Cogn Ther Res (2017) 41:730–744
DOI 10.1007/s10608-017-9842-0

ORIGINAL ARTICLE

How dysfunctional are Dysfunctional Attitudes? A Threshold Model of Dysfunctional Attitudes and Depressive Symptoms in Children and Adolescents

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Published online: 17 March 2017

Abstract In order to clarify further the role of Beck's vulnerability-stress model in the early development of depression, this longitudinal study tested a threshold model of dysfunctional attitudes in children and adolescents. An initially asymptomatic sample of 889 youths aged 9–18 years completed measures of dysfunctional attitudes and depressive symptoms. Twenty months later, participants reported stressful life events and current depressive symptoms. Results support a threshold view of cognitive vulnerability as only dysfunctional attitudes above a certain threshold significantly interacted with life events to predict depressive symptoms. Thus, findings suggest that dysfunctional attitudes must exceed a certain threshold to confer vulnerability to depressive symptomatology in youth. The term "dysfunctional" might therefore only apply to higher levels of the "dysfunctional attitudes" proposed by A. T. Beck. Results also indicate that studies using non-clinical samples may systematically underestimate the effect of dysfunctional attitudes when relying on conventional linear methods.

Keywords Cognitive vulnerability · Depression · Children · Adolescents · Dysfunctional attitudes · Threshold models

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Introduction

Despite extensive research on Beck´s cognitive theory of depression, evidence is still inconclusive regarding the applicability of this cognitive vulnerability-stress model to the emergence of depression in childhood and adolescence (Hankin 2012; Lakdawalla et al. 2007). This shortcoming demands further investigation as the majority of depressive disorders in adults originate in youth (Kim-Cohen et al. 2003) and therefore, investigating the development of depression within this young age range is vital to a thorough etiological understanding of the disorder.

The vulnerability-stress component of Beck´s theory posits that maladaptive self-schemata, i.e., latent cognitive structures, predispose an individual to depression (Beck 1967, 1987). According to Beck´s theory, these schemata are formed during childhood and organized as a set of dysfunctional attitudes, which remain latent until being activated by the experience of stress. Thus, dysfunctional schemata are thought to increase the likelihood of experiencing depression, but only in the presence of stress such as negative life events. Beck´s theory was originally conceptualized to explain depression in adults and has received mixed empirical support (e.g. Lakdawalla et al. 2007; Seeds and Dozois 2010). In recent years, several studies have tested whether Beck's vulnerability-stress component may be of use in predicting child and adolescent depression, and findings from these works also draw a heterogeneous picture:

A first comprehensive test of Beck´s vulnerability-stress component was carried out by Lewinsohn et al. (2001). In their prospective study assessing more than 1.500 adolescent participants, an interaction between initial levels of dysfunctional attitudes and subsequent negative life events was tested for its power to predict depression 1 year later. Results supported the vulnerability-stress hypothesis,

but only when dysfunctional attitudes exceeded a certain threshold.

Subsequent studies, too, obtained only partial support for Beck's vulnerability-stress hypothesis in children and adolescents: In several studies, significant effects only emerged in certain subgroups, for example in participants with low (Abela and Skitch 2007) or high (Abela and Sullivan 2003) self-esteem or at a certain age (D'Alessandro and Burton 2006). Other authors report significant vulnerability-stress effects only for a specific type of depressive symptoms (Hankin et al. 2008) or of maladaptive schemata (Calvete et al. 2013).

Thus, research provides some support for Beck's vulnerability-stress hypothesis, but a thorough understanding of how dysfunctional attitudes and depression relate to each other in children and adolescents, and to which subpopulations this association might be restricted, is still lacking. Moreover, when an interaction between dysfunctional attitudes and stress was detected, effect sizes were typically small to very small (Lakdawalla et al. 2007). Hence, empirical support for Beck's vulnerability-stress model is limited in children and adolescents. On the other hand, some important issues have not been addressed exhaustively. These relate, amongst others, to the possibility of other than strictly linear effects (Gibb et al. 2004; Lewinsohn et al. 2001) and the impact of the sample selection (Dykman and Johll 1998; Jacobs et al. 2008). It is the aim of the present study to enhance evidence on these questions, which will be outlined in more detail below.

Discontinuous Linear and Nonlinear Effects of Dysfunctional Attitudes

One reason for the weak associations reported by past research may be found in an over-reliance on traditional methods modeling continuous linear associations while the relationship between dysfunctional attitudes childhood and adolescent depression might actually be of a different shape. For example, the relationship between low levels of dysfunctional attitudes and depression might be weak or even very weak while high levels of dysfunctional attitudes might be much more closely related to the development of depression. On a conceptual level, this means that dysfunctional attitudes might confer vulnerability to depression only when strongly endorsed and thus might not be "dysfunctional" *per se* but only *become* dysfunctional when reaching a critical level.

The content of dysfunctional attitudes as commonly measured by the *Dysfunctional Attitudes Scale* (*DAS*; Weissmann and Beck 1978) and the mechanism by which they are hypothesized to confer vulnerability to depression (Beck 1967) can illustrate this idea: The *DAS* assesses dysfunctional beliefs regarding themes like personal failure, deprivation or rejection. According to Beck et al. (1979), dysfunctional attitudes lead to a biased interpretation of stressful events in terms of the maladaptive schemata and thereby produce negative affect which ultimately results in depression. Considering other than strictly linear effects of dysfunctional attitudes, however, might suggest that only maladaptive schemata which are strong enough to cause biased interpretations of stressful events in terms of personal failure or rejection might show vulnerability effects. Mild dysfunctional attitudes, on the contrary, might not elicit maladaptive processing of negative events and therefore not produce (statistically detectable) effects on depression.

So far, research addressing the possibility that the relationship between cognitive vulnerability variables and depression might be other than strictly linear is sparse: Results of the above-mentioned study by Lewinsohn et al. (2001) indicated that the hypothesized vulnerability-stress interaction only existed above a certain level of dysfunctional attitudes, i.e., no relationship between dysfunctional attitudes and depression was found in the lower range of dysfunctional attitudes, while a linear relationship the upper quartile of the spectrum could be shown. For the course of this paper, we will refer to this kind of *discontinuous linear* effect, which shows no relationship at low levels, but a linear effect when a certain point in the spectrum is exceeded, as *threshold* effect.[1]

Besser et al. (2007) specifically investigated nonlinear relations between depression and the *Depressive Experiences Questionnaire* (*DEQ*) factors dependency and self-criticism, two constructs which are conceptually closely related to dysfunctional attitudes (Blatt et al. 1976; Rude and Burnham 1993). It was found that associations between both variables and depression were of cubic shapes: Vulnerability effects of dependency and self-criticism were detected in the low and in the high ranges, whereas intermediate levels were not neutral but even showed resilience effects with regard to depression. The authors conclude that it is vital to consider the possible complexity of associations when seeking to determine the strength and even direction of relations between putative vulnerability factors and depression.

