 2001; Hankin et al., 2007) adolescent depression is crucial. As Beck's cognitive model of depression (Beck, 1976, 1996; Beck & Weishaar, 2005) has been commonly accepted to explain depression in adolescents and psychological interventions based on this model are among the most effective for this age group (Weisz et al., 2006; Pössel & Hautzinger, 2006), it is crucial to understand how cognitive variables predicted in this model interact in adolescents. However, studies examining the associations between those cognitive variables focus either on only a part of Beck's cognitive model (Abela & Skitch, 2007; Abela & Sullivan, 2003; Kercher et al., 2009; LaGrange et al., 2011; Lee & Hankin, 2009; Lewinsohn et al., 2001; Marcotte et al., 2006; McCreary et al., 2004) or on adults (Pössel & Winkeljohn Black, 2014) or both (Kwon & Oei, 1992; Oei et al., 1996; Oei & Kwon, 2007; Joiner et al., 1999). The present study helps filling this gap as the first examining the complex associations between all cognitive variables proposed in Beck's cognitive model in adolescents.

The findings of the present study (including the sex differences) can be interpreted within the context of previous studies with children (Cole et al., 2009) and young adults (Pössel & Winkeljohn Black, 2014). Doing so highlights the relevance of adolescence as developmental period during which the examined associations develop into the network they form in adulthood. However, to test this interpretation a study including subsamples from childhood to young adulthood and with samples large enough to separately analyze female and male subgroups is necessary.

The present study has not only academic but also clinical relevance. Due to the bidirectional interpretation of Beck's cognitive model (Beck, 1976, 1996; Beck & Weishaar, 2005) and the fact that cognitive errors are the mediators in the most significant mediation effects, it seems that psychological interventions focusing on cognitive errors might be the most promising. This hypothesis is supported by a study demonstrating that a cognitive-behavioral program focusing on cognitive errors prevented the development of depressive symptoms in adolescents longer than other cognitive-behavioral programs focusing on other parts of the cognitive network (e.g., dysfunctional attitudes; Pössel, Adelson, & Hautzinger, 2011). However, further studies comparing the effects of interventions focusing on individual cognitive variables are needed before final conclusions can be drawn. But if this hypothesis is confirmed, individual interventions as well as school-wide prevention and therapy programs focus on cognitive errors should be developed.

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Conflicts of Interest

The author reports no conflict of interest.

Compliance with Ethical Standards

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Ethical approval

All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Informed Consent

Informed consent was obtained from all individual participants included in the study.

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Table 1

Descriptive Data and Correlations between All Used Instruments.

	CES-Dw1	CES-Dw2	CES-Dw3	DASw1	DASw2	DASw3	CNCEQw1	CNCEQw2	CNCEQw3	CTI-Cw1	CTI-Cw2	CTI-Cw3	ATQ-Rw1	ATQ-Rw2	ATQ-Rw3
CES-Dw1															
CES-Dw2	.65														
CES-Dw3	.58	.60													
DASw1	.39	.32	.33												
DASw2	.36	.43	.33	.58											
DASw3	.27	.31	.38	.51	.61										
CNCEQw1	.47	.44	.39	.30	.30	.27									
CNCEQw2	.47	.57	.45	.35	.41	.35	.63								
CNCEQw3	.41	.46	.48	.30	.41	.38	.61	.70							
CTI-Cw1	-.59	-.52	-.46	-.31	-.30	-.18	-.56	-.46	-.44						
CTI-Cw2	-.49	-.63	-.44	-.28	-.38	-.21	-.45	-.56	-.45	.67					
CTI-Cw3	-.44	-.48	-.62	-.26	-.33	-.32	-.42	-.47	-.59	.62	.65				
ATQ-Rw1	.71	.61	.54	.40	.37	.28	.57	.56	.46	-.71	-.57	-.54			
ATQ-Rw2	.53	.72	.53	.33	.47	.33	.47	.67	.51	-.52	-.71	-.57	.64		
ATQ-Rw3	.52	.52	.67	.33	.40	.47	.46	.52	.59	-.49	-.52	-.70	.56	.63	
Mean	16.46	15.55	15.43	101.12	98.73	97.48	55.6	53.27	53.34	45.46	46.93	46.19	60.39	57.46	57.17

