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Passing on the Half-Empty Glass: A Transgenerational Study of Interpretation Biases in Children at Risk for Depression and Their Parents With Depression

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Children of parents with a history of depression have an increased risk of developing depression themselves. The present study investigated the role of interpretation biases (that have been found in adults and adolescents with depression but have rarely been examined in at-risk youth) in the transgenerational transmission of depression risk. Interpretation biases were assessed with two experimental tasks: Ambiguous Scenarios Task (AST) and Scrambled Sentences Task (SST) in 9–14-year-old children of parents with a history of depression (high risk; $n = 43$) in comparison to children of parents with no history of mental disorders (low risk; $n = 35$). Interpretation biases were also compared between the two groups of parents and relationships between children's and parents' bias scores were examined. As expected, we found more negative interpretation biases in high-risk children compared to low-risk children as well as in parents with a history of depression compared to never-depressed parents (assessed via the SST but not the AST). However, transgenerational correlations were only found for the AST. Our results indicate that negative interpretation biases are present in youth at risk for depression, possibly representing a cognitive vulnerability for the development of depression. Moreover, different measures of interpretation bias seemed to capture different aspects of biased processing with the more implicit measure (SST) being a more valid indicator of depressive processing.

General Scientific Summary

The study investigated interpretation biases in children of depressed parents in comparison to children of psychiatrically healthy parents. Children at risk for depression showed more negative interpretation biases than low-risk children suggesting that interpretation biases might represent a cognitive vulnerability for the development of depression.

Keywords: interpretation bias, parental depression, transgenerational transmission, Ambiguous Scenarios Task, Scrambled Sentences Task

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Depression is one of the most common psychiatric disorders with lifetime prevalence rates of 12.8% in the European (Alonso et al., 2004) and 16.2% in the United States (Kessler et al., 2003) population. Depressive disorders can have devastating consequences for psychosocial (Hirschfeld et al., 2000) and occupational (Adler et al., 2006) functioning as well as quality of life (Papakostas et al., 2004) and represent a major cause of disability (World Health Organization, 2008).

Among the multiple factors that contribute to the risk of developing depression, having a parent who is or has been suffering from the disorder is of major importance: compared to the offspring of psychiatrically healthy parents, children of parents who have experienced depression have a threefold risk of developing depression themselves (Weissman et al., 2006) with up to 50% being diagnosed with depression by the age of 20 (Beardslee et al., 1988). The most prominent theoretical model of the transgenerational transmission of depression (Goodman & Gotlib, 1999) identifies four core mechanisms by which parental depression may lead to vulnerabilities for depression in the offspring: genetic predispositions; dysfunctional neuroregulatory mechanisms transmitted during pregnancy; exposure to parents' negative or maladaptive cognitions, behaviors, and affect; as well as exposure to a stressful environment. The present study focuses on the role of cognitive mechanisms for the transmission of depression risk, since how parents perceive and process emotionally relevant information may crucially shape the way their children perceive and process these types of information themselves (e.g., Alloy et al., 2001), enabling the formation of cognitive vulnerabilities that place children at higher risk for the development of depression when exposed to stressful life events (Beck, 2008; Goodman & Gotlib, 1999).

Depression is associated with cognitive biases for negative information (i.e., automatic tendencies to overly focus on negative compared to positive or neutral information) in attention, interpretation, and memory[1] (e.g., Everaert, Koster, & Derakshan, 2012) and these biases are proposed to play a role in the development and maintenance of depressive disorders (e.g., Beck, 2008; Beck & Haigh, 2014). Whereas evidence for depression specific biases in implicit memory (Gaddy & Ingram, 2014) and early attention (Armstrong & Olatunji, 2012) is mixed, there seems to be relatively strong evidence for biases in explicit memory (Matt, Vázquez, & Campbell, 1992), higher-order attention (Armstrong & Olatunji, 2012), and interpretation processes (Everaert, Podina, & Koster, 2017).

Interpretation biases are measured in situations where people have to judge ambiguous emotional information in either a positive or negative way. Interpretations can be made during the encounter with the ambiguous material (online) or retrospectively/prospectively (offline; Mathews & MacLeod, 2005). The latter form of interpretations is frequently measured via self-report questionnaires (e.g., Wisco & Nolen-Hoeksema, 2010) which allows a certain degree of reflection and is therefore prone to distorted responding (e.g., Gotlib & Joormann, 2010), while the former type of interpretations can be measured using experimental approaches that allow a more objective assessment of cognitive processes. One frequently used experimental paradigm to assess interpretation biases is the Ambiguous Scenarios Task (AST; Mathews & Mackintosh, 2000). In this task, participants read several self-referent ambiguous scenarios and are then presented with different interpretations of each scenario. The relative endorsement of negative versus positive interpretations is understood as interpretation bias (e.g., Micco, Henin, & Hirshfeld-Becker, 2014). Another experimental approach to measure interpretation biases is the Scrambled Sentences Task (SST; Wenzlaff & Bates, 1998), which was specifically developed to assess interpretation biases in depressive disorders. In this task, participants have to form sentences out of arrays of words. In each trial a positive or a negative sentence can be built with the proportion of negatively resolved sentences indicating the interpretation bias.