In contrast to Lewinsohn et al. (2001) and Besser et al. (2007), whose results were obtained by regression analytic techniques, i.e., by a variable-centered approach analyzing *quantitative* differences in the spectrum of dysfunctional attitudes, Gibb and colleagues (2004) pursued

[1] Note that the described discontinuous linear effect differs from truly *nonlinear* effects in which the strength of the association between two variables changes continuously along the spectrum of one variable.

a person-centered approach and conducted a taxometric analysis of cognitive vulnerability to test for *qualitative* differences between dysfunctional attitudes at different levels. While their results support the dimensional nature of cognitive vulnerability, it was also revealed that the strength of the relationship between cognitive vulnerability variables (including dysfunctional attitudes) and depression varies along the continuum of vulnerability and becomes stronger at higher levels of dysfunctional cognitions.

In summary, although only little research involving discontinuous linear or nonlinear effects has as yet been conducted, the available findings suggest an association between cognitive vulnerability factors and depression which becomes stronger at higher levels of dysfunctional cognitions. As results of the most comprehensive test of Beck's vulnerability-stress model in youth to date, the study by Lewinsohn and colleagues (2001), were suggestive of a threshold view of dysfunctional attitudes, the current study explores a threshold model in which dysfunctional attitudes confer vulnerability to depressive symptoms only when exceeding a critical level. Thus, in accordance with the findings reported by Lewinsohn et al. (2001) and Besser et al. (2007), the current study aims to examine the idea that dysfunctional attitudes may emerge to confer vulnerability when reaching a critical *quantitative* threshold within their spectrum (or, in other words, a "tipping point").

A regression technique specifically designed to test discontinuous linear relationships like the hypothesized threshold effect will be employed in order to gain a better understanding of the type of associations. As Gibb et al. (2004) pointed out, studies using non-clinical samples with low overall levels of vulnerability might systematically underestimate the effect of cognitive vulnerability variables in the case of a nonlinear influence of cognitive vulnerability on depression. Likewise, support for a threshold effect in the association between dysfunctional attitudes and depression might put the weak associations reported by past research into perspective and explain the current inconsistency of findings.

Impact of Subject Selection

Furthermore, a lack of differentiation between initially asymptomatic individuals and individuals who already suffer from depressive symptomatology at the outset of a study can complicate the identification of cognitive vulnerabiliies. As pointed out by Dykman and Johll (1998; see also Monroe et al. 1986), cognitive models of depression are implicitly conceptualized as *acute onset* models in which initially symptom-free but vulnerable individuals become depressed after experiencing stress. This is also true for Beck's cognitive vulnerability-stress component, which suggests that maladaptive schemata may play a critical role in the initial emergence of depression, and which does not target their role in the maintenance of or remission from depression.

Accordingly, it is common in clinical studies to exclude participants who already suffer from depression upon study entrance (Alloy et al. 2006; Lewinsohn et al. 2001) because it must be expected that causal mechanisms involving vulnerability/risk factors and symptomatology vary considerably between initially symptom-free and initially depressed individuals: First, depressed youths and adults have repeatedly been shown to behave in ways which increase the likelihood of negative events happening to them (e.g. Auerbach et al. 2014; Chun et al. 2004; Joiner et al. 2005; Rudolph et al. 2000). Likewise, depression may have caused or reinforced dysfunctional cognitions in symptomatic individuals. Moreover, research has demonstrated elevated levels of cognitive vulnerability in individuals currently experiencing depressive symptoms or an episode of major depression (Beevers and Miller 2004; Ormel et al. 2004; Zuroff et al. 1999). The cognitive vulnerability scores of these individuals can therefore not be regarded solely as indicators of a predisposing factor; they might also reflect a symptom or consequence of depression.[2]

As pointed out by Dykman and Johll (1998), problems in establishing clear causal relationships may also occur in studies investigating depression at the level of symptoms when initially dysphoric participants are included. Apart from the factors described above, the authors argue that for participants exhibiting high depressive symptoms at the outset of a study, there is less potential for further increases in depressive symptomatology und thus less potential for predictors to show significant effects above the effect of previous symptomatology. Moreover, depressive symptomatology is likely to influence the reaction to the experience of stress, adding unexplained variance to the predictive model and thus making the contribution of vulnerability factors harder to detect. Hence, the authors advise to exclude initially symptomatic participants when examining effects of putative vulnerability or risk factors, following the rationale of a behavioral high-risk design (see e.g. Alloy et al. 2006).

[2] Note that although these "reverse" effects and the effects postulated in Beck's vulnerability-stress model are not mutually exclusive, detecting causal relationships can be impeded when using unselected samples. Moreover, it is not ruled out that cognitive vulnerability factors may not contribute to the further course of the symptomatology once an individual suffers from elevated depressive symptom levels. It is rather suggested that empirically demonstrating effects of putative vulnerability factors is complicated considerably when using unselected samples.

To our knowledge, the study by Dykman and Johll (1998) represents the only attempt so far to systematically investigate the effect of including already depressed individuals in a cognitive vulnerability study. They found that the interaction between dysfunctional attitudes and stress was significant in the subsample of initially asymptomatic individuals, but only when initially symptomatic participants were not included into the data analyses. The authors therefore emphasize the need for testing Beck's vulnerability-stress model as a model of acute depression onset by excluding initially symptomatic participants (see also Monroe et al. 1986 for a further illustration of the effects of including symptomatic participants in longitudinal studies; Roberts and Monroe 1992). However, as no attempt to replicate Dykman and Johll's findings in a cognitive vulnerability study has been made so far, more research addressing this matter is desirable (Jacobs et al. 2008).

In the present study, we propose that examining a child and adolescent sample enables us to test Beck's theory as a model of acute development of depressive symptomatology as first symptoms of depression typically occur at this young age, and thus mechanisms underlying this early development of depressive symptomatology can be captured.