SD	11.77	11.54	11.81	17.59	17.69	18.96	21.69	21.34	21.58	11.22	10.85	11.22	26.15	25.73	25.19
Range	0-57	0-52	0-55	40-164	40-162	40-173	24-120	24-120	24-119	7-60	9-60	4-60	30-150	30-150	30-150

Note. $N \geq 518$ for all variables. CES-D = Center for Epidemiological Studies – Depression Scale; DAS = Dysfunctional Attitudes Scale; CNCEQ = Children's Negative Cognitive Error Questionnaire; CTI-C = Cognitive Triad Inventory- Children; ATQ-R = Automatic Thoughts Questionnaire- Revised, negative self-statements; w1 = wave 1; w2 = wave 2; w3 = wave 3.

All correlations are significant at $p < .001$.

Table 2

Indices of Goodness of Fit and Parsimony of the Tested Models.

Models	*df*	χ^2	χ^2/df	CFI	TLI	RMSEA
Autoregressive model	65	398.37	6.13	*.927*	.864	.100
Causal meditational model with full mediation	57	298.65	5.24	*.947*	.888	.090
Symptom model with full mediation	57	339.56	5.96	*.938*	.869	.098
Bidirectional model with full mediation	49	237.86	4.85	*.958*	.898	.086
Causal meditational model with partial mediation	45	234.82	5.22	*.958*	.888	.090
Symptom model with partial mediation	45	259.18	5.76	*.953*	.814	.096
Bidirectional model with partial mediation	25	153.67	6.15	*.972*	.864	.100

Note. $N = 518$. Indices of goodness of fit or parsimony that are at least acceptable are in italics. CFI = Comparative Fit Index, TLI = Tucker-Lewis Index; RMSEA = root mean square error of approximation.

All χ^2 are significant at $p < .05$.

Table 3

Correlations of Constructs and Error Terms of the Constructs, Respectively, Within Each Wave of the Bidirectional Model.

		all	girls	boys
DASw1	CNCEQw1	.299***	.361***	.186*
DASw1	CTI-Cw1	-.315***	-.379***	-.211**
DASw1	ATQ-Rw1	.411***	.445***	.347***
DASw1	CES-Dw1	.394***	.416***	.365***
CNCEQw1	CTI-Cw1	-.563***	-.580***	-.549***
CNCEQw1	ATQ-Rw1	.568***	.549***	.601***
CNCEQw1	CES-Dw1	.473***	.480***	.435***
CTI-Cw1	ATQ-Rw1	-.709***	-.777***	-.591***
CTI-Cw1	CES-Dw1	-.590***	-.679***	-.452***
ATQ-Rw1	CES-Dw1	.711***	.760***	.563***
DASw2error	CNCEQw2error	.190***	.150*	.272***
DASw2error	CTI-Cw2error	-.222***	-.261***	-.173*
DASw2error	ATQ-Rw2error	.309***	.289***	.367***
DASw2error	CES-Dw2error	.247***	.210***	.312***
CNCEQw2error	CTI-Cw2error	-.323***	-.303***	-.357***
CNCEQw2error	ATQ-Rw2error	.473***	.426***	.559***
CNCEQw2error	CES-Dw2error	.307***	.262***	.396***
CTI-Cw2error	ATQ-Rw2error	-.534***	-.573***	-.450***
CTI-Cw2error	CES-Dw2error	-.415***	-.459***	-.320***
ATQ-Rw2error	CES-Dw2error	.527***	.540***	.484***
DASw3error	CNCEQw3error	.137**	.146*	.125
DASw3error	CTI-Cw3error	-.197***	-.281***	-.065
DASw3error	ATQ-Rw3error	.329***	.416***	.141
DASw3error	CES-Dw3error	.227***	.281***	.112