There is evidence of negative interpretation biases being related not only to anxiety (see, e.g., Hirsch, Meeten, Krahé, & Reeder, 2016; Mathews, & MacLeod, 2005, for reviews of the adult literature and Stuijfzand, Creswell, Field, Pearcey, & Dodd, 2018, for a meta-analysis of results in children and adolescents) but also to depression in adults (see Everaert et al., 2017, for a meta-analysis) as well as children and adolescents (see Platt, Waters, Schulte-Koerne, Engelmann, & Salemink, 2017, for a review). For example, Hedlund and Rude (1995) found currently as well as formerly depressed adults to show a more negative interpretation bias than never-depressed adults and Micco et al. (2014) found adolescents and young adults with depression to show a more negative interpretation bias compared to a nondepressed group of young people.

However, to clarify the role of interpretation biases for the transgenerational transmission of depression risk, studies in the offspring of depressed parents are necessary. While to date several studies have investigated attention (Gibb, Benas, Grassia, & McGeary, 2009; Joormann, Talbot, & Gotlib, 2007; Kujawa et al., 2011; Owens et al., 2016; Waters, Forrest, Peters, Bradley, & Mogg, 2015) as well as memory biases (Asarnow, Thompson, Joormann, & Gotlib, 2014; Fattahi Asl, Ghanizadeh, Mollazade, & Aflakseir, 2015) in youth at risk for depression, interpretation biases in at-risk children and adolescents have been addressed in only one study: Dearing and Gotlib (2009) compared daughters of mothers with recurrent major depression with daughters of never-depressed mothers and found that the at-risk group showed more negative interpretation biases than the control group, although both groups were psychiatrically healthy. The authors suggested that children might acquire their biased interpretation through the frequent exposure to such biases in their parents, but this transgenerational transmission was not addressed as interpretation biases were not assessed in mothers. Also, the generalizability of the results is limited, since only daughters of mothers with depression were included in the sample and fathers were not taken into account, even though paternal depression also has a negative impact on offspring development (Sweeney & MacBeth, 2016).

To overcome those limitations, the present study was designed to investigate interpretation biases as a possible means for the transgenerational transmission of depression risk by assessing bi-

[1] Note that cognitive biases have to be separated from cognitive deficits (e.g., impairments in executive functioning, attention, and memory) that are found in depressed samples (Hammar & Årdal, 2009), even though there might be interdependencies between deficits and biases (Gotlib & Joormann, 2010).

ases in at-risk youth (9–14-year-old children[2] of parents with a history of depression) as well as their parents in comparison to youth with a low risk for depression (children of parents with no history of psychiatric illness) and their parents. The main aim was to extend the current knowledge about interpretation biases in children and adolescents at risk for depression. By assessing interpretation biases not only in children but also in their parents we pursued two additional aims: (1) to replicate results on interpretation biases in adults with a history of depression, and (2) to examine relationships between interpretation biases in children and their parents. As cognitive models of depression suggest cognitive vulnerabilities such as negative biases to be activated by stressful life events or negative mood (e.g., Beck, 2008; Scher, Ingram, & Segal, 2005), a negative mood induction was applied before administering two different standard tasks (AST and SST) assessing interpretation biases. Additionally, symptoms of depression and anxiety were assessed in order to explore to what extent interpretation biases are (specifically) related to depressive symptoms. Based on theoretical predictions (Beck, 2008; Goodman & Gotlib, 1999) and previous findings (Dearing & Gotlib, 2009), we expected to find more negative interpretation biases in children of parents with a history of depression compared to children of never-depressed parents. Regarding the parents, we expected to find more negative interpretation biases in parents with a history of depression compared to never-depressed parents (consistent with the literature; Everaert et al., 2017). Positive relationships between depressive symptoms and interpretation biases were expected in both, children and parents. In line with a study demonstrating a relationship between children's and their mothers' attention biases (Waters et al., 2015), we expected positive relationships between children's and parents' interpretation biases. This would underline the assumption of interpretation biases being not only a vulnerability factor for depression but also subject to transgenerational transmission.

Method

The present data on interpretation biases were collected within a broader project on cognitive biases in the offspring of parents with depression (Platt, 2017). Data from interpretation bias tasks[3] are presented here while data from attention bias tasks are presented elsewhere (Sfärlea et al., 2019).

Participants

A total of 78 parent-child dyads were included in the data analysis.[4] Of the parents, $n = 43$ had a history of depression (HD group) so their $n = 43$ participating children were considered to have a high risk for depression (HR group). The remaining $n = 35$ parents had no history of depression or any other mental disorder (ND group) so the corresponding $n = 35$ children were considered to have a low risk for depression (LR group). The sample size was based on an a priori power analysis (α error probability = .05; power = .8; one-tailed): For our main aim (comparing HR and LR children) we expected an effect size around $d = 0.6$ (corresponding to Dearing & Gotlib, 2009) and aimed for a total sample of $N = 72$. Some of the HD/HR families were recruited through an ongoing study evaluating an intervention to prevent the development of depression in children of parents with a history of depression[5] (Platt, Pietsch, Krick, Oort, & Schulte-Körne, 2014), while others as well as the ND/LR families were recruited via local advertisements, previous studies, and mailings to randomly selected families with children in the corresponding age range provided by the local registry office.