The Present Study

In the present study, data from the "Potsdamer Intrapersonale EntwicklungsRisiken" project (*PIER*; "*Potsdam intrapersonal developmental risks"*) was used to examine Beck's vulnerability-stress component in a large sample of children and adolescents. Time 1 measures included depressive symptoms and dysfunctional attitudes. Twenty months later, at Time 2, stressful life events of the past year and present depressive symptoms were assessed. We further explored Beck's vulnerability-stress model by:

a) testing for "threshold" effects of dysfunctional attitudes in addition to the usually employed linear methods and
b) examining an initially asymptomatic sample of children and adolescents in order to test Beck's theory as a model of acute development of depressive symptoms.

Based on the findings by Gibb et al. (2004) and Lewinsohn et al. (2001), we predicted that in the initially asymptomatic sample, the interaction between dysfunctional attitudes and stressful life events would significantly predict future depressive symptoms only when a certain critical level in the dysfunctional attitudes spectrum would be exceeded.

Methods

Participants

Participants were recruited from local schools in Potsdam and the surrounding federal state Brandenburg (Germany), and took part in a larger longitudinal project examining intrapersonal developmental risk factors in children and adolescents (*PIER* study). Data used for the current study were first collected in 2011/2012 and again in 2013/2014 with a mean interval between assessments of $M = 20.06$ months ($SD = 3.00$ months). Participants came from 122 different schools and from urban (47.1%), suburban (36.5%) and rural (16.3%) areas. At T1, 36.5% of participants attended a primary school, 46.0% a secondary school, 9.7% a comprehensive school and 7.8% other school types.

At Time 1, 1489 children aged between 9 and 18 years ($M = 13.39$, $SD = 2.00$) took part. Of these, 1063 also completed Time 2 assessments. After excluding children and adolescents who reported elevated depressive symptoms at study entrance (n = 174), the final sample consisted of N = 889 participants with a mean T1 age of 13.05 years ($SD = 1.90$; 51.7% male). At T2, participants´ mean age was $M = 14.76$ years ($SD = 1.88$). Study dropouts between T1 and T2 did not differ from study completers regarding gender distribution and T1 depressive symptoms. However, compared to completers, dropouts were significantly older and showed higher dysfunctional attitudes at T1. Effect sizes for differences between groups were negligible for dysfunctional attitudes (Cohen's $d < 0.2$), but moderate for age (Cohen's $d = 0.58$). Increased dropout in older participants was largely due to participants moving away after finishing school in order to start higher education or vocational training.

Procedure

After parents or participants of age had provided written informed consent, children and adolescents completed the assessments in standardized individual 1.5–2 h sessions in their schools. Alternatively, assessments took place at the children´s homes or on the university campus if schools were unable to provide rooms for data collection. Participants completed all questionnaires privately on a netbook or via paper and pencil, except for the stressful life events interview, which was conducted face-to-face. All participants received a cinema voucher in reward for their participation. The procedure and instruments applied in the study were approved by the Ethics Committee of the University of Potsdam and the Ministry of Education of the German Federal state of Brandenburg.

Table 1 Descriptive statistics & bivariate correlations

	M (SD)	Range	1	2	3	4	5
1. DEP T1	5.58 (3.52)	0–13	–	0.269**	0.136**	0.417**	0.069*
2. DA T1	0.90 (0.48)	0–2.59	–	–	0.032	0.145**	0.267**
3. SLE T2	2.76 (2.07)	0–12	–	–	–	0.232**	0.183**
4. DEP T2	5.93 (5.13)	0–33	–	–	–	–	0.087**
5. Age T1	13.05 (1.90)	9–18	–	–	–	–	–

DA Dysfunctional attitudes, *DEP* depressive symptoms, *SLE* stressful life events

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

Measures

Dysfunctional Attitudes

To ensure age-appropriate measurement, items from two versions of the *Dysfunctional Attitudes Scale* (DAS; Weissmann and Beck 1978) were used: children younger than 14 years completed a translation of the *Dysfunctional Attitudes Scale for Children* (*DAS-C*) by D'Alessandro and Burton (2006), whereas individuals aged 14 years and older completed the German *Dysfunctional Attitudes Scale for Adolescents* ("Skala dysfunktionaler Einstellungen für Jugendliche (DAS-J)"; Keller et al. 2010). Both scales assess dysfunctional attitudes based on the DAS by Weissmann and Beck (1978) and use a 5-point Likert scale (0 = *disagree* to 4 = *agree*). The *DAS-C* consists of 22 items and the *DAS-J* of 20 items.

A procedure of extracting content equivalent item pairs from the two scales and subsequently collapsing scales across age groups was applied to ensure that dysfunctional attitudes were measured in an age-appropriate manner without requiring a division of the sample: First, pairs of content equivalent items from the *DAS-C* and *DAS-J* were identified so that for each item drawn from the *DAS-C*, one item expressing comparable content was drawn from the *DAS-J* (e.g. item 13 from the *DAS-C* "*If I disagree with other people, then they will hate me*" was paired with item 5 from the *DAS-J* "*If someone disagrees with me, it probably means that he/she doesn´t like me"*). Items for which no comparable counterpart existed were excluded from subsequent analyses.

This procedure resulted in two comparable sets of 17 items. Principal components analyses of the 17 items drawn from the *DAS-C* and the 17 items drawn from the *DAS-J* showed almost identical, essentially unidimensional structures with slopes in the scree plots approaching a horizontal line after the first eigenvalue (5.124, then 1.461, 1.031, 1.014 for the *DAS-C* items and 4.427, then 1.617, 1.237, 1.119 for the *DAS-J* items). Internal consistency of the obtained scales was $\alpha = 0.83$ for the *DAS-C* items and $\alpha = 0.79$ for the *DAS-J* items.

The final dysfunctional attitudes variable consisted of unstandardized mean scores of the age-appropriate item set (range 0–4). We decided against the age-standardization of raw scores as we were specifically interested in the impact of the *absolute* level of dysfunctional attitudes on the strength of their associations to depressive symptoms. Because a significant age trend emerged in the data with older participants reporting higher levels of dysfunctional attitudes (see Table 1), a standardization within the respective age group would have resulted in a loss of information regarding the absolute level of dysfunctional attitudes. As we hypothesized that dysfunctional attitudes would confer vulnerability when exceeding a certain absolute level (as opposed to elevated levels relative to one's age group), using unstandardized mean scores seemed appropriate.