CNCEQw3error	CTI-Cw3error	-.423***	-.477***	-.362***
CNCEQw3error	ATQ-Rw3error	.357***	.351***	.400***
CNCEQw3error	CES-Dw3error	.230***	.237***	.400**
CTI-Cw3error	ATQ-Rw3error	-.520***	-.580***	-.394***
CTI-Cw3error	CES-Dw3error	-.467***	-.504***	-.496***
ATQ-Rw3error	CES-Dw3error	.495***	.546***	.403***

Note. CES-D = Center for Epidemiological Studies – Depression Scale; DAS = Dysfunctional Attitudes Scale; CNCEQ = Children's Negative Cognitive Error Questionnaire; CTI-C = Cognitive Triad Inventory-Children; ATQ-R = Automatic Thoughts Questionnaire-Revised, negative self-statements; w1 = wave 1; w2 = wave 2; w3 = wave 3; error = error term.

** $p < .01$; *** $p < .001$.

Table 4

Standardized Regression Weights for associations between Waves and Z-Scores for Comparisons Between Girls and Boys.

		all	girls	boys	z-scores
DASw1	DASw2	.500***	.523***	.479***	0.64
DASw1	CNCEQw2	.131**	.166**	.083	0.92
DASw1	CTI-Cw2	-.017	.000	-.043	0.47
DASw1	ATQ-Rw2	.086	.097	.086	0.12
DASw1	CES-Dw2	.020	.038	.001	0.40
CNCEQw1	DASw2	.067	.025	.159*	-1.48
CNCEQw1	CNCEQw2	.435***	.438***	.411***	0.36
CNCEQw1	CTI-Cw2	-.024	-.033	-.023	-0.11
CNCEQw1	ATQ-Rw2	.137*	.134*	.119	0.17
CNCEQw1	CES-Dw2	.041	.030	.050	-0.22
CTI-Cw1	DASw2	-.003	.031	-.015	0.50
CTI-Cw1	CNCEQw2	.006	.035	-.032	0.73
CTI-Cw1	CTI-Cw2	.494***	.298***	.679***	-5.68***
CTI-Cw1	ATQ-Rw2	-.203	-.137	-.335*	2.30*
CTI-Cw1	CES-Dw2	-.079	-.017	-.174*	1.74
ATQ-Rw1	DASw2	.043	.085	-.031	1.27
ATQ-Rw1	CNCEQw2	.165***	.092	.281***	-2.15
ATQ-Rw1	CTI-Cw2	-.057*	-.070*	-.064	-0.07
ATQ-Rw1	ATQ-Rw2	.408***	.333***	.525***	-2.59*
ATQ-Rw1	CES-Dw2	.093***	.096**	.097*	-0.01
CES-Dw1	DASw2	.128	.093	.170	-0.86
CES-Dw1	CNCEQw2	.152	.285**	-.002	3.23***
CES-Dw1	CTI-Cw2	-.050	-.151**	.017	-1.85
CES-Dw1	ATQ-Rw2	.243*	.380**	.070	3.61***
CES-Dw1	CES-Dw2	.411***	.433***	.361***	0.94