All participants underwent extensive diagnostic assessment before inclusion in the study. Standardized, semistructured psychiatric interviews were administered to assess psychiatric diagnoses in parents (Diagnostisches Interview bei psychischen Störungen [DIPS]; Schneider & Margraf, 2011) and children (Diagnostisches Interview bei psychischen Störungen im Kindes- und Jugendalter [K-DIPS]; Schneider, Unnewehr, & Margraf, 2009; conducted with child and parent). The DIPS and the K-DIPS are well-established German diagnostic interviews that allow diagnosis of a wide range of psychiatric Axis I disorders according to the *Diagnostic and Statistical Manual of Mental Disorders* (4th ed., text rev.; American Psychiatric Association, 2000) with good interrater-reliabilities (accordance rate of at least 87% was found for all diagnoses; Adornetto, In-Albon, & Schneider, 2008; Suppiger et al., 2008). The interviews were conducted and evaluated by trained interviewers and interrater-reliability in our study was determined for 20% of the sample by an independent researcher rerating audio recordings of the diagnostic interviews. The accordance rate for lifetime diagnosis of depression (predefined criterion) was 94% for the DIPS and 100% for the K-DIPS.

Parents were included in the HD group if they met criteria for major depression ($n = 41$; 80% recurrent episodes; 17% currently depressed) or dysthymia ($n = 2$)[6] during the child's lifetime. Exclusion criteria were a history of bipolar disorder, psychosis, or substance abuse. Twelve parents currently met criteria for at least one other psychiatric disorder, including anxiety disorders and eating disorders (see Supplement 1 in the online supplemental materials). Parents were included in the ND group if they did not meet criteria for any past or current Axis I disorder. To ensure that neither of the parents in the ND/LR families had ever met criteria for a psychiatric disorder, psychiatric diagnoses and depression scores[7] were also obtained from the second parent, whenever possible (i.e., in 77% and 83% of families). The parent groups were comparable in terms of age and gender ratio but differed significantly, as expected, regarding depression and anxiety symptoms (Table 1).

[2] Children younger than 9 years were not included due to concerns about their ability to understand and perform the tasks. Adolescents older than 14 years were not included since the incidence of depression increases substantially after that age (e.g., Weissman et al., 2006) and this study was designed to investigate a high-risk population *before* onset of a depressive disorder.

[3] In addition to the AST and the SST that are presented here, we also piloted a short, picture-based task (resembling that used by Haller, Raeder, Scerif, Cohen Kadosh, & Lau, 2016) but the validity of this task was limited in our study (see Supplement 2 in the online supplemental materials).

[4] Altogether, we tested 81 dyads. One family was excluded due to bad compliance and two because the children had severe reading difficulties.

[5] Of the 27 HD/HR-families that were recruited through the prevention trial, 10 had already participated in the program by the time they took part in the present study.

[6] Analyses excluding these two families revealed the same pattern of results.

[7] Assessed via the DIPS and BDI-II ($M = 1.3$, $SD = 3.1$).

Table 1
Demographic and Clinical Characteristics of the Sample

Variable	Children				Parents			
	HR (n = 43)	LR (n = 35)			HD (n = 43)	ND (n = 35)		
Gender (m/f)	18/25	12/23	$\chi^2 < 1$	*n.s.*	11/32	5/30	$\chi^2 = 1.5$	*n.s.*
Age, *M* (*SD*)	11.5 (1.5)	11.8 (1.6)	$t < 1$	*n.s.*	46.4 (6.1)	45.1 (4.5)	$t_{76} = 1.1$	*n.s.*
IQ, *M* (*SD*)	108.9 (11.3)	112.4 (10.9)	$t_{76} = 1.4$	*n.s.*	n.a.	n.a.		
Depression symptoms, *M* (*SD*)	7.3 (5.4)	5.6 (4.9)	$t_{75} = 1.4$	*n.s.*	10.7 (8.3)	2.1 (3.8)	$t_{61.7} = 6.0$	$p < .001$
Anxiety, *M* (*SD*)	29.9 (6.4)	27.9 (6.3)	$t_{76} = 1.4$	*n.s.*	45.0 (10.0)	30.7 (7.9)	$t_{74} = 6.8$	$p < .001$

Note. In children, depressive symptoms were assessed with the Children's Depression Inventory (DIKJ; raw values presented) and anxiety was assessed with the State Trait Anxiety Inventory for Children-Trait subscale (STAIC-T); in parents, depressive symptoms were assessed with the Beck Depression Inventory-II (BDI-II) and anxiety was assessed with the State Trait Anxiety Inventory-Trait subscale (STAI-T). HR = high risk; LR = low risk; HD = history of depression; ND = never depressed; n.a. = not applicable; *n.s.* = not significant.

Children Aged 9–14 years who did not meet criteria for any current or past Axis I disorder[8] and had an IQ ≥ 85 (assessed using the Culture Fair Test 20 Revision [CFT 20-R]; Weiß, 2006) were included in the study. This resulted in groups that did not differ significantly in terms of age, IQ, gender ratio, as well as depression and anxiety symptoms (see Table 1).

The study was approved by the institutional ethics committee (Project 441–15) and all procedures were in accordance with the latest version of the Declaration of Helsinki. Written informed consent was obtained from all participants after a comprehensive explanation of the experimental procedures. Families received a reimbursement of 50€ for participation.

AST

A computerized version of the AST (Mathews & Mackintosh, 2000; adapted from Belli & Lau, 2014) was used to assess the tendency to interpret ambiguous situations as positive or negative.