Depressive Symptoms

The *Depression Test for Children*, a German self-report depression inventory designed for screening purposes was used to assess depressive symptoms in children and adolescents ("Depressionstest für Kinder [DTK]" Rossmann 2005). We used the two subscales "dysphoria/self-esteem" (25 items) and "tiredness/psychosomatic complaints" (14 items). The items are answered in a *yes/no* format and added up to a sum score, which represents the total number of reported depressive symptoms. The *DTK* has demonstrated good reliability and validity (Frühe et al. 2012; Rossmann 2005) including high correlations with the *Children's Depression Inventory* (Kovacs 1992, 2003; Rossmann 2014), and has successfully been employed in depression research in child and adolescent samples (Bondü and Esser 2015; Schwarz and Beyer 2008). It reached a Cronbach´s $\alpha = 0.86$ at T1 and $\alpha = 0.82$ at T2 in the current study.

Because no validated clinical cut-offs have been reported for this depressive symptom measure, a cut-off point to categorize participants as "symptomatic" at Time 1 was chosen according to the conventional criterion of the top 15% of the sample distribution constituting the "extreme group" of participants (Deater-Deckard et al. 1997; Eley 1997).

This cut-off corresponded to cut-off points suggested for screening purposes by Frühe et al. (2012). Thus, participants scoring in the top 15% of the *DTK* distribution at T1 were dropped from analysis. Choosing such a comparatively soft criterion to categorize participants as "symptomatic" was necessary as it should be ensured that our sample would truly consist of initially asymptomatic participants so that our analyses would detect the first indicators of depressive symptomatology as intended.

Stressful Life Events

Stressful life events were assessed via a semi-structured interview which was modelled after the *Munich Event List* (Maier-Diewald et al. 1983), a widely used instrument assessing stressful life events via a combination of self-report checklists and face-to-face interview (e.g. Asselmann et al. 2015; Perkonigg et al. 2004; Wittchen et al. 1989). For economic reasons, the self-report checklist was not administered and only a face-to-face interview was conducted. Participants were asked if stressful events in the following categories had occurred during the past year: parents/family, school/education, leisure/friends, romantic relationships, health, and others. If an event had occurred, participants were asked to describe the event and its subjective impact. To ensure comparability with previous studies (e.g. Abela and Skitch 2007; Abela and Sullivan 2003; Lewinsohn et al. 2001), the total number of stressful life events of the past year was used as stress measure for subsequent analyses, and not ratings of subjective or objective impact.

Data Analytic Approach

Data analysis was conducted in two steps. First, linear effects of dysfunctional attitudes, stressful life events and their interaction were tested via hierarchical linear regression analysis. In this linear hierarchical regression model, gender, age, and depressive symptoms at T1 were entered in the first step.[3] Dysfunctional attitudes assessed at T1 and stressful life events reported at T2 were entered in the next step, followed by the interaction between dysfunctional attitudes and stressful life events.

Second, segmented regression analysis was used to model a discontinuous linear threshold effect of dysfunctional attitudes. Segmented regression analysis, a regression technique rarely employed in the field of Applied Psychology (Jauk et al. 2013; Rigotti 2009), allows the determination of a specific point ("breakpoint" or "knot") within the range of the independent variable at which the slope changes significantly (Seber and Wild 2005). It follows the principle of moderated regression analysis: an intercept (ba0) and the direct effect of the independent variable X (ba1* X) as well as an interaction effect of the independent variable and the breakpoint (bb1* $X-$breakpoint* $X \geq$ breakpoint) are included. If there is a significant change in the slope at the breakpoint, then bb1 becomes a significant parameter. All parameters including the breakpoint are estimated by an algorithm looking for a minimization of the sum of squared residuals.

Segmented regression analysis was run using the nonlinear regression function of *IBM SPSS Statistics 22*. The segmented regression model contained the same variables as the linear regression model, but also included an effect of above-breakpoint dysfunctional attitudes and an interaction effect of above-breakpoint dysfunctional attitudes and stressful life events. The model requires entering start values for each parameter. These were gained from hierarchical regression analysis. As no information was available regarding the probable location of the knot in the spectrum of dysfunctional attitudes, we ran the model several times with different start values for the knot, ranging from 0.5 to 3.5 in 0.5 steps, and results did not change.

Results

Preliminary Analyses

A summary of the descriptive statistics and the bivariate correlations is presented in Table 1. Overall, correlations are in line with past research, and show the expected associations. We found a significant age trend for dysfunctional attitudes with dysfunctional attitudes increasing with age. Gender comparisons via *t*-tests showed that girls reported significantly more depressive symptoms at T1 ($T=-4.084$, $p<.001$) and T2 ($T=-7.475$, $p<.001$) and significantly more stressful life events ($T=-3.643$, $p<.001$), whereas boys reported higher dysfunctional attitudes ($T=2.997$, $p=.003$).

Given the intercorrelations of the study variables with age and gender, two- and three-way interactions between stressful life events, dysfunctional attitudes and age or gender, respectively, were tested in separate regression models. Moderating effects of age were all nonsignificant except for the age x stressful life events interaction ($\beta=-0.083$, $T=-2.705$, $p=.007$). Closer inspection of this interaction revealed that younger participants experienced a greater increase in depressive symptoms following stressful life

[3] Note that by entering baseline depressive symptoms prior to other predictors, residual change in depressive symptoms remains to be explained by the subsequent predictors (e.g. Abela and Sullivan 2003; D'Alessandro and Burton 2006). The dysfunctional attitudes and stressful life events variables should thus be interpreted as essentially predicting change in depressive symptoms between T1 and T2.