DASw2	DASw2	.602***	.619***	.580***	0.67
DASw2	CNCEQw3	.157***	.146**	.168*	-0.25
DASw2	CTI-Cw3	-.027	-.068**	.034	-1.12
DASw2	ATQ-Rw3	.164**	.269***	.008	2.93**
DASw2	CES-Dw3	.023	-.003	.068	-0.78
CNCEQw2	DASw3	.129**	.109*	.175*	-0.74
CNCEQw2	CNCEQw3	.615***	.567***	.719***	-2.87
CNCEQw2	CTI-Cw3	-.045	-.065*	.011	-0.83
CNCEQw2	ATQ-Rw3	.152*	.165*	.091	1.70
CNCEQw2	CES-Dw3	.051	.069	.006	0.69
CTI-Cw2	DASw3	.246*	.279*	.190	1.03
CTI-Cw2	CNCEQw3	-.132	-.206	-.007	-2.21*
CTI-Cw2	CTI-Cw3	.514***	.476***	.489***	-0.19
CTI-Cw2	ATQ-Rw3	-.272*	-.334	-.166	-1.97*
CTI-Cw2	CES-Dw3	-.021	-.071	-.055	-0.18
ATQ-RW2	DASw3	.021	.016	.028	-0.13
ATQ-Rw2	CNCEQw3	-.028	-.055	.001	-0.61
ATQ-Rw2	CTI-Cw3	-.058*	-.034	-.126*	1.01
ATQ-Rw2	ATQ-Rw3	.344***	.263**	.513***	-3.25***
ATQ-Rw2	CES-Dw3	.062*	.058	.063	-0.05
CES-Dw2	DASw3	.091	.148	-.061	2.30*
CES-Dw2	CNCEQw3	.069	.070	.132	-0.68
CES-Dw2	CTI-Cw3	.004	-.031	-.013	-0.20
CES-Dw2	ATQ-Rw3	.142	.208	.012	2.18*
CES-Dw2	CES-Dw3	.430***	.424***	.317***	1.36

Note. CES-D = Center for Epidemiological Studies – Depression Scale; DAS = Dysfunctional Attitudes Scale; CNCEQ = Children's Negative Cognitive Error Questionnaire; CTI-C = Cognitive Triad Inventory-Children; ATQ-R = Automatic Thoughts Questionnaire-Revised, negative self-statements; w1 = wave 1; w2 = wave 2; w3 = wave 3; error = error term.

* $p < .05$; ** $p < .01$; *** $p < .001$.

Table 5

Confidence Intervals for all Possible Mediation Effects in the Bidirectional Model.

	all		girls		boys	
	Lower CL	Upper CL	Lower CL	Upper CL	Lower CL	Upper CL
Bidirectional model						
DASw1 – CNCEQw2 – CTI-Cw3	-.001	.028	-.025	-.001*	-	-
DASw1 – CNCEQw2 – ATQw3	.003	.044*	.003	.064*	-	-
DASw1 – CNCEQw2 – CES-Dw3	-.001	.017	.001	.028*	-	-
CNCEQw1 – ATQ-Rw2 – CES-Dw3	.000	.021	-	-	-	-
CTI-Cw1 – ATQw2 – CES-Dw3	-.037	.003	-	-	-	-
ATQ-Rw1 – CNCEQw2 – DASw3	.005	.044*	-	-	.002	.111*
ATQ-Rw1 – CTI-Cw2 – DASw3	-.033	-.001*	-.049	-.001*	-	-
CES-Dw1 – ATQ-Rw2 - CNCEQw2	-.035	.017	-	-	-	-
CES-Dw1 – ATQ-Rw2 – CTI-Cw3	-.036	-.001*	-	-	-	-
CES-Dw1 – CNCEQw2 –DASw3	-	-	.001	.077*	-	-
CES-Dw1 – CTI-Cw2 –DASw3	-	-	-.102	-.002*	-	-

Note. A statistically significant mediation effect exists when the 95% confidence interval do not contain zero. CL = Confidence Limit; CES-D = Center for Epidemiological Studies – Depression Scale; DAS = Dysfunctional Attitudes Scale; CNCEQ = Children's Negative Cognitive Error Questionnaire; CTI-C = Cognitive Triad Inventory-Children; ATQ-R = Automatic Thoughts Questionnaire-Revised, negative self-statements; w1 = wave 1; w2 = wave 2; w3 = wave 3

* $p < .05$

Figure 1. Path diagrams of each of the tested structural equation models. Solid lines represent paths in the models with full mediation, dashed lines represent paths in the models with partial mediations.