Stimuli. Stimuli consisted of 10 ambiguous scenarios, that is, descriptions of self-referent situations that could be interpreted either positively or negatively. For parents, scenarios were translated and adapted from the original scenarios by Mathews and Mackintosh (2000). For children, stimuli were translated and adapted (from Belli & Lau, 2014; Klein, de Voogd, Wiers, & Salemink, 2018; Lothmann, Holmes, Chan, & Lau, 2011) in order to consist of age-appropriate situations. Separate versions for girls and boys were generated. Figure 1 illustrates an example scenario and Supplement 3 in the online supplemental materials provides an English translation of all scenarios.

Task procedure. The trial procedure is depicted in Figure 1. The experiment was presented using E-Prime 2.0 (Psychology Software Tools, 2013). In the first part of the task, each trial started with the title and the description of a situation with one word missing at the end. Participants were instructed to read the description carefully and to imagine they were in that situation. After reading the description, participants pressed the spacebar to reveal a fragment of the missing word. They completed the word by typing the missing letter. Subsequently, a comprehension question that had to be answered by pressing *J* for "yes" and *N* for "no" was presented, followed by feedback. The 10 scenarios were presented in random order.

After the first part, the task continued with a second part in which the title of each scenario was presented with four probe statements. Participants had to rate the similarity of the statements to the original scenario from 1 (*not similar at all*) to 4 (*very similar*). The statements consisted of one valid negative and one valid positive interpretation (targets), as well as one negative statement and one positive statement that were not directly related to the scenario (foils). Including foils allows analyzing the endorsement of negative versus positive interpretations of ambiguous scenarios compared to the tendency to simply endorse nonspecific negative versus positive statements (Belli & Lau, 2014). For each scenario, the four probe statements were presented consecutively in random order. The order of the scenarios was random. To familiarize participants with the task, one neutral scenario preceded the emotionally relevant scenarios in both parts.

Outcome variables. An interpretation bias score (IB_{AST}) was calculated by dividing the mean positive target score by the mean negative target score (e.g., Micco et al., 2014) so that scores <1 indicate a negative interpretation bias and scores >1 indicate a positive interpretation bias. A foil ratio was similarly calculated.

Reliability. Split-half reliability of the task was assessed by correlating bias scores based on odd versus even trials (e.g., Van Bockstaele, Salemink, Bögels, & Wiers, 2017); it was satisfactory in both children (r = .60; $p < .001$) and parents (r = .58; $p < .001$).

SST

A computerized version of the SST (Wenzlaff & Bates, 1998; adapted by Everaert, Duyck, & Koster, 2014) was used to assess the tendency to form negative or positive statements out of ambiguous verbal information. We administered the task during eye tracking in order to simultaneously assess attention biases (Everaert et al., 2014), but these data are reported elsewhere (Sfärlea et al., 2019).

Stimuli. The stimuli consisted of 70 scrambled sentences: 42 emotional sentences (e.g., "total I winner a loser am") and 28 neutral sentences (e.g., "like watching funny I exciting movies"). The emotional sentences were based on the original stimulus set developed by Wenzlaff and Bates (1998) which was translated into German (Rohrbacher, 2016), adapted, and extended. All sentences contained six words and had two possible solutions. In emotional trials, one solution was positive

[8] One HR girl met criteria for enuresis in the past. However, as she did not report symptoms of any other mental disorder she was included nonetheless.