Table 2 Hierarchical linear regression model predicting T2 depressive symptoms

Variable		B	SE	β	t	p	ΔR^2
Step 1	Age	0.152	0.082	0.055	1.856	0.064	
	Gender***	1.965	0.309	0.192	6.369	0.000	
	T1 DEP***	0.565	0.044	0.388	12.869	0.000	
							0.214***
Step 2	Age	0.030	0.085	0.011	0.359	0.720	
	Gender***	1.897	0.309	0.185	6.139	0.000	
	T1 DEP***	0.515	0.045	0.354	11.352	0.000	
	DA	0.662	0.343	0.062	1.931	0.054	
	SLE***	0.389	0.075	0.157	5.188	0.000	
							0.026***
Step 3	Age	0.720	0.086	0.026	0.838	0.402	
	Gender***	1.832	0.309	0.179	5.931	0.000	
	T1 DEP***	0.511	0.045	0.351	11.298	0.000	
	DA	0.652	0.342	0.061	1.907	0.057	
	SLE***	0.427	0.076	0.173	5.618	0.000	
	SLE × Age**	−0.097	0.036	−0.083	−2.705	0.007	
							0.006**
Step 4	Age	0.068	0.086	0.025	0.798	0.425	
	Gender***	1.824	0.308	0.178	5.917	0.000	
	T1 DEP***	0.513	0.045	0.352	11.362	0.000	
	DA*	0.657	0.341	0.061	1.927	0.054	
	SLE***	0.440	0.076	0.178	5.770	0.000	
	SLE × Age**	−0.112	0.037	−0.095	−3.053	0.002	
	DA × SLE	0.310	0.160	0.058	1.945	0.052	
							0.003

DA Dysfunctional attitudes, *DEP* depressive symptoms, *SLE* stressful life events

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

events than older participants. This interaction was controlled for in all subsequent analyses. No moderating effects of gender emerged.

Hierarchical Linear Regression Analysis

Results of the hierarchical linear regression model are shown in Table 2. To control for the significant interaction between age and life events, this effect was entered prior to the dysfunctional attitudes x life events interaction.

Depressive symptoms at T2 were significantly predicted by gender, T1 depressive symptoms and stressful life events. T1 dysfunctional attitudes were not significantly related to T2 depressive symptoms ($p = .055$), and nor was their interaction with stressful life events ($p = .067$).

Segmented Regression Model

Table 3 presents the parameter estimates obtained from segmented regression analysis. A significant breakpoint in the spectrum of dysfunctional attitudes was detected at 1.82. As displayed in Fig. 1, dysfunctional attitudes above this threshold significantly interacted with stressful life events to predict future depressive symptoms ($p = .021$). This effect resulted in an increase in explained variance by 1.2%.

Table 3 Segmented regression model predicting T2 depressive symptoms

	Estimate	SE	T	p
Age	0.082	0.086	0.953	0.341
Gender***	1.848	0.307	6.020	0.000
T1 DEP***	0.519	0.045	11.533	0.000
DA	0.257	0.382	0.673	0.501
SLE***	0.391	0.079	4.949	0.000
DA × SLE	0.073	0.185	0.395	0.693
SLE × age**	−0.105	0.037	−2.838	0.005
DA × breakpoint	6.044	3.148	1.920	0.055
DA × breakpoint × SLE*	5.058	2.181	2.319	0.021
Breakpoint	1.823	0.091	--	--

DA Dysfunctional attitudes, *DEP* depressive symptoms, *SLE* stressful life events

$R^2 = 0.261$

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

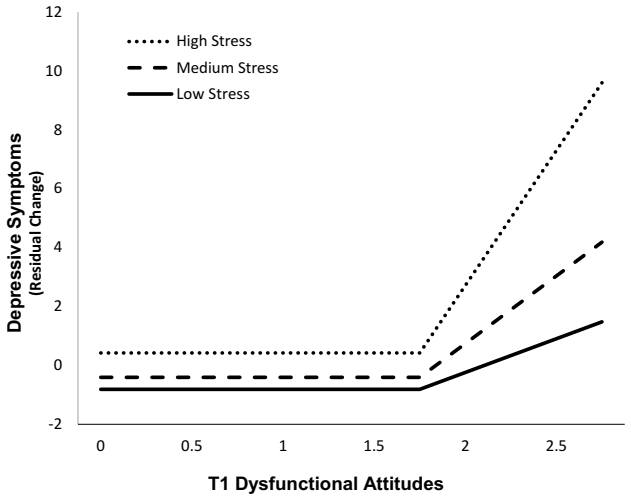

Fig. 1 Regression lines of the empirical best fit of the segmented regression model predicting change in depressive symptoms from T1 to T2 by T1 dysfunctional attitudes and stressful life events ("stress")

Consistent with results from the linear regression model, T1 depressive symptoms and stressful life events were significant linear predictors of T2 depressive symptoms, but neither the linear component of dysfunctional attitudes nor their interaction with life events reached significance. The direct effect of above-breakpoint dysfunctional attitudes also remained nonsignificant.

In an additional segmented regression model, all possible two-and three-way interactions between age, above-breakpoint dysfunctional attitudes and stressful life events were tested, but yielded nonsignificant results. The same was true for two- and three-way interactions between gender, above-breakpoint dysfunctional attitudes and stressful life events.

Because of the exploratory nature of the breakpoint estimation in the segmented regression analysis, additional analyses were performed to gain information on the reliability of the obtained breakpoint. For this purpose, the sample was randomly divided into subsamples A and B (n_A = 444, n_B = 445), which did not differ in distributions of gender, age, T1/T2 depressive symptoms, stressful life events, and dysfunctional attitudes. Next, to test if the previously obtained breakpoint could be replicated, the exploratory breakpoint estimation—as described above—was conducted with subsample A, and the thereby obtained breakpoint was then entered in the regression equation in subsample B. Breakpoint estimation in subsample A yielded a significant breakpoint at 1.81, which almost perfectly replicated the breakpoint estimated in the original analyses. Above-breakpoint dysfunctional attitudes significantly interacted with stressful life events. The breakpoint was also significant in the "confirmatory" analysis in subsample B, which revealed significant effects of above-breakpoint dysfunctional attitudes and their interaction with life events (detailed results are presented in Appendix 2). Results of these additional analyses were thus supportive of the reliability of the demonstrated threshold effect of dysfunctional attitudes.

Splitting the sample at the obtained breakpoint of 1.82 revealed that n = 848 participants scored below the obtained threshold and n = 41 participants above. An illustration comparing the effect of stressful life events in the two groups can be found in Appendix 1. Participants scoring above the breakpoint reported more depressive symptoms at T1 and T2 than those scoring below ($T_{T1} = -3.695$, $p = .001$, and $T_{T2} = -2.881$, $p = .006$), while groups did not differ regarding gender, age, or number of experienced life events (all $ps > 0.18$).

Supplementary Analyses

Polynomial Regression Analysis

To ensure that truly nonlinear associations such as quadratic or cubic effects would not have fit the data better than the proposed threshold model, we also tested a polynomial regression model including squared and cubic values of dysfunctional attitudes. For this purpose, the linear regression model described above was extended by entering nonlinear effects in steps 5–8, with quadratic and cubic values of dysfunctional attitudes included in steps 5 and 6, and interactions between squared and cubic values of dysfunctional attitudes in steps 7 and 8. This procedure revealed a significant cubic effect of dysfunctional attitudes ($B = 1.526$, $SE = 0.749$, $p = .042$, $\Delta R^2 = 0.004$), while all other effects involving nonlinear components of dysfunctional attitudes were nonsignificant (all $ps > 0.09$). Inspection of this cubic effect revealed a weak positive effect of dysfunctional attitudes at very low to low levels, a weak negative effect at low to moderate levels of dysfunctional attitudes, and a strong positive effect at moderate and high levels. With $R^2 = 0.247$, the total explained variance for the polynomial regression model was somewhat lower than for the segmented model.

Unselected Sample

In an exploratory analysis, effects of dysfunctional attitudes were also examined in the unselected sample including participants presenting symptomatic at study entrance. To this end, all analyses described above—linear, segmented and polynomial regression analyses—were conducted with the unselected sample. As in previous analyses, T2 depressive symptoms were significantly predicted by gender ($B = 2.344$, $SE = 0.300$, $p < .001$), T1 depressive symptoms ($B = 0.510$, $SE = 0.025$, $p < .001$) and stressful life events ($B = 0.321$, $SE = 0.070$, $p < .001$), but no significant linear,

threshold or nonlinear effects of dysfunctional attitudes emerged (all $ps > 0.18$).

Discussion

In order to examine a threshold model of the relationship between dysfunctional attitudes on future depressive symptoms in an initially non-depressed sample of children and adolescents, hierarchical linear and segmented regression models were tested. The former revealed a significant effect of stressful life events, but nonsignificant effects of dysfunctional attitudes and their interaction with life events on change in depressive symptoms. The segmented regression model, however, provided evidence for a threshold view of dysfunctional attitudes as a significant threshold was detected within the range of dysfunctional attitudes. Results indicated that dysfunctional attitudes above this threshold significantly interacted with stressful life events to predict future depressive symptoms. Dysfunctional attitudes below this threshold, however, were unrelated to future depressive symptoms.

The obtained threshold was estimated at approximately 1.8 within the dysfunctional attitudes scale, labels of which were 0 = *completely disagree*, 1 = *partly disagree*, 2 = *neutral*, 3 = *partly agree*, and 4 = *completely agree*. That is, participants scoring above the threshold appear to be those who do not generally disagree with the dysfunctional statements. A relationship to future depressive symptoms only emerged for this group of participants, which turned out to represent only a small proportion of the sample (4.6%). This group showed higher depressive symptoms at T1 and T2 than the participants scoring below the threshold, but no patterns regarding the experience of stressful life events, age or gender emerged.

It was beyond the scope of the present paper to investigate whether the subgroup of children and adolescents exhibiting above-threshold dysfunctional attitudes also differs from their peers in other dimensions (e.g. other cognitive risk factors) and thus constitutes a specific risk group for the development of depression in youth.[4] Clearly, this would be an important question to be addressed by future research. In this context, making use of person-centered methods could represent a fruitful approach to the identification of at-risk children and adolescents.

Consistent with the concept of a vulnerability factor, the small number of participants scoring above the threshold suggests that dysfunctional attitudes are indeed not a ubiquitous phenomenon among children and adolescents, but that they are endorsed by only a small proportion of the population. It also underlines the urgency of considering threshold or nonlinear effects when working with nonclinical samples in cognitive vulnerability studies.

Dysfunctional attitudes below the detected threshold were not related to an increased proneness to depressive symptoms in the current study, indicating that whether an individual would "completely" or only "partly" disagree with the dysfunctional statements is not predictive of the development of depressive symptoms. It thus appears that finding a grain of truth in the dysfunctional statements—as implied by the label "partly disagree"—is not dysfunctional with regard to depression risk. Items of the employed dysfunctional attitudes scale mostly capture perfectionistic achievement standards as well as personal standards regarding the importance of approval by others, e.g. "My value as a person depends greatly of what others think of me" or "Kids must be best at everything they do". It could be argued that individuals who do not *completely* disagree with statements like these may merely demonstrate a realistic perception that accomplishing achievement goals and gaining acknowledgement by one's social environment are important aspects of life. However, our results suggest that a level of "dysfunctionality" is reached when a readiness exists to accept statements like these as correct—then, these attitudes seem to increase children´s and adolescents´ susceptibility to depressive experiences in the light of stress.

It should be noted that the segmented regression model yielded only a small increase in R^2 compared to the linear regression model ($\Delta R^2 = 0.012$). However, the obtained findings should still be considered meaningful for two reasons: First, small or very small effect sizes are to be expected when testing interactions (McClelland and Judd 1993) and have been obtained in previous studies testing Beck's vulnerability-stress model in youth. D'Alessandro and Burton (2006) and Abela and Sullivan (2003) report partial correlations ranging between 0.21 and 0.28, but these were obtained in short-term longitudinal designs covering a time span of one (D'Alessandro and Burton) or six (Abela and Sullivan) weeks. Lewinsohn et al. (2001) found a considerably smaller effect size for the vulnerability – stress interaction in their 1-year longitudinal study (pr = .04, see Lakdawalla et al. 2007). Second,

[4] It can be argued that when looking specifically at a group of individuals reporting particularly high levels of dysfunctional attitudes, the phenomenon of *extreme responding* should be considered. Extreme responding has been defined as the tendency to endorse end-of-scale responses as a result of automatic, rapid information processing, which remains uncorrected by subsequent reappraisal. Extreme responding has been shown to predict relapse in depressed individuals (Forand and DeRubeis 2014; Teasdale et al. 2001). However, it seems unlikely that our above-threshold scoring group represents a group of "extreme responders" as (a) extreme responding has been shown primarily in currently depressed individuals, while the current study drew on an initially non-depressed sample and (b) even in the above-threshold scoring group, extreme answers were endorsed rarely (the average score on the dysfunctional attitudes measure was $M = 2.02$, $SD = 0.19$ with a possible range of the measure of 0–4).

as Adachi and Willoughby (2015) point out, very small effect sizes are common in longitudinal studies when past levels of the outcome construct—in the current study, depressive symptoms—are controlled for. They conclude that current guidelines for interpreting effect sizes may be misleading for longitudinal effects, and that even very small effect sizes should not be considered trivial.