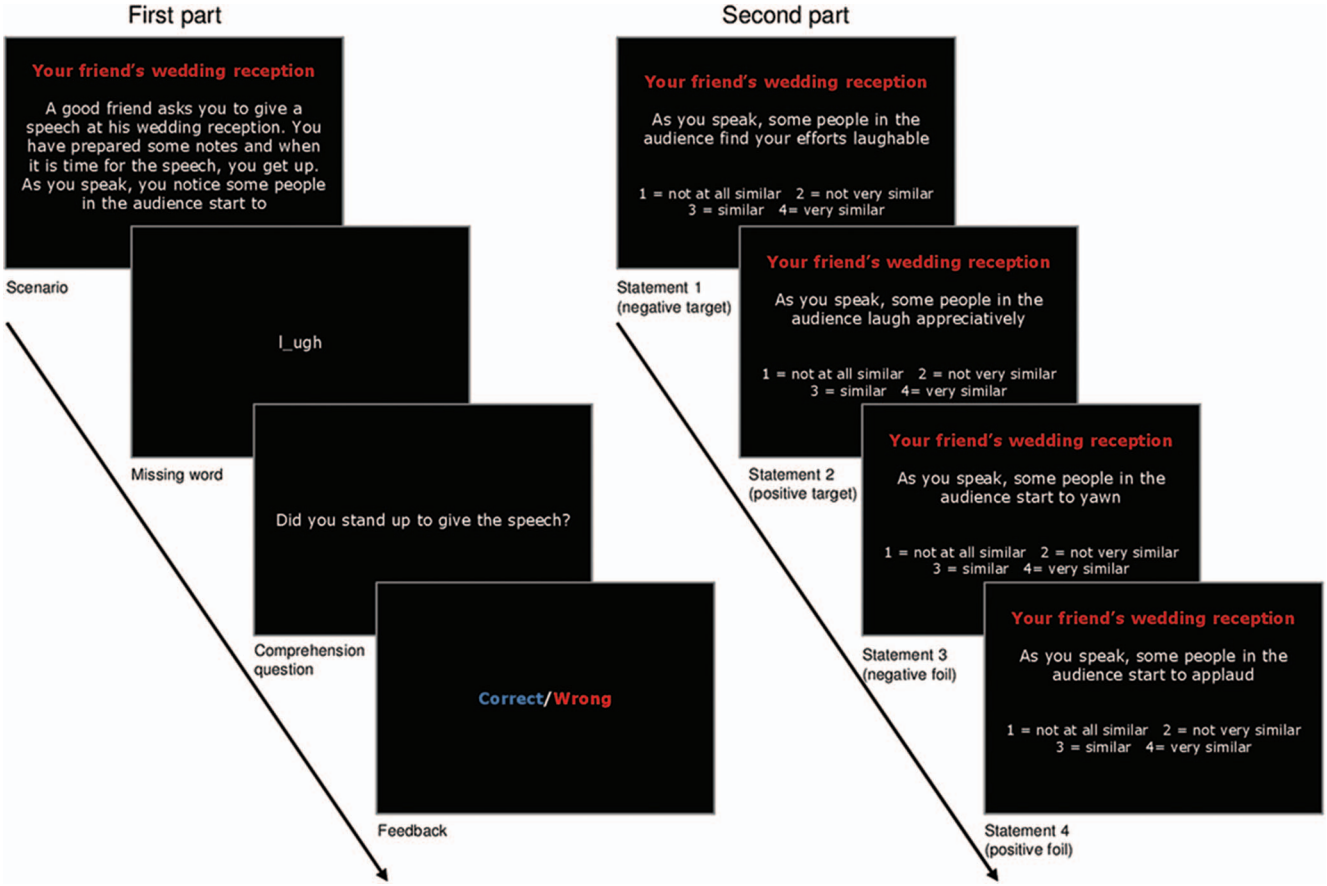

Figure 1. Example adult scenario from the Ambiguous Scenarios Task (AST; Mathews & Mackintosh, 2000). See the online article for the color version of this figure.

(e.g., "I am a total winner") whereas the other was negative (e.g., "I am a total loser"). In neutral trials both solutions were emotionally neutral. See Supplement 4 in the online supplemental materials for details and an English translation of the sentences. Whereas parents completed all 70 trials, children completed 50 trials (30 emotional, 20 neutral). Sentences that were easily understandable and relevant to children were chosen and adapted.

Task procedure. Figure 2 depicts the trial procedure. The experiment was presented using SR Research Experiment Builder 1.10 (SR Research Ltd., 2013). Each trial started with a fixation cross presented for 500 ms on the left side of the screen. This was followed by a stimulus display consisting of six words in scrambled order presented at the center of the screen on a single line. Participants were instructed to read the words and mentally form a grammatically correct five-word sentence as quickly as possible and to click on the mouse button as soon as they did so to continue to the response part of the trial. The scrambled sentence was presented for a maximum of 8,000 ms, if no mouse click occurred during that time the response part was omitted and the next trial began. In the response part five boxes appeared below the scrambled sentence and participants were required to build the sentence

Figure 2. Example of an emotional trial of the Scrambled Sentences Task (SST; Everaert et al, 2014; Wenzlaff & Bates, 1998).

they had mentally formed by ordering the words into the five boxes by mouse click.

Trials were randomly divided into seven or five blocks of 10 (each containing six emotional and four neutral trials presented in random order) for the parents and children. Before the first block participants completed five practice trials to familiarize themselves with the task.

Similar to earlier studies (e.g., Everaert et al., 2014) a cognitive load procedure was included to prevent deliberate response strategies. Before each block, a six-digit number was presented to parents and a four-digit number was presented to children for 5,000 ms. Participants were instructed to memorize the number in order to recall it at the end of the block.

Data processing and outcome variables. Participants' responses were rated as correct or incorrect. Trials in which no grammatically correct sentence was built (time out or incorrect sentence) were excluded from the analysis. Participants with a correct sentence rate of two standard deviations below the mean of parents or children were identified as outliers in terms of accuracy and excluded (1 ND parent, 2 HR children; see Supplement 4 in the online supplemental materials for details).

The correctly unscrambled emotional sentences were categorized as either positive or negative. An interpretation bias score (IB_{SST}) was calculated as the proportion of negatively resolved sentences from the total number of correctly resolved emotional sentences (Everaert et al., 2014).

Reliability. Split-half reliability of the SST was calculated analogous to the AST and was acceptable in children ($r = .53$; $p < .001$) and good in parents ($r = .78$; $p < .001$).

Self-Report Measures

Depressive symptoms. German versions of the Beck Depression Inventory-II (BDI-II; Hautzinger, Keller, & Kühner, 2006) and the Children's Depression Inventory (DIKJ; Stiensmeier-Pelster, Braune-Krickau, Schürmann, & Duda, 2014) were administered to assess depressive symptoms in parents and children. Reliability was good in our sample (BDI-II: Cronbach's alpha = .92; DIKJ: Cronbach's alpha = .83).

Anxiety. Anxiety was measured by the trait scales of the German versions of the State Trait Anxiety Inventory (STAI; Laux, Glanzmann, Schaffner, & Spielberger, 1981) in parents and the State Trait Anxiety Inventory for Children (STAIC; Unnewehr, Joormann, Schneider, & Margraf, 1992) in children. Reliability in our sample was good (STAI-T: Cronbach's alpha = .94; STAIC-T: Cronbach's alpha = .86).