When proposing a threshold view of dysfunctional attitudes, it is important to emphasize that even though a significant threshold was found in the present analyses, in most psychological contexts it is unlikely that there is one specific, exact value above which an effect exists while it is completely absent below this value. To rule out the possibility that curvilinear or cubic associations would have fit the data considerably better, we also tested a polynomial regression model, which revealed a cubic effect of dysfunctional attitudes. However, a comparison of R^2s showed that the segmented regression model performed slightly better at explaining the outcome ($R^2 = 0.261$ for the segmented and $R^2 = 0.247$ for the polynomial model).

Apart from this admittedly small difference in R^2, the segmented model can be regarded as superior to the polynomial model for the following reasons: First, it represents the more parsimonious model as it utilizes only three parameters to test the hypothesized threshold effect (intercept, slope 1, and slope 2) while four parameters are needed in polynomial regression (intercept, linear, quadratic, and cubic terms). Second, the segmented model is also conceptually less complex. At present, there seem to be no theoretical or empirical arguments for assuming a relationship of the complexity indicated by a cubic effect. However, given that differences between the two models are small regarding both R^2 and parsimony, further exploration and comparison of discontinuous linear and truly nonlinear associations between dysfunctional attitudes and depression by future studies is clearly desirable.

The fact that the association between dysfunctional attitudes and depressive symptoms does not seem to be strictly linear may have contributed to the inconsistency of results in the current literature. Our results suggest that whether or not significant vulnerability effects of dysfunctional attitudes can be detected in a study depends, among other factors, on the absolute level of dysfunctional attitudes. As absolute levels of dysfunctional attitudes vary between different samples, divergent results are to be expected when only assessing continuous linear effects.

It is important to highlight that the current findings were obtained by analyzing a sample of initially asymptomatic children and adolescents. In line with Dykman and Johll (1998), our exploratory analysis with the unselected sample including initially dysphoric participants did not yield any linear, threshold or nonlinear effects of dysfunctional attitudes. This suggests that high dysfunctional attitudes may play a critical role particularly during the early development of depressive symptomatology, whereas the further course of the symptomatology in already dysphoric individuals seems to be subject to other determinants. The possibility that dysfunctional cognitions confer vulnerability only with regard to specific stages of the depressive disorder (such as first onset, maintenance or recurrence) has already been addressed in earlier studies (e.g. Alloy et al. 2006; Hankin 2012; Iacoviello et al. 2006; Lewinsohn et al. 1999). However, researchers predominantly compared the predictive utility of dysfunctional cognitions regarding first onsets versus recurrences of depression, mostly yielding no differential effects (Alloy et al. 2006; Lewinsohn et al. 1999, 2001). In contrast, the question of whether dysfunctional cognitions are as predictive of first onset as of the course of symptomatology has received sparse attention.

Because of the dimensional nature of the depression measure and because history of depression was not collected in the present study, it could not be determined if participants of the current study actually experienced a first onset of depression. Therefore, our results should be understood as explaining the emergence of depressive symptoms in previously non-symptomatic individuals (which can, in some cases, represent first indicators of depression). In light of this limitation and of few comparable research findings, a replication of our results with diagnostic data is desirable before addressing the mechanisms underlying these specific effects of dysfunctional attitudes on the initial emergence of depressive symptoms.

The current study provides the first attempt of an explicit test of a threshold model of dysfunctional attitudes. Our findings are in line with those reported by Lewinsohn and colleagues (2001), whose results from a 1-year longitudinal study with initially non-depressed adolescents also implied a threshold view of cognitive vulnerability, however, without providing explicit evidence for such a model. The current results substantiate the idea that only dysfunctional attitudes above a critical level may act as a vulnerability factor for depressive symptoms. However, it should be noted that the lack of a diagnostic outcome measure in the current study also represents a major difference to the work by Lewinsohn et al., whose findings implying a threshold model referred to incidence rates of major depressive disorder. Relatedly, Lewinsohn et al. excluded only participants initially diagnosed with major depressive disorder from subsequent analyses, while in the current study, participants were excluded when exhibiting elevated symptom levels. These differences limit the comparability of the current results with those reported by Lewinsohn et al., and further research is needed to understand if (and how) the use of a dimensional versus diagnostic outcome measure and sample selection procedures affect

the replicability of threshold effects of dysfunctional attitudes.

Of note, no differential effects of dysfunctional attitudes emerged for boys and girls, suggesting that the obtained threshold model equally applies to both genders. Likewise, the reported effects of dysfunctional attitudes were invariant across the entire age range.[5] The absence of moderating effects of age and gender is remarkable considering the well-documented gender difference in depression prevalence as well as developmental hypotheses assuming that cognitive factors such as dysfunctional attitudes may not come to confer vulnerability until a certain age and cognitive maturity has been reached (Nolen-Hoeksema et al. 1992; Turner and Cole 1994). However, the current findings of nonsignificant age interactions do not necessarily refute developmental hypotheses of cognitive vulnerability. Consistent with findings reported by Hankin et al. (2008) and D'Alessandro and Burton (2006), our results suggest that dysfunctional attitudes can already emerge as a vulnerability to depressive symptomatology at pre-adolescent age, but this does not necessarily rule out developmental shifts in the impact of cognitive factors earlier during childhood. Future research investigating developmental hypotheses might thus benefit from further examination of cognitive vulnerability throughout early to late childhood.

Methodological Considerations

By using a depressive symptoms scale, we assessed depression as a dimensional construct. Unfortunately, no clinical benchmarks have been reported for the symptom scale used in the current study. It is thus not clear whether the effects of dysfunctional attitudes and stressful life events revealed in the current study also contribute to the development of clinical depression. However, the similarity of our findings to Lewinsohn et al. (2001) who included clinical diagnoses of depression, and evidence showing that risk factors of subthreshold depressive symptoms and of clinical depression are comparable (Carter and Garber 2011; Hankin et al. 2004) imply that our findings may be transferrable to the development of major depressive episodes. Nevertheless, a replication of our results by future studies assessing clinical depression is certainly necessary to ensure their clinical relevance.

The appropriate operationalization of the "stress"-component of diathesis–stress-models has been addressed in continuous research efforts and debates (Carter and Garber 2011; Cohen et al. 1997; Cole et al. 2011; Compas 1987; Grant et al. 2004). In the current study, the total number of stressful life events reported by the participant was used as an indicator of the amount of stress he or she had experienced during the previous year. The perceived impact of a specific life event, however, was not captured by our operationalization of stress. We assumed that retrospectively evaluating the impact of an experienced event was more likely to be confounded with individuals´ concurrent depressive symptoms than merely naming events that had happened during the past year (see also Abela and Skitch 2007; Monroe and Simons 1991). Moreover, our approach increased the comparability of our results to those of previous studies which mostly used counts of events or hassles (Abela and Skitch 2007; Abela and Sullivan 2003; Hankin 2008; Lewinsohn et al. 2001). However, it remains to be examined by future research if the obtained effect persists when other measures of stress and multi-wave designs allowing independent assessment of stress and depressive symptoms are employed.

Finally, it must be noted that sample selection procedures such as eliminating initially dysphoric participants are controversial, mainly because this might also deplete the subsample of participants with high scores on the vulnerability measure and result in an attenuation of statistical associations due to a restriction in range (Dykman and Johll 1998; Monroe et al. 1986). The possibility that differential effects are active in high ranges of vulnerability was directly addressed by the employed statistical methods so that the depletion of the highly vulnerable subsample would have hindered rather than facilitated the detection of the reported effects. However, categorizing participants in the top 15% of the depressive symptoms distribution as "symptomatic" certainly represents a rather arbitrary cut-off, which had to be drawn upon due to the lack of a validated cut-point for our symptom scale. Clearly, determining the levels of initial symptoms for which the model applies empirically would have been preferable, but was beyond the scope of the present article. Cognitive vulnerability research would thus benefit from future studies examining this question.

Conclusion and Implications

While our findings provide evidence for Beck's cognitive vulnerability-stress model of depression in children and adolescents, the vulnerability effect of dysfunctional attitudes appeared to be a very specific phenomenon which

[5] However, age significantly moderated the impact of life events on future depressive symptoms. This interaction indicated that younger participants experienced a greater increase in depressive symptoms following life events than older participants, which is in line with theories suggesting that in younger children, environmental circumstances such as life events may be particularly strongly linked to depression (Nolen-Hoeksema et al. 1992; Shirk 1988). Further details on this interaction can be received from the first author upon request.

was only present in initially asymptomatic individuals exhibiting high levels of dysfunctional attitudes. This was the case for children and adolescents across the entire age range (9–18 years). The fact that dysfunctional attitudes seem to confer vulnerability to depressive symptoms only when exceeding a certain threshold implies that studies using non-clinical samples with low overall vulnerability levels might systematically underestimate the effect of dysfunctional attitudes. Our findings thus emphasize the necessity of investigating other than linear associations and of testing Beck's model as a model of first, or acute, development of depressive symptomatology.

As this study represents the first explicit attempt to explore a threshold model of cognitive vulnerability, a replication of our findings by future studies using multi-wave designs and addressing more severe levels of depression is desirable. If replicated, however, our findings suggest that early preventive interventions involving the modification of dysfunctional attitudes are promising, but should specifically address risk groups for which high levels of vulnerability are expected.

Acknowledgements We would like to thank the children and adolescents participating in the study as well as the schools and their staff from Potsdam and the area of Potsdam-Mittelmark for their willingness to cooperate and for their support of this research project. We would further like to express our thanks to Anne Wyschkon and Sabine Quandte for their valuable feedback on the manuscript.

Funding This study was funded by the German Research Foundation ("Deutsche Forschungsgemeinschaft"), Grant No. GRK 1668/1.

Compliance with Ethical Standards

Conflict of Interest Susanne Meiser and Günter Esser declare that they have no conflict of interest.

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.

Animal Rights No animal studies were carried out by the authors for this article.

Appendix 1

See Fig. 2.

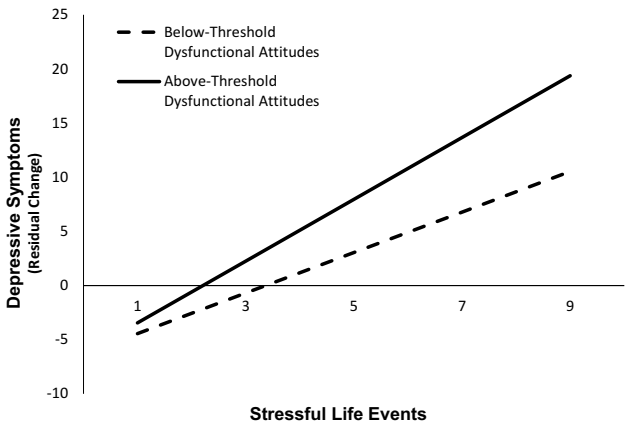

Fig. 2 Prediction of change in depressive symptoms from T1 to T2 by stressful life events in participants scoring above and below the threshold in the spectrum of dysfunctional attitudes

Appendix 2

See Tables 4 and 5.

Table 4 Exploratory breakpoint estimation using segmented regression analysis in subsample A

Variable	Estimate	SE	T	p
Age	−0.052	0.128	−0.406	0.685
Gender***	2.114	0.464	4.556	0.000
T1 DEP***	0.547	0.069	7.297	0.000
DA	0.388	0.567	0.684	0.494
SLE**	0.363	0.119	3.050	0.002
DA × SLE	−0.148	0.291	−0.509	0.611
SLE × Age	−0.064	0.056	−1.143	0.254
DA × Breakpoint	−4.297	5.959	−0.721	0.471
DA × Breakpoint × SLE*	9.294	4.599	2.021	0.044
Breakpoint	1.812	0.087	--	--

DA Dysfunctional attitudes, *DEP* depressive symptoms, *SLE* stressful life events

$R^2 = 0.271$

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

Table 5 Confirmatory test of breakpoint from subsample A using segmented regression analysis with a priori fixed breakpoint in subsample B

	Estimate	SE	T	p
Age*	0.188	0.114	1.649	0.010
Gender***	1.639	0.404	4.057	0.000
T1 DEP***	0.476	0.059	8.068	0.000
DA	0.176	0.498	0.353	0.724
SLE***	0.426	0.103	4.136	0.000
DA x SLE	0.208	0.231	0.900	0.369
SLE x Age**	−0.141	0.049	−2.878	0.004
DA x Breakpoint**	11.612	3.621	3.207	0.001
DA x Breakpoint x SLE*	4.955	2.014	2.460	0.014

DA Dysfunctional attitudes, *DEP* depressive symptoms, *SLE* stressful life events. No coefficients are presented for the breakpoint itself as it was not estimated in this analysis but fixed a priori according the results from subsample A

$R^2 = 0.274$

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

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