Experiment Procedure

The current experiment was part of a larger project which also included tasks assessing attention biases (Platt, 2017). Children and parents were tested simultaneously, with tasks presented in random order. The course of the experimental session is depicted in Supplement 5 in the online supplemental materials.

A mood induction procedure was administered twice during the experimental session: Participants watched a 2 min scene from the movie *The Lion King* (Hahn, Allers, & Minkoff, 1994) that successfully induced unpleasant mood in adults and children in earlier studies (Bruyneel et al., 2013; von Leupoldt et al., 2007) as well as ours (details presented in Supplements 5 and 6 in the online supplemental materials).

Data Analysis

Statistical data analysis was conducted with SPSS 24. *T*-tests were conducted to compare the interpretation bias scores (IB_{AST} and IB_{SST}) between the groups of children and between the groups of parents. For the AST, similar *t*-tests were conducted for the foil ratio. To assess relationships between psychopathology and interpretation bias, correlations were calculated between bias scores and depression and anxiety scores. To investigate transgenerational relationships, correlations between children's bias scores and their parents' bias scores were computed. Furthermore, correlations between IB_{AST} and IB_{SST} were computed in children and parent samples to examine if interpretation bias scores from the two tasks were related.

In order to rule out that group differences between HD and ND parents were driven by parents currently experiencing an episode of depression, analyses were repeated excluding the currently depressed parents (Supplement 7 in the online supplemental materials). As this did not change the pattern of results, we report results based on the whole parent sample.

Results

Bias scores for each group are presented in Table 2.

AST

Mean IB_{AST} scores as well as foil ratios were > 1, indicating that no group showed a negative bias. *T*-tests for IB_{AST} and foil ratio revealed no significant differences between HR and LR children or HD and ND parents ($ts \leq 1.6$; $ps > .1$). No significant correlations between IB_{AST} score and depression or anxiety scores were found in children or parents ($rs \leq .08$; $ps > .1$).

However, the children's IB_{AST} scores were positively correlated with their parents' IB_{AST} scores ($r = .46$; $p < .001$).

SST

T-tests revealed a significant difference between HR and LR children ($t_{71.9} = 2.4$; $p = .021$; $d = .60$), reflecting more negative interpretations in the HR than the LR group. Furthermore, strong positive correlations between children's IB_{SST} scores and depressive symptoms ($r = .56$; $p < .001$) as well as anxiety scores ($r = .41$; $p < .001$) emerged.

Table 2
Interpretation Bias Scores

	Children		Parents	
Variable	HR	LR	HD	ND
IB_{AST}, *M* (*SD*)	1.3 (0.5)	1.1 (0.4)	1.4 (0.5)	1.3 (0.4)
IB_{SST}, *M* (*SD*)	.15 (.13)	.08 (.10)	.23 (.16)	.07 (.09)

Note. HR = high risk; LR = low risk; HD = history of depression; ND = never depressed; IB_{AST} = interpretation bias score from the Ambiguous Scenarios Task; IB_{SST} = interpretation bias score from the Scrambled Sentences Task.

For the parents, *t*-tests revealed a significant difference between HD and ND groups ($t_{64.2} = 5.1$; $p < .001$; $d = 1.23$), reflecting more negative interpretations in the HD versus ND group. Strong positive correlations between parents' IB_{SST} scores and depressive symptoms ($r = .75$; $p < .001$) as well as anxiety scores ($r = .71$; $p < .001$) emerged.

No significant correlation between child IB_{SST} and parent IB_{SST} was found ($r = .11$; $p > .1$).

Additional analysis. As we found the IB_{SST} score to differ as a function of group and to be strongly related to depression and anxiety scores, an additional hierarchical regression analysis was performed on the children's data to assess which of these variables explained most variance of the bias score. In a first step, group was included as the only predictor; in a second step children's depression and anxiety scores were added. The analysis revealed that group accounted for a significant proportion of variance in bias scores ($F_{1,72} = 4.6$; $p = .035$; $R^2 = .06$), but that adding depression and anxiety scores significantly increased the amount of variance explained ($F_{3,70} = 12.0$; $p < .001$; $R^2 = .34$; $\Delta R^2 = .28$; $p < .001$). Depression scores were the strongest predictor while the contribution of group was reduced to a trend in the second step (Table 3). Anxiety, on the contrary, made no significant contribution to the model.

Relationship Between AST and SST

No significant correlation between IB_{AST} and IB_{SST} emerged for children or parent samples ($rs \leq .13$; $ps > .1$).

Discussion

The present study investigated the role of interpretation biases in the transgenerational transmission of depression risk by examining interpretation biases in the offspring of parents with a history of depression compared to the offspring of psychiatrically healthy parents, as well as in the parents themselves. We used two experimental measures of interpretation bias which yielded different results: One task (SST) revealed a more negative interpretation bias in both parents with a history of depression and their children in comparison to never-depressed parents and their children, as well as strong correlations between bias scores and depression and anxiety scores in children and parents. In the other task (AST), no group differences or correlations with measures of psychopathology were found. However, there was a strong relationship between children's and parents' bias scores. We first discuss the results regarding the three aims of the study, followed by considerations about the diverging results of the two tasks.

The main aim was to test the hypothesis that children of parents with a history of depression show more negative interpretation biases compared to children of never-depressed parents. In line with our expectation, we found children of depressed parents to draw more negative interpretations of ambiguous information, that is, to show a more negative interpretation bias (assessed with the SST) than children of never-depressed parents.[9] This extends the results of the only prior study investigating interpretation biases in children of parents with depression (Dearing & Gotlib, 2009) in showing that negative interpretation biases characterize both sons and daughters of depressed mothers as well as fathers. The presence of interpretation biases in children at risk for depression suggests that these biases are not merely a correlate or a consequence of a depressive episode (as we included only psychiatrically healthy children with no history of depression or other mental disorders) but are already present in at-risk populations before onset of the disorder, possibly representing a vulnerability factor that contributes to the development of depression (as suggested by theoretical models; e.g., Beck, 2008). Yet, the predictive value of interpretation biases in prospectively predicting the onset of an episode of major depression in at-risk youth has not been addressed in the present study and remains subject to future research.

The bias score was strongly positively related to depressive symptoms in the children, replicating previous results in youth with depression (Micco et al., 2014) as well as unselected samples of children and adolescents (e.g., Klein et al., 2018; Orchard, Pass, & Reynolds, 2016). An additional analysis revealed that, in fact, children's depressive symptoms were a stronger predictor of their bias score than group membership (i.e., history of parental psychopathology). Yet, no conclusions about causality can be drawn, as only longitudinal studies would allow us to examine if interpretation biases (that are influenced by parental depression) foster depressive symptoms in children or if their depressive symptoms give rise to cognitive biases. The relationship between bias scores and anxiety scores was also strong (not surprisingly; Stuijfzand et al., 2018), but the additional analysis indicated that this is most likely a result of the overlap of depression and anxiety scores.

However, we did not find evidence for negative interpretation biases as measured with the AST: in contrast to our expectations, neither group differences between youth with a high or low risk for depression, nor relationships between interpretation bias scores and symptoms of depression or anxiety emerged.

An additional aim of the study was to replicate the results on interpretation biases in adults with a history of depression (see Everaert et al., 2017). As expected, parents with a history of depression showed a more negative interpretation bias (assessed with the SST but not the AST) than never-depressed parents.[10]

Table 3
Results of the Additional Linear Regression Analysis Predicting Children's IB_{SST} as a Function of Group Membership and Psychopathology

Predictor	*B*	*SE* for *B*	95 % CI for *B*	β	*t*	*p*
Step 1						
Group	.06	.03	[.00, .11]	.25	2.1	.035
Step 2						
Group	.04	.02	[−.01, .08]	.17	1.7	.090
Depression symptoms	.01	.00	[.01, .02]	.56	3.7	.001
Anxiety	−.00	.00	[−.01, .01]	−.04	<1	*n.s.*

Note. IB_{SST} = interpretation bias score from the Scrambled Sentences Task; CI = confidence interval; *n.s.* = not significant.

[9] Although the majority of sentences were unscrambled in a positive way by both groups (85% vs. 92%).

[10] Similarly to the children, parents unscrambled the majority of sentences in a positive way (77% vs. 93%), which is in accordance with prior studies in remitted samples (e.g., Hedlund & Rude, 1995; Watkins & Moulds, 2007).

This bias score was strongly positively related to their depression and anxiety scores. Importantly, these results were not driven by the currently depressed adults in our parent sample, as the pattern of results remained the same when those were excluded (see Supplement 7 in the online supplemental materials). This result adds to the body of literature on interpretation biases in remitted depression (e.g., Hedlund & Rude, 1995; Romero, Sanchez, & Vazquez, 2014), underlining that interpretation biases are not a correlate of a current depressive episode but rather an underlying vulnerability that persists after remission of depressive symptoms (Everaert et al., 2017).

The third aim was to examine the relationship between interpretation biases in children and their parents, addressing the transgenerational transmission of interpretation biases. For interpretation bias assessed with the SST, we found no relationship between children's and parents' bias scores. However, for interpretation bias assessed with the AST, we found a strong positive relationship between children's and parents' bias scores, that is, the more negative a parent's IB_{AST} was, the more negative the child's IB_{AST} was (see below for a discussion of this divergence).

The result that interpretation bias scores from the two tasks were not related in children or parents together with the diverging results of the two tasks lead us to the assumption that the AST and the SST might capture differing aspects of interpretation: The time constraint and the cognitive load procedure render the SST more cognitively demanding, leaving less resources for volitional control and deliberate response strategies, and therefore capturing a more automatic and implicit aspect of interpretation of ambiguous information. The AST, on the contrary, allows for more reasoning and might therefore be more prone to problems typical for self-report measures, resulting in answers being influenced by demand characteristics, response biases, and deliberate response strategies (e.g., Gotlib & Joormann, 2010). Hence, the AST might measure an aspect of interpretation that is more conscious and less automatic than that measured by the SST. This assumption is in line with several studies arguing that measurement techniques which reduce participants' volitional control may enhance observation of negative processing (e.g., Rude, Valdez, Odom, & Ebrahimi, 2003): when a cognitive load procedure was included in the SST, a more negative bias was found to characterize not only currently but also formerly depressed individuals (e.g., Watkins & Moulds, 2007; Wenzlaff & Bates, 1998) and to prospectively predict depression (Rude et al., 2003), presumably by interfering with volitional attempts to suppress negative interpretation (e.g., Rude et al., 2003). Only the more implicit interpretation bias measure differentiating between groups and correlating with depressive symptoms suggests that implicit, automatic interpretations of ambiguous emotional information might be a more valid indicator of depressive processing than reflected, conscious interpretations.

Considering this, our observation of a correlation between children's and parents' bias scores emerging from the AST but not the SST suggests that implicit interpretation biases are not subject to transgenerational transmission but that a more conscious aspect of interpretation might be passed on from parents to their children. It could be speculated that this might be less of an automatic transmission but something children consciously learn from their parents (comparable to other cognitive vulnerabilities; Alloy et al., 2001), although this aspect of interpretation did not seem to be a valid indicator of depressive processing. However, it is also possible that the correlation between children's and parents' AST bias scores is a result of an external factor (e.g., exposure to a stressful environment) influencing conscious interpretations in both child and parent alike, rather than the result of transgenerational transmission or learning. The present study was the first to investigate relationships between children's and parents' interpretation biases (see Waters et al., 2015 for a comparable approach regarding attention biases) and further studies are needed to explore mechanisms for the transmission of interpretation biases from parents to children, which might be complex and require more sophisticated methodological approaches.

Clinical Implications

The presence of negative interpretation biases in children at risk for depression is highly relevant: as negative interpretation biases have been shown to be successfully modifiable in depressed (LeMoult et al., 2018; Micco et al., 2014) as well as nondepressed (Lothmann et al., 2011) adolescents, these biases could be the target of preventive approaches trying to reduce the impact of cognitive vulnerabilities in children of depressed parents. Modifying cognitive processes using implicit methods in addition to targeting conscious strategies to deal with negative emotions and stressful life events might enhance the efficacy of prevention programs in this high-risk group, whose effects are small and diminish over time (Loechner et al., 2018).

Moreover, we found the more implicit interpretation bias measure (SST) to be a valid indicator of depression-related automatic interpretation biases. The result that HR and LR children did not differ in their depression scores but in their interpretation bias scores suggests that the SST enables the detection of underlying cognitive vulnerabilities in HR children that cannot be detected via questionnaire measures of depressive symptoms. Therefore, the SST might be a useful measure for assessing the extent to which existing interventions are able to change automatic cognitive processes.

Strengths

The present study extends the scarce knowledge about interpretation biases in children at risk for depression holding several strengths. It is the first study to address transgenerational transmission of interpretation biases by assessing biases not only in children but also in their parents and investigating relationships between children's and parents' biases. It extends the results of Dearing and Gotlib (2009) by including both genders of children as well as parents. Furthermore, all participants underwent an extensive diagnostic assessment that also included the second parent in the ND/LR families to ensure that neither of the child's parents had a history of depression or any other psychiatric disorder. Finally, we assessed interpretation biases with two different tasks which both showed acceptable reliability (corresponding to e.g., Micco et al., 2014; Novović, Mihić, Biro, & Tovilović, 2014). The tasks yielded different results, indicating that different measures of interpretation bias

might capture different aspects of interpretation, an issue which Everaert et al. (2017) pointed out as especially important to investigate.

Limitations

One limitation of the present study is its sample size: larger samples would be preferable as they hold more statistical power and would allow more confidence in the replicability of our results. Thus, replication studies need to be run in larger samples which would also enable the examination of additional aspects (e.g., interactions between group and gender). Moreover, due to the cross-sectional design of the study we cannot determine whether the more negative interpretation bias predicts the onset of an episode of major depression in the at-risk group, that is, acts as a risk factor; prospective research is necessary to address this important question.

Furthermore, it remains unknown if group differences are also present during baseline mood (as interpretation biases were only assessed following a negative mood induction) and if the cognitive load procedure included in the SST was essential for observing negative interpretation biases in the study population or not. Future studies should address these possibilities as they have important implications for the theoretical model of cognitive vulnerability for depression.

In addition, even though we found split-half reliability for the two experimental tasks to be at least acceptable, we cannot provide data on other psychometric properties. Future studies should further explore reliability and validity of tasks assessing cognitive biases and attempt to improve them accordingly, in order to enable the assessment of cognitive biases with less error.

Finally, it has to be noted that a considerable proportion of the HD/HR families were recruited through an ongoing study evaluating a family based prevention program to prevent the development of depression in children of parents with a history of depression (Platt et al., 2014). Therefore, our HD/HR dyads might not be entirely representative of families affected by depression (Loechner et al., 2018; Spoth & Redmond, 2000) in that the children might be less vulnerable to depression than the average offspring of depressed parents, not only due to having received the prevention program (that addressed, e.g., positive thinking and reappraisal of stressful situations) but also due to having parents that were willing to concern themselves with the elevated risk of their children and able to take part in a time-consuming and potentially stressful activity despite their depressive disorder (Pihkala & Johansson, 2008). Considering this, differences between children of depressed and nondepressed parents are likely to be underestimated in our study and might be stronger in the general population.[11]

Conclusion

The present study provides evidence for the presence of negative interpretation biases in children at risk for depression but longitudinal studies are needed to investigate to what extent these biases act as risk factors. Furthermore, different measures of interpretation bias were found to capture different aspects of biased processing with the more implicit measure being a more valid indicator of depressive processing. The results have important clinical implications for the improvement of preventive interventions and the assessment of intervention effects.

[11] Indeed, analyses excluding the 10 families that had already participated in the prevention trial before taking part in the present study yielded a larger effect size ($d = 0.67$) for the difference between HR and LR children.

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